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THE UNIVERSITY OF KANSAS
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The Effect of Radiation from Intraperitoneally Injected Radium Chloride Upon the Hemopoietic Activity of the Bone Marrow in Albino Rats *

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INTRODUCTION

In the major portion of experiments in the past, radiation of the bone marrow has been accomplished by an external source, X-rays or gamma-rays in most cases. The literature relating to the effect of roentgen rays on the blood-forming organs is extensive and contradictory. The lack of unanimity among various reports may be attributed in part to differences in the experimental conditions in regard to radiation technique, the experimental animals used, and the time interval between radiation and examination of tissues.

Previous investigations of the effect of ionizing radiation on bone marrow, using radium as the internal source of radiation, were conducted over varying periods of time from a minimum of a few months to a maximum of several years duration. The results obtained after a few months of low dosage internal radiation are general hyperplasia of the erythrocytic tissue (Sabin, Doan, and Forkner, '32). Continued exposure over a longer period of time produces hyperplasia of granulocytic tissue and hypoplasia of the erythrocytic tissue (Rosenthal and Grace, '36). After an even longer time, however, radium causes the marrow to lose its ability to produce either erythrogenic or granulogenic tissue (Martland, '31).

The present experiment is an investigation of the effects of radium chloride on the hemopoietic activity of the cells of the bone marrow after exposure of short duration. In addition the effects of varying dosage are reported.

* This investigation was carried out under contract with the Office of the Surgeon General, U. S. Army, Research Contract, No. W49-007-MD 466.

† Paul G. Roofe, Hal G. Bingham, Department of Anatomy, University of Kansas, Lawrence, Kansas.

Following intraperitoneal injection of radium, elimination is rapid during the first three days. The rate decreases and becomes essentially zero after fifteen to twenty days. Since the alpha particle penetrates about 25μ in tissue, the maximum damage occurs during the first two or three days when the radium is still found in the circulating blood. Approximately thirty percent of the injected radium chloride is permanently retained in the bone matrix proper (Hoecker and Roofe, '49). When radioactive material is fixed in the bone, it is eliminated very slowly and the major portion remains as a source of alpha particle radiation.

METHODS AND MATERIALS

Thirty-two Sprague-Dawley male albino rats were used. All animals used were young adults and approximately the same weight. Seven of these were untreated controls to establish the normal bone marrow picture. Twenty-five animals were divided into five groups of five. The first group received 10μg of intraperitoneally injected $RaCl_2$ and each successive group received an increase of 10μg, so that groups receiving 10, 20, 30, 40, and 50μg of $RaCl_2$ were obtained. An animal from each group was sacrificed on the third day after injection; and one from each group was sacrificed at three-day intervals thereafter.

After the rats were anesthetized with sodium nembutal the femurs were quickly removed. The method of Mayer and Ruzicka ('45) was found to yield well-preserved pencils of marrow without previous decalcification. The marrow was fixed in Zenker-formol, imbedded in paraffin and sectioned serially at 8 micra. Sections were stained with hematoxylin-eosin-$azure_{II}$.

The bone marrow cell count was made with the aid of a camera lucida which projected a calibrated area onto especially printed sheets for recording the various cell types. The results of these counts were converted into number of cells per mm^3 to make comparison possible with other hemopoietic organs and peripheral blood. Twelve sections were chosen from each tissue so that the entire bone marrow was adequately sampled. Six fields or foci of cell concentration were counted on each of these bone marrow sections. An eosinophil field, a neutrophil field, an erythroid field, and two myeloiderythroid fields 50×50 micra were counted under oil immersion. A megakaryocyte field 500×500 micra was counted under low power.

In most cases the Maximow and Bloom ('42) terminology and method of cell identification were used. The various cell types in the neutrophil and eosinophil series were readily identified by the presence of their characteristic cytoplasmic granules. In addition the myeloid and erythroid series were not difficult to distinguish. However, the maturing cell forms within these series were difficult to distinguish from each other. To avoid this problem the promyelocyte and myelocyte forms of the myeloid series were grouped together as immature cells and the metamyelocyte and adult cells were counted as separate cell types. In the erythroid series two cell forms were distinguished, the erythroblast and the normoblast. The term erythroblast includes all the immature erythroid elements up to the cell form containing hemoglobin in its cytoplasm. The term normoblast includes all those cells with hemoglobin in their cytoplasm and maturing cell forms up to the adult red blood cell.

The other bone marrow cells were also identified and named by the Maximow and Bloom ('42) terminology. However, plasma cells, lymphocytes and basophils were found with such low frequency that they proved to be of little consequence in this study and were not included in the results.

In order to determine what the effects of the radiation were on the peripheral blood of the experimental animals, counts were made on the peripheral blood by other workers in this laboratory. The blood for the peripheral count was taken from the tail of the rats just before sacrifice and standard methods of counting were carried out.

RESULTS

Table I shows the mean and range of each hemopoietic cell type in mm^3 found in both the non-injected control animals and the 25 experimentals. The 25 experimental animals are represented in the table as five groups of five animals. The mean and the range of each group pertain to those five animals sacrificed on the same day. Each animal in the group of five received a different dose of $RaCl_2$ ranging from $10\mu g$ to $50\mu g$.

Statistical analysis of the material in Table I is not included in this paper. Superimposed on the variation due to the smallness of the sample and due to the difficulty in identifying the cells, was the great variability of the individual animals in response to the treatment. As a consequence, the range of the cell counts is great in many cases.

The data were plotted in the following manner: In each graph the ordinate represents the number of cells and the absissa represents time. The points on the vertical lines represent counts for individual animals with different doses killed on the same day. The curve represents the mean cell count of each day.

A. Granulocyte Series

As can be seen in Table I, the counts of the immature neutrophils for the experimental animals fall within the normal range. Because of the extreme variation in both control and experimental animals, it is not possible to tell if any change has occurred. On the other hand, the metamyelocyte and adult cell forms exhibit an incidence above normal with increase in time (Figures 1 and 2).

The trend of the count of the three cell types in the eosinophil series is to increase above normal as is shown in figures 3, 4, and 5. One of the 12 day animals gave exceptionally high counts for each of the cell types. These three values are indicated on the graphs, and were also included in the calculations of the means. All eosinophil cell types demonstrate a trend similar to that of the developing neutrophil cells in that they generally increase in number with time. Furthermore the adult forms of both series appear to reach a maximum at about the 12th day.

B. Erythroid Series

The cell counts for both erythroblasts and normoblasts drop below normal initially, then rise back to normal by the 14th day (Figures 6 and 7).

C. Other Bone Marrow Cells

Reticular cells. The cell count shows an initial rise, with a return to normal by the 9th to 12th days (Fig. 10). On the 14th day the count is again above normal.

Hemocytoblasts. It can be seen in figure 11, that the cell count is generally above normal and tends to increase with longer time.

Megakaryocytes. The cell number decreases reaching minimum values on the 9th and 12th days but returns to normal by the 14th day (Fig. 12).

D. Peripheral Blood

Megakaryocytes are compared with peripheral platelets in figure 12. The platelets show the same trend as the megakaryocytes but demonstrate the initial decrease and subsequent increase in count later than the megakaryocytes. It appears then that the platelet curve shows about a 3 day time lag when compared with the megakaryocyte curve. This observation has been published in a paper by Roofe, Bingham, and Comer ('51) and is discussed more extensively there.

The peripheral polymorphonuclear leukocyte count is considerably decreased from normal and remains that way for the duration of the experiment.

The peripheral red blood cell count did not show much variation from normal.

E. DOSAGE EFFECTS

In general the effects with increasing dose were comparable to the changes obtained with increase in time. However, it was evident that in most cases time was the important factor in determining the response to the injected radium.

The one apparent exception to this was the case of the erythroblasts and normoblasts. As figures 8 and 9 show, the number of erythroblasts was lowest with the smaller dose, while with increasing dose the counts tended to be more in the normal range. However, the normoblast count decreases with increase in dose. (The normoblast curve is included to show the more expected trend of cell count with increased dose.)

DISCUSSION

In the neutrophil series an increase in the metamyelocyte and adult cell forms was observed. This observation suggests that the rate of maturation of the earlier forms to the more mature forms may be accelerated. Lingley, Gall, and Hilcken ('40) also observed a similar trend in their studies with roentgen radiation. However, Martland ('31) and Rosenthal and Grace ('36), in experiments of longer duration than those discussed here, found that with radiation from radium the immature cells constituted the majority of the neutrophils. As has already been shown it is impossible to determine what, if any, trend has been established in the immature cells in this experiment.

In the case of the eosinophils, an accelerated maturation of immature cells forms similar to that in the neutrophil series is suggested by the results. Also an increased proliferation of the immature cell forms probably occurred, since all cell forms of this series increased to above normal incidence with increase in time and in dosage. Isaacs ('32) also found an increase in the number of eosinophils following roentgen radiation, as did Rosenthal and Grace ('36) with radium. Martland ('31) found that the only cell of the granulocytic series which proceeded to maturation was the eosinophilic myelocytes. The observed increase in the number of immature cells in the eosinophil series is in disagreement with the observations of Osgood ('42) and Osgood, Albersold, Erf, and Packham ('42), who found that roentgen radiation inhibited mitotic division of all progranulocytes, which would be expected to decrease the production of all cell forms. However in this case larger dosages and longer duration were involved.

The peripheral polymorphonuclear leucocyte count dropped considerably below normal and remained there throughout the experiment. This suggests that some mechanism associated with irradiation causes the mature granulocytes to be retained in the bone marrow. Dunlop ('42), who worked with roentgen rays, also found an increased bone marrow neutrophil count with a concomittant decreased peripheral polymorphonuclear leucocyte count. Martland ('31) and Jacobson, Marks, and Lorenz ('49), using radium, observed a reduction in leucocytes in the peripheral blood and Martland ('31) also reported a decrease in the bone marrow neutrophil count.

Both the erythroblast and normoblast show an initial decrease with a return to the normal range at a later time. Rosenthal and Grace ('36) found that continued action of radium inhibited maturation of the erythroblast as evidenced by a slight increase in number of erythroblasts despite a decided decrease in the total marrow erythrocytic elements. In the X-ray studies of Lingley, Gall, and Hilcken ('40), the lowered number of normoblasts was explained as due to an accelerated maturation of this cell into adult red blood cells. The lack of appreciable variation of the peripheral red blood cell count from normal is in agreement with the radon studies of Nemenow and Gurewitsch ('34). On the other hand Dunlop ('42) using roentgen rays and Jacobson, Marks and Lorenz ('49) using $RaCl_2$ found a peripheral anemic condition after a longer period of irradiation.

In regard to dosage the erythroid series showed a different kind of response than did the other bone marrow cells. Although the normoblast cell count is lower in animals that received greater doses, this was not the case with the erythroblasts. The greatest decrease in the number of erythroblasts was found in the animals receiving the lowest dose of radium. Interpretation of this phenomen is beyond the scope of the present experiment.

In the literature the myeloid-erythroid ratio is frequently used as an index of change occurring in the cells of the bone marrow. The value for normal animals found in this experiment was 0.739, which falls in the normal range reported in the literature, 0.500 (Brown, '51)-1.940 (Endicott and Ott, '45). The myeloid-erythroid ratio for the experimental animals was increased to 0.910 on the third day, and to 1.020 on the fourteenth day. Cellular processes of proliferation and maturation were increased more in the myeloid tissue, as has already been shown, leading to a cell count above normal for both the eosinophil and neutrophil series. In the erythroid tissue, however, there was an initial decrease in both cell types with a return to normal with longer time. This observation is not in agreement either with Bauer ('40) or Chien-Liang and Ma ('40) who both worked with roentgen radiation. They found a hyperplasia of the erythroid cells and a hypoplasia of the myeloid cells. However, in both of these cases a larger dose of radiation was employed.

Both the hemocytoblast and reticular cell counts were increased, which is in agreement with the findings of Lingley, Gall and Hilcken ('40). They found that primitive cells in general proliferated more rapidly in animals subjected to roentgen radiation. Warren, MacMillian, and Dixon ('50) using P^{32} as the internal source of radiation found that the stem cells were not injured at any time during their experiment.

The number of megakaryocytes was found to be below normal and remained that way throughout the duration of the experiment. Dunlop ('42) working with X-rays and Warren, MacMillian and Dixon ('50) using P^{32} also found that megakaryocytes were reduced in number. The relationship between the megakaryocyte and peripheral platelet curves is in agreement with the theory that the megakaryocytes fragment to become platelets. Three days pass before the peripheral platelets show any change in number resulting from the initial megakaryocyte decrease, indicating that they possibly survive this length of time in the peripheral blood after entering it. The newly produced megakaryocytes apparently do not fragment into platelets for approximately three days after they are produced because the peripheral platelet curve does not show a similar increase in number until this period of time has passed. Jacobson, Marks, and Lorenz ('49) also noted a reduction in the peripheral platelet count after injecting parenterally 0.94μg of radium chloride, but did not correlate this with the megakaryocyte changes in the bone marrow.

The sum total of the various cell responses to the initial irradiation results in a decreased total cell count for the bone marrow and a normal cell count for the peripheral blood. Some bone marrow cells increase while others decrease in number and this is probably due to a change in the rate of proliferation and/or maturation. With increased time the bone marrow cells appear to proliferate and mature rapidly but not to pass into the peripheral circulation, which tends to increase the marrow count and to slightly decrease the peripheral blood count. In contrast to these results, Lingley, Gall, and Hilcken ('40), using roentgen irradiation, observed a secondary or regenerative return of the bone marrow to normal cellular content between the second to fourth weeks, while Warren, MacMillian and Dixon ('50) found that maximum damage occurred at about 10 days with return of myelopoiesis 10 to 15 days after injection of P^{32}.

SUMMARY

Radium chloride emitting chiefly alpha particles was injected intraperitoneally into the albino rats. The $RaCl_2$ is eliminated rapidly from the animals during the first three days after injection so it is mainly found in the circulatory system during that period. Eventually, approximately 30 percent of the injected $RaCl_2$ becomes deposited in the bone tissue. Both the dosage and, more important, the duration of exposure determined the kind of effect obtained. In general, however, dosage effects and duration effects caused the same type of cell responses. These effects are a change in the rate of proliferation of the immature cells and a change in maturation time of the more mature cells. Considering the effects on the different marrow cells separately:

1. Neutrophils and eosinophils. The more mature neutrophils show an acceleration of maturation, but there is neither a decrease nor an increase in the rate of proliferation of the immature forms. The eosinophils follow this same tendency except that their immature cells increase in the rate of proliferation.

2. Erythroid cells. Both the normoblast and erythroblast number decreases initially with a return to the normal range at a later time. However, increase in dosage caused the normoblast to decrease, while the erythroblast decreased initially, it later returned to normal.

3. Myeloid-erythroid ratio. This ratio is increased because the myeloid cells increase above normal and the erythroid cells decrease below normal.

4. Stem cells. The reticular cells and hemocytoblasts show an increased proliferation.

5. Megakaryocytes and platelets. The two curves of these cells are very similar in shape but the platelet curve shows a time lag of about 3 days to the changes occurring in the megakaryocyte curve. This supports the theory that platelets are formed from fragmenting megakaryocytes.

6. Granulocytes and peripheral polymorphonuclear leucocytes, also erythroid cells and peripheral red blood cells. The peripheral blood picture does not indicate adequately the processes occurring in the marrow. The decreased peripheral polymorphonuclear leuco-

cyte count gives no indication of the increased granulocyte production in the marrow, nor does the apparently normal peripheral red blood cell count reflect the initial decrease with later return to normal of the erythroid production in the bone marrow.

7. Total bone marrow and total peripheral blood count. Initially the sum total of the various cell responses to the irradiation causes a total cell decrease in the bone marrow but the total peripheral blood count remains normal. With longer exposure to irradiation the peripheral blood count tends to decrease but the bone marrow count increases. This suggests a greater proliferation and maturation of the marrow cells and a mechanism which prevents the passage of these marrow cells into the periphery.

TABLE I

In Table I the bone marrow hemopoietic cell counts are expressed in mm^3. The numbers listed under "control" represent the mean and range of the cell counts for seven non-injected animals. The numbers listed under each different time interval represent the mean and range of the cell counts of five experimental animals.

	Control	3 Days	6 Days	9 Days	12 Days	14 Days
Neutrophils x 10^4						
Adults	99.2 70.7–123.0	103.4 77.6–125.5	101.1 71.5–119.0	100.9 54.3–124.4	136.9 108.2–169.5	131.1 121.1–147.7
Metamyelocytes	18.1 12.4–22.4	20.6 17.8–23.4	21.6 13.8–26.8	23.0 19.6–25.7	25.6 18.4–37.5	23.4 13.0–35.6
Immatures	7.4 2.7–10.4	5.4 4.6–6.7	4.1 2.5–5.3	5.3 1.8–9.0	6.1 4.0–12.4	5.5 0.90–10.6
Eosinophils x 10^4						
Adults	22.3 16.8–28.8	23.2 11.8–32.9	28.4 16.2–57.5	30.3 22.8–47.8	45.0 31.0–90.0	30.7 25.0–40.8
Metamyelocytes	10.9 8.0–15.0	11.1 7.6–14.8	11.3 6.0–18.8	11.8 9.1–16.3	19.3 9.4–44.8	14.2 6.7–19.3
Immatures	7.8 3.3–11.1	7.0 3.3–11.0	8.7 4.6–12.5	8.6 5.4–12.2	13.0 6.8–28.0	9.9 5.0–12.4
Erythroid cells x 10^5						
Normoblasts	17.9 15.6–20.2	14.0 12.4–16.0	15.2 11.4–19.6	17.6 10.8–21.6	18.6 13.4–25.8	16.3 12.8–19.4
Erythroblasts	4.5 3.1–6.5	4.7 3.3–5.9	3.3 1.9–5.3	4.5 2.6–7.4	4.6 2.9–6.5	4.8 3.1–6.4
Reticular cells x 10^3	14.0 0.0–35.0	50.0 13.0–113.0	40.0 18.0–80.0	21.0 8.0–47.0	16.0 5.0–33.0	37.0 16.0–54.0
Hemocytoblasts x 10^3	54.0 7.0–95.1	79.0 42.0–110.0	88.0 68.0–118.0	87.0 20.0–144.0	91.0 47.0–155.0	96.6 49.0–119.0
Megakaryocytes x 10^3	7.0 5.8–8.3	5.6 3.9–7.3	3.7 3.4–4.5	3.9 2.8–5.3	5.2 3.1–7.0	6.9 4.4–10.8

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PLATE LXVIII

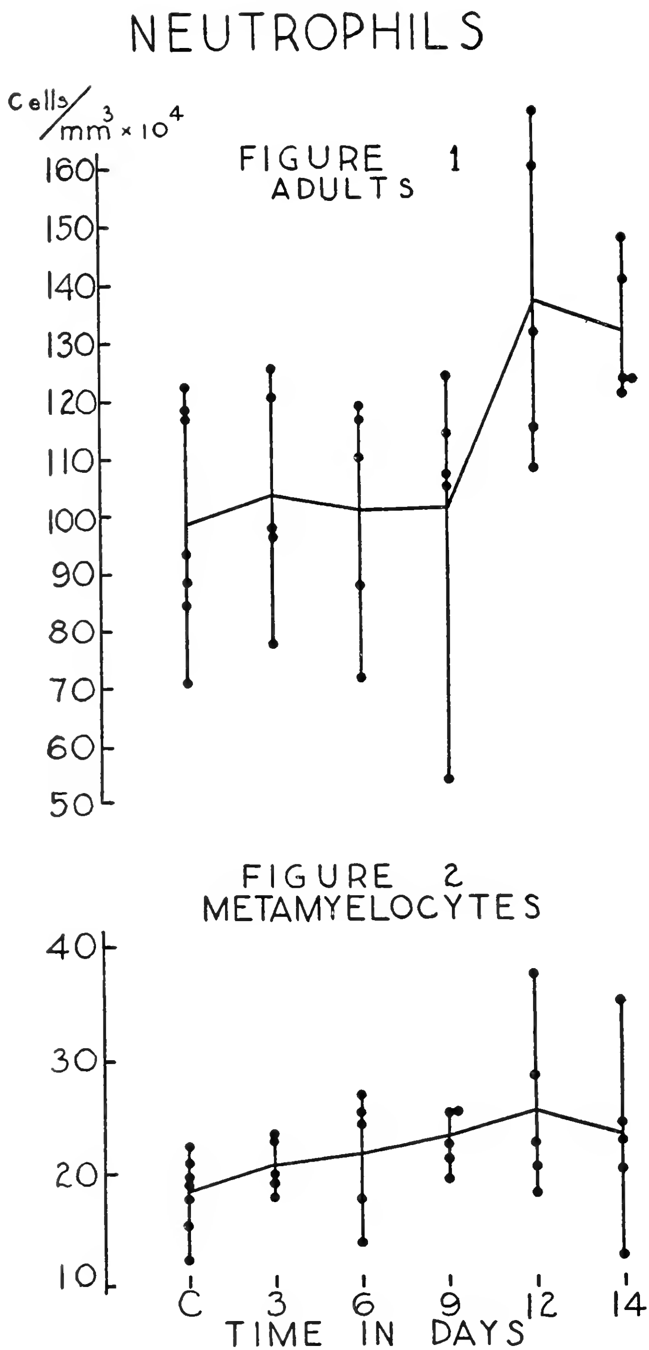


PLATE LXIX

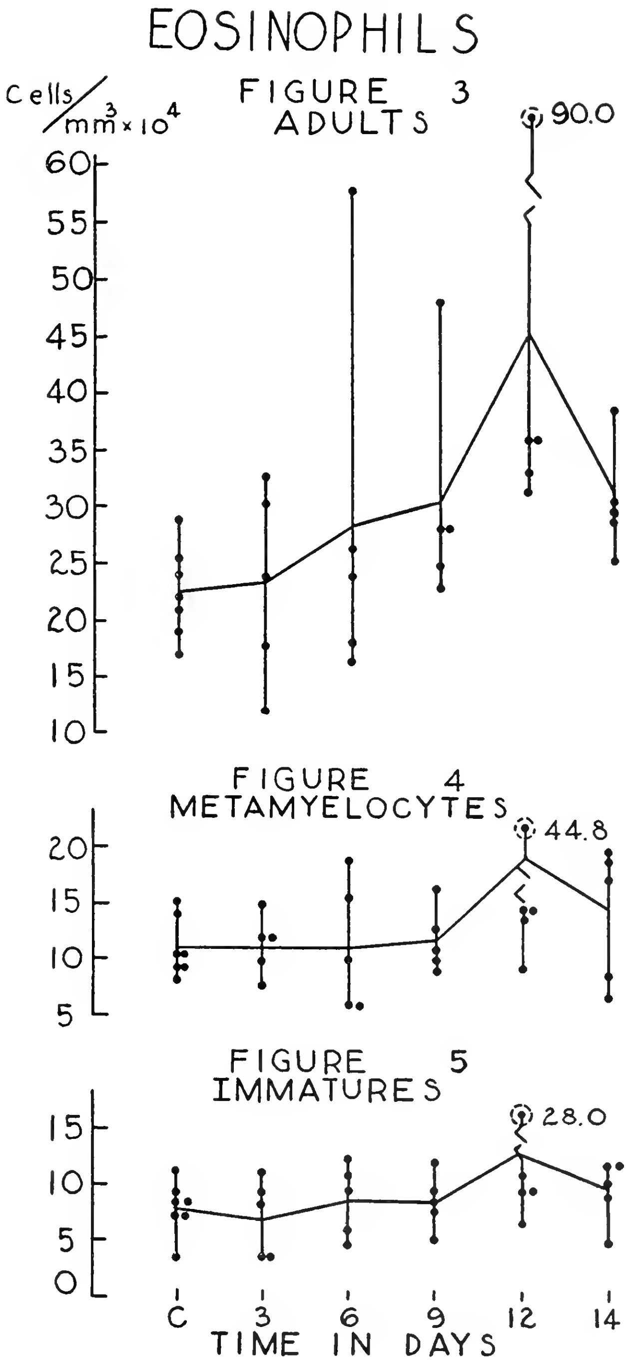

EOSINOPHILS
Cells/mm³ × 10⁴
FIGURE 3
ADULTS
90.0
60
55
50
45
40
35
30
25
20
15
10
FIGURE 4
METAMYELOCYTES
44.8
20
15
10
5
FIGURE 5
IMMATURES
28.0
15
10
5
0
C
3
6
9
12
14
TIME IN DAYS

PLATE LXX

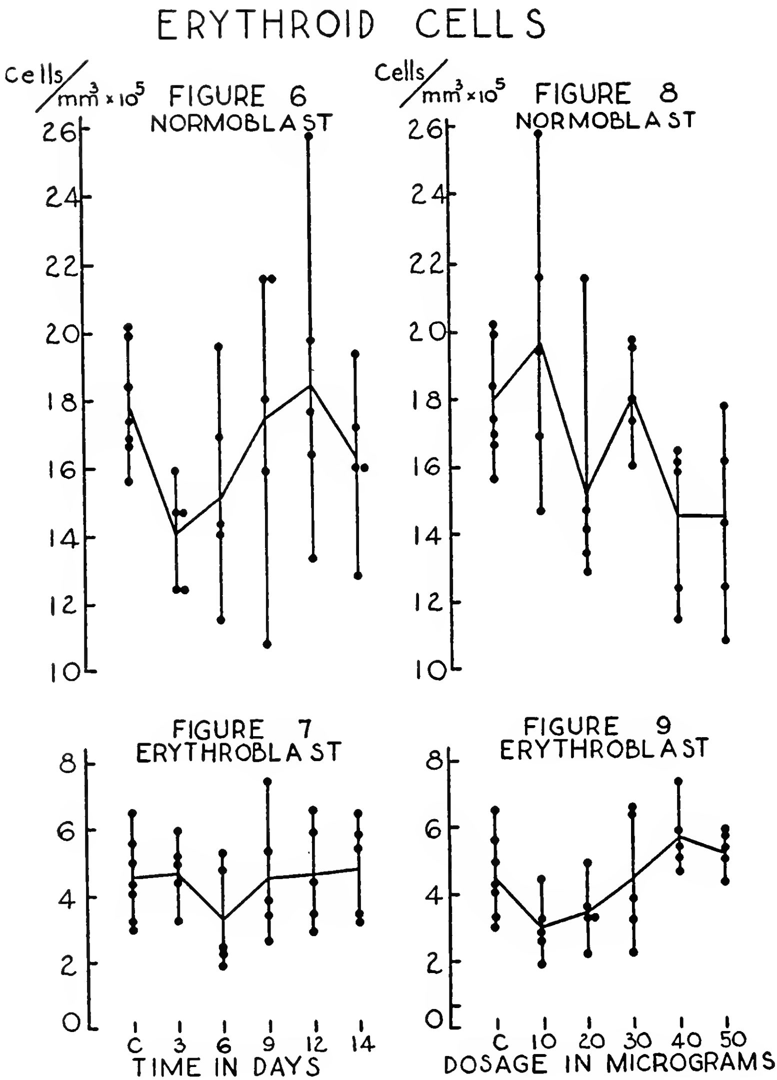

ERYTHROID CELLS
Cells/mm³ × 10⁵
FIGURE 6
NORMOBLAST
26
24
22
20
18
16
14
12
10
Cells/mm³ × 10⁵
FIGURE 8
NORMOBLAST
26
24
22
20
18
16
14
12
10
FIGURE 7
ERYTHROBLAST
8
6
4
2
0
C 3 6 9 12 14
TIME IN DAYS
FIGURE 9
ERYTHROBLAST
8
6
4
2
0
C 10 20 30 40 50
DOSAGE IN MICROGRAMS

PLATE LXXI

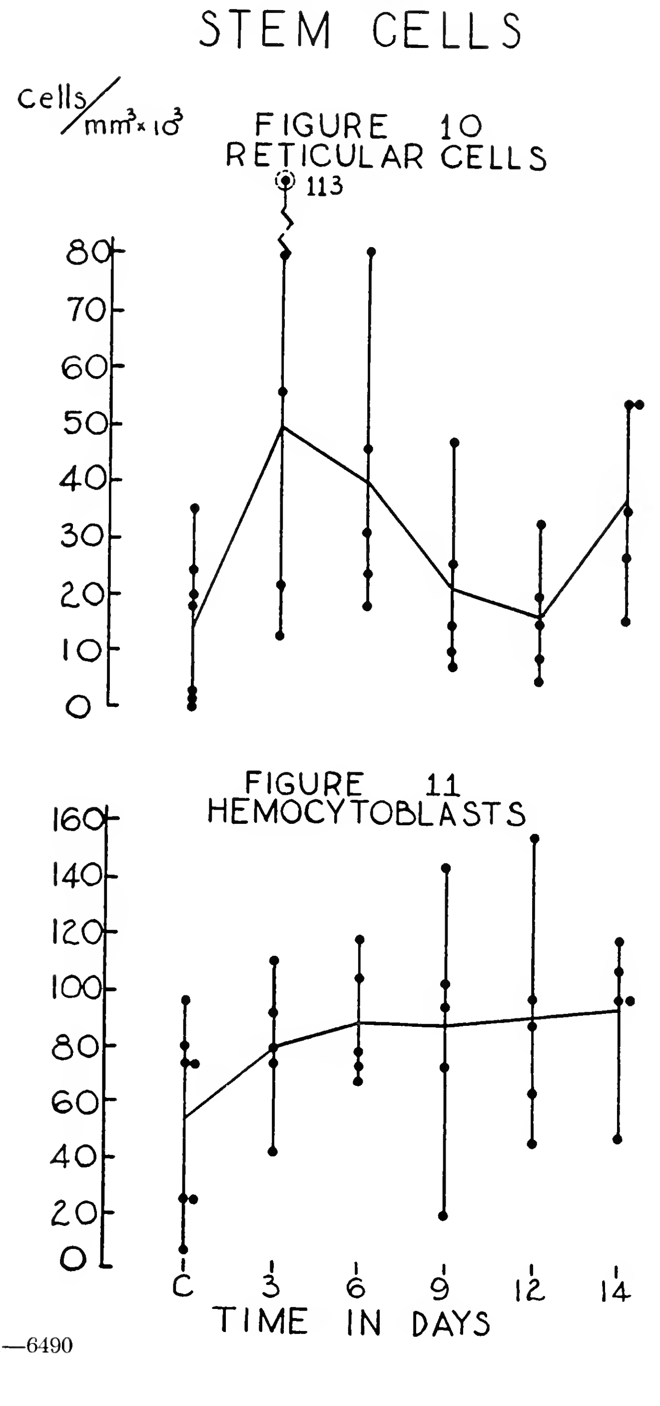
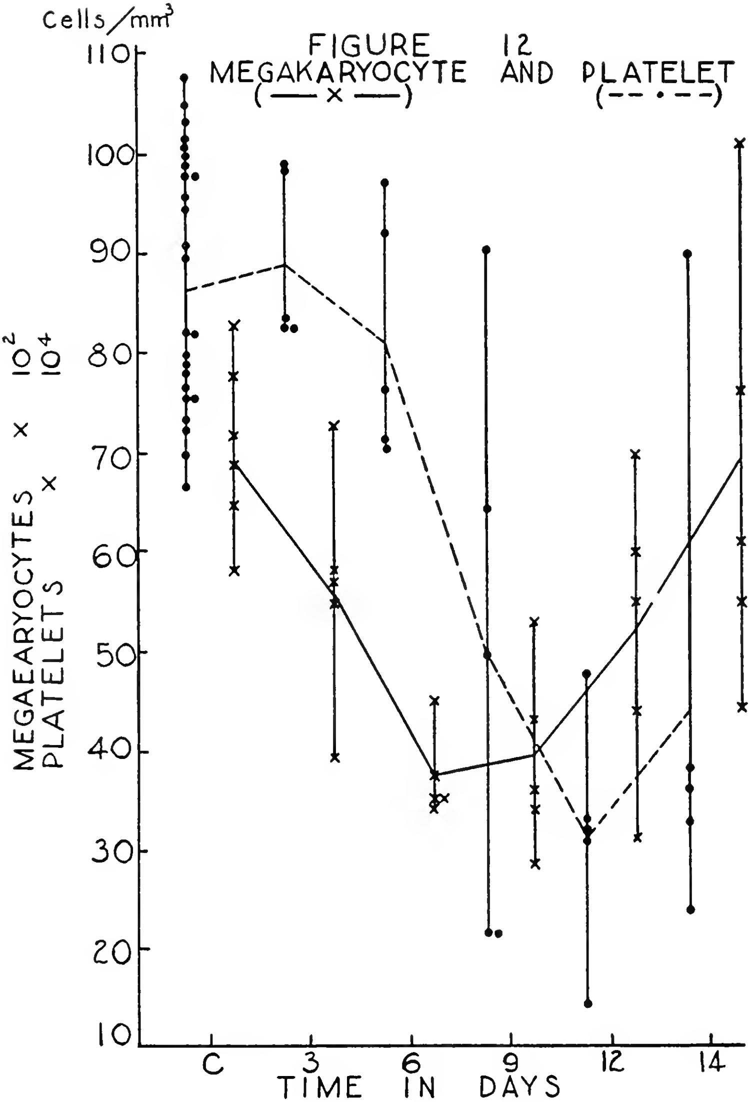

STEM CELLS
Cells/mm³ × 10³
FIGURE 10
RETICULAR CELLS
113
80
70
60
50
40
30
20
10
0
FIGURE 11
HEMOCYTOBLASTS
160
140
120
100
80
60
40
20
0
C
3
6
9
12
14
TIME IN DAYS

PLATE LXXII


Cells/mm³
FIGURE 12
MEGAKARYOCYTE AND PLATELET
(—— x ——)
(- - - • - - -)
MEGAEARYOCYTES × 10²
PLATELETS × 10⁴
110
100
90
80
70
60
50
40
30
20
10
C
3
6
9
12
14
TIME IN DAYS

THE UNIVERSITY OF KANSAS
SCIENCE BULLETIN

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Bees of the Genus Perdita in the Collection of the University of Kansas (Hymenoptera, Apoidea)*

BY

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ABSTRACT: This article is a revisionary study of the bees of the genus *Perdita* Smith, subgenera *Xerophasma, Cockerellula, Macroteropsis, Cockerellia,* and two other un-named groups, in the collection of the University of Kansas. Twenty-one species are treated; of these, eight species are new. Four new subspecies are also described.

This is a first report on a large collection of bees of the genus *Perdita* submitted to the author in the fall of 1950 by Charles Duncan Michener, and collected mostly in the states of Kansas and Texas. Types of new forms will be found in the collection of the University of Kansas, at Lawrence, Kansas.

SUBGENUS XEROPHASMA Cockerell

Perdita bequaertiana Cockerell

Xerophasma bequaerti Cockerell, Amer. Mus. Novitates vol. 66, 1923, p. 2, ♀ (not *Perdita bequaerti* Viereck, 1917).

Perdita bequaertiana Cockerell, *in* Muesebeck, Krombein, and Townes, U. S. Dept. Agri. Monog. No. 2, 1951, p. 1087.

One male, 11 females, Big Springs, Howard Co., Texas, June 20, 1947 (R. H. Beamer).

No flower record accompanies these specimens, but several of the females bear the coarse cobwebby pollen of *Oenothera*.

This is a large pallid bee (very large for the genus *Perdita*), and in the female the ocellar region, usually including the face above level of antennae and the vertex behind ocelli more faintly, may be slightly infuscated. On the abdcmen a pale brownish, or dilute fuscous, preapical crossband, not quite reaching lateral margins, is usually present in tergites 1 to 5. The structural characters have been described rather fully by Cockerell, but one feature not mentioned by him is the fact that the antennae are inserted unusually high on the face or above the middle of the eyes, in which respect members of *Xerophasma* differ from all other *Perdita*. The mouth parts are moderately elongate. Maxillary palpi are long and six-jointed, the first five joints subequal, the sixth somewhat shorter. Labial palpi are about equal to the maxillary pair, the first joint very long, the last three joints each about equaling the apical joint of the maxillary pair.

The male resembles the female except in the primary sexual characters. The only specimen at hand lacks the abdominal banding, and the dark cloud on the head is restricted to the area between the ocelli. Aedeagus composed of a rather large quadrate capsule, about one half longer than wide and somewhat wider than high. Stipites produced ventrally on each side in a slender lobe, which is abruptly bent inward and upward at the extreme tip. Sagittae moderately stout, tapering toward apex, which is narrow and thinly compressed dorsoventrally. Volsellae very large, the inferior pair reaching middle of sagittae and provided with numerous minute black tubercles along the dorsal margin; dorsal volsellae reaching middle of inferior pair. Length of male, about 9 mm.; anterior wing, 7 mm.

This species was described from a female collected about 10 p. m., July 9, 1917, at Fabens, El Paso Co., Texas.

SUBGENUS COCKERELLULA Strand

In 1922 (Amer. Mus. Novitates, vol. 47, pp. 1-4) Cockerell described *Perdita opuntiae* and erected the subgenus *Lutziella* for its reception. Because *Lutziella* Cockerell was preoccupied by *Lutziella* Enderlein, Strand, in 1932 (Folia Zool. Hydrobiol. Riga, vol. 4, p. 196), proposed to rename it *Cockerellula*.

The group *Cockerellula* is similar to *Macrotera* Smith, but differs in having the tongue short and the abdomen of the male modified in various ways, either at the apex or on the ventral surface. It is quite possible that discovery of additional species may reveal that these characters are gradational and only of specific importance, since members of both groups seem to be largely, although not completely, dependent on the pollen of various species of *Opuntia*.

The several species belonging in *Cockerellula* may be distinguished as follows:

1. Males 2
   Females 5
2. Basal ventrite without a median fold 3
   Basal ventrite strongly puckered out in middle of apical margin to form a strong fold, the following ventral segments unmodified 4
3. Second ventrite with a broad thickening on middle of apical margin, this thickening strongly dentate at outer ends; apical tergite very broad, with a slender, almost fingerlike lobe at the apical corners, and evenly truncate between the lobes; head and thorax black or blackish brown, with pale-yellow face marks; abdomen ferruginous; length, about 5.5 mm.; Colorado (White Rocks near Boulder) and South Dakota (Pine Ridge) . . . . *opuntiae* Cockerell
   Second ventrite only slightly thickened at middle of apex, the third ventrite with a strong thickening which is unarmed at outer ends and presents a transverse disk as viewed from behind; apical tergite quadrate, with apical corners slightly dentate, the disk a little concave and produced medially in a rounded angle a little beyond and below the dentiform lateral angles; head and thorax dark blue-green, the face below antennae pale yellow; abdomen ferruginous; length about 4-4.5 mm.; Texas (Big Bend Park) . . *bidenticauda* sp. nov.
4. Tergite 7 extremely broad, transversely quadrate, not at all narrowed to apex, which is truncate and at most with a small median notch; head and thorax dark blue-green, the face below antennae yellowish white, abdomen ferruginous; length, about 4 mm.; Texas (15 miles southeast of Dryden), *laticauda* sp. nov.
   Tergite 7 similar to that of *laticauda* but more convex, distinctly grooved medially and emarginate at apex, thus forming a broad, slightly oblique lobe on each side; head and prothorax brown, the face below antennae pale yellow; thorax otherwise dark blue-green, more or less washed with brown on pleura, sternum, and apical truncation of propodeum; abdomen ferruginous; length, 4-4.5 mm.; Texas (15 miles northwest of Mission) . . . . *lobata* sp. nov.
5. Head and thorax dark green; smaller species 6
   Head and thorax black, the abdomen ferruginous; mesoscutum shining, delicately tessellate and with minute close punctures; length, about 6 mm. . . . . *opuntiae* Cockerell

6. Mesoscutum tessellate but shining, finely punctured, the punctures about two to three puncture widths apart; abdomen ferruginous; length, about 4-4.5 mm. . . . . *bidenticauda* sp. nov.
   Similar to preceding and without good distinguishing characters in the female sex . . . . *laticauda* sp. nov.

Perdita bidenticauda sp. nov.

Allied to *P. opuntiae* Cockerell but distinguished by its smaller size and dark-green color, and by the very small lateroapical teeth of the apical tergite of male.

MALE.—Head and thorax dark green, slightly bluer on metanotum and propodeum and gradually changing to brown on under surface of head and at anterior end of cheeks. Narrow inferior orbits near base of mandibles, mandibles, except the rufous tips, and entire face below level of antennae, pale yellow, with the broad upper margin of lateral marks oblique and reaching upper level of antennal sockets and intruding slightly between the fovea and eye margin on the orbits. Tubercles and anterior margin of pronotum brownish. Abdomen ferruginous red, with only the lateral foveae of second tergite black. Legs black, more brownish at base, the front tarsi and the front tibae, except a brownish line behind, dull yellow. Antennae almost uniformly pale brown. Tegulae pale testaceous yellow. Wings nearly clear hyaline, the nervures brown, the subcosta more fuscous.

Head but little enlarged, broader than long, with the inner orbits slightly diverging below. Mandibles nearly straight, robust, and tapering to the blunt apex which has a small inner tooth. Labrum twice as broad as long. Subantennal plates very small, the lateral plates broad and becoming much broader at anterior ends. Clypeus short and transverse. Frontal foveae about three times as long as wide and well impressed. Cheeks simple and moderately wide. Abdomen moderately broad and depressed. Apex of last tergite rather broad and truncate, the apical corners a little dentiform, the disk slightly concave and medially produced a little beyond and well below level of the dentiform angles; as seen from behind and beneath, the lower apical margin is carinate and forms a broad ogival curve. First segment of venter normal, the second segment slightly, and the third strongly, swollen in middle of apical margin; this swelling elongate-oval as seen from behind, declivous, and with outer ends acute but not at all prominent or dentiform. Marginal cell about one fourth smaller than first submarginal cell, broad and oblique at apex, with the apendiculation of radius distinct and elongate.

First recurrent nervure received near apex of first submarginal cell. Stigma small and very narrow. Head and thorax minutely tessellate and dullish, the disk of mesoscutum more shining than other parts, the mesopleura duller, with the sculpture more lineolate and the basal middle of propodeum comparatively coarsely tessellate. Punctures of frons and mesoscutum minute and close, those of vertex sparser, and those of disk of clypeus coarser and shallow. Mesopleura impunctate except toward the sternum. Abdomen moderately shining. Pubescence whitish, short and sparse, that of abdomen extremely fine and subappressed, but a row of coarse, stiff hairs present across disk of tergite 6, and similar hairs on outer side of hind tibiae. Length, 3.45-4 mm.; anterior wing, 3 mm.

FEMALE.—Dark green, or blue-green, the metanotum and propodeum more bluish, the abdomen ferruginous red. Clypeus, supraclypeal area extending in a triangle well above antennae, and narrow orbital margins of face, black. Labrum brownish. Mandibles testaceous yellow, with rufous tips. Antennae rather dark brown, the flagellum dull yellowish beneath. Legs dark brown, the tarsi paler, the front knees with a small yellowish spot, the spurs reddish. Tegulae brown at base and pale testaceous on outer margin. Wings as in male.

Head as wide as long, the clypeus much larger and more produced than in male. Inner orbits of eyes parallel. Mandibles simple at apex. Frontal foveae about five times longer than wide and deeply impressed. Pygidium of abdomen acute at apex. Hind knee plates distinct. Spurs of middle and hind tibiae slightly hooked at apex and minutely serrate beneath. Claws with a small inner tooth just beyond the middle. Sculpture as in male except as follows: labrum, clypeus, and supraclypeal area with coarse, shallow punctures; frons and vertex with well-separated punctures that are much sparser than those of mesoscutum; abdomen duller, more strongly lineolate than in male, and impunctate. Pubescence as in male, the apical fimbria of abdomen tinged with fuscous. Scopal hairs of hind tibiae sparse and moderately long; those of dorsal margin with minute, close-set, short branches. In comparison with *opuntiae*, the scopal hairs are definitely shorter and sparser. Length about 3.45-4.5 mm.; anterior wing, 3-3.2 mm.

Holotype male, allotype, and 6 males, 2 females (paratypes) at flowers of *Opuntia*, Cooper's store, Big Bend Park, Texas, April 11, 1947 (Michener and Beamer).

Two of the females bear the extremely coarse pollen from *Opuntia*, and the third a much finer pollen from some other flower.

Perdita laticauda sp. nov.

Allied to *P. bidenticauda,* but the male has distinctive differences in the ventral segments and apical tergite of the abdomen. The females of the two species are apparently indistinguishable.

MALE.—Remarkably similar to the male of *bidenticauda* except in regard to the special characters of abdomen. Color the same, with the yellow mark on cheeks near base of mandibles either large or evanescent. First ventrite of abdomen strongly folded in middle of the apical margin, thus producing a large projecting pucker. Following ventrites little modified, although the third has a transverse preapical band of short dense hair, occupying the middle third of the width. Apical tergite extremely large and broad, more than twice as broad as long, and broadly truncate at apex, the truncation with a small median notch. Length, 3.5-4 mm.; anterior wing, 2.8-3 mm.

FEMALE.—Like the female of *bidenticauda.* First tergite sometimes infuscated on basal half. Length, 3.45-4.5 mm.; anterior wing, 2.8-3 mm.

Holotype male and allotype, 15 miles southwest of Dryden, Terrell County, Texas, at flowers of *Gilia acerosa,* April 13, 1949 (Michener and Beamer). Also the following paratypes taken at the same time and place: 10 males, 8 females on *Gilia,* and 2 males, 6 females on flowers of *Chamaesaracha conioides.*

The females bear a moderately fine-grained yellow pollen, which probably was derived from the *Gilia* flowers, as it seems to be slightly coarser and less pale yellow than the pollen borne by other species of *Perdita* that have been taken at flowers of *Chamaesaracha.*

Perdita lobata sp. nov.

This species is similar to *P. laticauda* but has the apical tergite even broader, more convex from side to side, rather strongly grooved medially, and broadly and shallowly emarginate in middle to form two broad, truncate apical lobes.

MALE.—Head enlarged, nearly as bulky as thorax, the temples and cheeks broad. Inner orbits distinctly diverging anteriorly. Mandibles with a weak inner tooth at apex. Frontal foveae well impressed, about five times as long as wide. Abdomen depressed and much broader than thorax. First ventrite with a strong fold in middle of apical margin, the fold producing a puckerlike process. A band of dense short hair on the third ventrite. Apical tergite as described above. Structural characters, sculpture and pubescence otherwise about as in *laticauda* and *bidenticauda.*

Thorax dark bluish green, a little suffused with brown, especially below the wings and on the sides and apex of propodeum. Entire prothorax and the head reddish brown, the frons with a slight greenish tinge. Mandibles, except piceous tips, labrum, face below level of antennae, and mark at anterior end of cheeks, pale yellow. The yellow of face gradually merges into the brown and extends slightly above the level of antennae on each side. Abdomen ferruginous red, nearly the same color as the head. Foveae on lateral margins of tergite 2 very short and black. Legs brown, the front tibiae on anterior side and front tarsi dull yellow. Antennae nearly uniformly pale brown. Tegulae pale testaceous. Wings hyaline, the nervures brown, the subcosta darker brown. Length, 4-4.5 mm.; anterior wing, 3 mm.

Two males (holotype and paratype), 15 miles northwest of Mission, Hidalgo County, Texas, on *Opuntia*, March 30, 1946 (C. D. Michener).

SUBGENUS MACROTEROPSIS Ashmead

Perdita latior Cockerell

Sixteen males, 5 females from the following localities in Arizona: 6 miles east of Douglas, Aug. 11, 1940; Portal, Aug. 12, 1940; Cave Creek, Chiricahua Mts., Aug. 12, 1940 (Michener); and Rustler's Park, Chiricahua Mts., July 5, 1940 (D. E. Hardy).

This is a common species in New Mexico and Arizona at flowers of *Sphaeralcea*.

One specimen of a new species of this group was also taken by Michener near Portal, Arizona, at flowers of *Sphaeralcea*. This will be described elsewhere.

Perdita arcuata dinognatha Cockerell

Many of both sexes from Mazourka Canyon, 6,000 feet, Inyo Mts., California, on *Sphaeralcea ambigua*, May 23, 1937 (Michener). Also taken at Mountain Springs Canyon, Argus Mts., 5,000 feet, Inyo County, May 22, 1937; Andreas Canyon near Palm Springs, April 6, 1939; Ribbonwood, San Jacinto Mts., May 21, 1940 (Michener); Piñon Flat, San Jacinto Mts., May 18, 1939 (E. G. Linsley); San Bernardino County, May 1, 1920 (W. Benedict); and Westgard Pass Plateau, Inyo County, May 27, 1937.

This form differs from *P. arcuata arcuata* Fox from Baja California merely in having the very short transverse clypeus of the male yellow.

Perdita trifasciata sp. nov.

This little species belongs to a new group which will be accorded subgeneric standing in a subsequent paper. In this group belong five species from the Colorado Desert of California, which are usually found at flowers of *Coldenia.* The New Mexico species differs from all except one of the California species in having the abdomen dark, and from the exception in having the face marks reduced and the pale abdominal bands very narrow and only three in number.

MALE.—Head and thorax dark olive-green, with yellowish-white markings as follows: basal half mandibles (these gradually changing to red at apex), labrum, clypeus, except usual dots and two broad brown stripes (somewhat farther apart than their own width) on disk, transversely linear lateral marks not reaching above level of clypeus, and a small spot on tubercles and at posterior corners of pronotum. Middle of supraclypeal area brownish around a very small whitish spot. Antennae nearly uniformly brown above and testaceous yellow beneath. Legs blackish, the front and middle knees, tibiae and tarsi, base of hind tibiae, and base of both hind tibiae and tarsi, pale yellow; front and middle tibiae blotched with brown behind. Abdomen black with a very narrow subapical yellowish-white band on tergites 1 to 3, the band on tergites 1 and 2 emarginate behind on each side, and that on tergite 3 broadly interrupted on each side. Tegulae testaceous brown. Wings somewhat dusky, the nervures and margins of stigma brown.

Head quadrate, as broad as long, the face below antennae prominent, the temples moderately wide. Disk of clypeus about one half as long as wide and shorter than the transverse length of the lateral extensions. Stigma narrowly lanceolate. Substigmatal and poststigmatal portions of marginal cell equal. Claws bifid. Sculpture of head and thorax microscopically tessellate, imparting a soft, dull, satiny appearance. Abdomen considerably smoother and more shining than thorax. Pubescence white, rather short, sparse, and coarse; that on mesoscutum subappressed. Length, about 2.5-3 mm.; anterior wing, 2.1-2.5 mm.

Two males (holotype and paratype), White Sands, New Mexico, June 27, 1940 (R. H. Beamer).

In Cockerell's table (1896) this species does not run easily, but probably goes best to *P. austini* Cockerell, which is a somewhat larger, shining species, with the lateral face marks reaching above level of the antennae.

Perdita ainsliei Crawford

One male, Sioux City, Iowa, July 26, 1924 (C. N. Ainslie).

The *ainsliei* group, which contains the following and some eight other undescribed species from the Southwest, apparently deserves subgeneric recognition.

Perdita peculiaris sp. nov.

A dark blue-green species, differing from *P. ainsliei* Crawford in the black abdomen and in having the light markings restricted to the mandibles and a narrow anterior band on disk of clypeus. (In *ainsliei* the abdomen is ferruginous and the clypeus and quadrate lateral marks are yellowish white.) In Cockerell's table (1896) this new species runs to a female variety of *P. phymatae* Cockerell which is only superficially similar.

MALE.—Head and thorax dark blue-green, the abdomen black. Mandibles, except rufous tips, and a band on anterior margin of disk of clypeus, yellowish white. Remainder of clypeus black. Labrum brown. Antennae blackish, the flagellum more brownish and becoming broadly rather light brown beneath. Legs black, the small joints of tarsi brown. Tegulae testaceous brown. Wings somewhat dusky hyaline, the nervures and margins of stigma sepia brown.

Head about as wide as long, rather thick fronto-occipitally, the face below antennae strongly convex. Clypeus prominent, its anterior margin rounded out and well elevated. Cheeks much narrowed anteriorly and simple. Subantennal plates about as broad as high. Inner anterior corners of lateral plates of face rounded and somewhat tumescent next to disk of clypeus. Abdomen broadly ovate, convex above, a little broader than thorax. Stigma of fore wing narrowly lanceolate. Marginal cell broadly and obliquely truncate at apex, with the portions beneath and beyond the stigma equal. Outer nervure of second discoidal cell obsolescent. Claws bifid. Mandibles moderately long, curved, and simple. Maxillary palpi rather long and six-jointed. Head and thorax minutely tessellate and moderately shining, the metanotum and propodeum strongly tessellate and more dullish than other parts. Puncturation of mesonotum very fine and close, and that of frons moderately sparse. Abdomen also dullish from a minute dense puncturation (in which it differs from *ainsliei* as well as almost all other species of *Perdita*) except on the depressed apical margin of the tergites. Pubescence fine, sparse, and inconspicuous. Length, about 3-4 mm. (the abdomen much recurved at apex); anterior wing, 2.5-3 mm.

Aedeagus of the type of *P. ainsliei;* the long slender apical lobes of stipites abruptly thickened and bent downward at apex (acuminate and very sharp at apex in *ainsliei*). Sagittae forming a fusiform body, tapering to the acute apex, as seen from side, but the tip of each rod expanding acutely outward, as seen from above, and armed with a slendar upward-directed spine at the inner apical corner (in *ainsliei* rather similar, but without the apical spine and clothed beneath with a loose fascicle of hairs close to the apex). Volsellae reduced to one pair, which are rather long and acuminate, as seen from above (two pairs of volsellae in *ainsliei*).

Two males (holotype and paratype), 15 miles southeast of Dryden, Terrell Co., Texas, on *Chamaesaracha conioides,* April 13, 1949 (Michener and Beamer).

SUBGENUS COCKERELLIA Ashmead

The type of *Cockerellia* is *P. hyalina* Cresson, which has been usually considered the male of *P. albipennis* Cresson, although the synonomy is doubtful. Excepting *Xerophasma,* the species of *Cockerellia* are the largest in the genus *Perdita* and are found almost exclusively at flowers of Compositae, mostly of the genera *Helianthus, Rudbeckia, Ratibida, Baileya, Verbesina, Coreopsis, Geraea,* and *Gaillardia,* but with records also from *Erigeron, Heterotheca, Pectis,* and *Prionopsis.*

KEY TO THE SPECIES OF COCKERELLIA FEMALES

1. Head and thorax mainly green 2
   Mainly bright yellow, the lower half of pleura black; clypeal dots, facial foveae and flagellum above, also blackish; mesonotum with short, dense, erect yellow hair .... *beata* Cockerell
2. Clypeus yellow or whitish, the lateral marks triangular and reaching level of antennae or beyond 3
   Face marks restricted to spots on clypeus and transverse lateral marks, the latter not extending above level of clypeus 6
3. Mesonotum minutely, densely punctate, the punctures not much more than their own diameter apart; supraclypeal area entirely dark 4
   Mesonotum polished, finely punctured, the punctures although very numerous, several times their own diameter apart; clypeus, triangular lateral marks, and a vestigial supraclypeal mark, yellowish white; prothorax, legs in large part and abdomen yellow, the abdomen with four black bands, *utahensis* Cockerell
4. Head and thorax brassy green, the mesonotum a little tessellate and dullish between the punctures 5

Head and thorax dark blue-green; mesonotum shining, the dense punctures very minute; base of mandibles, clypeus, lateral marks, prothorax and legs in large part, and abdomen, yellowish white, the abdomen with five black bands; pubescence white . . . . *baileyae* Cockerell

5. Clypeus and lateral marks white; prothorax, legs in large part, and abdomen, pale yellow or yellowish white, the abdomen with five rather broad black bands, and also black on middle of basal declivity of tergite 1 . . . . *perpulchra perpulchra* Cockerell
   Similar, but light parts of thorax, legs and abdomen bright yellow, the first tergite entirely yellow except for a narrow apical black band . . . . *perpulchra flavidior* subsp. nov.
6. Frons dull or opaque, obscurely punctate or impunctate 7
   Frons at most dullish, distinctly although minutely punctate 12
7. Wings slightly dusky hyaline, the nervures and stigma testaceous or pale brown; hair of hind tibiae more or less fuscous 8
   Wings whitish or milky hyaline, the nervures pale yellow or whitish, the stigma frequently yellow or pale orange; hair of hind tibiae usually but not always light 9
8. Wings rather distinctly dusky, the nervures and stigma pale brown; clypeus, except two dark stripes which are abbreviated anteriorly and more or less widened behind, transverse lateral marks, and a broad band on tergites 2 to 5, narrowly interrupted medially on 2 and 3, yellow . . . . *bequaerti bequaerti* Viereck
   Wings more faintly dusky, the nervures more yellowish; dark stripes on clypeus often enclosing a median yellow stripe, which expands anteriorly . . . . *bequaerti indianensis* Cockerell
9. Frons dull but not opaque, its punctures obscure 10
   Frons opaque and virtually impunctate 11
10. Clypeus strongly produced, the width of the anterior truncation a little less than length of the oblique sides to base of mandibles, the face below antennae prominent in profile; immaculately dark green, with the abdomen blackish, or spot or streak on middle of clypeus, slender transverse lateral marks, two spots on pronotum, and interrupted band on tergites 2 to 4, yellow . . . . *verbesinae* Cockerell
    Clypeus less produced, the anterior truncation broader than length of oblique sides, the face below antennae little prominent in profile; more brassy green than *verbesinae;* median streak on clypeus, slender, transversely curved lateral marks, scape of antennae beneath, cuneate marks on pronotum, tubercles, and a broad, interrupted band on tergites 2 to 4, yellow . . . . *fracticincta* sp. nov.
11. Large, robust species, about 9 mm. long; face entirely dark, or, typically, with median stripe on clypeus and transverse lateral marks, yellow; tubercles at apex, two spots on pronotum, and broad band, usually reaching lateral margins on tergites 2 to 5, also yellow; hair on hind tibiae whitish to pale brownish . . . . *lacteipennis lacteipennis* Swenk and Cockerell

Slightly smaller; abdominal bands rather narrow, not quite reaching lateral margins and narrowly interrupted on tergites 2 and 3; marks on pronotum and tubercles large; face marks large, the clypeus yellow except for two triangular dark areas on disk, with the yellow extending triangularly upward between them; hair of hind tibiae sometimes pale fuscous; length about 7-8 mm . . . . *lacteipennis pallidipennis* Graenicher

12. Clypeus more prominent, and more produced, the disk fully as long or a little longer than wide 13

Clypeus less produced and prominent, the disk somewhat broader than high; head therefore appears to be slightly broader than long, with face below antennae much less prominent in profile, 15

13. Frons minutely tessellate, shining, and minutely punctate; yellow bands of abdomen usually broad, and a yellow mark present on each side of disk of tergite 1 14

Frons rather strongly tessellate, more dullish and much more strongly punctate than in *albipennis;* a rather narrow yellow band, not reaching lateral margins on tergites 2 to 4; tergites 1 and 5 immaculate, or 5 with two yellow spots which are usually small or faint . . . . *tricincta* sp. nov.

14. Head and thorax dark olive-green; hair of legs light, the scopa of hind tibiae pale yellowish, yellow abdominal bands usually reaching lateral margins; face marks pale yellow, the upper part of clypeus disk with two dark blotches which usually outline a yellow "T" mark . . . . *albipennis* Cresson

Head and thorax brassy green; hair of legs fuscous to blackish, especially on middle and hind legs; abdominal bands broad and even but failing to reach lateral margins; clypeus usually black, with a medium pale-yellow line . . . . *scopata* sp. nov.

15. Abdomen always dark, the yellow bands nearly or quite reaching lateral margins on tergites 2 to 5, and tergite 1 dark with a yellow mark on each side of disk; median yellow mark on upper part of clypeus not much narrowed above and often T-shaped 16

Abdomen sometimes yellow, with dark subapical and basal spots on each side of segments; or sometimes dark, with enclosed yellow band on tergites 2 to 5, broadest at middle and narrowed toward sides (in which case tergite 1 lacks yellow lateral marks on disk, but may be more or less yellow at base); dark blotches on upper part of clypeus large, the yellow intrusion between them pointed above 17

16. Frons more or less distinctly tessellate and dullish, the punctures minute; yellow bands on tergites 2 to 5 rather even and entire, narrow on tergite 2 and gradually wider on successive segments, that on tergite 5 subabbreviated,
lepachidis lepachidis Cockerell

Frons almost polished, the punctures consequently very distinct; markings as in *lepachidis,* but bands on tergites 2 and 3 generally more or less notched medially behind, and that on 2 sometimes distinctly interrupted . . . *lepachidis levifrons* subsp. nov.

17. Abdomen and legs not almost entirely yellow; the abdomen with dark markings, at least on tergites 1 to 4 18
    Abdomen and legs almost entirely yellow; four small fuscous spots on disk of tergite 1, and two small subapical spots on tergite 2; femora of front and middle legs with a pale-brown blotch on inner side .... *coreopsidis kansensis* subsp. nov.
18. Abdomen yellow with a dark band at junction of tergites 1-2 to 4-5, more or less reduced to a basal spot on lateral margins and a subapical spot on each side; tergite 1 also with a dark blotch on each side at summit of basal declivity, *coreopsidis coreopsidis* Cockerell
    Abdomen dark above with an enclosed yellow band on tergites 2 to 5, broadest in middle and narrowed at outer ends; tergite 1 also more or less yellow at base, *coreopsidis obscurior* subsp. nov.

Perdita utahensis Cockerell

Five males, 2 females, 10 miles south of Tucson, Arizona, Aug. 7, 1940 (C. D. Michener); 5 males, 1 female collected by the writer at the same place and time were found at flowers of *Verbesina encelioides*. Cockerell described only the female of this species from a specimen collected in southwestern Utah.

MALE.—Head and thorax dark blue-green. Spot at anterior end of cheeks, mandibles, except rufous tips, labrum, clypeus, large triangular lateral marks reaching level of antennae, first three joints of antennae broadly beneath, collar and posterior band on pronotum, narrowed mesad, and the tubercles, bright yellow. Sometimes upper margin of subantennal plates yellow, and this even confluent with lateral marks. Legs blackish, the trochanters in part, the femora broadly at apex and an anterior stripe on front and middle pair, the tibiae except behind, and the tarsi, yellow. Flagellum orange ferruginous, becoming dusky above; the pedical and apex of scape fuscous above. Abdomen shining blackish, the apical tergite testaceous yellow, and the apical depression of tergites 1 to 6 whitish subhyaline. Preceding the depression is a yellowish-white band on tergites 1 to 6, this band obliterated except on lateral margins on tergite 1, dilated on each side and covering reflexed sides on tergites 2 to 6, and with remaining part of band broadly interrupted, or almost so, sublaterally, and notched or subinterrupted medially on tergites 3 to 5, but the same part on tergite 2 generally obliterated. Tegulae yellow at base and almost hyaline on outer margin. Wings whitish, with a slight dusky-yellowish opacity. Nervures and stigma yellowish, the margins of stigma generally slightly brownish.

Head quadrate, the cheeks broad. Face below antennae polished, impunctate. Vertex and frons minutely granular-tessellate, the latter moderately shiny and minutely punctate. Mesonotum nearly polished and set with minute, moderately close punctures. Pubescence white and moderately dense. Length, about 6-7 mm.; anterior wing, 4.3-4.9 mm.

Perdita baileyae Cockerell

One male, Rice Co., Kansas, July 3, 1923 (C. H. Martin).

Cockerell described the male of this species from Mesilla, New Mexico. I have seen a female from San Xavier Mission, Arizona (E. P. Van Duzee).

Perdita perpulchra flavidior subsp. nov.

Cockerell recorded *perpulchra* from Las Cruces, New Mexico, and described the type as having the abdomen white with black bands, the black on the basal tergite extending triangularly to the base, with the white on each side enclosing a black subapical spot. A female taken 15 miles west of Holbrook, Arizona, at flowers of *Erigeron*, Sept. 3, 1930 (Timberlake) agrees well with Cockerell's description, except that the abdomen is more yellowish. In *flavidior* the light parts, except those of face, are bright yellow, and the basal tergite is black only at apex.

FEMALE.—Head and thorax dark olive-green. Basal half of mandibles, clypeus, and triangular lateral marks reaching level of antennae, pale yellow. Scape of antennae, except spot at apex above, under side of pedicel and of first joint of flagellum, prothorax and legs in large part, and abdomen, bright yellow. Coxae at base, under side of front and middle trochanters and femora, spot at apex of hind femora above, posterior surface of front and middle tibiae, hind tibiae entirely and all tarsi, except basal joint of front pair, dark brown or blackish. A black band at juncture of tergites 1-2 to 4-5, with the broad intervening yellow bands distinctly notched on each side behind by sublateral swellings of the black, especially on tergites 2 and 3. Tergite 5 with a narrow, preapical blackish band. Venter pale brownish yellow at base; segments 2 and 3 each with two fuscous patches, and the apical segments extensively fuscous. Tegulae pale testaceous, with a yellow spot at base. Wings somewhat whitish hyaline, slightly tinged with dusky yellowish. Nervures and stigma testaceous yellow.

Head slightly broader than long, the clypeus little produced and prominent. Frons slightly duller, with somewhat closer and fainter punctures than in *albipennis.* Mesonotum minutely and very closely punctate and covered with fine very short, erect hair. This rather dense pubescence of mesonotum and that of vertex distinctly ochreous. Wings, in comparison with *albipennis,* small and slightly dusky. Length, 8 mm.; anterior wing, 4.8 mm.

One female (holotype), Great Bend, Barton Co., Kansas, on *Heterotheca subaxillaris,* Sept. 9, 1949 (Michener and Beamer).

Perdita bequaerti indianensis Cockerell

In preparing the preceding key to the species of *Cockerellia,* I noticed that a specimen from Gary, Indiana, that had been determined by Cockerell as *P. pallidipennis* Graenicher, had somewhat dusky wings, a character which would relegate it to *P. bequaerti* Viereck. I conclude that *indianensis* that was based on a male from Lafayette, Indiana, must be the same as the Gary specimen, since the margins of stigma and end of marginal cell could not be described as fuscous unless the wings were slightly dusky, rather than milky hyaline as in *pallidipennis.*

This is a rather weakly developed race of *bequaerti,* and was described as a race of *pallidipennis.* It and *P. wickhami* Cockerell were published in the same paper and must be the sexes of practically the same thing (new synonymy).

Perdita verbesinae Cockerell

Five males, 9 females, Portal, Arizona, on *Verbesina encelioides,* Aug. 12, 1940 (C. D. Michener).

Specimens of this species, even those of a series taken at the same spot, vary greatly in the extent of the yellow markings, and sometimes lack the markings altogether. Such immaculate specimens were named var. *nigior* by Cockerell in his original description.

Perdita fracticincta sp. nov.

This species is allied to *P. lepachidis* Cockerell and *P. coreopsidis* Cockerell in the shape of the head, but in the strongly tessellate and dull frons, the greatly reduced face marks, and the interrupted abdominal bands it strongly resembles *verbesinae.*

FEMALE.—Brassy green, the labrum and clypeus black, the latter green, however, on upper margin of disk. Small longitudinal median spot on clypeus, a small transverse spot on each lateral extension of clypeus, and slender to transversely arcuate lateral marks, yellow. The lateral marks bordering anterior margin of lateral plates of face are slightly interrupted on one side and have a short extension upward on orbits. Interrupted band on hind margin of pronotum, and the tubercles, yellow. Abdomen blackish, a small spot on lateral margins of tergite 1 (mostly on the reflexed ventral portions) and interrupted band on tergites 2 to 4, yellow; band on tergite 2 reaching the lateral foveae, and that on 3 having a faint, slender posterior extension to lateral margins. Mandibles and pygidium rufo-testaceous, the former more rufous at apex. Antennae blackish above, the scape yellow, the flagellum brown beneath. Legs blackish, a small spot on front knees and the front tibiae on anterior side, yellow. Tegulae pale testaceous. Wings milky hyaline, nervures nearly colorless, the stigma pale yellow.

Head hardly longer than wide, the clypeus little produced and prominent. Frons and vertex minutely granular-tessellate and rather dull, the minute shallow punctures of frons only moderately distinct. Face below antennae polished, with sparse minute punctures. Mesoscutum polished on disk, although minutely tessellate anteriorly, and provided with rather close minute punctures. In some ways, including shape of head, pubescence, size, etc., agreeing closely with *coreopsidis.* Length, 7 mm.; anterior wing, 4.9 mm.

One female (holotype) 29 miles south of Sarita, Willacy Co., Texas, on *Coreopsis,* Apr. 14, 1950 (Michener, Beamer, Stephen and Rozen).

Perdita lacteipennis lacteipennis Swenk and Cockerell

Unquestionably a common species in western Kansas at flowers of *Helianthus,* as there is a series of 127 females and 145 males in the University of Kansas collection from various localities in the Counties of Chase, Reno, Sheridan, Ottawa, Hamilton, Greeley, Meade, Ford, Finney, Pawnee, Osborne, Barton, Pratt, Russell, Rawlins, Saline, Ellsworth, Comanche, Stafford, Clark, Decatur, Rice, and Rooks. Nearly all the specimens that are labeled with the flower record were taken on *Helianthus petiolaris,* but 6 males from Chase and Hutchinson were on *Prionopsis ciliata.* The dates of capture range from June 14 to Sept. 6.

Also 79 specimens from La Junta, Colorado, two of them labeled as from *Helianthus annuus;* 2 males, Lamar, Colorado (Snow); 1 male, Artesia, Moffat Co., Colorado, on *Helianthus petiolaris,* July 22, 1950 (Michener); and 1 male each from Leonard, North Dakota, July 25, 1937, and Lusk, Wyoming, July 14, 1937 (C. L. Johnston).

Specimens from western Kansas are mostly typical *lacteipennis,* although about 10 per cent of the females have the face marks very small or absent and thus agree with the form *canadensis* Crawford.

Of 28 females from La Junta, Colorado, 6 verge toward *canadensis* (face marks obsolescent), 6 verge toward *pallidipennis* (clypeus with a yellow spot on each side besides the median mark), and 16 are typical *lacteipennis*.

Perdita lacteipennis pallidipennis Graenicher

Thirty-two females, 15 males, Douglas Co., Kansas, on *Helianthus annuus*, Sept. 9, 1949 (Michener and Beamer); 3 females, Topeka, Kansas, Sept. 17, 1910 (E. G. Titus).

These specimens are nearly typical *pallidipennis,* the female of which has the clypeus yellow, with a dark blotch above on each side of disk, or the dark color frequently reduced to a short strip on each side. Males have the basal half of mandibles, labrum, and anterior border of face yellow.

Specimens from Clay Co., Kansas (J. C. Bridwell), average somewhat closer to *pallidipennis* than to typical *lacteipennis* but probably should be classed as intermediates.

In the original description of *lacteipennis* it is stated on the authority of Prof. Myron Swenk that the species does not occur in eastern Nebraska. However, the species does occur there, as I have a female of *pallidipennis* from Nebraska City on *Helianthus,* Sept. 14, 1901 (M. A. Carriker). The form *pallidipennis* has the face markings much as in *albipennis* and hence must have been confused with *albipennis* by Swenk. The dull frons of *lacteipennis* and the shining punctate frons of *albipennis* easily distinguish the two species.

Perdita tricincta sp. nov.

Nearest *P. albipennis* Cresson, but distinguished by the duller, more tessellate, and more coarsely punctate frons, and by the three narrow bands on abdomen (the yellow on the fifth tergite restricted to two small spots or absent). The male has a dark, shining abdomen and transverse yellow face marks.

Female.—Head and thorax dark green, the mesonotum somewhat brassy. Labrum and clypeus blackish, the latter with a broad, pale-yellow, median stripe and a suffused yellowish mark on each side. Lateral marks pale yellow, rounded at inner ends and generally somewhat less than twice as broad as high. Mandibles testaceous brown, the tips dark rufous. Collar of pronotum obscurely yellowish, the hind margin and tubercles bright yellow. Abdomen blackish, with a rather narrow yellow band on tergites 2 to 4, that on 2 ending at the lateral fovea, the others not quite reaching lateral margins, all slightly notched medially, those on tergites 2 and 3 behind and that on tergite 4 in front. Tergites 1 and 5 entirely black, or the latter frequently with two submedian yellow spots. Pygidium ferruginous brown. Legs blackish, the front tibiae yellowish on anterior side. Antennae blackish, the scape narrowly clear yellow and the flagellum brown beneath. Tegulae pale testaceous. Wings milky hyaline, the nervures nearly colorless, the stigma pale yellow.

Head about as broad as long, with the clypeus produced and prominent. Facial foveae about one third as long as eyes. Sculpture as in *albipennis*, except the frons duller, with a stronger tessellation and coarser punctures. Pubescence of vertex and mesonotum more ochreous than in *albipennis*. Scopa of hind tibiae a pale yellowish brown. Length, 7.5-9 mm.; anterior wing, 5-5.2 mm.

MALE.—Head and thorax dark green. Base of mandibles, anterior band on clypeus (more testaceous far laterad), sometimes a median streak on clypeus to summit, and lateral face marks, about twice as wide as high, yellow. Mandibles testaceous in middle and rufous at tips. Labrum testaceous. Antennae orange-brown, a little dusky on apical half of flagellum above, becoming darker toward base of flagellum, and blackish on pedicel and on the scape except at base, with underside of scape and of first joint of flagellum yellow. Collar of pronotum yellowish, especially toward the middle, a small cuneate spot on posterior corners of pronotum clear yellow, but tubercles dark. Abdomen shining blackish, the apical tergite testaceous, the apical depression of preceding segments subhyaline. In some specimens, including the allotype, there is a trace of yellow just in front of the apical depression on tergites 5 and 6 and on the reflexed sides of the preceding segments. Legs blackish; all tarsi, front tibiae broadly and middle tibiae narrowly on anterior side, and front and middle knees, yellow. Tegulae and wings as in female. Head quadrate, the cheeks broad. Sculpture as in female, the pubescence white. Length, 5.3-8 mm.; anterior wing, 4-5 mm.

Holotype female and allotype, Southmost, Cameron Co., Texas, on *Helianthus annuus*, Apr. 13, 1950 (Beamer, Michener, Stephen, and Rozen). Paratypes as follows: 30 females, 40 males taken with the types; 1 male, 5 miles east of Brownsville, Apr. 13, 1950; 3 females, 4 males, Progresso, Hidalgo Co., on *Helianthus annuus*, Apr. 12, 1950; 1 male, 6 miles east of Rio Grande, Starr Co., Texas, Apr. 12, 1950 (all, Michener, Beamer, Stephen, and Rozen).

Perdita albipennis Cresson

The material recorded below belongs almost entirely, in respect to the females, to the variety *lingualis* Cockerell, which is the best-known and the most common form of *albipennis* in collections. This more highly colored form is, acording to Cockerell, possibly a valid race. The male variety *helianthi* Cockerell, with yellow markings on abdomen and a more or less blackish flagellum, flies in about equal numbers with males having the flagellum orange brown or ferruginous and the abdominal markings obsolete, and both fly with *lingualis*. The *P. hyalina* Cresson, without face or abdominal markings indicated in the original description, seems distinct from *albipennis*. The variety *pasonis* Cockerell, with a dull frons, is more likely allied to *P. lacteipennis* than to *albipennis*. Altogether, therefore, it is necessary to have a much fuller collection of *albipennis* in order to understand its variation and possible subspeciation.

The following material of *albipennis* has been examined:

Kansas: 14 females, 17 males, Clark Co., 1,950 feet, Aug. 23, 1911; 2 females, 1 male, Rawlins Co., 2,850 feet; 1 female, Norton Co., 2,270 feet, Aug. 12, 1912; 2 females, Smith Co., 1,800 feet, Sept. 4, 1912; 2 females, 1 male, Stevens Co., 2,700 feet, Aug. 10, 1911; 1 male, Sherman Co., 3,690 feet; 1 male, Ellis Co., 2,000 feet, July 18, 1912; 1 male, Decatur Co., 2,560 feet (all F. X. Williams); 1 male, Ness Co.; 10 females, 4 males, Sharon Springs, Wallace Co., on *Helianthus annuus*, Aug. 23, 1931 (Timberlake); 1 male, Lakin, Kearny Co., on *Helianthus petiolaris*, July 23, 1950 (C. D. Michener).

Colorado: 4 males, La Junta, July 3, 1949 (R. H. Beamer and J. R. White).

Wyoming: 1 male, Lingle, Goshen Co., July 14, 1937 (C. L. Johnston).

New Mexico: 1 female (probably belonging here, but it cannot be identified positively as the head is missing), Cuervo, Guadalupe Co., June 23, 1940 (E. E. Kenaga).

Arizona: 1 male, Fort Apache, Navajo Co., Aug. 26, 1897 (Snow, No. 2113).

Perdita scopata sp. nov.

This species is much like *P. albipennis*, but the hair of middle and hind legs and that of front tarsi more or less blackish, a character more faintly indicated in some of the other species of *Cockerellia*, such as *P. bequaerti* and *P. lacteipennis pallidipennis*, which, however, have the frons dull and impunctate. The male of *scopata* has the face markings greatly reduced or absent and the abdomen immaculate, opaque black.

FEMALE.—Head and thorax dark green, the frons, vertex, and mesonotum with a strong brassy luster, the labrum and clypeus black. Line on under side of scapes, median line on clypeus, not reaching anterior margin, and slightly transverse lateral marks, whitish. The lateral marks, rounded at inner ends, extend about half way to level of antennae. Sometimes a transverse whitish spot on lateral margins of disk of clypeus. Mandibles black at base and rufous on apical third or half. Antennae blackish, the flagellum slightly rufescent beneath. Tubercles and hind margin of pronotum pale yellow, the anterior margin narrowly yellowish. Abdomen black, the pygidial plate dark rufous. Tergites 2 to 5 each with a broad yellow band, these bands more even than in *albipennis* and falling distinctly short of the lateral margins. A slender, oblique, more or less sinuate and broken yellow line on each side of the base of the disk of tergite 1. Legs blackish, the front knees and a line on anterior side of front tibiae suffused with yellow. Tegulae testaceous. Wings whitish hyaline, the nervures and stigma pale testaceous yellow (in comparison with *albipennis* the wings have a barely perceptible dusky tinge and the nervures are less pallid). Structure, sculpture, and pubescence as in *albipennis*, with the following differences: cheeks less broadened and clypeus less prominent; punctures of mesonotum slightly closer; abdomen dull, with an excessively minute tessellation; pygidium very broad and broadly subtruncate at apex; basal middle of propodeum minutely rugose; pubescence flavo-ochraceous on top of head and on mesonotum, more or less dark fuscous on middle and hind legs and front basitarsi, and dilute fuscous at apex of abdomen. Length, 7-9 mm.; anterior wing, 5-5.5 mm.

MALE.—Dark green, the mesonotum with a brassy luster, the base of mandibles, labrum and clypeus shining black. Abdomen opaque black, the apical depression of tergites more shining but not pallescent; tergite 7 becoming brownish testaceous on apical half. No light facial thoracic or abdominal markings, except rarely a small pale-yellow spot on each side of disk of clypeus and another opposite anterior corners of eyes. Mandibles rufous at apex. Antennae blackish, the scape pale testaceous at extreme base, the flagellum brown beneath. Legs blackish, a small spot on front and middle knees pale yellowish, the front and middle tarsi testaceous yellow, and the hind tarsi brownish. Tegulae testaceous. Wings milky hyaline, with pale-yellow nervures and stigma (wings distinctly whiter than in female). Structure, sculpture, and pubescence similar to condition in male of *albipennis,* except the frons slightly duller, with less distinct punctures, mesonotum with somewhat closer punctures, base of propodeum with a small, triangular, finely rugose area, and abdomen dull from an excessively minute thimble-like tessellation. Length, 6-8 mm., anterior wing, 5-5.5 mm.

Holotype female and allotype, 29 miles south of Sarita, Willacy Co., Texas, on *Coreopsis,* Apr. 14, 1950 (Beamer, Michener, Stephen, and Rozen). Paratypes as follows: 25 females, 61 males, taken with the types; 10 females, 36 males, same locality and date, at flowers of *Helianthus annuus;* 7 females, 4 males, Southmost, Cameron Co., on *Helianthus annuus,* Apr. 13, 1950; 1 male, 5 miles east of Brownsville, Apr. 13, 1950 (Beamer, Michener, Stephen, and Rozen); 1 female, 20 miles south of Sarita, on yellow composite, April 2, 1946 (C. D. Michener); 1 female, Hidalgo Co., Texas, May 5, 1929 (H. B. Parks); 1 female, 1 male, Brownsville, June (F. H. Snow, No. 2428); and 1 female, 1 male, Galveston, May (Snow, No. 1824).

The Brownsville specimens taken in June (Snow) differ in having considerably larger face marks than usual.

Perdita lepachidis lepachidis Cockerell

This species was described in 1896 from Santa Fe and Socorro, New Mexico. Only the male was known to Cockerell, who collected it at flowers of *Ratibida tagetes* (the plant was then called *Lepachys tagetes*).

FEMALE.—Brassy green, much as in *coreopsidis,* but the median pale-yellow area of clypeus briefly crossed at the top like a "T" and expanding below, or sometimes isolated and Indian club-shaped (in *coreopsidis* triangular and pointed above). Anterior and posterior margin of pronotum and tubercles bright yellow. Abdomen blackish, with a spot on each side of tergite 1 and a crossband on tergites 2 to 5, bright yellow; these bands reaching lateral margins or nearly so, and that on tergite 2 rather narrow, but those on tergites 4 and 5 broad and emarginate behind on each side. Legs dark, the anterior side of front and middle tibiae and a small spot on knees, yellow. Scape of antennae yellow except at apex above, the flagellum brown above and yellowish brown beneath but becoming yellow beneath on the basal joint and on the pedicel. Tegulae pale testaceous. Wings milky hyaline, the nervures and stigma pale yellow. Length, about 7 mm.; anterior wing, 5-5.3 mm.

Four females, Lakin, Kearny Co., Kansas, on *Ratibida columnaris,* July 23, 1950 (C. D. Michener); and 1 female, Sheridan Co., Kansas, 2,650 feet (F. X. Williams).

The specimen from Sheridan Co. differs in having the clypeus yellow with two dark stripes which are irregular, that on the left side forming a figure 7 and that on the other side confluent with the usual lateral dot.

I have examined, also, a pair from Alpine, Texas, July 8, 1942 (H. A. Scullen), one female from Sterling, Logan Co., Colorado, May, 1923 (Grace Sandhouse), and two males from Santa Fe and Socorro, New Mexico (Cockerell).

Perdita lepachidis levifrons subsp. nov.

This race differs from typical *lepachidis* in the smoother, more shining frons and in the more restricted facial and abdominal markings.

FEMALE.—Brassy green. Lateral face marks and clypeus pale yellow, the disk of latter with a blackish blotch (becoming green on outer margin above) on each side, isolating a rather slender median yellow streak, which is briefly crossed at summit to form a "T." Yellow abdominal bands not quite reaching lateral margins, that on tergite 5 generally much abbreviated, those on tergites 2 and 3 notched medially behind, and that on tergite 2 frequently narrowly interrupted in middle. Flagellum more ferruginous and the dark part of legs, especially on tibiae, more brownish than in *lepachidis.* Frons so delicately tessellate as to be almost polished, its punctures minute but distinct. Length, 6.5-7.5 mm.; anterior wing, 4.8-5.1 mm.

MALE.—Not appreciably differing from male of *lepachidis* from New Mexico, except that frons is nearly polished and the wings are smaller. Length, 6-7 mm.; anterior wing, 4.3-4.6 mm. (length of wing in New Mexico male, 5 mm.).

Nine females, 4 males (holotype female, allotype, and paratype), Brownsville, Texas, June (F. H. Snow, Nos. 2416 and 2417). Three of the females lack the abdomen.

Perdita coreopsidis coreopsidis Cockerell

This species was described from specimens collected at Cotulla, La Salle Co., Texas, at flowers of *Coreopsis,* but it apparently prefers *Gaillardia* to any other flower.

Texas: 2 females, 1 male, Catarina, Dimmit Co., on *Monarda punctata coryi,* Apr. 11, 1950 (Beamer, Michener, Stephen, and Rozen).

Kansas: 9 males, Dodge City, Ford Co., on *Gaillardia*, June 15, 1949 (Michener and Beamer); 1 female, Satanta, Haskell Co., on *Gaillardia*, June 16, 1949 (Michener and Beamer); 1 female, 5 miles north of Quinter, Sheridan Co., on *Gaillardia*, June 17, 1950 (Michener); 1 male, Ashland, Clark Co., on *Gaillardia*, June 12, 1949 (Michener and Beamer); 4 females, 4 males, Larned, Pawnee Co., on *Gaillardia*, June 14, 1949 (Michener and Beamer); 2 females, Clark Co., 1,962 feet, May and June (F. H. Snow, Nos. 1160 and 1161); 2 females, Gove Co., 2,813 feet (F. X. Williams).

Perdita coreopsidis kansensis subsp. nov.

This form flies with the typical subspecies on the northwestern border of the known range of *coreopsidis*, but farther south and west it apparently attains the status of a race. It differs from typical *coreopsidis* in having the legs and abdomen of the female nearly all yellow, and the abdomen of male yellow with dark bands.

FEMALE.—Like typical *coreopsidis* except in color of legs and abdomen. Legs yellow, the anterior and posterior surface of front femora beneath except at apex, and anterior side of middle femora beneath except apex, brown or fuscous, and the hind margin of middle and hind tibiae and basitarsi slightly darkened. Abdomen yellow, with four fuscous spots on tergite 1 and sometimes two spots on tergite 2, these spots being situated as in the spotted form of *coreopsidis*, but small.

MALE.—Yellow face markings similar to those of female (obsolete or nearly so in typical male). Apex of femora, the tibiae and tarsi nearly all yellow (the yellow mainly restricted to anterior side of front tibiae in typical male). Tergite 1, except a narrow apical light crossband, and a crossband at base of tergites 2 to 5, black, the rest of abdomen yellow, except for a small transverse preapical dark spot on each side of tergites 2 and 3. Apical depression of tergites whitish subhyaline as in the typical male.

Two females, 1 male (holotype female, allotype, and paratype), Gove Co., Kansas, at 813 feet (F. X. Williams); 1 male (paratype), Dodge City, Ford Co., Kansas, on *Gaillardia*, June 15, 1949 (Michener and Beamer); and 1 male (paratype), Van Horn, Culberson Co., Texas, May 23, 1932 (E. G. Linsley).

Perdita coreopsidis obscurior subsp. nov.

This race of *coreopsidis* appears to be restricted to the coast of Texas, from the mouth of the Rio Grande to Galveston. It differs from the typical form in the less extent of yellow markings, and in the slightly sparser puncturation of the mesoscutum.

FEMALE.—Like *coreopsidis* except in color of abdomen. Tergite 1 nearly all dark except at base, and the following tergites fuscous or blackish around the margins to enclose a broad yellow band that is more or less narrowed and acute at outer ends. On tergites 4 and 5 the dark margin sometimes broadly interrupted in middle apically and more rarely also at the sides, thus more or less isolating two dark spots before the apical depression. Length, 6-7.5 mm.; anterior wing, 4.1-4.6 mm.

MALE.—Mandibles except tips and lateral extensions of clypeus, yellow; disk of clypeus black, with the yellow sometimes intruding slightly on each side anteriorly. Abdomen with the yellow markings evanescent or absent and never forming more than a thin line interpolated between the dark base and the subhyaline apical depression. Punctures of mesoscutum moderately close. Length, 4.8-6.5 mm.; anterior wing, 3.9-4.4 mm.

Sixteen females, 59 males (holotype female, allotype, and paratypes), Boca Chica, Cameron Co., Texas, on *Gaillardia*, Apr. 13, 1950 (Beamer, Michener, Stephen, and Rozen). Also the following paratypes: 1 female, Brownsville, July 3, 1938 (R. H. Beamer); 2 females, 12 males, Brownsville, Apr. 13, 1950 (Beamer); 6 females, 2 males, 18 miles north of Harlingen, Cameron Co., on *Gaillardia*, Apr. 2, 1938 (C. D. Michener); 1 female, 1 male, Galveston, May (F. H. Snow, Nos. 1825, 1826); and 3 females, 1 male, Corpus Christi, June 28, 1942 (E. S. Ross).

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Comparative Morphological and Systematic Studies of Bee Larvae With a Key to the Families of Hymenopterous Larvae [1, 2]

BY CHARLES D. MICHENER

CONTENTS

ABSTRACT: This paper is a study of known bee larvae from all parts of the world. It contains a key to the larvae of the major groups of Hymenoptera and an account of evolutionary trends among bee larvae. A detailed study of the external morphology of *Anthophora* is presented, (1) as a contribution to insect morphology, (2) as a basis for the establishment of a suitable terminology for the structures, and (3), as a basis for comparison of other genera. Descriptive comments on known bee larvae are presented, together with fuller descriptions and figures of forms from the Western Hemisphere.

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INTRODUCTION

The purposes of this paper are to shed light on the evolutionary trends and phylogeny of the bees as exemplified by larval characteristics, to interpret insofar as possible problems of larval evolution generally, and to make possible identification of certain bee larvae when not accompanied by associated adults.

The scope of the work is necessarily limited by the relatively few species which have been available for study. It is a deplorable fact that while many fine papers on bee biologies have been written, particularly in Europe, and while larvae of many bees have been seen, often sketched or photographed, most of these larvae have never found their way to museums nor have they been described or illustrated in detail. The magnificently illustrated works of Guido Grandi provide the most important exception; his descriptions and illustrations are virtually as useful as specimens themselves.

The scope of the study is also limited almost exclusively to mature larvae. The earlier stages are even less available in collections than are mature larvae. Except as otherwise indicated, all descriptions and figures in this paper are based upon mature larvae.

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A BRIEF ACCOUNT OF HYMENOPTEROUS LARVAE

In order to establish which of the characteristics of the various bee larvae are primitive and which are specialized, a general survey of hymenopterous larvae seems appropriate. As Peterson (1948) says, probably less is known about the larvae of Hymenoptera than about those of any of the other great orders. This applies particularly to the Clistogastra, many students having been impressed by the fact that larvae of this group all look more or less alike as a result of reduction and loss of sclerotization and structures. No doubt this reduction is correlated with their habitats; none of the larvae of Clistogastra are free-living, all are inhabitants of plant or animal tissues or live in protected places (nests) constructed by their parents or their hosts. A recent author remarks on the simplified soft bodies of these insects and even goes so far as to say that sclerotized mouthparts are usually wanting. This statement no doubt results from an examination of the larva of *Apis,* whose mouthparts, even the mandibles, are relatively unsclerotized. A casual examination of figures of the mandibles of other bees will show its inaccuracy.

No attempt has been made to give an exhaustive treatment of hymenopterous groups or to make a full survey of the literature other than that on bees. The following remarks, pertaining to mature larvae, are based on the principal literature and on the specimens at hand, special emphasis being placed on characters that vary among bee larvae because of the light which this information sheds on the relative specialization of such characters among bees.

The larvae of the suborder Chalastogastra usually have thoracic legs and often abdominal prolegs as well; the body usually bears setae, and there are often sclerotic projections at the end of the abdomen. Free-living forms have eyes above the antennae. The antennae and maxillary and labial palpi are usually several segmented. The cardo is distinct from the stipes, while a lacinia and galea are recognizable. The salivary opening is single, not guarded by lips or sclerotic projections. The mandibles are robust, with the inner surfaces concave and with several stout apical teeth. Some works describing and illustrating these larvae are Peterson (1948), Yuasa (1922), MacGillivray (1914), Short (1952) and Tokunaga, Tsujita, and Yamazaki (1951).

The larvae of the suborder Clistogastra differ from those of the Chalastogastra in lacking legs, in being unsclerotized and pale in color except for the spiracles and portions of the head capsule and mouthparts, and in lacking eyes. The antennae and maxillary and labial palpi have at most one projecting segment. The laciniae are absent or not recognizable.

The wasps have larvae more like those of Chalastogastra than do any other Clistogastra. In the Vespidae the body often bears a few setae and the antennae are reduced to mere convexities each of which bears a slightly more convex central area which is provided with a few sensillae. The maxillae and labium are distinct projecting structures but the maxillary and labial palpi are one-segmented, papillalike. The former are similar to the galeae, so that each maxilla appears to bear two papillae. The cardo is distinct from the stipes, while the lacinia is unrecognizable. The salivary opening is a transverse slit guarded by thin, slightly sclerotized lips. The mandibles bear several large teeth at their apices, or the apices may be attenuate, bidentate or simple. Vespid larvae are well described and illustrated by several authors (Grandi, 1928a, 1930, 1934, 1934a, 1935, 1937; Maneval, 1936, 1939; Micheli, 1930, 1934; Parker, 1943; Reid, 1942; Short, 1952; Soika, 1933, 1934). Reid has given an extensive treatment with a key to the subfamilies.

The larvae of Scoliidae (Grandi, 1940), Formicidae (Athias-Henriot, 1947; Menozzi, 1936; Stärke, 1949; W. M. Wheeler, 1918; G. C. Wheeler, 1928, 1935, 1943, 1948, 1950; G. C. and J. Wheeler, 1951, 1952), Pompilidae (Grandi, 1926, 1939; Maneval, 1936, 1939), Chrysididae (Maneval, 1936; Soika, 1934), and Sphecidae (Grandi, 1926, 1928, 1928a, 1929, 1930, 1931, 1934a; Maneval, 1936, 1939; Micheli, 1929, 1930, 1933, 1937; Soika, 1932, 1934) are essentially similar to those of the Vespidae. The body setae are present in some (e. g. Sphecidae). The antennae are frequently a little better developed than in the Vespidae with a distinct projecting papilla bearing the sensillae. The salivary opening is similar to that of the vespids in all of the above mentioned wasps groups except that in many Sphecidae it is divided into two openings, each of which may project as a long process. All intergrades exist within the Sphecidae from the single slitlike opening found in the Sphecinae (*Ammophila, Sceliphron*) and Astatinae, to the two small separate openings on projections characteristic of most other sphecids (see Michener, 1952). The maxillary galea is reduced in size in some sphecids (*Cerceris*, Grandi, 1926, 1928a; *Philanthus*, Grandi, 1931; and *Miscophus*, Maneval, 1939) and is in fact entirely absent in one minute sphecid, *Ammoplanus* (Maneval, 1939). While absence of this papilla (galea) is ordinarily a character of the Apoidea, the

Ammoplanus larva does not show other apoid characteristics, for it has the several apical mandibular teeth and the paired salivary openings characteristic of related sphecids.

Larvae of the Evaniidae (Genieys, 1924) and Gasteruptionidae, subfamily Gasteruptioninae (Short, 1952) differ from the wasps in lacking maxillary galeae. In this respect they resemble the Apoidea, from which they differ in having broader, tridentate mandibles. Larvae of the Gasteruptionidae, subfamily Aulacinae (Short, 1952), have retained the galeae as distinct papillae and have paired salivary openings as in most subfamilies of Sphecidae.

The Apoidea or bees, like the Evaniidae and the Gasteruptioninae, differ from the wasps principally in lacking the maxillary galeae so that there is only one papilla (the palpus) on each maxilla. Occasionally, as in *Centris* (= *Eulaema*) there is a projection in the position which would be occupied by the galea, but it is obviously a mere projection and not a distinct papilla, as is the galea in wasps. The bees also differ from wasps, ants, and the like in lacking the maxillary cardines as distinct sclerites, although in some groups, especially the megachilids and some halictids, they are represented by swellings. Moreover the mandibles are simple or bidentate at the apices, frequently with small teeth or serrations on the margins and inner surfaces. This is in contrast to wasps which usually have several large apical teeth and rarely have small teeth or serrations. The salivary opening is a slit, with sclerotic lips, or the lips may be absent; more rarely it is a round or oval opening, sometimes very inconspicuous. It is never bifid as in many sphecids. Setae are present on the body principally in the Megachilidae.

The Oryssidae, which on the basis of adult characters are merely parasitic Chalastogastra, have larvae with mouthparts more reduced than in the bees. The mandibles are tridentate with the median tooth longest, the whole mandible remarkably nearly bilaterally symmetrical, as shown by Rohwer and Cushman (1917). The labium is separated from the maxillae by grooves which do not reach far back on the sides of the head. The maxillary structure is difficult to interpret in the light of Rohwer and Cushman's illustration but there appears to be a basal piece (possibly cardo) at the level of the mandibular bases, not back toward the rear margin of the head. If this is the case, there is a great difference between the *Oryssus* structure and that of any other hymenopteron. Thanks to Dr. B. D. Burks and the authorities of the United States National Museum, I have been able to study some of the material used by Rohwer and Cushman, but it is now mounted on slides and difficult to interpret. However, it does appear that the maxillae were more or less correctly illustrated by Rohwer and Cushman.

The Chalcidoidea and Cynipoidea are characterized by the reduction of all mouthpart structures except the mandibles; the latter are commonly acute and edentate although they are sometimes toothed apically, particularly in phytophagous cynipoids. The labium and maxillae are usually (in Chalcidoidea) indistinguishably fused with the head and scarcely recognizable; rarely in chalcidoids, more commonly in cynipoids, they are separated by grooves; at their apices the palpi are absent or reduced to minute papillae or the maxillary palpi are distinct tubercles in cynipoids; the galeae are absent, and the cardines unrecognizable. The salivary opening, when recognizable, is small, single, not guarded by lips, sometimes a transverse slit. The body is often provided with setae.

Larvae of many species of chalcidoids are described and illustrated by Buscalioni and Grandi (1938), Parker (1924), Salt (1931), and Short (1952), while those of cynipids are described and illustrated by Short (1952), and Yasumatsu (1943).

The Ichneumonidae, Braconidae and Agriotypidae have remarkable mouthparts in which the rather small, usually acute and edentate, mandibles are the principal movable structures. The other appendages and sclerites of the front of the head are reduced to flat or slightly convex areas. The conspicuous structures in this region (except in *Collyria*) are not these appendages and sclerites, but the lines between them, which are strongly sclerotized. Suggestions of such sclerotization may be seen in bees and wasps, where they may indeed be conspicuous; however, in these forms the maxillae, labium, etc., are always projecting lobes. In the ichneumonoids, on the other hand, there are no projecting lobes or but feeble ones. The sclerotized lines are as follows: (1) one following the course of the epistomal suture, (2) one on each side extending between the anterior and posterior mandibular articulations (pleurostomal thickening), (3) one extending from each posterior mandibular articulation to the posterior tentorial pit (hypostomal thickening), (4) one on each side separating the maxillae from the labium (labio-maxillary thickening or maxillary sclerome of Vance and Smith, 1933), (5) one dividing each maxilla between cardo and stipes (stipital sclerome of Vance and Smith), and (6) one separating the prementum from the postmentum (labiostipital sclerome of Vance and Smith). In these insects there is only one maxillary papilla (presumably the palpus) and the salivary opening is slitlike, without distinct lips, or is apparently absent.

Some excellent descriptive and illustrative work on larvae of ichneumonoids is provided by Beirne (1941), Salt (1931), Short (1952), Thorpe (1930), and Vance and Smith (1933). Beirne and Short give keys for the separation of families and subfamilies.

A KEY TO SOME GROUPS OF HYMENOPTEROUS LARVAE [1]

(Based on mature larvae)

The following key to some groups of Hymenopterous larvae summarizes some of the information contained in the preceding paragraphs. In preparing it, I have borrowed freely from the keys of Peterson (1948) and Soika (1934). It should be remembered that in the Clistogastra only an exceedingly small percentage of the species have been studied. Therefore many exceptions will probably be found to the statements of the key; it is merely an outline to be improved as investigators obtain more information.

1. Antennae and maxillary and labial palpi distinctly several-segmented (if one-segmented, then apex of abdomen bears sclerotic processes); lacinia distinct; eye spot usually present; thoracic legs usually present and segmented; abdominal prolegs usually present (suborder Chalastogastra) 2
   Antennae and maxillary and labial palpi one-segmented to absent (apex of abdomen not sclerotized); lacinia indistinct or absent; eye-spot absent; legs absent. (Suborders Clistogastra and Idiogastra) 13
2. Thoracic legs with claws 3
   Thoracic legs without claws 10
3. No segmented subanal appendages on the tenth abdominal segment, if setiferous subanal knobs are present see couplet 8 (Xyelidae); thoracic legs usually stout, short and irregular in shape; prolegs usually present 4
   Paired, segmented, subanal appendages present on the sternum of the tenth abdominal segment; thoracic legs slender, elongated and straight; prolegs absent . . . . . . Pamphiliidae
4. Claws on thoracic legs usually conspicuous and with a distinct pad or divergent lobe arising from the base of each tarsal (claw) segment 5
   Claws on thoracic legs usually small and without a pad arising from the base of the tarsal (claw) segment. (If pads occur they arise from the tibia) 6
5. Suckerlike lateral protuberances on abdominal segments 2 to 4 or 5 and 8 . . . . Acordulecceridae
   No suckerlike lateral protuberances on abdominal segments . . Argidae
6. Antennae with one (or two) segment(s) 7
   Antennae with more than two segments 8

1. Since this paper was in proof the larva of an additional hymenopterous family, the Rhopalosomatidae, has been described (Gurney, Ashley B., 1953, Proc. U. S. Nat. Mus., vol. 103, pp. 19-34). The mature larva would run to couplet 14 in this key, agreeing with the Vespidae, etc., in having two papillae (galea and palpus) on each maxilla. It differs from these families in the small rather than traverse and slit-shaped salivary opening and in the presence of a long spine on either side of the salivary opening. The cardo is not described and may not be recognizable. The structures which Gurney considered as eye-spots seem certainly to be something else; possibly they are pigmented spots at the anterior tentorial pits. The preceding larval stage has wholly different and much reduced mouthparts.

7. Mid-abdominal segments with seven annulets; spiracles definitely winged . . . . Cimbicidae
   Mid-abdominal segments with one to four annulets; spiracles not definitely winged . . . . (Fenusinae) Tenthredinidae
8. Antennae never with more than five segments 9
   Antennae with six or seven segments. (Prolegs on all abdominal segments; setiferous knobs or protuberances on the subanal areas of the caudal segment) . . . . Xyelidae
9. Antennae with three segments, the third peglike and the first and second incomplete, crescentic, flattened areas; prolegs present on abdominal segments 2 to 8 and 10 . . (Diprioninae) Diprionidae
   Antennae with four or five segments, if only three, all are complete or the third is short and not peglike; prolegs present on abdominal segments 2 to 6, 2 to 7, or 2 to 8 and 10, Tenthredinidae
10. Thoracic legs mammalike or absent; caudal segment with median sclerotized process 11
    Thoracic legs indistinctly four segmented but without claws; caudal segment without median sclerotized process. (Prolegs vestigial on segments 2 to 8 and 10, caudal pair united, forming a single protuberance) . . . . . . (Phyllotominae) Tenthredinidae
11. No subanal appendages present; eye-spot not pigmented 12
    Small and short subanal appendages present; eye-spot pigmented. (Antennae with four or five segments) . . . . Cephidae
12. Antennae one-segmented; labial palpi one- or two-segmented; metathoracic spiracles conspicuous . . . . Siricidae
    Antennae with three or four segments; labial palpi three-segmented; metathoracic spiracles vestigial . . . . Xiphydriidae
13. Salivary opening paired, each opening on a projecting process. Gasteruptionidae (subfamily Aulacinae) and Sphecidae (part)
    Salivary opening single (slit-shaped, oval, round) or absent 14
14. Maxillae each with two papillae (galea and palpus). (Cardo separated from stipes by sclerotic line or at least by a fold except in some ants) . . Vespidae, Scoliidae, Pompilidae, Formicidae,[1] Chrysididae, and Sphecidae (part)
    Maxillae with a single papilla (palpus) or without papillae . . . 15
15. Most conspicuous structures of head, other than the mandibles, the heavy framework of sclerotic rods which lie on the lines between the primary structures of mouthparts and front of head; labium and maxillae not produced; cardo and stipes separated by sclerotic rod, the former very large 21
    Lines between mouthparts and parts of head capsule not or feebly sclerotic; cardo and stipes fused or nearly so, without a conspicuous sclerotic rod between them 16
16. Mandibles and head structures not sclerotized, only visible with staining . . . . Ichneumonidae (subfamily Collyriinae)
    Mandibles and usually other parts of head and mouthparts recognizably sclerotic 17

1. In ants the galea and maxillary palpus are often represented by mere clusters of sensillae, or the palpus is represented by a single sensilla in *Atta*. The peculiar larvae of the ant *Leptanilla* (see Wheeler, 1928) does not run properly in this key.

17. Maxillae and labium projecting as distinct separate lobes, usually distinguishable to their bases; salivary opening usually a slit . . 20
    Maxillae and labium not projecting as separate lobes, either completely fused and indistinguishable or partly so; salivary opening sometimes a slit, more often oval, round, or absent 18
18. Mandible symmetrical about longitudinal axis, apex tridentate, middle tooth longest . . . . .Oryssidae
    Mandible asymmetrical, lower or outer tooth usually longer than others 19
19. Maxillae and labium reduced and usually indistinguishably fused; maxillary and labial palpi usually unrecognizable . . . .Chalcidoidea
    Maxillae and labium distinct apically; maxillary and labial palpi usually minute . . . . .Cynipoidea
20. Mandibles with apices simple or bidentate . . . . .Apoidea
    Mandibles with apices tridentate,
    Evaniidae, Gasteruptionidae (subfamily Gasteruptioninae)
21. Last abdominal segment ending in two slender hooks; mandibles large . . . . .Agriotypidae
    Last abdominal segment without hooks; mandibles small 21
22. Accessory longitudinal tracheal commissure present in thorax, Ichneumonidae (most)
    Accessory longitudinal tracheal commissure of thorax absent, Braconidae

EVOLUTIONARY TRENDS

With the aid of the data assembled in the preceding sections, it is possible to determine with some certainty whether some of the larval characters of bees are primitive or specialized. Thus, since setae are present on the bodies of the larva of primitive Hymenoptera, an obvious conclusion would be that setae on the bodies of bee larvae are primitive. Long and conspicuous antennal papillae and maxillary and labial palpi would be considered primitive compared to short ones or compared to the absence of these papillae and palpi, since these structures are several-segmented in the Chalastogastra and are represented by long and conspicuous papillae in most wasps. Among bees the antennae range from scarcely detectable convexities on the head capsule to distinct convex areas each bearing a cylindrical papilla, which may be as much as three times as long as broad. The palpi may be similarly long, or may be entirely absent.

The salivary opening, in most wasps, is a transverse slit at the apex of the labial lobe guarded by a pair of thin, sclerotized lips. Such a structure is found in vespids, pompilids, chrysidids, and in some sphecids. In other sphecids the salivary opening is divided, so that there are actually two such openings, each at the apex of a projection. This is a specialization of certain sphecids, a condition not repeated elsewhere among the Hymenoptera except in the Aulacinae and having no counterpart among the bees. Among bees, therefore, the slitlike opening guarded by distinct lips would seem to be the primitive condition. Reduction of the lips, and reduction of the slit to a straight or crescentic mark or to a small round hole must be specializations.

The mandibles provide some of the most distinctive characteristics of the various groups of bee larvae. The mandibles of most sphecoid and vespoid wasps, chrysidids, evaniids, gasteruptionids, and for that matter those of the Chalastogastra as well, have several large sharp apical teeth. The greatest number of such teeth found in mandibles of bee larvae is two and it seems likely that acute, rounded, or truncate mandibular apices are derived from the bidentate type. The bees are peculiar in having, in many cases, numerous small teeth along the margins, those of the upper margin forming a band which curves onto the inner surface forming a "cusp". For bees this condition is considered primitive since it seems readily derivable from that found in certain sphecoid wasps in which there is a tooth on the inner surface of the mandible. In bees the inner surface of the mandible beyond the cusp is often hollowed out and the hollow margined by a more or less distinct ridge. This hollow can be seen with the cusp still present in *Nomia, Augochlora,* and *Melissodes,* although the cusp is much reduced in the last. In most forms in which this concavity is well formed the cusp is gone, as are also most or all of the small teeth of the mandible. Although the concavity is a specialized character, it is obviously lost, a further specialization, in *Trigona* and *Apis* so that here its absence represents a greater specialization.

In most bees the apices of the mandibles are much narrower than the bases, often acutely pointed, yet the mandibles are not drawn out into long attenuate apices. In some, however, the apices are much attenuate. This may occur among relatives of bees with a cusp (e. g., *Colletes*) or as an obvious derivation from forms with a concavity and no cusp (e. g., *Trigona*).

Table 1 shows a list of eleven trends with the supposed primitive alternatives on the right, specialized alternatives on the left. Intermediate conditions occur in all cases, indicating intermediate degrees of specialization. All of these trends involve characters which, from our present meager knowledge, appear to be of generic or greater importance at least somewhere among the bees.

TABLE 1

Some trends involved in evolution of bee larvae, with primitive alternatives at the left, specialized, at the right. Characters are judged as to primitiveness on the basis of the Hymenoptera as a whole.

Primitive	*Specialized*
1. Setae present on body	1. Setae absent on body
2. Antennal papilla long	2. Antennal papilla absent
3. Maxillary and labial palpi long	3. Maxillary and labial palpi absent
4. Maxillae and labium distinct	4. Maxillae and labium fused
5. Salivary opening a large slit, with lips	5. Salivary opening small, round, without lips
6. Prementum and postmentum clearly separate	6. Prementum and postmentum indistinguishably fused
7. Mandibles with large apical teeth	7. Mandible acute, rounded or truncate
8. Mandibles with small teeth forming a cusp	8. Mandible without cusp
9. Mandible without defined inner concavity	9. Mandible with clearly defined inner apical concavity
10. Apex of mandible rather broad	10. Apex of mandible attenuate
11. Peritreme present	11. Peritreme absent

RELATIVE SPECIALIZATION OF PRINCIPAL TYPES OF BEE LARVAE

Considering the small number of bee larvae which are adequately known, it seems futile to attempt to establish a detailed scheme of relationships or phylogenetic tree based upon their characters. However, some general conclusions as to the light which the larval characters shed on relationships can be reached.

No known bee larva agrees with all of the primitive characteristics listed in table 1, nor is there any which agrees with all of the specialized features.

In general bee larvae may be divided into two large and intergrading groups, as shown below:

GROUP I	GROUP II
antennal papilla reduced or absent	antennal papilla distinct
mandible with a multidentate area or cusp on inner surface	mandible without cusp, but with apical inner concavity
salivary opening reduced, without lips	salivary opening a long transverse slit guarded by lips

In the first group fall the Colletidae, Halictidae, Andrenidae, Melittidae, and the genera *Neopasites, Nomada, Epeolus,* and *Triepeolus* of the Apidae. From adult characters it seems likely that *Exomalopsis* and its relatives would fall here too, were their larvae known. (*Colletes, Hylaeus, Euryglossa, Epeolus, Triepeolus* and one species of *Nomadopsis* lack the mandibular cusps but the mandibles are attenuate, showing no resemblance to those of group II. Other larval characters show the obvious relationship of *Epeolus* and *Triepeolus* to *Nomada,* which has cusps, and of the *Nomadopsis* to another species of the genus which has them.)

In the second group fall the Megachilidae and the Apidae (sense of Michener, 1944) except for the genera *Neopasites, Nomada, Epeolus,* and *Triepeolus.* (Antennal tubercles are reduced or absent in *Anthophora,* although not in the similar larva of *Melecta,* and in *Melipona, Trigona* and *Apis,* although not in the similar *Bombus.* The mandibular concavity is absent in *Stelis,* although not in the similar larvae of other megachilids, in *Ceratina,* although not in the similar *Xylocopa,* and in *Trigona* and *Apis* although not in the similar *Melipona.* The salivary opening is reduced in *Ceratina* and *Xylocopa.*

If table 1 is correct, as it appears to be from a survey of the characters of the order as a whole, it is obvious that neither the group I larvae nor the group II larvae can be established as primitive, since group I combines primitive mandibles with specialized antennae and salivary opening while group II combines specialized mandibles, with primitive antennae and salivary opening. Making use of other characters, one finds that labio-maxillary fusion, an obvious specialization, occurs principally in group I (*Colletes,* Panurginae, *Nomada, Triepeolus,* to a lesser extent in *Hesperapis* and the Halictidae). Setae on the body surface, presumably primitive, occur only in group II (Megachilidae, *Allodape,* a few in *Bombus*). Large apical mandibular teeth, another primitive character, are found in both groups but principally in group II.

It is evident that the larvae of Megachilidae exhibit more supposedly primitive characters than those of any other bees, agreeing with the primitive alternatives of all trends listed in table 1 except for numbers 8 and 9, which might almost be considered a single trend. If this conclusion is accepted, then the other bees having group II larvae are more specialized in larval characters than the Megachilidae, while the group I larvae have even more specialized features, some of them agreeing with the specialized alternatives of most of the trends except numbers 8 and 9 in table 1.

It is scarcely necessary to mention that the combining of primitive and specialized traits is very common, for probably no living animal is primitive in every character. One may speak of a certain structure process, or function as primitive in relation to another structure, process, or function with some degree of safety, but when one speaks of a primitive organism it must be with the understanding that it has some specialized characters.

REVERSIBILITY IN EVOLUTION

A comparison of the foregoing with what is known of bee phylogeny, based on adult characters (see Michener, 1944) reveals the curious fact that the group II larvae, *i. e.* those having a number of primitive characters, are associated not with the adults which have numerous primitive characters but with long-tongued adults of specialized groups. The phylogeny of bees, in its general outlines (e. g. evolution of the proboscis from a short one like that of wasps to a much elongated one), is so clear and is supported by so many adult characters that it can scarcely be doubted. Yet the summation of larval characters suggests an opposite evolutionary direction.

A further study of the larval characters themselves, however, shows that some of them do fit into the general picture of bee phylogeny. Those that do so are characters 8 and 9 of table 1. The way in which these characters have probably evolved will be shown below.

The remaining characters are all ones in which specialization involves reduction or loss; all structures involved are relatively simple, for example, papillae and setae. The specialized condition of these characters in primitive bees could be explained as a series of parallel developments. Thus, body setae may have been present in all of the ancestors along the phyletic line leading to the Megachilidae, and such setae lost independently in each of the stocks which branched from this phyletic line. The same might have been true of other structures, such as the antennal papillae.

For at least some of these characters, a different explanation seems probable, namely that the structures were lost (or reduced) in very early bee evolution and later regained. The explanation seems more probable because it avoids the hypothesis of very numerous parallelisms. Although the "law of irreversibility" in evolution or Dollo's "law" is well known, there are many exceptions to it. Muller (1939) pointed out that there is no genetic basis for it. Most structures are controlled by many genes so that exact reversion is most unlikely but it is obvious that where only one or a few genes are concerned, as might be the case where mere length of a papilla or palpus is concerned, exact reversion might occur as a result of reverse mutations. Another possible explanation for the apparent reversions in larval characters of bees may be that the structures are lost morphologically as a result of inhibiting factors or complexes but the genetic determinants for the structures retained. Later, if the inhibition were removed, the structures would reappear unless the loci which govern them were altered in function during the time when the structures were not being produced.

Thus it seems that while the relatively complicated mandibular structures do offer characters of easily understood phylogenetic value, the other structures considered, probably because of reversions, show a reversal of expected phylogenetic significance. If the hypotheses presented are correct, the primitive and specialized alternatives for these characters shown in table I should be reversed for the bees.

AN ACCOUNT OF EVOLUTION AMONG BEE LARVAE

As indicated previously, the larvae of sphecid wasps usually have mandibles with several large apical teeth. Presumably in association with the change of food from insects or spiders to pollen and honey, the mandibles of bee larvae became smaller and no known form retains more than two large apical teeth. The mandibles acquired many small teeth, some of them grouped to form a cusp on the inner surface some distance from the apex, so that there is a concave surface between the cusp and the apex. Larvae having such mandibles are found among the short-tongued families of bees and as already indicated, in certain genera of Apidae. Presumably this mandibular structure is in some way correlated with handling the pollen food for, with some exceptions, all bee larvae have such a concave space, although it is quite different in nature in some.

The most primitive of the bees would undoubtedly be placed in the Colletidae. In this family the mother bee applies to the inner surfaces of the cells a thin transparent or translucent substance. This seems to take the place of the cocoon spun by the larva in wasps, for colletids, unlike their presumed ancestors (Sphecidae) spin no cocoons. It seems likely that the cell lining of the colletids and the cocoon of the wasps serve for water conservation.

It is noteworthy that among bee larvae as a whole, those which do spin cocoons have larger antennal papillae and palpi than those that do not. Of course they also have a large salivary opening which takes the form of a transverse slit guarded by lips, while those which do not spin usually have the salivary opening reduced to a curved slit, an oval, or a circle, and while it is sometimes produced, it does not have lips. It seems reasonable to suppose that the antennae and palpi bear the sensillae that enable the larva to apply its silk properly in cocoon construction. Among forms which do not spin the palpi are often not so completely reduced as the antennal papillae. Therefore it seems not unlikely that the palpi also bear sensillae utilized in some other activity, perhaps eating.

Considering the above it is not surprising that the larvae of the Colletidae have reduced antennal tubercles and palpi and a reduced salivary opening (*i. e.* they are group I larvae), for they construct no cocoons. In the absence of the need for a cocoon, there would be mutation pressures against the organs making cocoon spinning possible with no corresponding selection pressures maintaining these organs. Indeed, because of competition among the organs for the nutrient materials available, the individuals without the organs necessary for spinning should be at an advantage in a mixed population.

Among the Colletidae three of the genera studied (*Hylaeus*, *Euryglossa* and *Colletes*, apparently also *Lonchopria*) have the apices of the mandibles reduced and attenuate, the cusp absent. Similar attenuation can be found among some of the other bees; the reason is unknown but a suggestion is that it occurs in groups whose provisions are usually liquid. Perhaps with such provisions mandibles are not very effective. That there is no universal correlation between mandibular structure and food consistency is shown, however, by the fact that a cuckoo bee larva often has quite different mandibles from the host whose provisions it eats (compare, for example, *Triepeolus* and *Melissodes*).

The Halictidae, Andrenidae and Melittidae, like the Colletidae, have group I larvae with mandibular cusps and with reduced antennal papillae, palpi, and salivary openings. The cells are lined with a very thin layer of wax, so that cocoons are presumably unnecessary. Systropha, however, is reported to spin a cocoon. It may be that, like the higher bees, it has reacquired (or retained?) the necessary organs.

The genus *Neopasites* has larvae which, in head characters, are amazingly like certain halictids. *Nomada* likewise has larvae with mandibular cusps, reduced salivary opening, etc. *Epeolus* and *Triepeolus* are similar to *Nomada* except that their mandibles are attenuate, the cusps gone. All of these genera are parasitic, but it may be that their pollen-collecting ancestors among the Exomalopsini have similar group I larvae. Unfortunately larvae of Exomalopsini are virtually unknown. Claude-Joseph (1926) briefly describes and figures the larva of *Exomalopsis*. Details of mandibular structure are not shown, but the small salivary opening suggests a group I larva. The antennal papillae and palpi seem elongate, however, as in group II larvae. At least some of the more

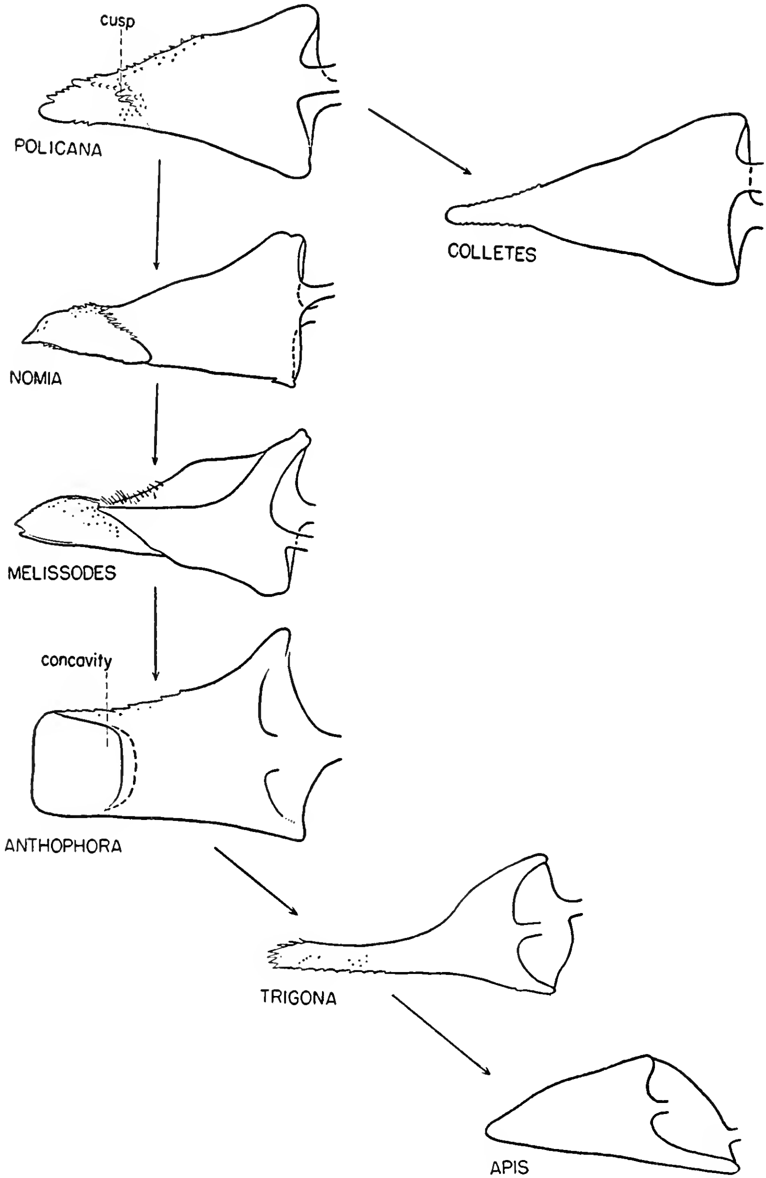


FIG. 1. Inner views of mandibles of various bee larvae showing the development of mandibular structure. The vertical series illustrates reduction and loss of the multidentate cusp and development of the carina surrounding the inner apical concavity of the mandible. The offshoots to the right illustrate attenuation and reduction of the mandibular apices.

primitive Apidae (sense of Michener, 1944) have larvae much more like those of the short-tongued families than those of the other Apidae and the Megachilidae. This means that, unless the mandibular structure of the type II larva arose twice, the Megachilidae arose from apid ancestors rather than from preapid ancestors as indicated by me in 1944. It suggests, furthermore, that *Neopasites, Nomada, Epeolus,* etc., together with the Exomalopsini might constitute a subfamily (or family) division co-ordinate with the Xylocopinae, Anthophorinae, Apinae, and Fideliinae. This division would be called the Nomadinae. Its limits are unknown at present. Further study may indicate adult characters by which it can be recognized. An alternative explanation of the occurrence of group I larvae among the parasitic Apidae (*Neopasites, Nomada, Epeolus, Triepeolus*) is that these larvae have mandibles, antennae, and palpi adapted to the type of nest and provisions supplied by their hosts. This suggestion could explain the characteristics of the first three genera listed for they are parasites of bees having group I larvae. *Triepeolus,* however, as already stated, is a parasite of *Melissodes* which has fairly typical group II larvae although remnants of mandibular cusps persist.

The larva of *Nomada* is so similar to those of *Epeolus* and *Triepeolus* as to lend weight to a conclusion reached from a study of adults of South American forms, namely that the Nomadini, Osirini, and Epeolini had a common parasitic ancestor. Details of this will be published elsewhere.

In certain group I larvae (e. g. *Augochlora,* in the Halictidae), the space between the cusp and the apex of the mandible is strongly concave and the concavity is bordered by a sharp line or ridge cutting obliquely across the mandible. In group II larvae (Megachilidae and Apidae except *Neopasites, Nomada, Epeolus,* and their relatives) the cusp, and usually the small teeth of the mandibular margins, are gone but a distinct inner apical concavity exists, margined basally by a transverse or oblique line or ridge. In *Melissodes* a small remnant of a cusp is retained and the line margining the concavity is oblique; in others (e. g. *Emphor*), the cusp is entirely gone, the line oblique; in most group II larvae, however, the line is transverse. As among the group I larvae, there are group II forms in which the mandible becomes attenuate and loses its characteristics group features. This is true of *Ceratina, Trigona, Apis,* and some species of *Stelis.* In *Apis* the mandible is so reduced as to not even be attenuate, as there is no longer a projecting apex.

More or less concurrently in phyletic history with the development of the type of mandible usual for type II larvae came the return to cocoon spinning habits. This may be associated with the fact that many of the bees of this lineage fail to line their cells with wax or other waterproof material. The Megachilidae, for example, do not do so. In any event the cocoon spinners among the bees have, as already indicated, larger antennae and palpi than others and large salivary openings with lips. It is interesting that, although obviously a group II larva, cocoon spinning has been abandoned in *Anthophora.* Its antennal papillae are reduced, as are its palpi. Most interestingly, its salivary opening, while of the shape of that of a typical group II larva, is much reduced in size, moved dorsally and no longer at the apex of the labium, and is provided with small nonsclerotic lips.

The larvae of the Xylocopinae are an exception to the rule that forms with reduced salivary openings also have reduced antennae, for the antennal papillae are of moderate size in spite of extreme reduction of salivary openings.

With regard to the setae on the bodies of larvae, it is remarkable that they are present only on a few of the most specialized of the groups of bees. Thus, scattered setae occur in the social genus *Bombus,* while setae are more numerous on the bodies of at least some groups of subsocial *Allodape,* and on megachilids which are among the most specialized of the solitary bees.

Some of the best specific characters found among bee larvae occur among the spiracles. Thus Ritcher (1933) was able to distinguish every species of *Bombus* larva available to him by means of the spiracles, and often these were the only specific characters detected. Although they may provide generic characters, the spiracles do not provide much help in the recognition of higher categories. Their various features suggest an endless series of recombinations of a few characteristics. The spines of the atrium, the spines of the subatrium, the peritreme, the collar, etc., may be large, small, or absent, each apparently without regard to the condition of the other structures.

The functional significance, if any, of the spiracular spines and other spiracular ornamentation is unknown. Possibly these structures are of value in keeping pollen grains out of the openings. If so, the variability might be correlated to some extent with variability in the kinds of pollen utilized by the bees. It is possibly significant that the only bee larva known to me in which important differences exist between anterior and posterior spiracles is the first stage larva of *Coelioxys,* in which the posterior spiracles are much larger than the others. The first stage larva lives within the rather liquid provisions of *Megachile,* not on the surface as does the *Megachile* and as does the *Coelioxys* also after the first stage.

The elevations or tubercles of the larval body also vary, like the spiracular characters, in an apparently meaningless manner. In general the tubercles seem higher and more consistently present in group I larvae than in group II larvae, but this is only a tendency.

As is well known (Brauns, 1926; Rayment, 1951) the larvae of certain Ceratinini (some species of *Allodape, Exoneura*) have peculiarly elongate and modified ventrolateral projections on the anterior part of the body which are used in holding the small quantities of pollen offered the larvae by these bees, which feed the larvae progressively. Other species of *Allodape* are provided with numerous body tubercles arranged in more than the usual series (dorsolateral and ventrolateral) found in other bee larvae. Apparently these serve to anchor the larvae in groups on the insides of hollow stems where they are fed progressively.

A long known peculiarity of some parasitic bee larvae is the great size of the head and mandibles of the first stage larva. It is in this stage that larvae of these cockoo bees destroy the egg or larva of their host. This condition occurs in quite unrelated parasites, for example, *Coelioxys* (Megachilidae), *Triepeolus* (Apidae), and *Melecta* (Apidae).

SOME GENERAL PROBLEMS OF LARVAL EVOLUTION

Certain general problems concerning larval forms which have been more or less evident to entomologists for many years are perhaps worth brief consideration here. The problems involved are incorporated into the following question: How does it happen that larvae can evolve in quite different directions and at different rates from adults, adapting themselves to different food requirements, habitats, and the like?

As to rates, it must of course be remembered that what is meant is rates of phenotypic evolution; there can be no differences in rates of true or genotypic evolution between larvae and adults.

It should be pointed out that mutations affect processes, and only indirectly, characters (see Beadle, 1945, 1946). A given process may influence only early development, only late development, or both. A mutation that affects a process influencing only a certain portion of the development might affect principally larval characters, since the cells which will develop into the adult structures are segregated into primordia which do not develop much until larval life is well along, or it might affect only adult characters if its influence is not felt until late in development. A mutation may affect a process influencing characters of selective value in one state (e. g. the larva) and other characters of little selective value in another stage. It may influence characters visible phenotypically and externally in one stage, but not in the other.

It is thus evident that the basis exists for the appearance and subsequent selection of characters of one stage in the life history, with little effect on other stages. Of course since larva and adult are the same individual, selection will depend upon success in both stages; it cannot act independently on either. Fundamentally the situation is little different from that which makes it possible for the young of animals without metamorphosis to have distinctive features (e. g. immature plumages of birds) different from those of the adult and subject to their own partially independent evolutionary development.

The segregation of larval from adult characters is certainly exaggerated in holometabolous insects. Possibly this is due in part to the fact that, at least in *Drosophila* and *Tineola,* larval and adult structures are determined at different times during development. Thus there is a time when minor injuries to the egg will cause larval but not adult defects, a later time when they will cause adult but not larval defects. (For a brief summary of our knowledge in this connection, see Wigglesworth, 1950.)

Rapid evolution of one stage, without comparable change in the other, could easily result and is not fundamentally different from another common phenomenon, namely rapid evolution of one structure or group of structures while the others remain little changed. In this light it is easy to see that larval characters are merely more characters, of no more systematic value and of no less, than adult characters.

TECHNIQUES

All studies were based upon larvae preserved in alcohol. This is best done by dropping live larvae into nearly boiling water for a few minutes before they are transferred to 70% alcohol. The material available, however, having been preserved by various collectors and at different times and in different ways, is in many different states of preservation and the drawings of whole larvae are undoubtedly adversely affected by this, for some specimens were badly shriveled. It should be pointed out also that last stage larvae vary greatly in shape, size of the tubercles, and the like according to their age. Two drawings of *Emphor* larvae are presented to illustrate a perhaps extreme example of this point. For most species only a few last stage larvae and these of unknown age, were available. There is no doubt, however, that in most instances the hibernating form is the one illustrated.

In order to study the mandibles in detail they may be removed from the head and cleared with caustic, or the whole head treated in the same manner. Spiracles were studied by removing them with a bit of adjoining integument and boiling in caustic. The parts so treated can be stained with acid fuchsin if necessary, and were examined in drops of glycerin so that, even under high magnification they could be moved about for study. For preservation such parts were placed in alcohol in small vials within the larger vial containing the rest of the larva.

Illustrations of heads were prepared from a study of the whole head both before and after clearing in caustic.

Illustrations of the mandibles were prepared by removing a mandible from the head and examining it in glycerin. Orientation was by means of the mandibular apodemes and articulations. In the inner view the adductor apodeme is as nearly as possible directly above the abductor while in the ventral (or dorsal) view the points of articulation are one above the other and the apodemes are at lateral extremities of the mandibular base.

Illustrations of spiracles were prepared with the aid of a compound microscope. Because of the need for frequent reorientation of the specimens, oil immersion was rarely used. Lateral views of spiracles are optical sections, while facial views show structures visible at all levels.

EXTERNAL MORPHOLOGY OF ANTHOPHORA STANFORDIANA COCKERELL

The following morphological account, based on the mature larva, is presented in order to provide a basis for the terminology used elsewhere in this paper and as a contribution to the general fund of knowledge on insect morphology. *Anthophora* was selected, not only because its larvae were available in numbers but because it is the genus utilized for a comparable study of adult morphology (see Michener, 1944).

The larva is grublike, robust, curved, with no separation between the thorax and the abdomen (figure 7). The color is yellowish white, the spiracular peritremes and the harder parts of the head brownish, the apices of the mandibles black.

The *head* (figures 8 to 11) is rounded, that part above (not including) the maxillae slightly sclerotic, this sclerotized portion which may be called the *head capsule* thickened and slightly inflexed along posterior margin. At each lower posterior angle of the head capsule there is a deep invagination into the *posterior tentorial pit.* The thickening along the posterior margin of the head capsule (termed postocciput by Vance and Smith, 1933) is directly connected with the posterior tentorial arms and continues anteriorly as the *hypostomal thickening* along the lateral margins of the head capsule to the bases of the mandibles. [These thickenings are termed habenae by Stärke (1949).] From each lower (i. e. posterior) mandibular articulation the marginal thickening of the head capsule bends dorsally as the *pleurostomal thickening,* extending around the posterior margin of the mandibular corium to the anterior mandibular articulation where it meets with the thickening which is the internal evidence of the epistomal suture. This entire thickening (including hypostomal and pleurostomal thickenings) may be called the *marginal thickening of the head capsule.* The *cleavage lines* (see Snodgrass, 1947) or epicranial suture are weak, λ-shaped, the unpaired portion appearing rather thick, the arms feeble, appearing as scarcely recognizable creases. Each *antenna* is a blisterlike convexity with a darkened center. The *parietal bands* are ill defined, slightly differentiated areas of cuticle (termed optic plate by Nelson, 1924, temporal fossa by Vance and Smith, 1933, and *bandarella temporale* by Grandi, 1934, etc.). The *epistomal suture,* separating the *clypeus* [1] from the *frons,* arches between the anterior mandibular articulations, which are in deep pockets or *precoilae* (Ritcher, 1933) beneath the sides of the clypeus. The epistomal suture is feeble medially and is marked internally by a ridge (likewise weak medially) which is connected laterally to the marginal thickening of the head capsule. The anterior tentorial arms arise from this internal ridge above and mesad of the precoilae. The *labroclypeal suture* is a mere fold. The *labrum* is a thick projection from the lower margin of the clypeus which bears apically a pair of tubercles, the *labral tubercles.* Beneath the labrum is a transverse slit, the *mouth,* leading

1. Du Porte (1946) considers this structure as the frontoclypeus. However, I see no reason for disregarding the evidence provided by muscular attachments emphasized by Snodgrass (1947), and have therefore followed Snodgrass in the interpretation of the face.

Since this paper was in proof a subsequent paper (Du Porte, E. Melville and R. S. Bigelow, 1953, Canadian Jour. Zool., vol. 31, pp. 20-29) greatly modifies Du Porte's earlier (1946) views.

into the foregut, the floor of which, a short distance behind the mouth, is marked by a transverse fold. Below the mouth is the small convex *hypopharynx*. The *salivary opening* is a transverse slit, shorter than the mouth, between two thin sclerotized projecting lips.

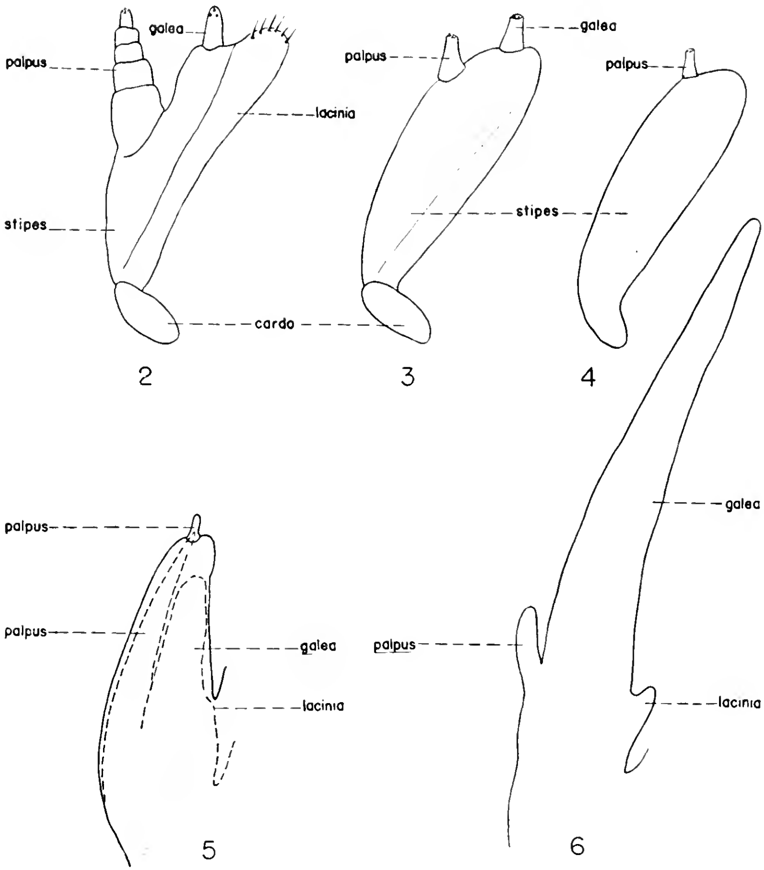
The labium, hypopharynx, and to some extent the maxillae form a single complex of fused or partially fused parts.

For morphological purposes it is assumed that the salivary opening is a suitable landmark lying between the hypopharynx and the prementum. From a study of *Anthophora* alone this would not be questioned, since in this genus the lips of the salivary opening are in a feeble transverse groove which seems to be the premental-hypopharyngeal line. In most other bee larvae studied a more distinct transverse groove exists in about the same position; however, the salivary opening is more apical in position on the labio-hypopharyngeal lobe and not in or near the groove. The groove, here called the *hypopharyngeal groove,* cannot be the premental-hypopharyngeal line if the salivary opening is the true landmark. Nonetheless, for descriptive purposes, the area basal to this groove is called the hypopharynx, that distal to it the prementum. This is done because the hypopharynx in this sense is frequently distinctively spiculate while the area beyond the hypopharyngeal groove is usually like the prementum in surface characteristics. Dobrovsky (1951) calls the entire region the labium-hypopharynx without attempting to differentiate the two components. The simpler expression "labial lobe" has been used in the descriptions which follow.

The *mandibles* are distinctly sclerotic, truncate, the inner apical surface concave, this concavity limited basally by an arcuate carina. The broad membranous *mandibular corium* lies between the mandibular articulations.

The *maxillae* are fleshy, with no separation of cardines and stipites. [Some bees (some megachilids, halictids, and *Bombus*) have a small faintly sclerotic area on the outer surface of the maxilla at its base (posterior end) which represents the cardo, and extending distad from this a weakly sclerotic ribbon described below as the labio-maxillary rod.] Near the apex of each maxilla is a projecting, slightly sclerotic papilla, the *maxillary palpus.*

Various authors (e. g. Kellogg, 1902, and Nelson, 1924) have correctly interpreted this structure. Ritcher (1933) in an important paper on bumblebee larvae, challenges this view and on the basis of ontogenetic evidence states that the papilla is not the palpus but



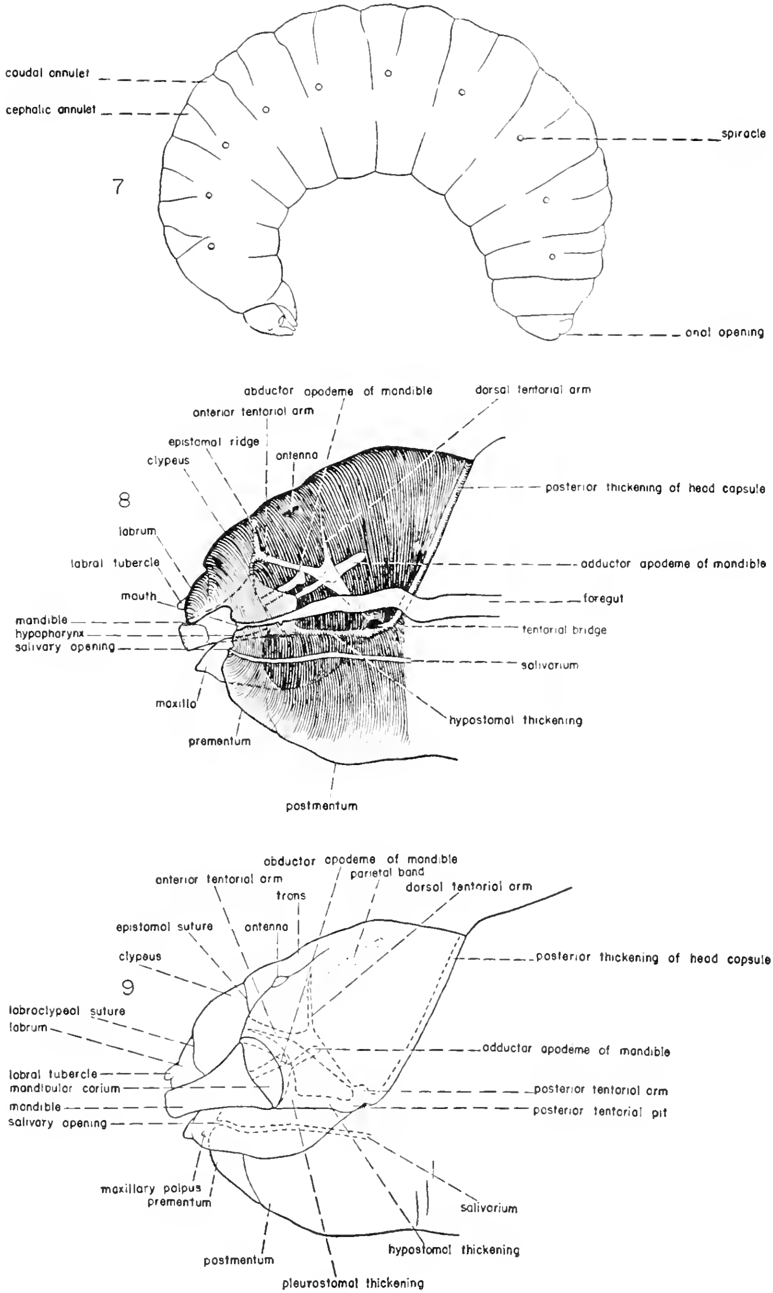
FIGS. 2-6. 2. Diagram of maxilla of larva of Tenthredinidae. 3. Diagram of maxilla of larva of Sphecidae. 4. Diagram of maxilla of larva of Anthophorinae. 5. Ventral view of right maxilla of larva *Bombus americanorum*, showing by broken lines the developing pupal maxilla within. 6. Ventral view of right maxilla of an individual of *Bombus americanorum* as it is becoming a pupa.

is the distal part of the galea. It is clear that he misinterpreted the evidence before him, however, largely due to the fact that in the adult and pupal *Bombus* the galea is a very large structure and the palpus very small. Grandi (1934a) shows clearly, by a series of developmental stages, that in *Polistes*, which has two maxillary papillae, the outer one is the palpus. In those sphecoid wasps in which one of the two papillae is reduced in size, it is the inner one; thus one might presume that the remaining one in the bees would be the outer one, or palpus. A re-examination of the developmental stages in *Bombus* clearly establishes this surmise. As time for pupation approaches, the larval maxilla is seen to contain two projecting processes, the longest and most slender reaching the larval palpus, the other shorter (fig. 5) and reaching toward the tip of the maxilla but not toward the palpus. It was perhaps natural for Ritcher to conclude that the longer process must represent the galea, which is so long in the pupa and adult. This leaves the inner process unexplained, however. The obvious conclusion is that the outer process, in spite of its length, represents the palpus, the inner the galea, and a weak convexity on the inner surface of the developing pupal maxilla the lacinia. That this interpretation is correct is shown in figure 6, a diagram of the maxilla of a pupa which had recently emerged from the last larval skin. In this individual the processes can readily be homologized with adult structures, and almost equally readily, with the processes of the pupal maxilla seen within the larval maxilla. The phylogenetic series of larval galeae also supports this interpretation (see figures 2 to 4).

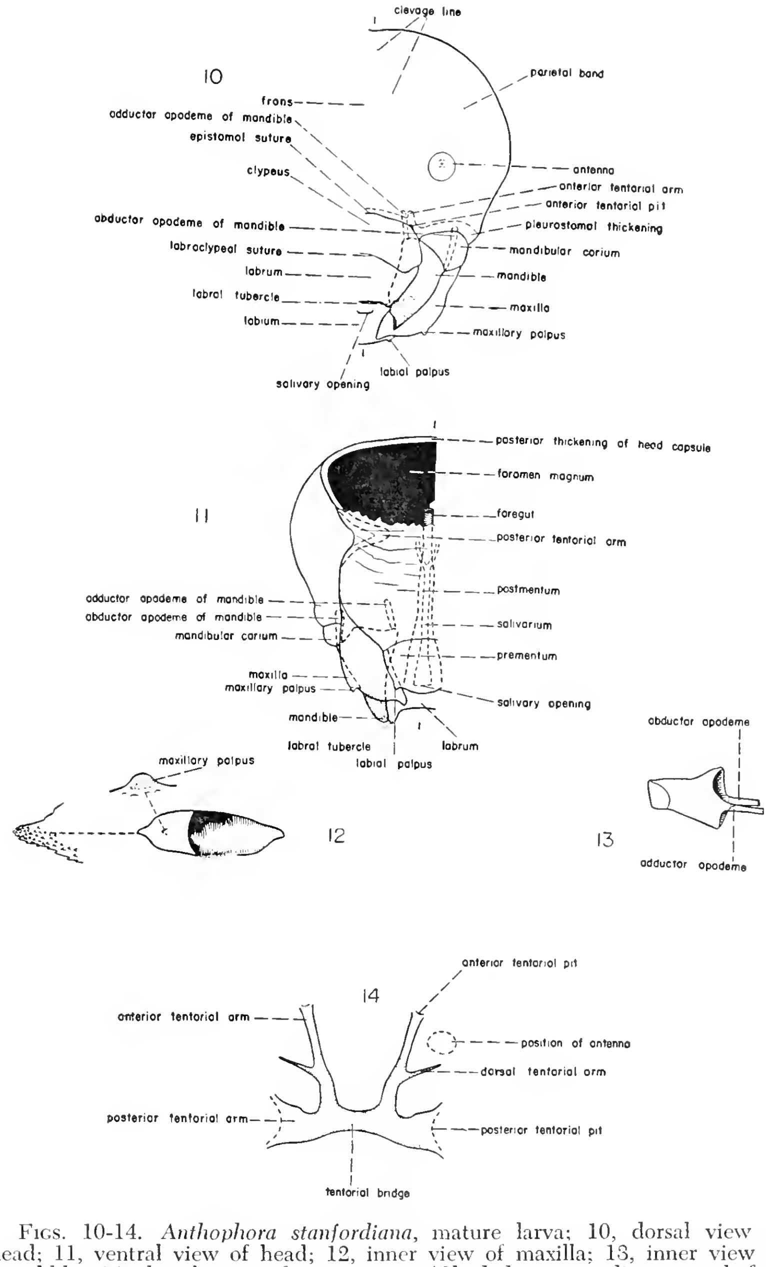
The upper margin of the maxilla, beneath the hypostomal thickening of the head capsule, is curved inward to form a furrow. Nelson (1924) calls this the lateral furrow but it is more accurately termed the hypostomal furrow. In many aculeate Hymenoptera there is a sclerotic rod or thickening marking the union between the maxilla and the postmentum (see Snodgrass, 1935, and Ritcher, 1933). The upper or posterior end of this rod is connected with the hypostomal thickening. This rod is very feeble in *Anthophora*, but is termed the *labiomaxillary rod* or thickening. This structure is present in the tenthredinids, as a fragmentum of the stipes which supports the lacinia, or perhaps as a basal prolongation of the lacinia itself so that the latter contacts the cardo. Its reduction is clearly shown in the series of maxillae (figures 2 to 4).

The labium is divided by a weak transverse furrow into two parts which, following Snodgrass (1935), are termed the *postmentum* and *prementum*. The prementum bears a pair of apical tubercles which appear to represent labial palpi (see Ritcher, 1933).

The *tentorium* in larvae which are not preparing to molt consists of *posterior tentorial arms*, united by a *tentorial bridge*, connected to the *anterior tentorial arms* which give rise to the slender *dorsal tentorial arms*. As shown in figure 14, the bridge, the dorsal arms, and the posterior halves of the anterior arms disappear before the pupal molt, probably before every molt since molting would seem to be impossible with the tentorium intact. The portions which do not disappear are more heavily sclerotic than the remainder of the tentorium.



FIGS. 7-9. *Anthophora stanfordiana*, mature larva; 7, lateral view; 8, head cut on saggital line to show internal skeletal structures; 9, lateral view of head.



FIGS. 10-14. *Anthophora stanfordiana*, mature larva; 10, dorsal view of head; 11, ventral view of head; 12, inner view of maxilla; 13, inner view of mandible; 14, dorsal view of tentorium. (Shaded portion disappears before the molt into pupal stage.)

There are thirteen *postcephalic segments,* three *thoracic* and ten *abdominal.* The intersegmental lines between the thoracic segments are absent laterally; they are weakened laterally on the abdomen. The tergal regions of most of the segments are divided by a transverse furrow into a *cephalic annulet* which is transversely wrinkled and a *caudal annulet* which is not wrinkled and is convex dorsolaterally, forming very weak *dorsolateral tubercles.* It is produced in some bee larvae to form distinct tubercles. In others there are tubercles below the line of spiracles, termed *ventrolateral tu-*

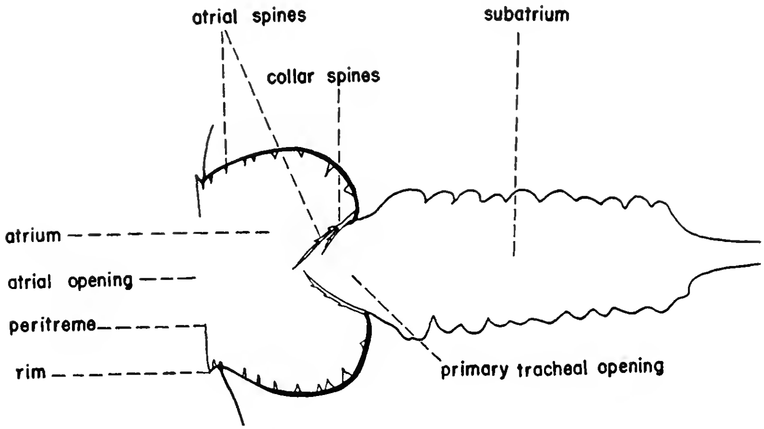


FIG. 15. Longitudinal sectional view of spiracle of *Anthophora stanfordiana.*

bercles. The last body segment bears an arcuate slit, the *anal opening.*

There are ten pairs of spiracles, two thoracic and eight abdominal, all round. The *primary tracheal opening* lies between the cup-shaped, heavy-walled *atrium* and the annulated *subatrium* which extends inward to a sharp constriction in the trachea. The primary tracheal opening is guarded by long serrate or toothed spines forming a collar. The atrium is lined with rows of small spines arising from ridges. These spines together with the collar spines are called *atrial spines.* The walls of the atrim extend above the general body surface and flare slightly to form a sharp *rim.* The transparent *peritreme* extends inward from the rim, narrowing the *atrial opening.*

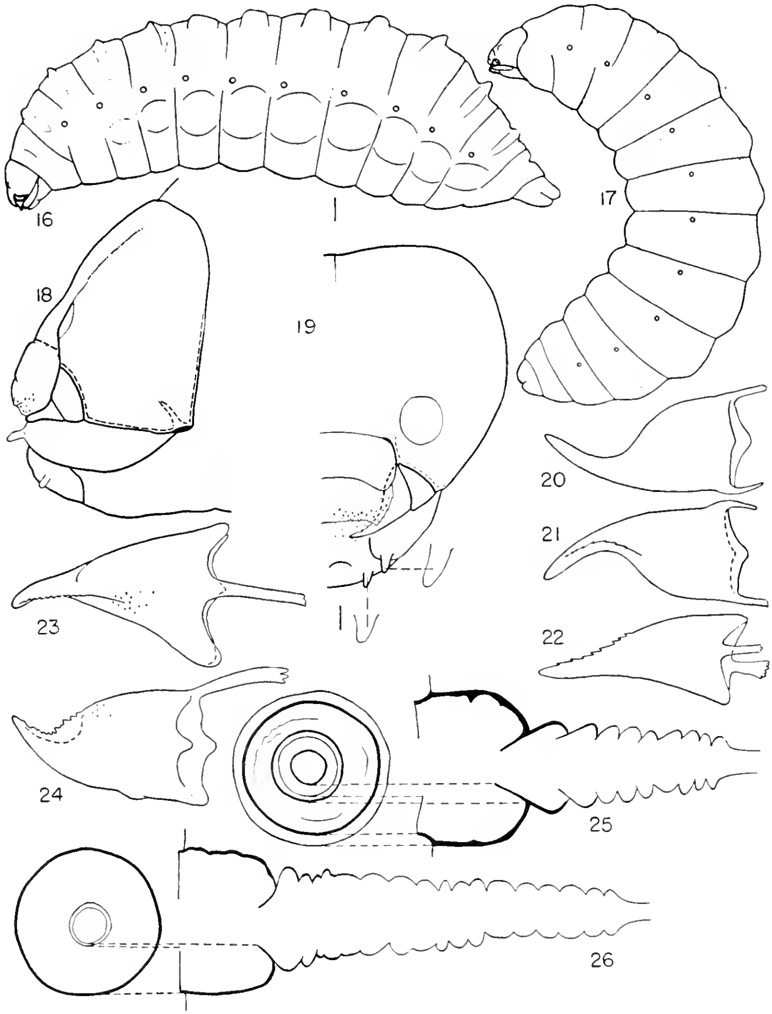
DESCRIPTIVE ACCOUNTS

FAMILY COLLETIDAE

This family contains rather diverse elements, both on the basis of larval and of adult structures. As indicated elsewhere, the larvae lack certain primitive features which they would be expected to exhibit in view of the primitive mouthparts of the adults. Outstanding among these is the reduction of the salivary opening from a straight transverse slit guarded by sclerotic lips to small snoutlike projection (*Caupolicana* and *Policana*), a small curved slit without lips (*Hylaeus* and *Euryglossa*), or an apparently closed scar (*Colletes*). This reduction is doubtless correlated with the fact that these larvae spin no cocoons. Presumably it is unnecessary for them to do so, since their cells are lined with a smooth transparent material secreted by the adult female. Perhaps for this reason the antennal papillae are reduced, another specialized feature. Mandibles of colletids do not show the large apical teeth which characterize wasp larvae but are instead acute in known forms. Those of *Caupolicana* and *Policana* have the subapical multidentate inner cusp which appears to be a primitive feature among bee larvae but the others lack the cusp and have the mandibles apically attenuate. In a number of other features also *Caupolicana* and *Policana* show a close relationship. (For example, the subapical maxillary palpus, the short labrum compared to the clypeus, and the spinose atrium and subatrium.) For these reasons I approve of the relationships of these groups indicated in Moure's (1945) classification based upon the adults.

The relationship of *Euryglossa* and *Hylaeus*, evident also in adults, is supported by the similar mandibles and salivary openings of the larvae and especially by the spiracles, which in these two genera differ from other colletids studied in having atria produced above the body surface.

Unfortunately larvae contribute nothing to the question of the relationships between the Hylaeinae and Euryglossinae on the one hand and the Colletinae, Paracolletinae, etc. on the other. These groups are held together as the family Colletidae almost solely because of the primitive wasplike mouthparts of the adults. There seems to be no group of characters which will unite the larvae of the Colletidae and distinguish them from the Halictidae and Andrenidae; neither are there characters which show that any of the colletids are closely related to any other bees and that the family should be split.



FIGS. 16-26. 16, *Euryglossa fasciatella*, larva; 17, *Hylaeus* sp?, larva; 18, lateral view of head of same; 19, dorsal view of head of same; 20, 21, 22, ventral, dorsal and inner views of mandible of same; 23, 24, inner and ventral views of mandible of *Euryglossa fasciatella;* 25, spiracle of same; 26, spiracle of *Hylaeus* sp.

Hylaeus sp?

(Figs. 17-22, 26)

The larva is rather slender, with the intersegmental lines conspicuous ventrally but indicated only by broad concavities dorsally and laterally. The annulets of the segments are scarcely separated from one another. Feeble dorsolateral tubercles are present on the dorsum high above the spiracles; except for these tubercles the body is faintly transversely wrinkled. Rounded ventrolateral tubercles are feebly in evidence.

Head capsule and mouthparts without setae; labrum and hypopharynx finely spiculate; head capsule weakly sclerotized without much constriction between head and thorax. Marginal thickening of head capsule very weak, posterior tentorial pits small and tentorial arms slender; epistomal suture weak, its position indicated by a depression arching between bases of mandibles; cleavage line (and dorsal longitudinal median thickening of head capsule) scarcely evident. Antennae mere convexities; clypeolabral suture weak, labrum with small labral tubercles, as in *Anthophora*. Mandibles with attenuate, pointed, apices, their upper margins with a row of small teeth. Maxillae with apices not bent inward, maxillary palpi more than twice as long as broad; hypostomal furrow shallow; salivary opening small, crescentic, at apex of labial lobe; labial palpi longer than broad, weak furrow between postmentum and prementum.

Body without spicules or setae. Spiracular atria without spines, its walls projecting slightly beyond body surface, peritreme flat, primary spiracular opening narrowed by a collar.

Mineral King, Tulare County, California, August, 1939 (Bohart).

Hylaeus variegata (Fabricius)

Stöckhert (1922) describes the larva of this species briefly. So far as can be determined, it is similar to that described above, although the dorsolateral tubercles are probably sharper.

Euryglossa fasciatella Cockerell

(Figs. 16, 23-25)

This larva is rather slender, similar in many ways to that of *Hylaeus,* with the intersegmental lines conspicuous ventrally, rather weak dorsally. The dorsolateral tubercles are much higher than in *Hylaeus* and are transverse but reach neither the middorsal line nor the level of the spiracles. The ventrolateral tubercles are rather distinct, small and rounded.

Head capsule and mouthparts without setae, head capsule slightly more sclerotized than in *Hylaeus* and less broadly attached to thorax. Marginal thickening of head capsule present although weak, posterior tentorial pits more conspicuous than in *Hylaeus.* Epistomal suture indicated by a shallow trough arched between bases of mandibles, thickening apparent in this trough only laterally; antennae indicated by weak convexities; labroclypeal suture indicated by distinct furrow, lower margin of labrum beneath the small labral tubercles with a band of minute setae. Mandibles pointed, more robust than in *Hylaeus*, with sharp serrate ridge on inner surface apically. Maxillary palpi conical, about as long as broad; salivary opening not clearly recognizable, not provided with produced lips; labial palpi small, rather close together, conical, broader than long; furrow between postmentum and prementum inconspicuous.

Body without spicules or setae. Spiracles with atrium without spines (but with broken ridges), projecting beyond body surface, peritreme flat, primary tracheal opening narrowed by collar.

A single specimen is available without locality data but marked 14 months old. It is from the collection of the U. S. National Museum.

Chilicola spp.

Claude-Joseph (1926) describes and figures the larvae of *C. inermis* Friese and *C. friesei* Herbst. His brief accounts, and figures which show few details, indicate a larva similar to that of *Hylaeus*.

Colletes fulgidus Swenk

(Figs. 27, 30-33, 35)

The larva is similar to *Hylaeus*, a little more robust, with the dorsolateral tubercles large though broad and rounded, extending downward nearly to the level of the spiracles. The ventrolateral tubercles are absent.

Head capsule as described for *Hylaeus* but tentorium virtually absent,* epistomal suture represented by thickening of cuticle arching between mandibular bases, labroclypeal suture weak, strongly arched. Antennae represented by distinct swellings. Mandibles with attenuate apices finely serrate on both margins. Salivary opening apparently closed but duct present; a furrow separates hypopharynx from upper margin of prementum.

Spiracular atria shallow, without spines, with a few broken circular ridges; peritreme large; primary tracheal opening wide but provided with a small collar.

Bodega Bay, Sonoma County, California, January 14, 1948 (MacSwain) and Montara, San Mateo County, California, September, 1940 (MacSwain).

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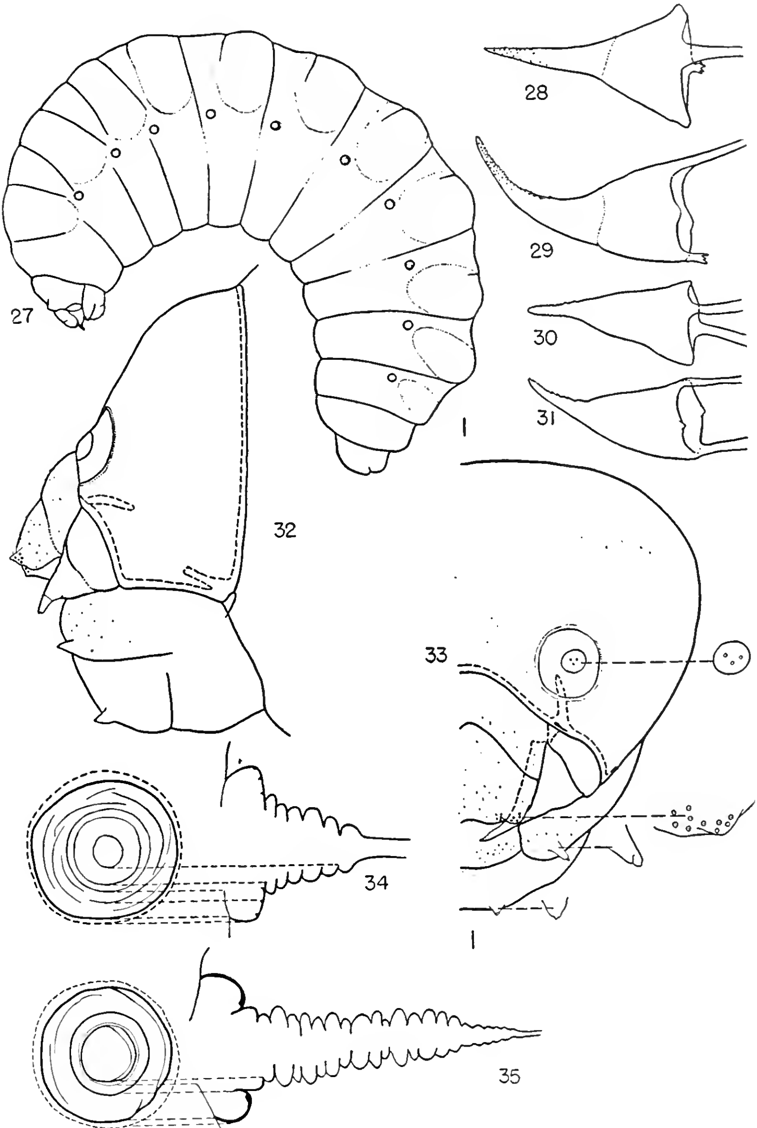
* It is presumably present in feeding stages but, as indicated in the section on *Anthophora* morphology, the tentorium largely disappears before a molt.



FIGS. 27-35. 27, *Colletes fulgidus*, larva; 28, 29, inner and ventral views of mandible of *Colletes araucariae;* 30, 31, inner and ventral views of mandible of *Colletes fulgidus;* 32, 33, lateral and dorsal views of head of same; 34, spiracle of *Colletes araucariae;* 35, spiracle of *Colletes fulgidus.*

Colletes araucariae Friese

(Figs. 28, 29, 34)

The larva, first described by Claude-Joseph (1926), is similar to that of *C. fulgidus* but the labral tubercles more pronounced; the mandibles are longer, crossing near their apices, and minutely spiculate apically on the inner surfaces. The spiracles have atria which are broader and shallower, with more broken internal ridges. The peritreme is smaller. There is no distinct collar around the primary tracheal opening. The subatrium is very short.

Correo Nuñoa, Chile (Claude-Joseph) (one specimen).

Colletes succinctus (Linnaeus)

Mayet (1875) described and figured the larva of this species. His figures are not very detailed, but there are no obvious differences indicated between his species and *C. fulgidus.*

Colletes spp.

Claude-Joseph (1926) describes and figures larvae of *C. laticeps* Friese and *C. ciliatus* Friese. The illustrations of the heads are not detailed but show structures not widely different from those of *C. fulgidus.* The body apparently bears no tubercles in *C. laticeps* and only ventrolateral tubercles in *C. ciliatus.*

Lonchopria marginata Spinola

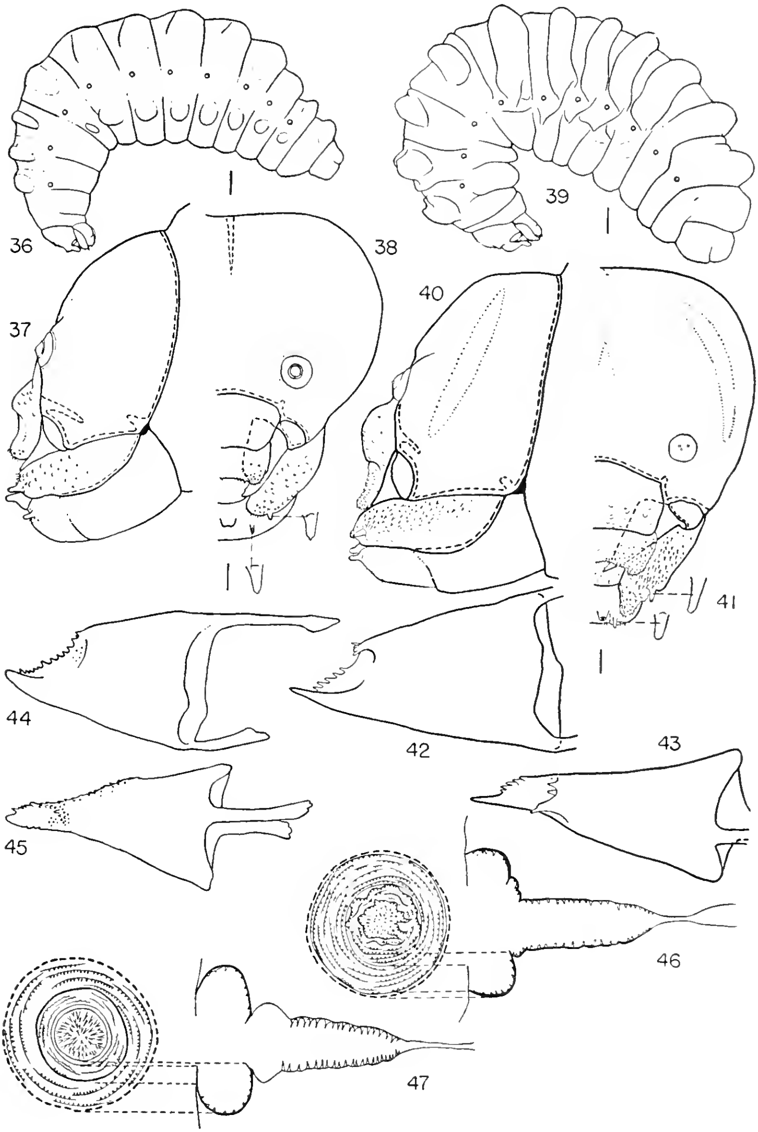
The larva of this species, described and figured by Claude-Joseph (1926), seems similar to that of *Colletes,* at least in its attenuate mandibular apices. The body of the larva apparently lacks all evidence of tubercles.

Policana herbsti Friese

(Figs. 36-38, 44-46)

The larva first described by Claude-Joseph (1926) is rather robust, strongly tuberculate, with the dorsolateral tubercles transverse, nearly meeting on the middorsal line, not extending downward to the level of the spiracles at the sides. The ventrolateral tubercles are conspicuous, rounded, present on the first eight abdominal segments, those of the first small. The intersegmental lines are deep, strongly constricted dorsally and ventrally, but weak laterally. The lines between the cephalic and caudal annulets of the segments are absent except as they mark the anterior margins of the dorsolateral tubercles, especially on the second to the fifth abdominal segments.

Head capsule more heavily sclerotized than in *Colletes,* marginal



FIGS. 36-47. 36, *Policana herbsti*, larva; 37, 38, lateral and dorsal views of head of same; 39, *Campolicana gayi*, larva; 40, 41, lateral and dorsal views of head of same; 42, 43, ventral and inner views of mandible of same; 44, 45, ventral and inner views of mandible of *Policana herbsti;* 46, spiracle of same; 47, spiracle of *Campolicana gayi*.

thickening distinct, posterior tentorial pits distinct and tentorial arms presumably not as slender as in *Colletes,* epistomal suture as in *Hylaeus,* that is weak but its position indicated by a depression arching between bases of mandibles; unpaired portion of cleavage line visible but arms of cleavage line absent, dorsal longitudinal median thickening of head capsule not evident. Antennae represented by distinct convexities; clypeolabral suture distinct, slightly arched upward medially; labrum with minute setae distally, labral tubercles large and blunt. Apices of mandibles not attenuate and sharply pointed as in *Hylaeus* and *Colletes* but broader, with inner apical concavity poorly defined, dorsal margin strongly toothed, this row of teeth continuous with those of mandibular cusp; concavity with a few very small teeth; dorsal surface of mandible spiculate. Maxillae with apices not bent inward, maxillary palpi near apices, about twice as long as broad; hypostomal furrow shallow; salivary opening being near apex of labial lobe, the lobe as a whole being very thick and considerably projecting; salivary opening narrow, only about one fourth as broad as distance between labial palpi, but lips of the opening exceedingly long, forming a projection that is nearly as long as wide and is distinctly longer than the labial palpi; labial palpi considerably longer than broad; labium with a distinct furrow between postmentum and prementum; outer surfaces of mouthparts with scattered minute setae, labiomaxillary thickening rather distinct.

Body without spicules or setae. Spiracles with atrium shallow, not projecting above level of body surface, with minutely spinose broken ridges within; peritreme flat; subatrium spinose; primary tracheal opening not narrowed by collar.

Correo Nuñoa, Chile (Claude-Joseph) (one specimen).

Policana occidentalis (Haliday)

According to Claude-Joseph (1926) the larva is similar to that of *P. herbsti.* His figures of both species, doubtless made from life, show larval forms very different from that shown in the present paper and based on one of Claude-Joseph's preserved specimens of *P. herbsti.* He shows no dorsal tubercles, but very strong ventral convolutions for both species.

Caupolicana gayi Spinola

(Figs. 39-43, 47)

The larva first described by Claude-Joseph (1926) is rather robust with the intersegmental furrows quite deep, the dorsolateral tubercles high, transverse, nearly meeting middorsally and on the second and following abdominal segments extending down to the level of the spiracles, these elevated tubercles arising abruptly from the surface of the body. The lines between the cephalic and caudal annulets of the body segments are absent unless they are indicated by the abrupt anterior faces of the dorsolateral tubercles. Folds and slight elevations below these tubercles indicate ventrolateral tubercles on the third to the ninth abdominal segments.

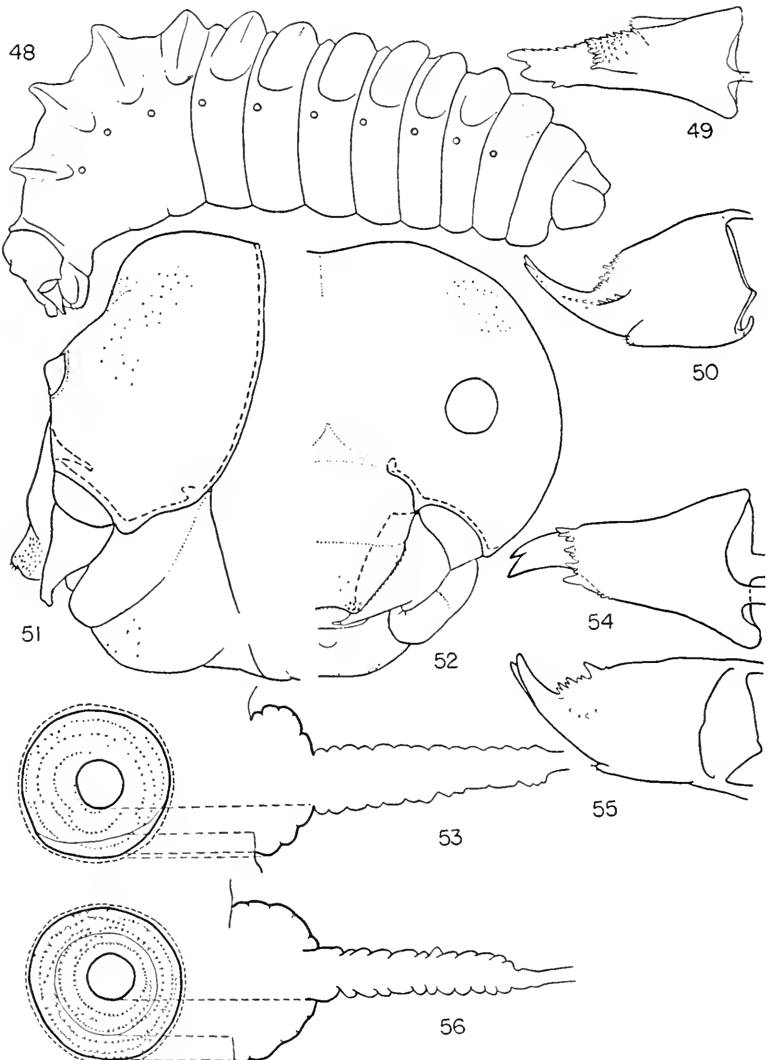
Head capsule rather distinctly sclerotized, its marginal thickening distinct; posterior tentorial pits rather large and tentorial arms presumably not as slender as in *Hylaeus;* epistomal suture not easily recognizable, its position indicated by a depression arching between bases of mandibles, a slight broad thickening of cuticle probably following this depression; unpaired portion of cleavage line present but arms feeble or absent and dorsal longitudinal median thickening of head capsule absent. Antennae present as distinct convexities; labroclypeal suture distinct, feebly arched; labrum with rather numerous spicules, some of them long and setalike, tubercles large and broad. Mandibles much as in *Policana* but with fewer teeth, no spicules, and a very strong toothed cusp, a distinct untoothed space between its teeth and teeth of upper apical margin; median portions of mandibles hidden from view in repose by overlapping labral tubercles which practically contact maxillae. Maxillae with long spicules, apices bent inward and downward, reaching labial palpi; maxillary palpi not apical, more than twice as long as broad; labial lobe very thick and elongate; salivary opening at apex of labial lobe, almost circular, on a projecting snoutlike process, the apex of which is dark; labial palpi about twice as long as broad; labium with distinct furrow between postmentum and prementum.

Body without spicules or setae. Spiracles with atrium shallow, not projecting above level of body surface, with spinose ridges within, flat peritreme, weak collar at primary tracheal opening; subatrium spinose within.

Correo Nuñoa, Chile (Claude-Joseph) (one specimen).

FAMILY HALICTIDAE

This family contains a relatively homogenous group of larvae. Like those of the Colletidae, they combine certain primitive features with features specialized by reduction. For example the salivary opening in all known cases is a curved slit, provided with no projecting lips. Such forms do not spin cocoons. However, *Systropha* is reported to spin cocoons, and it is therefore presumed that it has a transverse salivary opening with lips, as with other cocoon-spinning bees and wasps. As in the Colletidae, the antennal papillae are insignificant or absent. The palpi are reduced in halictid larvae, even absent in some. The mandibles are of what is believed to be the most primitive type found in bees, that is, with



FIGS. 48-56. 48, *Lasioglossum kincaidii*, larva; 49, 50, inner and ventral views of mandible of same; 51, 52, lateral and dorsal views of head of same; 53, spiracle of same; 54, 55, inner and ventral views of mandible of *Lasioglossum sparsum;* 56, spiracle of same.

two large apical teeth (except in *Augochlora* and some *Nomia*) and with a multidentate cusp on the inner surface, the region between this cusp and the apex concave.

The close relationship of *Lasioglossum* and *Halictus*, obvious in any event from the adults, is shown in the larvae also by the basal obliteration of the lines between the labium and the maxillae, by the shallow spiracular atria, not projecting above the body surface, with their spines minute or absent, and by the peritremes which are often incomplete or absent.

The great diversity of species of *Nomia*, likewise evident from adults, is shown among the larvae, which, for example, may have acute or bidentate mandibular apices, spinose or spineless spiracular atria, etc.

Claude-Joseph (1926) describes the larvae of a number of halictine bees from Chile. So far as can be determined from his descriptions and figures, all agree rather well with the better known members of this group.

Lasioglossum (*Evylaeus*) *kincaidii* (Cockerell)

(Figs. 48-53)

The larva is rather robust with the intersegmental lines distinct all around the body but with no clear division of the segments into cephalic and caudal annulets. The dorsolateral tubercles are conspicuous and transverse, nearly meeting on the middorsal line and extending downward on the sides nearly to the level of the spiracles. Only on the last two or three abdominal segments are the dorsolateral tubercles low and rather inconspicuous. They are highest and most sharply ridged on the thoracic segments.

Head capsule without setae, with spicules in temporal regions, rather distinctly sclerotized, separated by distinct constriction from thorax. Marginal thickening of head capsule weak; posterior tentorial pits inconspicuous from the outside but represented internally by short and rather robust tentorial arms similar to those found in specimens of *Anthophora* approaching the pupal stage; head with two large rounded convexities above the level of the antennae so that seen in lateral view it seems to have a "high forehead"; epistomal suture nearly absent between anterior tentorial pits, represented by shallow, transverse depression, not indicated by an internal thickening; cleavage line and dorsal longitudinal median thickening of head capsule absent or nearly so. Antennae clearly defined, broadly conical; labroclypeal suture weak, scarcely arched; labrum with a pair of large tubercles rather near to one another, bearing minute setae arising from large sockets; sides of clypeus spiculate. Mandibles each with large tubercle on outer surface midway between base and apex, this tubercle bearing one or two minute setae; apical portions of mandibles attenuate, ending in two teeth; margins dentate; cusp multidentate, numerous small teeth basad from cusp. Maxillae with apices not bent inward, maxillary palpi absent, a very few scattered minute setae on outer surface of each maxilla in some specimens; labial lobe scarcely exceeding maxillae; salivary opening minute and inconspicuous, not marked by lips or other projecting structures, located near apex of labial lobe; labial palpi absent; no distinct furrow between postmentum and prementum.

Body with spicules on some areas. Spiracles rather shallow, with broken rows of small spines; peritreme flat, incomplete; primary tracheal opening without collar.

Montara, San Mateo County, California, June 12, 1940 (MacSwain).

Lasioglossum (*Evylaeus*) *malachurus* (Kirby)

Soika (1934) has described and figured the larva of this species. It is similar to that of *Lasioglossum kincaidii* but the antennae are lower and flatter. The mandibles are more attenuate than in *L. kincaidii,* bidentate at the apices, with one tooth much shorter than the other, with a distinct multidentate cusp, and apparently without small teeth on the margins of the mandibles. As with *L. kincaidii,* the palpi are absent and the maxillae are blunt and rounded.

Lasioglossum (*Chloralictus*) sp?

(Figs. 62, 63, 65)

This species is similar to *L. kincaidii* in general structure but differs in numerous details. The dorsolateral tubercles are much lower and less conspicuous than in *L. kincaidii* although transverse as in that species. The head capsule is white and apparently not at all sclerotized, the convexities above the antennae are lower and more rounded than in *L. kincaidii.* The antennae are lower and blunter than in *L. kincaidii* and the labral tubercles are mere broad prominences. The mandibles are fundamentally as in *kincaidii* but the attenuate apical portions are shorter and do not have teeth on their upper margins, the lower margins have more teeth, the tubercle on the outer surface of each mandible is weaker than in *L. kincaidii.* The spicules and setae on the head and body are apparently absent. The spiracles lack atrial spines and teeth, although the inner surface of the atrium is marked with curved lines; the peritreme is absent.

Arlington, Virginia, collected under bark.

Larvae of another unidentified species of *Chloralictus* from North Carolina were essentially similar to the form described above.

Lasioglossum (*Chloralictus*) *sparsum* (Robertson)

(Figs. 54-56)

Similar to the above described species of *Chloralictus*. The mandibular structure differs slightly, however, in the greatly reduced number of teeth on the lower margin of the mandible, the more transverse cusp, perhaps with heavier teeth, and the sharper apical teeth. The spiracles differ in the presence of rows of teeth on the inner surface of the atrium, the presence of a peritreme and of a collar around the primary tracheal opening.

Lawrence, Kansas, April 24, 1951 (Michener).

Halictus (*Halictus*) *sexcinctus* (Fabricius)

Grandi (1937) has described and figured the larva of this species. It is similar to that of *Lasioglossum kincaidii* but the antennae are lower and flatter and the mandibular dentation appears different in details. (The cusp is not clearly shown although it is apparently present.) The palpi are absent. The spiracular atria evidently contain many more teeth than in *L. kincaidii.*

Packard (1897) gives brief descriptions of the larvae of *Halictus* (*Halictus*) *ligatus* Say and *H.* (*H.*) *parallelus* Say. They seem to agree in major features with the halictine bees described herein.

Halictus (*Seladonia*) *tripartitus* Cockerell

(Figs. 60, 61, 66, 67)

Larva similar to that of *Lasioglossum kincaidii* from which it differs in minor features such as the larger number of teeth on the lower margin of the mandible, the more slender mandibular apex with the ventral apical tooth longer than the dorsal one, and the larger number of seta-bearing tubercles on the outer surfaces of the mandibles. The spiracular atrium is marked with anastomosing circular ridges within, these ridges sometimes bearing numerous small spines. The peritreme is absent and the primary tracheal opening is narrowed by a small collar.

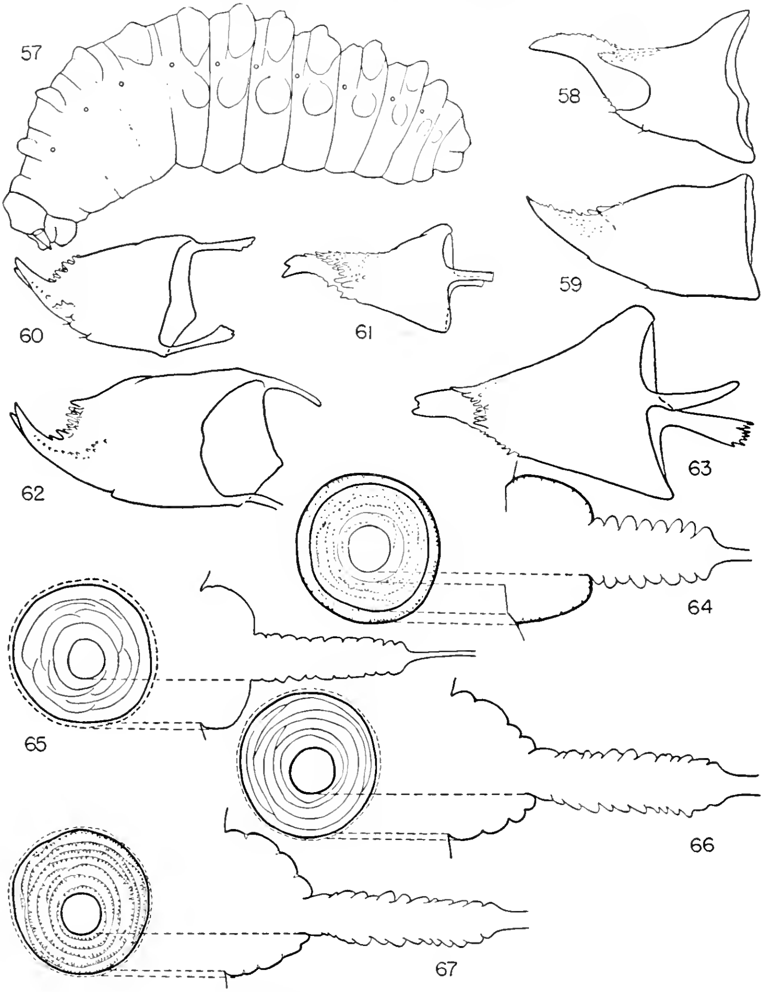
The presence or absence of atrial spines seems erratic and uncorrelated with body segments.

Chino, Arizona, July 4, 1950 (R. H. Beamer, J. G. Rozen).

Augochlora (Augochlora) pura (Say)

(Figs. 57-59, 64)

The larva is similar in most respects to that of *Lasioglossum kincaidii*. It differs in the smaller and lower thoracic tubercles, so that these are lower than the abdominal tubercles instead of higher as in *L. kincaidii*, and in the presence of ventrolateral tubercles on the second and following abdominal segments. The mandibles



FIGS. 57-67. 57, *Augochlora pura*, larva; 58, 59, inner and ventral views of mandible of same; 60, 61, ventral and inner views of mandible of *Halictus tripartitus;* 62, 63, ventral and inner views of mandible of *Lasioglossum* (*Chloralictus*) sp?; 64, spiracle of *Augochlora pura;* 65, spiracle of *Lasioglossum* (*Chloralictus*) sp?; 66, 67, spiracles of *Halictus tripartitus*.

bear several setae on their outer surfaces; the apices of the mandibles are simple and acute, the ventral margin not serrate, the cusp produced as a slender projection which may end in two large teeth instead of the simple apex shown in the figure. The presence of a distinct curved line outlining the distal mandibular concavity and extending from the cusp to a point on the ventral margin of the mandible is distinctive. The spiracles have the atrium slightly projecting above the body surface, its inner surface with rows of minute spines; the peritreme is flat. The primary tracheal opening is narrowed by a very small collar.

Short Mountain, Shenandoah, Virginia, June 6, 1941 (A. B. Gurney); Lawrence, Kansas (Michener); York County, Pennsylvania, June 16, 1951; Sand Gap, Kentucky, August 30, 1946 (Ritcher).

Among specimens presumably from a single nest from York County, Pennsylvania, considerable variability occurs in details of mandibular dentition. For example, in one specimen the cusp ends in two distinct darkened teeth, while in the other the teeth of the cusp are all small, as shown in the figure.

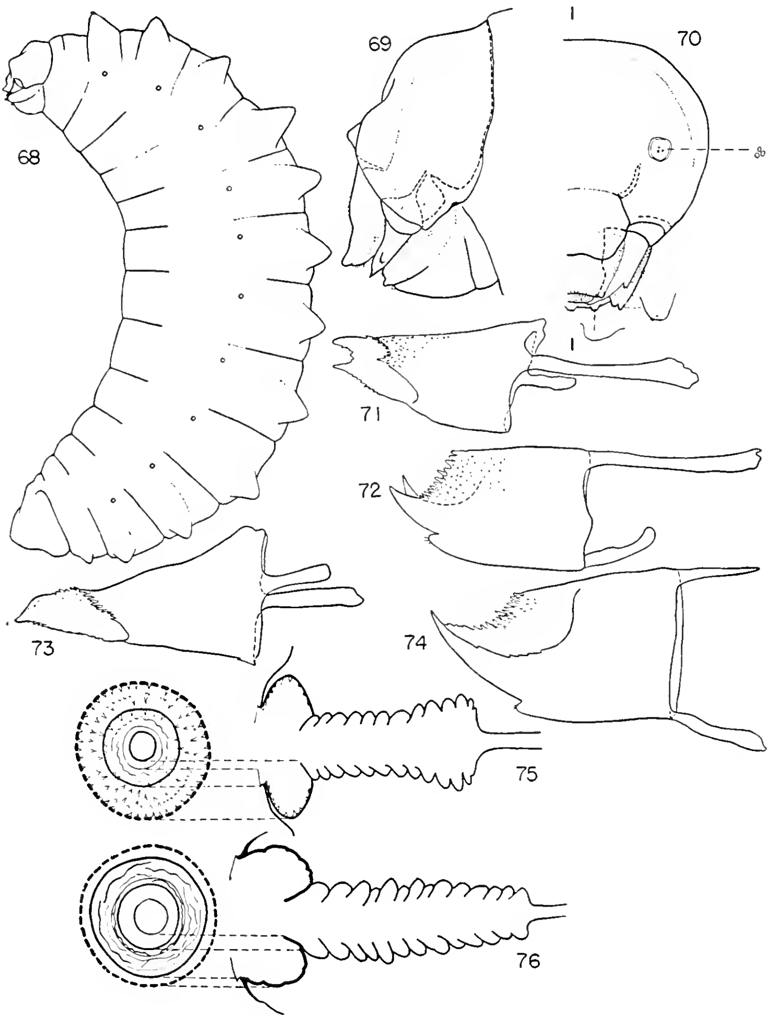
Nomia (*Epinomia*) *nevadensis nevadensis* Cresson

(Figs. 68, 71, 72, 76)

The larva is similar to that of *Lasioglossum* in many respects. The intersegmental lines are distinct except laterally while the lines between cephalic and caudal annulets of the segments are absent. The dorsolateral tubercles of the body are high and pointed, those of the thorax forming distinct transverse ridges but those of the abdomen not transverse but conical; these tubercles do not extend down toward the level of the spiracles. The ventrolateral tubercles are absent.

Head capsule and outer surfaces of mouthparts with scattered minute setae, the former rather distinctly sclerotized, separated from thorax by a distinct constriction. Marginal thickening of head capsule narrow; cleavage line and dorsal longitudinal median thickening of head capsule absent; head with a rounded convexity on each side above antennae as in *Lasioglossum* and with a broad longitudinal median depression of the dorsal surface extending downward to level of anterior tentorial pits. Antennae distinct, rounded conical; epistomal suture absent but its position roughly indicated by a transverse depression between the anterior tentorial pits, clypeolabral suture weak, the labrum with small apical tubercles. Mandibles robust, with large tubercle on outer surface of each, apices deeply bifid, cusp with many teeth of varying sizes;

lower margin of mandible serrate subapically. Maxillae with apices not bent inward; maxillary palpi robust, longer than broad; hypostomal furrow rather shallow; labial lobe exceeded by maxilla; labial palpi much broader than long; salivary opening small, near apex of labial lobe, not projecting, but about as wide as projection in *Nomia melandri.*



FIGS. 68-76. 68, *Nomia nevadensis,* larva; 69, 70, lateral and dorsal views of head of *Nomia melandri;* 71, 72, inner and ventral views of mandible of *Nomia nevadensis;* 73, 74, inner and ventral views of mandible of *Nomia melandri;* 75, spiracle of same; 76, spiracle of *Nomia nevadensis.*

Body without spicules or setae; spiracles with thick-walled atria bearing broken irregular ridges within, atria projecting slightly above body surface and with rim at upper extremity; peretreme nearly flat; primary tracheal opening narrowed by large collar.

Blythe, California, July 25, 1945 (Linsley and MacSwain).

Nomia (*Acunomia*) *melandri* Cockerell

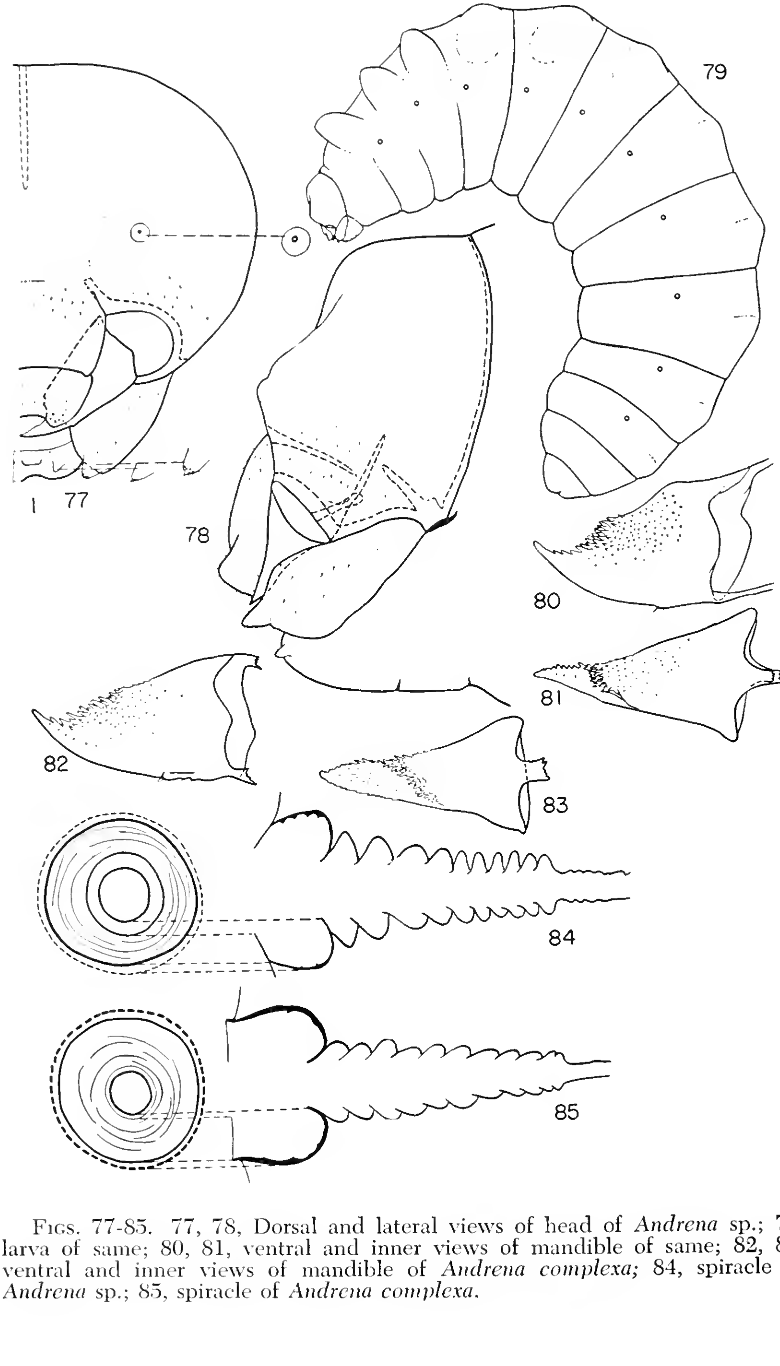
(Figs. 69, 70, 73-75)

This species is similar to *N. nevadensis* but differs in having the dorsolateral tubercles slightly lower, those of the abdominal segments somewhat transverse, more like those of the thorax although not so strongly so as those of the thorax. The longitudinal median depression in the head capsule is less conspicuous than in *N. nevadensis.* The apices of the mandibles not bidentate but acute, the cusp with fewer teeth. The maxillary palpi are shorter than in *nevadensis,* being pigmented but only about as long as broad; the salivary opening is on a small but distinct pigmented prominence. There are distinct spicules on some areas of the body. The spiracles are more heavily pigmented than in *nevadensis,* the atrium much narrowed near the surface, its inner surface spinose. The atrium projects slightly above the body surface and provided with a rim. The peritreme is flat. The primary tracheal opening is narrowed by a collar.

Fillmore, Utah, June 29, 1950 (Michener).

Nomia ruficornis Spinola

The larva of this species is described and figured by Soika (1932). It differs from *N. nevadensis* in not being gently curved but rather being abruptly bent in the vicinity of the base of the abdomen. The dorsolateral tubercles are larger, although not higher, than in *N. nevadensis,* largest on the last thoracic and first two abdominal segments. The antennae are low and rounded, much less protuberant than in *N. melandri.* The labrum has slightly more conspicuous labral tubercles than does *N. melandri.* The mandibles are simple, not bidentate at their apices, and each has a multidentate cusp, apparently with more teeth than in *N. melandri.* Each also has a clearly defined inner apical concavity as in our species of *Nomia,* and the surface of this concavity bears small scattered teeth. The maxillary palpi are longer than broad, apical, not slightly subapical as in *N. melandri.* The labial palpi are about as broad as long.



FIGS. 77-85. 77, 78, Dorsal and lateral views of head of *Andrena* sp.; 79, larva of same; 80, 81, ventral and inner views of mandible of same; 82, 83, ventral and inner views of mandible of *Andrena complexa;* 84, spiracle of *Andrena* sp.; 85, spiracle of *Andrena complexa.*

FAMILY ANDRENIDAE

Like the last family, this one is relatively homogenous in larval characters. Indeed most of its characters are shared with the Halictidae. Like that family and the Colletidae, larvae of the Andrenidae exhibit a mixture of primitive and specialized features. Thus the salivary opening is reduced to a curved slit with no lips and the antennal papillae are insignificant or absent. The palpi are small, but on the basis of the small number of species examined, are less often absent than in the Halictidae. Very often the maxillary palpi are strikingly larger than the labial palpi. The mandibles are acute (or sometimes bidentate) at their apices and exhibit the presumably primitive feature of a multidentate cusp, sometimes reduced to a few small teeth (see *Nomadopsis fracta*). The region between this cusp and the mandibular apex is distinctly concave in the genus *Andrena* but not in the Panurginae. In all species examined the spiracular atria lack spines. The atrial walls may project above the body surface or not, even within the genus *Andrena*.

As shown by the descriptions and figures, the Panurginae have particularly large dorsolateral tubercles which are ordinarily conical, not transverse as in most groups. These tubercles reach maximum length in *Perdita zebrata* (Cresson) (see Custer, 1929.)

Andrena sp.

(Figs. 77-81, 84)

The larva is similar to that of *Lasioglossum kincaidii* in many respects. The intersegmental furrows are distinct and faint lines between cephalic and caudal annulets of the abdominal segments are visible. The dorsolateral tubercles are conspicuous, particularly on the thorax where they are high and rounded; on the abdomen they are lower and more transverse, reaching downward almost to the level of the spiracles. The ventrolateral tubercles are absent.

Head capsule and mouthparts with a few minute setae; head capsule shaped much as in *Lasioglossum* with a rounded elevation above each antenna and with the antennae themselves arising from rounded prominences. Marginal thickening of head capsule feeble and inconspicuous but posterior tentorial pits distinct; epistomal suture indicated by a weak depression, no thickening between the anterior tentorial pits; cleavage line and longitudinal median thickening of head capsule weak. Antennae represented by convexities;

labroclypeal suture weak; labrum with two rather large tubercles. Mandibles with apices attenuate and sharply pointed, upper and lower margins finely serrate apically, the serrations continued along the margin to the densely toothed cusp. Maxillae with apices not bent inward; maxillary palpi large, slightly longer than broad; labial lobe similar to that of *Lasioglossum* but with minute labial palpi.

Body without setae, with spicules on some areas ventrally. Spiracular atria with internal ridges; atrium not projecting above body surface; peritreme present; collar around primary tracheal opening present.

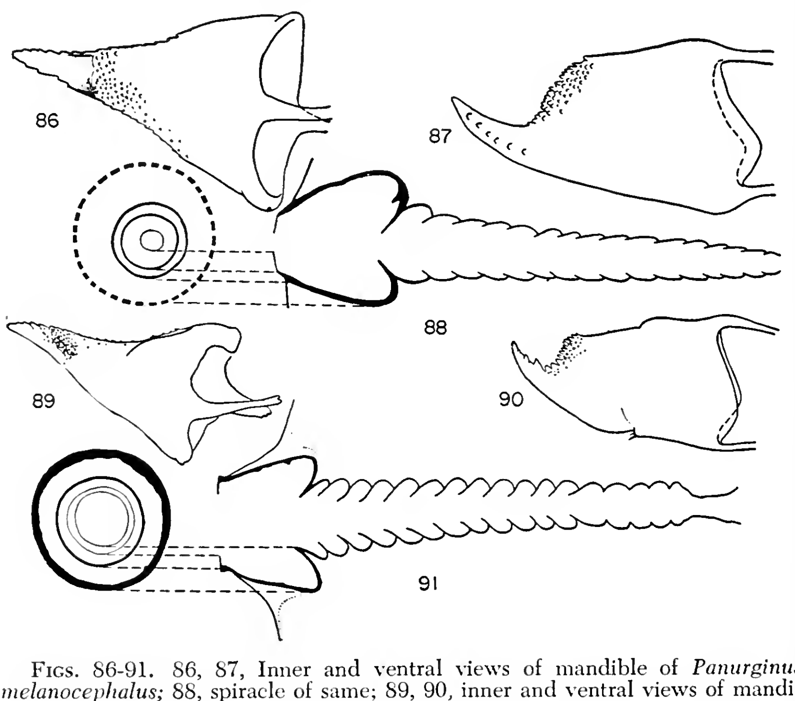
Tesla, San Joaquin County, California, May 23, 1946 (MacSwain).

Andrena (*Ptilandrena*) *complexa* Viereck

(Figs. 82, 83, 85)

The larva of this species seems to differ from that of *A.* sp? described above in the somewhat larger dorsolateral tubercles of the body segments and in having the spiracular atria projecting above the body surface and the peritreme flat.

Berkeley, California (MacSwain).



FIGS. 86-91. 86, 87, Inner and ventral views of mandible of *Panurginus melanocephalus;* 88, spiracle of same; 89, 90, inner and ventral views of mandible of *Andrena erythronii;* 91, spiracle of same.

Packard (1897) gives a brief description of the larva of *Andrena vicina* Smith. It seems to agree in major features with the species described herein.

Andrena (*Leucandrena*) *erythronii* Robertson

(Figs. 89-91)

The larva is similar to that of *Andrena* sp? described above but has more distinct dorsolateral tubercles all along the body so that those of the thorax are only slightly larger than those of the abdomen. The details of mandibular shape and dentition differ slightly from those of *Andrena* sp?. The spiracular atrium is much deeper, more constricted toward the surface, and projects above the body surface.

Lawrence, Kansas, May 11, 1952 (Michener).

Panurgus banksianus (Kirby)

The larva is described and figured by Micheli (1931). In body form it somewhat resembles *Andrena,* but the lines between the cephalic and caudal annulets of the body segments are distinct on all segments, and the caudal annulets are swollen to form large dorsolateral tubercles, largest on the middle segments of the body, and extending downward almost to the level of the spiracles. There are also small ventrolateral tubercles. The head is shaped much as in *Nomadopsis* and *Calliopsis,* with the low antennae on broad protuberances. The clypeus and labrum are not clearly defined but the latter bears large and acute labral tubercles. The mandibles are slender and acutely pointed, much as in *Calliopsis,* but the upper margins are more coarsely toothed, and the teeth spread out to form a multidentate cusp area much larger than in *Calliopsis* and nearer the base of the mandible. The apex of the maxilla is broad and blunt as in *Calliopsis,* with the maxillary palpus arising in the middle of apex. Maxillary and labial palpi are about as long as broad.

Panurgus calcaratus Scopoli

Micheli (1936) describes and figures the larva of this species, comparing it with that of *P. banksianus.* It is similar in body form although with the dorsolateral tubercles higher. The upper lateral portions of the head, above the antennae, are more convex, as in *Andrena.* There are also minor differences in mandibular dentition, etc. The spiracles are shown with a peritreme, with no atrial teeth, but with atrial ridges.

Panurginus melanocephalus (Cockerell)

(Figs. 86-88)

The larva is similar to that of *Nomadopsis fracta.* The antennal protuberances are larger. The labral tubercles are more distinct and longer, the margin between them straight. The mandible is rather slender, pointed, serrate on both margins, with a multidentate cusp. The maxillary palpi are large, several times as large as the labial palpi, longer than broad, distinctly pigmented. The spiracular atria are produced above the body surface, without inner spines, with nearly flat peritreme and distinct collar.

Berkeley, California, April 28, 1952 (MacSwain).

Nomadopsis fracta Rozen

(Figs. 92-98)

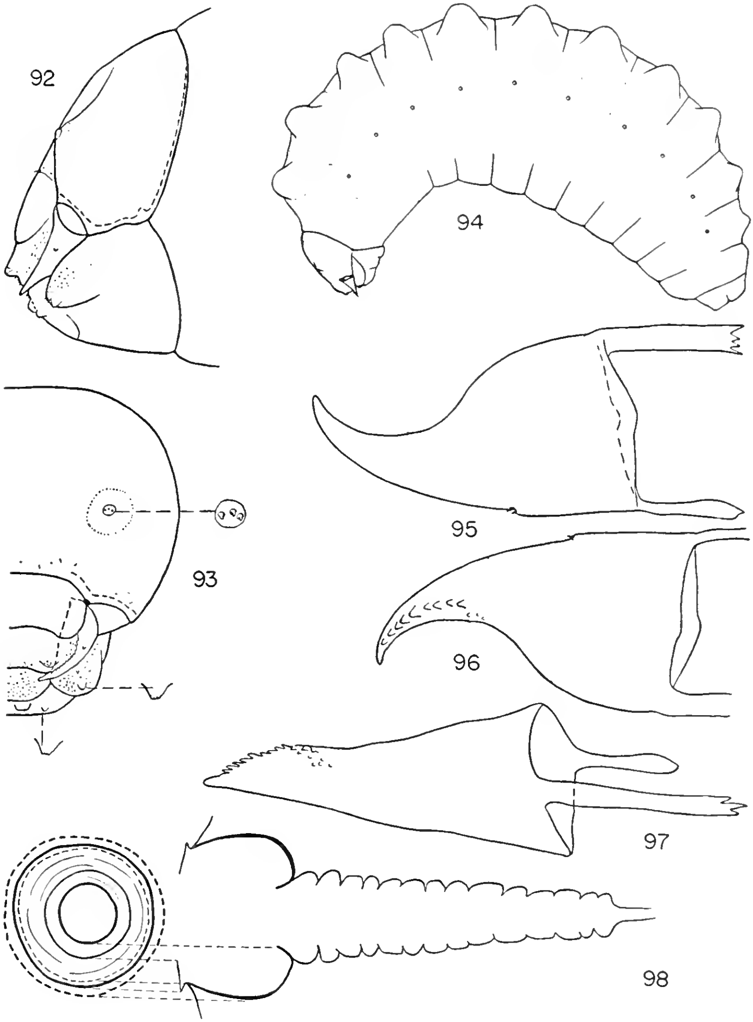
The larva is rather robust and similar to that of *Andrena* but the dorsolateral tubercles are all high and rounded, not transverse as in *Lasioglossum, Andrena,* etc. The ventrolateral tubercles are absent. The head capsule is essentially as in *Andrena,* agreeing with it in the light sclerotization, the reduced antennae and other features; the swellings above the antennae and those on which the antennae are borne are smaller than in *Andrena.* The mandibules are slender, thin upper margins serrate apically, the row of teeth in such a position that they are out of sight when the mandible is seen from beneath. The cusp is nearly absent although there are a few small teeth in its position. The maxillary palpi are broader than long. The labial lobe bears the apical salivary opening which is not or but little protruding and in some views almost circular. The spiracular atrium projects above the body surface, with a rim and with feeble internal ridges. The peritreme is nearly flat and the primary tracheal opening is provided with a collar.

Mount Diablo, Contra Costa County, California, June 5, 1940 (Bohart and MacSwain). Additional specimens presumably of the same species are from Oakley, Contra Costa County, California, May, 1939 (Bohart and MacSwain).

Nomadopsis euphorbiae (Cockerell)

(Figs. 99, 106-108)

The larva is similar to that of *Nomadopsis fracta* except that the dorsolateral tubercles are very much higher, those of some of the body segments being twice as high as the width near the base, those of the first two thoracic segments being distinctly more robust than the others but nonetheless higher than basal width. The



FIGS. 92-98. 92, 93, Lateral and dorsal views of head of *Nomadopsis fracta;* 94, larva of same; 95, 96, 97, ventral, dorsal, and inner views of mandible of same; 98, spiracle of same.

head is similar to that of *N. fracta* except that the antennae are much more conspicuous and distinctly conical while the tubercles above the antennae and the elevations on which the antennae arise are less conspicuous. The mandible more robust, less attenuate, apically than in *N. fracta,* cusp more evident, provided with numerous teeth, marginal teeth in evidence seen from beneath, not hidden on upper surface as in *N. fracta.* The maxillary and labial palpi are absent; the salivary opening is on a feeble prominence.

Riverside County, California, August 17, 1946 (MacSwain).

Spinoliella spp.

Claude-Joseph (1926) has described and figured larvae of *S. maculata* (Spinola) and *S. herbsti* (Friese). Both species have high dorsolateral tubercles but this is especially true of *S. herbsti* in which the tubercles of the thorax are elongated and directed backward. The mandibular apices are acute.

Calliopsis (*Calliopsis*) *andreniformis* Smith

(Figs. 100-105)

The larva is similar to that of *Nomadopsis fracta* but the dorsolateral tubercles of the thorax are a little higher and more angular and ventrolateral elevations are feebly evident on the middle segments of body. The head is much as in *Nomadopsis* but the upper parts are more gently rounded. The mandible bears teeth along its dorsal margin and in an inner subapical patch or cusp. The spiracular atrium has thick walls without distinct ridges inside. It is not produced above the body surface. The peritreme is large, and the primary tracheal opening is provided with a collar.

Lawrence, Kansas, June, 1951 (Michener).

Acamptopoeum submetallicum (Spinola)

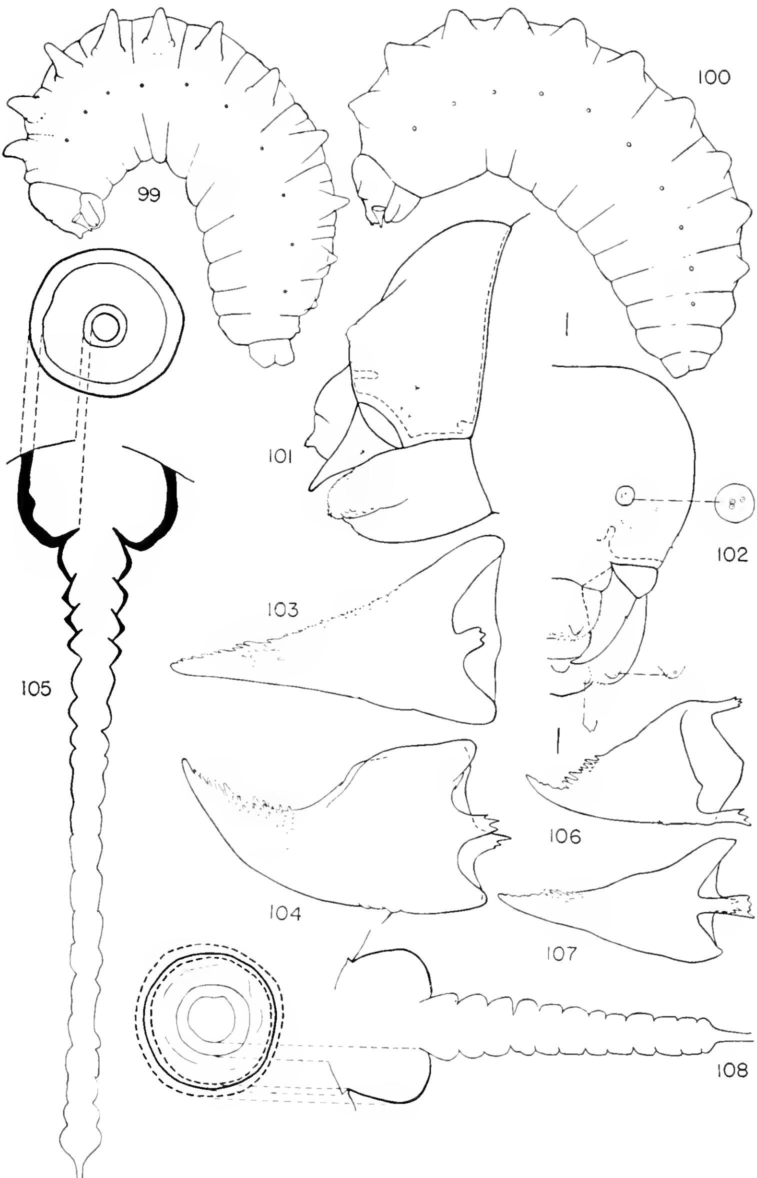
The larva is briefly described and figured by Claude-Joseph (1926). It has high dorsolateral tubercles as in *Nomadopsis euphorbiae.* Unlike this species, the mandibular apices are bidentate. The salivary opening appears to be narrow and quite protuberant.

Perdita spp.

Custer (1929) briefly describes the larva of *Perdita zebrata* Cresson and *P. opuntiae* Cockerell, and also gives brief comments on that of *Nomadopsis australior* (Cockerell). All of these bees have the usual long dorsolateral tubercles of panurgine larvae, but they are unusually attenuate, broadened and provided with bristles at the apices in *P. zebrata.* This larva is even more remarkable for the possession of a very long posterior median "spine" or tubercle.

Family Melittidae

Only a single species of this small family has been studied. It agrees in most respects with the larvae of the families Colletidae,



FIGS. 99-108. 99, *Nomadopsis euphorbiae,* larva; 100, *Calliopsis andreniformis,* larva; 101, 102, lateral and dorsal views of head of same; 103, 104, inner and ventral views of mandible of same; 105, spiracle of same; 106, 107, ventral and inner views of mandible of *Nomadopsis euphorbiae;* 108, spiracle of same.

Andrenidae, and Halictidae. The salivary opening is short and transverse. The antennal papillae are absent, and unlike representatives of the three families mentioned, the remnants of the antennae are mere discs which are not themselves elevated nor are they borne on elevations of the head surface. The palpi are reduced and the mandibles are pointed, each with a multidentate cusp.

Hesperapis rufipes (Ashmead)

(Figs. 281-287)

The larva is moderately robust with the intersegmental lines conspicuous, the lines between the cephalic and caudal annulets of the segments absent or nearly so but posterior portions of each segment somewhat elevated on the dorsum. Ventrolateral tubercles form a low ridge beneath the spiracles.

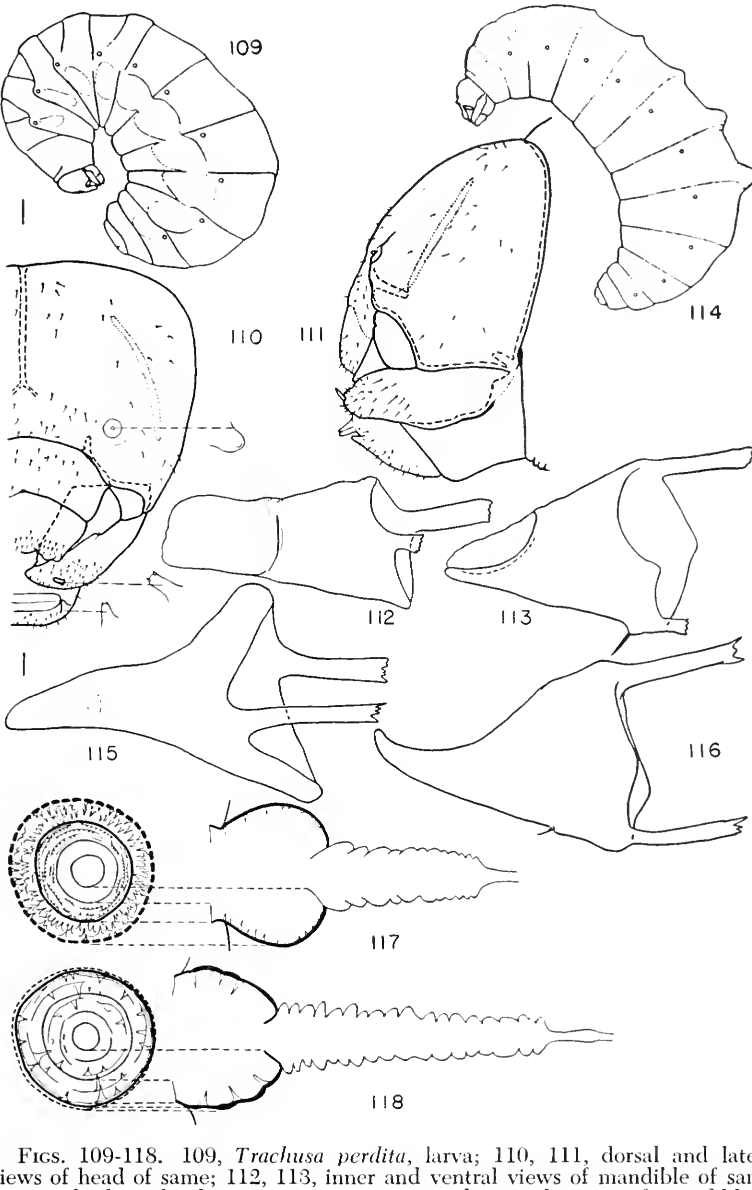
Head capsule scarcely sclerotic, without setae. Marginal thickening of head capsule weak; epistomal suture not recognizable; dorsal longitudinal line of head capsule absent; parietal bands conspicuous. Antennae mere discs, not at all elevated; labroclypeal suture distinct; labrum spiculate laterally. Mandibles each acutely pointed, a series of small teeth along lower margin near apex, the series along upper margin grading into the multidentate cusp; outer surfaces of mandibles each with a single small seta. Maxillae not clearly separated from labium except apically, not much bent inward, palpi as long as broad. Labium short, rounded, exceeded by maxillae, palpi broader than long; salivary opening small, nearly round, in a slight depression, its upper margin produced as a slight lip.

Spiracular atria without internal ridges or spines, produced above body surface, with distinct rim and peritreme; primary tracheal opening with collar.

Tanbark Flat, San Gabriel Mountains, Los Angeles County, California, July 16, 1952 (MacSwain).

FAMILY MEGACHILIDAE

The family is shown by larval characters, as well by those of the adults, to be very homogeneous. The larvae exhibit certain clearly primitive characters. Thus they differ from all other known bee larvae except those of certain *Allodape* in the abundant setae on the body. Other primitive features include the distinct antennal papillae, the long maxillary and labial palpi, and the large transverse salivary opening provided with large lips. As explained elsewhere, it is believed that these primitive features may be reversions, not actual indications of primitiveness, for the mandibles are of a specialized type, like those of many of the other long tongued bees, having an inner apical concavity limited by a distinct transverse



FIGS. 109-118. 109, *Trachusa perdita*, larva; 110, 111, dorsal and lateral views of head of same; 112, 113, inner and ventral views of mandible of same; 114, *Stelis lateralis*, larva; 115, 116, inner and ventral views of mandible of same; 117, spiracle of *Trachusa perdita;* 118, spiracle of *Stelis lateralis.*

ridge (absent in *Stelis lateralis*) on the inner surface. The apices of the mandibles have two large teeth, a presumably primitive feature, except in *Stelis lateralis* in which they are acute, in *Trachusa* in which they are truncate, and in *Megachile* (*Chalicodoma*) in which one of the teeth is much reduced. The Anthidiini (except *Trachusa*) are noteworthy for the presence of small teeth along the mandibular margins apically. Such teeth are absent in most Megachilini, although *Coelioxys* exhibits them. They are also found in immature larvae of *Megachile brevis* (see Michener, in manuscript), but are scarsely discernable in mature larvae. As such teeth are found in short-tongued families of bees, it is assumed that they are a primitive feature, supporting the view, based upon adult morphology, that the Anthidiini are a more primitive group than the Megachilini.

An interesting feature of megachilid larvae is that there are no dorsolateral tubercles in the sense that these structures are understood in other groups of bees. Dorsal protuberances when present are middorsal or if they extend onto the sides of the body (as in *Ashmeadiella*) they are continuous across the middorsal line.

Spiracles in all forms examined have atria extending above the body surface. Atrial spines are common but not universal. It may be remarked that among the few species examined the absence of atrial spines distinguishes larvae of *Megachile,* subgenera *Chelostomoides* and *Chalicodoma,* from other subgenera of *Megachile.*

Lithurge dubius (Herbst)

The larva is described by Claude-Joseph (1926) as fusiform with the posterior segments more dilated than the anterior. The caudal annulets of the segments are elevated. As in other megachilids, the antennal papillae and the palpi are distinct.

Trachusa perdita Cockerell

(Figs. 109-113, 117)

The larva is very robust, with the intersegmental lines inconspicuous except ventrally where they are rather distinct and with the lines between the cephalic and caudal annulets of the segments present anteriorly but inconspicuous. The caudal annulets of the dorsal segments in the middle portion of the body are somewhat elevated, the elevations extending across the middorsal line and highest middorsally, not produced to form distinct dorsolateral tubercles. Rounded ventrolateral tubercles are present on the abdomen (except for the apical segments) and less strongly so on the second and third thoracic segments.

Head capsule and mouthparts somewhat sclerotized, with numerous distinct setae. Marginal thickening of head capsule distinct; posterior tentorial pits conspicuous; epistomal suture indicated by a slightly arched line between anterior tentorial pits, cuticle not thickened in this area; dorsal longitudinal thickening of head capsule distinct, divided into two branches anteriorly which are directed toward anterior tentorial pits. Antennae represented by broad low convexities, each of which bears a small median papilla somewhat longer than broad; labroclypeal suture distinct, slightly arched; labrum with apex concave. Mandibles rather short and robust, apices truncate, upper apical angle more rounded than lower; inner surface of apical portion gently concave, the concavity bounded by a weak ridge. Maxillae each with a basal swelling; apices bent somewhat inward as in *Anthophora;* maxillary palpi longer than broad; apical portions of maxillae bearing coarse setae; hypostomal furrow deep, labiomaxillary rod distinct; labial lobe rather thick, salivary opening at its apex, a transverse slit provided with very large sclerotized lips; labial palpi more than twice as long as broad, separated by a distance equal to width of salivary opening; postmentum and prementum clearly separated, the latter provided with coarse bristles.

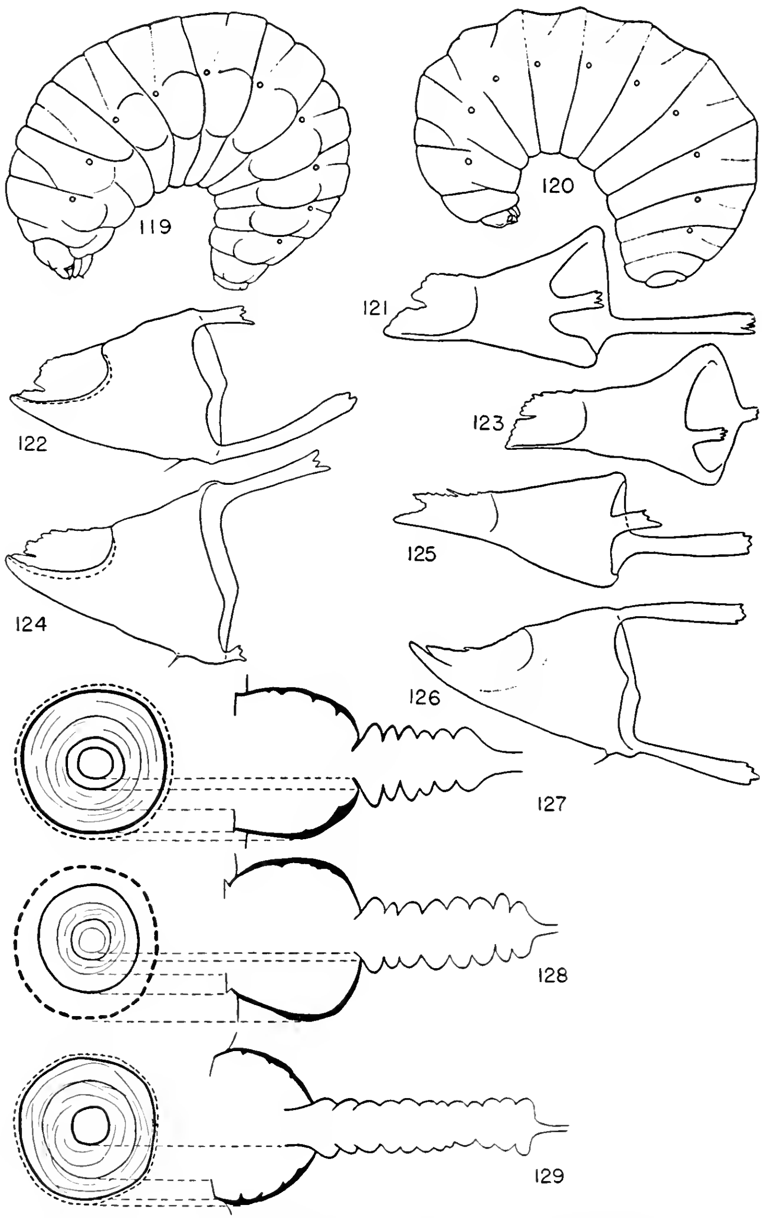
Body provided with numerous setae. Spiracles with large atrium, inner walls of which are spinose, spines reduced to tubercles below; atrium projecting above body surface; peritreme rather narrow, flat; primary tracheal opening with delicate collar.

The Pinnacles, California, April, 1940 (MacSwain).

Dianthidium sp.

(Figs. 120, 125, 126, 129)

The larva is similar to that of *Trachusa* but even more robust, the intersegmental lines very inconspicuous, the division of the segments into cephalic and caudal annulets feeble. The ventrolateral portions of the segments are slightly swollen. The head capsule is somewhat more elongate than that of *Trachusa* but is similar in all important respects. The setae of the head capsule and mouthparts are slender, not bristlelike. The cleavage lines are more distinct than in *Trachusa.* The antennal papilla is about twice as long as broad. The apex of the mandible is bifid, the teeth pointed, the lower tooth much longer than the upper, the margin between the teeth and the lower margin of the mandible finely serrate, a long slender tooth on the lower margin. The maxillary and labial palpi are about twice as long as broad.



FIGS. 119-129. 119, *Anthidiellum erhorni*, larva; 120, *Dianthidium* sp?, larva; 121, 122, inner and ventral views of mandible of *Anthidiellum notatum robertsoni;* 123, 124, inner and ventral views of mandible of *Anthidiellum erhorni;* 125, 126, inner and ventral views of mandible of *Dianthidium* sp?; 127, spiracle of *Anthidiellum erhorni;* 128, spiracle of *Anthidiellum notatum robertsoni;* 129, spiracle of *Dianthidium* sp?.

The spiracular atria lack spines but bear internal ridges. The primary tracheal opening is provided with a collar.

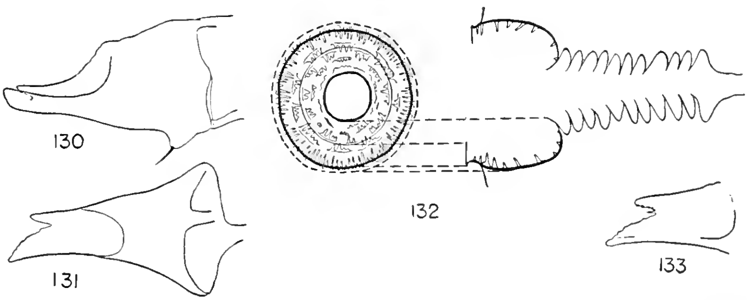
Mount Diablo, Contra Costa County, California, December, 1940 (MacSwain).

Dianthidium curvatum sayi Cockerell

(Figs. 130-133)

The larva is similar to that of *D.* sp. described above. It differs, however, in the absence of serrations along the upper margins of the mandibles, and in other details of mandibular dentition, particularly in the presence of a slender sharp spine arising in the notch between the mandibular teeth. The spiracles differ from those of the other *Dianthidium* available in the presence of numerous groups of atrial teeth.

Garden City, Kansas (Roland Fischer).



FIGS. 130-133. 130, 131, ventral and inner views of mandible of *Dianthidium sayi;* 132, spiracle of same; 133, inner ventral view of apex of mandible of same.

Anthidiellum erhorni (Cockerell)

(Figs. 119, 123, 124, 127)

The larva is very robust, similar in shape to that of *Dianthidium*, but with the intersegmental lines more distinct and the lines between the cephalic and caudal annulets of the segments more clearly visible. The ventrolateral tubercles are large and distinct. The head capsule is essentially as in *Dianthidium.* The mandibles have bidentate apices with the notch between the teeth a narrow sinus, the teeth obliquely truncate, their distal margins, and the upper distal margin of the mandible, finely serrate. The apical concavity of the mandible is deeper than in *Trachusa* or *Dianthidium.* The spiracles are much as in *Dianthidium* but with a slight rim around outer margin of the atrium and a smaller collar around the primary tracheal opening.

Vidal, San Bernardino County, California, September 6, 1947 (MacSwain).

Anthidiellum notatum robertsoni (Cockerell)

(Figs. 121, 122, 128)

This larva may not be distinguishable from that of *erhorni*. However, in the two specimens examined there are differences of mandibular dentition, the notch between the two principal teeth being broader and the serrations coarser in *robertsoni*. The spiracular atria are more narrowed at the body surface, and the rim is more distinct.

Antioch, Contra Costa County, California, September 10, 1947 (MacSwain).

Anthidium oblongatum Latreille

The larva of this species is described by Xambeu (1896) and Maneval (1937). It is much like that of *Megachile brevis* in shape, perhaps a little more robust anteriorly, with a similar series of somewhat confluent ventrolateral tubercles. The characters in general are like those of most megachilids, the palpi and antennal papillae being about three times as long as broad, the salivary opening being transverse and apparently with lips. The labroclypeal suture is strongly arched as usual in the family. The maxillary palpi arise preapically on the maxillae. The mandibles are bidentate apically, the teeth blunt, the notch between them rather shallow; the upper margin of each mandible bears a slender tooth like the single long slender tooth on this margin in *Dianthidium* sp?. Otherwise the mandibles lack small teeth. The labrum bears a marginal series of papillae.

Anthidium chilense Spinola

Claude-Joseph (1926) describes and figures the larva of this species. It is similar in shape to that of *Dianthidium*, but has a subspiracular ridge made up of fused ventrolateral tubercles. The mandibular apices also appear to be similar to those of *Anthidiellum robertsoni*.

Paranthidium (?) *caturigense* (Giraud)

Micheli (1935) and Maneval (1936a) describe and figure the larva of this species. The larva is robust, not swollen posteriorly as in many megachilids, with lines between the cephalic and caudal annulets of the body segments evident dorsally, the dorsal tubercles absent, the ventrolateral tubercles present. The usual features of a megachilid are present, such as the setose body, the long palpi and antennal papillae, the large transverse salivary slit provided with distinct lips, the arched labroclypeal suture, etc. The labrum is armed with several rows of papillae apically. An unusual feature according to Maneval is the bifid apex of each antenna but Micheli shows a normal apex. The mandibles are bidentate, the teeth short, not separated by a deep notch, the upper margin of the mandible denticulate.

Paranthidium septemdentatum (Latreille)

A larva, supposedly of this species, was briefly described by Xambeu (1896). Since he describes the maxillary palpi as biarticulate and the mandibles as laterally ciliate, it seems likely that he had the larvae of some other insect.

However, Grandi (1934a, 1935) describes and figures the larva in detail. As with *P. caturigense*, the larva is not swollen posteriorly as in many megachilids. The comments on *P. caturigense* apply also to the present species, except that the deeply emarginate apex of the labrum bears only a single irregular row of papillae, the antennae are not bifid, the mandibular teeth are blunt, especially the shorter one, and there are small denticles on the upper margin of the upper (shorter) tooth. The spiracular atria bear small inner teeth.

The placement of this species in *Paranthidium* is subject to question. It does not fall in any described subgenus, and should perhaps fall in the allied *Paraanthidium* (see Michener, 1948). Unlike American *Paranthidium*, it uses both plant down and resin in its nests.

Paranthidiellum lituratum (Panzer)

Enslin (1923) and Micheli (1934) give accounts of the larva of this species. The larva is shaped much like that of *Dianthidium* but is more slender anteriorly so that the swollen posterior portion is more striking. The setose body, long antennal papillae, long palpi, and broad salivary opening with lips are as in other Megachilidae. The labroclypeal suture is more strongly arched than shown in *Trachusa*, almost angulate medially. The lower margin of the labrum bears an irregular transverse row of small papillae. Unfortunately the mandible is not well illustrated nor fully described, but it is bidentate, and evidently without the small teeth found in *Anthidiellum* and *Dianthidium*.

Stelis nasuta (Latreille)

The larva of this species was described by Maneval (1937). It is very different from the larva of *Stelis lateralis* illustrated in the present paper. The body form is similar but middorsal tubercles are entirely absent and ventrolateral tubercles are present. Weak lines separating the cephalic from the caudal annulets of the body are present dorsally on the middle body segments. Like most megachilids, the palpi and antennal papillae are elongate, the salivary opening transverse and with lips, the labroclypeal suture strongly arched, the sides of the labrum drawn down to form broad and undefined labral tubercles. The margin of the labrum bears a row of papillae. The maxillary palpi are preapical on the maxillae. The mandibles, unlike those of *Stelis lateralis*, are bidentate at their apices, each tooth obliquely truncate. They are said to be much like those of S. *ornatula*.

Stelis ornatula Nylander

The larva of this species was described and figured by Micheli (1935). Unlike S. *lateralis*, the larva is robust, swollen posteriorly, the dorsal tubercles virtually absent and ventrolateral tubercles present. Distinct lines separate the caudal from the cephalic annulets of the body segments. The palpi and antennal papillae are elongate as in most megachilids, the salivary opening is transverse and provided with large lips, the labroclypeal suture is arched, the sides of the labrum are produced to form distinct tubercles. The margin of the labrum bears a broken row of papillae. The maxillary palpi are preapical. The mandibles are bidentate, the upper margin of each mandible minutely dentate apically.

Stelis (*Microstelis*) *lateralis* Cresson

(Figs. 114-116, 118)

The larva is similar in body form to that of *Hoplitis* (*Alcidamea*) sp? described elsewhere in this paper, but with the middorsal tubercles higher, that of the fourth abdominal segment particularly large. The ventrolateral tubercles are absent. The head is similar to that of other megachilids, but the mandible is pointed, neither truncate nor bifid, with virtually no indication of an apical inner concavity or of a cusp. The spiracular atrium is provided with scattered long spines arising from short ridges. The atrium is produced above the level of the body surface. The peritreme is flat, and the primary tracheal opening is narrowed by a collar.

Lawrence, Kansas, June 27, 1950, from nest of *Hoplitis* (*Alcidamea*) *pilosifrons* (Cresson) (Michener).

Stelis minuta Lepeletier

Enslin (1925) described and figured the larva of this species. It apparently does not have conspicuous dorsal tubercles but has large rounded ventrolateral tubercles. The lines of division between caudal and cephalic annulets of the dorsal body segments are shown as feeble. The mandibles, like those of *S. lateralis,* are sharply pointed.

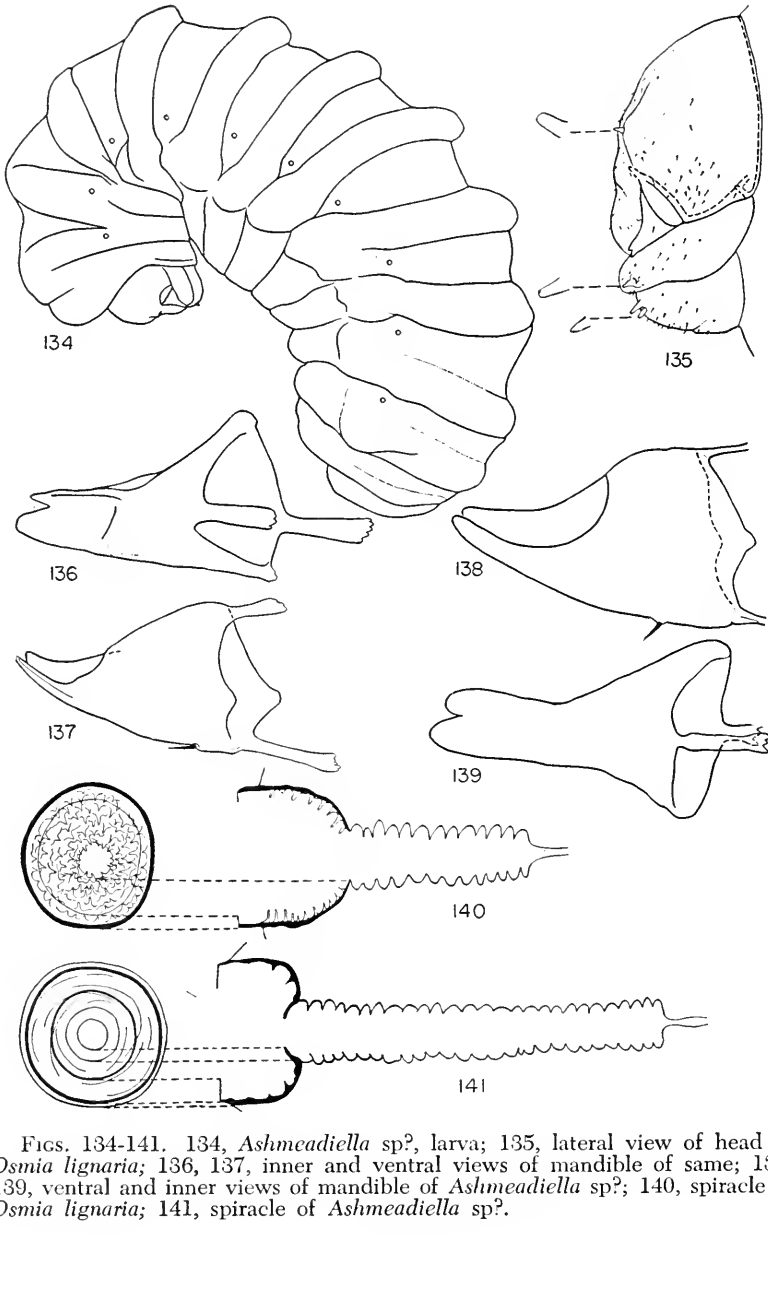
Dioxys cincta (Jurine)

Micheli (1936) described and illustrated the larva of this parasite. It is peculiar for a megachilid in having only a few scattered setae on the body. The head has only a few scattered but rather long setae. It agrees with the majority of megachilids in the long antennal papillae, long palpi, transverse salivary opening with large lips, etc. The spiracles are described as having numerous very minute teeth in the atrium. The labroclypeal suture is strongly arched; the labrum bears a small cluster of papillae subapically at each side. The mandible is bidentate, the teeth rather small and blunt. There are no minute teeth or serrations. Micheli shows no defined inner apical concavity, but he fails to show the transverse line defining the concavity basally in certain other bees which almost certainly have such a line (e. g. *Hoplitis lepeletieri*). Probably there is no such line in *Dioxys,* but it may be present.

It seems likely that the larva described by Grandi (1934a) from a nest of *Megachile* (*Chalicodoma*) *muraria* is a *Dioxys.*

Heriades (*Heriades*) *crenulatus* Nylander

The larva of this species is fully described and figured by Grandi (1934a). The body shape is typical of megachilids, the posterior portion being swollen. The lines separating the cephalic from the caudal annulets of the dorsal body segments are evident and extend downward below the spiracles as shown for *Megachile brevis.* The caudal annulets are swollen dorsally but not so strongly as in *Ashmeadiella.* Feeble ventrolateral swellings are present. Other characters also are like those of most megachilids. The body bears numerous setae, the antennal papillae and the palpi are elongate, the salivary opening is transverse and provided with very long lips, and the labroclypeal suture is strongly arched. The labrum is unusually narrow, with the apex emarginate; it lacks papillae, or they are represented by small pegs. The mandibles are bidentate, the teeth acute, the inner apical concavity distinct. The spiracular atria contain a few blunt teeth.



FIGS. 134-141. 134, *Ashmeadiella* sp?, larva; 135, lateral view of head of *Osmia lignaria;* 136, 137, inner and ventral views of mandible of same; 138, 139, ventral and inner views of mandible of *Ashmeadiella* sp?; 140, spiracle of *Osmia lignaria;* 141, spiracle of *Ashmeadiella* sp?.

Ashmeadiella sp.

(Figs. 134, 138, 139, 141)

The larva is essentially as in *Trachusa* but the caudal annulets of the dorsal body segments are much more strongly elevated, the elevations continued across the dorsum and extending down laterally to the elevations of the ventrolateral regions of the body which are not formed into distinct tubercles but are elevated to produce an irregular ridge. The head capsule is essentially as in *Trachusa*. The papilla of each antenna is about twice as long as broad and the maxillary and labial palpi are distinctly longer than broad. The mandible is bidentate at its apex, the teeth rounded, the upper tooth slightly shorter than the lower. The spiracular atria lack spines but have high sharp ridges within; the collar surrounding the primary tracheal opening is thick.

Mount Diablo, Contra Costa County, California, December 24, 1940 (MacSwain) (a single specimen removed from the nest of *Pseudomasaris*).

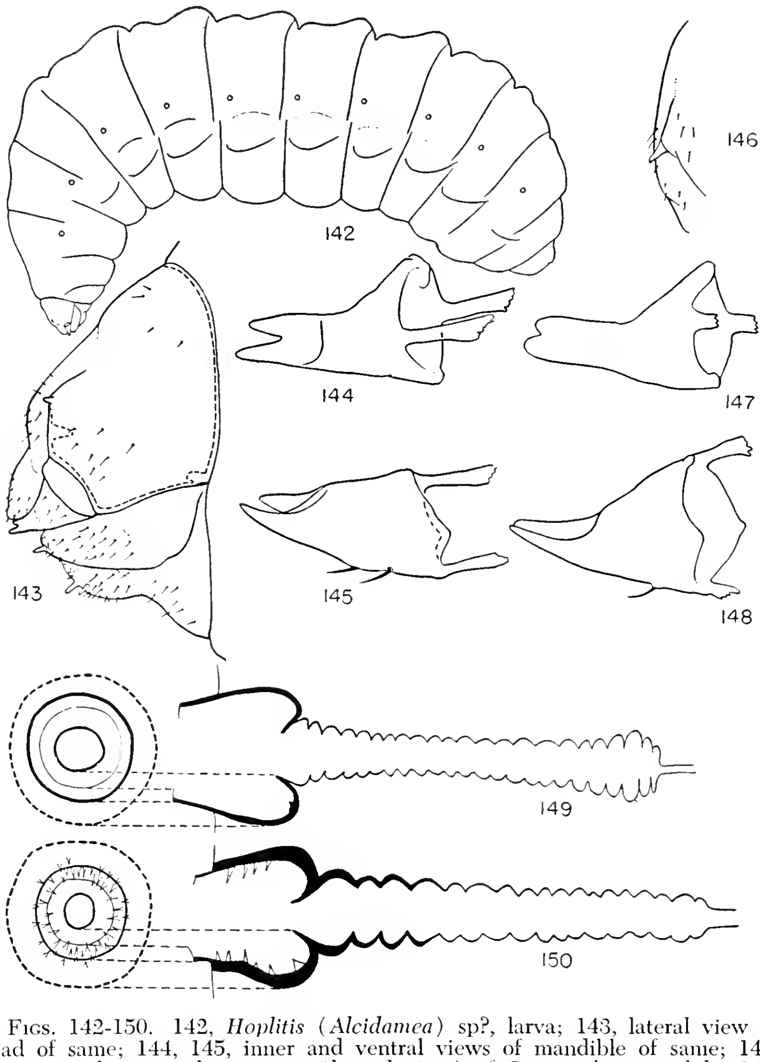
Hoplitis (*Alcidamea*) sp.

(Figs. 142-145, 149)

In fundamental structure this larva is similar to that of *Trachusa* but it is much more slender, the lines of separation between the cephalic and caudal annulets of the body segments are even less conspicuous and the ventrolateral tubercles are inconspicuous. The posterior portions of the middle body segments, and to a lesser extent of the last thoracic to the sixth abdominal segments bear middorsal unpaired elevations or tubercles. The head capsule differs from that of *Trachusa* in the absence of a cuticular thickening along the branches of the cleavage line. The antennae are more conspicuously conical than in *Trachusa*, the apex of each cone bearing a papilla as in *Trachusa*. The mandibles are deeply bifid at their apices, the upper tooth shorter than the lower, the inner apical concavity weak. The maxillary palpi are over twice as long as broad. The spiracular atria are deep, thick walled, nearly smooth inside, much produced above the body surface; the peritreme is narrow and flat.

Mineral King, Tulare County, California, August 10, 1939 (Bohart). From their large size it is clear that they are either *H. sambuci* Titus or *H. uvulalis* (Cockerell).

Larvae of *H.* (*Alcidamea*) *parvula* (Dufour and Perris) and *H.* (*Tridentosmia*) *tridentata* (Dufour and Perris) were described briefly by Dufour and Perris (1840).



Figs. 142-150. 142, *Hoplitis* (*Alcidamea*) sp?, larva; 143, lateral view of head of same; 144, 145, inner and ventral views of mandible of same; 146, antenna and surrounding region (lateral view) of *Proteriades xerophila;* 147, 148, inner and ventral views of mandible of same; 149, spiracle of *Hoplitis* (*Alcidamea*) sp?; 150, spiracle of *Proteriades xerophila.*

Hoplitis (*Hoplitis*) *adunca* (Panzer)

The larva of this species is described and figured by Grandi (1935). Grandi suggests that this larva may have been that of a parasite, *Dioxys cincta* Jurine, but Micheli (1936) describes the larva of *Dioxys* and shows clearly that Grandi's "*Osmia adunca*" is correctly identified.

The body is more robust and more curled than that of *Hoplitis* (*Alcidamea*), and lacks dorsal protuberances as well as ventrolateral tubercles. The cephalic and caudal annulets of the body are distinct dorsally. Most structures are typical of megachilids, for example, the elongate antennal papillae and palpi, the arched labroclypeal suture, the transverse salivary opening with lips, and the setae on the body surface. The mandibles are bidentate with the teeth rounded, the inner concavity well defined. The labral margin is provided with a broken row of papillae.

Hoplitis lepeletieri (Pérez)

The larva of this species is described and figured by Micheli (1933). It is more robust than that of *Hoplitis* (*Alcidamea*), being more like the larva of *Megachile* in form although not so robust as usual in that genus. *H. lepeletieri* exhibits the usual megachilid features. The labroclypeal suture is strongly arched and the lowest margin of the labrum bears an irregular broken row of small papillae. The mandibles are bidentate, the upper tooth shorter than the lower, in ventral view looking much like those of *Osmia lignaria*, but with the upper margin provided with several small blunt teeth.

Hoplitis loti (Morawitz)

The larva of this species is described by Micheli (1931). It has very much the shape of *Hoplitis* (*Alcidamea*), although Micheli shows it in a more curled position. All of its features are typical of the Megachilidae in general. The mandibles are bidentate, the teeth shorter than in *Alcidamea* and blunt as in *Proteriades*. The anterior margin of the labrum bears a broken row of papillae absent in the similar *Hoplitis leucomelaena*.

Hoplitis leucomelaena (Kirby)

The larva of this species is described by Enslin (1925) and by Micheli (1930). The larva has the body form of the *Hoplitis* (*Alcidamea*) described in the present paper except that it is more slender with the intersegmental lines more deeply constricted on the venter. All its features described and figured by Micheli are typical of Megachilidae in general. The mandibles are bidentate with the teeth shorter than those figured for *Hoplitis* (*Alcidamea*) but not blunt as are those of *Proteriades*.

Diceratosmia submicans (Morawitz)

The larva of this species is briefly described and figured by Maneval (1939). It exhibits the usual megachilid features. The antennal papillae and palpi are over three times as long as broad. The maxillary palpi are preapical on the maxillae. The labrum bears an apical row of papillae. The salivary opening is transverse with unusually long lips. The mandibles are bidentate, the apical teeth narrowly rounded, the notch between them deep. There is no evidence in Maneval's description and figures of the well-defined inner apical concavity of most megachilids.

Osmia (Osmia) lignaria Say

(Figs. 135-137, 140)

The larva is similar to that of *Trachusa* except that the intersegmental lines are even less conspicuous and the lines between the cephalic and caudal annulets of the segments are also less conspicuous, the caudal annulets not being elevated as in *Trachusa*. The ventrolateral tubercles are absent. The head capsule is essentially as in *Trachusa;* the swellings on which the antennae are located are even lower, being essentially indistinguishable, and the antennal papillae are higher, being more than twice as long as broad. The mandibles are bidentate at their apices, the upper tooth being smaller and shorter than the lower; the inner apical concavity is shallow. The maxillary palpi are longer than broad and the maxillae and labium are not provided with bristlelike hairs but only with ordinary fine setae. The spiracles have atria spinose within and produced well above body surface. The peritreme is narrow and the primary tracheal opening lacks a collar.

Pittsburg, California, May, 1940 (MacSwain).

Osmia (Osmia) rufa (Linnaeus)

The larva of this species was described and figured by Losinski (under the name *O. bicornis* Linnaeus) in 1911. No conspicuous specific characters are evident but the structures in general are similar to those of *O. lignaria*.

Osmia (Helicosmia) aurulenta (Panzer)

Maréchal (1926) has described and illustrated the larva of this species. The mature larva is more slender than that of *Trachusa*, and differs from that of *O. lignaria* in having the lines between cephalic and caudal annulets of the segments distinct dorsally, the caudal annulets elevated dorsally. The ventrolateral tubercles of the body are present. The usual megachilid characters of long antennal papillae, long palpi, transverse salivary opening with lips, and setose body are present. The mandibles are bidentate, the upper tooth apparently being short and rounded in the mature larva although pointed in younger ones.

Proteriades xerophila (Cockerell)

(Figs. 146-148, 150)

The larva is similar to that of *Trachusa* but somewhat more slender and with less distinct ventrolateral tubercles. The head capsule is essentially as in *Trachusa* with the position of the cleavage line being indicated by slight depressions and slight thickenings and the position of the epistomal suture between the anterior tentorial pits being indicated by a slight depression. The antennal papillae are much larger than in *Trachusa*, being more than twice as long as broad. The mandibles are bifid, the teeth blunt, the lower one longer than the upper. The maxillary as well as the labial palpi are more than twice as long as broad. The spiracles have very thick-walled atria which have scattered large spines within and are produced above the body surface. The peritreme is narrow and the primary tracheal opening is much narrowed by a thick collar.

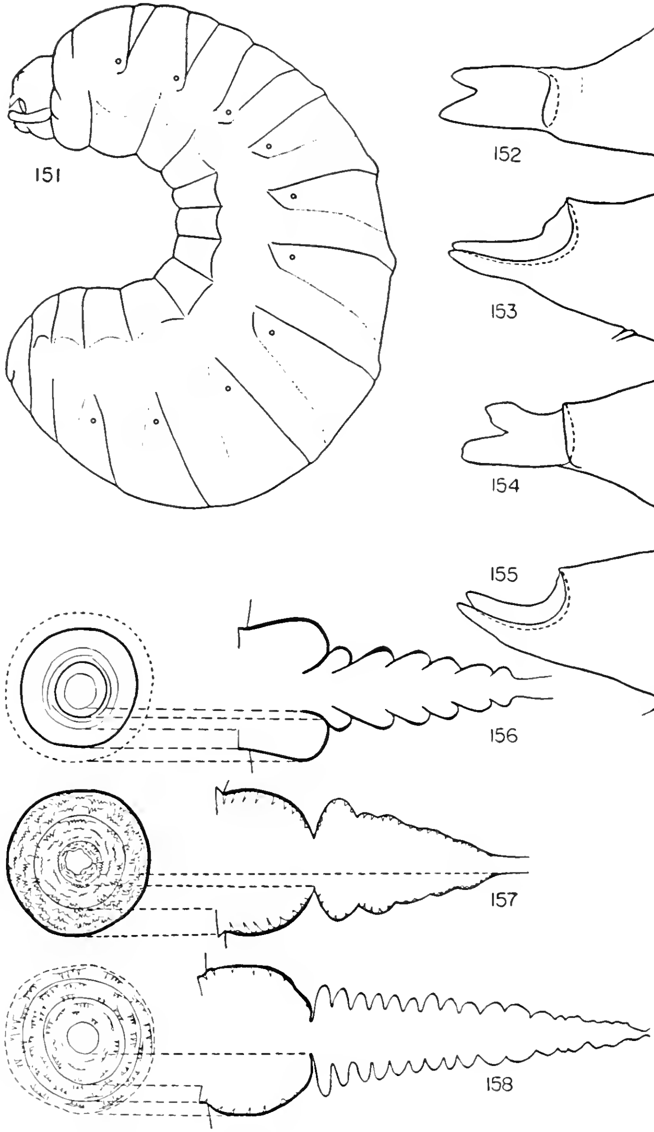
Little Lake, Inyo County, California, February 29, 1940 (Linsley, Bohart, and MacSwain).

Megachile sp.

(Figs. 154, 155, 158)

The larva is similar to that of *Trachusa*, but the caudal annulets of the body segments are less elevated (although weak middorsal elevations are present) and the ventrolateral regions of the body, instead of being formed into separate tubercles, are elevated to form a broad ridge on each side below the level of the spiracles. The head capsule is much as in *Trachusa*, the antennal papillae being more than twice as long as broad. The apices of the mandibles are bifid, the lower tooth longer than the upper, the inner apical concavity of each mandible deep and delimited by a distinct and sharp ridge which forms a conspicuous inner shoulder on the mandible. The maxillary and labial palpi are similar in appearance, both more than twice as long as broad. The maxillae and labrum bear setae similar to those found elsewhere on the head and mouthparts, not coarse and bristlelike. The spiracular atria are spinose within, the spines being arranged in short rows, each row on a short ridge; the spines are lower toward the primary tracheal opening. The peritreme is rather narrow.

New York City, August, 1928 (Lillian Clum).



FIGS. 151-158. 151, *Megachile brevis*, larva; 152, 153, inner and ventral views of mandible of same; 154, 155, inner and ventral views of mandible of *Megachile* sp?; 156, spiracle of *Megachile* (*Chelostomoides*) sp? from Panama; 157, spiracle of *Megachile brevis;* 158, spiracle of *Megachile* sp?.

Megachile (*Litomegachile*) *brevis* Say

(Figs. 151-153, 157)

This species is similar to that of *Megachile* sp. described above but the mandibular teeth are less flaring; the teeth of the atrium are more numerous, the subatria of the spiracles are spinose within, swollen and only irregularly annulate.

Lawrence, Kansas (White, Michener, Fischer, LaBerge, Wille).

Megachile (*Megachile*) *centuncularis* (Linnaeus)

Buysson (1902) makes a brief comment on the larva of this species, comparing it with that of *M. lagopoda;* Packard (1897) describes the general characteristics of a larva supposed to be this species; and Grandi (1934a) gives a full description and figures. The larva is similar to that of *M.* sp. and *M. brevis,* described in the present paper. The mandibles are more like those of *M. brevis,* but have the lower tooth even more acute. The atria contain groups of small teeth, as in *M. brevis* but perhaps smaller.

Megachile (*Eutricharaea*) *argentata* (Fabricius)

The larva of this species is described and figured by Grandi (1931). It differs from that of *M. albiseta* only by very minor characters.

Megachile nigriventris Schenck

The larva of this species is described and figured in some detail by Micheli (1937). It is similar to that of *M. brevis* in most respects. The most striking characteristic of the larva of *nigriventris* is that the head bears a pair of conspicuous tubercles well above the antennal bases. The apices of these tubercles are rounded, not pointed as they are in *Centris,* the only other bee larva known to have comparable tubercles. The mandible is similar to that of *M. brevis* but with the upper tooth conspicuously acute, the upper margin smooth. The body is less plump than in *M. brevis,* with the lines between cephalic and caudal annulets of the segments conspicuous, the latter distinctly more swollen than the former. The spiracles are not figured or adequately described.

Megachile albiseta (Klug)

Grandi (1931) describes and figures the larva of this species in detail. As with *M. nigriventris,* the body is less plump than in such forms as *M. brevis,* not noticeably swollen posteriorly, with the caudal annulet of each segment considerably swollen. Ventrolateral tubercles are present. The elongate palpi and antennal papillae, the transverse salivary opening with lips, and the setose body are characteristic of megachilids. The mandibles are bidentate, with an inner apical concavity.

Megachile spp.

Buysson (1902) very briefly describes the larva of *M. lagopoda* (Linnaeus), pointing out such conspicuous characters as the bidentate mandibles. He then states that larvae of the following are similar to that of *M. lagopoda: M. maritima* (Kirby), *pyrenaica* Lepeletier, and *buyssonii* Pérez.

Another group of species was described by Claude-Joseph (1926). These are *M. pollinosa* Spinola, *saulcyi* Guérin-Meneville, *rancaguensis* Friese, and *euzona* Pérez. All have bidentate mandibles and the other usual characters of the genus.

Megachile (*Chalicodoma*) *muraria* (Retzius)

The larva of this species is well described and figured by Grandi (1934a). Like the adult, it is somewhat unusual for a *Megachile,* having mandibles which are not bidentate but narrowed apically with a suggestion of a subapical tooth represented by a small shoulder. As in the subgenus *Chelostomoides,* the spiracular atria lack spines. As would be expected, it resembles most megachilids in the principal characters of the group, such as the setose body, the long antennal papillae and palpi, and the large transverse salivary opening with lips.

Megachile (*Chalicodoma*) *pyrenaica alpina* Morawitz

The larva is described by Micheli (1935) who notes only very minor differences between this species and *M. muraria.*

Megachile (*Chelostomoides*) sp?

(Fig. 156)

This species is much like the above, differing in the less elevated caudal annulets of the body segments (in the single specimen studied) and in the spiracular details, the atrium being narrowed toward the surface and the subatrium having few annulations.

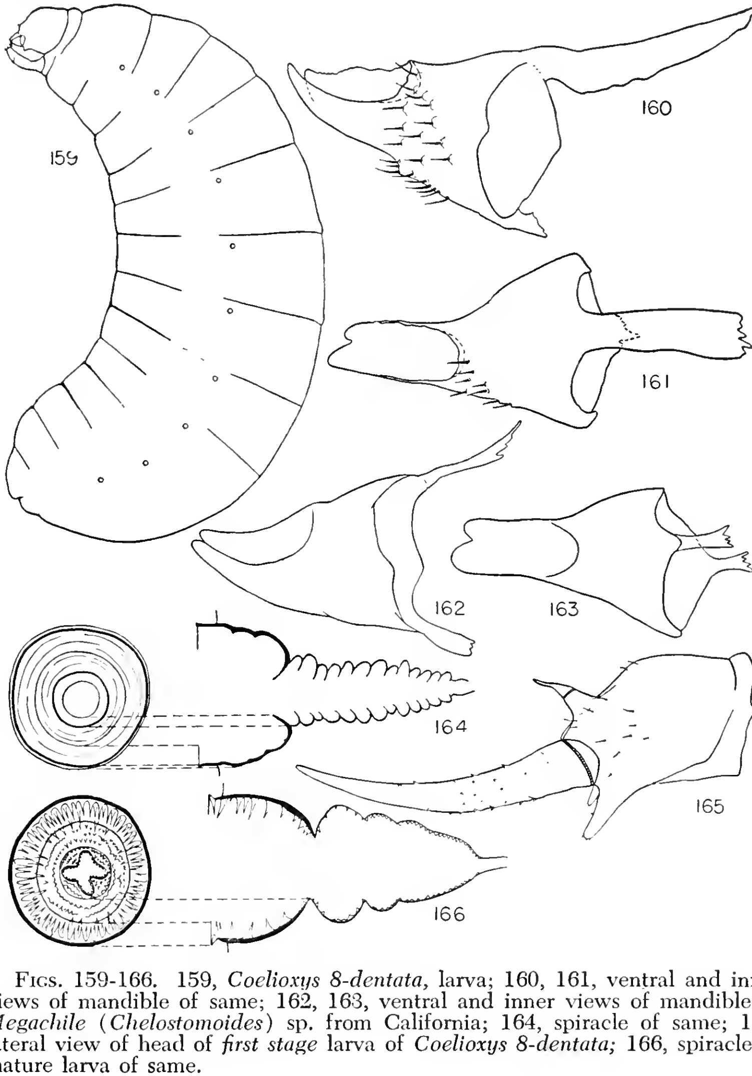
Between Pacora and Chepo, Panamá, February 25, 1924 (Snyder, Zetek, and Molino). The larva was in the outer layer of a nest of *Amitermes medius.* The adult bee was identified by S. A. Rohwer as *Megachile howardi* Cockerell. This species is a member of the subgenus *Sayapis,* but the female originally associated with it is

Megachile (*Chelostomoides*) *zaptlana* Cresson (see Mitchell, 1937). Identification was probably based on a female, and it seems likely that the larva in question is a *Chelostomoides,* perhaps *M. zaptlana.*

Megachile (*Chelostomoides*) sp?

(Figs. 162-164)

The larva is shaped approximately as in *M. brevis* but the lines between the cephalic and the caudal annulets of the body seg-



FIGS. 159-166. 159, *Coelioxys 8-dentata,* larva; 160, 161, ventral and inner views of mandible of same; 162, 163, ventral and inner views of mandible of *Megachile* (*Chelostomoides*) sp. from California; 164, spiracle of same; 165, lateral view of head of *first stage* larva of *Coelioxys 8-dentata;* 166, spiracle of mature larva of same.

ments are conspicuous, and the caudal annulets are elevated dorsally and dorsolaterally. The ventrolateral tubercles are absent. The head structures are essentially as in *M. brevis.* The mandibular teeth are shorter and more rounded than in that species while the basal limit of the mandibular concavity, is distinct but not strongly elevated as in *M. brevis.* Unlike *M. brevis,* the spiracular atrium lacks spines and the primary tracheal opening is narrowed by a collar.

Five miles northwest of Blythe, California, April 2, 1941, in old *Colletes* burrow (Linsley, MacSwain).

Coelioxys 8-dentata Say

(Figs. 159-161, 165, 166)

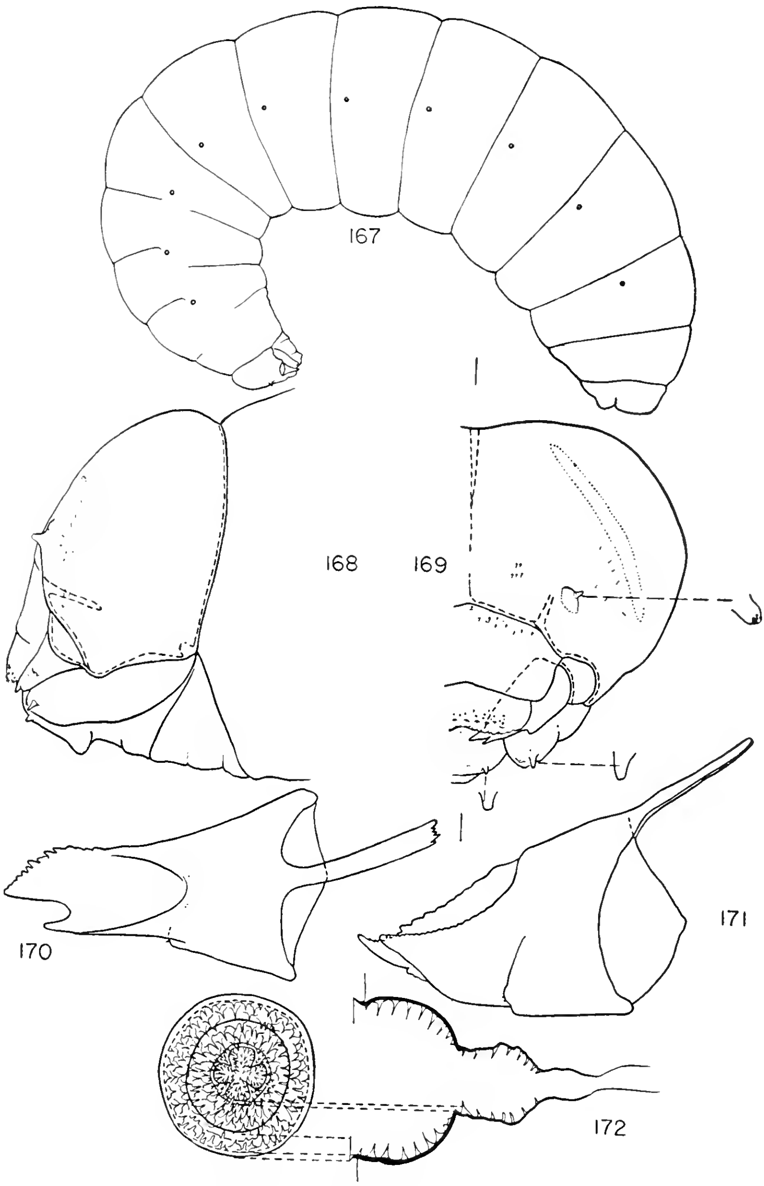
The larva is similar to that of *Megachile* but differs by having longer setae on the body, numerous long setae on the outer surfaces of the mandibles, and a projection, variable in size, extending downward from the hypostomal thickening immediately behind the mandible. The spiracular atria have very long spines, progressively shorter toward the primary tracheal opening. The preatrium is spinose or tuberculate within, swollen, only irregularly annulate, and longitudinally folded.

Lawrence, Kansas, various dates (Michener and White), in nests of *Megachile brevis* Say.

XYLOCOPINAE

The evidence of relationship of the Ceratininae and the Xylocopinae on the basis of adult characters has been rather tenuous. It is therefore interesting that the larval characters of *Xylocopa* and *Ceratina* in general support the relationship. Common characters include the absence of body tubercles (although there are greatly enlarged and modified ventrolateral tubercles in *Allodape* and *Exoneura*), the bidentate mandibles (acute in *Allodape*) with small marginal teeth, the great reduction of the salivary opening which is hidden from outside view, being far back on the upper surface of the labial lobe, and the distinct antennal tubercles. In the attenuate mandible which has lost its inner apical concavity, *Ceratina* is more specialized than *Xylocopa.*

Among the most remarkable bee larvae are those of *Allodape* (Brauns, 1926, Masi, 1930; Yasumatsu, 1938) and *Exoneura* (Rayment, 1949, 1949a, 1951; Erickson and Rayment, 1951). They are progressively fed and have various modifications of the body tubercles important for the progressive feeding utilized by members of



FIGS. 167-172. 167, *Xylocopa virginica*, larva; 168, 169, lateral and dorsal views of head of same; 170, 171, inner and ventral views of mandible of same; 172, spiracle of same.

these genera. Unfortunately few of the finer details of structure have been recorded for members of these genera, the most complete information available being that provided by Yasumatsu. It is interesting that at least certain *Allodape* larvae have setae on the body like those of the Megachilidae and more abundant than those of *Bombus*.

Xylocopa (*Schönherria*) *virginica* (Linnaeus)

(Figs. 167-172)

The larva, which was briefly described by Packard (1897), is rather slender with intersegmental lines conspicuous but not deep, the lines between the caudal and cephalic annulets of the segments absent, the dorsolateral and ventrolateral tubercles also absent.

Head capsule somewhat sclerotized with a distinct constriction separating it from thorax; head capsule and mouthparts provided with scattered minute setae; epistimal suture represented by a rather distinct groove between anterior tentorial pits; cleavage line not evident but dorsal longitudinal median thickening of head capsule present. Antennae each with distinct papilla which is longer than broad arising from a broad convexity; labroclypeal suture distinct; labrum with apical margin subtruncate, labial tubercles absent. Mandibles each with a tubercle or projection on outer side midway between base and apex, apices bidentate, upper tooth much longer than lower, its upper margin coarsely serrate; lower tooth small and slender, its inner margin feebly serrate. Maxillae with apices extending a short distance beyond maxillary palpi which are longer than broad; labium with salivary opening small, circular, on dorsal surface of labial lobe, without lips or projections; labium with a distinct ventral tubercle just anterior to line between postmentum and prementum; hypostomal furrow deep.

Body without spicules or setae. Spiracles with atrium and preatrium both densely spinose within, the former produced above body surface, with rim; preatrium short, not annulate, thrown into longitudinal folds; peritreme flat.

Geitch, Virginia, July 7, 1914 (T. D. Snyder) (A single specimen).

Xylocopa (*Xylocopa*) *violacea* (Linnaeus)

The larva of this species was briefly described and figured by Lucas (1868) and fully so by Grandi (1934a). The larva is similar to that of *X. virginica,* differing in the more slender upper mandibular tooth which bears a distinct shoulder at the base of the lower mandibular tooth. Minor apparent differences in the arrangement of the minute setae may or may not exist in reality.

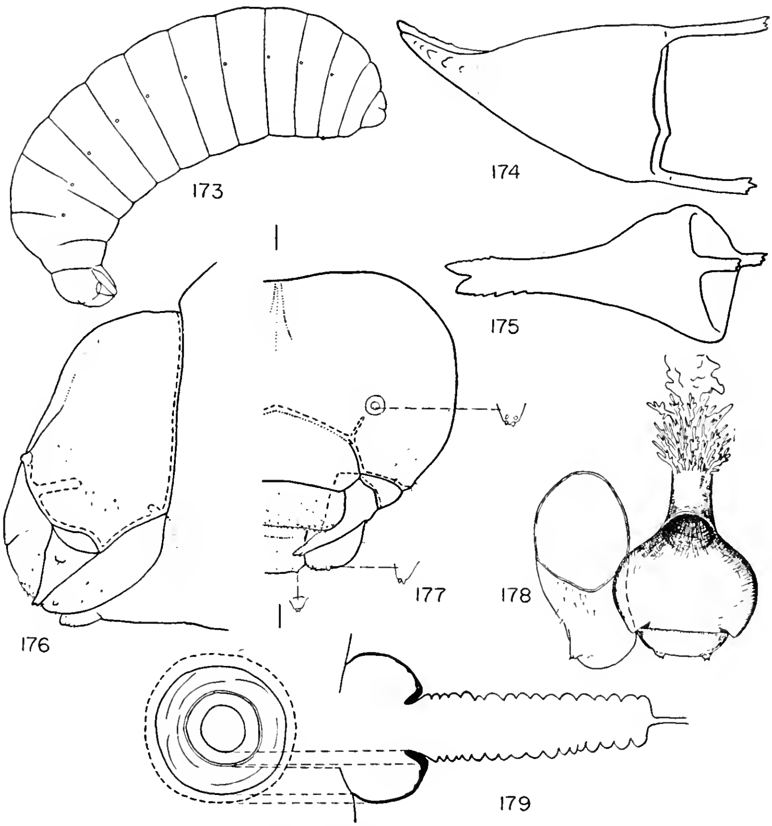
Xylocopa aestuans (Linnaeus)

Dover (1924) described and figured the larva of this species. So far as can be determined, the species agrees with the two better known *Xylocopa* species whose larvae are described above.

Ceratina (*Zadontomerus*) *dupla* Say

(Figs. 173-179)

The larva, which was crudely figured by Packard (1897), is slender with the intersegmental lines rather distinct but the lines between cephalic and caudal annulates of segments absent or visible only on some of the middle segments of the body. The dorsolateral and ventrolateral tubercles are absent.



FIGS. 173-179. 173, *Ceratina dupla,* larva; 174, 175, ventral and inner views of mandible of same; 176, 177, lateral and dorsal views of head of same; 178, dorsal view of labiomaxillary complex showing salivary opening of same; 179, spiracle of same.

Head capsule and mouthparts with scattered exceedingly minute setae; head capsule rather weakly sclerotized, a slight constriction separating it from the thorax; marginal thickening of head capsule weak and posterior tentorial pits inconspicuous; epistomal suture indicated by a very feeble depression and feeble thickening of the integument extending between the anterior tentorial pits; cleavage line feebly indicated, dorsal longitudinal median thickening of head capsule absent. Antennae distinct, each represented by a rather high prominence; labroclypeal suture distinct; labrum with apex subtruncate, labral tubercles absent. Mandibles with apices bidentate, upper tooth longer than lower, upper and lower margins of mandible serrate apically; cusp absent, inner apical concavity not distinct. Maxillae with apices not bent inward as in *Anthophora*, maxillary palpi broader than long; hypostomal furrow deep; labium with salivary opening small, round, on dorsal side of labial lobe; division between prementum and postmentum distinct.

Body without spicules or setae. Spiracles with atrium with a few feeble ridges, without spines, not projecting above level of body surface; peritreme present; collar around primary tracheal opening present and thick.

Washington, D. C., June 18, 1930 (J. E. Barr).

Ceratina (*Ceratina*) *cucurbitina* (Rossi)

Grandi (1935) has described and illustrated this species. It is similar to *C. dupla*, with the antennae and palpi perhaps slightly shorter. The small denticles of the mandibles appear to be somewhat differently arranged than in *C. dupla*.

Ceratina (*Ceratina*) *callosa* (Fabricius)

The larva of this species is described and figured by Micheli (1936). It is essentially like *C. dupla*, apparently with the antennal papillae and the palpi slightly longer. The mandibles evidently have the small teeth of the margins smaller than in *dupla*, indeed Micheli's outer view does not show them at all.

Manuelia gayatina (Spinola)

Claude-Joseph (1926) describes and figures the larva of this species. It is similar to that of *Ceratina*, the body lacking tubercles. The antennal papillae are unusually large. The mandibles are slender apically as in *Ceratina* and terminate in a group of teeth, but are not bidentate.

Allodape ceratinoides Gribodo

The larva of this species is briefly described and figured by Brauns (1926). The head is of the usual shape with a few very long hairs on the vertex. Antennae are not illustrated, perhaps they are much reduced. The dorsolateral tubercles are absent while the ventrolateral ones anteriorly are elongated to form "arms" in which pollen is held during feeding. The dorsum of the larva is provided with numerous setae.

Allodape strandi Masi

Masi (1930) described and figured the larva of this species. It is similar to that of *A. ceratinoides* but differs in details of the "arms", etc. It, too, has setae on the body.

Allodape marginata Smith

Yasumatsu (1938) has described and figured the larva of this species. It is somewhat similar in general form to *A. ceratinoides* but the ventrolateral tubercles ("arms") are absent. The head is greatly broadened, the lateral projecting parietal regions being provided with long curved hairs. The antennae are low. The palpi are virtually absent. The mandibles are attenuate apically, acute, with three to six small inner subapical teeth. The body is provided with setae. As in *A. ceratinoides,* the last two body segments are unusually elongate.

Allodape pringlei Cameron

The larva of this species is described and figured by Brauns (1926). The head is of the ordinary shape, without long setae. The antennal papillae are long. The labrum has distinctly produced, broad labral tubercles. No setae are shown on the body but numerous small tubercles are present both dorsally and ventrally.

Allodape sp.

A distinctive type of *Allodape* larva described by Brauns (1926) (his third type) has only two tubercles on each side of the body.

Exoneura spp.

The larvae of several species of *Exoneura* have been recently described, as follows: *E. simillima* Rayment, *frogattii* Cockerell, *fultoni* Cockerell, *obliterata* Cockerell (Rayment, 1949); *concava* Rayment, *sub-holmesi* Rayment, *roddi* Rayment, *montana* Rayment, *variabilis* Rayment, *excavata* Cockerell, and *apposita* Rayment (Rayment, 1949a); *rufitarsis* Rayment, *sub-baculifera* Rayment, *richardsoni* Rayment, *hamulata* Cockerell (Rayment, 1951); and *illustris* Erickson and Rayment, *pictifrons* Alfken (Erickson and Rayment, 1951). Unfortunately the numerous descriptions and figures are not detailed, emphasis being placed on the armlike projections, apparently modified ventrolateral tubercles, which are highly variable in size, position, and number, much as in *Allodape*. No details of the mouthparts are known. The antennal papillae are usually very long, several times as long as broad. Presumably this is correlated with the somewhat active life of the larvae in a common chamber where they are fed progressively. One species (*sub-baculifera*) has a conspicuous frontal projection on the head.

Subfamily ANTHOPHORINAE

That the bees which were placed in the Anthophorinae in a previous work (Michener, 1944) constitute a diverse, although probably monophyletic, unit is evident enough from adult morphology. The diversity is emphasized by larval morphology, and as pointed out in the section on phylogeny, a rearrangement of the classification may be indicated. However, at least until larvae of the Exomalopsini can be studied, or until adult characters are found, such a rearrangement will not be formalized.

Larvae of *Nomada* and *Neopasites*, especially the latter, share most of their characters with the Halictidae and Andrenidae. For example, the salivary opening is reduced, without lips, the antennal papillae are reduced or absent, and the mandibles are acute at their apices with small teeth on the margins and an inner multidentate cusp. No inner apical concavity marked by a ridge is present. *Epeolus* and *Triepeolus* are essentially similar except that the small teeth of the mandibles are much reduced and the cusp is absent, the distal portions of the mandibles being attenuate. *Nomada* and the epeolines show the most extensive labiomaxillary reduction and fusion seen in bee larvae. In all four of the above mentioned genera the spiracular atria are produced above the body surface.

The other genera of Anthophorinae are quite different from those discussed above in that the salivary opening is a slit, provided with lips which are usually large but are much reduced in *Anthophora*. The antennal papillae are distinct except in *Anthophora*. Each mandible possesses an inner apical concavity demarked basally by a distinct line or ridge. Small teeth are reduced or absent and the multidentate cusp is absent, or in *Melissodes* indicated by a mere remnant. The mandibular apices are usually blunt, often subtruncate, but may be nearly acute, as in some species of *Anthophora*, or bidentate, as in *Melissodes* and *Emphor*.

The view that *Melecta* arose from ancestors of *Anthophora*, as indicated by several adult characters (see Michener, 1944), not from *Anthophora* itself as suggested by Grütte (1935) and others, is supported by larval characters. For example, *Melecta* has long antennal papillae, larger palpi, a larger salivary opening, and larger lips for this opening than *Anthophora*. All of these are presumably primitive features among the bees of this group.

Exomalopsis caerulea Friese

Claude-Joseph (1926) briefly describes and figures the larvae of this bee. It appears to have the caudal annulets of the body segments strongly elevated down to the level of the spiracles. The antennal papillae and the palpi are elongated. The labrum is strongly emarginate apically so that the labial tubercles are prominent. The mandibles are robust, oblique or beveled apically; unfortunately nothing is known of their inner surfaces. The salivary opening is transverse but short, not as long as the distance between the labial palpi.

Neopasites sp?

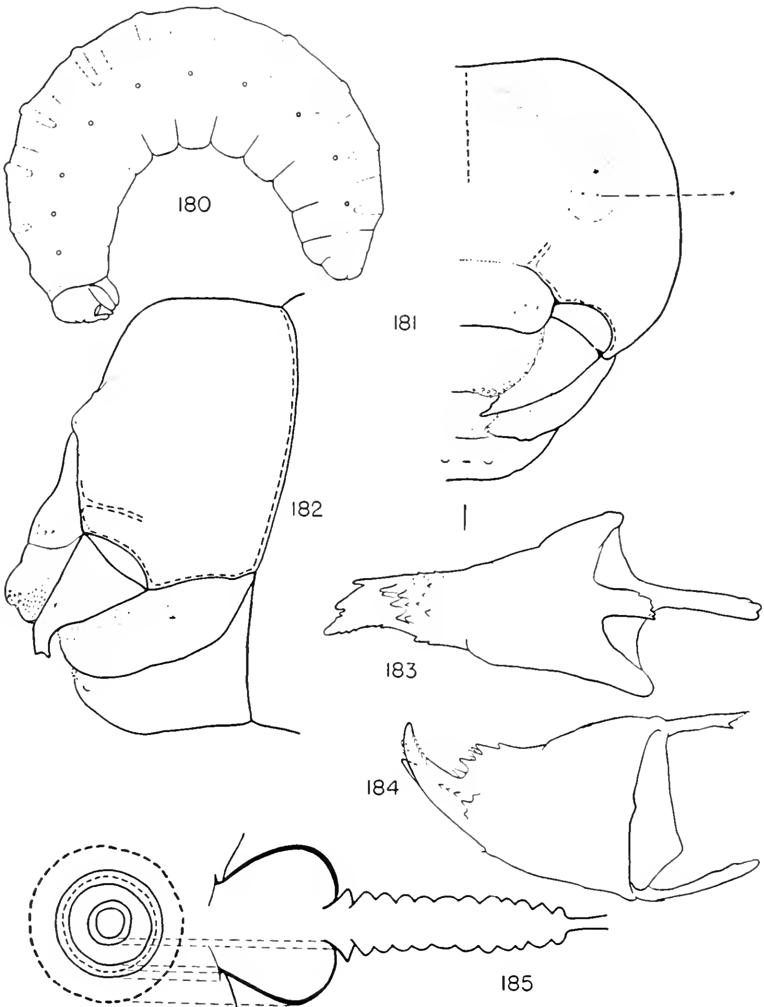
(Figs. 180-185)

The larva is somewhat slender, the intersegmental lines absent laterally and weak dorsally, the lines between the cephalic and the caudal annulets of the segments absent unless the anterior margins of dorsolateral tubercles represent them. The dorsolateral tubercles are low, transverse, nearly meeting on the middorsal line. The ventrolateral tubercles are absent.

Head capsule scarcely sclerotized, with a few minute scattered hairs on clypeus and mouthparts; marginal thickening of head capsule weak; epistomal suture indicated by weak concavity, no thickening between anterior tentorial pits; cleavage line indicated on upper part of head, arms not indicated; longitudinal median thickening of head capsule absent. Antennae prominent convexities; head capsule above antennae with broad convexities suggestive of those of the halictids; labrum without distinct tubercles although distal margin has feeble convexities laterally which bear minute setae arising from large pits. Mandible with apex acute, bearing two large teeth on upper margin and some small teeth on both margins; cusp distinct, bearing several large teeth. Maxillae without distinct palpi; labial palpi mere convexities; salivary opening a short slit without lips at apex of labial lobe.

Spiracular atria without spines or ridges, produced above level of body surface, strongly rimmed; peritreme large; primary tracheal opening narrowed by distinct collar.

Lawrence, Kansas, June, 1951 (Michener); described from a single specimen obtained from a nest of *Calliopsis andreniformis* and identified by comparison with a shed larval skin from which a *Neopasites* pupa emerged. As no adult was obtained specific identification proved impossible.



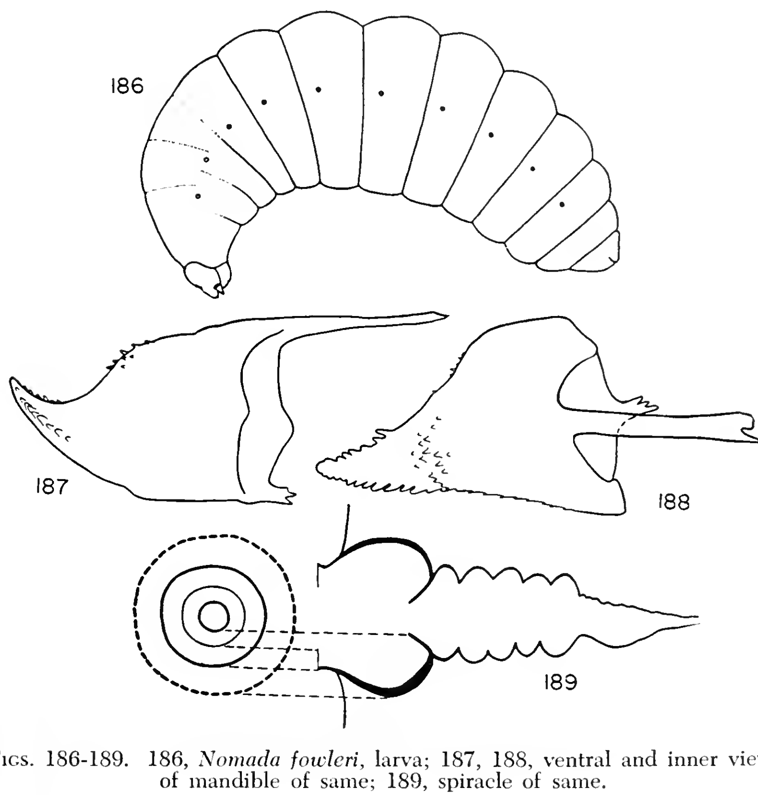
FIGS. 180-185. 180, *Neopasites* sp?, larva; 181, 182, dorsal and lateral views of head of same; 183, 184, inner and ventral views of mandible of same; 185, spiracle of same.

Nomada (Nomada) fowleri Cockerell

(Figs. 187-189)

This species agrees with *Triepeolus* in nearly all details, including the body shape, the large and conspicuous spiracles, and the anatomical peculiarities of the head capsule. The following differences exist: The hypopharynx and labium are even more receding, much overhung by the labrum; the external portion of the hypopharynx is nearly round, not transverse, the salivary opening, therefore, is farther from the mouth than in *Triepeolus.* The mandibles are thick basally, pointed and curved inward apically, their upper and lower margins coarsely serrate apically. (The details of serration vary in the two mandibles of one individual.) The cusp is indicated by a group of teeth. The maxillary palpi are about twice as long as their basal widths.

The body bears spicules in certain dorsal areas. The spiracular atria lack spines. The atria are produced above the body surface,



Figs. 186-189. 186, *Nomada fowleri,* larva; 187, 188, ventral and inner views of mandible of same; 189, spiracle of same.

each with a rim. The peritreme is flat and the primary tracheal opening is much narrowed by a collar.

Berkeley, California, June 1, 1946, from the nest of *Andrena complexa* Viereck (MacSwain).

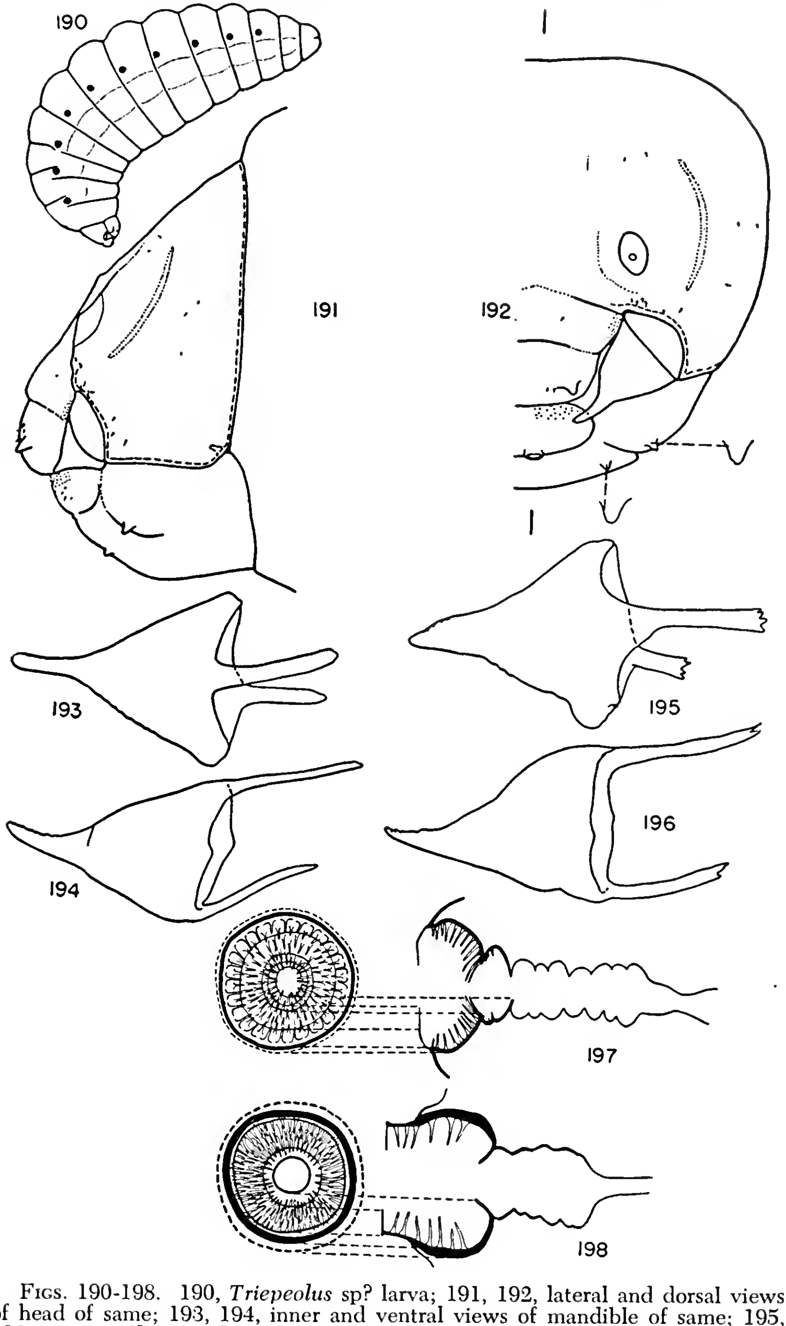
Packard (1897) gives a brief description of the larva of *Nomada imbricata* Smith? It seems to agree in major features with the species described above.

Triepeolus sp?

(Figs. 190-194, 197)

The larva is unusual in shape, being broadest at about the third abdominal segment and tapering posteriorly from this point. The intersegmental lines are distinct but the segments are not divided into cephalic and caudal annulets. The dorsolateral tubercles are entirely absent, the abdominal segments are swollen laterally, below the level of the spiracles, and the integument is finely and transversely wrinkled.

Head capsule and mouthparts with a very few scattered small setae; head capsule weakly sclerotized, attached to thorax broadly, without much constriction between head and thorax; marginal thickening of head capsule very weak, posterior tentorial pits small and inconspicuous, tentorium reduced to exceedingly delicate strands (strands incomplete in specimens studied but perhaps complete in younger specimens); epistomal suture faint, not represented by an internal ridge; anterior tentorial pits weak, located near anterior mandibular articulation; dorsal longitudinal median thickening of head capsule absent; arms of cleavage line absent; parietal bands present. Antennae mere convexities; labroclypeal suture weak, labrum a thick rounded lobe bearing a pair of very distinct though small tubercles. Mandibles thick basally, with attenuate and sclerotized apices which are feebly serrate on upper margins. Maxillae reduced to a mere lobe on each side, much exceeded by labium, indistinguishably fused to labium posteriorly and not separated by a furrow but merely by the pigmentation of the hypostomal thickening from the head capsule; apices of maxillae mere broad convexities, séparated from labium only by shallow furrow; maxillary palpi slightly pigmented, about as broad as long; labium a broadly rounded, thick lobe, exceeded by hypopharynx, the external portion of which is a transverse convex area separated from labium by shallow furrow; salivary opening small, lunate (not slit-shaped), surrounded by feebly projecting dark lips; labial palpi as broad as long; furrow between postmentum and prementum absent; labiomaxillary rod absent.



FIGS. 190-198. 190, *Triepeolus* sp? larva; 191, 192, lateral and dorsal views of head of same; 193, 194, inner and ventral views of mandible of same; 195, 196, inner and ventral views of mandible of *Epeolus* sp?; 197, spiracle of *Triepeolus* sp? 198, spiracle of *Epeolus*.

Body without spicules or setae. Spiracles large, conspicuous, pigmented, on slight protuberances; atria clearly defined, pigmented, shallow, densely lined with long spines, no particularly large spines around primary tracheal opening, atrium projecting well beyond level of body surface, this outer portion sloping inward; peritreme flat; few small spines in what is presumed to be the distal portion of the subatrium; no collar around primary tracheal opening.

Marsh Creek Canyon, Contra Costa County, California, February 18, 1947, in nests of *Melissodes* sp? (MacSwain, Bohart).

Epeolus sp.

(Figs. 195, 196, 198)

Like *Triepeolus* sp? described above but smaller with the apical portions of the mandibles shorter and thicker. The spiracles have that portion of the peritreme which projects above the level of the body surface erect, not sloping, and the primary tracheal opening is provided with a collar. The subatrium lacks spines.

Bodega Bay, Sonoma County, California, January 14, 1948, in nests of *Colletes fulgidus* Swenk (MacSwain).

Epeolus tristis Smith

This species is briefly described and figured by Mayet (1875). The information available is not detailed, but the body form, large protruding spiracles, slender mandibular apices, and fused maxillae and labium agree with the *Triepeolus* and *Epeolus* available for study.

Epeolus gayi Spinola

Claude-Joseph (1926) describes and illustrates this species. The larva is more slender than that of other known species of the genus, but the head structure seems like that of North American *Epeolus* and *Triepeolus*. The mandibles are much attenuate, like those of the species of *Triepeolus* described above.

Isepeolus luctuosus (Spinola)

The larva is described and figured by Claude-Joseph (1926). It has a more tuberculate body than *Epeolus*, and the palpi are very long. The salivary opening is a broad transverse slit, formed by large lips, unlike *Epeolus*. The mandibular apices are attenuate.

Hemisia cineraria (Smith)

Claude-Joseph (1926) describes and figures the larva of this species. It is shaped about in *Anthophora*, with the caudal annulets of the first five body segments having transverse dorsolateral tubercles. Maxillary palpi appear to be distinct and subapical; the labial palpi are absent. The mandibles are narrowly truncated at their apices. The salivary opening is rather large and transverse.

Melissodes sp?

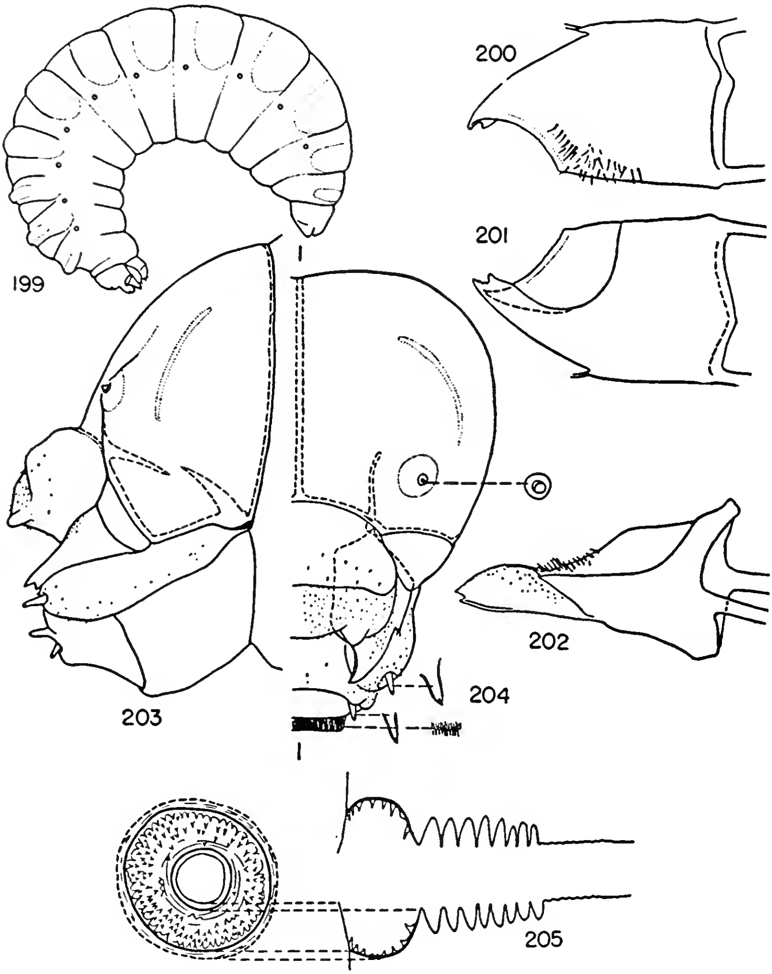
(Figs. 199-205)

The larva is about the same shape as that of *Anthophora*, with the intersegmental lines weak, and the lines between the cephalic and caudal annulets of the body even weaker except on the thorax. The dorsolateral tubercles are weak posteriorly, being indicated by broad convexities, extending down to level of spiracles and highest only a little above that level, but become progressively higher anteriorly, being quite conspicuous on the thoracic segments. The fine transverse wrinkles on the body are very faint.

Head capsule white, unsclerotized, with a few scattered minute setae on clypeus and mouthparts; marginal thickening of head capsule delicate, narrower than in *Anthophora;* epistomal suture weaker than in *Anthophora,* represented by a broad transverse sulcus, indicated internally by a feeble, broad thickening; arms of cleavage line very short or absent; longitudinal median thickening of head capsule extending to epistomal suture or nearly so. Antennae conical, with median, acutely pointed papilla; labrum much shorter than clypeus, labral tubercles large, broad, rounded. Mandibles broad seen from above or below, narrow apically seen from side of head, apices minutely bidentate; cusp oblique, upper margin of mandible which extends to cusp minutely denticulate, inner apical concave area of mandible large; mandibles thus similar to those of *Emphor;* inner upper surfaces of mandibles with dense group of hairs; outer surfaces of mandibles, maxillae and labium with scattered minute hairs. Maxillae with palpi subapical, apices not much bent inward as in *Anthophora,* palpi long and slender, a small rounded tubercle below each; labium thick, salivary opening at apex of labial lobe; salivary opening large, as broad as distance between labial palpi, with projecting lips which are very large and apparently armed with large teeth as in *Emphor;* labial palpi over twice as long as broad.

Body neither spiculate nor setose. Spiracular atria with spines and a few ridges; atria not projecting above body surface, peritreme large, collar around primary tracheal opening absent.

Marsh Creek Canyon, Contra Costa County, California, February 18, 1947 (Bohart, MacSwain).



FIGS. 199-205. 199, *Melissodes* sp?, larva; 200, 201, 202, dorsal, ventral, and inner views of mandible of same; 203, 204, lateral and dorsal views of head of same; 205, spiracle of same.

Tetralonia spp.

Claude-Joseph (1926) briefly describes and illustrates larvae of *T. chilensis* Herbst, *tristrigata* Spinola, and *melanura* Spinola. All are rather like the larva of *Melissodes*. Unfortunately details such as mandibular structure are not recorded.

Diadasia enevata (Cresson)

(Figs. 206-211)

The larva is more slender than that of *Anthophora,* frequently more curved than in the specimen figured, the dorsolateral tubercles of the body feebly represented by broad, ill-defined convexities. Both the cephalic and the caudal annulets of the body segments are transversely wrinkled.

Head capsule with scattered minute hairs. Marginal thickening of head capsule weaker than in *Anthophora,* epistomal suture weaker than in *Anthophora,* represented internally only by weak broad thickening; arms of cleavage line absent; parietal bands scarcely recognizable. Antennae with a slender papilla arising from the broad feeble convexity; labral tubercles absent. Mandibles short and robust, obliqely truncate, with apical concavity margined by a ridge, much as in *Anthophora stanfordiana;* outer surfaces of mandibles, maxillae, and labium with scattered minute hairs. Maxillae with apical portions bent inward as in *Anthophora;* maxillary palpi long and slender, far from apices of maxillae; labium thick, salivary opening at apex of labial lobe; salivary opening larger than in *Anthophora,* as broad as distance between labial palpi, with thin projecting lips which are much longer than in *Anthophora;* labial palpi dark, twice as long as broad; labium only feebly divided into postmentum and prementum; labiomaxillary rod slightly more heavily sclerotized than in *Anthophora.*

Body minutely spiculate, especially densely so dorsally, without setae; spiracles with atrium broad and shallow, without spines or ridges, wide open since peritreme is reflexed; primary tracheal opening narrowed by a large collar.

Delta, Utah, June 27, 1950 (Bohart, Michener).

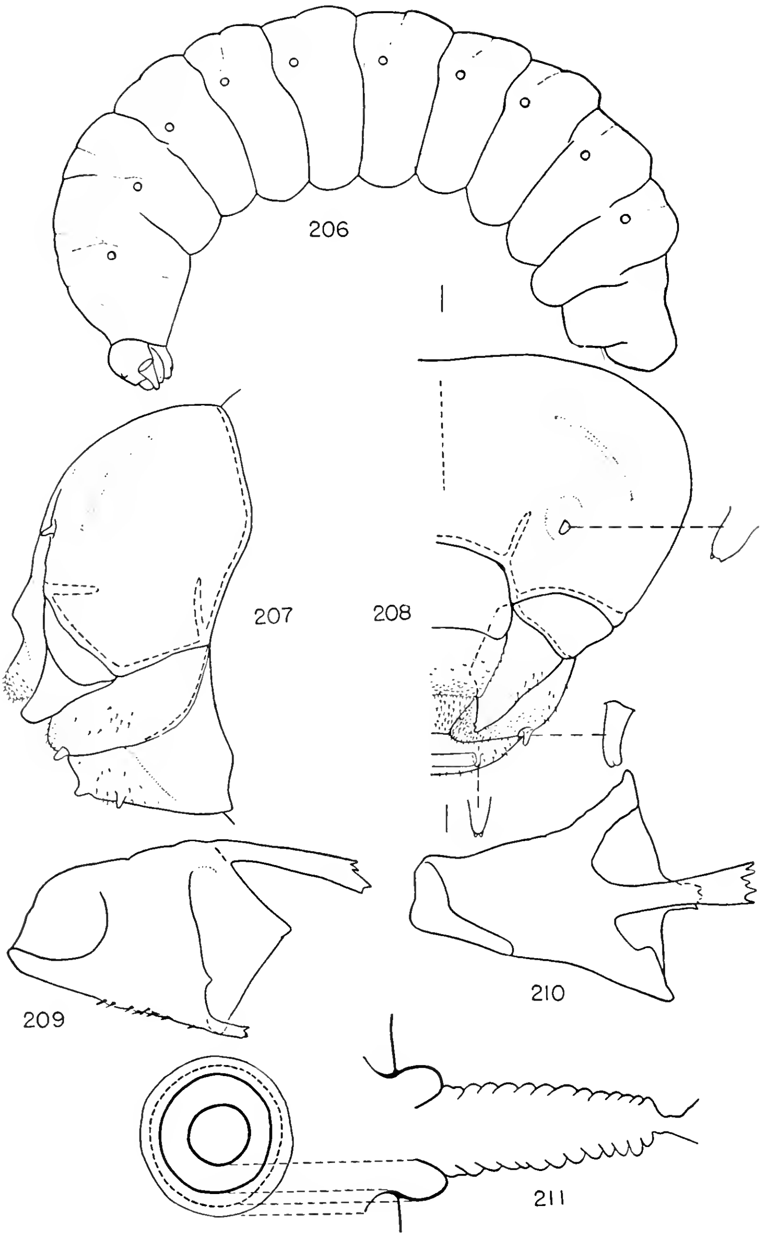
Melitoma chilensis Spinola

The larva, as described and figured by Claude-Joseph (1926), is similar to that of *Diadasia,* with no evidence of tubercles on the body. The mandibles are beveled at the apices and the salivary opening is transverse.

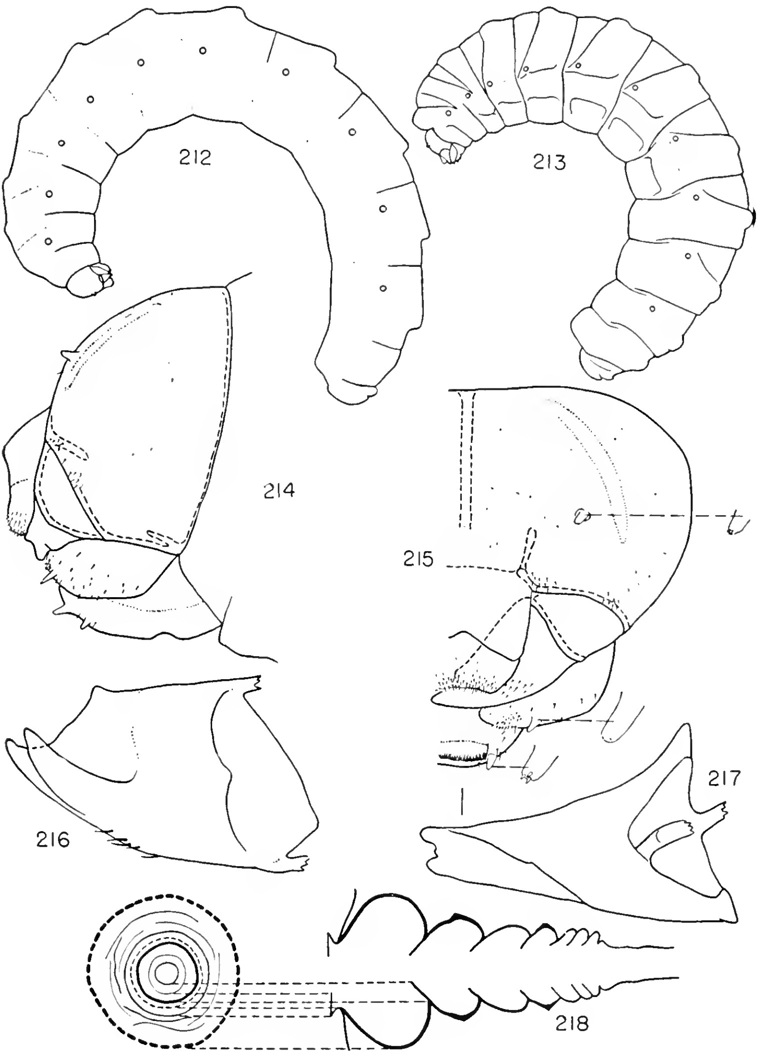
Emphor bombiformis (Cresson)

(Figs. 212-218)

The larva is more slender than that of *Anthophora* or *Diadasia,* immature specimens being particularly slender. In immature larvae the intersegmental lines are weak, absent laterally, and there



FIGS. 206-211. 206, *Diadasia enevata*, larva; 207, 208, lateral and dorsal views of head of same; 209, 210, ventral and inner views of mandible of same; 211, spiracle of same.



FIGS. 212-218. 212, 213, *Emphor bombiformis*, last stage larvae of different ages; 214, 215, lateral and dorsal views of head of same; 216, 217, ventral and inner views of mandible of same; 218, spiracle of same.

is no division of the body segments into cephalic and caudal annulets. In prepupae the intersegmental lines are more distinct and the anterior body segments are somewhat swollen just below the level of the spiracles. The dorsolateral tubercles are absent but each abdominal segment bears a transverse median dorsal elevation, possibly produced by confluence of dorsolateral tubercles. Except for these elevations, most of the body surface is finely transversely wrinkled in the prepupa.

Head capsule with scattered minute setae. Marginal thickening of head capsule distinct, hypostomal and pleurostomal portions particularly dark; epistomal suture weaker than in *Anthophora*, represented internally by weak, broad, thickening; arms of cleavage line absent or short; parietal bands distinct. Antennae with slender papilla and broad basal convexity; labral tubercles absent or nearly so, distal half of labrum densely setose. Mandibles robust, with a few minute setae on outer surfaces; apices bidentate, cusp very oblique seen in inner view (as in *Melissodes*), connected by a ridge or carina to upper apical tooth, thus partially enclosing a subapical inner concavity. Outer surfaces of maxillae with scattered small hairs, apical portions of maxillae extending inward as in *Anthophora*, maxillary palpi long and slender, far from apex of maxilla; labium thick, the salivary opening at apex of labial lobe; salivary opening larger than in *Anthophora*, as broad as distance between labial palpi, with thin projecting lips which are larger than in *Anthophora;* labial palpi pale, longer than broad; line between postmentum and prementum weak; labiomaxillary rods more distinct than in *Anthophora*.

Body neither spiculate nor setose; spiracles with atria devoid of spines but with weak ridges, atrium much narrowed near body surface, projecting beyond body surface to form strong rim; peritreme flat; primary tracheal opening with collar.

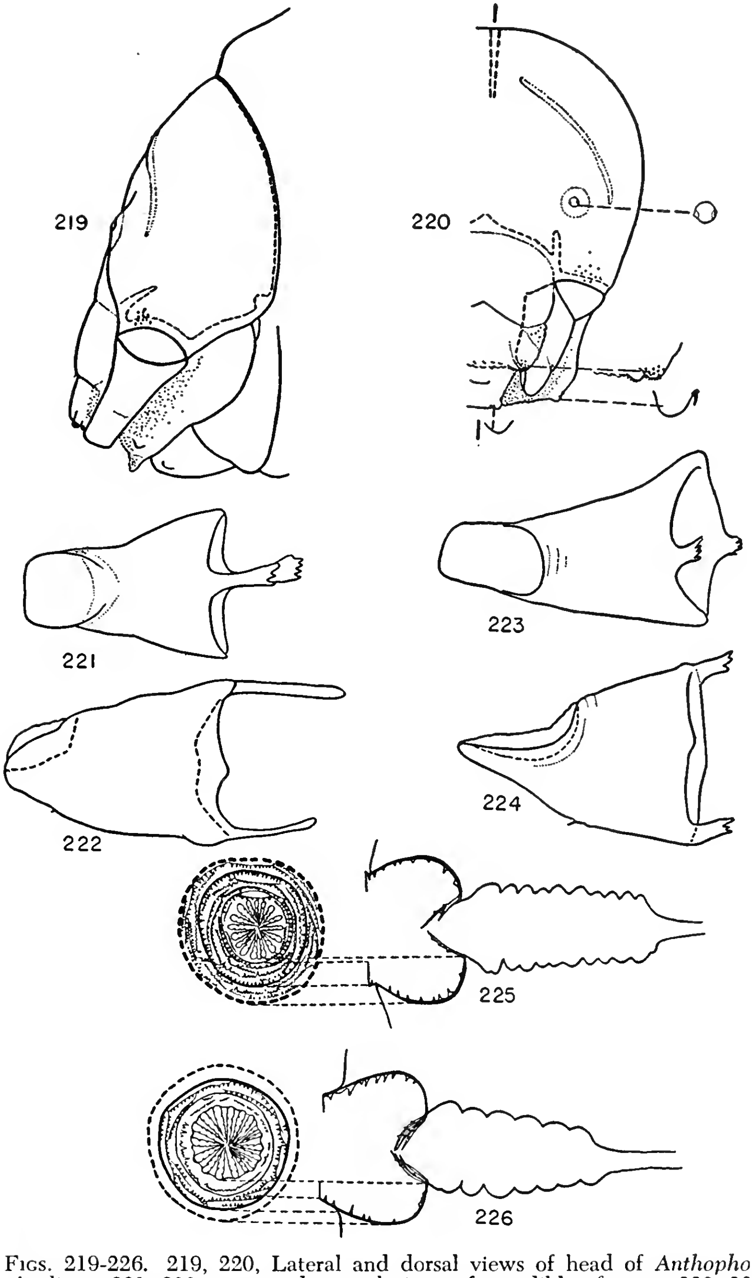
Hattiesburg, Mississippi, August 20, 1944 (Michener). Some half grown larvae are from Washington, D. C., July 9, 1935 (Sandhouse and Brown).

Anthophora stanfordiana Cockerell

(Figs. 7-15, 219-222, 225)

Since the larva of this species is rather fully described from a morphological standpoint in an earlier part of this paper, it seems unnecessary to repeat characteristics here. Certain features not mentioned in that description are as follows:

Labroclypeal suture angulate upward medially; labral tubercles low, separated by a long, nearly straight, papillate margin. Mandibles robust, truncate at apices, with distinct inner apical concavity. Maxillae with palpi weak, broader than long, far from apices of maxillae; salivary opening much smaller than in such forms as *Emphor*, shorter than distance between labial palpi, on dorsal



FIGS. 219-226. 219, 220, Lateral and dorsal views of head of *Anthophora stanfordiana;* 221, 222, inner and ventral views of mandible of same; 223, 224, inner and ventral views of mandible of *Anthophora urbana;* 225, spiracle of *Anthophora stanfordiana;* 226, spiracle of *Anthophora urbana.*

surface of labial lobe rather than at its apex, provided with small projecting lips; labial palpi much broader than long.

Montara, California, May, 1940 (MacSwain); Bodega Bay, Sonoma County, California, January 14, 1948 (MacSwain); Sommersville and Nortonville, Contra Costa County, California, February 18, 1947 (Bohart, MacSwain, Hurd).

Anthophora urbana Cresson

(Figs. 223, 224, 226)

This species differs from *A. stanfordiana* in the slightly higher dorsolateral tubercles of the body. In this respect it resembles *A. edwardsii.* The mandible is narrower apically than in *A. stanfordiana* and the upper margin is feebly crenulate, suggesting the serrations found in some species. The spiracles have fewer rows of atrial spines than in *A. stanfordiana,* the inner ones being smaller, while the toothed collar spines nearly meet in the center, closing the primary tracheal opening. The shape of the atrium is distinctive, for it is narrowed toward the surface (fig. 226) so that much of the inner wall is invisible from the surface. The atrial wall is more produced above the body surface than in *A. stanfordiana* and lacks a rim.

Montara, California, May 18, 1940 (MacSwain) (a single specimen).

Anthophora edwardsii Cresson

(Figs. 228, 234, 235)

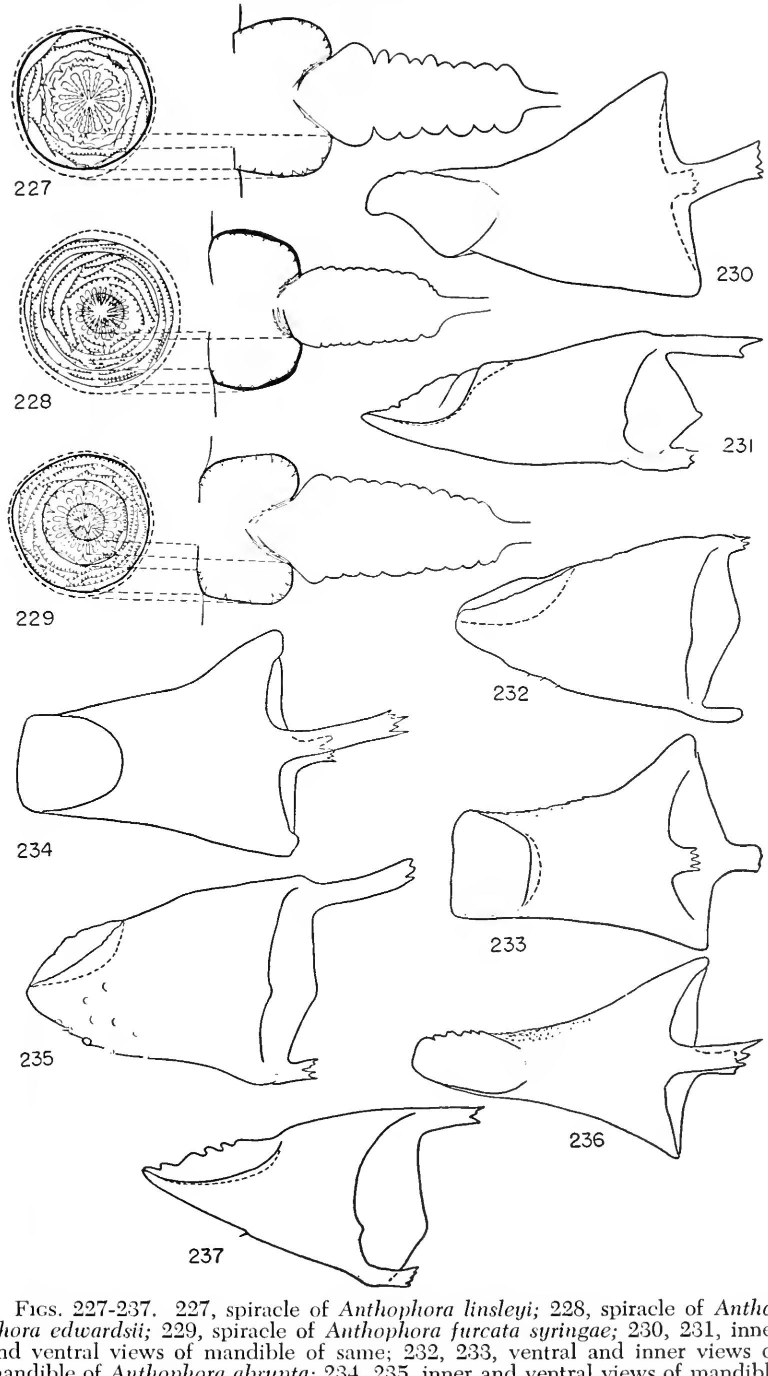
The mature larva differs significantly from *A. stanfordiana* in the slightly more convex and higher dorsolateral tubercles of the body and in the spiracles (figure 235). The atrial spines, except for those which cover the primary tracheal openings, are shorter than many of those of *stanfordiana,* while the collar spines do not meet to close the primary tracheal opening; the atrial walls form no rim but converge above the level of the body surface.

One mile south of Pittsburg, California, May 21, 1940 (MacSwain) and five miles north of Madera, California, March 29, 1941 (Linsley, MacSwain).

Anthophora abrupta Say

(Figs. 232, 233)

The mature larva differs from that of *A. stanfordiana* in the low dorsolateral tubercles, in which it resembles *A. edwardsii* and *A. urbana.* The mandible is very broadly truncate, the upper surface spiculate medially. The spiracles resemble those of *A. urbana* but



FIGS. 227-237. 227, spiracle of *Anthophora linsleyi;* 228, spiracle of *Anthophora edwardsii;* 229, spiracle of *Anthophora furcata syringae;* 230, 231, inner and ventral views of mandible of same; 232, 233, ventral and inner views of mandible of *Anthophora abrupta;* 234, 235, inner and ventral views of mandible of *Anthophora edwardsii;* 236, 237, inner and ventral views of mandible of *Anthophora linsleyi.*

are not narrowed at the surface, the atria being shaped as in *A. stanfordiana.*

Alexandria, Virginia, July 20, 1935 (Sandhouse) (a single specimen).

Anthophora linsleyi Timberlake

(Figs. 227, 236, 237)

The mature larva is smaller than that of *A. stanfordiana* and has slightly more convex dorsolateral tubercles, much as in *A. edwardsii.* The mandibles are more slender than in *stanfordiana,* narrowly truncated at the apices and the upper margins apically are coarsely serrate (figure 236); the upper surfaces, medially, are spiculate. The spiracular atrium has the usual large spines nearly covering the primary tracheal opening, but the atrial walls above the spines have fewer spines than in *A. stanfordiana.*

Twenty miles east of Bakersfield, California, March 29, 1941 (Linsley and MacSwain).

Anthophora personata (Illiger)

Semichon (1925) briefly describes this species. It evidently agrees in its main features with the various species described above.

Anthophora incertus Spinola

Claude-Joseph (1926) describes the larva which is evidently similar to that of North American species. The mandibles are truncate, as in *A. stanfordiana.*

Anthophora villosula Smith

The larva is described by Torikata (1931). It apparently resembles the various species described above.

Anthophora (*Clisodon*) *furcata syringae* (Cockerell)

(Figs. 229-231)

This species is most similar to *A. linsleyi,* with which it agrees in the serrate upper apical margins of the mandibles. The mandible is more robust, however, than that of *A. linsleyi,* with a translucent, rounded, subapical projection on the lower margin, and with the apex rounded, not truncate. Specimens at hand are somewhat shriveled so that the height of the dorsolateral tubercles cannot be determined but they appear to be about as in *A. linsleyi,* slightly higher than in *A. stanfordiana.* The spiracles are essentially like those of *edwardsii.*

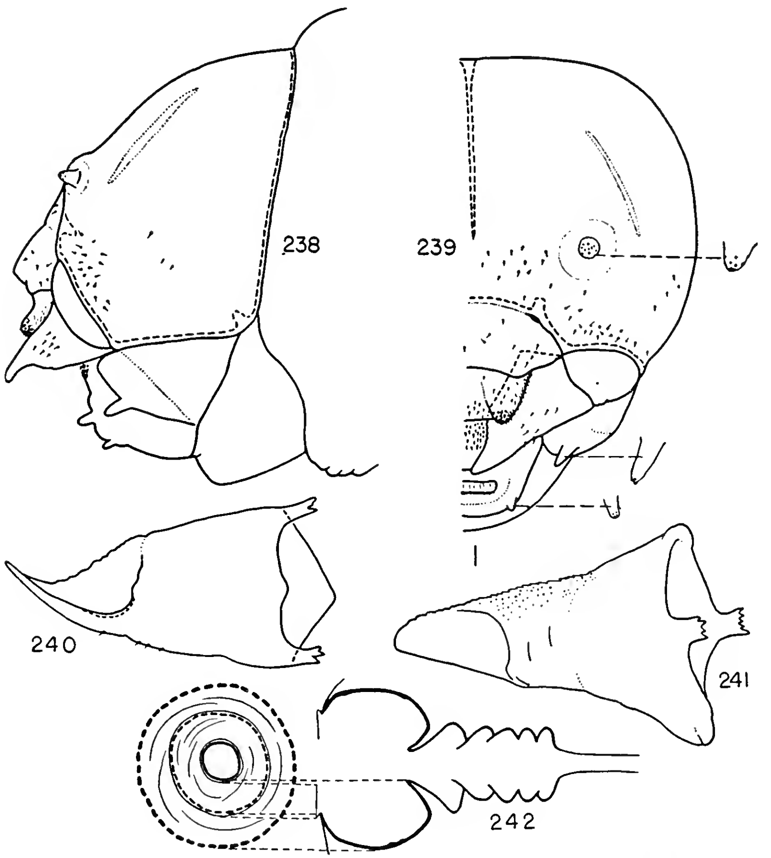
Mineral King, Tulare County, California, August, 1939 (Bohart).

Melecta (Melectomorpha) californica Cresson

(Figs. 238-242)

The body form of the larva, to judge by the two shriveled specimens available, is similar to that of *Anthophora stanfordiana.* The dorsolateral tubercles are transverse, nearly meeting middorsally, and are slightly higher and more conspicuous than in *Anthophora.* Both the cephalic and the caudal annulets of the body, except for the dorsolateral tubercles, are transversely wrinkled.

Head capsule rather strongly sclerotized, with scattered minute hairs. Marginal thickening of head capsule strong; epistomal suture weak, represented externally by shallow transverse depression, internally by a cuticular thickening; arms of cleavage line absent.



FIGS. 238-242. 238, 239, lateral and dorsal views of head of *Melecta californica;* 240, 241, ventral and inner views of mandible of same; 242, spiracle of same.

Antennae with rather large papillae; labroclypeal suture particularly distinct; labral tubercles broad and rounded so that entire apex of labrum is broadly emarginate, apical portion of labrum rather densely setose. Mandibles tapering from broad bases to blunt apices, upper apical margin feebly serrate, apical portion of mandible concave on inner surface, this concavity not margined by such distinct ridges as in *Anthophora stanfordiana;* outer surfaces of mandibles, maxillae, and labium with scattered minute hairs. Maxillae short and broad, much exceeded by labium, apices not bent inward as in *Anthophora* but maxillary palpi slightly preapical, these palpi large, twice as long as basal width; salivary opening at apex of labial lobe; salivary opening not as broad as distance between labial palpi, lips long and distinctly sclerotic, much larger than in *Anthophora;* hypopharynx well defined; labial palpi dark, longer than broad; division between postmentum and prementum a deep furrow; labiomaxillary rod rather distinct.

Body without spicules or setae, a perpendicular flat area above anal opening. Spiracular atria with weak internal ridges, walls slightly projecting above level of body surface, with rims; peritreme flat; primary tracheal opening surrounded by thick collar.

Specimens are from Montara, California, May, 1940, in nests of *Anthophora* (probably *stanfordiana*) (MacSwain).

Melecta (*Melecta*) *armata* Panzer

This species is briefly described but not figured by Semichon (1925). Evidently it does not differ greatly from that of *M. californica.*

Subfamily APINAE

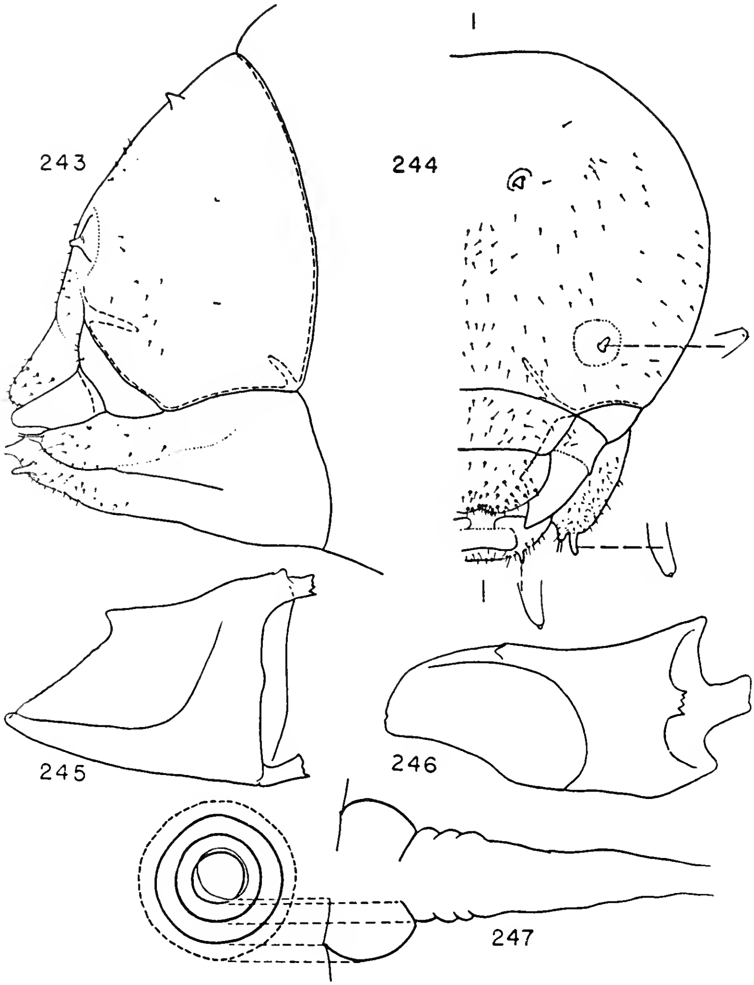
The larvae of this subfamily exhibit considerable diversity, due perhaps to reductions of structures correlated with social life. The antennal papillae are largest in *Centris,* small in *Bombus* and *Psithyrus,* virtually absent in *Melipona, Trigona,* and *Apis.* The palpi are present in all genera although largest in *Centris.* The mandibles lack a cusp. They have an inner apical concavity, clearly defined, in *Centris, Bombus,* and *Psithyrus.* In *Melipona* such a concavity is present although less conspicuous, in *Trigona* it is inconspicuous or absent, while in *Apis* it is entirely absent. The mandibular apices are bidentate, with the upper apical tooth much smaller than the lower, in *Bombus* and *Psithyrus;* in *Centris* the upper tooth is reduced to a mere tubercle well away from the blunt apex of the lower tooth; the remaining genera have the mandibular apex blunt with no evidence of two teeth but in *Melipona* and *Trigona* with coarse setae or long spicules. The mandibles of *Melipona* are rather slender, those of *Trigona* conspicuously attenuate; those of *Apis* are more reduced than in any other bee larva known. In all the Apinae the salivary opening is a transverse slit provided with large lips. The larva of *Apis* is one of the few forms examined in which the spiracular peritreme is entirely absent. (It is also absent in some *Lasioglossum*, incomplete in *Trigona* and other *Lasioglossum*). The larvae of *Centris, Bombus, Psithyrus,* and *Melipona,* differ from those of other bees in having the dorsolateral tubercles of the thoracic segments represented by small points. *Centris* is remarkable for having a pair of similar points on the head. *Trigona* has such points on most of the body segments, arising from the summits of broad rounded tubercles. It is surprising that there are a few scattered setae on the body in *Bombus.* They are shown clearly by Grandi (1934a) and are present in *B. americanorum.*

Centris (*Euplusia*) *violacea* (Blanchard)

(Figs. 243-247)

The only specimen available is one which was killed as it was molting into the pupal stage so that details as to larval form cannot be established. It is obvious, however, that the intersegmental lines are rather inconspicuous. No lines are visible separating the cephalic from caudal annulets of the segments. Each of the thoracic segments bears a pair of minute, dark, and slightly sclerotized pointed dorsal or dorsolateral tubercles. A pair of similar tubercles occurs on the upper part of the head capsule.

Head capsule lightly sclerotic, the thickening of the posterior margin of the head capsule virtually absent but remainder of marginal thickening of head capsule distinct; posterior tentorial pits apparently inconspicuous, the posterior tentorial arms short and robust; epistomal suture not represented by a thickening between anterior tentorial pits but probably represented by a depression in fresh or properly preserved larvae. Antennae each with clearly defined papilla arising from broad convexity; labroclypeal suture weakly evident in shed skin; labrum with apex emarginate medially, no distinct labral tubercles, apical portion with numerous minute setae. Mandibles short and robust, heavily sclerotized, apices bluntly rounded; inner surfaces each with a broad apical concavity margined by a ridge, upper margin with a large tooth midway the length of the concavity. Apical portions of maxillae rather small, not bent inward but with a small apical projection immediately



FIGS. 243-247. 243, 244, lateral and dorsal views of head of *Centris violacea;* 245, 246, ventral and inner views of mandible of same; 247, spiracle of same.

mesad of base of each maxillary palpus, the latter nearly three times as long as broad; labial lobe with salivary opening at apex, a transverse slit provided with rather large sclerotized lips, width of slit equal to distance between labial palpi which are about twice as long as broad; labium and maxillae both with rather numerous setae; hypostomal furrow very deep.

Body without setae or spicules. Spiracle with atrium shallow, without spines or ridges, scarcely projecting above body surface but with weak rim; peritreme flat; primary tracheal opening narrowed by collar.

Brasil (W. E. Kerr).

The name *Centris* is here used for the group usually called *Eulaema*.

Bombus (Fervidobombus) americanorum Fabricius

(Figs. 248-253)

The larva is robust with the intersegmental lines weak, absent on the sides, and the lines between the caudal and the cephalic annulets of the body segments weak. The dorsolateral tubercles are absent except for minute conical ones on the thoracic segments, similar to those of *Centris*. Head capsule rather distinctly sclerotic, conspicuously constricted in front of thorax, marginal thickening of head capsule rather weak but posterior tentorial pits distinct, epistomal suture represented by an indistinct thickening arching between anterior tentorial pits, longitudinal median thickening of head capsule present and reaching epistomal suture. Antennae represented by convexities, each with minute low median papilla; labroclypeal suture distinct laterally but weak medially; labrum deeply emarginate medially and bearing exceedingly minute setae. Mandibles short and rather heavily sclerotized, apices bluntly rounded with a blunt subapical tooth on upper margin; apical portions deeply concave on inner surface, concavity except basally delimited by a sharp ridge. Maxillae not bent inward apically, maxillary palpi about twice as long as broad; labial lobe with salivary opening at apex, this opening marked by weakly sclerotic lips, the opening nearly as broad as distance between labial palpi, the latter nearly twice as long as broad; hypostomal furrow deep; outer surfaces of maxillae and labium with scattered setae.

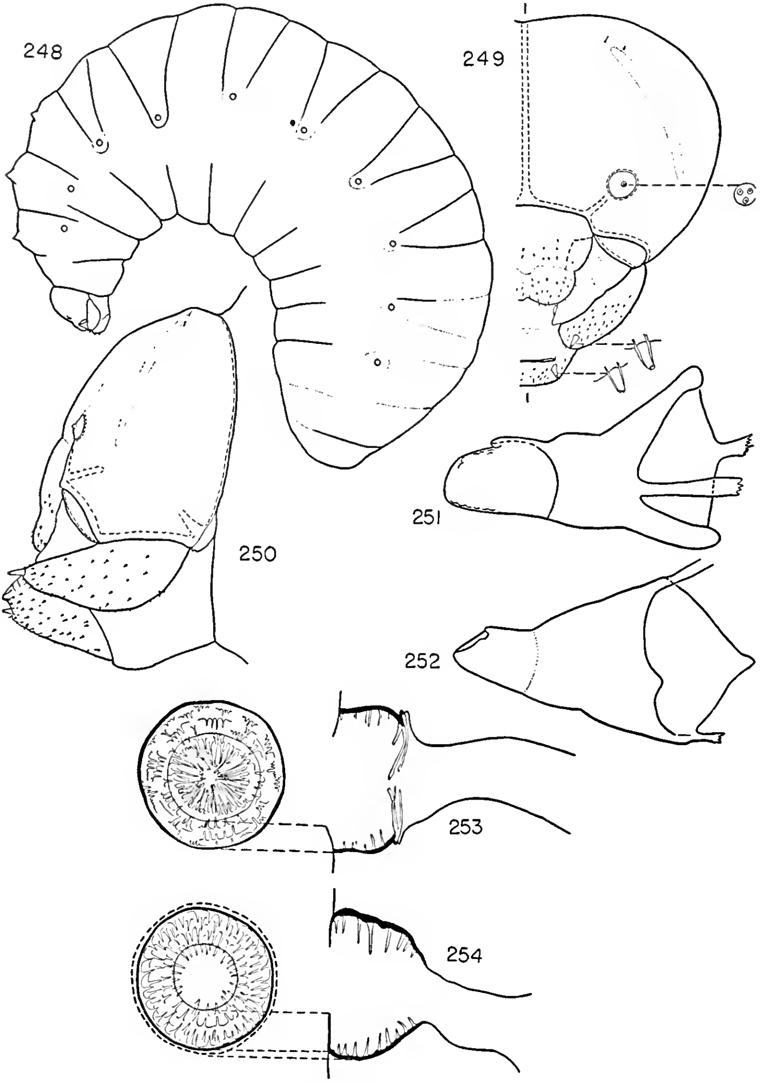
Body with spicules and a very few scattered setae. Spiracles with atrium rather shallow, inner wall with spines, mostly in groups, collar spines very long and many of them toothed at apices; preatrium not annulate; peritreme flat.

Lawrence, Kansas, August 20, 1950 (Michener).

This species has also been described by Ritcher (1933).

Bombus (Fervidobombus) fervidus (Fabricius)

This species agrees with *B. americanorum* except in details of the spiracular atria (see Ritcher, 1933). Its general features were also described by Packard (1897).



FIGS. 248-254. 248, *Bombus americanorum*, larva; 249, 250, dorsal and lateral views of head of same; 251, 252, inner and ventral views of mandible of same; 253, spiracle of same; 254, spiracle of *Bombus vosnesenskii*.

Bombus (Separatobombus) griseocollis (DeGeer)

This species was described by Ritcher (1933) under the name *separatus* Cresson. It resembles *B. americanorum* except in certain details of the spiracular atria.

Bombus (Bombus) terricola Kirby

This species resembles *B. americanorum* except in certain details of the spiracular atria (see Ritcher, 1933).

Bombus (Pratobombus) vosnesenskii Radoszkowski

(Fig. 254)

Specimens at hand differ from those of *Bombus americanorum* in showing feeble intersegmental lines across the pleural regions of the body [1] as well as on the sternal and tergal regions. Spiracles with spines isolated, not in groups as in *americanorum,* no large collar spines, collar region not dilated as in *americanorum.*

Berkeley, California, March 22 and June 4, 1946 (MacSwain); Hat Creek, Lassen County, California, June 4, 1941 (Linsley and Michener).

The larva of this species runs to the vicinity of *B. impatiens* and *B. bimaculatus* in Ritcher's (1933) key.

Bombus (Pratobombus) impatiens Cresson

This species resembles *B. americanorum* except in the details of spiracular atria (see Ritcher, 1933).

Bombus (Pratobombus) bimaculatus Cresson

This species resembles *B. americanorum* except in the details of spiracular atria (see Ritcher, 1933).

Bombus (Pratobombus) perplexus Cresson

This species resembles *B. americanorum* except in the details of spiracular atria (see Ritcher, 1933).

Bombus (Pratobombus) vagans Smith

This species resembles *B. americanorum* except in the details of spiracular atria (see Ritcher, 1933).

Bombus (Agrobombus) agrorum pascuorum Scopoli

This species was described and illustrated by Grandi (1937). It resembles *B. americanorum* except for details of the spiracular atria.

Bombus (Agrobombus) senilis Smith

Sakagami (1951) has illustrated the larva of this species. It resembles the majority of *Bombus* larvae. The spiracular atria are

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1. The larvae are all rather small, and almost equally distinct lines are visible in small individuals of *B. americanorum.* The lines across the pleural regions of the body are not as distinct as in the subgenus *Bombias.*

said to be similar to those of *B. fervidus.* The illustration of the mandible shows the teeth more acute than in other *Bombus,* but not as acute as in *Psithyrus.*

Bombus (Mastrucatobombus) mastrucatus Gerstaecker

The head and mandibles are well figured by Móczár (1938) but unfortunately the spiracular details are not illustrated.

Bombus silvarum Linnaeus

The larva of this species is described and figured by Grandi (1934a). It evidently resembles *B. americanorum* in most of its characters, differing, however, in the details of the spiracular atria. The intersegmental lines are rather clearly illustrated in the pleural regions of the body by Grandi, perhaps they are more distinct than in *B. americanorum.* The mandibles have the lower apical margin minutely denticulate, unlike other known *Bombus.*

Bombus (Bombias) auricomus Robertson

The larva of this species was described by Ritcher (1933). It is the only known larva of the subgenus *Bombias.* It closely resembles *B. americanorum* but differs from it and all other known *Bombus* larvae in the greatly reduced atrial spines and in the presence of intersegmental lines across the pleural regions of the body.

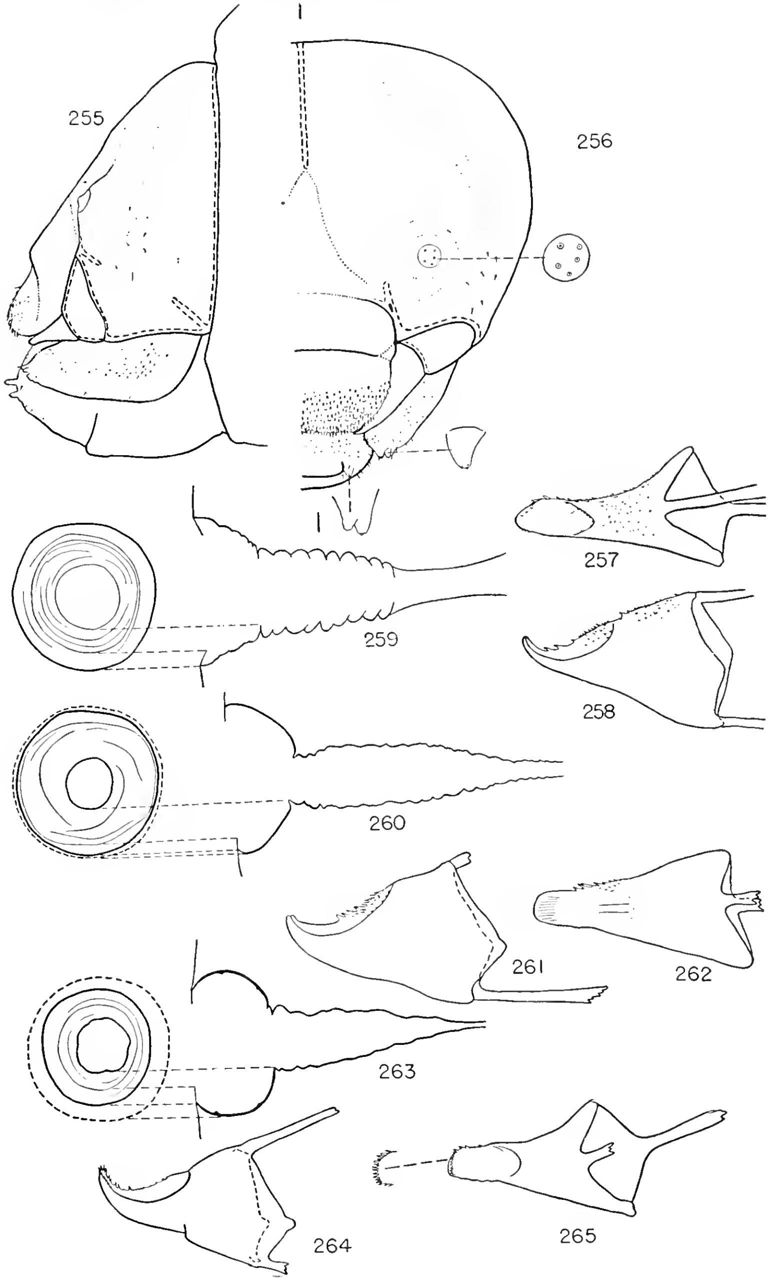
Psithyrus variabilis (Cresson)

The larva of this species is similar to that of *Bombus americanorum* but differs in having the apical and subapical mandibular teeth acute, falcate (see Ritcher, 1933). The details of the spiracular atria also differ from those of any known species of *Bombus,* but do not seem to provide a generic character. The atrial spines are long, as in most known species of *Bombus,* not short or absent as in the subgenus *Bombias.*

Melipona quadrifasciata quadrifasciata Lepeletier

(Figs. 255-259)

The larva is robust, similar in shape to that of *Bombus,* exhibiting weak intersegmental lines and even weaker lines between the cephalic and caudal annulets of the body segments but showing somewhat distinct ventrolateral tubercles below the level of the spiracles on the sides of the body, particularly on the abdominal segments. The thoracic segments have minute conical dark and slightly sclerotized dorsal or dorsolateral tubercles similar to those found in *Centris* and *Bombus.*



FIGS. 255-265. 255, 256, lateral and dorsal views of head of *Melipona quadrifasciata;* 257, 258, inner and ventral views of mandible of same; 259, spiracle of same; 260, spiracle of *Melipona marginata;* 261, 262, ventral and inner views of mandible of same; 263, spiracle of *Melipona variegatipes;* 264, 265, ventral and inner views of mandible of same.

Head capsule weakly sclerotized with a distinct constriction between it and thorax. Marginal thickening of head capsule feeble, head essentially as in *Bombus* but anterior margin of clypeus convexly truncated; lower portion of labrum with numerous scattered minute setae; outer surfaces of maxillae and labium with scattered minute setae, the former spiculate above. Apical portions of mandibles more slender than in *Bombus,* apices bluntly pointed without subapical dorsal tooth; inner apical concavity rather shallow but distinct; mandibles abundantly spiculate in certain areas, some large spicules or small spines on upper margin subapically. Maxillary and labial palpi slightly longer than broad; labium with salivary opening broad, formed by distinct lips about as broad as distance between labial tubercles. Spiracular atria thin walled, shallow, not produced above body surface, inner surfaces with ridges; primary tracheal opening without a collar, peritreme (in specimens examined) slightly inflexed.

Brasil (W. E. Kerr).

Melipona variegatipes Gribodo

(Figs. 263-265)

The larva is similar to that of *M. quadrifasciata* although in the poorly preserved specimens at hand the ventrolateral swelling or row of tubercles obvious in *quadrifasciata* is not visible. The head capsule and mouth parts seem to be similar to those of *quadrifasciata* except that the apical portions of the mandibles are broader and fringed with small spines while elsewhere the mandibles are not or scarcely spiculate. The spiracular atria are heavier walled and more spherical than in *quadrifasciata,* with fewer ridges, and the annulations of the preatrium are poorly developed.

Montserrat, British West Indies, March 3, 1894 (Hubbard).

Melipona marginata Lepeletier

(Figs. 260-262)

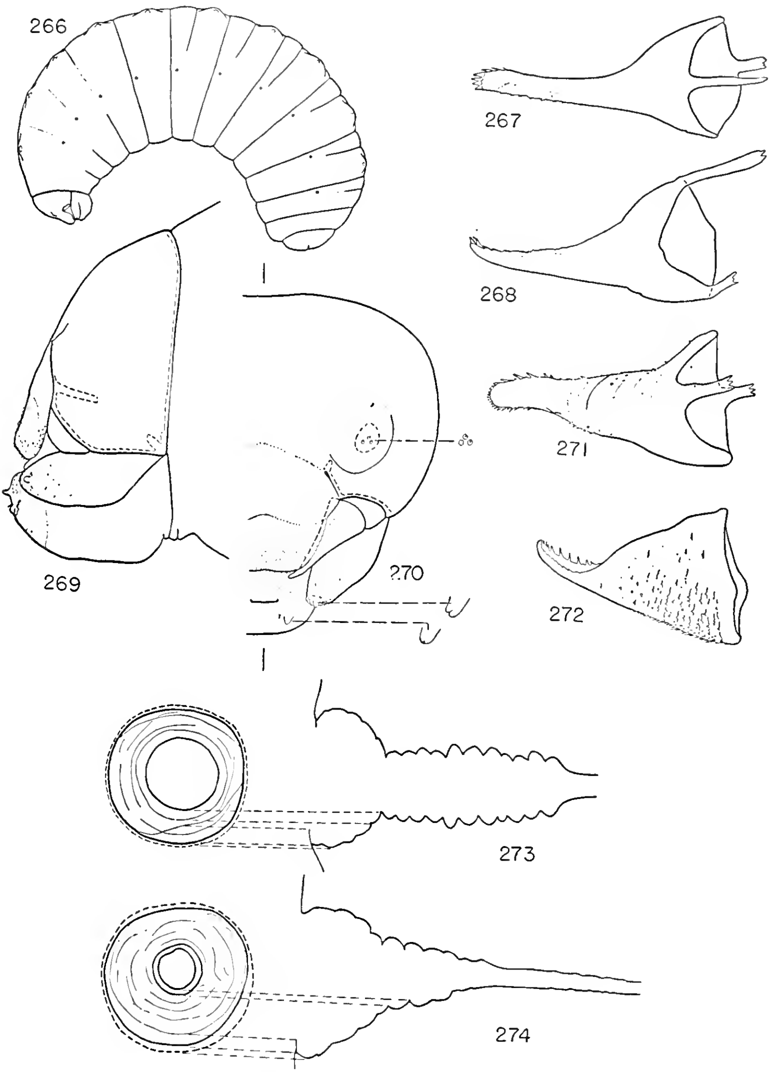
This species agrees with the description of *M. quadrifasciata* except that the labroclypeal suture is distinct throughout its entire length (this appears to be a matter of individual variation). The mandible is more robust than in *quadrifasciata* with spicules or teeth on the upper portion subapically but margin otherwise smooth. The spiracular atrium has very few ridges.

Specimens are from Brasil collected by Kerr.

Trigona (*Partamona*) *cupira* Smith

(Figs. 266-270, 273)

The larva is rather robust with the intersegmental lines weak, though distinctly recognizable, and with the lines separating the caudal and the cephalic annulets of the segments also weak but



FIGS. 266-274. 266, *Trigona cupira*, larva; 267, 268, inner and ventral views of mandible of same; 269, 270, lateral and dorsal views of head of same; 271, 272, ventral and inner views of mandible of *Trigona corvina;* 273, spiracle of *Trigona cupira;* 274, spiracle of *Trigona corvina.*

recognizable. The dorsolateral tubercles are present, of moderate size and rounded, high on the body and not extending downward toward the tubercles. All these tubercles except for those of the last two abdominal segments terminate in small conical papillae which are largest on the thoracic segments where they correspond to similar tubercles or papillae found on the thorax in *Melipona, Bombus,* and *Centris.* The head is similar to that of *Melipona quadrifasciata,* the apex of the labrum being shallowly and broadly emarginate. The antennae are broad convexities without distinct papillae. The labroclypeal suture is continuous. The maxillary and labial palpi are small, about as long as broad. The mandibles have slender and attenuate apices, slightly curved inward, without margined concave spaces on the inner surfaces. The apices bear a comb of teeth and the lower margins are spiculate. The body is spiculate. The spiracular atria are shallow, with internal ridges but no spines. They are not produced above the level of the body surface. The peritreme is incomplete. The primary tracheal opening lacks a collar.

Specimens are from Juan Mina, Canal Zone, May 4, 1945 (Michener).

Trigona (Trigona) corvina Cockerell

(Figs. 271, 272, 274)

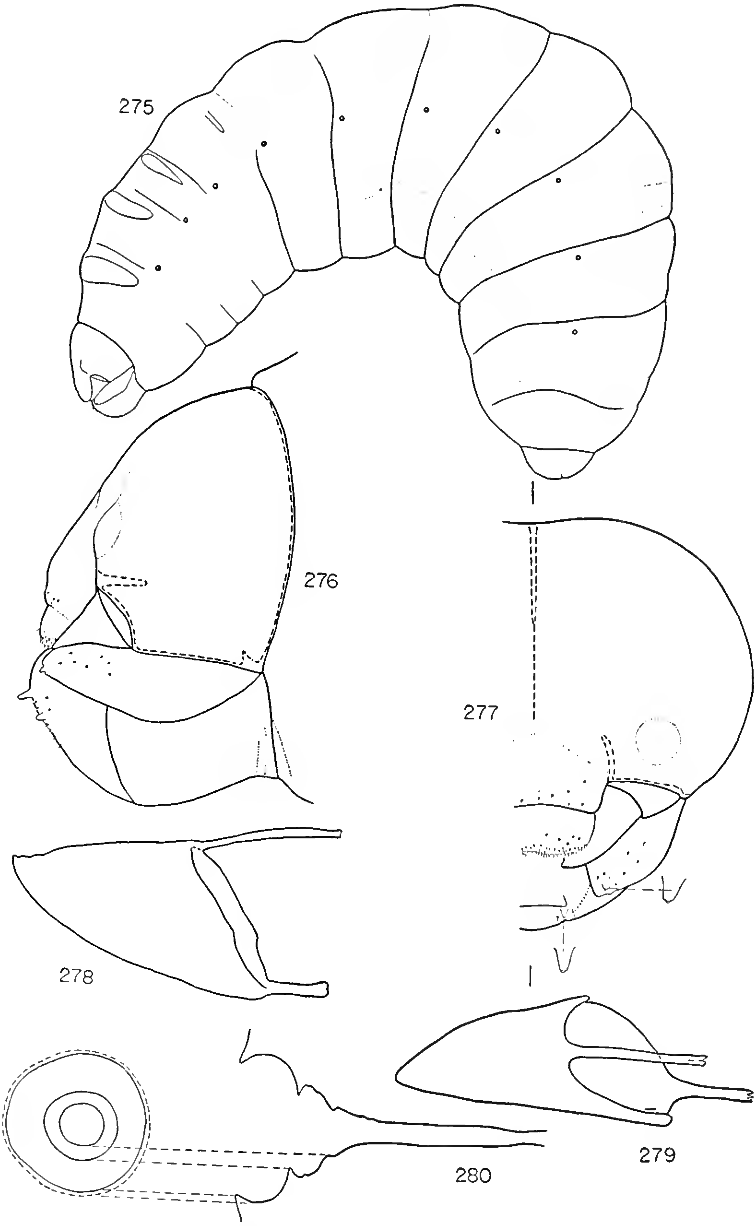
The specimens at hand are poorly preserved but in so far as can be determined the body form closely resembles that of *T. cupira.* As in that species, much of the body is densely spiculate. The mandibles are more robust and are provided with minute denticles or spines on both the upper and the lower margins near and around the apices, and are considerably spiculate. The spiracles are fundamentally like those of *T. cupira* although they differ in details, such as the very short preatrium, which may or may not be of specific importance.

Juan Mina, Canal Zone, April 27, 1945 (Michener).

Apis mellifera Linnaeus

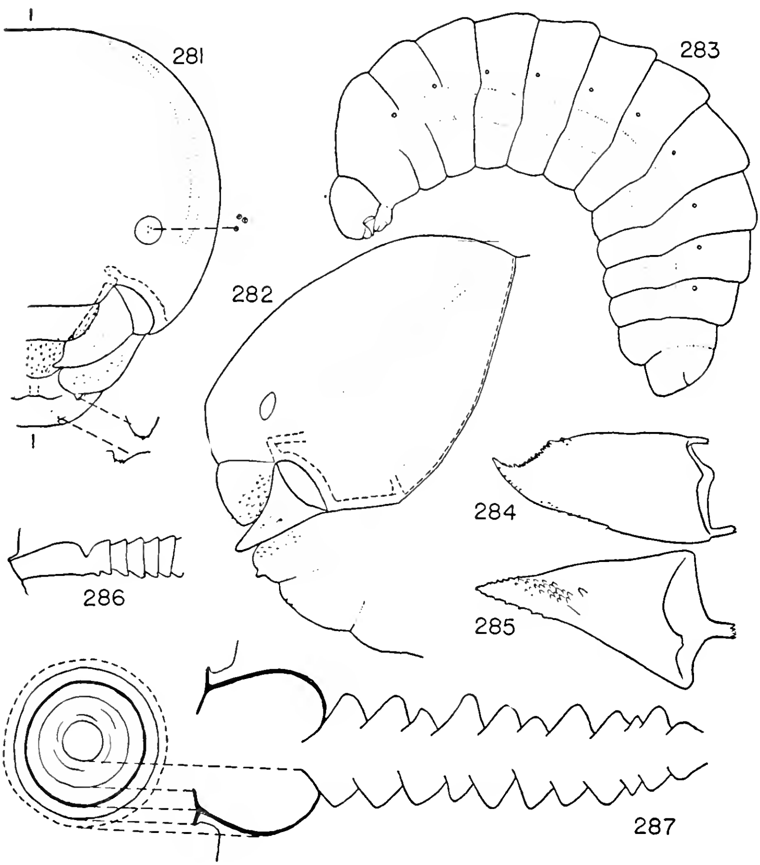
(Figs. 275-280)

The larva is robust with the intersegmental lines conspicuous and the lines between the cephalic and caudal annulets of the segments visible. The caudal annulets are elevated laterally, the elevations being continuous with rather distinctly elevated ventrolateral tubercles below the level of the spiracles. The thorax and even the first abdominal segment have transverse dorsolateral tubercles which are progressively smaller toward the rear.



FIGS. 275-280. 275, *Apis mellifera,* larva; 276, 277, lateral and dorsal views of head of same; 278, 279, ventral and inner views of mandible of same; 280, spiracle of same.

Head capsule scarcely sclerotic, separated by slight constriction from thorax; setae on head capsule and mouthparts very short and sparse. Marginal thickening of head capsule feeble; epistomal suture not clearly recognizable between anterior tentorial pits; dorsal longitudinal thickening of head capsule present posteriorly. Antennae distinct, dome shaped, without papillae; labroclypeal suture distinct; apex of labrum broadly concave and bearing minute setae and elongate spicules. Mandibles feebly sclerotic, bluntly pointed, without concavity on inner surface apically. Maxillae with apices not bent inward, maxillary palpi longer than broad; labium exceeding maxillae; salivary opening at its apex, the opening a



FIGS. 281-287. 281, 282, dorsal and lateral views of head of *Hesperapis rufipes;* 283, larva of same; 284, 285, ventral and inner views of mandible of same; 286, lateral view of salivary opening and salivarium of same; 287, spiracle of same.

transverse slit margined by slightly sclerotic but large lips, the slit equal in length to distance between bases of labial palpi; labial palpi longer than broad; hypostomal furrow deep; prementum and postmentum distinctly separated by a furrow.

Spiracular atria shallow, without internal ridges or spines; peritreme absent; primary tracheal opening without collar; preatrium very short and scarcely annulate.

The larva of this species has been described and figured in a general way by many workers. The first detailed figures of the head structures are those of Grandi (1934, 1934a).

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A Revision of the North American Species of *Typhlocyba* and its Allies (Homoptera, Cicadellidae)[1]

By PAUL J. CHRISTIAN [2]

ABSTRACT: This revision includes descriptions of the Typhlocybid genera *Henribautia, Ribautiana, Ossiannilssonola, Typhlocyba, Empoa, Edwardsiana,* and a new genus *Mcateeana* (Homoptera, Cicadellidae), with redescriptions of all of the known North American species of each, keys to the species, new illustrations, new host records, new distribution records, and descriptions and illustrations of the following twenty-two new species: *Henribautia beameri; Ribautiana multispinosa, R. parapiscator; Ossiannilssonola bangsoni, O. knulli, O. mcateei, O. rossi; Empoa acericola, E. caryata, E. elmata, E. latifasciata, E. platana; Typhlocyba alabamaensis, T. attenuata, T. inflata, T. medleri, T. transviridis; Edwardsiana dejecta, E. delongi, E. nigripennis, E. projecta, E. pseudocommissuralis.*

Typhlocyba jacobii nom. nov. for *T. duplicata* Jacobi, nec *T. duplicata* McAtee is proposed, and *Ossiannilssonia* Young and Christian, nec Lambers, is replaced by *Ossiannilssonola* nom. nov.

Edwardsiana plebeja and *E. frustrator* are recorded for the first time as occurring in North America.

New synonymy is as follows: *Ribautiana unca* (McAtee) (= *Typhlocyba surda* DeLong and Johnson); *Ossiannilssonola australis* (Walsh) (= *Typhlocyba nicarete* McAtee), *O. danae* (McAtee) (= *Typhlocyba eurydice* McAtee), *O. appendiculata* (Malloch) (= *Typhlocyba gillettei* var. *sellata* McAtee); *Typhlocyba rubriocellata* Malloch (= *Typhlocyba escana* Ross and DeLong), *T. persephone* McAtee (= *Typhlocyba lancifer* McAtee); *Empoa albicans* Walsh (= *Typhlocyba cymba* var. *pallens* McAtee); *Edwardsiana australis* Froggatt replaces the name *Typhlocyba froggatti* (Baker).

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INTRODUCTION

The purpose of this revision is to define more clearly each of the genera of the Typhlocyba Complex which contain species occurring in North America, and to present clear descriptions, illustrations, keys, and new synonymy for the known North American species of these genera of leafhoppers.

The genera of the Typhlocyba Complex included are as follows: *Typhlocyba, Empoa, Edwardsiana, Ribautiana, Henribautia, Ossiannilssonola* and a new genus *Mcateeana.*

New descriptions and illustrations of the male genitalia are given for nearly all of the previously described species, for two European species not previously recorded from North America, and for twenty-two new species.

New host records, biological notes, and locality records have been included under each species subsequent to its description, and for many species these add greatly to our knowledge of the habits and distribution of the species.

HISTORICAL ACCOUNT

The first revision of the species now placed in the Typhlocyba Complex was made by W. L. McAtee in 1926, who gave descriptions of the known North American species, all of which were then included in *Typhlocyba*, and described twenty-three new species and sixteen new varieties, with figures of the male genitalia for each species. The descriptions of two European species were also included although no North American specimens of these species had been seen. Much of the work included in this revision was accurate, but due to insufficient material to work with, lack of proper equipment, or to insufficient time, a number of inaccuracies occurred.

Since McAtee's revision a number of papers, which have added to our knowledge of the genus *Typhlocyba*, have appeared in various parts of the world. In 1928, Edwards moved the British species of *Typhlocyba* into the genus *Anomia* Fieber, and in 1929 Jazykov (Zachvatkin) proposed the genus *Edwardsiana* with *Cicada rosae* Linnaeus as the type species. Ribaut redescribed the French species of the Ulmi and Rosae Groups in 1931, with the description of several new species. The Oriental species of *Typhlocyba* were described by Matsumura in 1931-32, but without descriptions of the internal male genitalia. Wagner reviewed the species for Northern Germany in 1935, while in the same year Ossiannilsson reviewed the *Typhlocyba* species occurring in Sweden. In 1936 Ribaut redescribed all of the French species of *Typhlocyba* with illustrations of the male genitalia for each. Jacobi described a number of species of *Typhlocyba* from Lombok Island and adjacent islands in 1941.

The British species were brought up to date by China in 1943, who redescribed those species not considered by Ribaut (1936). In 1946 Dlabola recorded four species new to Bohemia. The genus *Ribautiana* was proposed in 1945 (1947) by Zachvatkin, along with the descriptions of new species of *Edwardsiana*. In 1949 Linnavouri described several species which had not been previously recorded for Finland. In 1950 China listed the British species, giving recognition to the genera *Edwardsiana* and *Ribautiana*, and in the same year Dlabola (1950) revised the leafhoppers from central Europe in Melichar's Collection, listing the species of *Typhlocyba* in the collection and indicating previous misdeterminations.

While this work was going on in other parts of the world, work was continuing on the North American species as well. New species were described by a number of workers: one by DeLong

(1926), one by Osborn (1928), one by DeLong and Davidson (1934), one by Ossiannilsson (1936), six by DeLong and Johnson (1936), one by Medler (1942), three species and one subspecies by Beamer (1943), six by Knull (1944), two by Knull (1945), and five by Ross and DeLong (1949). In 1949 a list of synonyms and references for another European species, of economic importance to cultivated prune, was made by Oman (1949a). Two new introductions of European species were reported recently, one in 1949 by Ross and DeLong, and the other by Andison, 1950.

With this increase in the number of North American species, some of which were known to be synonyms of previously described species and others whose identity was held in question, it was imperative that a revision be made in order to clear up the identity of all of the known species. While undertaking the revision of this genus the author has tried to use those methods which would permit the most accurate observations, and has included illustrations of those structures which best characterize the species.

Since the work on this genus was begun, the genera *Henribautia* Young and Christian, and *Ossiannilssonia* Young and Christian, have been segregated from *Typhlocyba* (see Young, 1952). The study of additional material subsequent to the completion of that paper has led the author to regard the species *sexnotata,* previously placed in the genus *Ossiannilssonia,* to have characters which justify the establishment of a new genus in which it has been placed.

Further consideration of the species of *Typhlocyba,* which on the basis of aedeagal structure appeared to be intermediate between the species in the Rosae Group and other species of *Typhlocyba,* has led the author to believe that the absence of atrial processes in such species as *T. tortosa, T. persephone, T. niobe,* and *T. sollisa* is due to a fusion of these with the aedeagal shaft, as is partly seen in *T. athene.* In species of the Rosae Group there is no indication that atrial processes have ever existed. When considered from this aspect, species of the Rosae Group are seen as having the aedeagus fundamentally different enough to set them off from *Typhlocyba* as a separate genus (*Edwardsiana* Zachvatkin). The group of species near and including *querci* Fitch has, on the basis of the structure of the aedeagus and pygofer, also been recognized as a genus distinct from *Typhlocyba* and has been segregated as the genus *Empoa* Fitch.

Ossiannilssonola, nom. nov.

The name replaces *Ossiannilssonia* Young and Christian *in* Young, Bull. Univ. Kansas Sci. Bull., vol. 35, pt. 1, July 1, 1952, p. 97 (*nec* Lambers, Ent. Tidskr., vol. 73, no. 1-2, May 10, 1952, p. 41).

Typhlocyba jacobii nom. nov.

The name *Typhlocyba duplicata* Jacobi (Jacobi, 1941, nec. *Typhlocyba duplicata* McAtee, 1926) is here replaced by the name *Typhlocyba jacobii.* See *Ossiannilssonola duplicata* (McAtee) p. 1146.

During the time spent working on this revision, it was possible for the author to study type specimens and determined specimens in the following collections: the Illinois State Natural History Survey Collection, Urbana, Illinois; the Colorado Agricultural and Mechanical College Collection, Ft. Collins, Colorado; the U. S. National Museum Collection, Washington, D. C.; and the private collection of Dr. D. M. DeLong, Columbus, Ohio. In addition to these, type material in the Snow Entomological Collections of the University of Kansas was available for study, and type specimens were loaned for study by the Canadian National Collection, and by Mrs. J. N. Knull from her personal collection.

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GENITALIC CHARACTERISTICS

The genitalic structures of the male have been found important in distinguishing genera as well as species of the Typhlocyba Complex. The characteristic genitalic structure has been found to be generally constant for each species, and has proven to be reliable for use in the determination of species.

Although the form of the styles, connective, and male plates is generally uniform for all of the species of some genera, in other genera these structures are sometimes specifically distinct.

The shape of the aedeagus shows the greatest degree of modification, and has proven to be the most useful structure for grouping the species comprising different genera. The form of the aedeagus is equally useful in distinguishing between species within a genus.

The shape of the pygofer, though not as useful for generic distinction because of its wide diversity of form in some genera, is in these genera almost as important as the aedeagus for helping to distinguish between species within the genus.

For a concise summary of the relations of the male genitalic structures to each other, in the Cicadellidae, the reader is referred to Oman (1949b), pp. 22-23.

BIOLOGICAL NOTES

A number of interesting observations of the habits of some of the species collected have been made by the author while collecting.

Population shifts during the day were noticed for several species, and appeared to be caused by difference in temperature, difference in light intensity, or a combination of both of these factors. During the mornings in early June, adults could usually be found in greater abundance on those branches upon which the sun was shining, while they were seldom found on shaded branches. Shortly before noon, as the temperature began to rise, the adults were found to have shifted to the shaded lower branches. In the warm afternoons they were found in greatest abundance on branches on the shaded sides of the trees. Species living on small trees and shrubs were found in greater abundance along the edges of woods where the sun shone on the host plants, while in densely shaded areas only a few specimens could be found.

When disturbed from the branches, it was found that most species would fly to dark objects such as the bark on the trunk of trees, stones, or to the ground. Species living in thickets were found to fly deeper into the thicket, or toward the ground when disturbed. In one instance, while collecting on *Quercus macrocarpa,* it was found to be more profitable to beat the lower branches of the trees with the net handle and to aspirate the insects from the tree trunks than to attempt to use the bag in the dense foliage. When returning to the leaves after having been disturbed, the insects usually alight on the under surfaces of the leaves. In collecting species which are not abundant or are not easily disturbed, when the branches are within easy reach it is sometimes possible to aspirate the insects from the undersurfaces of the leaves before beating. A large number of specimens were taken from *Acer saccharum* in this way, being easily seen from beneath, appearing as dark spots on the translucent light green leaves. This method was found to be most effective for collecting *Edwardsiana candidula* from the fastigiate form of *Populus alba,* after beating had proven ineffective.

On warm humid nights the collection of Typhlocybid leafhoppers at light was found to be particularly good. While collecting in Milwaukee, Wisconsin, on June 27, 1950, a warm humid night when thousands of specimens of species of *Empoa* were seen, it was found that certain colors of neon lights were more attractive than others. Few specimens were found at yellow, some at red, more at white, while most specimens were found around green and blue lights. Blue light was apparently more attractive than green.

Serious host injury was observed in only a few cases, the greatest injury seen being that done by *T. hockingensis* on a species of *Viburnum* used in Milwaukee County parks as an ornamental shrub. Damage was particularly heavy in some areas, with leaves nearly white from feeding injury, while in other areas only slight injury or none was seen. The host plant was quite abundant, and usually planted in hedgelike rows, which made it possible to easily see the irregularity of injury. Similar irregularity of host injury was observed on *Quercus alba,* caused by several species of leafhopper, but principally by *Ossiannilssonola berenice* in association with *O. danae* and *O. australis.* Noticeable injury was seen on *Acer saccharum* caused by an association of several species, but primarily by *Typhlocyba niobe* and *T. persephone.*

This factor of irregularity of population distribution makes it possible to collect large numbers of specimens in one place while in another place under apparently the same conditions specimens of the same species are rare.

Males were found to begin reaching maturity several days before females of the same species, so that early collections frequently contained a large majority of males. Within one week after the first males were taken, about equal numbers of both sexes were found, but after two more weeks the majority of specimens found were females. Observations made on *Typhlocyba modesta* showed that this pattern was not followed, but that a ratio of nearly equal numbers of both sexes was maintained for several weeks before the population became predominantly female in composition. Observations on *Typhlocyba persephone* showed a rapid change to an all female population within about two weeks, and after four weeks it was impossible to find even a single female specimen in places where there had previously been an abundance of specimens.

The only species observed by the author to have a second generation were *Typhlocyba modesta, T. hockingensis,* and *T. melite.* Other species have been observed to have more than one generation a year by other workers, but populations of some of these species were so small that it was impossible to be certain whether a second generation had developed. Some of the species observed could not possibly have had a second generation on the host that the first generation was observed to feed on, because the leaves of the host withered and dropped before a second generation could have developed.

During the process of maturing, adults of some of the species of *Ossiannilssonola* and *Empoa* pass progressively through several color stages, with the color markings appearing to increase in extent and in intensity so that specimens killed at different stages of this process are marked to greater or lesser degree. Another factor influencing coloration which appears to be independent of the maturing process controls the ultimate extent of color on the mature adult. A more complete discussion of coloration is given in the description of the genus *Empoa,* and problems which concern other species are discussed in the color descriptions of these species.

Because of progressive coloration, and because male and female insects begin emerging at different times, male and female specimens taken at the same time often appear to be differently marked, the females being usually much lighter in color than the males with which they are taken. When fully colored specimens of both sexes are compared there is no color distinction between them.

Eye color has sometimes been referred to in the descriptions of light colored species. This color is caused by the migration of dark color pigment in the iris cells of the compound eye (Wigglesworth, 1947, pp. 113-115). When the insect is in a dark place the dark pigment moves toward the surface of the eye, but when exposed to the light the pigment moves away from the surface of the eye. Because of this movement of pigment it has been possible for the author to collect specimens of one species showing both light and dark colored eyes by collecting on both shaded and sunny sides of a single tree, or by collecting at different times of the day. Specimens collected at night are frequently dark eyed when they come to the light, but the eye color becomes lighter as they remain at the light for some time.

TECHNIQUE

A particular type of net was found to be more efficient in collecting the insects studied than were the types commonly used for collecting leafhoppers. Since all of the species collected live on trees or bushes, a durable net bag was needed. A heavy canvas beating net was found to be impractical because it could not be moved rapidly enough, did not collapse quickly enough, and did not let in sufficient light. After testing several kinds of net bags, a fine-meshed nylon bag was found to be best suited for this type of collecting. Because most of the species collected were light colored, it was found that a bag dyed navy blue permitted them to be seen more easily, and they appeared to be less active than in a light colored bag. The bag was also pointed to restrict these rather active insects to a smaller space from which they could be aspirated more easily.

Most of the species studied were particularly fragile, and in order to remove the abdomen for dissection without detaching the specimen from the point, or injuring its wings, the paper point with the insect attached was removed from the pin and placed inverted on a piece of sheet cork. This exposed the abdomen in ventral aspect so that it could easily be separated from the thorax by a slight pressure with the point of the pin at its base.

Less heavily sclerotized specimens and those used for illustration were stained with acid fuchsin to show differences in sclerotization and to bring out obscure details.

Dissections were held stationary for drawing by means of a small amount of petroleum jelly placed on the slide before adding the glycerine. Dry slide mounts of the wings were used for making illustrations of the wings.

Drawings of the pygofer, plates, and head represent a magnification of 60 times actual size; drawings of the aedeagus, styles, connective of the male, and eighth abdominal sternite of the female, 120 times; drawings of the wings 56 times.

SYSTEMATIC ACCOUNT

INTRODUCTION TO THE TYPHLOCYBA COMPLEX

Most of the species included in the genus *Typhlocyba* prior to the segregation of the genera included in this revision were placed in this genus on the basis of wing venation as found in the type species, *Typhlocyba quercus* (Fabricius), the hind wing having two open apical cells, the fore wing with the inner and outer apical cells short and not attaining the wing apex, and the third apical cell of the fore wing triangular and usually stalked. Some of the species included in the genus differ from the type species in having the third apical cell of the fore wing quadrate and not stalked. The North American species with rare exceptions agreed with the type species in wing venation.

In recent interpretation of the genus *Typhlocyba* the structure of the male genitalia has been regarded as more significant than wing venation as a generic character, resulting in the segregation of groups of species from *Typhlocyba* as genera (Zachvatkin, 1939, 1947; Young, 1952). This change in generic concept has brought about a need for restudying the species of *Typhlocyba* to determine their generic status on the basis of the male genitalia. It is the opinion of the author that when this has been done for the species from other regions, additional new genera will be added to the Typhlocyba Complex.

The following systematic account includes only those genera of the Typhlocyba Complex which occur in North America.

KEY TO THE GENERA OF THE TYPHLOCYBA COMPLEX

1. Crown with median length equal to median length of pronotum or nearly so; ocelli present; pygofer without group of macrosetae near basal angle of male plate. (Pl. LXXIII, fig. 1), *Henribautia* p. 1115

   Crown with median length much less than median length of pronotum; ocelli rarely present; pygofer usually with macrosetae near outer basal angle of male plate 2

2. Aedeagal shaft reduced to a flattened membranous structure occurring between a pair of arms formed by longer forcipate atrial processes; plate without macroseta at outer basal angle. (Pl. IV, fig. 1) . . . . *Ossiannilssonola* p. 1132

   Aedeagal shaft strongly sclerotized or absent, not so enclosed; plate with macroseta at outer basal angle 3

3. Aedeagal shaft absent, atrial processes fused at base, branched near apex. (Pl. I, fig. 4) . . . . *Mcateeana* p. 1130

   Aedeagal shaft present, heavily sclerotized, atrial processes when present not branching 4

4. Mesal margin of style with distinct preapical angular protuberance. (Pl. II, fig. 1) . . . . *Ribautiana* p. 1119
   Mesal margin of style without distinct preapical angular protuberance 5
5. Aedeagal shaft with three pairs of apical processes and three broad, thin plates arising from anterior margin. (Pl. LXXXVIII) . . . . *Empoa* p. 1187
   Aedeagal shaft with less than three pairs of apical processes or none, rarely with one thin plate arising from anterior margin . . 6
6. Aedeagal shaft with two pairs of apical processes, frequently one or both pairs branched; without atrial processes; aedeagal apodeme a slender arm nearly two thirds the length of shaft, *Edwardsiana* p. 1208
   Aedeagal shaft with one pair or without apical processes; usually with atrial processes present; aedeagal apodeme usually laterally broadened, less than two thirds the length of shaft, *Typhlocyba* p. 1160

GENUS HENRIBAUTIA Young and Christian

(Pl. LXXIII, figs. 1, 2, 3)

Henribautia Young and Christian, *in* Young, Bull. Univ. Kansas Sci. Bull., vol. 35, pt. 1, 1952, pp. 96-97.

Type of the genus, *Typhlocyba nigricephala* Beamer, by original designation.

Fore wings.—Inner and outer apical cells short, not attaining wing apex; second apical cell much broader at apex than at base; third apical cell petiolate; wing apex somewhat oblique; apical half of wing having a number of transparent areas scattered along the cross veins and in apical cells. (Pl. LXXIII, fig. 1h).

Hind wings.—Vein 1V branching from vein 2V near its midlength; submarginal vein absent at wing apex; both apical cells open apically; posterior branch of R fused with apical portion of vein M_{1+2}; basal half whitish hyaline, apical half fumose with veins brown. (Pl. LXXIII, fig. 1h).

Genital capsule.—Male plate, in ventral aspect, broadened on basal half, abruptly narrowed near middle of length to narrow upturned apex; in lateral aspect with single macroseta near outer basal angle of male plate, and a few small setae on apical half; pygofer, in lateral aspect with numerous small setae scattered over ventral half of disc, completely without macrosetae, dorsal posterior half of disc covered with numerous awl-shaped spines, posterior margin slightly inrolled, differentially sclerotized area near base of plate, posterodorsal margin with row of small setae; anal hooks wanting.

Internal male genitalia.—Style narrow, gradually tapered and curved laterad on apical half, with preapical triangular protuberance on inner margin, with one or few setae on outer, and several alveoli on inner margin near middle of length; connective triangular to Y-shaped, the stem broad, aedeagal articulation subterminal; aedeagus without preatrial arm, apodeme simple, well developed, shaft slender, elongate, with paired apical processes.

Female.—With posterior margin of eighth abdominal sternite as in *H. nigricephala.* (Pl. LXXXVII, figs. 2a, b).

Head well produced medially, conical, median length of the crown greatly exceeding length next the eye particularly in female, nearly, or quite as long as, but narrower than pronotum, crown sharply rounded to the slightly convex face, contour divergent from the line of dorsum; ocelli present, situated on the margin between crown and face, distant from compound eyes; pronotum with lateral margins divergent posteriorly, posterior margin scarcely emarginate; pleural portion much broader than the ocellocular area; head, pronotum, and scutellum black to dark brown, face yellow ventrad of antennal pits, abdomen black to dark brown, male plates yellow with apices brown.

The known distribution of this genus is the southern United States from Mississippi westward to New Mexico.

KEY TO THE SPECIES OF HENRIBAUTIA

1. Vertex of head brownish black with only ocelli white; fore wings with basal half white to yellow-orange and meeting black-brown apical half in a transverse line, a small bilobed black mark along scutellum . . . . . . *nigricephala* p. 1116
   Vertex of head brownish black with a narrow white line extending between eye and ocellus; fore wings with black-brown markings extending along commissural margin or with light markings meeting black-brown markings on apical half in an oblique line 2
2. Vertex of head with narrow white line extending between ocelli; fore wing with white to yellow markings on basal half extending to or nearly to commissural margin . . . . . . *hubbardi* p. 1117
   Vertex of head with narrow white line not extending between ocelli; fore wing with white to yellow markings only on lateral third of basal two thirds along costal margin . . . . *beameri* p. 1118

Henribautia nigricephala (Beamer)

(Pl. LXXIII, fig. 1)

Typhlocyba nigricephala Beamer, Canadian Ent., vol. 75, no. 7, 1943, pp. 131-133.

Henribautia nigricephala, Young, Bull. Univ. Kansas Sci. Bull., vol. 35, pt. 1, 1952, p. 97.

Resembling *H. hubbardi*, but differs in having dark brown markings on outer half of fore wing with anterior margin almost transverse, and in lacking narrow white band between ocelli and eyes.

Length.—2.5-3.0 mm.

Color.—Fore wings, with dark brown markings on clavus bordering scutellum roughly bilobed; milky-white to golden-yellow on basal half of wing, dark brown along scutellum; anterior margin of dark brown apical marking almost transverse.

Specimens from Arizona are dark brown to black, while specimens from other localities are lighter brown, nearly maroon.

Genital capsule.—Male pygofer, in lateral aspect, with posterior margin forming two evenly rounded lobes, the dorsal lobe bearing a few microsetae and projecting beyond ventral lobe posteriorly, ventral margin slightly lobed.

Internal male genitalia.—Shaft of aedeagus with inferior pair of apical processes directed basad to slightly below middle of shaft, superior pair short, thornlike, slightly curving laterodorsad.

The only known host plant is *Rhamnus californica*, a large series having been collected from it by Dr. R. H. Beamer, July, 1950, at Granite Dells, Arizona. The name of the host plant from which the type series was taken, which differed from the above host, is not known.

Specimens have been seen from the following localities: *Arkansas:* Fouke, December 21; *Mississippi:* Shuqualak, July 16; *Louisiana:* Calcasieu County, August 16; Caddo County, August 19; Colfax, December 23; Vinton, December 25; *Texas:* Orange County, August 14; *Arizona:* Santa Catalina Mountains, July 14; Santa Rita Mountains, July 17, August 18; Yarnell, July 27; Oak Creek Canyon, August 9; Granite Dells, July 5.

The specimens taken in Arizona differ from those from the other states, in being darker in color, and in being one-fifth to one-sixth larger in size in all dimensions, though identical in form and proportions with those from other places. After more is known about the biology of this species, these forms may prove to be distinct species. At present the author considers it best to continue to regard these as extremes in variation of a single species.

Types.—Holotype male, allotype female, and numerous paratypes of both sexes, in the Snow Entomological Collections of the University of Kansas.

Henribautia hubbardi (McAtee)

(Pl. LXXIII, fig. 3)

Erythroneura hubbardi McAtee, Florida Ent., vol. 8, no. 3-4, 1924, p. 35.
Typhlocyba hubbardi, Beamer, Canadian Ent., vol. 66, no. 1, 1934, p. 18.
Henribautia hubbardi, Young, Bull. Univ. Kansas Sci. Bull., vol. 35, pt. 1, 1952, p. 97.

Resembling *H. nigricephala,* but differs in having dark brown markings on outer half of fore wing with anterior margin strongly oblique, and in having a narrow white band on vertex of head between ocelli and eyes.

Length.—2.75-3.0 mm.

Color.—A narrow white line between eyes on vertex across ocelli; fore wings with dark brown markings on clavus along scutellum evenly rounded; brown markings continuing along commissural margin on inner half of clavus, joining anterior and posterior markings in some specimens; if not joined, with anterior edge of posterior markings crossing wing obliquely; with a narrow V-shaped white band bordering dark areas and enclosing a triangular golden-yellow area which borders on costal margin near middle; male plate light brown on lateral margins.

Genital capsule.—Male pygofer with posterior lobes not as deeply notched between as in *H. nigricephala.*

Internal male genitalia.—Aedeagus with apical processes parallel to shaft, superior and inferior pairs of almost equal length, fused at base near point of attachment to shaft, superior pair strongly divergent, inferior pair directed basad parallel to shaft.

Specimens have been seen from the following localities in *Arizona:* Chiricahua Mountains, July 8, August 7, September 6; Santa Rita Mountains, June 16, July 16; Huachuca Mountains, June 11, July 9, August 1, October 31.

Types.—Holotype female, in the U. S. National Museum collection; allotype male, in the Snow Entomological Collections of the University of Kansas. Types have been seen by the author.

Henribautia beameri sp. nov.

(Pl. LXXIII, fig. 2)

Resembling *H. nigricephala,* but differs in having more extensive black markings on wing and in having inferior pair of apical processes of aedeagus sharply angled at the middle and directed mesad toward the shaft.

Length.—2.5 mm.

Color.—Vertex of head with narrow yellow line extending between eye and ocellus on each side, yellow color of face sometimes extending anteriorly between ocelli to anterior third of crown; fore wings dark brown over most of their surface, with a bright yellow stripe along basal two thirds of costal margin outlined by a narrow white band.

Genital capsule.—Male pygofer, in lateral aspect, with posterior margin medially produced posteriorly as a single lobe.

Internal male genitalia.—Aedeagus with inferior pair of apical processes diverging laterocephalad from shaft for two thirds their length, then directed toward shaft, apices meeting or almost meeting near basal third of shaft, superior pair of processes short, appearing as a distal continuation of base of inferior processes, processes somewhat S-shaped from right lateral aspect.

The host of this species is thought to be *Condalia spathulata.*

Types.—Holotype male, allotype female, and numerous male and female paratypes, Oracle Junction, Arizona, April 29, 1948, R. H. Beamer and L. D. Beamer. One male paratype, Tucson, Arizona, April 28, 1948, R. H. Beamer. Types in the Snow Entomological Collections of the University of Kansas.

GENUS RIBAUTIANA Zakhvatkin

(Pls. LXXIV and LXXV)

Ribautiana Zakhvatkin, Rev. Ent. URSS, vol. 28, no. 3-4, (1945), 1947, p. 113.

Type of the genus, *Cicada ulmi* Linnaeus, by original designation.

Fore wings.—Inner and outer apical cells short, not attaining wing apex; second apical cell much broader at apex than at base; third apical cell petiolate, wing apex smoothly rounded; with dark markings at apices of the veins which form distal margins of inner and outer apical cells, dark areas in apices of inner three basal cells. (Pl. LXXIV, fig. 1).

Hind wings.—Vein 1V branching from vein 2V near its mid-length; submarginal vein absent at wing apex; both apical cells open apically; posterior branch of R fused with apical portion of vein M_{1+2}; usually whitish hyaline, fuscous on apical half in *R. ulmi.* (Pl. LXXIV, fig. 1).

Genital capsule.—Male plate, in ventral aspect, abruptly narrowed near middle its length to narrow upturned divergent apex, with single macroseta near outer basal angle and two smaller setae near lateral margin near middle of plate; in lateral aspect, with a number of scattered microsetae, some of which tend to form a submarginal row along lateral margin; pygofer, in lateral aspect, with group of macrosetae just dorsad of outer basal angle of plate, with numerous microsetae in region caudad and dorsad of these, and a small row on inrolled margin directed mesad; posterior margin scarcely inrolled, not differentially sclerotized, not well differentiated, merging with ventral margin; pygofer hooks wanting; anal hooks wanting.

Internal male genitalia.—Style elongate, slender, gradually tapering and curved laterad or dorsad towards apex, inner margin with preapical triangular protuberance and several alveoli, outer margin with a few long setae; connective Y-shaped or triangular; aedeagal articulation terminal or subterminal; aedeagus without preatrial arm; aedeagal apodeme well developed, simple; atrial processes or basal shaft processes present, and usually one or more pairs of processes more distad on the shaft.

Female.—With posterior margin of eighth abdominal sternite as in *R. piscator* (Pl. LXXXVII, figs. 3a, 3b) except in *R. ulmi* (Pl. LXXXVII, figs. 4a, 4b).

Head in dorsal aspect, narrower than pronotum, scarcely produced, median length not greatly exceeding the length next the eye, female longer than male, anterior margin of crown smoothly rounded; in lateral aspect contour of face convex and divergent from the line of dorsum; ocelli absent; pronotum short, with lateral margins greatly divergent posteriorly, and with posterior margin shallowly emarginate; width of pleural portion greatly exceeding width of ocellocular area.

The genus has a Holarctic distribution.

KEY TO THE SPECIES OF RIBAUTIANA

1. Length 3.5-4.0 mm.; fore wings greenish-yellow; abdomen black on venter; aedeagus without processes on shaft. (Pl. LXXIV, fig. 1) . . . . *ulmi* p. 1121
   Length 3.25 mm. or less; fore wings white to orange-yellow; abdomen yellow on venter; aedeagus with processes on shaft 2
2. Scutellum dark brown or black 3
   Scutellum light colored 4
3. Aedeagus with two pairs of apical processes, shaft three times as long as atrial processes. (Pl. LXXV, fig. 1) . . . . *luculla* p. 1127
   Aedeagus with three pairs of apical processes, median pair branched, shaft twice as long as atrial processes. (Pl. LXXV, fig. 5) . . . . *sciotoensis* p. 1128
4. Aedeagus with a pair of processes arising near middle of shaft . . . 5
   Aedeagus without processes arising near middle of shaft 6
5. Shaft of aedeagus slender, apex gradually curving ventrocaudad, with two or three pairs of short apical processes. (Pl. LXXIV, fig. 4) . . . . *unca* p. 1129
   Shaft of aedeagus stout, apex not curving ventrad, with a pair of apical processes directed cephalad, and a single unpaired process directed dorsad from posterior margin. (Pl. LXXIV, fig. 2) . . . . *tenerrima* p. 1122

6. Inferior pair of apical processes of aedeagus with numerous spine-like projections 7
Inferior pair of apical processes of aedeagus smooth . . 8
7. Length of shaft of aedeagus beyond apical processes equal or nearly equal to length of inferior processes. (Pl. LXXV, fig. 4) . . *multispinosa* p. 1125
Length of shaft beyond apical processes of aedeagus less than half the length of inferior processes. (Pl. LXXV, fig. 3), *piscator* p. 1124
8. Apical half of aedeagal shaft nearly straight, inferior pair of processes only slightly curved. (Pl. LXXIV, fig. 3) . . *parapiscator* p. 1123
Apical half of aedeagal shaft curved into nearly a complete circle, inferior pair of apical processes following curve of shaft. (Pl. LXXV, fig. 2) . . . . . *foliosa* p. 1126

Ribautiana ulmi (Linnaeus)

(Pl. LXXIV, fig. 1)

Cicada ulmi Linnaeus, Systema naturae, Regnum animale. ed. 10, 1758, p. 439. (Engelmann reprint, 1894, p. 439.)
Typhlocyba ulmi, Burmeister, Handbuch der Entomologie, 1835, vol. 2, p. 107.
Anomia ulmi, Fieber, Katalogue der europaischen Cicadinen, 1872, p. 15.
Empoa ulmi, Van Duzee, Check List of Hemiptera (excepting the Aphididae, Aleurodidae and Coccidae) of America North of Mexico, 1916, p. 77.
Ribautiana ulmi, Zakhvatkin, Rev. d'Ent. URSS, vol. 28, nos. 3-4, (1945), 1947, p. 113.
Eupteryx ocellata Curtis, British Entomology, vol. 14, art. 640, 1837, p. 2.

Resembling *R. tenerrima*, but easily distinguished by its larger size, darker color, and absence of processes on aedeagal shaft.

Length.—3.5-4.0 mm.

Color.—Head, pronotum, and scutellum pale greenish-yellow, female with two oval black spots on vertex of head between eyes, another on middle of anterior margin of pronotum also present on male, spots faint or absent on teneral specimens; fore wings with basal half evenly colored light yellowish-green to olive-green; abdomen with dorsum and venter black, with a narrow yellow band on posterior margin of each segment, pygofer black.

Genital capsule.—Male pygofer, in lateral aspect, with posterior margin produced mesally in an evenly rounded lobe.

Internal male genitalia.—Connective distinctly Y-shaped; aedeagus with pair of broadly flattened atrial processes directed dorsolaterad for half the length of aedeagal shaft; shaft without processes, slender, gradually tapering to slightly bifid apex, recurved on outer fourth; aedeagal apodeme more than one third as long and almost twice as broad as shaft in lateral aspect.

A large series of specimens was taken on *Ulmus fulva* in Milwaukee, Wisconsin, by the author, and a short series is on hand from Salem, Oregon, taken on *Ulmus glabra camperdownii*, by Mr.

John E. Davis. Other specimens seen are labeled only "*Ulmus*", or "Elm".

Specimens have been seen from the following North American localities: *Ontario:* Vineland, July, August, September, October; Jordan, August 11, 15; *Massachusetts:* Cambridge, October 24, 30, November 1; Wood's Hole, July 10, September 1; Arlington, September 10; *Nova Scotia:* King's County, July; *Rhode Island:* Kingston, September; *New York:* Ithaca, October 6; *New Jersey:* Bound Brook; *Ohio:* Columbus, October 13; *Missouri:* St. Louis, April 25; *Wisconsin:* Milwaukee, June 27-July 7; *Texas:* ?; *Utah:* Logan, August 26; *British Columbia:* Vernon; Victoria, August 8, October 12; *Washington:* Seattle; Shelton, July 24; Tacoma, June 29; Puyallup, June; *Oregon:* Salem, September 26; Orenco, November 1; *California:* Mountain View, Milbrae, October 3; Mill Valley, Marin County, October 3; Berkeley, September 1, 8, 12; San Jose, October 24.

Other specimens have been seen from the following European localities: *Germany:* Halle, September 23; *France:* Paris, October 28; *Russia:* Samara, July 15; *England:* Cambridge, October 17; Oxfordshire, June 17; *Scotland:* Edinburgh, August 19; *Finland:* Helsinki, September 25; *Bohemia:* Perimov, September 24; *Sweden:* Uppland, Solna, October 26; Skåne, Ven, August 2; Gotland, Roma Kl, July 3.

Ribautiana tenerrima (Herrich-Schäffer)

(Pl. LXXIV, fig. 2)

Typhlocyba tenerrima Herrich-Schäffer, Faunae Insectorum Germanicae initia; oder Deutschlands Insecten gesammelt und herausgegeben von D. G. W. F. Panzer. Fortgesetzt von G. A. W. Herrich-Schäffer, vol. 124, 1834, p. 10.
Typhlocyba rubi Hardy, Trans. Tyneside Nat. Club, vol. 1, 1850, p. 417.
Typhlocyba misella Boheman, Handlingar. Kongliga Svenska Vetenskaps Akademien, 1851, p. 122.
Anomia tenerrima, Fieber, Katalogue der europaischen Cicadinen, 1872, p. 15.
Empoa tenerrima, Van Duzee, Trans. San Diego Soc. Nat. Hist., vol. 2, no. 1, 1914, p. 57.
Ribautiana tenerrima, Zakhvatkin, Revue d'Ent. URSS, vol. 28, no. 3-4. (1945), 1947, p. 113.

Resembles *R. piscator* and other similarly marked species in external appearance, but differs in having aedeagal shaft straight, not curving posteriorly at apex, and in having a pair of short slender basally fused processes arising on posterior margin near middle, another pair on anterior margin, and an unpaired process on posterior margin at apex.

Length.—3.0 mm.

Color.—Head, pronotum, and scutellum pale white to light yellow, without dark markings; fore wings white to yellow; abdomen black on basal half of dorsum of each segment, venter light yellow, or with narrow black basal band on each segment, basal half of pygofer black.

Genital capsule.—Male pygofer, in lateral aspect, subquadrate, ventral angle projecting slightly beyond dorsal angle.

Internal male genitalia.—Connective triangular; aedeagus with pair of atrial processes elongate, slightly flattened on distal half, length exceeding aedeagal shaft, gradually reduced to acute apices; aedeagal shaft expanded on basal third, laterally compressed shortly before apex, with a pair of short slender basally fused processes arising on posterior margin near middle, another pair at apex directed laterocephalad from anterior margin, and with unpaired dorsally directed process arising from posterior margin at apex; aedeagal apodeme one sixth length of shaft, as broad as narrowest width of shaft in lateral aspect.

The description of this species made by McAtee (1926) was based on a specimen of *R. cruciata* Ribaut, according to Ribaut (1931a, p. 287). The first reliable report of the occurrence of this species in North America was made by H. Andison (1950) from specimens collected on Loganberry at Brentwood, British Columbia, June 20, 1947, and illustrations for this species have been made from one of these. No other North American specimens of this species are known to the author, and previous records of the occurrence of this species apparently apply to other species in the genus.

Determination of this species is based on figures of male genitalia as illustrated by Ribaut (1936, p. 117). A pair of specimens from Sweden, determined by Dr. Ossiannilsson as this species, agree with the North American specimens seen. Other specimens from Europe, determined as *tenerrima* are: a pair of specimens from Budapest, determined by Horvath, which agree with the figures of *Typhlocyba scalaris* Ribaut, (Ribaut, 1936), and a specimen from France, determined by Signoret, which has male genitalia which agree with *T. debilis* Douglas as illustrated in the same paper.

The approved common name for this species is "The Bramble Leafhopper" (Muesbeck, 1950, p. 138).

Ribautiana parapiscator sp. nov.

(Pl. LXXIV, fig. 3)

Typhlocyba piscator McAtee, Proc. U. S. Nat. Mus., vol. 68, art. 18, 1926, p. 7 (part).

Resembling *R. piscator* in external appearance, but with aedeagal shaft forming nearly a right angle near middle and with inferior pair of apical processes smooth.

Length.—2.75 mm.

Color.—Dorsum pale milky white to light orange-yellow; abdomen black on basal half of dorsum of each segment, venter light yellow.

Genital capsule.—Male pygofer, in lateral aspect, subquadrate with dorsal angle projecting beyond ventral angle.

Internal male genitalia.—Aedeagus with atrial process elongate, evenly tapered from base to acute apices, sinuate, almost as long as shaft; aedeagal shaft elongate, slender, bent posteriorly at middle in almost a right angle, with two pairs of slender, smooth, acute processes at apex, superior pair appearing as a continuation of shaft in lateral aspect, slightly curved ventrad, length two thirds that of inferior pair which curve dorsad toward apices of atrial processes.

This species has been collected by the author from *Ostrya virginiana* in abundance, both in Douglas County, Kansas, and in Milwaukee County, Wisconsin, along with *R. multispinosa.*

Types.—Holotype male and twenty-seven male paratypes, Douglas County, Kansas, June 7, 1950, P. J. Christian; additional paratype males: twenty-eight, Douglas County, Kansas, May 30, 1949, R. H. Beamer; two, Douglas County, Kansas, May 30, 1949, P. J. Christian; one, June 1, 1949, Douglas County, Kansas, P. J. Christian; twenty-six, Milwaukee, Wisconsin, June 26-July 5, 1950, P. J. Christian; one, Ames, Iowa, September 20, 1940, D. R. Lindsay; one, Brandenburg, Kentucky, September 14, 1941, D. A. Young; one, Vineland Station, Ontario, September 21, 1940, W. L. Putman; one, Ames, Iowa, September 28, 1894, a paratype of *Ribautiana piscator* bearing the same data as the allotype female of that species.

Holotype and paratypes in the Snow Entomological Collections of the University of Kansas; the Brandenburg, Kentucky, paratype in the U. S. National Museum Collection; the Vineland Station, Ontario, paratype in the Canadian National Collection; and the Ames, Iowa, specimen of the type series of *R. piscator,* in the Iowa State College Collection.

Ribautiana piscator (McAtee)

(Pl. LXXV, fig. 3)

Typhlocyba piscator McAtee, Proc. U. S. Nat. Mus., vol. 68, art. 18, 1926, p. 7 (part).

Ribautiana piscator, Young, Bull. Univ. Kansas Sci. Bull., vol. 35, pt. 1, 1952, p. 100.

Resembling *R. multispinosa,* but differing in having length of aedeagal shaft distad of superior pair of processes, shorter than these.

Length.—2.75-3.0 mm.

Color.—Head, pronotum, scutellum and light portions of fore wing pale milky-white to light yellow; abdomen black on basal half of dorsum of each segment, venter yellow.

Genital capsule.—Male pygofer, in lateral aspect, somewhat quadrate, dorsal angle rounded, projecting beyond ventral angle which is less distinct.

Internal male genitalia.—Aedeagus, with pair of atrial processes three fourths as long as shaft, elongate, gradually reduced to acute apices, sinuate; shaft broadly curved posteriorly, with two pairs of apical processes of about equal length, superior pair slender, smooth, directed ventrolaterad toward apices of atrial processes, inferior pair fused basally, a stout spine on mesal margin at basal third, numerous small spines scattered over apical two thirds.

Most of the specimens seen have the inferior pair of processes more spinose than in the specimen figured which is nearer in appearance to the holotype than any of the other specimens seen.

A series of twenty specimens, eleven males and nine females, were collected by the author from *Carpinus caroliniana* in Milwaukee, Wisconsin, July 7, 1950.

Type.—Holotype male, Elizabeth, Illinois, in the Illinois State Natural History Survey Collection; allotype female, in the Iowa State College Collection, bears the same data as a paratype male which is a specimen of *Ribautiana parapiscator*, and is probably also a specimen of that species.

Ribautiana multispinosa sp. nov.

(Pl. LXXV, fig. 4)

Resembling *R. piscator*, but differing in having length of aedeagal shaft distad of superior pair of processes longer than these.

Length.—2.75-3.0 mm.

Color.—Head, pronotum, scutellum and light areas of fore wings pale milky-white to light yellow; abdomen black on basal half of dorsum of each segment, venter yellow.

Genital capsule.—Male pygofer, in lateral aspect, somewhat quadrate, dorsal angle rounded, projecting beyond ventral angle.

Internal male genitalia.—Aedeagus with pair of atrial processes elongate, evenly tapered from base to acute apices, sinuate, almost half as long as aedeagal shaft; shaft elongate, slender, bent posteriorly on outer third, forming a half circle in lateral aspect, apex curving toward middle of shaft; two pairs of processes on apical sixth of shaft, superior pair slender, smooth, directed laterocaudad toward apices of atrial processes, half as long as inferior pair which are broadly flattened laterally forming an oval in caudal aspect and armed with numerous short stout spines which vary somewhat in number and location on different specimens.

This species has been collected by the author from *Ostrya virginiana* in association with *R. parapiscator,* in Milwaukee, Wisconsin, and in Douglas County, Kansas.

Types.—Holotype male, July 2, 1950, Milwaukee, Wisconsin, P. J. Christian; paratype males: eight, May 30, one, June 5, 1949, Douglas County, Kansas, R. H. Beamer; one, June 1, 1949, eight, June 7, 1950, Douglas County, Kansas, P. J. Christian; one, June 28, three, July 1, two, July 2, one, July 3, three, July 5, 1950, Milwaukee, Wisconsin, P. J. Christian; one, July 4, 1949, Cheboygan County, Michigan, H. B. Hungerford. An abnormal male of this species, August 1, 1949, Cheboygan County, Michigan, H. B. Hungerford, is not made a paratype. Types in the Snow Entomological Collections of the University of Kansas.

Ribautiana foliosa (Knull)

(Pl. LXXV, fig. 2)

Typhlocyba foliosa Knull, Ohio J. Sci., vol. 45, no. 3, 1945, pp. 104, 107, pls. 1-2.

Ribautiana foliosa, Young, Bull. Univ. Kansas Sci. Bull., vol. 35, pt. 1, 1952, p. 100.

Resembling *R. piscator,* but differing in having apical half of aedeagal shaft forming nearly a circle, and in having the inferior pair of shaft processes smooth and strongly curved, following the curvature of the shaft.

Length.—3.0 mm.

Color.—Head, pronotum, and scutellum pale milky-white to light orange yellow; abdomen black on basal half of dorsum of each segment.

Genital capsule.—Male pygofer, in lateral aspect, somewhat quadrate, dorsal angle rounded, projecting beyond ventral angle.

Internal male genitalia.—Aedeagus with atrial processes broadly attached at base, distinctly S-shaped in left lateral aspect, gradually reduced to sharp apices, half as long as aedeagal shaft, sinuate in posterior aspect; aedeagal shaft swollen at base and broadly flattened on outer third, with two pairs of processes near apex, inferior pair foliaceous, curved ventrolaterad in a semicircle, with apices directed toward apices of atrial processes, superior pair of processes forming almost a complete circle with the distal half of shaft, apices directed ventrolaterad toward middle of shaft in lateral aspect, shaft sharply reduced to a short sinuate apex beyond processes.

A number of specimens of this species have been taken by the author from *Fagus grandifolia.* Two other specimens are on hand labeled "host *Carpinus caroliniana*", while another specimen from the same locality is labeled "*Fagus grandifolia*". One male specimen from New Hampshire, determined by McAtee as *R. piscator,* and a male paratype have been seen. Specimens seen have been from the following localities: *Ontario:* Vineland Station, September 19; *Manitoba:* Birtle, August 6, 10, September 2; *New Hampshire:* Durham, June 23; *Virginia:* Mountain Lake, July 2; *Tennessee:* Gatlinburg, June 24, 25; *Ohio:* Hocking County, September 16; Delaware County, October 10; *Wisconsin:* Milwaukee, July 5; *Minnesota:* Itaska County, July 26-28.

Types.—Holotype, allotype, and paratypes in the collection of Mrs. J. N. Knull; six paratypes in Ohio State University Collection.

Ribautiana lucella (Medler)

(Pl. LXXV, fig. 1)

Typhlocyba lucella Medler, Minnesota Agr. Exp. Sta. Tech. Bull., no. 155, 1942, pp. 139-140, pl. 9.
Ribautiana lucella, Young, Bull. Univ. Kansas Sci. Bull., vol. 35, pt. 1, 1952, p. 100.

Resembling *R. sciotoensis* in outward appearance, but with aedeagal shaft dorsoventrally flattened, with only two pairs of apical processes on shaft.

Length.—3.25 mm.

Color.—Head, pronotum, and light portions of fore wing pale yellowish white; scutellum fuscus; fore wing with band across distal ends of three inner basal cells more pronounced, cross veins darker near wing margins, third apical cell fuscus; abdomen black on dorsum, yellow on venter.

Genital capsule.—Male pygofer, in lateral aspect, somewhat quadrate, dorsal angle rounded, projecting beyond ventral angle.

Internal male genitalia.—Aedeagus, with pair of atrial processes one half width and one third length of shaft in lateral aspect, very gradually reduced to acute apices, sinuate; aedeagal shaft slender, greatly attenuated, width in lateral aspect one third width from caudal aspect, inferior pair of processes at outer third of shaft with apices directed toward apices of atrial processes, slightly broader but only half as long as atrial processes, superior pair of processes as long and stout as inferior pair, directed dorsolaterad, arising at half their length from apex of shaft.

The host plant for this species is believed to be *Corylus americana,* on the basis of a female specimen taken on that host, which agrees in external appearance with a male paratype of this species.

The following specimens have been seen: one female, La Crosse, Wisconsin, August 7; one female, Merrillan, Wisconsin, August 5; one female, Thornton, Illinois, September 7; and a series of twelve unpinned male and female specimens from Illinois, in the Illinois Natural History Survey Collection.

Types.—Holotype male and two paratype males, in the University of Minnesota Collection; one male paratype in the Snow Entomological Collections of the University of Kansas.

Ribautiana sciotoensis (Knull)

(Pl. LXXV, fig. 5)

Typhlocyba sciotoensis Knull, Ohio J. Sci., vol. 45, no. 3, 1945, pp. 103, 107, pl. 2.

Ribautiana sciotoensis, Young, Bull. Univ. Kansas Sci. Bull., vol. 35, pt. 1, 1952, p. 100.

Resembling *R. luculla* in external appearance, but with third apical cell white, and with three pair of apical processes on aedeagal shaft, the median pair branching.

Length.—3.0 mm.

Color.—Head and pronotum chalky white with a yellowish tinge; scutellum dark brown, darker in median basal area; fore wing with a pronounced dark brown band over white crossveins, extending farther anteriorly than posteriorly.

Genital capsule.—Male pygofer, in lateral aspect, with posterior margin distinct, ventral angle projecting beyond dorsal angle.

Internal male genitalia.—Aedeagus, with pair of atrial processes narrow, reaching to two thirds length of shaft, separated at base by three times width of shaft, directed dorsocaudad parallel to each other, apex of shaft slightly broadened and strongly curved ventrad, bearing three pairs of apical processes the superior pair arising before apex, incurving, median pair branched, directed laterad, inferior pair curved sharply ventrad, apices directed toward apex of shaft in lateral aspect; aedeagal shaft sharply curved, narrowing from broad base to complex apex, forming an incomplete semicircle, somewhat swollen at juncture of processes. Illustrations for this species are adapted from the original description by permission of the author.

The following specimens have been seen: one paratype, Scioto County, Ohio, June 17, and one female from Salamanca, New York, July 24.

Types.—Holotype, allotype, and male paratype in the collection of Mrs. J. N. Knull.

Ribautiana unca (McAtee)

(Pl. LXXIV, fig. 4)

Typhlocyba unca McAtee, Proc. U. S. Nat. Mus., vol. 68, art. 18, 1926, p. 8.
Ribautiana unca, Young, Bull. Univ. Kansas Sci. Bull., vol. 35, pt. 1, 1952, p. 100.
Typhlocyba surda DeLong and Johnson, Ent. News, vol. 47, no. 4, April, 1936, pp. 101-102. (new synonymy).
Ribautiana surda, Young, Bull. Univ. Kansas Sci. Bull., vol. 35, pt. 1, 1952, p. 100.

Resembling *R. piscator* in external appearance, but with a pair of processes arising from near middle of aedeagal shaft, apical processes short and without numerous spines.

Length.—3.0 mm.

Color.—Head, pronotum, and scutellum pale milky-white to light orange yellow.

Genital capsule.—Male pygofer, in lateral aspect, somewhat quadrate, dorsal angle rounded, projecting beyond ventral angle.

Internal male genitalia.—Aedeagus, with atrial processes elongate, nearly as long as shaft, evenly tapered from base to acute apices, sinuate; shaft elongate, slender on apical half, with a pair of dorsolaterally directed processes arising at or slightly below middle, apex curved toward apices of atrial processes, bearing at apex from one to three pairs of short processes which show a marked degree of variability. (Pl. LXXIV, figs. 4d, e, f, g.)

R. surda (DeLong and Johnson) is based upon a specimen of this species with the apical processes broadened toward the base, and is considered synonymous with *R. unca* (McAtee).

A series of specimens from Glen Haven, Colorado, differ from other specimens seen in having the median pair of processes arising from the base at a point lower than the aedeagal apodeme.

Numerous specimens of this species have been collected by Dr. R. H. Beamer and the author from *Corylus americana.* Other specimens have been seen with the following host labels: "vine maple," "on filbert," "alder," and "on beech."

Specimens have been seen from the following localities: *Maine:* Fryeburg, August 20; *Massachusetts:* Holliston, September 4; *New Hampshire:* Durham, September 9; *New York:* Cranberry Lake, July 25; Salem, June 27, July 27; Minetto, July 23, September 16; *Pennsylvania:* Hartstown Bog, September 12, 13, 14; Snowshoe, August 22; Northeast, July 4; *Ontario:* Ottawa, June 24, Trenton, September 30; *Tennessee:* Gatlinburg, June 29; Great Smoky Mountain National Park, September 1; *Virginia:* Glencarlyn, June 12; *Michigan:* September 23, Gogebic, August 18; *Wisconsin:* Milwaukee, June 26-July 5; Lake Geneva, June 21; *Minnesota:* Itaska County, July 16, 26, 27; Anoka County, September 21; *Illinois:* Salem, September 22; *Manitoba:* Deepdale, August 1; *Missouri:* Goodman, May 28; *Kansas:* Douglas County, May 27, 30, June 1, 7; Jefferson County, June 15; *Colorado:* Glen Haven, August 3; *Oregon:* Woodburn, October 2; Selma, June 14; *California:* Marin County, August 3; Giant Forest, July 28; Fort Dick, July 13; Leona Hights, Alameda County, August; Wild-Cat Canyon, San Pablo, Contra Costa County, May 16.

Types.—Holotype male, and paratype males and females, in the U. S. National Museum Collection; allotype female and paratypes of both sexes in the Iowa State College Collection.

Mcateeana gen. nov.

(Pl. LXXIII, fig. 4)

Type of the genus, *Empoa querci* var. *sexnotata* Van Duzee.

Fore wings.—Inner and outer apical cells short, not attaining wing apex; second apical cell much broader at apex than at base; third apical cell petiolate; wing apex smoothly rounded. (Pl. LXXIII, fig. 4h).

Hind wings.—Vein 1V branching from vein 2V near its midlength; submarginal vein absent at wing apex; both apical cells open apically; posterior branch of R fused with apical portion of vein M_{1+2}. (Pl. LXXIII, fig. 4h).

Genital capsule.—Male pygofer, in lateral aspect, with a small group of short macrosetae dorsad of outer basal angle of male plate and a few microsetae caudad of these, with posterior margin slightly inrolled and bearing a few microsetae near posterior angle on mesal surface, with awl-shaped spines scattered on posterior third, pygofer hooks wanting; male plate in ventral aspect, broadened at base, widest at basal fourth, gradually reduced to upturned apex, in lateral aspect with single macroseta near outer basal angle, a row of microsetae on dorsolateral margin of apical two thirds, others along ventrolateral margin on apical half.

Internal male genitalia.—Style elongate, slender, gradually tapering and curved laterad or dorsad, abruptly curved ventrad before apex, inner margin with several alveoli on outer margin, with a few setae near middle, and a single large seta basad of apical curve; connective Y-shaped; aedeagal articulation subterminal; aedeagus with preatrial arm well developed, aedeagal apodeme well developed, shaft not present, gonopore at base of fused portion of apically branching atrial processes.

Female.—With posterior margin of eighth abdominal sternite as shown in Pl. LXXXVII, figs. 5a, b.

The head in dorsal aspect narrower than pronotum, moderately produced, its median length not greatly exceeding length next the eye, anterior margin of crown smoothly rounded; face convex, divergent from the line of the dorsum; ocelli present; pronotum short, with lateral margins greatly diverging caudally, posterior margin shallowly emarginate.

The following species is the only representative of this genus known.

Mcateeana sexnotata (Van Duzee) (*new combination*)

(Pl. LXXIII, fig. 4)

Empoa querci var. *sexnotata* Van Duzee, Trans. San Diego Soc. Nat. Hist., vol. 2, no. 1, 1914, p. 57.
Typhlocyba querci var. *sexnotata*, McAtee, Canadian Ent., vol. 51, no. 8, 1919, pp. 225-226.
Typhlocyba sexnotata, McAtee, Proc. U. S. Nat. Mus., vol. 68, art. 18, 1926, p. 34.
Ossiannilssonia sexnotata, Young, Bull. Univ. Kansas Sci. Bull., vol. 35, pt. 1, 1952, p. 99.

Length.—3.5 mm.

Color.—Head and pronotum yellowish-white; scutellum orange-red, disc yellow; fore wings whitish hyaline, with inner half of clavus and most of brachial cell light orange-yellow, with a large brown spot in apex of brachial cell and two round black spots on clavus, one at middle, the other near apex of scutellum, with commissural vein black near apex of scutellum in some specimens, distal ends of second and third basal cells, and apical cells fumose; abdomen with dorsum black, apical margin of each segment yellow, venter yellow, male plates yellow.

Internal male genitalia.—Aedeagus with a pair of stout, forcipate, basally fused atrial processes bearing two pairs of slender, posteriorly directed, apical branches, the superior pair directed dorsocaudad, each pair crossing apically; aedeagal apodeme directed cephalad for three fourths length of preatrial arm.

Specimens labeled "sycamore", and others labeled "*Ribes*" are on hand. All specimens seen by the author are from California.

Types.—Holotype female, in California Academy of Sciences Collection; *neoallotype* male, Gilroy, California, August, 1942, R. H. Smith, here designated, and one male *paraallotype*, San Luis Obispo, August, 1942, R. H. Smith, in the Snow Entomological Cellections of the University of Kansas. Additional *paraallotype* males: one, Cucamonga, California, December 21, 1917, in the Cornell University Collection; one, Niles Canyon, California, July 15, 1916, E. P. Van Duzee, in the California Academy of Sciences Collection.

GENUS OSSIANNILSSONOLA nov. nom.

(Pls. LXXVI-LXXX)

Ossiannilssonia Young and Christian, *in* Young, Bull. Univ. Kansas Sci. Bull., vol. 35, pt. 1, 1952, pp. 97-99.

Type of the genus, *Typhlocyba berenice* McAtee, by original designation.

Fore wings.—Inner and outer apical cells short, not attaining wing apex; second apical cell much broader at apex than at base; third apical cell petiolate; wing apex smoothly rounded.

Hind wings.—Vein 1V branching from vein 2V near its mid-length; submarginal vein absent at wing apex; both apical cells open apically; posterior branch of R fused with apical portion of vein M_{1+2}.

Genital capsule.—Male plate, in ventral aspect, gradually narrowed on outer margin towards apex, occasionally with small lobe on lateral margin before apex (*O. appendiculata* and *O. phryne*), without single macroseta near outer basal angle of male plate, with a dorsal submarginal row of setae and a row of microsetae along ventrolateral margin on apical half; pygofer, in lateral aspect, with posterior margin distinct, not rounded to ventrocaudal margin, rectilinear in form; pygofer wall frequently with sclerotized bars occurring within the limits of pygofer proper, or prolonged dorsocaudad or caudad as short pygofer hooks; a group of macrosetae usually present on pygofer just dorsad of outer basal angle of male plate, with numerous small awl-shaped cuticular projections over dorsal posterior half of pygofer, and a row of microsetae on disc extending dorsocaudad from the group of macrosetae; anal hooks wanting.

Internal male genitalia.—Style elongate, slender, gradually curved laterad or dorsolaterad apically, usually without triangular preapical projection on inner margin (exceptions, *O. danae*, *O. bangsoni*, and *O. flavomarginata*), with elongate slender setae on outer margin, with a few alveoli on inner margin; connective triangular or Y-shaped; aedeagus with preatrial arm distinct, aedeagal apodeme short, well developed or not, shaft occurring as a flattened membranous structure between basal portions of a pair of forcipate atrial processes.

Female.—With posterior margin of eighth abdominal sternite usually broadly evenly rounded as in *O. berenice* (Pl. LXXXVII, figs. 6a, b), except in *O. flavomarginata* where it is strongly incised laterally forming two lateral lobes and a slightly emarginate median lobe (Pl. LXXXVII, figs. 7a, b).

Head, including the eyes, narrower than pronotum, only slightly produced medially on rounded anterior margin, median length of the crown not greatly exceeding length next the eyes, face strongly convex to slightly below antennal insertions, then slightly convex to tip of clypellus; ocelli present or absent, when present, situated on round margin between crown and face, nearer the eyes than to each other; pronotum short, but much longer than head, lateral margins greatly divergent caudally, posterior margin shallowly concave; width of pleural portion greatly exceeds width of ocellocular area.

The species are usually pale in color, with dark markings which are occasionally extensive.

Most of the species of this genus live on species of *Quercus*, but *Ulmus*, *Crataegus*, *Acer*, and *Prunus* are also host genera. None of the known North American species has been recorded from outside of this continent, but from the figures of *Typhlocyba callosa* Then, by Ribaut (1936), it appears that this species could belong to this genus, and should this be true, the range of this genus would be holarctic.

KEY TO THE SPECIES OF OSSIANNILSSONOLA

1. Male plate distinctly forked near apex 2
   Male plate not forked 3
2. With black parenthesis-shaped marks on pronotum; fore wing with narrow black lines along commissural margin to cross-veins; pygofer with posterior angle strongly produced in a broad rounded lobe. (Pl. LXXIX, fig. 2a) .... *phryne* p. 1152
   With light colored pronotum, pygofer with posterior margin nearly vertical, only slightly produced on dorsal angle. (Pl. LXXIX, fig. 1a) .... *appendiculata* p. 1150
3. Styles with apical third sharply curved mesad, a small triangular protuberance on lateral margin. (Pl. LXXX, fig. 2e), *flavomarginata* p. 1157
   Styles with apical third not curved mesad 4
4. Styles appearing truncate at apex, with small projection near apex, 5
   Styles evenly tapering to an acute apex 6
5. Triangular projection on lateral margin of style near apex; pygofer with two vertically arranged, posteriorly directed hooks on dorsal posterior margin. (Pl. LXXVIII, fig. 1) .... *bangsoni* p. 1145
   Triangular projection on mesal margin of style near apex; pygofer with two horizontally arranged, mesally directed hooks on dorsal posterior margin. (Pl. LXXVIII, fig. 5) .... *danae* p. 1149
6. Atrial processes forked near apex 7
   Atrial processes not forked 8

7. Pygofer with posterior margin nearly vertical, dorsal angle forming a broad, blunt, dorsomesally directed process. (Pl. LXXVI, fig. 1) . . . . . . *berenice* p. 1136
   Pygofer with posterior margin obliquely slanted toward base of plate, dorsal angle forming a moderately rounded projection with two mesally directed, spinelike processes. (Pl. LXXVI, fig. 2) . . . . . . *hermione* p. 1137
8. Atrial processes tumid, apical third sharply reduced, slender, thornlike 9
   Atrial processes not tumid, gradually tapering to apex 11
9. Atrial processes greatly broadened at base in posterior aspect, lateral margins nearly parallel; fore wing with entire basal half bright crimson red, without black markings. (Pl. LXXVII, fig. 3) . . . . . . *tunicarubra* p. 1141
   Atrial processes not greatly broadened at base in posterior aspect, lateral margins divergent toward apex; fore wings white to yellow with black spots in apices of inner three basal cells 10
10. Posterior margin of tumid portion of atrial processes forming nearly a right angle near middle, in lateral aspect. (Pl. LXXVII, fig. 4) . . . . . . *australis* p. 1142
    Posterior margin of tumid portion of atrial processes forming an evenly rounded semicircle, in lateral aspect. (Pl. LXXVII, fig. 2) . . . . . . *clymene* p. 1140
11. Ventral angle of pygofer directed caudally as a small thumblike lobe. (Pl. LXXVI, fig. 3) . . . . . . *volans* p. 1138
    Ventral angle of pygofer without lobe, or with lobe directed ventrad when present 12
12. Atrial processes gradually curved dorsocaudad 13
    Atrial processes abruptly bent caudad 14
13. Dorsal angle of pygofer projecting caudad beyond ventral angle as a broad quadrate process bearing two mesally directed diverging spines. (Pl. LXXVIII, fig. 2) . . . . . . *duplicata* p. 1146
    Dorsal angle of pygofer not projecting caudad as a quadrate process, but as two short fingerlike processes which cross each other. (Pl. LXXVII, fig. 1) . . . . . . *antigone* p. 1139
14. Dorsal angle of pygofer forming a broad caudally directed hook, lower half of the posterior margin S-shaped from the left side, ventral angle broadly rounded 15
    Dorsal angle of pygofer not forming a hook, posterior margin straight, ventral angle somewhat angulate 17
15. Pygofer hook large, half as deep as broad; atrial processes of aedeagus broadly flattened beyond membrane, appearing forked in posterior aspect. (Pl. LXXIX, fig. 3) . . . . . . *rossi* p. 1153
    Pygofer hook small, one third to one fourth as deep as broad; atrial processes not appearing forked in posterior aspect 16
16. Base of aedeagus greatly broadened laterally, abruptly reduced before bases of atrial processes to one third its greatest width; with sclerotized plate extending over bases of atrial processes; pygofer with two acute mesocaudally directed spines on dorsal posterior margin. (Pl. LXXX, fig. 3) . . . . . . *quadrata* p. 1155

Base of aedeagus of almost uniform width; bases of atrial processes not covered by a sclerotized plate; pygofer with only slight projections on dorsal posterior margin. (Pl. LXXIX, fig. 4) .... *knulli* p. 1154

17. Atrial processes widely separated at base, apices finely serrate. (Pl. LXXVIII, fig. 3) .... *serrula* p. 1147

Atrial processes not widely separated at base, apices smooth 18

18. Dorsal angle of pygofer excavated; fore wings milky-white, with two dark crossbands, anterior band interrupted by white scutellum. (Pl. LXXVII, fig. 5) .... *hinei* p. 1144

Dorsal angle of pygofer not excavated; fore wings with black spots only in apices of inner three basal cells 19

19. Dorsal angle of pygofer directed dorsad as a broad acutely-angled hook, ventral angle produced as a short caudally directed hook. (Pl. LXXX, fig. 1) .... *troza* p. 1156

Dorsal angle of pygofer not directed dorsad as a broad acutely angled hook, but mesocaudad as a short broad lobe; ventral angle rounded, not projecting caudad. (Pl. LXXVIII, fig. 4), *mcateei* p. 1148

Many of the species of this genus can be distinguished on the basis of color markings. The following key based on fully colored specimens will permit the determination of female specimens of a number of species, but closely colored species which are not easily distinguished have of necessity been grouped together.

Color Key to the Species of Ossiannilssonola

1. Without black or brown markings on fore wings 2

With black or brown markings, or traces of these on fore wing ... 6

2. Fore wings with crimson, or light red markings 3

Fore wings white or orange-yellow 4

3. Anterior half of fore wings bright crimson-red, white on remainder of dorsum .... *tunicarubra* p. 1141

Entire fore wing colored light red; head, pronotum, and scutellum bright yellow .... *flavomarginata* type III p. 1157

4. Dorsum white to cream colored .... *flavomarginata* type V p. 1158

Dorsum orange-yellow 5

5. Length 3.25 mm. .... *flavomarginata* type IV p. 1158

Length 3.5-3.75 mm. .... *serrula* p. 1147

6. Dark markings extensive, not restricted to three spots anterior to cross veins 7

Dark markings not extensive, restricted to three spots, one in each of inner three basal cells just anterior to cross veins 13

7. Dark markings in the form of two transverse bands 8

Dark markings not as two transverse bands 10

8. Anterior band near base of fore wings, interrupted by white scutellum .... *hinei* p. 1144

Anterior band near middle of fore wing 9

9. Posterior band solid color . . . . *volans* p. 1138
   Posterior band made up of six distinctly separated spots, ground color of dorsum milky-white, resembling forms of *Empoa,* casta group . . . . *duplicata* p. 1146
10. Dark markings covering entire dorsum . . . . *flavomarginata* type II p. 1157
    Dark markings less extensive 11
11. Dark markings forming a brown saddle over fore wings anterior to cross veins, sometimes limited in extent to only the apical third of inner three basal cells and a stripe along claval suture, *appendiculata* (in part) p. 1150
    Dark markings otherwise 12
12. With dark parenthesis-shaped markings on pronotum which continue posteriorly to cross veins as a black commissural line, *phryne* p. 1152
    With dark markings in apical cells along cross veins and apical veins . . . . *berenice* (in part) p. 1136
13. Ground color orange-yellow, *antigone, berenice* (in part), *quadrata, rossi,* and *knulli*
    Ground color white to light yellow 14
14. With a flavescent stripe along commissural suture 15
    Without such a stripe 16
15. With row of black spots slanting obliquely toward apex of wing, *flavomarginata* type I p. 1157
    With row of black spots nearly transverse . . . . *australis* (in part) p. 1142
16. Ground color cream, dark brown spots filling most of outer fourth or fifth of inner three basal cells, irregular in intensity, *appendiculata* (in part) p. 1150
    Ground color white, dark spots smaller, of even intensity, *danae, clymene, hermione, troza, mcateei, bangsoni, australis* (in part)

Ossiannilssonola berenice (McAtee) (*new combination*)

(Pl. LXXVI, fig. 1)

Typhlocyba berenice McAtee, Proc. U. S. Nat. Mus., vol. 68, art. 18, 1926, p. 38.
Ossiannilssonia berenice, Young, Bull. Univ. Kansas Sci. Bull., vol. 35, pt. 1, 1952, p. 99.

Resembling *O. hermione* in shape of the aedeagus, but differing in lacking spinelike hooks on mesal margin of dorsal angle of pygofer, and in having posterior margin of pygofer vertical.

Length.—3.25-3.5 mm.

Color.—Head, pronotum, and scutellum yellow to orange-yellow; fore wings light yellow to uniform deep orange-yellow anterior to cross veins, lighter apically, veins sometimes red-orange, wing subhyaline to cross veins, hyaline apically, with a transverse row of three black spots in apices of inner three basal cells separated from veins by a narrow yellow margin; apical cells smoky along veins and outer margins, forming indistinct spots in apical cells three and four; abdomen with dorsal segments black medially, yellow to orange-yellow laterally, venter yellow, male plate yellow. Black spots sometimes reduced or missing.

Genital capsule.—Male pygofer, in lateral aspect, with posterior margin vertical, dorsal angle forming a broad blunt dorsally directed projection, ventral angle nearly a right angle, a few macrosetae on posterior margin near dorsal angle.

Internal male genitalia.—Aedeagus, with atrial processes elongate, slender, apices almost meeting medially, in posterior aspect outlining a rectangle, a single pair of slender subapical processes arising from the posterior margin and curving mesocaudad, crossing at outer fourth; aedeagal apodeme one fourth length of atrial processes, directed cephalad on apical third in lateral aspect.

Several thousand specimens of this species have been collected by the author from *Quercus alba* in Milwaukee, Wisconsin, in association with *O. australis* and *O. danae.*

Specimens have been seen from the following localities: *Ontario:* Toronto, August 8; *Massachusetts:* Wood's Hole, July 10; *Connecticut:* New Haven, July 4; *New York:* Ithaca, July 8; *District of Columbia:* Rock Creek, June 19; *Virginia:* Arlington, October 12; Mountain Lake, July 17; *North Carolina:* Franklin, August 17; *Illinois:* Thornton, September 7; *Wisconsin:* Milwaukee, June 26-July 7; *Minnesota:* Ramsay County, August 30; St. Paul, June 27.

Types.—Holotype male and one male paratype in the U. S. National Museum Collection, Washington, D. C.; a female specimen from Milwaukee, Wisconsin, June 30, 1950, taken in copula with a male of this species, here designated *neoallotype,* in the Snow Entomological Collections of the University of Kansas.

Ossiannilssonola hermione (McAtee) (*new combination*)

(Pl. LXXVI, fig. 2)

Typhlocyba hermione McAtee, Proc. U. S. Nat. Mus., vol. 68, art. 18, 1926, pp. 38-39.

Ossiannilssonia hermione, Young, Bull. Univ. Kansas Sci. Bull., vol. 35, pt. 1, 1952, p. 99.

Resembling *O. berenice* in shape of aedeagus, but differing in having two spinelike hooks on mesal margin of dorsal angle of pygofer, and in having ventrocaudal margin oblique.

Length.—4.0 mm.

Color.—Head, pronotum, and scutellum white to yellowish-white; fore wings whitish-hyaline with three black spots anterior to cross veins, apical cells slightly fumose; abdomen white, male plates white.

Genital capsule.—Male pygofer, in lateral aspect, with ventrocaudal margin obliquely slanted from base of plate to dorsal angle, ventral angle directed ventrad in a lobe, dorsal angle appearing as a moderately rounded projection with two vertically arranged toothlike processes directed mesad from inner margin, upper process one third length of lower.

Internal male genitalia.—Aedeagus with atrial processes elongate, slender, gradually reduced toward apex, curving ventromesad and continuing anteriorly, a pair of short subapical processes arising from dorsal surface; aedeagal apodeme a short apically enlarged shaft directed cephalodorsad.

The following specimens have been seen by the author: holotype male, Washington, D. C., July 2; paratype male, Madison, Wisconsin, August 11; paratype male, Bluemont, Virginia, July 1; one male, Northeast, Pennsylvania, July 7.

Types.—Holotype male and paratype males, in the U. S. National Museum Collection.

Ossiannilssonola volans (McAtee) (*new combination*)

(Plate LXXVI, fig. 3)

Typhlocyba querci var. *volans* McAtee, Canadian Ent., vol. 51, no. 8, 1919, pp. 225-226.
Typhlocyba gillettei var. *volans*, McAtee, Proc. U. S. Nat. Mus., vol. 68, art. 18, 1926, p. 28.

Resembling *O. hinei* in color markings, but differing in having anterior band at middle of fore wing; ventrocaudally directed thumblike lobe on pygofer distinguishing it from other species in the genus.

Length.—3.75-4.0 mm.

Color.—Head, pronotum, and scutellum light yellow; fore wing light yellow overlaid with variable dark brown markings which usually form two broad bands, one over the cross veins forming a broad inverted V, the other V-shaped, arising at the middle of clavus and slanting obliquely forward to costal margin; some specimens from the Great Smoky Mountains taken on *Prunus pennsylvanicus* differ from this pattern by having a longitudinal band connecting these transverse bands, others by having only traces of this band; specimens collected from *Ulmus fulva* differ by having the anterior band transverse and posterior band nearly transverse; apical cells fumose; abdomen with black markings on dorsum, venter yellow, plates yellow.

Genital capsule.—Male pygofer, in lateral aspect, with dorsal angle a broad rounded lobe projecting caudally beyond ventral angle, without hooks, ventral angle produced caudally into a thumb-like lobe, a number of macrosetae scattered submarginally along dorsal two thirds of posterior margin.

Internal male genitalia.—Aedeagus, with atrial processes elongate, slender, unbranched, in caudal aspect describing an oval, apices sharply directed ventromesad and crossing near tip, aedeagal apodeme reduced to a short anteriorly directed arm.

Several hundred specimens have been collected by the author in Milwaukee, Wisconsin, and in Lawrence, Kansas, from *Ulmus fulva.* Additional specimens seen are from the following localities: *Ontario:* Vineland Station, August 2; *New York:* Monroe, July 10; Batavia, July 15; Indian Lake, Sabael, August 25; *Pennsylvania:* Hartstown Bog, June 26; *Tennessee:* Great Smoky Mountain National Park, July 30, September 1; *Michigan:* Agricultural College, July 7; *Wisconsin:* Marshfield, August 20; *Milwaukee,* June 26-July 7; *Utah:* Richfield, July 15; *Kansas:* Douglas County, June 9, August; *Oregon:* Portland, August 1; Independence, June 21; Azalea, September; McMinville, August 15; *California:* Placer County, June 16.

One pair of paratype specimens of *Typhlocyba gillettei* var. *casta* McAtee, bearing the label "Douglas Co. Ks. August 1923 W. Robinson" are specimens of this species like those collected on *Ulmus fulva.*

Types.—Mr. M. E. Neary, Entomologist for the Nova Scotia Department of Agriculture and Marketing, informs me that the holotype female of this species was destroyed by fire in June, 1946.

Because of the lack of material from the type locality, and the diversity of color pattern found in the specimens on hand, the author considers it best not to erect a neotype for this species until specimens from the type locality are available.

Ossiannilssonola antigone (McAtee) (*new combination*)

(Pl. LXXVII, fig. 1)

Typhlocyba antigone McAtee, Proc. U. S. Nat. Mus., vol. 68, art. 18, 1926, pp. 35-36.
Ossiannilssonia antigone, Young, Bull. Univ. Kansas Sci. Bull., vol. 35, pt. 1, 1952, p. 99.
Typhlocyba eurydice var. *distincta* McAtee, Proc. U. S. Nat. Mus., vol. 68, art. 18, 1926, p. 38. (*new synonymy*)

Resembling *O. berenice* externally, but distinguished by having two fingerlike processes at dorsal angle of pygofer, and in not having atrial processes of aedeagus branching near apex.

Length.—3.5 mm.

Color.—Head, pronotum, and scutellum pale yellow to orange-yellow; fore wing pale yellow to orange-yellow, subhyaline to cross veins, apex hyaline with indistinct black spots in apices of inner three basal cells, veins in some specimens orange-red, in others almost white; abdomen yellow, plates yellow.

Genital capsule.—Male pygofer, in lateral aspect, with posterior margin sinuate, dorsal angle produced in two short fingerlike processes directed mesocaudad and crossing each other, ventral angle forming an angular lobe projecting caudally as much as dorsal processes, without macrosetae dorsad of outer basal angle of plate, with two or three macrosetae on dorsal posterior margin.

Internal male genitalia.—Aedeagus with atrial processes short, stout, half as long as base in lateral aspect, with apices directed toward each other and slightly caudad, describing almost a complete circle in caudal aspect; aedeagal apodeme short, as broad as long in lateral aspect.

Only a few specimens of this species have been seen. The author has taken a single pair from *Quercus alba* in Jefferson County, Kansas, in association with *O. tunicarubra*, and a single male from the same host in Milwaukee, Wisconsin. Other specimens seen are from the following localities: *Connecticut:* New Haven, July 4; *Maryland:* Beltsville, June 23; *Delaware:* Wilmington, June 20; *Virginia:* Glencarlyn, June 12, 16, 20; Arlington, June 14; Mountain Lake, July 23; *Illinois:* Monticello, June 11; *Wisconsin:* Milwaukee, July 3; *Kansas:* Jefferson County, June 15.

The holotype and six paratype males have been seen.

Types.—Holotype male, in the Illinois State Natural History Survey Collection; paratypes in the U. S. National Museum, and DeLong Collections; a female specimen collected by the author in Jefferson County, Kansas, June 15, 1950, here designated *neoallotype*, in the Snow Entomological Collections of the University of Kansas.

The holotype specimen of *Typhlocyba eurydice* var. *discincta* McAtee, from Beltsville, Maryland, has been dissected and found to be a specimen of *O. antigone.*

Ossiannilssonola clymene (McAtee) (*new combination*)

(Pl. LXXVII, fig. 2)

Typhlocyba clymene McAtee, Proc. U. S. Nat. Mus., vol. 68, art. 18, 1926, pp. 36-37.

Ossiannilssonia clymene, Young, Bull. Univ. Kansas Sci. Bull., vol. 35, pt. 1, 1952, p. 99.

Resembling *O. australis* in external appearance and in the shape of the aedeagus, but differing in having the ventral angle of the pygofer rounded apically and slightly projecting caudad, and in having ventral margin of atrial processes of aedeagus rounded, not angular.

Length.—3.5-3.75 mm.

Color.—Head, pronotum, and scutellum white to light yellow; fore wings pale yellowish-white with a transverse row of three black spots in apices of inner three basal cells, apical cells hyaline; abdomen white, male plates white.

Genital capsule.—Male pygofer, in lateral aspect, with posterior margin nearly vertical, dorsal and ventral margins nearly parallel, dorsal and ventral angle evenly rounded, not produced, a row of macrosetae along dorsal half of posterior margin.

Internal male genitalia.—Aedeagus with atrial processes short, greatly enlarged to outer third, sharply reduced on outer third to slender elongate acute apices directed ventromesad and posteriorly and crossing at apex, processes appearing cordate in caudal aspect; aedeagal apodeme slender, as long as apical portion of atrial processes, directed anteriorly; aedeagus with posterior margin slightly sinuate, posterior margin of atrial processes smoothly rounded, not angulate.

A short series of three females and four males from Vineland Station, Ontario, collected from *Quercus alba* by W. L. Putman, July 8, 1931, and the holotype, McLean, New York, July 14, 1919, are the only specimens known to exist. The aedeagus of the holotype has been lost.

Types.—Holotype male, in U. S. National Museum Collection, Washington, D. C. A female specimen from the above mentioned series, here designated *neoallotype*, in the Canadian National Collection, Ottawa, Canada.

Ossiannilssonola tunicarubra (Gillette) (*new combination*)

(Pl. LXXV, fig. 3)

Typhlocyba tunicarubra Gillette, Proc. U. S. Nat. Mus., vol. 20, no. 1138, 1898, pp. 752-753.
Erythroneura tunicarubra, Van Duzee, Check List of Hemiptera (excepting the Aphididae, Aleurodidae and Coccidae) of America North of Mexico, 1916, p. 77.
Ossiannilssonia tunicarubra, Young, Bull. Univ. Kansas Sci. Bull., vol. 35, pt. 1, 1952, p. 99.

Resembling *O. clymene* and *O. australis* in structure of male genitalia, but easily distinguished from these species by having anterior half of fore wings bright crimson red, and bases of atrial processes of aedeagus enlarged in caudal aspect.

Length.—3.5-4.0 mm.

Color.—Head, pronotum, and scutellum bright lemon-yellow; fore wings from base to short distance before cross veins crimson red, forming a sharply distinct transverse line posteriorly, remainder of wing yellow, apical cells hyaline; abdomen, dorsum black with outer margins of segments yellow, venter bright lemon-yellow, plates yellow.

Genital capsule.—Male pygofer, in lateral aspect, with posterior margin vertical, dorsal margin horizontal, ventral margin obliquely slanting dorsad, dorsal and ventral angles evenly rounded, not produced except for small tooth on mesal margin near dorsal angle, a row of macrosetae along dorsal half of posterior margin.

Internal male genitalia.—Aedeagus with atrial processes short, greatly enlarged laterad on basal third, slightly reduced on median third, greatly reduced to slender, elongate, acute apices directed ventromesad on outer third and crossing at apex, in caudal aspect almost quadrate in outline; aedeagal apodeme slender, as long as apical third of atrial processes, directed ventrocephalad, posterior margin in lateral aspect strongly sinuate, margin of atrial processes smoothly rounded, not angulate.

A short series of specimens of this species were collected from *Quercus alba* by the author in Jefferson County, Kansas, June 15, 1950, including a number of teneral females which show only a slight tinge of pink on the anterior half of the fore wings, and three males of intermediate color intensity. Final instar nymphs collected with these bear wing pads which are also colored pink.

Specimens have been seen from the following localities: *New York:* Conesus Lake, July 16; Ithaca, July 22; *Pennsylvania:* Point Royal, July 24; *Virginia:* Mountain Lake, July 24; *Tennessee:* Knoxville, June 24; Clarksville, July 5; *Ohio:* Delaware County, July 4, 8, 2, 27, August 3; *Michigan:* Agricultural College, July 15; *Wisconsin:* Lake Geneva, July 21; *Iowa:* Ames, July 26; *Kansas:* Douglas County, August; Jefferson County, June 15; Atchison, July 8.

Types.—Holotype female, in the U. S. National Museum Collection, Washington, D. C.; a male specimen compared with holotype, collected by the author in Jefferson County, Kansas, June 15, 1950, here designated *neoallotype*, is in the Snow Entomological Collections of the University of Kansas.

Ossiannilssonola australis (Walsh) (*new combination*)

(Pl. LXXVII, fig. 4)

Erythroneura australis Walsh, The Prairie Farmer, (n. s.), vol. 10, no. 10, September 6, 1862, p. 149.
Typhlocyba australis, Woodworth, Psyche, vol. 5, no. 157-159, 1889, p. 214.

Empoa australis, Van Duzee, Check List of Hemiptera (excepting the Aphididae, Aleurodidae and Coccidae) of America North of Mexico, 1916, p. 77.
Typhlocyba nicarete McAtee, Proc. U. S. Nat. Mus., vol. 68, art. 18, 1926, p. 36. (*new synonymy*)
Ossiannilssonia nicarete, Young, Bull. Univ. Kansas Sci. Bull., vol. 35, pt. 1, 1952, p. 99.

This species is not *Empoasca australis* Froggatt (1918), which was subsequently moved into *Typhlocyba* (Myers, 1921), renamed *Typhlocyba froggatti* (Baker, 1925), as a secondary homonym, and has recently been moved to *Edwardsiana* (China, 1950). Synonymy of that species is given on p. 1220 of this paper.

Resembling *O. clymene* externally in lightly colored specimens, and in shape of aedeagus, but differs in having the ventral angle of the pygofer slightly angular and reduced cephalad, and in having ventral margin of atrial processes of aedeagus angular near middle.

Length.—3.5 mm.

Color.—Head, pronotum, and scutellum light yellow to yellow; fore wings show marked progressive coloration from whitish-hyaline with only veins yellow, to orange-yellow or deep orange-yellow with longitudinal red band along commissural margin from base of wing to cross veins on inner half of clavus, with a transverse row of three sharply defined black spots in apices of inner three basal cells; abdomen with dorsum black, outer margin of each segment yellow, male plates yellow.

Genital capsule.—Male pygofer, in lateral aspect, with posterior margin slightly convex, with dorsal angle evenly rounded, ventral angle reduced forming a slight projection on ventral margin, a row of macrosetae along dorsal half of posterior margin.

Internal male genitalia.—Aedeagus with atrial processes short, stout, tumid on basal two thirds, sharply reduced on outer third to a slender elongate acute apex directed ventromesad posteriorly, in caudal aspect somewhat cordate in outline; aedeagal apodeme slender, as long as outer third of atrial processes, directed anteriorly; posterior margin of aedeagus nearly straight to middle of atrial processes, then abruptly curved dorsocephalad at nearly a right angle.

Numerous specimens of this species have been collected by the author from *Quercus alba* in Milwaukee, Wisconsin. Another large series of this species from Illinois was seen in the Illinois Natural History Survey Collection. *Quercus macrocarpa* has also been recorded as a host plant.

The original description of *Erythroneura australis* Walsh (1862) (nec. *australis* Froggatt, 1918) indicates that this species belongs in the genus *Ossiannilssonola.* In the absence of a type specimen the author has concluded, after considering all of the species in this genus which might fit the original description, that the majority of specimens of the species *Typhlocyba nicarete* McAtee (1926), which is abundant in Illinois, the type locality of *australis,* fit the limited description more nearly than do specimens of any other species seen.

Specimens have been seen from the following localities: *New York:* Salem, July 27, 28; *Pennsylvania:* Greenberg, August 17; *Virginia:* Blacksburg, Glencarlyn, June 12, 16, 20; Mountain Lake, July 8-26; near District of Columbia, June 15; *Washington, D. C.; Tennessee:* Clarksville, July 11, 29; Tullahoma, August 3; *Ohio:* Delaware County, August 27; Wooster, July 5; Shawnee Forest, June 9; *Minnesota:* St. Paul, June 16, 22, August 6, 11; *Wisconsin:* Milwaukee, June 27; Polk County; *Illinois:* Tinley Park, September 8; Olmsted, July 15; Urbana; Pere Marquette State Park, August 12; Decatur, August; Bell Smith Springs, July 16; Bellwood, June 21; *Missouri:* Goodman, May 28; *Arkansas:* Siloam Springs, May 26; *Oklahoma:* LeFlore County, May 24; *Louisiana:* Ida, June 6.

Types.—The holotype male of *Typhlocyba nicarete* McAtee, White Heath, Illinois, June 24, 1916, here designated *neotype* of *Ossiannilssonola australis* (Walsh), in the Illinois State Natural History Survey Collection; a female specimen taken in copula with a male of this species, July 3, 1950, Milwaukee, Wisconsin, by the author, here designated *neoallotype,* in the Snow Entomological Collections of the University of Kansas.

Ossiannilssonola hinei (Knull) (*new combination*)

(Pl. LXXVII, fig. 5)

Typhlocyba hinei Knull, Ohio. J. Sci., vol. 44, no. 6, 1944, p. 272.
Ossiannilssonia hinei, Young, Bull. Univ. Kansas Sci. Bull., vol. 35, pt. 1, 1952, p. 99.

Resembling *O. volans* in outward appearance, but with anterior crossband at base of fore wings interrupted by white scutellum, and with dorsal angle of pygofer excavated in lateral aspect.

Length.—3.5-4.0 mm.

Color.—Head, pronotum, and scutellum chalky white; fore wings chalky white, subhyaline, with two transverse chocolate-brown bands, one at base of wings interrupted by white scutellum, the other over cross veins formed by a row of four spots in apices of basal cells, veins between spots white, size of spots progressively reduced from inner to outer cell, apical cells whitish-hyaline; abdomen yellow, pygofer yellow.

Genital capsule.—Male pygofer, in lateral aspect, with posterior margin vertical on lower two thirds, dorsal third shallowly excavated, dorsal margin broadly produced, with dorsal angle ending in a short, mesally directed spine, ventral angle forming an angular ventrally directed lobe, several submarginal macrosetae near middle of posterior margin.

Internal male genitalia.—Aedeagus with atrial processes elongate, slender, gradually tapering toward apex, curved ventromesad caudally and crossing at apices, in posterior aspect nearly describing a circle; aedeagal apodeme broadly joined to base, enlarged apically into a smoothly rounded club.

According to Mrs. J. N. Knull (1944) this species occurs on *Quercus alba* in association with *O. tunicarubra.*

Specimens have been seen from the following localities: *Ohio:* Delaware County, June 25, July 2, 4, 5; *Tennessee:* Clarksville, July 1; *North Carolina:* Franklin, August 17.

Types.—Holotype female and female paratypes, in the collection of Mrs. J. N. Knull, Columbus, Ohio; one paratype female, in the Herbert Osborn Collection of the Ohio State University; a male specimen, Delaware County, Ohio, July 5, 1945, D. J. and J. N. Knull, here designated *neoallotype,* three *paraallotype* males from Delaware County, Ohio, July 2, 5, 1945, and July 4, 1947, D. J. and J. N. Knull, in the Knull Collection; five *paraallotype* males, Delaware County, Ohio, July 5, 1945 and July 4, 1947, in the Snow Entomological Collections of the University of Kansas.

In his revision of the genus Typhlocyba, (1926), McAtee makes reference to a collection record by Mrs. Annie Trumbull Slosson (1906) from Mount Washington, New Hampshire, of *T. nitidula* (Fabricius), a synonym of *T. bifasciata* Boheman, and on the basis of this record described it as doubtfully occurring in North America, suggesting that the Slosson record might be based on one of the varieties of *Typhlocyba gillettei* or *T. cymba.* It is the opinion of the present author that this record was more likely based upon a specimen of *O. hinei* which was described subsequently, since no specimens of *T. bifasciata* Boheman (nec. *bifasciata* Gillette and Baker, 1895) have been seen from North America.

Ossiannilssonola bangsoni sp. nov.

(Pl. LXXVIII, fig. 1)

Resembling *O. troza* in external appearance, but differs by bearing two short posteriorly-directed spinelike processes on dorsal angle of pygofer.

Length.—3.75 mm.

Color.—Head, pronotum, and scutellum yellowish-white; fore wing yellow with veins lemon yellow, subhyaline to cross veins, apex hyaline and slightly fumose, a transverse row of three black spots in apices of inner three basal cells.

Genital capsule.—Male pygofer, in lateral aspect, with posterior margin convexly rounded, dorsal angle produced into a short acute caudally directed hook, a blunt triangular process arising from the mesal margin near dorsal third of posterior margin and directed mesocaudad, ventral angle reduced to a small slightly angular ventrally directed lobe, without macrosetae near outer basal angle of plate, a few macrosetae on posterior margin along concavity between processes.

Internal male genitalia.—Style with apex appearing somewhat truncate, with small triangular projection on lateral margin near apex, aedeagus with base greatly enlarged, atrial processes shorter than base, gradually narrowed from base to apex, directed ventromesad posteriorly, nearly meeting at apex, in lateral aspect with ventral margin of basal two thirds produced medially forming nearly a right angle, apical third abruptly recurved ventrad; aedeagal apodeme reduced to a broad triangular anteriorly directed process in lateral aspect.

This species is known from two male specimens both of which were taken at light, and was doubtfully referred to as *O. quadrata* (DeLong and Johnson) by Medler (1942).

Types.—Holotype male, Berea, Kentucky, July 4, 1941, J. S. Bangson, in the U. S. National Museum Collection; one paratype male, Ramsey County, Minnesota, U. Farm Light, July 8, 1921, collected by Wm. E. Hoffman, in the University of Minnesota Collection. Since its description by Medler, and prior to its being sent to the author, the body of the paratype was lost from the point, but the dissection of the abdomen is complete, and in view of the clear description of the specimen by Dr. Medler which agrees in every particular with that of the holotype, it has been made a paratype even though it is not now complete.

Ossiannilssonola duplicata (McAtee) (*new combination*)

(Pl. LXXVIII, fig. 2)

Typhlocyba duplicata McAtee, Proc. U. S. Nat. Mus., vol. 68, art. 18, 1926, pp. 16-17. (nec. *T. duplicata* Jacobi, 1941) (*Typhlocyba jacobii,* nom. nov. for *Typhlocyba duplicata* Jacobi, see p. 1107.

Ossiannilssonia duplicata, Young, Bull. Univ. Kansas Sci. Bull., vol. 35, pt. 1, 1952, p. 99.

Resembling *Empoa casta* in color pattern, but with ground color milky white, and without macroseta near base of plate; dorsal angle of pygofer produced as a broad distinctly quadrate process.

Length.—3.0 mm.

Color.—Head, pronotum, and scutellum milky white to light yellowish white; fore wings milky white, with brown markings forming two transverse bands, one near middle of wing variable in width from a trace of a line in partly teneral specimens to a band one fourth the width of wing, the other band over cross veins made up of six spots, one in each of the inner three basal and first, second, and fourth apical cells; abdomen, dorsum black with apical half of each segment white to yellow; venter yellow, plates light yellow.

Genital capsule.—Male pygofer, in lateral aspect, with posterior margin sinuate on lower two thirds, dorsal third produced dorsocaudad beyond ventral angle as a broad quadrate process bearing two mesally directed diverging spines, ventral angle directed ventrad in a broad lobe slightly constricted near apex, a few macrosetae along posterior margin of quadrate process.

Internal male genitalia.—Aedeagus with atrial processes elongate, broad at base, gradually reduced to acute apices, outer margins quadrate from posterior aspect, apices directed mesad toward each other, widely separated, in lateral aspect sinuate, curved anteriorly near middle, apex directed dorsad; aedeagal apodeme similar to that of *O. hinei,* enlarged apically.

Several hundred specimens of this species were collected by the author from *Crataegus* sp. in Milwaukee, Wisconsin, June 26-July 4. The type series, from Toronto, Ontario, August 8, the only other specimens known, have been seen by the author.

Types.—Holotype male, allotype female, and female paratypes, in the U. S. National Museum Collection.

This species shows the same type of color variability due to varying degrees of maturity, as *O. appendiculata, O. volans,* species of *Empoa,* and heavily marked species of *Typhlocyba.*

Ossiannilssonola serrula (Ross and DeLong) (*new combination*)

(Pl. LXXVIII, fig. 3)

Typhlocyba serrula Ross and DeLong, Ohio J. Sci., vol. 49, no. 3, 1949, pp. 117-118.

Ossiannilssonia serrula, Young, Bull. Univ. Kansas Sci. Bull., vol. 35, pt. 1, 1952, p. 99.

Resembling *Typhlocyba niobe* and *T. persephone* in outward appearance, but distinguished from these by its larger size and absence of macrosetae on outer basal angle of male plate; distinguished from other species of *Ossiannilssonola* by lacking brown markings anterior to cross veins in inner three basal cells, and by having apices of atrial processes of aedeagus serrate.

Length.—3.5-3.75 mm.

Color.—Head, pronotum, and scutellum light yellow; fore wings sulfur yellow, yellow-orange to nearly red-orange in some specimens, subhyaline to shortly before cross veins, without black or brown spots anterior to cross veins, areas occupied by spots in other species hyaline; apical cells hyaline; apical veins sulfur yellow; hind wing with veins yellow; abdomen and plates entirely yellow.

Genital capsule.—Male pygofer, in lateral aspect, with posterior margin straight, slightly slanting toward base of plate; dorsal angle rounded, with a short, acute, dorsomesally directed spine, another similar spine on mesal margin, slightly lower; ventral angle a broad evenly rounded ventrally projecting lobe, a few slightly submarginal macrosetae near dorsal posterior margin.

Internal male genitalia.—Aedeagus with atrial processes elongate, slender, apices almost meeting mesally, in posterior aspect diverging to outer third, then broadly curved mesad toward each other, finely serrate at apex, in lateral aspect apical third bent ventrocaudad, processes joining base of aedeagus at an acute angle; aedeagal apodeme short, curving caudad, closely appressed to base of aedeagus.

A large series of specimens has been collected by the author from *Acer saccharum* in association with the similarly colored species *Typhlocyba niobe*, *T. persephone*, *T. athene*, and *Edwardsiana lethierryi*. Specimens have been seen from Gatlinburg, Tennessee, June 21, 28; Milwaukee, Wisconsin, June 28-July 5; and the type series from Waynesburg, Pennsylvania, July 17; and North Bloomfield, Pennsylvania, July 16.

Types.—Holotype male, allotype female, and female paratypes, in the DeLong Collection, Columbus, Ohio; one male paratype, in the Illinois State Natural History Survey Collection.

Ossiannilssonola mcateei sp. nov.

(Pl. LXXVIII, fig. 4)

Resembling *O. danae* in external appearance, but with apex of style acute, not truncate; pygofer with dorsal angle a broad blunt projection.

Length.—3.5 mm.

Color.—Head, pronotum, and scutellum pale white to light yellow; fore wing with a transverse row of three black spots in apices of inner three basal cells, apical cells slightly fumose; abdomen white, male plates white.

Genital capsule.—Male pygofer, in lateral aspect, with posterior margin nearly transverse, dorsal angle produced into a broad blunt mesally directed projection, ventral angle somewhat angular, apically rounded, a few macrosetae on dorsocaudal margin.

Internal male genitalia.—Style with acute apex; aedeagus with atrial processes slender, elongate, sharply bent ventromesad caudally, crossing near apex, in caudal aspect quadrate, in lateral aspect evenly curving dorsad to middle then sharply bent ventrocaudad; aedeagal apodeme short, indistinct.

This species was first recorded under the name *Typhlocyba eurydice* by McAtee (1926), from a male specimen from Odenton, Maryland, July 12, 1914, which was made a paratype of *eurydice*. The holotype, allotype, and paratype females of *eurydice* from Beltsville, Maryland, June 23, 1916, seen by the author, are specimens of *O. danae* agreeing with the holotype of that species. On the basis of specimens compared with the type, Ross and DeLong (1949) published a description of *eurydice* which agrees with the holotype. The original descriptions of both species occur on p. 37 (McAtee, 1926), but since the description of *O. danae* precedes that of *O. eurydice*, the latter is here recognized as a synonym of *O. danae* (McAtee).

Types.—Holotype male, Odenton, Maryland, July 12, 1914, W. L. McAtee, (paratype of *T. eurydice*) in the U. S. National Museum Collection, Washington, D. C.; allotype female, and one pair of paratypes, Bell Smith Springs, Illinois, July 16, 1947, L. J. Stannard, from *Quercus alba*, and two male paratypes, Palos Park, Illinois, June 22, 1949, Ross and Stannard, from *Quercus alba*, in the Illinois State Natural History Survey Collection; one female and two male paratypes, "Ohio Pl.," Pennsylvania, July 19, 1919, D. M. DeLong, and one pair of paratypes, Northeast, Pennsylvania, July 4, 1918, D. M. DeLong, in the Collection of D. M. DeLong, Columbus, Ohio. One male, from Berea, Kentucky, June 28, 1941, J. S. Bangson, is recognizable as this species, but is in too poor condition to be made a paratype.

Ossiannilssonola danae (McAtee) (*new combination*)

(Pl. LXXVIII, fig. 5)

Typhlocyba danae McAtee, Proc. U. S. Nat. Mus., vol. 68, art. 18, 1926, p. 37.
Typhlocyba eurydice McAtee, *op. cit.*, pp. 37-38. (*new synonymy*)
Ossiannilssonia danae, Young, Bull. Univ. Kansas Sci. Bull., vol. 35, pt. 1, 1952, p. 99.
Ossiannilssonia eurydice, loc. cit.

Resembling *O. mcateei* in external appearance, but with apex of style appearing truncate; pygofer with dorsal angle acute and with two acute horizontally arranged spines visible in caudal aspect.

Length.—3.5 mm.

Color.—Head, pronotum, and scutellum milky white; fore wings milky white, subhyaline nearly to cross veins, with a transverse row of three indistinct brown spots in apices of inner three basal cells; abdomen white; male plate white.

Genital capsule.—Male pygofer, in lateral aspect, with posterior margin obliquely slanted from dorsal angle to base of plate, dorsal angle produced in an acute mesally-directed spine, a similar spine arising from the mesal margin, ventral angle a large tongue-shaped lobe arising from mesal margin near dorsal third of pygofer, a few macrosetae on posterior margin of dorsal angle.

Internal male genitalia.—Style with a sharp subapical triangular projection on mesal margin; aedeagus with atrial processes elongate, slender, sharply bent ventromesad posteriorly, crossing near apex, strongly divergent on basal half, apical halves bent at right angles toward each other, directed ventrocaudad; aedeagal apodeme elongate, slender, curving dorsocephalad.

A large series of specimens of this species has been collected by the author from *Quercus alba* in Milwaukee, Wisconsin, in association with *O. berenice* and *O. australis.*

The synonymy of this species is discussed under *O. mcateei*, pages 1148-1149.

Specimens have been seen from the following localities: *New York:* Conesus Lake, July 16; *Maryland:* Beltsville, June 23; *Virginia:* Glencarlyn, June 12, 16, 20, 23; *Wisconsin:* Milwaukee, June 30-July 7; *Illinois:* Palos Park, June 22.

Types.—Holotype male, allotype female, and a pair of paratypes from Conesus Lake, New York, in the Snow Entomological Collections of the University of Kansas; nine paratypes from Glencarlyn, Virginia, in the U. S. National Museum Collection. All type specimens have been seen.

Ossiannilssonola appendiculata (Malloch) (*new combination*)

(Pl. LXXIX, fig. 1)

Typhlocyba appendiculata Malloch, Canadian Ent., vol. 52, no. 4, 1920, p. 95.
Ossiannilssonia appendiculata, Young, Bull. Univ. Kansas Sci. Bull., vol. 35, pt. 1, 1952, p. 99.
Typhlocyba gillettei var. *sellata* McAtee, Proc. U. S. Nat. Mus., vol. 68, art. 18, 1926, p. 29. (*new synonymy*)
Typhlocyba querci var. *sellata,* Young, Bull. Univ. Kansas Sci. Bull., vol. 35, pt. 1, 1952, p. 103.

Resembling *O. phryne* in having male plate bilobed near apex, but differing by not having black or brown markings on head, pronotum, or scutellum; pygofer with posterior margin almost vertical.

Length.—3.5 mm.

Color.—Head, pronotum, and scutellum light yellow; fore wings with ground color light yellow, subhyaline to near cross veins; with variable amounts of brown color forming rather indistinct patterns, lightly colored specimens with brown markings in outer fourth of inner three basal cells forming almost a solid band, with a dash of brown along basal half of claval suture, color irregular in intensity, progressively increasing in area, darkly marked specimens with most of the wing anterior to cross veins brown, a yellow semicircle along basal third of costal vein and another along middle of costal vein extending inward to middle of third basal cell, apices of third and fourth basal cells yellow; apical cells hyaline, slightly fumose.

Genital capsule.—Male pygofer, in lateral aspect, with posterior margin almost vertical, slightly projecting on dorsal angle, smoothly rounded, ventral margin forming nearly a right angle with posterior margin, a number of macrosetae submarginally arranged near dorsal posterior margin; plates with a short laterally directed lobe at outer third (Pl. LXXIX, fig. 1f).

Internal male genitalia.—Style with apex more elongate than usual (Pl. LXXIX, fig. 1e); adeagus with atrial processes elongate, slender, sinuate, gradually tapering from base to acute apices which are sharply directed mesad on outer third, crossing at apex medially, in caudal aspect nearly quadrate, in lateral aspect slightly sinuate; aedeagal apodeme slender, elongate, slightly enlarged apically, directed cephalad.

A large series of specimens has been taken from *Quercus macrocarpa* in Milwaukee, Wisconsin, and several other series from the same host taken by H. H. Ross and L. J. Stannard in Illinois, are at hand.

Specimens have been seen from the following localities: *New York:* Batavia, July 4, August 12; Norris, August 15; New York City Botanic Garden, July 7; *Pennsylvania:* Hartstown Bog, August 13; *Washington D. C.* June 18, 29; *Tennessee:* Great Smoky Mountain National Park, June 12; *Ohio:* Barberton, August 13; *Illinois:* Cook County—Palos Park, June 22; Urbana, July 9, 14; Tinley Park, September 8; Thornton, September 7; *Iowa:* Ames, June 19, September 11; *Kansas:* Manhattan, June 8; *Wisconsin:* Madison, July 19; Milwaukee, June 26-July 4; *Minnesota:* Ramsey County, July 20, 26; August 3, 25.

Both the holotype female and female paratype of McAtee's *Typhlocyba gillettei* var. *sellata* have been seen, and are identical in color marking with heavily pigmented specimens of this species.

Types.—Holotype male, allotype female, and one paratype male in the Illinois State Natural History Survey Collection. Types have been seen by the author.

Ossiannilssonola phryne (McAtee) (*new combination*)

(Pl. LXXIX, fig. 2)

Typhlocyba phryne McAtee, Proc. U. S. Nat. Mus., vol. 68, art. 18, 1926, pp. 34-35.
Typhlocyba phryne var. *subpulchra* McAtee, *loc. cit.*
Ossiannilssonia phryne, Young, Bull. Univ. Kansas Sci. Bull., vol. 35, pt. 1, 1952, p. 99.

Resembling *O. appendiculata* in the shape of male plate, but differing by having a black line along commissural margin and parenthesis-shaped black lines on scutellum, pronotum, and sometimes extending onto head; pygofer strongly produced caudally on dorsal half as a broad apically rounded lobe.

Length.—3.5 mm.

Color.—Head, in very darkly marked specimens, with two chocolate brown longitudinal bars on either side of midline from anterior margin of eye to pronotum, ecdysial line dark, remaining portions yellow, entirely yellow in most specimens; pronotum, with two parenthesis-shaped chocolate brown longitudinal bands continuing posteriorly from basal margin of head broadening caudally and nearly meeting medially at base, with remaining portions yellow, almost entirely yellow in lightly marked specimens with only a faint trace of chocolate brown color; scutellum, with lateral angles chocolate brown, yellow medially; fore wings, with chocolate brown stripes along commissural margin to cross veins covering inner half of clavus, chocolate brown spots in apices of inner three basal cells forming a transverse band; size of spots progressively smaller towards costal margin, lighter areas anterior to cross veins subhyaline, yellowish-white; apical cells hyaline, fumose; abdomen, chocolate brown on basal half of median third of dorsal segments, laterally deep orange yellow, dorsal third of pygofer chocolate brown, venter yellow, plates yellow.

Genital capsule.—Male pygofer, in lateral aspect, with posterior margin greatly produced caudally on dorsal half, ventral angle forming a right angle, with one or usually two macrosetae just dorsad of outer basal angle of plate, a row of macrosetae along posterior margin on dorsal half; male plate elongate, dorsoventrally compressed near middle, forked shortly before apex into two thumb-like processes, one directed dorsad, the other laterad, setae mostly restricted to outer fourth. (Pl. LXXIX, fig. 2a).

Internal male genitalia.—Aedeagus with atrial processes elongate, slender, apices directed mesocaudad, separated at apex, in caudal aspect nearly forming a circle; aedeagal apodeme reduced to a broad triangular anteriorly directed process.

A large series of specimens of this species collected by H. H. Ross and L. J. Stannard, from *Quercus macrocarpa,* in Illinois, has been seen by the author.

Specimens have been examined from the following localities: *New York:* Norris, August 15; *Ontario:* Ottawa, June 30, September 27; *Illinois:* Western Springs, June 21; Tinley Park, September 8; *Wisconsin:* Milwaukee, June 27; *Minnesota:* St. Paul, June 22-23, August 12, 18, 25.

Types.—Holotype female, in the Illinois State Natural History Survey Collection; another female holotype of var. *subpulchra,* in the Iowa State College Collection; a male specimen collected by the author, June 27, 1950, Milwaukee, Wisconsin, here designated *neo-allotype,* two *paraallotype* males, June 21, 1949, Western Springs, Illinois, Stannard and Ross, and three *paraallotype* males, June 16, 1949, Tinley Park, Illinois, Ross and Stannard, in the Snow Entomological Collections of the University of Kansas; additional *para-allotype* males: five, June 21, 1949, Western Springs, Illinois, Stannard and Ross; eight, September 8, 1949, Tinley Park, Illinois, Ross and Stannard, in the Illinois State Natural History Survey Collection; one, August 15, 1942, Norris, New York, R. E. Olson, in Cornell University Collection; one, August 12, 1938, St. Paul, Minnesota, A. A. Granovsky, in the University of Minnesota Collection; one, September 8, 1904, Ottawa, Ontario, W. Metcalfe, in the Colorado Agricultural and Mechanical College Collection.

Ossiannilssonola rossi sp. nov.

(Pl. LXXIX, fig. 3)

Resembling *O. quadrata* and *O. knulli* in external appearance and in general form of pygofer and aedeagus, but distinguished from these species by having the dorsal angle of pygofer greatly produced into a large hook, and in having the apices of the atrial processes appearing forked in caudal aspect.

Length.—3.5 mm.

Color.—Head, pronotum, and scutellum light yellow; fore wings, light yellow, subhyaline to near cross veins, apex hyaline and slightly fumose, with a transverse row of three clearly defined black spots in apices of inner three basal cells; abdomen black on dorsum, venter light.

Genital capsule.—Male pygofer, in lateral aspect, with posterior margin distinctly S-shaped on lower half, dorsal angle produced posteriorly in a broad ventrally hooked lobe, curving mesad, and appearing as a broad hook in caudal aspect as well, ventral angle rounded, reduced, a dense brush of macrosetae on dorsal lobe.

Internal male genitalia.—Aedeagus with atrial processes elongate, slender, apices distant from each other the width of base, in caudal aspect subquadrate, slightly diverging toward apex, sharply bent mesad on apical fourth, with apices flattened and twisted dorso-caudad, appearing forked; base of aedeagus roughly S-shaped from left side; aedeagal apodeme reduced to a slight projection on anterior margin.

Type.—Holotype male, Thornton, Illinois, June 22, 1949, H. H. Ross and L. J. Stannard, on *Quercus bicolor,* in the Illinois State Natural History Survey Collection.

Ossiannilssonola knulli sp. nov.

(Pl. LXXIX, fig. 4)

Resembling *O. quadrata* in external appearance, but with dorsal angle of pygofer less prominent, and with base of aedeagus not broadly inflated below bases of atrial processes.

Length.—3.0-3.25 mm.

Color.—Head, pronotum, and scutellum bright sulfur-yellow; fore wings sulfur-yellow, subhyaline to cross veins, apex hyaline, slightly fumose, with a transverse row of three black spots in apices of inner three basal cells, sometimes one or two missing; abdomen yellow, male plates yellow.

Genital capsule.—Male pygofer, in lateral aspect, with posterior margins somewhat S-shaped on lower half, dorsal angle directed caudally as a broad ventrally hooked lobe one fourth as long as broad, hook more prominent from caudal aspect, ventral angle broadly rounded, a group of macrosetae on dorsal posterior margin.

Internal male genitalia.—Style abruptly reduced to an acute apex (Pl. LXXIX, fig. 4), with atrial processes elongate, slender, slightly curved ventromesad caudally, crossing near apex; base of aedeagus roughly S-shaped in lateral aspect; aedeagal apodeme reduced to a slight projection on anterior margin; base of aedeagus slender in caudal aspect, not enlarged as in *O. quadrata.*

A large series of both male and female specimens has been collected by the author, from a single tree of *Quercus borealis* in Lawrence, Kansas.

Types.—Holotype male and numerous paratypes of both sexes, Douglas County, Kansas, June 8, 1951; allotype female, two male and twenty-one female paratypes, Douglas County, Kansas, June 10, 1950; ten female paratypes Douglas County, Kansas, June 12, 1950, P. J. Christian, in the Snow Entomological Collections of the University of Kansas; one male paratype collected by Nathan Banks, North Mountain, Pennsylvania, July 4, in the Museum of Comparative Zoology; a pair of paratypes collected by E. D. Ball, Woods Hole, Massachusetts, July 7, 1925, in the U. S. National Museum Collection; one female, June 12, and pair of paratypes June 20, 1951, Dale Bray, Wilmington, Delaware, in the University of Delaware Agricultural Experiment Station Collection.

Ossiannilssonola quadrata (DeLong and Johnson) (*new combination*)

(Pl. LXXX, fig. 3)

Typhlocyba quadrata DeLong and Johnson, Ent. News, vol. 47, no. 4, April, 1936, pp. 102-104.
Ossiannilssonia quadrata, Young, Bull. Univ. Kansas Sci. Bull., vol. 35, pt. 1, 1952, p. 99.

Resembling *O. knulli* in outward appearance, but with dorsal angle of pygofer more prominent, hook terminating in strong, acute, ventrally-directed spine, base of aedeagus laterally inflated below bases of atrial processes.

Length.—3.5 mm.

Color.—Head, pronotum, and scutellum pale yellow; fore wings yellow, subhyaline to cross veins, with a transverse row of three black spots in apices of inner three basal cells; apex fumose, hyaline.

Genital capsule.—Male pygofer, in lateral aspect, with lower half of posterior margin less distinctly S-shaped than in *O. rossi,* dorsal angle produced caudally into a short broad process curving ventrad as a sharp elongate spine and with another shorter spine directed mesad near dorsal margin, a few submarginal macrosetae on dorsal angle, ventral angle broadly rounded but less prominent than in preceding species.

Internal male genitalia.—Style with apex less abruptly reduced than in *O. knulli* (Pl. LXXIX, fig. 4e); aedeagus with atrial processes elongate, slender, directed ventromesad caudally; aedeagal apodeme absent; base of aedeagus greatly inflated laterally, sharply constricted before bases of atrial processes, with a sclerotized plate extending over bases of processes into membrane.

Type.—This species is known from one male specimen collected at Kane, Pennsylvania, August 19, 1928, by D. M. DeLong, and is in the collection of the collector. Illustrations for this species have been drawn from the type specimen.

Ossiannilssonola troza (Ross and DeLong) (*new combination*)

(Pl. LXXX, fig. 1)

Typhlocyba troza Ross and DeLong, Ohio J. Sci., vol. 49, no. 3, 1949, pp. 116-118.

Ossiannilssonia troza, Young, Bull. Univ. Kansas Sci. Bull., vol. 35, pt. 1, 1952, p. 99.

Resembling *O. bangsoni* in external appearance, but with dorsal angle of pygofer produced as a broad, acute, dorsomesally-directed arm.

Length.—3.5-3.75 mm.

Color.—Head, pronotum, and scutellum white to light yellow; fore wings, light yellow to yellow, subhyaline to cross veins, with a transverse row of three black spots in apices of inner three basal cells, apex hyaline, slightly fumose; abdomen yellow, male plates yellow.

Genital capsule.—Male pygofer, in lateral aspect with posterior margin nearly transverse, dorsal angle produced into a large broad dorsomesally directed hook, ventral angle slightly produced caudally in a short hook, a row of macrosetae on posterior margin of dorsal hook.

Internal male genitalia.—Aedeagus with atrial processes elongate, slender, apices separated, in caudal aspect nearly quadrate in outline, widely separated near basal third, slightly converging to outer third which is abruptly curved mesodorsad caudally; aedeagal apodeme short, enlarged apically, directed dorsad.

In addition to the holotype, a short series collected by R. H. Beamer and the author, from *Quercus muhlenbergii*, and one male taken on *Quercus palustrus* by the author, in Douglas County, Kansas, June 11-24, have been seen.

Types.—Holotype male, in the Illinois State Natural History Survey Collection; a female specimen collected by R. H. Beamer, Douglas County, Kansas, June 11, 1949, taken with males of this species, here designated *neoallotype*, in the Snow Entomological Collections of the University of Kansas.

Ossiannilssonola flavomarginata (Gillette and Baker) (*new combination*)

(Pl. LXXX, fig. 2)

Typhlocyba flavomarginata Gillette and Baker, Bull. Colorado Agr. Exp. Sta., no. 31, Tech. ser. no. 1, 1895, pp. 111-112.
Typhlocyba flavomarginata var. *vesta* McAtee, Proc. U. S. Nat. Mus., vol. 68, art. 18, 1926, p. 18.
Typhlocyba flavomarginata var. *scorta* McAtee, *op. cit.*, pp. 18-19.
Typhlocyba flavomarginata var. *media* McAtee, *op. cit.*, p. 19.
Ossiannilssonia flavomarginata, Young, Bull. Univ. Kansas Sci. Bull., vol. 35, pt. 1, 1952, p. 99.

Specimens of Form I which have a red longitudinal stripe on clavus along commissural margin, resemble in external appearance deeply colored species of *O. australis,* but are easily distinguished from this species and other species in the genus by having styles with apical third sharply curved mesad, and a triangular projection on lateroventral margin.

Length.—3.25-4.0 mm.

Color.—The color of this species is highly variable resulting in five recognizable forms, but with numerous intermediates of all degrees between these. Perhaps a study of the genetic constitution of this species will be necessary before the diversity of color pattern will be understood.

Color descriptions of the five most distinct patterns, designated by Roman numerals I to V, are as follows:

Form I.—Head light yellow; pronotum yellow with a red triangle with apex on disc and base on posterior margin; scutellum with outer angles red, forming an inverted V with the triangle on pronotum; fore wings with red commissural band extending from base to cross veins on inner half of clavus, with a dark spot in each of inner three basal cells appearing as a band obliquely slanted caudally toward costal margin, remaining portions of wing anterior to cross veins subhyaline, yellow, apex hyaline, fumose; abdomen with dark brown median band on dorsum broader on basal segments, sides yellow, venter and male plates yellow.

Form II.—Head, yellowish-white; pronotum yellow, light brown from disc to posterior margin; scutellum light brown; fore wings light to dark brown, hyaline, without spots; abdomen with median band on dorsum dark brown, sides bright yellow, venter and male plates yellow.

Form III.—Head, pronotum, and scutellum bright yellow; fore wings pale red throughout, subhyaline to cross veins, hyaline beyond; abdomen and male plates yellow.

Form IV.—Head yellow-orange; pronotum yellow-orange, disc orange; scutellum yellow-orange; fore wings deep orange throughout, subhyaline to cross veins, hyaline beyond; abdomen and male plates yellow.

Form V.—Head, pronotum, scutellum, and all of fore wings white to ivory, without dark markings.

All degrees of color intergradation can be found between forms I and II, I and V, and II and V. Some intergrades occur between III and IV, and there is a gradation through teneral specimens of III and IV, toward V. The holotype of McAtee's var. *media* is like form I, the holotype of var. *scorta* is like form III, and the holotype of var. *vesta* is like form V. The lectotype of var. *flavomarginata* is intermediate between forms II and V, but nearer form II.

Genital capsule.—Male pygofer, in lateral aspect, with posterior margin nearly vertical, ventral margin extended dorsad obliquely nearly to dorsal angle; dorsal angle broadly rounded, ventral posterior margin slightly recurved, with a slight, papillose, ventral lobe, a number of macrosetae on dorsal posterior margin; male plate in ventral aspect, wedge-shaped, lateral and mesal margins nearly straight, in lateral aspect slightly curved dorsad, with a broad dorsolateral excavation on outer three fourths.

Internal male genitalia.—Styles with outer third of apical portion abruptly curving mesad, a small triangular hooklike projection on lateroventral margin (Pl. LXXX, fig. 2e); aedeagus with atrial processes broadly flattened laterally on basal two thirds, reduced on apical third to slender mesoventrally curving acute apices, directed caudally; aedeagal apodeme in lateral aspect broad, elongate, apically enlarged, directed cephalad.

Female.—With posterior margin of eighth abdominal sternite strongly incised laterally forming two lateral lobes and one slightly emarginate median lobe (Pl. LXXXVII, figs. 7a, b).

Two large series collected by R. H. Beamer in Sapello, New Mexico, and in Raton, New Mexico, from *Quercus sp.*, have been seen by the author, and short series have been seen from the following localities: *Arizona:* Grand Canyon, August 1, 3, 11; Flagstaff, August 1, 5; Oak Creek Canyon, July 9, 31, August 9, 14; Coconino County, August 13; Huachuca Mountains, July 8, August 1, 2; Cochise County, July 29; *New Mexico:* Ruidoso, August 10, October 10, 15; Pecos, Sapello, July 24; Raton, July 26; Jamez Springs, July 22; Taos Pass, August 13; Cimarron, August 13; Colfax County, August 21; Cowles, July 18; Luna, July 25; Soroco County, August

18; *Colorado:* LaVeta Pass, July 28; Colorado Springs, July 19; Palmer Lake, October 9; Trinidad, July 13, August 19; Manitou, September 29; Cimarron, August 22; Cerro Summit, August 21; Durango, August 7; Salida, October 8; Alder, August 25; Rabbit Ear Pass, August 18; Royal Gorge, July 3; Glenwood Springs, August 17; Garden of the Gods; Colorado City; *Utah:* Freedom, August 24, Fruitland, July 16; Keetley, August 16; Park City, August 16; Grant, June 25, July 4, 14, 15, 22, 24, August 6; Farmington, June 12; Panguitch, September 4; Alton, July 30, August 14; Salt Lake City, July 3, 13, August 29; Emery, August 16; Cove Fort, August 14; Cedar City, August 13; Pintura, August 11; Salina, August 13, 26; Fish Lake, September 2; Richfield, July 14; Mount Carmel Highway, June 18.

Types.—Specimens seen bearing machine printed cotype labels are as follows: two specimens, "Colo 2280" in the Snow Entomological Collections of the University of Kansas; four specimens, "Colo 2280" and one specimen, "Colo 2266" in the Colorado Agricultural and Mechanical College Collection; and two specimens, "Colo 2266" and "Colo 2270" in the U. S. National Museum Collection. Two female specimens each bearing a handwritten label "type" on white paper, have also been seen, one "Colo 1375" in the U. S. National Museum Collection, and the other "Colo 1780" in the Colorado Agricultural and Mechanical College Collection. These numbers refer to the collecting numbers of either Baker or Gillette and have been checked on the lists of each of these men, for the data which the numbers represent.

The data for number 1780 on Gillette's list which fits that given for the three females in the original description of *T. flavomarginata* G. & B., is "9-29-'94, at Manitou, Colo. C.P.G., *Quercus undulosa*". The data for each of the other numbers seen indicates that the specimens bearing these can not be more than metatypes.

In 1926 McAtee selected a lectotype from three females which he thought were the type series of *flavomarginata,* and designated a fourth specimen, a male with a cotype label on it, as *neoallotype,* recognizing that it was not a cotype since only females were in the type series. These specimens were given the U.S.N.M. catalogue number 3456, and placed in the U. S. National Museum Collection. Only three of these four specimens are now in this collection, and of these, two, "Colo 2270" a female, and "Colo 2266" a male, bear cotype label U.S.N.M. 3456. The male is unquestionably the *neoallotype* set up by McAtee while the other specimen is only a metatype. The third specimen, "Colo 1375" which on Baker's list is "May, Ft. Collins", may have been the specimen selected by McAtee as lectotype, since it does not bear a U.S.N.M. cotype label as the others do, although it does *not* have a lectotype label either. There is also the possibility that the fourth specimen seen by McAtee may have been the one selected as lectotype, but this specimen is now missing.

Since the only remaining specimen which could have been selected as lectotype, "Colo 1375", is not one of the type series, and since only one specimen of the type series is now known to exist, the author proposes that this specimen, "Colo 1780" in the Colorado Agricultural and Mechanical College Collection, be made lectotype of *Typhlocyba flavomarginata* Gillette and Baker.

GENUS TYPHLOCYBA Germar

(Pls. LXXXI-LXXXVII)

Typhlocyba Germar, Rev. Ent. Silbermann, vol. 1, 1833, p. 180.
Anomia Fieber, Verh. Zool.-bot. Ges. Wien, vol. 16, 1866, p. 509. (type, *Cicada quercus* Fabricius, 1794, by subsequent designation of Evans, 1947, Trans. Roy. Ent. Soc. Lond., vol. 98, p. 200). Type of the genus, *Cicada quercus* Fabricius, by subsequent designation of Woodworth, 1889.

Fore wings.—Inner and outer apical cells short, not attaining wing apex; second apical cell much broader at apex than at base; third apical cell petiolate; wing apex smoothly rounded. (Pl. LXXXI, fig. 1f).

Hind wings.—Vein 1V branching from 2V near its midlength; submarginal vein absent at wing apex; both apical cells open apically; posterior branch of R fused with apical portion of vein M_{1+2} (Pl. LXXXI, fig. 1f).

Genital capsule.—Male plate gradually curved dorsad apically, reduced near middle but enlarged apically, with one or rarely two macrosetae near outer basal angle, submarginal row of microsetae near outer basal angle, submarginal row of microsetae parallel to lateral margin near middle and extending over apical half of length, a few other irregularly arranged microsetae, apex usually black; pygofer, in lateral aspect, of various forms with or without sclerotized barlike thickenings which when present may or may not be extended as caudal or dorsocaudal pygofer processes, with ventrocaudal margin occasionally inrolled, often with group of macrosetae just dorsad of outer basal angle of male plate, almost always with group of small submarginal setae along dorsocaudal margin and with numerous microsetae arranged over disc; apex of ventral lobe or ventral hook usually black.

Internal male genitalia.—Style elongate, slender, usually either smoothly curved laterad or dorsad apically, with mesal preapical protruberance poorly developed or absent in broad aspect (which may be dorsal or caudal); style with setae in various arrangements; connective massive, the aedeagal articulation subterminal; aedeagus with preatrial arm well developed or not, apodeme usually well developed; aedeagal shaft with paired ventral processes arising from atrium or base of shaft, sometimes fused to shaft, with one or two pairs of apical processes and occasionally with processes along length of shaft.

Head in dorsal aspect narrower than pronotum, longer medially than next the eye, anterior margin of crown broadly rounded; pronotum short and broad, lateral margins strongly divergent caudally, posterior margin smoothly, shallowly convex, pleural portion broader than ocellocular area.

The species, for the most part, are slender and delicate in appearance, usually pale white or yellow, occasionally with darker markings.

The genus is holarctic in distribution.

The following key to the North American species of the genus is based primarily on characteristics of the male genitalia.

KEY TO THE SPECIES OF TYPHLOCYBA

1. Aedeagus with atrial processes arising from base of shaft 2
   Aedeagus without atrial processes, or with processes fused to shaft 20
2. Atrial processes fused with aedeagal shaft on basal fourth 3
   Atrial processes arising from near, or at the base of aedeagal shaft 4
3. Aedeagal shaft with elongate apical processes (Pl. LXXXI, fig. 3b, c) ...... *athene* p. 1166
   Aedeagal shaft simple, without apical processes (Pl. LXXXV, figs. 2b, c) ...... *cassiopeia* p. 1181
4. Aedeagal shaft with processes 5
   Aedeagal shaft without processes 7
5. Aedeagal shaft with two pairs of processes (Pl. LXXXIV, fig. 3b, c) ...... *shawneeana* p. 1178
   Aedeagal shaft with one pair of processes 6
6. Aedeagal shaft processes apical, broad at base, short and stout, slightly curving laterad. (Pl. LXXXI, fig. 2b, c) ...... *oneka* p. 1165
   Aedeagal shaft processes slightly subapical, elongate, slender, curving strongly laterodorsad. (Pl. LXXXI, fig. 4b, c) ...... *arsinoe* p. 1166
7. Aedeagal shaft flattened laterally and apically into a broad thin semitransparent plate 8
   Aedeagal shaft not flattened laterally and apically 12

8. Posterior margin of pygofer projecting ventrad as a long sharp hook; face of males usually orange-red. (Pl. LXXXII, fig. 4), *pomaria* p. 1170
   Posterior margin of pygofer not projecting ventrad as a long sharp hook; face never orange-red 9
9. Dorsal angle of pygofer forming a prominent caudally directed process 10
   Dorsal angle of pygofer not forming a prominent caudally directed process 11
10. Dorsal process of pygofer narrow, acute, heavily sclerotized. (Pl. LXXXIII, fig. 3) .... *surcula* p. 1175
    Dorsal process of pygofer a broad continuation of pygofer, not heavily sclerotized. (Pl. LXXXIII, fig. 1) .... *attenuata* p. 1172
11. Posterior half of pygofer nearly quadrate; fore wing white, without markings. (Pl. LXXXIII, fig. 4) .... *andromache* p. 1176
    Posterior half of pygofer with margin strongly rounded; fore wing with a broad brown band over cross veins, often with a red spot in middle. (Pl. LXXXIII, fig. 2) .... *rubriocellata* p. 1174
12. Apex of male plate produced laterally as a short, heavily sclerotized, beaklike process (Pl. LXXXI, fig. 1); fore wings with five red to orange-brown spots, and with brown markings in cells bordering cross veins .... *quercus* p. 1163
    Apex of male plate smoothly rounded; fore wings without red or orange markings 13
13. Atrial processes of aedeagus broadly flattened. (Pl. LXXXIV, fig. 1) .... *melite* p. 1176
    Atrial processes of aedeagus not broadly flattened 14
14. Aedeagal shaft arising greatly elevated above bases of atrial processes 15
    Aedeagal shaft arising between or slightly above bases of atrial processes 16
15. Atrial processes of aedeagus fused on basal fourth, or basal half; style with thumblike projection on lateral margin near middle; pygofer with a short, acute, dorsally directed hook. (Pl. LXXXII, fig. 1) .... *modesta* p. 1167
    Atrial processes of aedeagus not fused on basal fourth, style without thumblike projection near middle; pygofer with a long, sharp, ventrally directed process on ventral angle. (Pl. LXXXII, fig. 3) .... *hockingensis* p. 1169
16. Fore wings with a transverse brown or black band 17
    Fore wings without dark transverse band 18
17. Fore wings with band distad of cross veins; shaft of aedeagus with posterior margin concave; dorsal angle of pygofer forming a broad, angular, laterally-concave process. (Pl. LXXXIV, fig. 2) .... *alabamaensis* p. 1177
    Fore wings with band covering middle third; shaft of aedeagus convex on posterior margin; dorsal and posterior margins of pygofer nearly continuous, not produced. (Pl. LXXXIV, fig. 4) .... *transviridis* p. 1179

18. Aedeagus with atrial processes not exceeding shaft in length; pygofer with a small ventrally directed lobe near middle of posterior margin. (Pl. LXXXII, fig. 2) .... *medleri* p. 1169
Aedeagus with atrial processes exceeding shaft in length by one third their length 19
19. Aedeagal shaft anterior to atrial processes throughout its length; posterior margin of pygofer nearly straight, without short ventral tooth. (Pl. LXXXV, fig. 3) .... *crassa* p. 1182
Aedeagal shaft posterior to or even with atrial processes; pygofer with posterior margin angled near middle, extended ventrad as a short tooth. (Pl. LXXXV, fig. 1) .... *putmani* p. 1180
20. Aedeagus with two pairs of shaft processes, one pair arising near middle of shaft. (Pl. LXXXI, fig. 3) .... *athene* p. 1166
Aedeagus with only one pair of shaft processes 21
21. Aedeagal shaft processes arising at or before middle of shaft, shaft greatly reduced beyond processes 22
Aedeagal shaft processes apical 24
22. Aedeagal shaft processes arising before middle of shaft, pygofer with ventral angle evenly rounded, not produced. (Pl. LXXXV, fig. 2) .... *cassiopeia* p. 1181
Aedeagal shaft processes arising at middle of shaft; pygofer with ventral posterior angle produced laterad or ventrad as a short process 23
23. Aedeagal shaft processes closely appressed to apical portion of shaft, basal half of shaft stout, broad in lateral aspect. (Pl. LXXXVI, fig. 4) .... *niobe* p. 1183
Aedeagal shaft processes distinctly separated from shaft, from base; basal half of shaft slender, slightly wider than processes in lateral aspect. (Pl. LXXXVI, fig. 1) .... *sollisa* p. 1182
24. Apical processes of aedeagus broadened in middle, half as long as shaft; pygofer without a lobe at dorsal angle. (Pl. LXXXVI, fig. 3) .... *persephone* p. 1184
Apical processes of aedeagus short, less than one fourth length of shaft, appearing as a continuation of shaft 25
25. Apical processes of aedeagus nearly straight, shaft broadly inflated on distal half in caudal aspect; pygofer without lobe on dorsal angle. (Pl. LXXXVII, fig. 1) .... *inflata* p. 1186
Apical processes of aedeagus sinuate, shaft of uniform width throughout in caudal aspect; pygofer with a lobe on dorsal angle. (Pl. LXXXVI, fig. 2) .... *tortosa* p. 1185

Typhlocyba quercus (Fabricius)

(Pl. LXXXI, fig. 1)

Cicada quercus Fabricius, Genera Insectorum, Rhyngota, 1777, p. 298.
Tettigonia quercus, Germar, Magazin der Entomologie, vol. 4, 1821, p. 73.
Typhlocyba quercus, Herrich-Schäffer, Deutschlands Insecten, vol. 124, 1834, pp. 1-15.
Typhlocyba fasciata Tollen, Stett, Ent. Zeit., vol. 12, 1851, p. 73.
Anomia quercus, Fieber, Katalogue der Europaischen Cicadinen, 1872, p. 15.

This species is easily distinguished from other species in the genus by having the apex of the plate laterally produced as an acute beaklike process, and by having fore wing with five orange-red spots forming a rough W.

Length.—3.0-3.5 mm.

Color.—Head, with dorsum bearing an orange-red, inverted V-shaped mark extending from margins of eyes to near middle of disc; pronotum, with an orange-red band along anterior margin, a large round orange spot on disc, remaining portions milky-white to light yellow; scutellum, with lateral angles orange-red, median band white to yellow; fore wing, with ground color white, with three evenly spaced red to orange-red spots on clavus along commissural margin, and two spots of the same color on inner two basal cells forming a rough W, connected to costal margin by two oblique brown lines; apical and cross veins white, apical and basal cells with light brown areas bordering cross veins; abdomen, dorsum black with outer margins of segments yellow, venter yellow, basal segments darker on basal half; pygofer, dorsum black, venter yellow.

Genital capsule.—Male pygofer, in lateral aspect, with posterior margin continuous with ventral margin, evenly rounded to dorsal angle which is produced dorsad as a heavily-sclerotized, darkly-pigmented, sharply pointed hook, without macrosetae dorsad of outer basal angle of plate; plate, in ventral aspect, gradually reduced toward apex, produced laterad as a short, heavily sclerotized, beak-like process, in lateral aspect slightly curving dorsad, with one or two macrosetae near outer basal angle, a number of scattered microsetae in a submarginal row along lateral margin, a small group of macrosetae at apex. (Pl. LXXXI, fig. 1a).

Internal male genitalia.—Style with apical portion reduced, nearly equal in length to basal apodeme, a row of setae on outer margin and several alveoli on inner margin near apex; connective, almost quadrate; aedeagus, with atrial processes elongate, slender, gradually curving laterocephalad, length nearly equal to that of shaft; aedeagal shaft without apical processes, width nearly uniform from base to apex, slightly curving dorsad, anterior margin recurved at apex, with lightly sclerotized areas on sides near apex; aedeagal apodeme as wide as, but less than half as long as shaft in lateral aspect.

Female.—With posterior margin of eighth abdominal sternite nearly transverse, slightly sinuate, lateral fourth sharply directed cephalad (Pl. LXXXVII, figs. 8a, b).

A series of twenty-seven specimens collected from cultivated cherry, in Vancouver, British Columbia, by Dr. H. H. Ross, July 15, 1948, and August 4, 1950, are the only North American specimens seen by the author. European specimens seen are: a pair from Poland, determined by J. Nast, 1937; one male from Sweden, labeled "Prunus", determined by F. Ossiannilsson, 1948; and three specimens in the U. S. National Museum Collection, bearing only the number 191.

Typhlocyba oneka Knull

(Pl. LXXXI, fig. 2)

Typhlocyba oneka Knull, Ohio J. Sci., vol. 44, no. 6, 1944, p. 270.

Resembling *T. tortosa* and *T. inflata* in having an apical pair of shaft processes, but differing in having a pair of slender atrial processes.

Length.—3.5 mm.

Color.—"Pale yellowish white, elytra semihyaline, below cream-colored, eyes pale", [from original description].

Genital capsule.—Male pygofer, in lateral aspect, with posterior margin slightly convex, dorsal angle produced dorsad as a broad apically rounded projection, ventral angle slightly produced ventrocaudad as a small lobe, a few macrosetae dorsad of outer basal angle of male plate, a large group of macrosetae along middle of posterior margin extending inward toward disc, posterior margin deeply inrolled; plate with apex spatulate.

Internal male genitalia.—Style elongate, slender, gradually tapering to acute apex, curving ventrolaterad, with a large patch of setae of ventral surface near middle extending from mesal to lateral margins, several alveoli on mesal margin near middle; connective, Y-shaped, with posterior margin produced medially; aedeagus, with atrial processes setaeform, two thirds length of shaft, slightly diverging apically; aedeagal shaft elongate, slender, with apical processes broadly attached at base, sharply reduced to acute laterally directed apices; aedeagal apodeme as broad as base of aedeagal shaft, strongly curving dorsocephalad.

Only the dissected abdomen of one male specimen has been seen by the author. The reported host for this species is *Corylus.* The known distribution for this species: *Minnesota:* Itasca County, July 27; *New York:* Cranberry Lake, July 15.

Types.—Holotype male, allotype, and paratypes, in the Herbert Osborn Collection of Ohio State University.

Typhlocyba athene McAtee

(Pl. LXXXI, fig. 3)

Typhlocyba athene McAtee, Proc. U. S. Nat. Mus., vol. 68, art. 18, 1926, p. 31.

Resembling *Typhlocyba niobe* and *T. persephone* externally, but differing in having the dorsal angle of pygofer produced as a slender acute hook, and by having a pair of atrial processes which are fused to shaft to middle, and a pair of apical processes.

Length.—3.0-3.5 mm.

Color.—Head, pronotum, and scutellum pale to deep yellow; fore wings deep yellow; abdomen yellow.

Genital capsule.—Male pygofer, in lateral aspect, with posterior margin slightly convex, dorsal angle produced as a sharp, elongate, ventrocaudally directed hook, ventral angle produced as a short acute hook directed ventrad, one or a few macrosetae dorsad of outer basal angle of male plate, a large group of macrosetae dorsad of outer basal angle of male plate, a large group of macrosetae on middle of posterior margin extending inward toward disc; male plate with apex spatulate.

Internal male genitalia.—Styles and connective like those of *Typhlocyba oneka* (Pl. LXXXI, fig. 2d, e); aedeagus, with atrial processes fused to shaft to near middle, gradually tapering to acute, dorsolaterally directed apices; aedeagal shaft broad at base, slightly reduced toward apex, with a pair of laterally diverging apical processes; aedeagal apodeme broad as shaft, nearly vertical, with a short anteriorly directed arm at apex.

A series of twenty-eight male specimens has been collected from *Acer saccharum*, by the author, in Milwaukee, Wisconsin, taken in association with *T. niobe*, *T. persephone*, *Ossiannilssonola serrula*, and *Edwardsiana lethierryi*. It has not been possible to separate the female specimens from those of some of these species.

Specimens have been seen from the following localities: *New Hampshire:* Lee, July 7; *Connecticut:* New Haven, October 16; *Pennsylvania:* Northeast; Kane; *Illinois:* Urbana, June 7; *Wisconsin:* Milwaukee, June 27, 28, 30, July 1.

Types.—Holotype male, in the Illinois State Natural History Survey Collection.

Typhlocyba arsinoe McAtee

(Pl. LXXXI, fig. 4)

Typhlocyba arsinoe McAtee, Proc. U. S. Nat. Mus., vol. 68, art. 18, 1926, pp. 31-32.

Resembling *T. pomaria* in external appearance, but differing in not having face of male orange-red, in having a pair of apical processes on shaft of aedeagus, and in having ventral angle forming a small apically rounded lobe.

Length.—3.25-3.5 mm.

Color.—Head, pronotum, and scutellum white to light yellow; fore wings white to deep orange-yellow; abdomen yellow; apex of ventral angle of pygofer black.

Genital capsule.—Male pygofer, in lateral aspect, with posterior margin slightly concave, dorsal angle slightly produced, ventral angle strongly produced as a short, rounded ventrocaudally directed lobe which curves laterad, macrosetae near anterior margin of ventral lobe distant from outer basal angle of plate, microsetae posterior to these, a few scattered along posterior margin; male plate, with apex spatulate.

Internal male genitalia.—Styles and connective as in *T. oneka* (Pl. LXXXI, fig. 2d, e) but with fewer setae on style; aedeagus with atrial processes elongate, slender, gradually tapering to acute apices, nearly attaining apex of aedeagal shaft in length, closely appressed to ventral margin of shaft to middle its length, then diverging laterad; aedeagal shaft slightly laterally compressed, a single pair of apical processes arising subapically on posterior margin and curving sharply laterodorsad; aedeagal apodeme directed dorsocaudad on basal two thirds, cephalad on apical third in lateral aspect.

Specimens have been seen from the following localities: *Ontario:* Vineland Station, June 22; *New Hampshire:* Durham, August 30; *Michigan:* Lake Gogebic, August 18; *Wisconsin:* Milwaukee, June 27, July 3, 5; Amery, August 13; *Illinois:* Muncie, July 23; Oakwood, June 14; *Massachusetts:* Boston, August 31.

The host species is *Tilea americana.*

Types.—Holotype male and allotype female, in the U. S. National Museum Collection.

Typhlocyba modesta Gibson

(Pl. LXXXII, fig. 1)

Typhlocyba modesta Gibson, Canadian Ent., vol. 49, no. 5, 1917, p. 184.

Resembling *Edwardsiana candidula* in outward appearance, and *T. hockingensis* in shape of aedeagus, but distinguished from these and other species by having aedeagus with atrial processes fused medially on basal fourth or half, and by having on dorsal angle of pygofer a short, thornlike, dorsally directed hook.

Color.—Dorsum uniform ivory white to pale yellow; fore wings subhyaline to cross veins, apical cells hyaline and slightly fumose; abdomen ivory white.

Genital capsule.—Male pygofer, in lateral aspect, with posterior margin produced on dorsal half as a broad arm, bearing a short, acute, dorsally directed hook and a small ventral lobe, ventral angle a smoothly rounded lobe, a group of short macrosetae just dorsad of outer basal angle of male plate, and a patch of macrosetae on dorsal arm near margin; male plate with apex spatulate.

Internal male genitalia.—Style with lateral margin bearing a short thumblike lobe covered with setae, inner and outer margins with a row of microsetae, several alveoli on inner margin near outer third; connective broadly attached to base of aedeagus; aedeagus with atrial processes fused to each other on basal fourth or half, continuing dorsad nearly parallel to each other, slightly diverging laterad at apex, elongate, slender, scarcely tapering until shortly before apex; aedeagal shaft greatly elevated above atrial processes, arising from anterior margin of base of aedeagus near dorsal extremity; base of aedeagus broadened laterally near apex; aedeagal apodeme having both anterior and posterior arms.

Female.—With posterior margin of eighth abdominal sternite having a distinct median notch between two smoothly rounded lobes (Pl. LXXXVII, fig. 11).

A large series has been taken by the author in Douglas County, Kansas, and a short series in Milwaukee, Wisconsin, on *Acer saccharinum.* Specimens have been seen from the following localities: *New York:* Minetto, August 15; *Virginia:* Mountain Lake, July 11, 12, 15, 18, 23; Falls Church, May 30, August 4, 11; *Massachusetts:* Holiston, July; *Kentucky:* Louisville, July 27; Kentucky Ridge State Forest, June 11; *North Carolina:* Brevard, June 20; *South Carolina:* Clemson College; *Georgia:* Pemiscot County, September 26; *Ohio:* Wooster, July 8; Barberton, August 11; *Indiana:* Kosciusko County, July 8; Lafayette, August 21, 30; *Illinois:* Decatur, August; Urbana, July 13; *Wisconsin:* Milwaukee, June 27-July 5; *Minnesota:* St. Paul, June 17, August 17; *Iowa:* Ames, June 8, 19, September 6; Davenport, September 8; Muscatine, June 6, 8, 9, August 22; County #88, September 23, August 1; *Missouri:* Charleston, June 7; *Kansas:* Manhattan, June 8, 14; Douglas County, May 29 to August 14; *Colorado:* Ft. Collins, June 24, July 3, 14.

Types.—Holotype, allotype, and female paratype, in U. S. National Museum Collection, have been seen.

Typhlocyba medleri sp. nov.

(Pl. LXXXII, fig. 2)

Resembling *T. surcula* in external appearance, but distinguished from this species by not having pygofer hook on dorsal angle, and having aedeagal shaft a slender cylindrical tube of nearly uniform diameter.

Length.—3.5-3.75 mm.

Color.—Dorsum milky-white to cross veins, subhyaline, apical cells entirely fumose, hyaline; abdomen milky-white, apex of male plate black.

Genital capsule.—Male pygofer, in lateral aspect, with posterior margin nearly straight, slanting obliquely ventrocaudad on dorsal half, dorsal angle not produced, forming an apically rounded right angle; ventral angle reduced to a small, rounded, ventrally directed lobe arising near middle of posterior margin of pygofer, ventral half of posterior margin forming an evenly rounded ventral lobe, a group of macrosetae just dorsad of outer basal angle of male plate, a row of macrosetae along dorsal half of posterior margin; male plate with apex spatulate.

Internal male genitalia.—Connective broadly attached to aedeagus; aedeagus with atrial processes elongate, slender, diverging from each other from base, strongly curving dorsad; base of aedeagus forming a U-shaped, posteriorly opened plate with atrial processes broadly attached to arms; aedeagal shaft slender, elongate, arising from between arms of base, nearly uniform in diameter throughout its length; aedeagal apodeme short, apically enlarged.

Types.—Holotype male, allotype female, paratype male, and four paratype females, Milwaukee, Wisconsin, June 26, 1950; two female paratypes, Milwaukee, Wisconsin, June 29, 1950, P. J. Christian, in the Snow Entomological Collections of the University of Kansas.

Typhlocyba hockingensis Knull

(Pl. LXXXII, fig. 3)

Typhlocyba hockingensis Knull, Ohio J. Sci., vol. 44, no. 6, 1944, p. 270.

Resembling *T. pomaria* and *T. modesta,* but differing from these by having the dorsal angle of pygofer without hooks, and forming a right angle; aedeagus with atrial processes distant from aedeagal shaft, asymmetrical, the left process curving cephalad and crossing over right process.

Length.—3.25-3.5 mm.

Color.—Dorsum pale yellowish-white to light yellow; fore wings subhyaline to cross veins, apical cells faintly fumose, hyaline; abdomen light yellow.

Genital capsule.—Male pygofer, in lateral aspect, with posterior margin slightly convex, dorsal angle slightly rounded forming nearly a right angle, ventral angle produced ventrad in a long sharp hook, a small group of macrosetae just posterior to lateral basal angle of male plate, a few macrosetae on ventral half of posterior margin; male plate with apex spatulate.

Internal male genitalia.—Aedeagus with atrial processes elongate, slender, as broad as shaft in lateral aspect, asymmetrical, left process crossing over right anteriorly near middle; shaft arising from dorsal anterior margin of base, parallel to and half the length of atrial processes; aedeagal apodeme reduced or absent.

A large series of this species was collected in Milwaukee, Wisconsin, from a species of *Viburnum* used as an ornamental shrub in the city parks. Serious injury was noted in some areas while in other areas injury was only slight. A short series was collected from blackberry bushes, Goodman, Missouri, and another short series from *Ulmus fulva*, in Douglas County, Kansas. Specimens have been seen from the following localities: *Alaska:* Ft. Yukon, July 15; *British Columbia:* Hope, August 1; *Ontario:* Vineland Station, July 1; Beamsville, June 20; *New Hampshire:* Alton, October 2; Jackson, September 18; Durham, July 8, 14; *Maryland:* Ashton, September 5; *Pennsylvania:* Hartstown Bog, September 14; *Virginia:* Mountain Lake, September 2; *Kentucky:* Louisville, June 7, July 28; *Tennessee:* Great Smoky Mountains National Park, September 1; *Ohio:* Shawnee Forest, June 9; *Minnesota:* St. Paul, June 16; Marshall County, June 24; *Wisconsin:* Lake Geneva, September 1; Milwaukee, June 26-July 5; *Missouri:* Goodman, May 28; *Kansas:* Douglas County, May 28, 30, June 9-30, July 1, September 24.

Types.—Holotype male, allotype female, and paratypes, in the Collection of Mrs. J. N. Knull, Columbus, Ohio; paratypes in the Ohio State University Collection, in the Canadian National Collection, and in the Snow Entomological Collections of the University of Kansas.

Typhlocyba pomaria McAtee

(Pl. LXXXII, fig. 4)

Typhlocyba pomaria McAtee, Proc. U. S. Nat. Mus., vol. 68, art. 18, 1926, pp. 29-31.
Empoa pomaria, Stear, Pennsylvania Acad. Sci., vol. 2, 1928, pp. 54-58.

Resembling *T. hockingensis* in shape of pygofer, but distinguished by having aedeagal shaft arising from between atrial processes;

pygofer with dorsal angle reduced and not forming a right angle; face of male usually red-orange.

Length.—3.25-3.5 mm.

Color.—Dorsum light yellowish-white to yellow; fore wings subhyaline to cross veins, apical cells hyaline, fumose; abdomen light yellow.

Genital capsule.—Male pygofer, in lateral aspect, with posterior margin nearly straight, obliquely slanting posteriorly, dorsal angle broadly rounded, ventral angle produced ventral in a long sharp hook as in *T. hockingensis*, a group of macrosetae just dorsad of outer basal angle of plate, a patch of macrosetae on posterior margin near middle; male plate with apical lobe rounded, only slightly enlarged.

Internal male genitalia.—Aedeagus with atrial processes elongate, broadly attached at base, tapering to acute sinuate apices; aedeagal shaft arising from between atrial processes, broadened laterally and apically as a thin plate, gonopore subapical on ventrocaudal surface; base of aedeagus and apodeme reduced.

Female.—With posterior margin of eighth abdominal sternite sinuate, slightly produced medially, with lateral third curving strongly dorsocephalad (Pl. LXXXVII, figs. 12a, b).

This species occurs on species of *Malus* and on *Ulmus americana*. The approved common name for this species is "The White Apple Leafhopper" (Muesbeck, 1950, p. 138) and is referred to by this name in the numerous papers concerning its biology and control which have been published since its description. It probably occurs in all of the regions of North America where its host plants are found. Specimens have been seen from the following localities: *Alaska:* Fairbanks, July 30; Matanuska, July 21; Ft. Yukon, July 15; *British Columbia:* Vancouver, August 5, 8; *Quebec:* Newaygo, July 30; *Nova Scotia:* Smith's Cove, October 4; King's County; *Ontario:* Vineland Station, August 17, 29, September 9, 14, October 10; Simcoe, October 6; Trenton, June 17; Chelsea, June 20-25; Ottawa, June 18, August 22, October 1; Fenwick, October 10; St. David's, June 26; *Massachusetts:* Greenfield, August 24; Holliston, July, September 16-22; *New Hampshire:* Wilton County, September 30; Durham, September 13, August 21, 27; *Vermont:* Mount Mansfield, July 26; *New York:* Ithaca, June 8, 12, 17; *Pennsylvania:* Procter, July 21; Hartstown Bog, June 26, September 13; Northeast, June 15, July 2, 3; Westchester, July 6; *Maryland:* Lakeland, September 12; *Virginia:* Arlington, May 30, June 11, 15, September 19, 29; Leesburg, August 17, September; Copeley, October 6; *Kentucky:* Louisville, October

12; *Tennessee:* Gatlinburg, June 14; Great Smoky Mountains National Park, September 1; *Indiana:* Noble County; *Illinois:* Cook County, June 22; Thornton, September 7; R. Canyon State Park, July 10; Olney, September 21; *Minnesota:* St. Paul, August 25; Winona County, July 1; Itaska County, August 19; *Michigan:* August 18; *South Dakota:* Brookings, June 7, 8, 25, July 1; *Wisconsin:* Milwaukee, June 26-July 7; Brule, August 19; Rib Mountain State Park, August 27; Madison, June 24; Cramoor, August 11; Lake Geneva, June 16-24, July 4, 9, 12; *Iowa:* Ames, September 3 through 22; Davenport, June 10, September 3; Muscatine, June 4-15; *Missouri:* Oregon County, May 28; *Kansas:* Douglas County, May 27-June 24, September 20-21; Riley County, September 21; *Arkansas:* Bentonville, September 1; *Colorado:* Glen Haven, August 1; Ft. Collins, June 14, 20, July 3, September 4, 10, 23; *Utah:* Providence, October 8; Richfield, June 15, August 7; Logan, June 2-27, September 14, 22; Provo, September 17; Lake View, July 17; *New Mexico:* Espanola, June 18; *Idaho:* Twin Falls, June 14; Moscow, June 19; Parma, July 25, September 22; Idaho Falls, July 27; River Dale, August 12, September 1; *Washington:* Dishman, July 7; *Oregon:* Salem, October 22; Hood River, July 17, August 20; Yoncalla, July 12; The Dalles, June 8, 10, 18; Azales, September, October; Peoria, October; Lancaster, October; Umatilla, October; Junction City, October; Gold Hill, October; 5 miles north of Coberg, October; Durfur; Green Springs Mountain; Ashland; Jacksonville; Clackomas; *California:* Mount Shasta Canyon, June 29.

Types.—Holotype, allotype, and paratypes, in the U. S. National Museum Collection; paratypes, in the Snow Entomological Collections of the University of Kansas, in the Illinois State Natural History Survey Collection, and in the Iowa State College Collection. The male paratype from Cabin John Bridge, Maryland, June 17, 1915, Roberts, is a male of *Edwardsiana rosae.*

Typhlocyba attenuata sp. nov.

(Pl. LXXXIII, fig. 1)

Resembling *T. putmani, Edwardsiana dejecta,* and *Empoa albicans* in outward appearance, and *T. rubriocellata* in shape of aedeagus, distinguished from these species by having dorsal posterior angle of pygofer produced in an acute, lightly sclerotized, attenuate hook.

Length.—4.0-4.25 mm.

Color.—Dorsum pale white to yellow; fore wings subhyaline to cross veins, apex hyaline, not fumose; abdomen yellow, ventral angle of pygofer black on apex.

Genital capsule.—Male pygofer, in lateral aspect, with dorsal angle produced posteriorly in an attenuate hook, ventral angle acute, produced ventrad as a small, apically rounded tubercle, a group of macrosetae just posterior to outer basal angle of plate, a large patch of short macrosetae along middle of posterior margin extending inward submarginally on disc; male plate with apex rounded, not spatulate.

Internal male genitalia.—Style broad, elongate, slightly enlarged subapically, with setae on outer margin extending nearly to apex, several alveoli on mesal margin near middle, scattered setae basad of these; connective broadly triangular; aedeagus with atrial processes elongate, slender, nearly straight, as long as shaft, fused shortly before base, diverging laterad to dorsally curved apices, a small ventral process at base; aedeagal shaft arising from anterior margin of dorsal half of base of aedeagus, expanded laterally and apically as a thin, lightly sclerotized plate, medially more heavily sclerotized, apical third slightly broader and distally rounded, gonoduct opening subapically on ventrocaudal surface; base of aedeagus forming a broad pillar supporting and elevating shaft above atrial processes.

Female.—With posterior margin of eighth abdominal sternite broadly evenly rounded, not produced or incised (Pl. LXXXVII, fig. 9).

A large number of specimens of this species have been collected on *Aesculus glabra* var. *sargentii* in Douglas County, Kansas.

Types.—Holotype male, allotype female, and numerous paratypes of both sexes, Douglas County, Kansas, May 28, 1949, R. H. Beamer; additional paratypes: one male, Rosedale, Kansas, June 23, 1924, E. P. Breaky; six females, Atchison County, Kansas, July 10-16, E. P. Breaky and R. H. Beamer; six females, Douglas County, Kansas, June 25, 1945, R. H. Beamer; ninety-nine males and females, Douglas County, Kansas, May 27, 1949, R. H. Beamer and P. J. Christian; sixty-seven males and females, Douglas County, Kansas, May 29-31, 1949, R. H. Beamer and P. J. Christian; two females, June 18, 22, 1949, Douglas County, Kansas, P. J. Christian; three females, May 29, 1950, ten females, June 3, 1950, one male and four females, June 5, 1950, one male and two females, June 7, 1950, two males and two females, June 8, 1950, Douglas County, Kansas, P. J. Christian. Types in the Snow Entomological Collections of the University of Kansas.

Typhlocyba rubriocellata Malloch

(Pl. LXXXIII, fig. 2)

Typhlocyba rubriocellata Malloch, Bull. Brooklyn Ent. Soc., vol. 15, nos. 2 and 3, 1920, p. 48.
Typhlocyba rubriocellata var. *clara* McAtee, Proc. U. S. Nat. Mus., vol. 68, art. 18, 1926, p. 21.
Typhlocyba escana Ross and DeLong, Ohio J. Sci., vol. 49, no. 3, 1949, pp. 117-118. (*new synonymy*)

Resembling *T. attenuata* in shape of aedeagus, but easily distinguished by having a broad brown band across apical veins, and usually with a bright crimson-red spot on fore wing.

Length.—3.5-4.0 mm.

Color.—Dorsum with ground color yellowish-white; fore wings with a solid dark brown band over cross veins covering ends of cells bordering on cross veins, with bright crimson-red spot of variable size in middle of each fore wing along middle of inner half of clavus and over part of basal half of inner two basal cells, entirely absent in some specimens, fore wings subhyaline to cross veins, hyaline beyond dark band, slightly fumose; abdomen yellowish-white.

Genital capsule.—Male pygofer, in lateral aspect, with posterior margin strongly convex, dorsal posterior margin directed dorsad, ventral angle forming a broadly rounded lobe interrupted by a slight ventral hook, posterior margin deeply inrolled; male plate with apex rounded but not spatulate.

Internal male genitalia.—Style, connective, and aedeagus very similar to those of the preceding species; aedeagus with atrial processes shorter than shaft, elongate, slender; aedeagal shaft arising from dorsal two thirds of base, broadly expanded, not constricted subapically, more broadly expanded laterally; base of aedeagus broadened laterally, a short anteriorly directed apodeme on anterior margin at apex.

Female.—With posterior margin of eighth abdominal sternite broadly evenly rounded, as in *T. attenuata* (Pl. LXXXVII, fig. 9).

A large series of specimens has been seen from the type locality, collected on *Aesculus* sp. Specimens have been seen from the following localities: *Illinois:* Urbana, July 12, 14, 20; *Ohio:* Columbus, June 1; *New York:* Monroe, July 10; *Kentucky:* Kentucky Ridge State Forest, June 11; *Tennessee:* Gatlinburg, June 24, 28, July 12, 20, 21; Great Smoky Mountains, June 18, September 1.

Types.—Holotype female, in the Illinois State Natural History Survey Collection; a male from Urbana, Illinois, July 14, 1946, R. H.

Beamer, here designated *neoallotype,* in the Snow Entomological Collections of the University of Kansas; one *paraallotype* male, Great Smoky Mountains, Tennessee, June 18, 1939, C. P. Alexander, in the U. S. National Museum Collection.

Typhlocyba surcula DeLong and Johnson

(Pl. LXXXIII, fig. 3)

Typhlocyba surcula DeLong and Johnson, Ent. News, vol. 47, no. 4, 1936, p. 103.

Resembling *T. medleri* externally, but with an acute pygofer hook directed posteriorly from dorsal angle.

Length.—3.25 mm.

Color.—Dorsum pale yellowish-white; fore wings subhyaline to cross veins, apical cells hyaline, faintly fumose; abdomen yellowish-white.

Genital capsule.—Male pygofer, in lateral aspect, with posterior margin slightly convex ventrad of dorsal processes, dorsal process broad basally but reduced strongly to an acute, heavily sclerotized, posteriorly directed apex, ventral angle forming a small round ventrally directed lobe; male plate with apex not spatulate.

Internal male genitalia.—Style produced laterad in a broad, angular projection near point of attachment to connective, apex strongly curving ventrolaterad, setae scattered over ventral surface from lateral to mesal margins at middle, a few setae on lateral margin extending more distad, several alveoli on mesal margin at outer third; connective with anterior median lobe strongly produced; aedeagus, similar to preceding species but with atrial processes slender from base, shaft arising slightly above bases of processes; apex transparent, acutely pointed, sclerotized portions making it appear bifurcate; aedeagal apodeme V-shaped in dorsal aspect, arising from lateral arms of base.

One specimen of this species was taken on *Quercus muhlenbergii* in Douglas County, Kansas, and other specimens have been collected in Milwaukee, Wisconsin, from mixed trees and bushes not including the above species.

Specimens have been seen from the following localities: *Minnesota:* St. Paul, June 27; *Wisconsin:* Milwaukee, June 29, July 2, 7; Wisconsin Rapids, July 27; Cranmoor, July 27; *Illinois; Kansas:* Douglas County, June 11.

Types.—Holotype and paratype males, in the collection of D. M. DeLong, Columbus, Ohio.

Typhlocyba andromache McAtee

(Pl. LXXXIII, fig. 4)

Typhlocyba andromache McAtee, Proc. U. S. Nat. Mus., vol. 68, art. 18, 1926, p. 32.

Resembling *T. surcula* in external appearance and in shape of aedeagus, but easily distinguished by lacking dorsal hook on pygofer, and by having posterior margin nearly straight.

Length.—3.0-3.25 mm.

Color.—Dorsum pale yellowish-white; fore wings subhyaline to cross veins, apical cells hyaline, slightly fumose.

Genital capsule.—Male pygofer, in lateral aspect, with posterior margin nearly straight, dorsal angle acute, slightly less than a right angle, ventral angle slightly more than a right angle and forming a small ventrally directed hook; male plate with apex only slightly enlarged.

Internal male genitalia.—Aedeagus with atrial processes broad, elongate, exceeding shaft in length, diverging laterodorsad from base, slightly sinuate, reduced to acute apices on outer fourth; aedeagal shaft arising from base slightly above bases of processes, laterally broadened, margins foliaceous, broadest at gonopore, nearly transparent and extending beyond gonopore as a thin plate with apex acute; base of aedeagus reduced, aedeagal apodeme directed dorsad and cephalad.

The following specimens have been seen: six males, Itasca County, Minnesota, July 26, 1939, J. T. Medler, and the holotype male, Salem, New York, June 27, 1924, on birch, E. D. Ball.

Typhlocyba melite McAtee

(Pl. LXXXIV, fig. 1)

Typhlocyba melite McAtee, Proc. U. S. Nat. Mus., vol. 68, art. 18, 1926, p. 32.

Resembling *T. arsinoe* in external appearance, but differing in having atrial processes of aedeagus greatly broadened on basal two thirds, and with a short hook at middle of posterior margin of pygofer.

Length.—3.5-3.75 mm.

Color.—Dorsum pale yellowish-white to yellow; fore wings subhyaline to cross veins, apical cells hyaline, not fumose; abdomen yellow.

Genital capsule.—Male pygofer, in lateral aspect, with posterior margin slightly convex, dorsal angle reduced, dorsal and posterior margins almost continuous, a small ventrocaudally directed hook near middle of posterior margin, ventrocaudal margin broadly rounded ventrad of hook; male plate with apex spatulate.

Internal male genitalia.—Connective Y-shaped with anterior and posterior medial lobes narrowed; aedeagus with atrial processes broadly flattened on basal two thirds, slightly narrowed before base, outer third gradually tapering to acute apex; aedeagal shaft arising from ventrad of processes and between them, slender, laterally flattened, elongate, gradually tapering to apex, strongly recurved just before apex and appearing bifid due to differential sclerotization, posterior margin strongly convex; aedeagal apodeme short, sharply curving ventrocephalad.

A large series of specimens has been collected by the author from gooseberry (*Ribes* sp.) in Milwaukee, Wisconsin, and another series from pawpaw (*Asimina triloba*) in Douglas County, Kansas. Specimens have been seen from the following localities: *Ontario:* Vineland Station, June 30, July 4, 8; *Massachusetts:* Boston, July 27; *New York:* Sea Cliff, August; Hudson Valley, June 14; *Kentucky:* Kentucky Ridge State Forest, June 11; *Ohio:* Columbus, June 15; *Minnesota:* St. Paul, June 15, 16, 19; Ramsay County, May 30; *Wisconsin:* Milwaukee, June 27-July 4; *Illinois:* Western Springs, June 21; *Iowa:* Ames, May 25; *Missouri:* Kansas City, May 29; *Kansas:* Douglas County, June 2-July 5, September; *Colorado; Washington:* Kalama, July 4.

Types.—Holotype male, and paratype, in U. S. National Museum; allotype and paratypes of both sexes in the Museum of Comparative Zoology.

Typhlocyba alabamaensis sp. nov.

(Pl. LXXXIV, fig. 2)

Resembling *T. medleri* externally, but with dark apical markings more intense along cross veins, aedeagus differs from those of other species in having ventrocaudal margin concave rather than convex.

Length.—3.5 mm.

Color.—Dorsum light yellow to cross veins; fore wings subhyaline to cross veins, apical cells dark brown, hyaline, more intensely colored along cross veins.

Genital capsule.—Male pygofer, in lateral aspect, with posterior margin sinuate, dorsal angle produced in a broad, laterally concave, dorsocaudally directed, apically rounded process, ventral angle directed ventrocaudad as a broad apically rounded lobe arising from mesad of ventral lobe, a group of macrosetae just dorsad of outer basal angle of male plate extending to middle of disc, scattered microsetae posterior to these and along dorsal margin near base of anal tube; male plate with apical lobe scarcely enlarged.

Internal male genitalia.—Connective with a transverse bar at apex of anterior lobe, appearing T-shaped as in *T. crassa;* aedeagus with atrial processes broad, elongate, diverging laterally from base, curved sharply mesad near apex, curving dorsocaudad in lateral aspect, gradually reduced to acute apex; aedeagal shaft arising from between processes, half as long as atrial processes, broadly attached to base in lateral aspect, laterally compressed, posterior margin forming a sharp ventrally concave keel gradually diminished toward apex; base of aedeagus shield shaped in posterior aspect, with aedeagal apodeme V-shaped and attached to divergent arms of base.

Types.—Holotype male and male paratype, La Place, Alabama, near Tuskeege, June 9, 1917, in the Cornell University Collection.

Typhlocyba shawneeana Knull

(Pl. LXXXIV, fig. 3)

Typhlocyba shawneeana Knull, Ohio J. Sci., vol. 44, no. 6, 1944, p. 270.

Resembling *T. andromache* in external appearance and in shape of pygofer, but easily distinguished from that species by having two pairs of shaft processes.

Length.—3.5-4.0 mm.

Color.—Dorsum pale yellow; fore wings subhyaline to cross veins, apex hyaline.

Genital capsule.—Male pygofer, in lateral aspect, with posterior margin nearly straight, almost vertical, dorsal and ventral angles sharp right angles, slightly produced, a few macrosetae just dorsad of outer basal angle of male plate, a group of macrosetae on dorsal half of posterior margin of pygofer extending slightly inward on disc; male plate with apex spatulate.

Internal male genitalia.—Aedeagus with atrial processes elongate, broad, enlarged at base, gradually reduced on outer third to acute apices, exceeding shaft in length; aedeagal shaft bearing two pairs of processes of about equal length, one pair at apex directed dorsocaudad, widely diverging, the other pair at outer fifth curving mesad caudally from lateral margins of shaft, shaft greatly broadened, margins foliacious, outer fifth reduced to half width at base, directed dorsad, slightly convex on basal half; aedeagal apodeme broad, directed cephalad.

This species has been collected by the author from witch hazel (*Hamamelis virginiana*) in Milwaukee, Wisconsin. Although not abundant, a number of specimens were collected by aspirator from the under surfaces of those leaves which showed considerable feeding injury. Nymphs and freshly emerged males were found on the host.

Specimens have been seen from the following localities: *Ohio:* Fairfield, June 16; *Tennessee:* Great Smoky Mountain National Park, September 1, on witch hazel; *Wisconsin:* Milwaukee, July 5, 7.

Types.—Holotype and paratype males, in the collection of Mrs. J. N. Knull, Columbus, Ohio; a female collected by the author, July 7, 1950, Milwaukee, Wisconsin, here designated *neoallotype,* in the Snow Entomological Collections of the University of Kansas.

Typhlocyba transviridis sp. nov.

(Pl. LXXXIV, fig. 4)

Resembling *T. cassiopeia* in being light green when fresh and later changing to yellow; easily distinguished from other species by having a broad, brown, transverse band covering median third of fore wings.

Length.—3.25-3.5 mm.

Color.—Fresh specimens bright green with a broad greenish-brown transverse band on median third of fore wings, color later changing to yellow with a broad yellowish-brown band, veins across band sometimes light colored, apical cells light colored, hyaline; abdomen bright green changing to yellow.

Genital capsule.—Male pygofer, in lateral aspect, with posterior margin continuous with dorsal margin, dorsal angle greatly reduced, ventral angle forming a broad caudally directed lobe with a small ventrally directed hook on ventral margin, a group of macrosetae just dorsad of outer basal angle of male plate, numerous microsetae scattered on ventral lobe over disc and along dorsal margin, a large group of macrosetae extending along most of the posterior margin and inward on disc; male plate not enlarged at apex.

Internal male genitalia.—Style with lateral margin bearing two lobes near middle, a few scattered setae on lateral and mesal margins; connective as in *T. cassiopeia* (Pl. LXXXV, fig. 2); aedeagus with atrial processes elongate, slender, gradually reduced to acute apices, slightly divergent on outer sixth to apex, strongly curving dorsocephalad from base, parallel to shaft; aedeagal shaft arising between processes and continuing between them throughout its length, two thirds as long as processes and of equal width; base of aedeagus a broad dorsal arm bearing a short anteriorly directed apodeme at apex.

A large series of specimens of this species has been collected by the author from *Tilea americana* (linden) in Milwaukee, Wisconsin.

Types.—Holotype, allotype, six male and fourteen female paratypes, July 2, 1950, Milwaukee, Wisconsin, P. J. Christian; additional paratypes: one male, June 30, 1950; one female, July 1, 1950; three females, July 3, 1950; four males, July 4, 1950; eight males and four females, July 5, 1950; two females, July 7, 1950, Milwaukee, Wisconsin, P. J. Christian. Types in the Snow Entomological Collections of the University of Kansas.

Typhlocyba putmani Knull

(Pl. LXXXV, fig. 1)

Typhlocyba putmani Knull, Ohio J. Sci., vol. 44, no. 6, 1944, p. 269.

Resembling *T. attenuata, Empoa albicans,* and *Edwardsiana dejecta* in size and color; distinguished by having aedeagal shaft flattened laterally and lying ventrocaudad of atrial processes throughout its length.

Length.—4.0-4.25 mm.

Color.—Dorsum pale yellow without dark markings; fore wings subhyaline to cross veins, apical cells hyaline; abdomen pale yellow.

Genital capsule.—Male pygofer, in lateral aspect, with posterior margin slightly angular, dorsal angle reduced, ventral angle produced ventrad as a short acute tooth, a vertical row of macrosetae just dorsad of outer basal angle of male plate, a patch of macrosetae at middle of posterior margin; male plate with apex spatulate.

Internal male genitalia.—Style with a short hook on lateral margin near attachment to connective, a row of setae along lateral and mesal margins, several alveoli beyond these on mesal margin at outer third; connective triangular; aedeagus, with atrial processes broadly attached at base, compressed laterally, gradually tapering to acute recurved apices, exceeding shaft in length by outer third; aedeagal shaft elongate, slender, laterally flattened, gradually reduced to outer fourth, more abruptly reduced to apex, arising ventrad of processes and continuing posterior of them throughout its length; aedeagal apodeme similar to that of the preceding species.

A large series of this species has been collected by the author from *Cornus stolonifera*, Milwaukee, Wisconsin, in association with *Edwardsiana dejecta,* where noticeable injury could be seen on hedges of the host plants in the city parks. Specimens have been seen from the following localities: *New York:* Glen Cove, Long Island, July 8; *Virginia:* Mountain Lake, July 21; *West Virginia:*

Great Cacapon, July 4; *Tennessee:* Great Smoky Mountains National Park, September 1; *Wisconsin:* Milwaukee, July 1, 3, 4; *British Columbia:* Vancouver, August 4.

Types.—Holotype male, allotype, and paratypes, Vineland Station, Ontario, in the Canadian National Collection.

Typhlocyba cassiopeia Knull

(Pl. LXXXV, fig. 2)

Typhlocyba cassiopeia Knull, Ohio J. Sci., vol. 44, no. 6, 1944, p. 269.

Resembling *T. transviridis* in shape of aedeagus and pygofer, but lacking brown color markings; atrial processes fused to aedeagal shaft on basal third and closely appressed to shaft concealing it throughout most of its length.

Length.—3.25-3.5 mm.

Color.—Entire body light green when fresh, color changing to pale yellow, legs with apex of tibia remaining green longer than rest of body.

Genital capsule.—Male pygofer, in lateral aspect, with posterior margin evenly convex, dorsal angle reduced, dorsal and caudal margins nearly continuous, ventral angle forming an evenly rounded lobe; male plate not enlarged apically.

Internal male genitalia.—Aedeagus with atrial processes arising from basal third of shaft, slender, elongate, gradually reduced to acute apices, slightly divergent, directed dorsad, closely following shaft and exceeding it in length; shaft slender, sometimes difficult to see in less heavily sclerotized specimens; base of aedeagus short with apodeme reduced.

The green color of the legs is useful in separating freshly collected specimens of this species from those of other light colored species, but after a month or two this color distinction is lost.

A large series of this species has been collected by the author from *Prunus virginiana* (*P. serotina*), in Milwaukee, Wisconsin. Paratype males from Vineland Station, Ontario, have been seen. Specimens have been seen from the following localities: *Massachusetts:* Holliston, July; *Ontario:* Vineland Station, June 27, July 4; *Minnesota:* St. Paul, June 22, Itasca County, July 12; *Wisconsin:* Milwaukee, June 26-July 7; *Illinois:* Cook County, June 22; *Iowa:* Ames, June 17; *Kansas:* Douglas County, August 19, 24 (a paratype of *T. pomaria* McAtee); *Washington:* Mount Rainier, July 27; *Oregon:* Jacksonville.

Types.—Holotype male, allotype, and paratypes, in the collection of Mrs. J. N. Knull; paratypes, in the Canadian National Collection.

Typhlocyba crassa DeLong and Johnson

(Pl. LXXXV, fig. 3)

Typhlocyba crassa DeLong and Johnson, Ent. News, vol. 47, no. 4, 1936, pp. 102, 104.

Resembling *T. putmani* in external appearance and in structure of male genitalia, but with posterior margin of pygofer straight, aedeagal shaft slender and of uniform diameter throughout its length, and atrial processes curving ventrad at base forming a bow which projects between male plates.

Length.—3.5-3.75 mm.

Color.—Dorsum pale yellowish-white; fore wings subhyaline to cross veins, apical cells hyaline.

Genital capsule.—Male pygofer, in lateral aspect, with posterior margin straight, nearly vertical, dorsal margin convex, dorsal angle rounded, ventral angle produced in a broad, acutely angled, ventrally-directed lobe, several macrosetae dorsad of outer basal angle of male plate, a patch of macrosetae along dorsal half of posterior margin; male plate with apex spatulate.

Internal male genitalia.—Connective broadened anteriorly as a transverse plate (Pl. LXXXV, fig. 3e); aedeagus, with atrial processes usually attenuate, twice length of shaft, directed ventrad at base, curved dorsocaudad to outer third, then curved dorsocephalad diverging laterally on outer fourth, median third appearing broadened in lateral aspect; shaft slender, elongate, of nearly uniform diameter from base to outer sixth where it is abruptly reduced beyond gonopore to a very acute apex; aedeagal apodeme forming a massive anteriorly directed arm.

The recorded host for this species is *Prunus serotina*.

Specimens have been seen from the following localities: *Ontario:* Vineland Station, July 4; *Pennsylvania:* Hartstown Bog, June 16, September 30; *Wisconsin:* Milwaukee, July 7; *Colorado:* Glen Haven, August 1; *Wyoming:* Yellowstone Park, August 15.

Types.—Holotype male, allotype female, and three female paratypes, in the collection of Dr. D. M. DeLong, Columbus, Ohio.

Typhlocyba sollisa Ross and DeLong

(Pl. LXXXVI, fig. 1)

Typhlocyba sollisa Ross and DeLong, Ohio J. Sci., vol. 49, no. 3, 1949, pp. 116-117.

Resembling *T. niobe* and *T. persephone* externally, but distinguished from these species by the aedeagal shaft having processes subapical and distinctly separate from shaft from base.

Length.—3.5 mm.

Color.—Head, pronotum, and scutellum yellow; fore wings yellow-orange, subhyaline to cross veins, apex hyaline, veins red-orange.

Genital capsule.—Male pygofer, in lateral aspect, with dorsal angle produced in a slight hook, ventral angle produced lateroventrad as a small tubercule, a single macroseta dorsad of outer basal angle of male plate, patch of macrosetae near middle of posterior margin; male plate, with apex spatulate.

Internal male genitalia.—Aedeagus with a pair of lateral processes arising near middle of shaft and continuing parallel to it to apex, then curving sharply laterad, broadly attached to shaft; aedeagal shaft greatly reduced distad of processes, slender, shorter than processes; base of aedeagus slender, directed dorsad, a short, broad, anteriorly directed apodeme at apex.

The only specimen known is the holotype, taken at Grand Tower, Illinois, May 30, 1935, by Ross and Mohr.

Type.—Holotype male, in Illinois State Natural History Survey Collection.

Typhlocyba niobe McAtee

(Pl. LXXXVI, fig. 4)

Typhlocyba niobe McAtee, Proc. U. S. Nat. Mus., vol. 68, art. 18, 1926, p. 20.

Resembling *T. persephone* and *T. sollisa* externally, but distinguished from these by having aedeagal shaft broad on basal half and greatly reduced beyond shaft processes, shaft processes closely appressed to shaft, ventral angle of pygofer with pronounced hook.

Length.—3.5 mm.

Color.—Dorsum light sulfur-yellow to deep yellow-orange; fore wing subhyaline to cross veins, apex hyaline; abdomen sulfur-yellow.

Genital capsule.—Male pygofer in lateral aspect, with posterior margin slightly convex, dorsal angle slightly pointed, ventral angle produced ventrocaudad as a broad hooked lobe.

Internal male genitalia.—Aedeagus without atrial processes, with a pair of lateral processes arising near middle of shaft broadly attached to shaft and gradually diminishing to acute apices; aedeagal shaft greatly reduced distad of processes, continuing parallel to these nearly to apex where they diverge laterodorsad, basal half broadened dorsoventrally; base of aedeagus directed dorsocaudad with a short anteriorly directed apodeme.

A large series of this species has been taken in Milwaukee, Wisconsin, by the author, on *Acer saccharum* and *Acer platanoides* in association with *T. persephone* and several similarly colored species. Specimens have been seen from the following localities: *Michigan:* Agricultural College, July 5; *Wisconsin:* Milwaukee, June 26-July 6; *Illinois:* Andres, June 17; *Iowa:* Ames, June 20, 23.

Types.—Holotype male and paratypes of both sexes, in the U. S. National Museum Collection; allotype female and one pair of paratypes, in the Iowa State College Collection.

Typhlocyba persephone McAtee

(Pl. LXXXVI, fig. 3)

Typhlocyba persephone McAtee, Proc. U. S. Nat. Mus., vol. 68, art. 18, 1926, p. 11.
Typhlocyba lancifer McAtee, *op. cit.*, pp. 19-20. (*new synonymy*).

Resembling *T. niobe* and *T. sollisa* in external appearance, but distinguished by having aedeagal shaft processes apical.

Length.—3.5 mm.

Color.—Dorsum light sulfur-yellow to deep orange-yellow, some specimens red-orange; abdomen sulfur-yellow.

Genital capsule.—Male pygofer, in lateral aspect, with posterior margin slightly convex, dorsal angle not produced but slightly angular, ventral angle produced as a broad lobe slightly hooked at apex, a few macrosetae dorsad of outer basal angle of male plate, a row of macrosetae along dorsal three fourths of posterior margin; male plate with apex spatulate.

Internal male genitalia.—Style with apical portion beyond alveoli strongly reduced, apex curving ventrad; connective strongly produced anteriorly in a slender, elongate, median lobe; aedeagus without atrial processes, with shaft slender, elongate, gradually tapering toward apex in lateral aspect, apical processes broadly inflated near middle, directed dorsolaterad forming a distinct angle with shaft; base of aedeagus broad, directed dorsocaudad, with aedeagal apodeme arising from anterior margin at apex and directed cephalad.

Female.—With posterior margin of eighth abdominal sternite strongly curving dorsocephalad from midline, slightly produced medially as a rounded lobe (Pl. LXXXVII, figs. 10a, b).

A large series of specimens of this species has been taken by Dr. R. H. Beamer and the author, on *Acer saccharum,* in Douglas County, Kansas, in an unmixed population. Another large series was taken by the author from *Acer saccharum* and *A. platinoides,* in Milwaukee, Wisconsin, in association with *Typhlocyba niobe* and several other similar species.

Specimens have been seen from the following localities: *Massachusetts:* Hampshire County, June; *New Hampshire:* Durham, July 5, September 7; *Vermont:* Mansfield, July 24; *Ontario:* Vineland Station, June 22; *New York:* Minetto, June 13; *Tennessee:* Gatlinburg, June 14; *Wisconsin:* Milwaukee, June 27-July 5; *Illinois:* Urbana, June 4; *Kansas:* Douglas County, May 26-June 24; *Iowa:* Ames, June 20.

This species was described from a male specimen with apical processes of the aedeagus broken off, but in all other respects like the holotype of *T. lancifer.* Since the description of *T. persephone* precedes that of *T. lancifer,* the latter is considered a synonym of the former.

Types.—Holotype male, allotype and paratype females, in the U. S. National Museum Collection; all paratype males of this species seen by the author are specimens of *T. niobe.* The allotype and female paratype specimens may also be this species, but at present the author has not been able to distinquish between females of these two species so that they are being regarded as specimens of *T. persephone* until a sufficiently reliable method is found for distinguishing between them.

Typhlocyba tortosa Ross and DeLong

(Pl. LXXXVI, fig. 2)

Typhlocyba tortosa Ross and DeLong, Ohio J. Sci., vol. 49, no. 3, 1949, pp 115-116.

Resembling *T. niobe* in external appearance, but distinguished by having pygofer with ventral angle smoothly rounded, and in having apical processes short and only slightly subapical.

Length.—3.0 mm.

Color.—Dorsum pale white to light yellow; abdomen yellow.

Genital capsule.—Male pygofer, in lateral aspect, with posterior margin convex at middle, dorsal angle produced as a short, broad, ventrally hooked process, ventral angle broadly rounded, with macrosetae dorsad of outer basal angle of plate, a large group of macrosetae on posterior margin at middle extending inward on disc; male plates with apex spatulate.

Internal male genitalia.—Style broadly curved ventrolaterad, slender, elongate, with ventral surface covered with setae at middle from lateral to median margins, several alveoli on mesal margin; connective as in *T. persephone* (Pl. LXXXVI, fig. 3); aedeagus without atrial processes, shaft slender, elongate, gradually reduced toward apex, extending dorsad; apical processes short, parallel, sinuate, continuing in same direction as shaft; base of aedeagus forming a broad, caudally concave plate, with apodeme directed cephalad from dorsal margin.

A large series of specimens of this species collected by Dr. R. H. Beamer and the author, from *Ostrya virginiana,* Douglas County, Kansas, May 30, June 1, 7, a shorter series from the same host, Milwaukee, Wisconsin, June 28, 29, July 2, 7, collected by the author, and a single male, Wonalancet, New Hampshire, July 1, have been seen.

Types.—Holotype male from Oakwood, Illinois, June 14, in the Illinois State Natural History Collection; a female specimen collected by the author in Douglas County, Kansas, June 7, 1950, in association with males of this species, here designated *neoallotype,* is in the Snow Entomological Collections of the University of Kansas.

Typhlocyba inflata sp. nov.

(Pl. LXXXVII, fig. 1)

Resembling *T. tortosa* in outward appearance and in form of male genitalia, but differing in having distal half of aedeagal shaft inflated laterally, and in lacking lobe on dorsal angle of pygofer.

Length.—3.25-3.5 mm.

Color.—Dorsum pale whitish-yellow to light yellow; abdomen light yellow.

Genital capsule.—Male pygofer, in lateral aspect, with posterior margin convex on lower third; dorsal angle rounded apically, not forming a lobe; ventral angle broadly rounded, a short laterally-directed hook at apex, several short macrosetae dorsad of outer basal angle of plate, a large group of macrosetae on posterior margin at middle extending inward on disc; male plate with apex spatulate.

Internal male genitalia.—Style broadly curving ventrolaterad, slender, elongate, with ventral surface covered with setae at middle from lateral to median margins, several alveoli on mesal margin; connective broadly triangular, median anterior lobe strongly produced; aedeagus without atrial processes, shaft slender, elongate, broadly inflated on apical half in caudal aspect; apical processes short, parallel, appearing as a continuation of shaft in lateral aspect; base of aedeagus forming a laterally flattened dorsal arm, with apodeme at apex reduced.

Types.—Holotype male, allotype female, one male and two female paratypes, Shelton, Washington, July 24, 1949, R. H. Beamer in the Snow Entomological Collections of the University of Kansas; one male paratype, Wanakena, New York, August 1, 1917, C. J. Drake, in the Collection of Dr. D. M. DeLong.

GENUS EMPOA Fitch

(Pl. LXXXVIII)

Empoa Fitch, Ann. Rpt. New York St. Cab. Nat. Hist., vol. 4, 1851, p. 63.

Type, *Empoa querci* Fitch, 1851, by subsequent designation of Van Duzee (Check List of the Hemiptera, 1916, p. 77).

Fore wings.—As in genus *Typhlocyba.*

Hind wings.—As in genus *Typhlocyba* (Pl. LXXXI, fig. 1f).

Genital capsule.—Male plate gradually curving dorsad apically, reduced near middle, gradually tapering to rounded apex, with one macroseta near outer basal angle, a submarginal row of microsetae parallel to lateral margin near middle and extending over apical half of length; pygofer in lateral aspect with dorsal margin nearly horizontal, dorsal angle prominent, apex rounded, ventral angle reduced, lacking group of macrosetae dorsad of outer basal angle of male plate, a few scattered microsetae on disc and a group of macrosetae on posterior margin.

Internal male genitalia.—Style elongate, slender, gradually reduced to an acute apex, curving lateroventrad apically, with numerous setae on ventral surface at basal third, a row of setae extending along lateral margin to middle, several alveoli on mesal margin near middle, apex attenuate beyond these; connective elongate, triangular in ventral aspect; aedeagus without atrial processes, aedeagal shaft with posterior margin strongly curving dorsad from base, with three platelike enlargements on anterior margin, with three pairs of apical processes; aedeagal apodeme a broad dorsally directed arm arising at base of aedeagal shaft.

Female.—With posterior margin of eighth abdominal sternite slightly sinuate, strongly resembling that found in *Typhlocyba pomaria* (Pl. LXXXVII, figs. 12a, b).

Head in dorsal aspect narrower than pronotum, longer medially than next the eye, anterior margin of crown broadly rounded, face with clypellus conspicuously gibbous; pronotum short and broad, lateral margins strongly divergent posteriorly; posterior margin smoothly, shallowly convex, pleural portion broader than ocellocular area.

All of the species of the genus have black or brown color markings ranging in extent from only three spots along the cross veins, to covering nearly the entire dorsum. The ground color is usually white to light yellow, but may be bright orange-yellow or even light pink to rose. The dark color pattern is variable within a species, and sometimes two or three sharply distinct forms may occur in one population. Variability of coloration appears to be the result of the action of two factors or groups of factors, one causing the gradual increase in intensity of color observed in maturing adults, the other controlling the ultimate extent of color pattern, shade of color, and intensity of color.

As a result of the action of the first factor, specimens of *Empoa gillettei* and similarly marked species pass successively through several color stages in the process of maturing. Extremely teneral specimens show traces of spots in the apices of the inner three basal cells, and as the intensity of color increases, an apical band will gradually become evident. As the apical band deepens in intensity a pale transverse median band begins to appear and increases in intensity while the scutellum and dorsum of the abdomen begin to show signs of dark color. The color of the scutellum continues deepening until it becomes dark brown or black.

This same sequence is observed in the maturing of *Empoa casta* and similarly marked species but usually terminates at the point when only the apical and median bands have become dark. Specimens of *Empoa apicata* and similarly colored species have only the apical band dark so that this process of color change is less noticeable. Specimens of *Empoa vestita*, and darkly marked specimens of *venusta* and *scripta* show a tendency toward a more uniform development of color, the apical portion of the wings darkening slightly earlier than the rest of the wing. In *Empoa albicans* the dark color appears to become evident in the scutellum before it can be seen in the wings. Color in the wings first appears in the apex of the clavus and gradually spreads to include all of the clavus and adjacent areas of the inner two or three basal cells.

The second factor, one which influences the final extent of color pattern and intensity of color, appears to be responsible for the occurrence of polymorphic species such as *E. venusta, E. scripta, E. albicans*, and to a lesser degree *E. casta, E. aureotecta*, and *E. vestita*.

Because of the similarity of partly colored specimens of species of the Gillettei Group to more fully colored specimens of species of the Casta Group, and because of similarity of partly colored specimens of species of the Casta Group to specimens of species of the Apicata Group, species in one group may be confused with species of another group. In addition to intergroup similarity, specimens of species within each group are frequently very similar to each other when not fully mature. Variability of color pattern within these closely similar species is such that it is impossible to be certain to which species these marginal specimens belong in the absence of reliable host records, although usually the majority of mature specimens are easily distinguishable.

Although it is sometimes difficult to separate some of these species on the basis of color alone, population behavior observed has been such as would be expected of distinct species. Each species studied in the field was found to be closely associated with a certain host and was usually found on this host even in widely separated localities. Host relationship studies were made on *E. vestita* showing that fourth and fifth instar nymphs when transferred from their preferred host, *Ulmus fulva,* and restricted to either *U. pumila* or *U. americana* were able to develop normally. Under natural conditions where branches of *U. fulva* and *U. americana* were found interlaced, the nymphs showed exclusive preference for *U. fulva.* The nymphs of *E. vestita* were easily distinguished from those of *E. elmata,* which usually occurs on *U. americana,* because they are olive-green to greenish-brown in color and prefer to feed on the upper surfaces of the leaves, while nymphs of *E. elmata* and other species in the genus are white and prefer to feed on the lower surfaces of the leaves.

Population size was found to vary greatly for species on different hosts within the same area and under the same climatic conditions. Collections of a number of species on the University of Kansas campus in 1949 showed that populations of *E. vestita* and *E. casta* were very large, populations of *E. acericola, E. apicata, E. caryata,* and *E. elmata* to be small, and the population of *E. querci* very small, while no specimens of *E. venusta* could be found although collections were made on its host.

Changes in the size of population from 1949 to 1950 were found to differ for some of the species studied, while other species populations appeared to remain constant. Only a slight decrease in population was noted for *E. vestita,* while *E. casta* showed a very marked decrease in the size of its population. The populations of *E. acericola, E. caryata, E. elmata, E. apicata,* and *E. querci* did not show any marked degree of change in population.

Population size was found to differ for species collected both in Douglas County, Kansas, and in Milwaukee County, Wisconsin. Populations of *E. vestita, E. caryata,* and *E. acericola,* were much larger in Douglas County than in Milwaukee County. Population size of *E. casta* and *E. querci* were much larger in Milwaukee County than in Douglas County, while *E. apicata* was in equal abundance in both places and *E. venusta* was only found in Milwaukee County.

These studies have led the author to regard the following species as distinct although population studies could not be made for all of the species. In some cases where only a few specimens of a distinct color form were on hand the author has preferred to refrain from describing these as distinct species until sufficient material can be seen and adequate studies have been made to show host relationships.

This genus is Nearctic in distribution.

Because of the great similarity of structure of the male genitalia, only *Empoa spinosa* and *E. albicans* have been found to have genitalia distinctly different enough for recognition on the basis of these characteristics. The rest of the species have male genitalia which may be characterized by the following description:

Genital capsule.—Male pygofer, in lateral aspect, with posterior margin nearly vertical, dorsal angle rounded apically, ventral angle reduced, ventral and posterior margins nearly continuous.

Internal male genitalia.—Aedeagal shaft with median plate on apical half of anterior margin produced as a hook which arises from the base of plate rather than from middle as seen in *Empoa spinosa*, shape of hook variable within a species; median pair of apical shaft processes of aedeagus strongly curving mesad and crossing near middle, second pair of apical processes shorter than median pair and diverging laterodorsad, lateral pair of apical processes nearly straight, curving laterad and of nearly equal length to median pair.

KEY TO THE SPECIES OF EMPOA

1. Median plate on anterior margin of aedeagal shaft smoothly rounded, not forming a hook (Pl. LXXXVIII, fig. 1b); fore wing without spots or apical band of color along cross veins, *albicans* p. 1206
   Median plate on anterior margin of aedeagal shaft forming a hook; fore wing with spots or apical band along cross veins . . . 2
2. Hook on anterior margin of shaft of aedeagus arising from the middle of plate (Pl. LXXXVIII, figs. 2b, c); median apical pair of processes of aedeagus slender, slightly curving mesad and crossing on outer fourth . . . . *spinosa* p. 1205
   Hook on anterior margin of shaft of aedeagus arising from base of plate (Pl. LXXXVIII, figs. 3b, c); median apical pair of processes of aedeagus broadly flattened, sharply curving mesad and crossing near middle 3

3. With pronotum brown or black (host *Ulmus fulva*) .... *vestita* p. 1204
With pronotum light colored 4
4. With scutellum brown or black 5
With scutellum neither brown nor black but sometimes deep yellow 14
5. With only two transverse brown or black bands on fore wing 7
With brown or black markings more extensive 6
6. With dark markings on fore wing covering most of basal half of wing, but not connecting with apical band (host *Tilea americana*) ..... *venusta* p. 1201
With dark markings on fore wing extending from base of wing to cross veins, joining apical band with median band (host possibly *Salix* sp.) ..... *scripta* p. 1202
7. Length 3.75-4.0 mm., median band on fore wing one half to one third as broad as width of wing; apical band of fore wing as broad or broader than median band (host *Alnus* sp.), *latifasciata* p. 1203
Length 3.75 mm. or less, median band usually less than one third as broad as width of wing; apical band narrower than median band 8
8. Fore wing with brown or black spot absent from first basal cell, or reduced to a faint trace along cross vein 9
Fore wing with brown or black spot present in first basal cell, usually two thirds as long as width of cell 10
9. Length 3.0-3.5 mm., ground color yellow, subhyaline to hyaline (host *Carya ovata*) ..... *caryata* p. 1198
Length 3.25-3.75 mm., ground color milky white, opaque (host *Acer saccharinum*) ..... *acericola* p. 1200
10. Fore wing with apical band of five spots, in inner three basal and inner two apical cells; median band frequently not reaching costal margin; sometimes restricted to clavus; scutellum pale yellowish brown (host *Platanus occidentalis*) .... *platana* p. 1199
Fore wing with apical band of more than five spots, median band extending to costal margin; scutellum chestnut-brown, chocolate-brown, or yellow-brown 11
11. Scutellum pale yellowish brown to yellow, usually light colored; median band of fore wing narrow, one fourth to one fifth as broad as fore wing (hosts *Quercus alba, Q. macrocarpa*, and other white oak species) ..... *casta* p. 1196
Scutellum usually dark colored, chestnut to dark chocolate brown; median band of fore wing usually one third to one fourth as broad as fore wing 12
12. Fore wing with median band narrow, one fourth to one fifth as broad as fore wing, margins nearly straight (host *Alnus* sp.), *gillettei* p. 1200
Fore wing with median band broad, one fourth to one third as wide as fore wing, margins irregular 13
13. Fore wing with median band broad, nearly one third as broad as fore wing, broadest near middle, narrowing toward margins of wing (host *Tilea americana*) ..... *venusta* p. 1201

Fore wing with median band less broad, usually only one fourth as broad as fore wing, usually somewhat irregular in outline, but of nearly uniform width throughout (host ? *Salix* sp.), *scripta* p. 1202

14. Fore wing with two transverse bands 18
 Fore wing with one transverse band near apex 15
15. Length 2.75-3.0 mm. (host *Ostrya virginiana*) . . . . *apicata* p. 1195
 Length 3.25-3.75 mm. (host *Quercus* or *Ulmus*) 16
16. Fore wing without brown spot in first basal cell, with only three brown spots, in second and third basal and first apical cells (hosts *Quercus borealis* and *Q. palustrus*) . . . . *querci* p. 1193
 Fore wing with brown spot in first basal cell 17
17. Fore wing with distinct lunate white markings anterior to brown spots in inner three basal cells and fourth apical cell; ground color pale rose to bright red orange (host *Quercus* sp.), *aureotecta* p. 1193
 Fore wing without distinct white markings; ground color a uniform orange-yellow or whitish-hyaline 18
18. Fore wing opaque yellowish-white to orange-yellow, with four to five brown spots in inner three basal and in inner two apical cells; without any traces of a median band (host *Ulmus americana*) . . . . *elmata* p. 1194
 Fore wing hyaline to subhyaline, pale yellow to whitish, sometimes with faint traces of a median band, with four to eight spots along cross veins making up apical band (hosts *Quercus alba*, *Q. macrocarpa* and other species of the white oak group), *casta* p. 1196
19. Fore wing with median band nearly uniform in width and parallel sided; apical band with brown spot usually absent from inner basal cell, scutellum frequently light colored (host *Carya ovata*) . . . . *caryata* p. 1198
 Fore wing with median band irregular in width, color pale yellowish brown; brown spot present in inner basal cell of fore wing 20
20. Fore wing with apical band composed of five spots, in inner three basal and inner two apical cells; median band frequently not reaching costal margin, sometimes limited to clavus, band one fourth to one third as wide as wing; ground color opaque milky white to bright yellow (host *Platanus occidentalis*) . . . . *platana* p. 1199
 Fore wing with apical band usually composed of four to eight black spots along cross veins; median band very narrow, in most cases one fourth to one fifth as wide as wing; wing hyaline to whitish subhyaline, rarely opaque (hosts *Quercus alba*, *Q. macrocarpa* and other species of the white oak group), *casta* p. 1196

THE QUERCI GROUP

The species of this group are characterized by having only an apical band of spots on the fore wing when fully matured.

Empoa querci Fitch

(Pl. LXXXVIII, fig. 3)

Empoa querci Fitch, Ann. Rpt. New York State Cab. Nat. Hist., vol. 4, 1851, p. 63. (Reprint) Rpt. New York State Mus. Nat. Hist., vol. 46, 1893, p. 403.
Typhlocyba querci, Woodworth, Psyche, vol. 5, no. 157-159, May-July, 1889, pp. 214.
Typhlocyba gillettei var. *fitchii* McAtee, Proc. U. S. Nat. Mus., vol. 68, art. 18, 1926, p. 25, pls. 1-6.
Typhlocyba querci var. *querci*, Young, Bull. Univ. Kansas Sci. Bull., vol. 35, 1952, p. 103.

Resembling *Empoa elmata* but distinguished from this species by lacking brown spot in inner basal cell of fore wing.

Length.—3.25-3.5 mm.

Color.—Head, pronotum, and scutellum white to bright yellow-orange in deeply colored specimens; fore wing white to bright yellow-orange to shortly anterior to cross veins, with brown spots in apices of second and third basal and in first apical cells, rarely with traces of dark color in first basal cell, and slight traces of brown color at bases of second and fourth apical cells; veins white to yellow-orange, hyaline areas anterior to cross veins in inner three basal cells, apical cells hyaline.

Specimens of this species have been collected on *Quercus borealis* and *Q. palustrus* in Douglas County, Kansas, and from *Q. borealis* in Milwaukee, Wisconsin, by the author.

Specimens have been seen from the following localities: *Tennessee:* Gatlinburg, July 21; *Kentucky:* Jellico, August 15; *North Carolina:* Brevard, June 20; *Michigan:* Muskeegon, July 21; *Wisconsin:* Milwaukee, June 30-July 5; *Kansas:* Douglas County, June 6, 8, 10, 12, 14; *Arkansas:* Fayetteville.

Types.—Allotype female of *Typhlocyba gillettei* var *fitchii*, Washington, D. C., here designated neoholotype of *querci*, and holotype male of *Typhlocyba gillettei* var. *fitchii*, Washington, D. C., July 16, 1885, here designated neoallotype of *querci*, in the U. S. National Museum Collection.

Empoa aureotecta Sanders and DeLong

Empoa aureotecta Sanders and DeLong, Ann. Ent. Soc. America, vol. 10, no. 1, March, 1917, pp. 93-94, pls. 8-9.
Typhlocyba aureotecta, McAtee, Proc. U. S. Nat. Mus., vol. 68, art. 18, 1926, pp. 20, 26, 40, 42.
Typhlocyba gillettei var. *russeola* McAtee, *loc. cit.*, p. 26, (*new synonymy*).
Typhlocyba gillettei var. *saffrana* McAtee, *op. cit.*
Typhlocyba querci var. *russeola*, Young, Bull. Univ. Kansas Sci. Bull., vol. 35, pt. 1, 1952, p. 103.
Typhlocyba querci var. *saffrana*, Young, *op. cit.*

Resembles *Empoa elmata* in color pattern, but differs in having fore wing with distinct lunate white marks anterior to brown spots of apical band.

Length.—3.25-3.75 mm.

Color.—Head, pronotum, and scutellum yellowish white to orange-yellow; fore wings with ground color light rose to bright reddish-orange, extending to shortly basad of cross veins, with brown spots in apices of three inner basal, and in first and fourth apical cells, lunate white spots anterior to spots in inner three basal and fourth apical cells; remaining areas of apical cells fumose hyaline; abdomen yellow to reddish-orange, without dark markings.

The reported host for this species is *Quercus* sp.

Specimens have been seen from the following localities: *Virginia:* Mountain Lake, July 11; *New York:* Heart Lake, Essex County, August 25; *Pennsylvania:* Northeast, July 4; *Ohio:* Delaware County, June 26, July 20; *Wisconsin:* Osceola, July 20; Madison, July 9; Milwaukee, June 28.

Types.—Holotype female, in the collection of D. M. DeLong, Columbus, Ohio; *neoallotype* male, Milwaukee, Wisconsin, June 28, 1950, P. J. Christian, and one *paraallotype* male, Delaware Co., Ohio, June 26, 1947, D. J. & J. N. Knull, here designated, in the Snow Entomological Collections of the University of Kansas; *paraallotype* males: two, Mountain Lake, Virginia, July 11, 1938, and one, July 23, 1940, L. J. and M. J. Milne, in the U. S. National Museum Collection.

Empoa elmata sp. nov.

Resembling *Empoa aureotecta* specimens which tend toward yellow-orange in color, but differs by not having distinct white lunate spots anterior to apical band of spots on fore wing.

Length.—3.5 mm.

Color.—Head, pronotum, and scutellum milky white to bright orange yellow; fore wings whitish-hyaline to opaque milky white, yellow, or orange yellow, usually with four to five small brown spots along cross veins in inner three basal and inner two apical cells, rarely with apical half of fourth and all of third apical cells brown; apical cells whitish or yellowish hyaline; abdomen with dorsum of each segment black or brown on basal half, apical half yellow, lateral sixth entirely yellow on some specimens, venter with basal three segments black on basal half, remaining portions yellow.

This species has been collected by the author on *Ulmus americana* in Milwaukee, Wisconsin, and in Douglas County, Kansas.

Types.—Holotype male and sixteen male paratypes, Douglas

County, Kansas, June 4, 1949, P. J. Christian; allotype female and one male paratype, Douglas County, Kansas, June 6, 1949, P. J. Christian; additional paratypes as follows: two males and two females, Cheboygan County, Michigan, July 18, 1935, H. B. Hungerford; one male, Long Lake, New York, July 28, 1946, L. D. Beamer; one male, June 8, one male, June 11, one male, June 13, two males, June 14, 1929, and four males June 3, 1930, Douglas County, Kansas, P. B. Lawson; one male, June 5, 1948, Wichita, Kansas, P. J. Christian; one male, Jefferson County, Kansas, June 15, 1950, P. J. Christian; one male, May 27, six males, May 30, nine males, May 31, one male, June 1, one male, June 7, five females, June 14, three females, June 18, two females, June 24, 1949, one male, June 5, one male, June 6, four males, June 12, and three females June 21, 1950, Douglas County, Kansas, P. J. Christian; thirty-seven males, June 27, five males, June 8, three males, June 29, eight males and one female, July 1, one female, July 2, five males and two females, July 3, 1950, Milwaukee, Wisconsin, P. J. Christian; allotype female of *Typhlocyba gillettei* var. *saffrana,* Douglas County, Kansas, August, 1923, W. Robinson, in the Snow Entomological Collections of the University of Kansas; one male paratype June 10, 1947, Louisville, Kentucky, D. A. Young, in the U. S. National Museum Collection; one male, Sta. 10, August 11, 1924, a-52, in the collection of Dr. D. M. DeLong.

Empoa apicata (McAtee)

Typhlocyba gillettei var. *apicata* McAtee, Proc. U. S. Nat. Mus., vol. 68, art. 18, 1926, pp. 25-26.
Typhlocyba querci var. *apicata,* Young, Bull. Univ. Kansas Sci. Bull., vol. 35, pt. 1, 1952, p. 103.

Resembling single-banded specimens of *Empoa casta,* but easily distinguished by being smaller in size, and occurring on *Ostrya virginiana* rather than on species of *Quercus.*

Length.—2.75-3.0 mm.

Color.—Head, pronotum, and scutellum white to light yellow; fore wings white to deep yellow-orange, with a transverse band of black spots along cross veins in inner three basal and in first, base of second, and most of third and fourth apical cells; abdomen with dorsum of basal three segments black medially, dorsum of pygofer and anal tube black, venter white to light yellow.

This species has been collected by the author from *Ostrya virginiana* in Milwaukee, Wisconsin, June 27, 28, July 5, and in Douglas County, Kansas, May 30, June 1, 7, in association with *Ribautiana parapiscator* and *R. multispinosa.*

Type.—Holotype male and paratypes in the U. S. National Museum Collection; paratypes in Illinois State Natural History Survey Collection; *neoallotype* female, Douglas County, Kansas, June 7, 1950, P. J. Christian, here designated, in the Snow Entomological Collections of the University of Kansas.

The type series of McAtee includes a number of specimens of *Empoa casta* from *Quercus alba,* but the holotype is more nearly like specimens from *Ostrya virginiana* than from *Quercus alba.*

THE CASTA GROUP

The species of this group are characterized by usually having only the apical and median bands dark.

Empoa casta (McAtee) (*new combination*)

Typhlocyba gillettei var. *casta* McAtee, Proc. U. S. Nat. Mus., vol. 68, art. 18, 1926, pp. 26-27.

Typhlocyba querci var. *casta,* Young, Bull. Univ. Kansas Sci. Bull., vol. 35, pt. 1, 1952, p. 103.

Resembling *Empoa caryata* in color markings, but distinguished by specimens of the same sex being .25-.5 mm. longer, by having median band usually noticeably irregular, and occurring on species of *Quercus* rather than on *Carya.*

Length.—3.25-3.75 mm.

Color.—Head, pronotum, and scutellum usually pale yellowish-white to light yellow, scutellum sometimes deep yellow to light yellow-brown; fore wings yellowish-white to whitish-hyaline, with a narrow light brown median crossband irregular in outline, sometimes indicated by several spots or only by slight traces of brown at the costal margin, apical band of the same color, variable in the number of spots from only four in inner three basal and first apical cells to eight or nine in inner three basal and apical cells; abdomen with dorsum of each segment black on basal half, venter with basal half of each segment black in males, females with venter usually yellow or white. Specimens with only four spots making up the apical band usually lack the median band also.

This species was found to be very abundant in Milwaukee, Wisconsin, where the author collected over a thousand specimens from a wide variety of plants. Many of the specimens taken were seeking shelter from the wind, but specimens were found to consistently occur on *Quercus macrocarpa* and *Ulmus americana.* Specimens from these two hosts form a complete, closely intergrading series extending from typical *casta* specimens to typical *elmata* specimens.

In Douglas County, Kansas, specimens were found to be abundant on *Quercus macrocarpa* in 1949, and were of the typical *casta* pattern, while specimens were rare on *Ulmus americana,* and were consistently specimens of the *elmata* pattern, lacking intergrading specimens between these two species.

Because of the sharp line of distinction between these forms in Douglas County, Kansas, the author has chosen to regard them as distinct species. The intergradation which is found in the specimens from Milwaukee may be due to a shift of specimens from one host to another during a part of their development, resulting in specimens which are extremes in variation from the typical forms which are intermediate between the typical forms.

Specimens from a white oak species in Arizona, and specimens from *Quercus alba* from Milwaukee, Wisconsin, are indistinguishable from typical specimens of *casta* found on *Quercus macrocarpa,* but show no tendency toward a development of intermediate specimens as are found on *Quercus macrocarpa.*

A series of specimens from *Quercus* species? from Franklin, North Carolina, differs from typical *casta* specimens in being slightly larger in size, and in having the median transverse band sharply distinct with smooth margins and the ground color of opaque light yellow. This form may eventually prove to be a distinct species.

Specimens have been seen from the following localities: *Ontario:* Brockville, August 12; *Massachusetts:* Woods Hole, July 7; *New York:* Canisteo, August 14; Elba, August 23; Ithaca, June 17, 27; Minetto, August 30; West Nyack, June 11; Sea Cliff; *Pennsylvania:* Hummelstown, July 7; Duncannan, June 24; *West Virginia:* Great Cacapon, July 4; *Washington D. C.,* June 4; *Virginia:* Mountain Lake, July 12, 23; *Kentucky:* Berea, June 14; *Tennessee:* Gatlinburg, June 20, 24, 25; *North Carolina:* Franklin, August 17; Cherokee, July 19; Raleigh, June 20; *Florida:* Ocala, April 29; *Ohio:* Summit County, June 17; Barberton, August 13; Wooster, July 5, 8; Columbus, October 16; *Illinois:* Urbana, June 8, 9; Bellwood, June 21; Aroma Park, July 8; Bell Smith Springs, July 16; Palos Park, June 23; Roseville, September 1; *Wisconsin:* Milwaukee, June 26-July 5, 18; Madison, July 2, 9; Cranmoor, June 21, 27, September 3; Wisconsin Rapids, June 21; Blue River, July 28; Lake Wingra, July 18; *Minnesota:* St. Anthony Park, June 23; Itasca County, July 26, 28, 29; St. Paul, August 25; Ramsey County, July 20; *South Dakota:* Custer, August 26; *Iowa:* Ames, June 16, September 20-22; Muscatine, June 10, 15; Ledges State Park, June 29; *Missouri:* Neosho, May 28; *Arkansas:* Washington County, June 30; Rodgers, July 10; *Louisiana:* Madisonville, June 11; *Kansas:* Douglas County, June 2-July 20; Wyandotte County, June 23; Leavenworth County, June 28-30; Atchison County, July 10; Coffey County, June 19; Jefferson County, June 15; Cherryvale, June 9; Leon, June 20; *Colorado:* Royal Gorge, July 3; Garden of the Gods, August 19; Ft. Collins, August 6; Sloss, August 17; Creede, July 22; *Arizona:* Oak Creek Canyon, August 9; *New Mexico:* Sapello, July 25; Ruidoso, October 6.

Empoa caryata sp. nov.

Resembling *Empoa casta* but differing in having color markings chestnut brown rather than yellowish-brown, in having dark spot absent from inner basal cell or reduced to only a slight trace, in having margins of median band sharply defined and smooth, and in occurring on species of *Carya* rather than species of *Quercus.*

Length.—3.0-3.5 mm.

Color.—Head and pronotum whitish-yellow to yellow, scutellum usually of the same color but sometimes chestnut brown; fore wings with chestnut brown markings forming a narrow median transverse band one third as broad as long and usually parallel sided, sharply distinct from ground color, apical band composed of chestnut brown spots in second and third basal, all of first, base of second, and all of third apical cells, rarely a trace of dark color in first basal cell, ground color of fore wing pale white to light yellow; abdomen white to light yellow, usually without dark markings.

Types.—Holotype male, allotype female, two male and thirty-seven female paratypes, Douglas County, Kansas, June 11, 1949, P. J. Christian; additional paratypes: one female, July 5, two males and one female, July 1, 1939, Clarksville, Tennessee, R. H. Beamer; one female, August 16, 1946, New Haven, Connecticut, R. H. Beamer; two males and one female, Tuskahoma, Oklahoma, R. H. Beamer; ten males and forty-one females, June 11, 1949, Douglas County, Kansas, R. H. Beamer; one female, Rosedale, Kansas, June 23, 1928, E. P. Breakey; two males and three females, June 12, thirty-three females, June 19, one female, June 21, thirteen females, June 24, two females, June 28, 1949, one male and twenty-two females, June 10, four males and four females, June 12, 1950, Douglas County, Kansas, P. J. Christian; eight males and fourteen females, June 30, two males, July 4, 1950, Milwaukee, Wisconsin, P. J. Christian, in the Snow Entomological Collections of the University of Kansas; one male and five females, July 9, 1948, Ross and Burks, (on hickory), N. Chicago, Illinois, in the Collection of the Illinois State Natural History Survey; one female, June 22, 1918, Mercer County, Ohio, R. F. Hussey, (on *Carya* sp.), in the University of Michigan Collection; one male and six females, July 2, 1939, Ithaca, New York, P. A. Readio; one male, Elba, New York, in the Cornell University Collection.

Empoa platana sp. nov.

Resembling *Empoa casta* in having scutellum light colored but differing in having apical band composed of only five brown spots in inner three basal and inner two apical cells, median band frequently not reaching costal margin, and ground color opaque milky-white.

Length.—3.25-3.75 mm.

Color.—Head and pronotum chalky or milky-white to pale yellowish-white, scutellum pale yellowish-brown on disc; fore wing with ground color chalky white to yellow, with a narrow light brown median band sometimes extending to costal margin, sometimes restricted to clavus, apical band composed of five light brown spots in inner three basal cells and in inner two apical cells; cross veins and apical veins milky white, a border of the same color the width of vein along veins; apical cells whitish-hyaline with traces of brown along outer margins of third and fourth apical cells; abdomen chalky white to light yellow without dark markings.

The host plant for this species is *Platanus occidentalis.*

Types.—Holotype male, allotype female, Louisville, Kentucky, June 10, 1947, in the U. S. National Museum Collection; paratypes: three males and four females, same data as type, in the collection of Dr. D. A. Young, Jr.; two females and two males, same data as type, in the Snow Entomological Collections of the University of Kansas; three females, Columbus, Ohio, October 20, 1920, in the University of New Hampshire Collection; two females, Lexington, Kentucky, August 27, 1915, in the U. S. National Museum Collection; one male and three females, Harrisburg, Pennsylvania, June 13, 1921, in the collection of Dr. D. M. DeLong.

THE GILLETTEI GROUP

The species of this group are characterized by usually having the scutellum dark colored and by having a median and apical band of the same color. Some of the species in this group show polymorphism, having forms with color patterns which are more extensive than the pattern found on specimens of *Empoa gillettei.*

Empoa gillettei Van Duzee (*new combination*)

Typhlocyba bifasciata Gillette and Baker, Bull. Colorado Agr. Exp. Sta., no. 31, Tech. ser. no. 1, 1895, p. 111. (nec. *bifasciata* Boheman, 1852).
Empoa bifasciata, Van Duzee, Check List of Hemiptera (excepting the Aphididae, Aleurodidae and Coccidae) of America North of Mexico, 1916, p. 77.
Empoa querci var. *bifasciata,* Sanders and DeLong, Ann. Ent. Soc. America, vol. 10, no. 1, 1917, p. 93.
Empoa querci var. *gillettei* Van Duzee, Tech. Bull, California Agr. Exp. Sta. Ent., vol. 2, 1917, p. 708. (nom. nov. for *Typhlocyba bifasciata* Gillette and Baker).
Typhlocyba querci var. *gillettei,* McAtee, Canadian Ent., vol. 51, no. 8, 1919, p. 225.
Typhlocyba gillettei var. *gillettei,* McAtee, Proc. U. S. Nat. Mus., vol. 68, art. 18, 1926, pp. 23-24, 27-28.

Resembling *Empoa acericola* but differing in having spot in inner basal cell as large as in other basal cells, median band nearly parallel margined, ground color deeper yellow, and in occurring on *Alnus* sp.

Length.—3.25-3.5 mm.

Color.—Head white, pronotum white with yellow markings on anterior half, laterad of disc; scutellum deep orange yellow to light yellowish brown; fore wings light yellowish white, subhyaline, with a narrow transverse chestnut-brown median band one third to one fifth as broad as width of wing, with an apical band of the same color over cross veins filling apices of inner three basal cells and most of apical cells, apical two thirds of second apical cell fumose hyaline and less deeply colored than other apical cells; abdomen yellow with basal half of dorsum of three basal segments black, dorsum of male pygofer, and anal tube chestnut brown, venter yellow or whitish yellow.

A large series of specimens collected on *Alnus,* Carrizo Creek, Arizona, June 16, 1950, seen by the author, more nearly resemble the type of *Typhlocyba bifasciata* Gillette and Baker, from Colorado, than do specimens of any of the other species in the group.

Types.—Holotype female, type of *Typhlocyba bifasciata* Gillette and Baker, in the U. S. National Museum Collection.

Empoa acericola sp. nov.

Resembling *Empoa gillettei* in color pattern but distinguished by lacking dark spot in inner basal cell of fore wing.

Length.—3.25-3.75 mm.

Color.—Head and pronotum milky-white to light yellow; scutellum chestnut-brown; fore wing with a median transverse chestnut-brown band one third as wide as width of fore wing, of nearly uniform width, margins somewhat irregular, an apical band of same color composed of spots in second and third basal cells, and in all of first, basal third of second, and apical two thirds of fourth apical cells; apical two thirds of second and all of third apical cells strongly fumose-hyaline, areas anterior to bands milky-white to light yellow; abdomen with dorsum of basal three segments brown on basal half, dorsum of pygofer and anal tube brown, venter white to yellow.

This species has been collected by the author in Douglas County, Kansas, and in Milwaukee, Wisconsin, from *Acer saccharinum.*

Types.—Holotype, allotype, and three female paratypes, June 12, 1950, Douglas County, Kansas, P. J. Christian; additional paratypes: two males, June 9, one male, June 15, one male, June 19, 1940, Muscatine, Iowa, and one male, June 12, 1940, Davenport, Iowa, D. R. Lindsay; two males and one female, June 5, one female, June 28, 1949, Douglas County, Kansas, R. H. Beamer; one male, May 31, two males and six females, June 6, two females and one male, June 7, one female, June 9, one female, June 15, two females, July 1, one female, July 15, 1949; seven males, June 3, six males, June 5, twenty-two males, June 8, three males and seven females, June 10, one male and seven females, June 21, 1950, Douglas County, Kansas, P. J. Christian; five males, June 28, five males, June 29, two males and two females, June 27, 1950, Milwaukee, Wisconsin, P. J. Christian, in the Snow Entomological Collections of the University of Kansas.

Empoa venusta (McAtee) (*new combination*)

Typhlocyba gillettei var *venusta* McAtee, Proc. U. S. Nat. Mus., vol. 68, art. 18, 1926, p. 29.
Typhlocyba querci var. *venusta*, Young, Bull. Univ. Kansas Sci. Bull., vol. 35, pt. 1, 1952, p. 103.

Resembling *Empoa gillettei,* but distinguished by having median band usually broader at middle than at margins. Dark form distinguished by having anterior half of fore wing chestnut-brown except for a narrow yellow band along costal margin.

Length.—3.25-3.75 mm.

Color.—Head and pronotum yellowish white to bright yellow; scutellum chestnut-brown, apex sometimes yellow; fore wing with a broad, transverse, chestnut-brown median band, its greatest width half as broad as wing, apical band chestnut-brown, composed of spots in inner three basal cells and all of first, basal third of second, all of third and apical two thirds of fourth apical cells, whitish yellow to yellow on basal fourth of wing and between bands, a narrow whitish-hyaline band basad of dark spots in basal cells and in basal third of fourth apical cell, disc of second apical cell hyaline; dark form specimens differ in having area anterior to median band also chestnut-brown except for a narrow yellow band along costal margin; abdomen yellow with dorsum of basal three segments chestnut-brown, some specimens with basal half of dorsum of all segments chestnut-brown.

A large series of specimens of this species has been collected from *Tilea americana,* in Milwaukee, Wisconsin, by the author.

Specimens have been seen from the following localities: *New Hampshire:* Bretton Woods, August 31; *Connecticut:* New Haven, August 16, 18, 20; *New York:* Albany, June 20; Minetto, August 18, 20, 24, 30; *Ontario:* Trenton, August 25, 29; Vineland Station, June 16; Ottawa, June 27; Toronto, August 8; *Ohio:* Sandusky, Cedar Point, July 11; Barberton, August 13; Milan, September 1; Cleveland, September 3; *Michigan:* Lake Gogebic, August 18; Cheboygan County, July 30; *Minnesota:* Itasca County, July 20, 26; *Wisconsin:* Amery, August 11, 13; Polk County, July; Wisconsin Rapids, August 11; Milwaukee, June 26-July 7; *South Dakota:* Brookings, June 17, 27, July 4, August 10, 17, September 15; Big Stone, August 27.

Types.—Holotype male, allotype female, and paratype male in U. S. National Museum Collection; paratype male in the Snow Entomological Collections of the University of Kansas.

Empoa scripta (McAtee) (*new combination*)

Typhlocyba querci var. *scripta* McAtee, Canadian Ent., vol. 51, no. 8, 1919, p. 226.
Typhlocyba gillettei var. *scripta,* McAtee, Proc. U. S. Nat. Mus., vol. 68, art. 18, 1926, p. 28.
Typhlocyba gillettei subsp. *oregonensis* Beamer, Canadian Ent., vol. 75, no. 7, 1943, p. 133. (*new synonymy*).
Typhlocyba querci var. *scripta,* Young, Bull. Univ. Kansas Sci. Bull., vol. 35, pt. 1, 1952, p. 103.

Resembling *Empoa venusta* in color pattern of lightly marked forms, distinguished in some cases by having median transverse band of nearly uniform width throughout its length, dark color pattern easily distinguished by having a longitudinal dark marking connecting median and apical bands.

Length.—3.25-3.75 mm.

Color.—Head and pronotum yellowish white to yellow, scutellum chestnut-brown to dark yellow-brown; fore wing with variable pattern of chestnut-brown markings, usually with median transverse band nearly half as broad as fore wing, apical band of spots in apices of inner three basal cells, in all of first, base of second, and in apical two thirds of fourth apical cells, ground color yellowish-white to light yellow; some heavily marked specimens with longitudinal stripe from base of fore wing to cross veins, clavus yellow to white along basal and apical third of commissural margin, outer two basal cells yellow to white on basal and apical third; very heavily marked specimens with only a narrow band of yellow on basal and apical third of outer basal cell.

Partly teneral specimens are light yellowish brown, but have the same color pattern. The type series of *Typhlocyba gillettei* var. *oregonensis* is composed entirely of such specimens.

The host for this species is not known definitely, but field notes made at the time of collection of several short series of specimens, include only willow and alder. None of the specimens seen from alder are like specimens of this species so that the more likely host is some species of willow (Salix).

Specimens have been seen from the following localities: *Tennessee:* Great Smoky Mountains National Park, June 24, July 20, September 1; *New York:* Onteora Mountain, Green County; Keene Valley, Essex County, August 24; *Idaho:* Bliss, July 7; *Oregon:* Dixie, Grant County, July 8; Haines, Baker County, July 10; *British Columbia:* Hope, August 1.

Types.—The holotype female of this species was destroyed by fire in 1946, in the Nova Scotia Department of Agriculture. A female specimen, Alum Cave Area, Great Smoky Mountains National Park, September 1, 1948, Ross and Stannard, agreeing with the description of the type in every particular, here designated *neoholotype*, in the Illinois State Natural History Survey Collection; a male specimen, Hope, British Columbia, August 1, 1931, R. H. Beamer, agreeing with the type description, here designated *neoallotype*, in the Snow Entomological Collections of the University of Kansas.

Empoa latifasciata sp. nov.

Resembling *Empoa spinosa* in size and in color pattern, but easily distinguished from this species by having hook on anterior margin of apical half of aedeagal shaft arising from base of median plate rather than from middle.

Length.—3.75-4.25 mm.

Color.—Head and pronotum white to bright yellow; scutellum chestnut-brown; fore wings with a broad transverse median band of chestnut-brown one half as broad at commissural margin as width of fore wing, reduced to nearly half this width at costal margin, posterior margin of band nearly straight but with anterior margin strongly rounded, apical band of same color covering apices of inner three basal cells and all of apical cells, apical cells subhyaline with apical two thirds of second apical cell hyaline, veins in apical band usually fumose, area anterior to median band and between median and apical bands whitish-yellow to orange-yellow with whitish-hyaline areas anterior to apical band in inner three basal cells.

A large series of specimens has been collected from a species of *Alnus* in Sapello, New Mexico.

Types.—Holotype male, allotype female, eight male and twenty-eight female paratypes, July 24, 1950, Sapello, New Mexico, R. H. Beamer; three female paratypes, August 1, 1931, Hope, British Columbia, R. H. Beamer; one female paratype, August 13, 1928, Harris County Texas, L. D. Beamer, in the Snow Entomological Collections of the University of Kansas; one female, August 1, 1916, Maine Agricultural Experiment Station, Orono, Maine; one female, September 7, 1922, Durham, New Hampshire; two females, September 2, 1928, Fabyans, New Hampshire; 1 female August 19, 1928, Alton, New Hampshire, in the New Hampshire State University Collection.

THE VESTITA GROUP

This group is characterized by having the pronotum dark colored. At present it is represented by only one species although three specimens of one, and single specimens of two other color forms which may prove to be species of this group have been seen by the author. Until the hosts for these are known and a sufficient number of specimens is on hand to be able to tell whether or not these are distinct species or only extremes of variability of some described species, the author considers it best for them to remain undescribed.

Empoa vestita (McAtee) (*new combination*)

Typhlocyba gillettei var. *vestita* McAtee, Proc. U. S. Nat. Mus., vol. 68, art. 18, 1926, p. 29.
Typhlocyba querci var. *vestita* McAtee, Young, Bull. Univ. Kansas Sci. Bull., vol. 35, pt. 1, 1952, p. 103.

Resembling the most darkly colored specimens of *Empoa scripta*, but easily distinguished by having the pronotum and usually the head dark chocolate-brown or greenish brown.

Length.—3.25-3.5 mm.

Color.—Head, pronotum, and scutellum greenish- or yellowish-brown to chocolate-brown; fore wings greenish- to yellowish-brown, rarely deep chestnut-brown, with areas in apices of inner three basal cells and areas of apical cells bordering on cross veins deeper brown, veins on apical third of fore wing lighter than surrounding areas, costal vein yellow to reddish-brown, deeply colored specimens of uniform color intensity throughout; face, venter of thorax, and venter of abdomen yellow; basal half of each abdominal segment dark brown; male plates yellow to buff.

More than a thousand specimens of this species have been collected from *Ulmus fulva* in Douglas County, Kansas, where it has been very abundant. A few specimens were taken from the same host in Milwaukee, Wisconsin.

Specimens have been seen from the following localities: *New York:* Norris, August 15; *Pennsylvania:* Greensburg; *Michigan:* Cheboygan County, July 16; *Wisconsin:* Amery, August 14; Milwaukee, June 27-July 4; *Illinois:* Castle Rock, Grand Detour, July 2; Apple River Can. State Park, July 11; *Kansas:* Clay Center, July 2; Douglas County, June through July.

Types.—Holotype male, allotype female, and paratypes, in the Snow Entomological Collections of the University of Kansas; paratypes in U. S. National Museum Collection.

THE SPINOSA GROUP

The species making up this group is marked like some species of the Gillettei Group, but is distinguished by having the aedeagal shaft with hook on anterior margin arising from middle of plate rather than from basal attachment as in all of the species in preceding groups, and with median pair of apical processes equal in length to the second pair of apical processes and crossing near the apex rather than near the middle.

Empoa spinosa (Beamer) (*new combination*)

(Pl. LXXXVIII, fig. 2)

Typhlocyba spinosa Beamer, Canadian Ent., vol. 75, no. 7, 1943, pp. 131-132.

Resembling *Empoa latifasciata* in external appearance, but with hook on anterior margin of aedeagal shaft arising from middle of plate rather than from base.

Length.—3.75-4.25 mm.

Color.—Head and pronotum light to deep yellow; scutellum chocolate brown; fore wings with a broad transverse median band one third to one half as broad as fore wing, apical band chocolate brown and covering apices of inner three basal cells, basal half of first, basal fourth of second, all of third, and all of fourth apical cells; apical half of first and apical three fourths of second apical cells fumose-hyaline or whitish-hyaline, remaining areas of fore wing yellowish white to yellow; abdomen with dorsum of basal three segments entirely chocolate brown, basal half of remaining segments and dorsal half of pygofer chocolate brown, cross veins and apical veins white to slightly fumose, whitish-hyaline areas anterior to apical band in inner three basal cells.

Genital capsule.—Male pygofer with dorsal angle more pronounced than in *Empoa querci*, only slightly rounded at apex, ventral angle broadly rounded, not forming a distinct lobe.

Internal male genitalia.—Aedeagus with median pair of apical processes elongate, crossing at outer fourth, second pair of apical processes equal to median pair in length, with apices nearly meeting, lateral pair of apical processes exceeding both inner pairs in length; median plate on dorsal half of anterior margin of aedeagal shaft produced apically as a large dorsoanteriorly directed hook arising from middle of anterior margin of plate.

Specimens have been seen from the following localities: *Alaska:* Ft. Yukon, July 15; *Colorado:* Sloss, August 17. The type series was collected from huckleberry (*Vaccinium* sp.).

Types.—Holotype male, allotype female, and female paratypes, in the Snow Entomological Collections of the University of Kansas.

THE ALBICANS GROUP

This group composed of only a single species at present, is distinguished from the other species groups by lacking an apical band of dark colored spots, and by having median plate on anterior margin of shaft of aedeagus smoothly rounded rather than produced as a hook.

Empoa albicans Walsh

(Pl. LXXXVIII, fig. 1)

Empoa albicans Walsh, The Prairie Farmer, (n. s.) vol. 10, no. 10, September 6, 1862, p. 149.
Typhlocyba albicans, Woodworth, Psyche, vol. 5, no. 157-159, 1889, p. 214.
Typhlocyba cymba var. *pallens* McAtee, Proc. U. S. Nat. Mus., vol. 68, art. 18, 1926, p. 22. (*new synonymy*).
Typhlocyba cymba var. *cymba* McAtee, Canadian Ent., vol. 50, no. 11, 1918, pp. 360-361.
Typhlocyba cymba var. *grata* McAtee, Canadian Ent., vol. 51, no. 8, 1919, p. 226.
Typhlocyba cymba var. *unipuncta* McAtee, Proc. U. S. Nat. Mus., vol. 68, art. 18, 1926, p. 23. (nec. *Typhlocyba unipuncta* Matsumura, 1908).

Resembling *Typhlocyba putmani*, *T. attenuata*, and *Edwardsiana dejecta* in size and outward appearance when lacking dark markings on dorsum, easily distinguished from these by having three pairs of apical processes on aedeagus.

Length.—4.0-4.5 mm.

Color.—Head, pronotum, and in some specimens entire dorsum yellowish-white to light yellow; scutellum dark brown on specimens with dark markings; fore wings if marked, with dark brown markings varying from having only a trace of a spot in apex of clavus, to having entire clavus and most of inner two basal cells dark brown;

abdomen with basal three segments brown on basal half, venter yellowish white.

Genital capsule.—Male pygofer, in lateral aspect, with ventral angle forming a slight lobe arising mesad of ventral margin; ventral margin obliquely curving dorsocaudad and joining posterior margin near middle.

Internal male genitalia.—Aedeagus with posterior margin of shaft strongly curving dorsad from base, apical processes directed dorsocephalad, median pair nearly parallel to each other, not crossing apically, second pair short, one third length of median pair, lateral pair nearly of equal length to median pair; median plate on dorsal half of anterior margin of shaft of aedeagus evenly rounded, not produced as a hook.

Four short series of specimens each of which includes three or four of the described varieties of McAtee have been seen. In addition to these varieties, intermediate forms also occur and seem to indicate that these forms are only stages in the maturing of some adult specimens such as has been seen in other species of the genus. A single specimen with only the scutellum dark brown has been seen, which seems to indicate that some specimens may terminate color formation at various stages before attaining full coloration. Other specimens entirely lacking dark markings also appear to be fully matured. These may prove to be only color forms of a single species with various individuals terminating color formation at different stages, or they may prove to be specimens of closely related species. Because of insufficient numbers of specimens and inability to study this species in the field, the author has not been able to settle this question.

In the absence of the type specimen of *Empoa albicans* the identity of this species has long been held in question. The original description, reprinted below, is sufficient to indicate that this species belongs in the Typhlocyba Complex.

"*Empoa albicans*—New species, whitish. Eyes fuscous. Two or three of the basal and of the terminal joints of abdomen fuscous at tip; ovipositor black; elytra subhyaline, at tip a little cloudy; triangular cell peduncled; apex of vein which forms the inner cell not attaining half the distance to the apex of elytrum; wings hyaline. Length to tip of wings nearly one-fifth of an inch."

After a consideration of all of the North American species in the Typhlocyba Complex, only four species could be found which were whitish, and one sixth of an inch or more in length. Of these four, only one had dark markings on the dorsal segments of the abdomen, *Typhlocyba cymba* var. *pallens*. Since this is the only known species which fits the description of the type specimen, the author has placed it in synonymy with *Empoa albicans* although the type variety of *Typhlocyba cymba* has color markings which do not fit the description of *E. albicans*.

Specimens have been seen from the following localities: *Nova Scotia:* Halifax, August 9; Wolfville; *Quebec:* Newaygo, July 30, Ridgland, August 15; *Ontario:* Toronto, July 9; Vineland Station, July 1; *Maine:* Portland, July 9; Mt. Katahdin, August; Mt. Bethel, July 7; *Massachusetts:* Cambridge, August 19; *New Hampshire:* Wonalancet, July 1; Jackson, September 18; Durham, August 21; *New York:* Rock City, July 4; Ithaca, July 26; Gowanda, August 2, 9; Stanford, August 2; Catskill, September 17; Heart Lake, Essex County, August 23; Onteora Mt. Green County; *Michigan:* Cranberry Lake, August 9; Cheboygan County, July 7, 26; Douglas Lake, July 13; Agricultural College, June 21; Lake City, July; *Wisconsin:* Hazelhurst, July 12.

Types.—*Neoholotype* female, *neoallotype* male, Newaygo, Quebec, July 30, 1929, Parrish, here designated, in the Snow Entomological Collections of the University of Kansas.

The following type specimens of varieties of *Typhlocyba cymba* McAtee have been destroyed by fire in the Nova Scotia Department of Agriculture, in 1946: Holotype specimens of varieties *cymba, grata, pallens,* and *unipuncta;* allotype and paratypes of variety *pallens*. Paratypes of var. *pallens* are in the Illinois State Natural History Survey Collection, and in the U. S. National Museum Collection. Paratypes of var. *unipuncta* are in the Iowa State College Collection, and in the U. S. National Museum Collection.

GENUS EDWARDSIANA Jazykov (Zachvatkin)

(Pls. LXXXIX-XCII)

Edwardsiana Jazykov (Zachvatkin), Rev. Russe d'Ent., vol. 23, nos. 3-4, 1929, pp. 262-265.

Type of the genus, *Cicada rosae* Linnaeus, by original designation.

Fore wings.—Inner and outer apical cells short, not attaining wing apex; second apical cell much broader at apex than at base; third apical cell petiolate; wing apex smoothly rounded.

Hind wings.—Vein 1V branching from vein 2V near its midlength; submarginal vein absent at wing apex; both apical cells open apically; posterior branch of R fused with apical portion of vein M_{1+2}.

Genital capsule.—Male plate in ventral aspect, broad on basal half, strongly reduced near middle, in lateral aspect gradually curved dorsad on apical half, apical third slightly enlarged but not spatulate, a row of short stout setae on outer half submarginally along dorsal margin, a few scattered setae laterally on apex, and a single large macroseta on base of male plate near outer basal angle; pygofer, in lateral aspect, usually broadly rounded, with a protuberance on dorsocaudal margin sometimes enlarged as a broad angular arm, ventral angle forming a broadly rounded lobe, rarely with a short caudally directed hook; a large group of macrosetae just dorsad of outer basal angle of male plate, numerous setae posterior to these and extending across disc, a patch of macrosetae on inrolled margin of dorsal angle.

Internal male genitalia.—Style elongate, slender, curving laterodorsad, with apex abruptly curved lateroventrad and reduced, appearing setiform, a row of setae along outer margin, mesal margin without setae but with a few alveoli on outer third; connective Y-shaped to triangular, slightly longer than broad; aedeagus without atrial processes, shaft usually slender, gradually tapering to apex, rarely with anterior margin inflated, in lateral aspect as a broad thin plate (*rosae*), with two pairs of apical processes unbranched, or with one or both pairs branched; preatrial arm long; aedeagal apodeme a slender bar, laterally compressed, nearly two thirds length of shaft, usually forming an acute angle with the preatrial arm.

Female.—With posterior margin of eighth abdominal sternite strongly produced medially as an acute lobe as seen in *E. rosae.* (Pl. LXXXVII, figs. 13a, b).

The head in dorsal aspect narrower than pronotum, longer medially than next the eye, anterior margin of crown broadly rounded; pronotum short and broad, lateral margins strongly divergent posteriorly, posterior margin smoothly, shallowly convex, pleural portion broader than ocellocular area.

The species are usually pale white or yellow, occasionally with dark markings.

The genus is holarctic in distribution.

The following key to the North American species of the genus is based primarily on characteristics of the male genitalia.

KEY TO THE SPECIES OF EDWARDSIANA

1. Aedeagal shaft with two paired processes and one mesal unpaired process. (Pl. XC, fig. 6) . . . . *australis* p. 1220
   Aedeagal shaft with only paired processes 2
2. Aedeagal shaft with one or both pairs of apical processes branching 3
   Aedeagal shaft with apical processes unbranched 10

3. Aedeagal shaft with both pairs of apical processes branching . . . 4
Aedeagal shaft with only mesal pair of processes branching 5
4. With mesal pair of processes branching near base; pygofer only slightly produced on dorsal angle. (Pl. LXXXIX, fig. 1), *lethierryi* p. 1213
With mesal pair of processes branching near middle; pygofer strongly produced dorsad as a broad triangular projection. (Pl. LXXXIX, fig. 4) . . . . . . *bergmani* p. 1213
5. With lateral pair of apical processes strongly curved laterocaudad. (Pl. XC, fig. 1) . . . . . . *expanda* p. 1215
With lateral pair of apical processes straight, directed cephalad or dorsad 6
6. Mesal pair of processes fused on basal two thirds, with dorsal branch arising from middle of fused portion. (Pl. XCI, fig. 2), *pseudocommissuralis* p. 1222
Mesal pair of processes not fused on basal two thirds 7
7. Mesal pair of processes branching near middle. (Pl. XC, fig. 2), *frustrator* p. 1216
Mesal pair of processes branching near base 8
8. Dorsal branch of mesal processes broad, strongly curving dorsad anteriorly, dorsal margin concave. (Pl. XC, fig. 3) . . . . *plebeja* p. 1217
Dorsal branch of mesal processes narrow, nearly straight, directed cephalad 9
9. Apices of branches of mesal processes of aedeagus converging apically, forming nearly a circle in anterior aspect. (Pl. XC, fig. 5) . . . . . . *candidula* p. 1219
Apices of branches of mesal processes of aedeagus diverging apically. (Pl. XC, fig. 4) . . . . . . *prunicola* p. 1218
10. Anterior margin of aedeagal shaft laterally compressed to a broad flat plate, lateral apical processes broad, curving strongly dorsocephalad, diverging laterad. (Pl. LXXXIX, fig. 2) . . . . *rosae* p. 1211
Anterior margin of aedeagal shaft not compressed, lateral apical processes slender, directed dorsad, appearing as a continuation of shaft in lateral aspect 11
11. Pygofer with ventral angle strongly produced as a short acute caudally directed process 12
Pygofer with ventral angle evenly rounded, or only slightly produced 13
12. Lateral processes of aedeagus half to one third length of mesal processes. (Pl. XCII, fig. 5) . . . . . . *euphrante* p. 1228
Lateral processes of aedeagus only slightly shorter than mesal processes, mesal processes strongly curved dorsad on apical third. (Pl. XCII, fig. 2) . . . . . . *delongi* p. 1226
13. Mesal processes of aedeagus sharply directed ventrad, convex on anterior margin. (Pl. XCI, fig. 3) . . . . . . *dejecta* p. 1222
Mesal processes of aedeagus not directed ventrad, straight, or slightly concave on dorsal margin 14
14. With dorsal surface of mesal processes of aedeagus concave, strongly curving dorsad near outer half or third 15
With dorsal surface of mesal processes of aedeagus straight, or slightly convex 16

15. Lateral processes of aedeagus one third as long as mesal processes; fore wings entirely white. (Pl. XCI, fig. 4) . . . . *dorsti* p. 1225
    Lateral processes of aedeagus nearly as long as mesal processes; fore wings with commissural margins black. (Pl. XCII, fig. 1), *nigripennis* p. 1225
16. With mesal processes of aedeagus distinctly shorter than lateral processes 17
    With mesal processes of aedeagus equal to or slightly longer than lateral processes; fore wings with commissural margins and part of clavus usually black. (Pl. XCII, fig. 3) . . . . . *commissuralis* p. 1223
17. With mesal processes of aedeagus less than half as long as lateral processes, fused on basal third. (Pl. XCI, fig. 1) . . . . . *projecta* p. 1221
    With mesal processes of aedeagus two thirds as long as lateral processes, not fused on basal third. (Pl. XCII, fig. 4) . . . *ariste* p. 1227

Edwardsiana rosae (Linnaeus)

(Pl. LXXXIX, fig. 2)

Cicada rosae Linnaeus, Systema Naturae, ed. 10, 1758, p. 439. (Engelmann Reprint, ed. 10, p. 439, 1894).
Cicada (Tettigonia) rosae, Geoffroy, Histoire d'Insectes, 1762, p. 428.
Typhlocyba rosae, Herrich-Schäffer, Fauna Insectorum Germanicae initia; oder Deutschlands Insecten gesammelt und herausgegeben von D. G. W. F. Panzer. Fortgesetzt von G. A. W. Herrich-Schäffer, vol. 124, 1834, p. 10.
Cicadula rosae, Zetterstedt, Insecta Lapponica, 1840, p. 300.
Tettigonia rosae, Harris, Insects Injurious to Vegetation, 1842, p. 199.
Typhlocyba pteridis Dahlbom, Handlingar. Kongliga Svenska Vetenskaps Akademien, 1850, pp. 179-181.
Anomia rosae, Fieber, Katalogue der europaischen Cicadinen, 1872, p. 15.
Typhlocyba lactea Douglas, Ent. Monthly Mag., ser. 1, vol. 12, 1875, p. 77.
Empoa rosae, Weed, American Garden, July 1889, p. 257.
Edwardsiana rosae, Jazykov (Zachvatkin), Revue Russe, Ent., vol. 23, nos. 3-4, 1929, p. 265.

Resembling *E. candidula* in external appearance, but easily distinguished from this species and other North American species of the genus by having the anterior margin of the aedeagal shaft produced into a flat plate, appearing greatly enlarged in lateral aspect.

Length.—3.5-3.75 mm.

Color.—White to pale yellow, without dark markings.

Genital capsule.—Male pygofer, in lateral aspect, with posterior margin nearly vertical, slightly slanting ventrocaudad; dorsal angle produced, forming an obtuse angle; ventral angle broadly rounded projecting slightly beyond dorsal angle.

Internal male genitalia.—Aedeagus, shaft with anterior margin produced in a flat plate on apical two thirds, appearing greatly swollen near middle in lateral aspect, with both pairs of unbranched apical processes directed laterocephalad, lateral pair greatly broadened near middle, gradually tapering from middle to acute apex, median pair less broad and with apices curving mesad.

A single abnormal male with processes on each side of aedeagal shaft fused for most of their length, resembling var. *manca* of Ribaut

(1936), but differing in having apices of inner pair of processes forming three short branches, has been seen from Catskill, New York, taken with normal males of this species, and has been drawn for comparison with normal specimens. (Pl. LXXXIX, figs. 2f, g).

The approved common name for this species is "The Rose Leafhopper" (Muesbeck, 1950, p. 138).

Specimens taken on *Malus, Rosa,* and *Rubus* have been seen. Specimens seen are from the following localities: *Nova Scotia; Ontario:* Trenton, June 11; *Massachusetts:* Boston, July 27; Lexington, September 16; *New Hampshire:* Durham, August 20, 29; September 3, 7, 11, 13, 14, 22; *New York:* Ithaca, July; Catskill, October 19; *Pennsylvania:* Northeast, June 7, 8, July 4, October 15; Hazelton, June 12; *Ohio:* Cleveland, September 1, Columbus, May 31, Wooster, August 14; *Minnesota:* Ramsay County, August 22; *Wisconsin:* Green Bay, June 10; Milwaukee, June 26-July 5; Bayfield, September 10; Racine, September 7; *Illinois:* Urbana, October 1, November 4, 10; *Iowa:* Davenport, June 8; *Colorado:* Ft. Collins, September 23; *Utah:* Salt Lake, June 4; Logan, June 11, 26; September 20, 22, October 17; Magna, June 7; Millville, August 2, 3, September 13; Providence, July 18, September 19, 22, October 4; Granite, July 16; Riverside, August 12; Provo, September 17; Hooper, October 14, 16; Fountain, October 22; Richfield, June 9, August 7; Farmington, September 27; *Idaho:* Sandpoint, July 3; Shoshone Basin, July 27; Moscow, October 16; Jerome, June 15; *British Columbia:* Oliver, August 6; Vernon, August 5, 23; Vancouver, August 4; Victoria, October 29, 30; *Washington:* Buckley, July 6; Republic, August 5; Wenatchee, June 26; Pullman, July 2, 3; Puyallup, June 29, July 5; Sumner, October 20; Northwest of Yakima, June 19; *Oregon:* Yoncalla, July 12; Hood River, August 20; Gresham, September 12; Tillanook, October 15; Gilliam County, 30 Mile Creek, June 24; Freewater, August 23; Corvallis, October; LaGrenda, September 11; Jacksonville; Ashland; Waldport, October 22; Rogue River, September; Grant's Pass, September; West of Junction City, October; North of Cobury, October; South of Peoria, October; North of Kirby, September; North of Gold Hill, September; Lancaster, October; Azalea, September, October; Brentwood, August 25; Astoria, August 1; Portland, August, October; Salem, October 21; *California:* San Jacinto Mountains, July 21; Mountain View, September 21, 24; San Francisco, July 25; Quincy, July 23; *Sweden:* Rystad, Frosta, June 20; *Germany:* Bornkagen, Eichsfeld, October 8; *Poland:* Warsaw, June.

Determination of this species is based on figures by Ribaut (1936).

Edwardsiana lethierryi (Edwards)

(Pl. LXXXIX, fig. 1)

Typhlocyba lethierryi Edwards, Ent. Monthly Mag., vol. 17, 1881, p. 224.
Anomia lethierryi, Edwards, Ent. Monthly Mag., vol. 64, 1928, p. 82.
Edwardsiana lethierryi, China, Ent. Monthly Mag., vol. 86, 1950, p. 248.

Resembling *E. hippocastana* (Edwards) (1888), and *E. bergmani* Tullgren, but differs from the former in not having the dorsal branch of mesal pair of processes on aedeagus rebranching, and differs from the latter by having the mesal pair of processes branching nearly from the base.

Length.—3.5-3.75 mm.

Color.—Dorsum yellowish-white to yellow, without dark markings.

Genital capsule.—Male pygofer, in lateral aspect, with posterior margin strongly convex, dorsal protuberance small, ventral angle a large smoothly rounded lobe.

Internal male genitalia.—Aedeagus with shaft slender, elongate, curving dorsocephalad, with two pairs of branching apical processes, lateral pair directed dorsolaterad to fork, dorsal branch shorter than ventral branch and directed dorsad, ventral branch directed ventrolaterad; median pair of processes branching near base, dorsolateral branch one third length of ventral branch.

A large series of male specimens has been collected by the author from *Acer platanoides*, in Milwaukee, Wisconsin.

Specimens have been seen from the following localities: *Nova Scotia:* Truro, August 17; *Massachusetts:* Cambridge, October 13, 20, 24; *New Hampshire:* Durham, September 9; *New York:* Salem, June 26, New York City, June 29, 1900; *Quebec:* St. Anne's, September 2; *Wisconsin:* Milwaukee, June 26, 27, 29; *England:* Cambridge, October 17.

Determination of this species is based on figures by Ribaut (1936).

Edwardsiana bergmani var. *bergmani* (Tullgren)

(Pl. LXXXIX, fig. 4)

Typhlocyba bergmani Tullgren, Ent. Tidskr., vol. 37, 1916, pp. 65-69.
Anomia bergmani, Edwards, Ent. Monthly Mag., vol. 64, 1928, p. 82.
Edwardsiana bergmani, China, Ent. Monthly Mag., vol. 86, 1950 p. 248.

Resembling *E. lethierryi* externally and in shape of aedeagus, but distinguished by having mesal pair of apical processes of the aedeagus branching near middle rather than near base, and by having a broad dorsal process on pygofer.

Length.—3.75 mm.

Color.—Dorsum light yellow without dark markings.

Genital capsule.—Male pygofer in lateral aspect, with posterior margin rounded on lower two thirds, deeply excavated on dorsal third, dorsal angle directed dorsad as a broad triangular, apically rounded process, ventral angle forming a slight lobe.

Internal male genitalia.—Aedeagus, with both pairs of apical shaft processes branching, lateral pair with branches of nearly equal length, directed dorsad, apices slightly curving toward each other; mesal pair of processes branching near middle, both branches slightly concave on dorsal surface, directed cephalad, ventral branches with apices converging mesad; aedeagal shaft strongly convex on posterior margin, recurved near apex, anterior margin more strongly recurved than posterior, width nearly uniform from base to apex in lateral aspect.

Only a single specimen of this variety from Arvidajaur, Sweden, September 20, in the collection of Dr. Frej Ossiannilsson of Uppsala, Sweden, has been seen. Illustrations for this variety have been made from this specimen to show how it differs from the following variety.

Edwardsiana bergmani var. *ariadne* (McAtee)

(Pl. LXXXIX, fig. 3)

Typhlocyba ariadne McAtee, Proc. U. S. Nat. Mus., vol. 68, art. 18, 1926, pp. 14-15.

Length.—4.0-4.25 mm. (Alaska and Montana specimens).
3.75 mm. (Oregon specimens).
3.50 mm. (Michigan, Pennsylvania and Maine specimens).

Color.—Light yellow to light yellow-orange, disc of pronotum and fore wings deeper yellow.

Genital capsule.—Male pygofer, in lateral aspect, with posterior margin rounded on lower two thirds, dorsal angle as in type variety, ventral lobe more pronounced on specimens from Michigan, Pennsylvania, and Maine.

Internal male genitalia.—Aedeagus similar to that of type variety but with shaft strongly convex on both anterior and posterior margins, broader on apical two thirds and apex not recurved, length of apical processes proportionately longer on specimens from Alaska, Montana, and Oregon, lateral processes directed strongly laterad, length of processes on specimens from Michigan, Pennsylvania, and Maine nearly of the same proportion as those of the specimen of the type variety but with shaft distinctly characteristic of that of the holotype of variety *ariadne,* from Vancouver, British Columbia.

The type of variability shown by this species is like that found between *Edwardsiana australis* Froggatt and *E. crataegi* (Edwards), still regarded as distinct species. Because of the scarcity of male specimens, the limited number of localities from which specimens have been collected, and the wide distribution of the species, the author has considered it best to regard *ariadne* as a variety of *bergmani* until conclusive evidence can be seen for regarding it as a distinct species.

Specimens have been seen from the following localities: *Alaska:* Ft. Yukon, July 15; Matanuska, July 12, 19, 21, 27, 28, August 17, September 24, 27, 28, October 2, 5, 6; Northeast of Anchorage, August 4; Sleese Highway, September 4; Anchorage, July 20; North of Paxton's Lodge 27-52 miles, July 28; *British Columbia:* Hope, August 1; Vancouver; Kalso, July 13, 17, June 22; *Oregon:* Mount Hood, July 3; Bonnville, July 4; Tillamook, October 15; *Washington:* Shelton, July 24; Sumner, August 20, September 18; Kalama, July 21; Conway, July 28; Quinault, July 26; *Montana:* Haugan, August 9; *Michigan:* Au Train, August 21; *Pennsylvania:* Hartstown Bog, September 13; *Maine:* Dixfield, October 20.

Types.—Holotype male, allotype female, and paratypes in the U. S. National Museum Collection; paratypes in the collection of W. Downes.

Edwardsiana expanda (DeLong and Johnson) (*new combination*)

(Pl. XC, fig. 1)

Typhlocyba expanda DeLong and Johnson, Ent. News, vol. 47, no. 4, April, 1936, p. 104.

Resembling *E. bergmani* var. *ariadne* in external appearance, but distinguished by having aedeagus with lateral pair of apical processes unbranched and strongly recurved laterodorsad.

Length.—4.0-4.5 mm.

Color.—White to light yellow without dark markings.

Genital capsule.—Male pygofer in lateral aspect very similar to that of *E. lethierryi,* but with ventral lobe more pronounced.

Internal male genitalia.—Aedeagus with lateral pair of apical processes unbranched, elongate, longer than mesal pair, closely appressed to shaft on basal fourth and directed dorsad, apical three fourths sharply recurved laterodorsad; mesal pair of processes directed laterocephalad branching near middle, dorsal branch slightly longer than ventral branch, branches diverging from base and slightly curving toward each other at apices in lateral aspect.

Two abnormal specimens of this species which have the lateral processes shorter than usual and not recurved, have been seen, and superficially resemble the illustration of *Edwardsiana kemneri* Ossiannilsson, but are distinguished by having the mesal pair of processes like those of typical specimens of *E. expanda.* (see Plate XC, fig. 1d).

Specimens have been seen from the following localities: *Alaska:* Ft. Yukon, July 15; North of Paxton's Lodge 27-52 miles, July 28; *Northwest Territories:* Good Hope, August 23; *Oregon:* Hood, August 22; *California:* Siskiyou Mountains, June 24; *Colorado:* Cameron Pass, June 24; Estes Park, August 21, 25.

Types.—Holotype male, allotype female, and female paratype, in the collection of Dr. D. M. DeLong, Columbus, Ohio.

Edwardsiana frustrator (Edwards)

(Pl. XC, fig. 2)

Typhlocyba frustrator Edwards, Ent. Monthly Mag., vol. 44, 1908, p. 84.
Anomia frustrator, Edwards, Ent. Monthly Mag., vol. 64, April, 1928, p. 82.
Typhlocyba solearis Ribaut, Bull. Soc. Hist. Nat. Toulouse, vol. 61, pt. 1, 1931, p. 339.
Edwardsiana frustrator, China, Ent. Monthly Mag., vol. 86, 1950, p. 248.

Resembling *E. prunicola* in the shape of the aedeagus, but distinguished from it by having mesal pair of apical processes with branches as long as unbranched portion, and aedeagal shaft more slender and nearly straight.

Length.—3.5 mm.

Color.—Pale yellowish white to light yellow without dark markings.

Genital capsule.—Male pygofer, in lateral aspect, with dorsal angle smoothly rounded, ventral angle slightly angular and rounded apically.

Internal male genitalia.—Aedeagus with shaft slender, elongate, nearly straight, directed dorsad, lateral pair of apical processes unbranched, slightly concave on dorsal surface, directed cephalad for half the length of mesal pair, mesal pair of apical processes branching near middle, directed cephalad, with dorsal branch convex on dorsal surface and with ventral branch slightly concave on dorsal surface, branches less divergent than in *E. expanda.*

This species has not previously been recorded from North America and has recently been introduced from Europe, where it has been found on "nut bushes" and on "sycamore" according to China

(1943). Specimens seen have been taken on *Corylus*. Specimens have been seen from the following localities: *Washington:* Shelton, July 24, 1949; *Oregon:* McMinnville, August 22, 1946; Salem, September 29, 1947; Portland, October, 1948; Wheatlend, October 15, 1949; Orleans, October, 1949; West of Junction City, October, 1949; North of Coburg, October, 1949; Clackomas, October, 1950; *Sweden:* Linkoping, July 7, 1935 on *Acer platanus*.

Determination of this species is made on the basis of figures of the male genitalia of *Typhlocyba solearis* by Ribaut (1931b, 1936), reprinted by China (1943) as representative of the type of *T. frustrator* Edwards.

Edwardsiana plebeja (Edwards)

(Pl. XC, fig. 3)

Typhlocyba plebeja Edwards, Ent. Monthly Mag., vol. 50, 1914, pp. 168, 172.
Anomia plebeja, Edwards, Ent. Monthly Mag., vol. 64, April, 1928, p. 82.
Typhlocyba divergens Ribaut, Bull. Soc. Hist. Nat. Toulouse, vol. 61, pt. 1, 1931, pp. 339-341.
Edwardsiana plebeja, China, Ent. Monthly Mag., vol. 86, 1950, p. 248.

Resembling *E. prunicola* in external appearance and in male genitalia, but differing in having dorsal branch of mesal pair of aedeagal processes curving strongly dorsad, and by having margins of pygofer forming nearly a semicircle in lateral aspect.

Length.—3.25-3.75 mm.

Color.—Yellowish-white to light yellow without dark markings.

Genital capsule.—Male pygofer, in lateral aspect, with posterior margin outlining a semicircle from base of anal tube to middle of ventral lobe, dorsal and ventral angles reduced.

Internal male genitalia.—Aedeagus with shaft evenly convex on posterior margin from base of preatrial shaft to apex, gradually reduced toward apex, lateral pair of apical processes unbranched, short, one third as long as mesal pair and directed dorsolaterad, mesal pair of apical processes branching at basal fourth, dorsal margins of both branches concave, dorsal branch broad in lateral aspect and strongly curving dorsad, ventral branch shorter and directed ventrocephalad.

A large series of specimens including nymphs labeled *Ulmus americana,* and several specimens labeled "Weeping Elm" have been seen.

Specimens have been seen from the following localities: *Massachusetts:* Wood's Hole, July 9, 1900; Cambridge; *New York:* September 1, 1919 (a series of 18 specimens made paratypes of *T. commissuralis* var. *munda* McAtee); *Washington D. C.:* May 24, 26;

Virginia: Arlington, October 2. Mrs. J. N. Knull informs me she has specimens of this species taken in Ohio.

This species has not previously been recorded as occurring in North America, although the first specimens were collected in 1900.

Determination of specimens is based on the figures of the male genitalia of *Typhlocyba divergens* Ribaut, (1931b, 1936), reprinted by China (1943) as representative of the type of *T. plebeja* Edwards.

Edwardsiana prunicola (Edwards)

(Pl. XC, fig. 4)

Typhlocyba prunicola Edwards, Ent. Monthly Mag., vol. 50, 1914, pp. 168, 172.
Anomia prunicola, Edwards, Ent. Monthly Mag., vol. 64, April, 1928, p. 82.
Typhlocyba barbata Ribaut, Bull. Soc. Hist. Nat. Toulouse, vol. 61, pt. 1, 1931, pp. 338-339.
Typhlocyba pruni DeLong and Davidson, Ohio J. Sci., vol. 34, no. 3, 1934, pp. 161-162, figs. 1-3.
Typhlocyba pruniella DeLong, Ohio J. Sci., vol. 44, no. 6, 1944, p. 272. (n. n. for *pruni* DeLong and Davidson, nec. *pruni* Edwards).
Edwardsiana prunicola, China, Ent. Monthly Mag., vol. 86, 1950, p. 248.

Resembling *E. plebeja* in outward appearance and in male genitalia, but distinguished by having median pair of apical processes of aedeagus branching near base, dorsal branch slender and longer than ventral branch, nearly straight and directed cephalad, and by having dorsal and ventral angles of pygofer produced.

Length.—3.75-4.0 mm.

Color.—Uniform light yellowish white to yellow without dark markings.

Genital capsule.—Male pygofer, in lateral aspect, with dorsal angle forming a rounded protuberance, ventral angle slightly produced forming nearly a right angle.

Internal male genitalia.—Aedeagus with lateral pair of apical processes unbranched and curving dorsocephalad and diverging laterally, mesal pair of apical processes branching near basal third, dorsal branch nearly straight, directed cephalad forming nearly a right angle with the axis of shaft, ventral branch directed ventrad toward base of aedeagal apodeme in lateral aspect, apices of both pairs of processes diverging laterad.

Specimens have been seen from the following localities: *New York:* Albany, August 17, 1900; *Utah:* Provo, September 17; Logan, June 26; Bountiful, June 20, July 2; *Idaho:* Boise, July 11; Parma, September 3; *Washington:* Puyallup, July 5; Yakima, August; *Oregon:* The Dalles; Milton, June 8; Dufur; Ashland; South of Peoria; *California:* Berkeley, May 15; San Jose, April 22; *Sweden:* August 14, "Prunus"; *Rumania:* Bucharest; *Bohemia.*

Determination of specimens is based on the figures of the male genitalia printed by China (1943). Specimens have been seen which have the pygofer rounded on ventral angle in addition to specimens similar to each of the drawings of the pygofer shown by China. The shape of the aedeagus is identical in specimens having variation in the shape of posterior margin of pygofer which seems to indicate that these forms are only degrees of variation within the species and insufficient as evidence for making *prunicola* and *barbata* distinct species.

Edwardsiana candidula (Kirschbaum)

(Pl. XC, fig. 5)

Typhlocyba candidula Kirschbaum, Jharb., Ver. Nat. Nassu., vol. 21-22, 1868, p. 185.
Anomia candidula, Edwards, Ent. Monthly Mag., vol. 64, April, 1928, p. 82.
Edwardsiana candidula, China, Ent. Monthly Mag., vol. 86, 1950, p. 248.

Resembling *E. expanda* in outward appearance and in shape of male genitalia, but distinguished by having lateral pair of processes on aedeagus directed dorsolaterad, not sharply recurved, apices of both branches of mesal pair of processes curving mesad.

Length.—3.5-3.75 mm.

Color.—Uniform milky-white without dark markings.

Genital capsule.—Male pygofer, in lateral aspect, with dorsal and ventral angles reduced, forming a single caudally directed, apically rounded lobe.

Internal male genitalia.—Aedeagus with shaft strongly convex on posterior margin, smoothly curving and evenly tapered to apex, lateral pair of apical processes unbranched, slender, directed dorsolaterad and appearing as a continuation of the shaft in lateral aspect, length equal to that of the mesal processes, mesal pair of processes of the aedeagus branching near base, branches slender, slightly diverging and curving laterocephalad outlining nearly a complete circle in cephalic aspect.

A large series of specimens of this species has been collected by the author from *Populus alba* in Milwaukee, Wisconsin. Specimens have been seen from the following localities: *Wisconsin:* Milwaukee, June 26-July 5; *Minnesota:* St. Paul, July 8, 11; *Oregon:* North of Coburg, October; *Germany:* Buchen, September 30, 1934, determined by W. Wagner.

Determination of specimens of this species has been based on figures of the male genitalia according to Ribaut (1936).

Edwardsiana australis (Froggatt) (*new combination*)

(Pl. XC, fig. 6)

Empoasca australis Froggatt, Agr. Gaz. New South Wales, vol. 29, 1918, pp. 568-571.
Typhlocyba australis, Myers, Proc. Linn. Soc. New South Wales, vol. 46, 1921, pp. 473-474.
Typhlocyba froggatti (Baker), Philippine J. Sci., vol. 27, 1925, p. 537. (nom. nov. for *australis* Froggatt, nec. *australis* Walsh 1862.)
Typhlocyba xanthippe McAtee, Proc. U. S. Nat. Mus., vol. 68, art. 18, 1926, p. 14.
Empoa (*Typhlocyba*) *malini* DeLong, J. Econ. Ent., vol. 19, no. 3, 1926, pp. 469-470.
Typhlocyba oxyacanthae Ribaut, Bull. Soc. Hist. Nat. Toulouse, vol. 61, pt. 1, 1931, pp. 334-335.
Edwardsiana froggatti, China, Ent. Monthly Mag., vol. 86, no. 1035, (4th ser. vol. XI, no. 128) 1950, pp. 243-248.

This species is not *Erythroneura australis* Walsh (1862), the synonymy of which is given on p. 1142.

Resembling *E. crataegi* in external appearance, and in male genitalia, but differing in having lateral pair of apical processes on aedeagus shorter, distinguished from other species by having a median unpaired process as well as two pairs of unpaired processes.

Length.—3.5-3.75 mm.

Color.—Dorsum yellow to orange-yellow; fore wings with fumose areas along commissural suture covering outer half of clavus, apices of inner three basal cells, and all of hyaline apical cells.

Genital capsule.—Male pygofer, in lateral aspect, with posterior margin nearly straight, obliquely slanting ventrocaudad, dorsal posterior margin excavated and with a short projection arising on dorsal margin.

Internal male genitalia.—Aedeagus with shaft broad on basal half, apical half slender, with two pairs of unbranched apical processes and a single unpaired median process; lateral pair of apical processes shorter than mesal pair, curving laterodorsad and caudad; mesal pair of processes strongly concave on dorsal surface and curving dorsolaterad anteriorly; unpaired process arising between mesal pair of processes and strongly convex on dorsal margin curving dorsocephalad.

Several short series of specimens of this species were collected by the author in Milwaukee, Wisconsin, from: *Crataegus* sp., *Malus* sp., *Aesculus hippocastanum,* and *Prunus* sp.

Specimens have been seen from the following localities: *Massachusetts:* Lexington, June 19; Cambridge; Boston, June 23; *Connecticut:* New Haven, August 18, 20; Mystic, August 19; *New York:* New York City, June 22; *Ontario:* Vineland Station, September 2, 8, 13; *Ohio:* Wooster, July 5; Columbus, July; *Minnesota:* St. Paul, August 20; *Wisconsin:* Milwaukee, June 26-July 5; *Utah:* Castle Dale, August 27; *British Columbia:* Vancouver, August 4; *Washington:* Puyallup, July 5; *Oregon:* Portland, October; Neskowin, October 3; Clachomas, October 13; *California:* Sequel, June 7; *Chile:* Santiago Quinta Normal, December, 1946; El Pino Angol, February 27, March 24, 1932, on apple.

Although Mrs. J. N. Knull has informed me (in correspondence) that she has seen a specimen of *E. crataegi* among specimens of *E. froggatti* from Wooster, Ohio, the author has not seen any specimens of *crataegi* in the samples of this species examined. It is quite possible that this species is only a variety of *crataegi,* and if this is the case additional specimens of *crataegi* should be found in North America.

Determination of specimens of this species are based on figures of the male genitalia printed by W. E. China (1943).

Edwardsiana projecta sp. nov.

(Pl. XCI, fig. 1)

Resembling *E. candidula* in outward appearance, but easily distinguished by having mesal pair of processes on aedeagus one fourth the length of lateral processes, and fused on basal half, appearing as single branching median process.

Length.—3.5-4.0 mm.

Color.—Uniform milky-white without dark markings.

Genital capsule.—Male pygofer, in lateral aspect, with posterior margin nearly straight, slanting obliquely ventrocaudad, dorsal angle more prominent than in preceding species, ventral angle forming a broad, caudally protruding lobe.

Internal male genitalia.—Aedeagus very similar to that of *E. fratercula* (Edwards) but with mesal pair of apical processes unbranched; shaft proportionately short and stout as compared to other species, scarcely longer than aedeagal apodeme, apical half straight and only slightly reduced in diameter toward apex; lateral processes slender, widely diverging laterodorsad, posterior margin convex in lateral aspect; mesal processes straight, directed cephalodorsad, one fourth the length of lateral processes, fused on basal third and appearing as a single branched process, apical two thirds as long as broad.

Types.—Holotype male and three male paratypes, LaVeta Pass, Colorado, July 28, 1937, L. D. Tuthill, in the Iowa State College Collection.

Edwardsiana pseudocommissuralis sp. nov.

(Pl. XCI, fig. 2)

Resembling *E. commissuralis* in color markings, but with mesal pair of apical processes on aedeagus branching.

Length.—3.75-4.0 mm.

Color.—Head and pronotum yellow to yellow-orange; scutellum brown medially, outer angles yellow; fore wings yellow to yellow-orange, with black longitudinal band along commissural margin on outer half of clavus extending to cross veins, apices of basal and all of apical cells fumose-hyaline.

Genital capsule.—Male pygofer, in lateral aspect, with posterior margin strongly rounded, similar to pygofer in *E. plebeja.*

Internal male genitalia.—Aedeagus with shaft slender, slightly enlarged on basal half, posterior margin slightly angled near middle, with two pairs of apical processes; lateral pair of apical processes unbranched, exceeding mesal pair in length, directed dorsolaterad, sinuate on apical two thirds; mesal pair of apical processes fused on basal two thirds, with a pair of short straight branches arising at basal third, directed dorsocephalad parallel to each other, apical two thirds strongly curving laterodorsad anteriorly, apical third divided into two branches which diverge laterad.

Types.—Holotype male, Trinity Bay, Quebec, August 20, 1929, W. J. Brown, in the Canadian National Collection; allotype female and female paratype, Crawford Notch, New Hampshire, August 21, 1934, P. W. Oman, in the U. S. National Museum Collection.

Edwardsiana dejecta sp. nov.

(Pl. XCI, fig. 3)

Resembling *Typhlocyba putmani* in external appearance, but easily distinguished by the absence of atrial processes on the aedeagus, and by having mesal pair of apical processes unbranched and directed sharply ventrad from base.

Length.—4.0-4.5 mm.

Color.—Uniformly light yellowish-white to yellow without dark markings.

Genital capsule.—Male pygofer, in lateral aspect, with posterior margin nearly straight, dorsal angle slightly produced, ventral angle slightly angular.

Internal male genitalia.—Aedeagus with shaft elongate, slightly enlarged on basal two thirds, reduced on outer third and slightly sinuate, with two pairs of unbranched apical processes on aedeagus, lateral pair half as long as mesal pair, nearly straight, diverging laterodorsad anteriorly, mesal pair of apical processes sharply directed ventrad from base, broadly joined basally by a transverse plate, only slightly diverging and curving toward base of shaft.

A large series of specimens has been collected by the author from *Cornus stolonifera*, in Milwaukee, Wisconsin, in association with *Typhlocyba putmani*, a species almost identical with it in external appearance.

Types.—Holotype male and fifty-nine paratype males, Milwaukee, Wisconsin, July 1, 1950; allotype female and twenty-three female paratypes, July 3, 1950, Milwaukee, Wisconsin; one male paratype June 26, 1950, Milwaukee, Wisconsin; seven male paratypes, July 4, 1950, Milwaukee, Wisconsin, P. J. Christian; types in the Snow Entomological Collections of the University of Kansas; one male paratype, July 13, 1940, and two female paratypes, July 16, 1940, Vineland Station, Ontario, W. L. Putman, in the Canadian National Collection.

THE COMMISSURALIS COMPLEX

The following six species compose a group which on the basis of male genitalia appear to be more closely related to each other than to other species in the genus.

Edwardsiana commissuralis (Stål) (*new combination*)

(Pl. XCI, fig. 3)

Typhlocyba commissuralis Stål, Stett. Ent. Zeit., vol. 19, 1858, p. 196. (Reprint by Gillette, 1898, Proc. U. S. Nat. Mus., vol. 20, pp. 769-770.)
Kybos commissuralis, Fieber, Verh. Zool.-bot. Ges. Wien., vol. 16, 1866, p. 508.
Empoasca commissuralis, Ashmead, Harriman Alaskan Exped., vol. 8, 1904, p. 135.
Empoa commissuralis, Van Duzee, Trans. San Diego Soc. Nat. Hist., vol. 2, no. 1, 1914, p. 57.
Typhlocyba commissuralis var. *munda* McAtee, Proc. U. S. Nat. Mus., vol. 68, art. 18, 1926, p. 12.

Resembling *E. pseudocommissuralis* in color markings, but with apical processes of aedeagus unbranched, lateral pair as long as or slightly shorter than median pair, pygofer with posterior margin oblique and with ventral angle smoothly rounded.

Length.—3.0-4.5 mm.

Color.—Head, pronotum, and lighter portions of fore wing light yellowish-white to orange-yellow; scutellum and commissural margin of fore wings usually dark black, width of black on wing varies from a narrow line to two-thirds the width of clavus, apical cells fumose, heavily pigmented specimens with dorsal surface of head near base, pronotum, apical half of clavus, and basal fourth of costal margin dark black, lighter portions deep yellow and apical cells strongly fumose; abdomen yellow, margin of each segment of dorsum black, pygofer with heavily sclerotized portions black.

Genital capsule.—Male pygofer, in lateral aspect, with posterior margin evenly rounded from base of anal tube to ventral angle, slightly produced as a broad ventrally directed lobe.

Internal male genitalia.—Aedeagus slender, gradually tapering to apex, curving cephalad from base, with two pairs of unbranched apical processes, processes slightly sinuate, the lateral pair directed dorsocephalad diverging laterad and continuing in the same axis as the shaft in lateral aspect, mesal pair of processes directed ventrocephalad and diverging laterad.

The host plants known for this species are *Alnus viridis* and *A. rhombifolia.* A series of specimens is also on hand collected on "flowering dogwood".

Specimens have been seen from the following localities: *Alaska:* Fairbanks, July 24, 28; Valdez, August 24; Matanuska, July 21; *Northwest Territories*: Aklavik, July 18; *British Columbia:* Vancouver, August 4, 8, September 3; Saanich District, September 12; Gorgon Head, September 12; Victoria, November 11; *Washington:* Buckley, July 6; Sumner, August 20; Puyallup, July 6; Shelton, July 24; *Oregon:* Rogue River, August 16; Lee's Camp, September 23; The Dalles, October 8; Scapoose, October 16; Mount Hood, July 3, 8; McMinnville, August 15, 19, 21; Tillamook, October 15; Pioneer, October 15; Booneville, July 4; Bend, July 2, 3; Dixie, July 8; North Powder, July 13; Pendleton, July 14; *California:* North of Cassel 5 miles, July 15; Muir Woods, September 5; Tahoe South Alpine Creek, July 15; Cucamonga, December 12; Eureka, July 23; Bray, June 30; Alameda County, July 19; Lemon Cove, July 24; Strawberry, August 8; Stinson Beach, August 15; Donner Lake, June 6; Colfax, June 23; *Wyoming:* Laramie, August 16; *Idaho:* Alturas Lake, July 19; *Utah:* Emery, August 16; *Colorado:* Pagosa Springs; Sloss, August 17; Durango, July 17.

Types.—Holotype male, Sitka, Alaska, (present location of type unknown).

Variety *munda,* holotype, allotype and paratypes, in the U. S. National Museum Collection. One paratype male, Vancouver, British Columbia, is a specimen of *E. bergmani* var. *ariadne,* and a series of paratypes from New York are specimens of *E. plebeja.* Some of the specimens of this variety are only teneral specimens, but others appear to be fully matured yet lack the dark markings of the type variety.

Specimens bearing a black commissural line, and occurring in Northeastern United States and Southeastern Canada, will probably be specimens of *E. pseudocommissuralis.* Specimens of *Ossiannilssonola phryne* may also be confused with it, but differ by having black parenthesis-shaped markings on the scutellum and pronotum, and a black spot in each of inner three basal cells.

Edwardsiana dorsti (Ossiannilsson) (*new combination*)

(Pl. XCI, fig. 4)

Typhlocyba dorsti Ossiannilsson, Ent. Tidskr., vol. 57, no. 1, 1936, pp. 10-11, figs. 1-3.
Typhlocyba enascora DeLong and Johnson, Ent. News, vol. 47, no. 4, April, 1936, pp. 103-104, figs. 1-6. (*new synonymy*).

Resembling *E. euphrante* in outward appearance and in proportion of apical processes of aedeagus, but differs in having posterior margin of pygofer smoothly rounded and without hook on ventral angle, and in having median pair of apical processes parallel to each other and strongly curving dorsocephalad on apical half.

Length.—3.5 mm.

Color.—Light yellowish-white to light yellow without dark markings.

Genital capsule.—Male pygofer, in lateral aspect, with posterior margin forming a broadly rounded lobe, ventral angle slightly pointed.

Internal male genitalia.—Aedeagus with shaft slender, gradually reduced toward apex, with two pairs of unbranched apical processes, lateral pair straight and directed dorsolaterad, less than half as long as mesal pair, mesal pair of apical processes strongly curving dorsocephalad on apical half, fused at base and continuing nearly parallel to each other to apex.

Specimens from the following localities have been seen: *Idaho:* Idaho Falls, July 27; *Oregon:* Dufur; *Nevada:* Ormsby, July.

Types.—Holotype male, in the collection of Dr. Frej Ossiannilsson, Uppsala, Sweden. The aedeagus of the holotype has been lost since its description, but the original drawings are sufficiently clear to recognize it as the same species as the holotype of *Typhlocyba enascora.* The description of *dorsti* was mailed on February 2, 1936, while that of *enascora* was mailed April 12, 1936.

Edwardsiana nigripennis sp. nov.

(Pl. XCII, fig. 1)

Resembling *E. commissuralis* externally by having commissural vein black on basal two thirds and in its large size, but distinguished by having median pair of apical processes strongly curving dorsocephalad and in having all of aedeagus but the apical third of shaft black rather than brown.

Length.—4.0 mm.

Color.—Light yellowish-white to yellow with commissural vein brown on basal two thirds.

Genital capsule.—Male pygofer, in lateral aspect, with posterior margin nearly straight, obliquely slanting ventrocaudad, dorsal angle slightly produced to a point, ventral angle slightly produced caudally to a point.

Internal male genitalia.—Aedeagus with shaft slender, with two pairs of unbranched apical processes of nearly equal length, lateral pair of processes slender, directed dorsolaterad in the same axis as the shaft, median pair of processes strongly curving dorsolaterad from base, preatrial arm and basal two thirds of shaft black, apical third dark brown as in other species.

Types.—Holotype male, allotype female, four male and three female paratypes, Stinson Beach, California, August 15, 1938, R. H. Beamer, in the Snow Entomological Collections of the University of Kansas.

Edwardsiana delongi sp. nov.

(Pl. XCII, fig. 2)

Resembling *E. nigripennis* in shape of the aedeagus, and *E. euphrante* in the shape of the pygofer, distinguished from the first by having hook on ventral angle of pygofer, and from the second by having apical processes of aedeagus of nearly equal length.

Length.—3.25-3.5 mm.

Color.—Light yellowish-white to yellow without dark markings.

Genital capsule.—Male pygofer, in lateral aspect, with posterior margin nearly straight and slanting ventrocaudad, dorsal angle slightly produced, ventral angle with a short caudally directed hook.

Internal male genitalia.—Aedeagus with two pairs of unbranched apical processes, lateral pair directed strongly laterad on basal half and curving dorsocephalad on apical half, median pair of processes strongly curving dorsocephalad and only slightly distant from each other throughout their length.

Types.—Holotype male, allotype female, and one male paratype, Bray, California, June 30, 1935, R. H. Beamer, and one male paratype, Dixie, Oregon, July 8, 1939, R. H. Beamer, in the Snow Entomological Collections of the University of Kansas; twenty-four female and sixteen male paratypes, Bray, California, June 30, 1935, P. W. Oman, and eight female and four male paratypes, Kalama, Washington, July 4, 1935, P. W. Oman, in the U. S. National Museum Collection; one male, Grant's Pass, Oregon, September, 1949, S. M. Dietz, in the Oregon State Department of Agriculture Collection, Salem, Oregon; two males and one female paratype, south of San Francisco, California, October 2, 1915, O. E. Essig, on Wild Blackberry, in the University of California Collection; some paratypes from Washington, Oregon, and S. of San Francisco, differ in having the ventral hook of the pygofer reduced.

Edwardsiana ariste (McAtee) (*new combination*)

(Pl. XCII, fig. 4)

Typhlocyba ariste McAtee, Proc. U. S. Nat. Mus., vol. 68, art. 18, 1926, p. 13.

Resembling *E. australis* (Froggatt) in size and color markings, and *E. commissuralis* in form of male genitalia, differing by having only two pairs of apical processes on aedeagus and in having the lateral pair exceeding the median pair by one fourth.

Length.—3.5-3.75 mm.

Color.—Yellowish-white to slightly greenish-yellow or yellow, with fumose spots in apices of basal and all of apical cells, slightly fumose along commissural margin.

Genital capsule.—Male pygofer, in lateral aspect, with posterior margin convex, with ventral angle slightly produced caudad as a small apically rounded lobe.

Internal male genitalia.—Aedeagus slender on distal half, with two pairs of unbranched apical processes, lateral pair of processes one-fourth longer than median pair, slender and widely diverging laterodorsad appearing as a continuation of apex of shaft in lateral aspect, median pair of processes slender and straight, diverging laterocephalad.

This species occurs on *Ribes.* Specimens have been seen from the following localities: *New Mexico:* Pecos, September 1; *Colorado:* Creede, July 2, 3, 16; Estes Park, July 18, August 25; Ft. Collins, July 19.

Types.—Holotype male, in the U. S. National Museum Collection; female, Creede, Colorado, July 16, 1938, L. D. Tuthill, collected with males of this species, here designated *neoallotype,* in the Iowa State College Collection.

Edwardsiana euphrante (McAtee) (*new combination*)

(Pl. XCII, fig. 5)

Typhlocyba euphrante McAtee, Proc. U. S. Nat. Mus., vol. 68, art. 18, 1926, pp. 12-13.

Resembling *E. ariste* in external appearance and in form of the male genitalia, but distinguished by having lateral pair of apical processes of aedeagus one third length of median pair and by having ventral hook on pygofer produced to an acute apex.

Length.—3.5 mm.

Color.—Yellowish-white to dark yellow, fore wings sometimes light greenish-yellow, apical and apices of basal cells slightly fumose.

Genital capsule.—Male pygofer, in lateral aspect, with posterior margin slightly convex, slanting ventrocaudad, dorsal angle not produced, ventral angle with a short, acute caudally directed hook.

Internal male genitalia.—Aedeagus with shaft broad on basal two thirds and reduced on apical third, with two pairs of unbranched apical processes, lateral pair straight, one third length of median pair, directed laterodorsad, median pair straight, directed laterocephalad.

Specimens labeled "wild currant" have been seen. No other host plant records are known.

Specimens have been seen from the following localities: *British Columbia:* Vancouver, August 8; Hope, August 1; *Washington:* South of Cheney, July 9; Kalama, July 4; *Oregon:* South of Bend, July 2; Bend, July 2; Galena Summit, June 3; *California:* Clear Lake, July 21; *Idaho:* Craters of the Moon, June 29; *Utah:* Fish Lake, August 16; Soldier, August 13, (*type series*); Soldier Summit, August 13; *Colorado:* Kremmling, July 17. A single male specimen from 2 miles west of St. Louis, Missouri, is very similar to specimens of this species, but lacks the ventral hook on the pygofer.

Types.—Holotype male, allotype female, and two male paratypes, in the U. S. National Museum.

DISCUSSION OF THE COMMISSURALIS COMPLEX

Although the preceding six species have been described as sharply distinct species, intermediate forms have been found to occur. Two large series of specimens have been seen which are morphologically intermediate between *E. ariste* and *E. euphrante*. *E. ariste* is characterized as having the lateral pair of apical processes of the aedeagus one-fourth longer than the median pair, and having the posterior margin of the pygofer strongly convex with a short rounded apical lobe. *E. euphrante* is characterized as having the lateral pair of apical processes of the aedeagus one third as long as the median pair, and having the posterior margin of the pygofer strongly convex with the ventral angle strongly produced caudally as a short acute hook.

Two large series of specimens have been seen which are intermediate between these two species. One of these series taken on *Ribes inebrians,* near Flagstaff, Arizona, is close to *E. ariste,* and has both pairs of apical processes of the aedeagus of nearly equal length, the posterior margin of the pygofer is convex in the majority of specimens with the ventral angle only slightly lobed and apically rounded. Some specimens which appear to be subnormal have the posterior margin of the pygofer straight and nearly vertical. The second series of specimens is intermediate between the preceding series and *E. euphrante,* having the lateral pair of apical processes of the aedeagus only one half as long as the median pair, and having the ventral lobe of the pygofer only slightly lobed and apically rounded. This series was taken on *Ribes* sp. near Hot Sulfur Springs, Colorado.

E. dorsti is another species which does not differ from the preceding two species and their intermediates in external appearance, but differs only in that the pygofer is broadly rounded on the ventral lobe, and that the apical processes of the aedeagus which are of the same proportionate length as those found on *E. euphrante* have the median pair strongly curving dorsocephalad on the apical third. The author has seen only four specimens of this species so that the interspecific variability is not known.

Some specimens of a fourth species, *E. commissuralis* are also very similar to the preceding species in size, and differ from the series of specimens from Flagstaff, Arizona, only in the presence of the commissural black stripe on the fore wings, and in the shape of the ventral lobe of the pygofer which is broadly rounded apically and does not form a small ventral lobe. The great difference in the size of specimens from different localities (3.0-4.5 mm.) and in the relative amounts of black color composing the wing markings indicates the degree of external variability which one of these species may show, although on the basis of the shape of the male genitalia this constitutes only one species.

The larger specimens of *E. commissuralis* are similar to *E. nigripennis* in size and the narrow dark line along the commissural margin in *nigripennis* strengthens the similarity although the genitalia are easily recognized as those of distinctly different species.

The sixth species in this complex, *E. delongi,* strongly resembles

E. euphrante in the shape of the posterior margin of the pygofer, but its greater length, and the size, relative lengths, and shape of the aedeagal processes set it off from *euphrante* as a distinct species.

A number of abnormal specimens, some taken singly, others in association with normal specimens have been seen. Some of these showed evidences of the presence of internal parasites while in others no evidences of the parasitism could be seen. Many of these specimens were intermediate in structure of the aedeagus and pygofer so that the species to which they belonged could not be determined. Although some of the specimens in the two large series of intermediate forms mentioned in relation to *E. ariste* and *E. euphrante* were apparently abnormal in structure, sufficient numbers of apparently normal specimens were on hand to indicate that something other than parasitism must account for so many specimens having the same degree of modification.

Whether this complex of species represents the extremes of variation of one or two species, or whether each of these is a distinct species cannot be conclusively decided from the evidence that is on hand. Only by the collection of numerous samples of specimens throughout the range of these species will it be possible to determine the relationships between these species.

GLOSSARY OF TERMS

aedeagus.—The sclerotized intromittent organ of the male, composed of base, dorsal apodeme, preatrial arm, shaft, and atrial processes, though some of these may be absent.

aedeagal apodeme.—A dorsal arm arising from the base of the aedeagus, for muscle attachment.

alveolus.—A socket in the cuticula for a seta, vestigial on inner margin of styles.

apical processes.—Processes arising from the shaft of the aedeagus at, or distad of outer third.

atrial processes.—Paired processes arising from the base of the aedeagus ventrad or laterad of the atrium, rarely fused with shaft and thus becoming shaft processes.

atrium.—A large opening in the base of aedeagus through which the gonoduct passes to the base of the shaft.

apical cells.—Areas of the wings distad of cross veins, marked off by apical veins, numbered outward from mesal or caudal margin of the wing.

basal cells.—Areas of the wings basad of cross veins, marked off by longitudinal veins, numbered from the mesal, or caudal margin, outward.

base of aedeagus.—Part of aedeagus to which shaft, atrial processes, aedeagal apodeme, and preatrial arm are attached, sometimes massive, sometimes reduced and indistinct.

brachial cell.—First basal cell of fore wing, lying along claval suture.

connective.—A ventrally located plate with styles attached laterally, and aedeagus attached posteriorly.

dorsal angle.—Portion of pygofer bordering on dorsal half of caudal margin, and caudal half of dorsal margin.

genital capsule.—Ninth abdominal segment, composed of pygofer and plates.

gonopore.—Distal opening of gonoduct.

internal male genitalia.—Composed of aedeagus, connective, and styles.

macrosetae.—Large setae with diameter several times that of microsetae, with large lumen, arising from alveolus.

microsetae.—Filiform setae, short or greatly elongate, lumen small or indistinct, arising from alveolus.

plate.—An elongate lobe arising from the venter of the genital capsule of the male, functioning as a clasping organ.

preatrial arm.—Ventral arm of aedeagus extending cephalad from ventral margin of atrium.

process.—A cuticular projection sometimes elongate, slender, heavily sclerotized (on aedeagus); sometimes a modified lobe of cuticula terminating as a hook or spine (on pygofer, style, or plate).

pygofer.—Side of genital capsule.

pygofer hooks.—Projections from dorsal, posterior, or ventral margins of pygofer, strongly sclerotized or not, apex acutely pointed.

shaft.—Usually a sclerotized tubular portion of aedeagus through which the gonoduct passes; in the genus *Ossiannilssonola* reduced to a membranous structure between atrial processes.

shaft processes.—Processes arising from shaft of aedeagus, usually paired.

spine.—A heavily sclerotized, acute, cuticular appendage, not articulate.

style.—One of the paired clasping organs comprising the inner male genitalia.

Typhlocyba Complex.—Those genera of leafhoppers which have two apical cells open in the hind wing, and have the fore wing with first apical cell not reaching the apex of the wing, and third apical cell usually triangular and stalked.

ventral angle.—Portion of pygofer bordering on ventral half of caudal margin, and caudal half of ventral margin.

ventral lobe.—Lobe of pygofer just dorsad of outer basal angle of male plate.

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INDEX TO GENERA AND SPECIES

PLATE LXXIII

FIG. 1. *Henribautia nigricephala* (Beamer)
- 1a. Left side of pygofer, lateral aspect.
- 1b. Aedeagus, left lateral aspect.
- 1c. Aedeagus, posterior aspect.
- 1d. Right style, ventral aspect.
- 1e. Connective, ventral aspect.
- 1f. Left plate, ventral aspect.
- 1g. Left plate, left lateral aspect.
- 1h. Left fore and hind wing.
- 1i. Head of male and female, dorsal aspect.

FIG. 2. *Henribautia beameri* sp. nov.
- 2a. Left side of pygofer, lateral aspect.
- 2b. Aedeagus, left lateral aspect.
- 2c. Aedeagus, posterior aspect.

FIG. 3. *Henribautia hubbardi* (McAtee)
- 3a. Left side of pygofer, lateral aspect.
- 3b. Aedeagus, left lateral aspect.
- 3c. Aedeagus, posterior aspect.

FIG. 4. *Mcateeana sexnotata* (Van Duzee)
- 4a. Left side of pygofer and left plate, lateral aspect.
- 4b. Aedeagus, left lateral aspect.
- 4c. Aedeagus, posterior aspect.
- 4d. Aedeagus, dorsal aspect.
- 4e. Right style, ventral aspect.
- 4f. Connective, ventral aspect.
- 4g. Left plate, ventral aspect.
- 4h. Left fore and hind wing.
- 4i. Head of male and female, dorsal aspect.

PLATE LXXIII

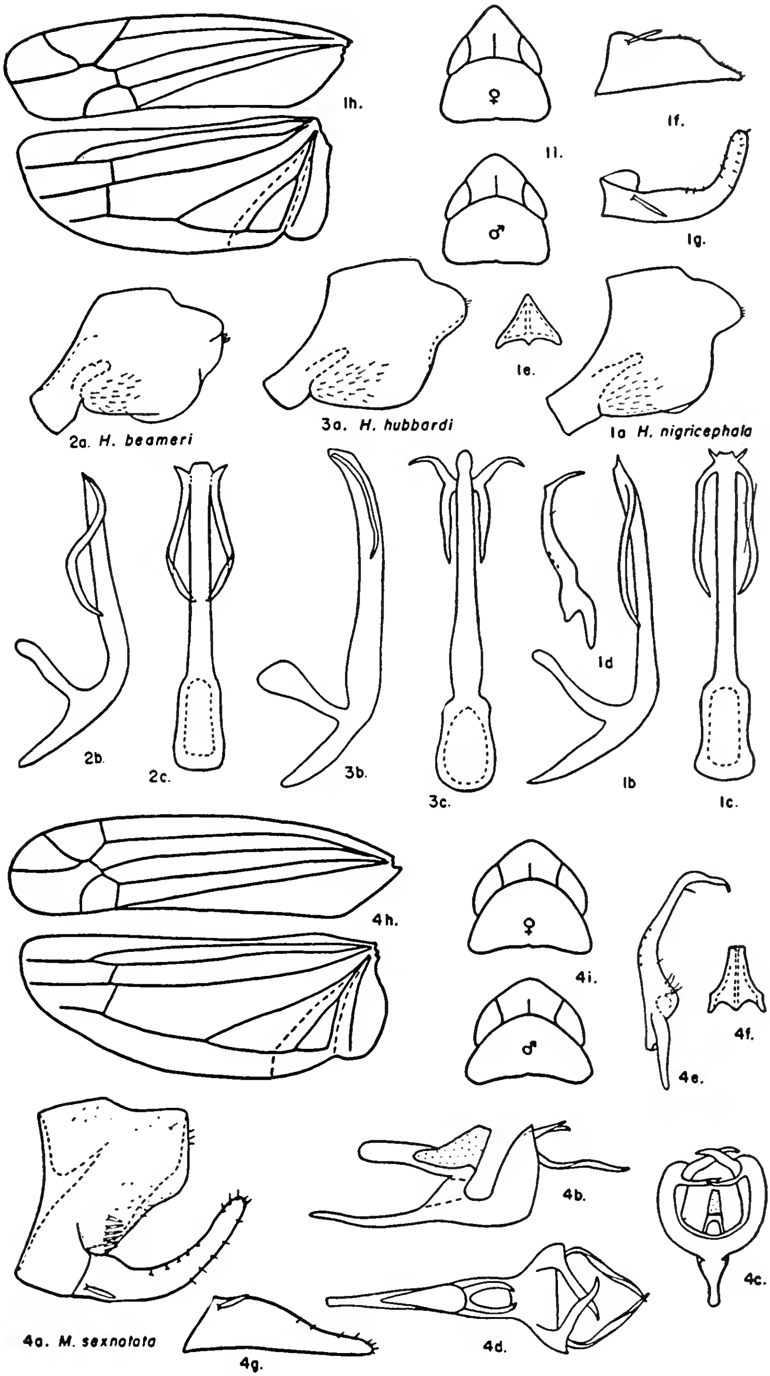


PLATE LXXIV

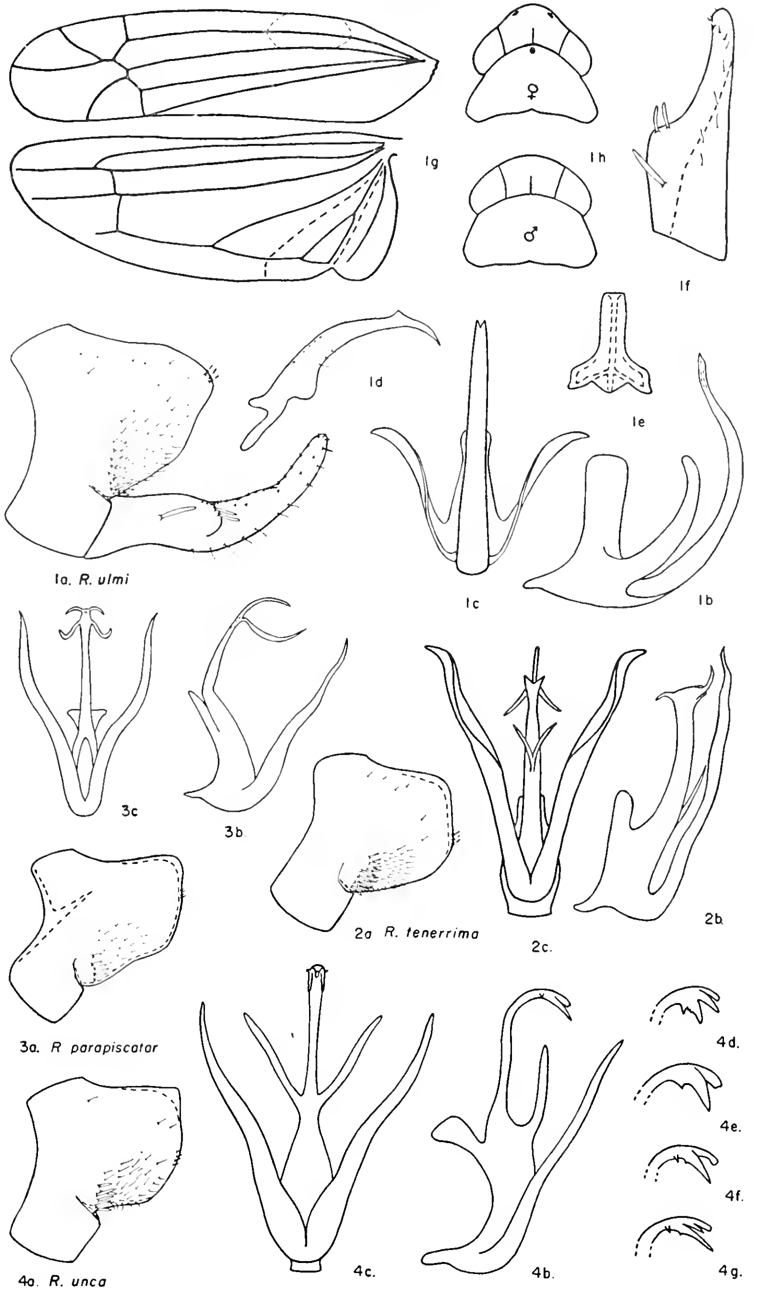
FIG. 1. *Ribautiana ulmi* (Linnaeus)
- 1a. Left side of pygofer and left plate, lateral aspect.
- 1b. Aedeagus, left lateral aspect.
- 1c. Aedeagus, posterior aspect.
- 1d. Right style, ventral aspect.
- 1e. Connective, ventral aspect.
- 1f. Left plate, ventral aspect.
- 1g. Left fore and hind wing.
- 1h. Head of male and female, dorsal aspect.

FIG. 2. *Ribautiana tenerrima* (Herrich-Schäffer)
- 2a. Pygofer, left side, lateral aspect.
- 2b. Aedeagus, left lateral aspect.
- 2c. Aedeagus, posterior aspect.

FIG. 3. *Ribautiana parapiscator* sp. nov.
- 3a. Left side of pygofer, lateral aspect.
- 3b. Aedeagus, left lateral aspect.
- 3c. Aedeagus, posterior aspect.

FIG. 4. *Ribautiana unca* (McAtee)
- 4a. Left side of pygofer, lateral aspect.
- 4b. Aedeagus, left lateral aspect.
- 4c. Aedeagus, posterior aspect.
- 4d. Tip of aedeagus, left lateral aspect. Oregon specimen.
- 4e. Tip of aedeagus, left lateral aspect. California specimen.
- 4f. Tip of aedeagus, left lateral aspect. Missouri specimen.
- 4g. Tip of aedeagus, left lateral aspect. Colorado specimen.

PLATE LXXIV



1g
♀
♂
1h
1f
1d
1e
1a. R. ulmi
1c
1b
3c
3b
2a R. tenerrima
2c.
2b
3a. R parapiscator
4d.
4e.
4f.
4g.
4a. R. unca
4c.
4b.

PLATE LXXV

FIG. 1. *Ribautiana luculla* (Medler)
- 1a. Left side of pygofer, lateral aspect.
- 1b. Aedeagus, left lateral aspect.
- 1c. Aedeagus, posterior aspect.

FIG. 2. *Ribautiana foliosa* (Knull)
- 2a. Left side of pygofer, lateral aspect.
- 2b. Aedeagus, left lateral aspect.
- 2c. Aedeagus, posterior aspect.

FIG. 3. *Ribautiana piscator* (McAtee)
- 3a. Left side of pygofer, lateral aspect.
- 3b. Aedeagus, left lateral aspect.
- 3c. Aedeagus, posterior aspect.

FIG. 4. *Ribautiana multispinosa* sp. nov.
- 4a. Left side of pygofer, lateral aspect.
- 4b. Aedeagus, left lateral aspect.
- 4c. Aedeagus, posterior aspect.

FIG. 5. *Ribautiana sciotoensis* (Knull)
- 5a. Aedeagus, left lateral aspect.
- 5b. Aedeagus, posterior aspect.

PLATE LXXV

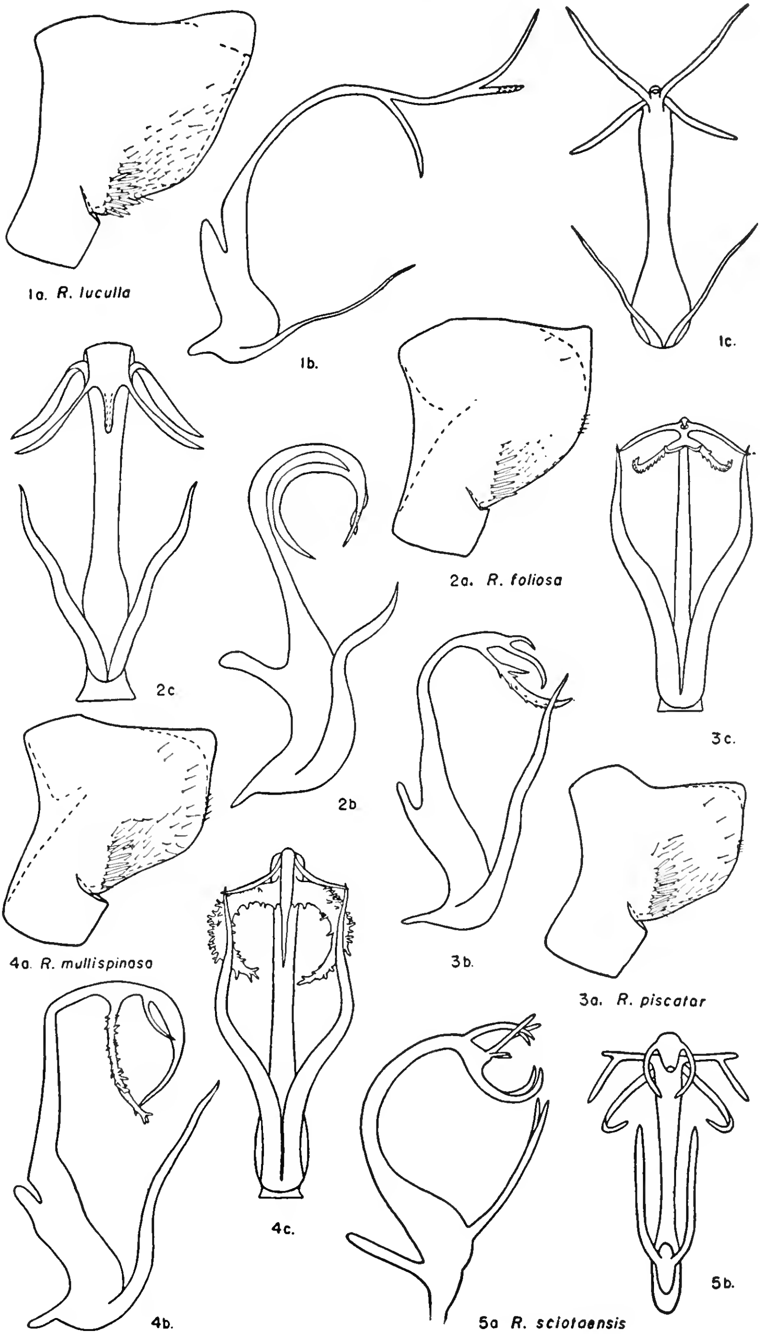

1a. R. luculla
1b.
1c.
2a. R. foliosa
2b
2c
3a. R. piscator
3b.
3c.
4a. R. multispinosa
4b.
4c.
5a R. sciotaensis
5b.

PLATE LXXVI

FIG. 1. *Ossiannilssonola berenice* (McAtee)
- 1a. Left side of pygofer and left plate, lateral aspect.
- 1b. Aedeagus, left lateral aspect.
- 1c. Aedeagus, posterior aspect.
- 1d. Right style, ventral aspect.
- 1e. Connective, ventral aspect.
- 1f. Left plate, ventral aspect.
- 1g. Left fore and hind wing.
- 1h. Head of male and female, dorsal aspect.
- 1i. Left side of pygofer, dorsal angle, posterior aspect.

FIG. 2. *Ossiannilssonola hermione* (McAtee)
- 2a. Left side of pygofer, lateral aspect.
- 2b. Aedeagus, left lateral aspect.
- 2c. Aedeagus, posterior aspect.
- 2d. Left side of pygofer, dorsal angle, posterior aspect.

FIG. 3. *Ossiannilssonola volans* (McAtee)
- 3a. Left side of pygofer, lateral aspect.
- 3b. Aedeagus, left lateral aspect.
- 3c. Aedeagus, posterior aspect.
- 3d. Left side of pygofer, dorsal angle, posterior aspect.

PLATE LXXVI

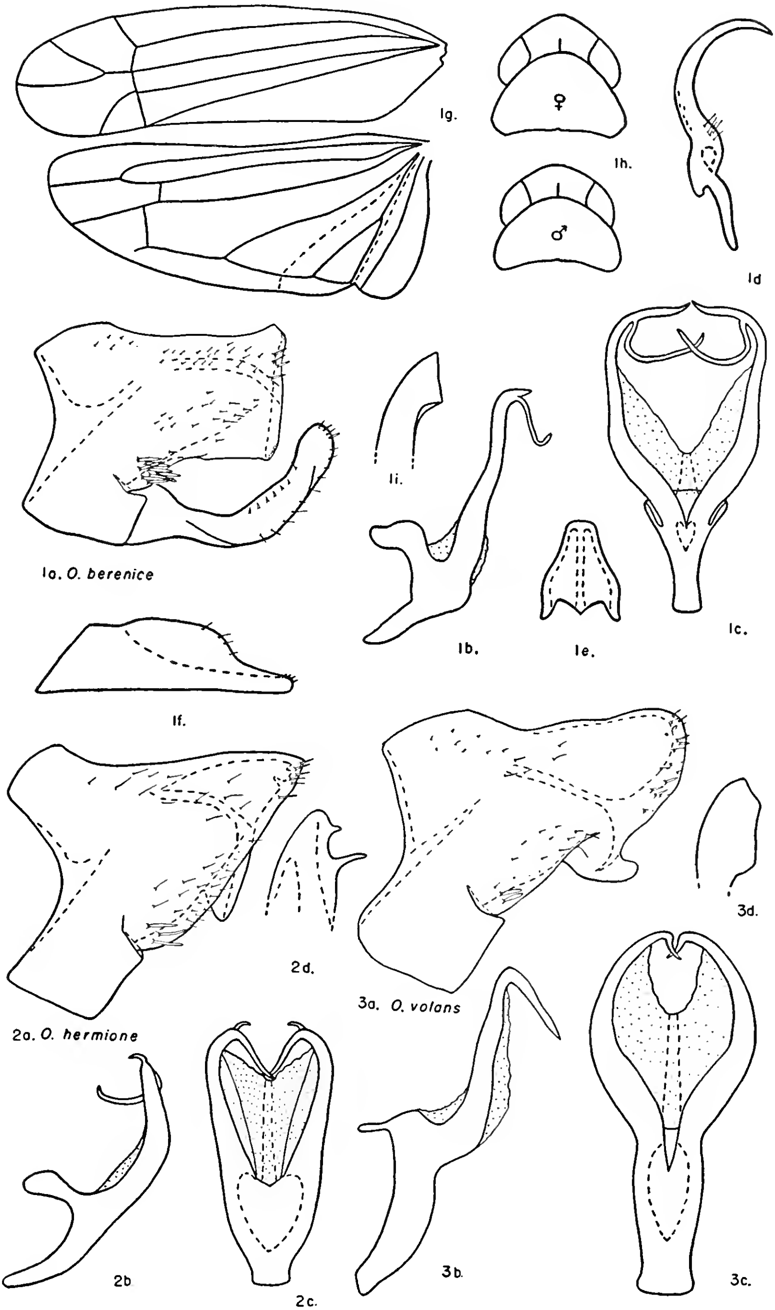

1g.
1h.
1d
1a. O. berenice
1i.
1b.
1e.
1c.
1f.
2d.
2a. O. hermione
3a. O. volans
3d.
2b
2c.
3b.
3c.

PLATE LXXVII

FIG. 1. *Ossiannilssonola antigone* (McAtee)
- 1a. Left side of pygofer, lateral aspect.
- 1b. Aedeagus, left lateral aspect.
- 1c. Aedeagus, posterior aspect.
- 1d. Left side of pygofer, dorsal angle, posterior aspect.

FIG. 2. *Ossiannilssonola clymene* (McAtee)
- 2a. Left side of pygofer, lateral aspect.
- 2b. Aedeagus, left lateral aspect.
- 2c. Aedeagus, posterior aspect.
- 2d. Left side of pygofer, dorsal angle, posterior aspect.

FIG. 3. *Ossiannilssonola tunicarubra* (Gillette)
- 3a. Left side of pygofer, lateral aspect.
- 3b. Aedeagus, left lateral aspect.
- 3c. Aedeagus, posterior aspect.
- 3d. Left side of pygofer, dorsal angle, posterior aspect.

FIG. 4. *Ossiannilssonola australis* (Walsh)
- 4a. Left side of pygofer, lateral aspect.
- 4b. Aedeagus, left lateral aspect.
- 4c. Aedeagus, posterior aspect.
- 4d. Left side of pygofer, dorsal angle, posterior aspect.

FIG. 5. *Ossiannilssonola hinei* (Knull)
- 5a. Left side of pygofer, lateral aspect.
- 5b. Aedeagus, left lateral aspect.
- 5c. Aedeagus, posterior aspect.
- 5d. Left side of pygofer, dorsal angle, posterior aspect.

PLATE LXXVII

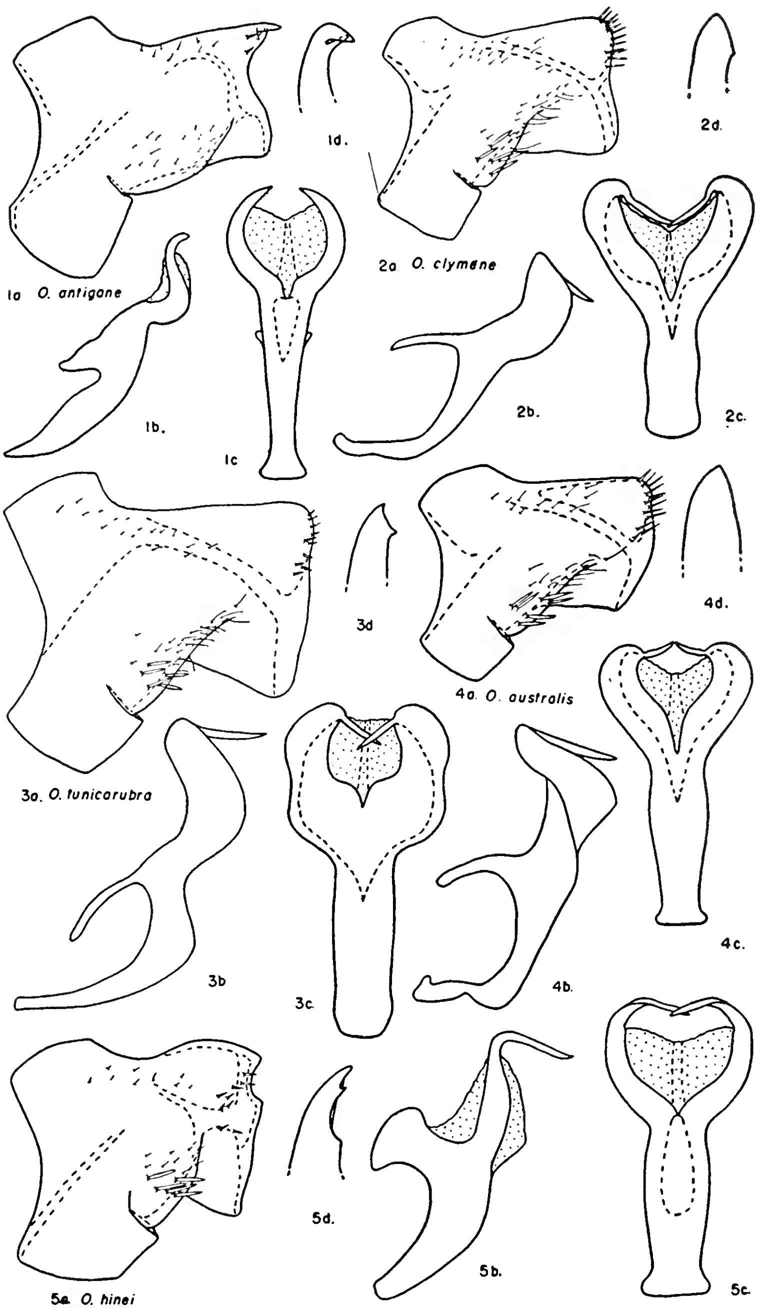


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PLATE LXXVIII

FIG. 1. *Ossiannilssonola bangsoni* sp. nov.
1a. Left side of pygofer, lateral aspect.
1b. Aedeagus, left lateral aspect.
1c. Aedeagus, posterior aspect.
1d. Left side of pygofer, dorsal angle, posterior aspect.
1e. Apex of right style, ventral aspect.
FIG. 2. *Ossiannilssonola duplicata* (McAtee)
2a. Left side of pygofer, lateral aspect.
2b. Aedeagus, left lateral aspect.
2c. Aedeagus, posterior aspect.
2d. Left side of pygofer, dorsal angle, posterior aspect.
FIG. 3. *Ossiannilssonola serrula* (Ross and DeLong)
3a. Left side of pygofer, lateral aspect.
3b. Aedeagus, left lateral aspect.
3c. Aedeagus, posterior aspect.
3d. Left side of pygofer, dorsal angle, posterior aspect.
FIG. 4. *Ossiannilssonola mcateei* sp. nov.
4a. Left side of pygofer, lateral aspect.
4b. Aedeagus, left lateral aspect.
4c. Aedeagus, posterior aspect.
4d. Left side of pygofer, dorsal angle, posterior aspect.
FIG. 5. *Ossiannilssonola danae* (McAtee)
5a. Left side of pygofer, lateral aspect.
5b. Aedeagus, left lateral aspect.
5c. Aedeagus, posterior aspect.
5d. Left side of pygofer, dorsal angle, posterior aspect.
5e. Apex of right style, ventral aspect.

PLATE LXXVIII

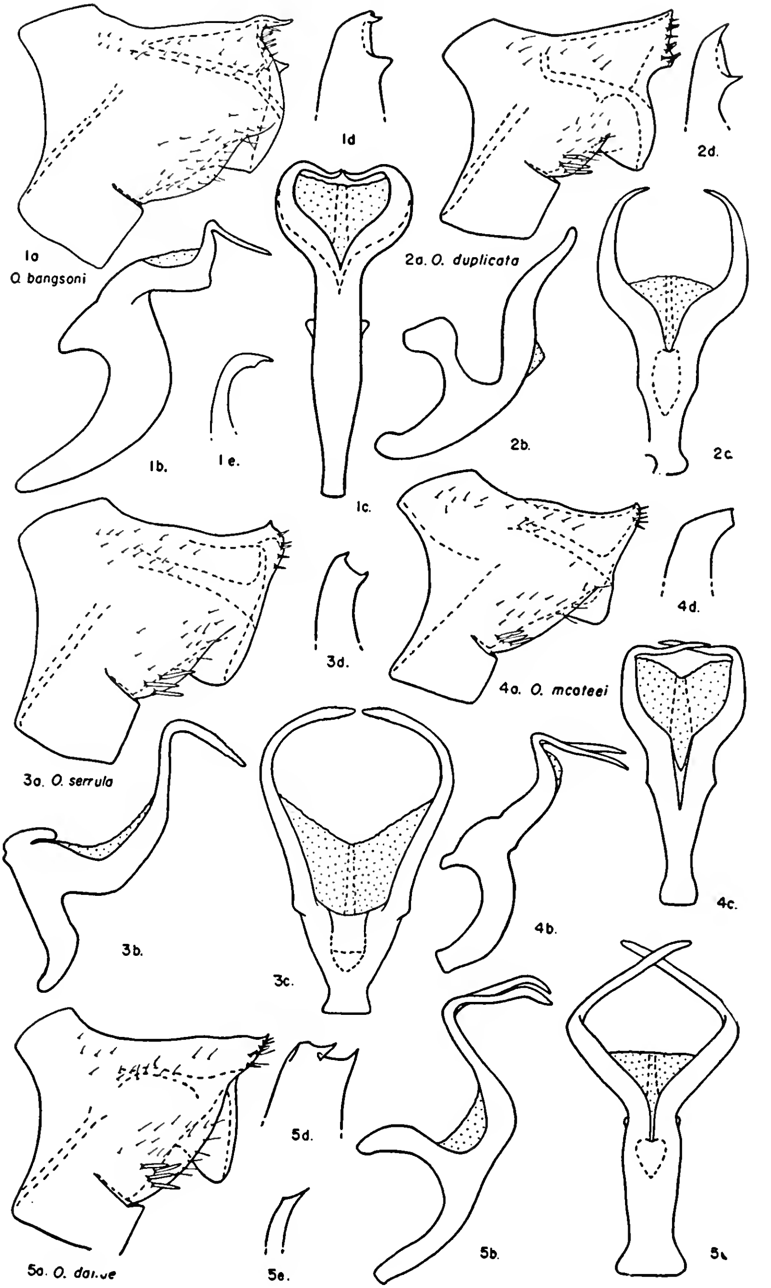


PLATE LXXIX

FIG. 1. *Ossiannilssonola appendiculata* (Malloch)
- 1a. Left side of pygofer and left plate, lateral aspect.
- 1b. Aedeagus, left lateral aspect.
- 1c. Aedeagus, posterior aspect.
- 1d. Left side of pygofer, dorsal angle, posterior aspect.
- 1e. Right style, ventral aspect.
- 1f. Left plate, ventral aspect.

FIG. 2. *Ossiannilssonola phryne* (McAtee)
- 2a. Left side of pygofer and left plate, lateral aspect.
- 2b. Aedeagus, left lateral aspect.
- 2c. Aedeagus, posterior aspect.
- 2d. Left side of pygofer, dorsal angle, posterior aspect.

FIG. 3. *Ossiannilssonola rossi* sp. nov.
- 3a. Left side of pygofer, lateral aspect.
- 3b. Aedeagus, left lateral aspect.
- 3c. Aedeagus, posterior aspect.
- 3d. Left side of pygofer, dorsal angle, posterior aspect.

FIG. 4. *Ossiannilssonola knulli* sp. nov.
- 4a. Left side of pygofer, lateral aspect.
- 4b. Aedeagus, left lateral aspect.
- 4c. Aedeagus, posterior aspect.
- 4d. Left side of pygofer, dorsal angle, posterior aspect.
- 4e. Apex of right style, ventral aspect.

PLATE LXXIX

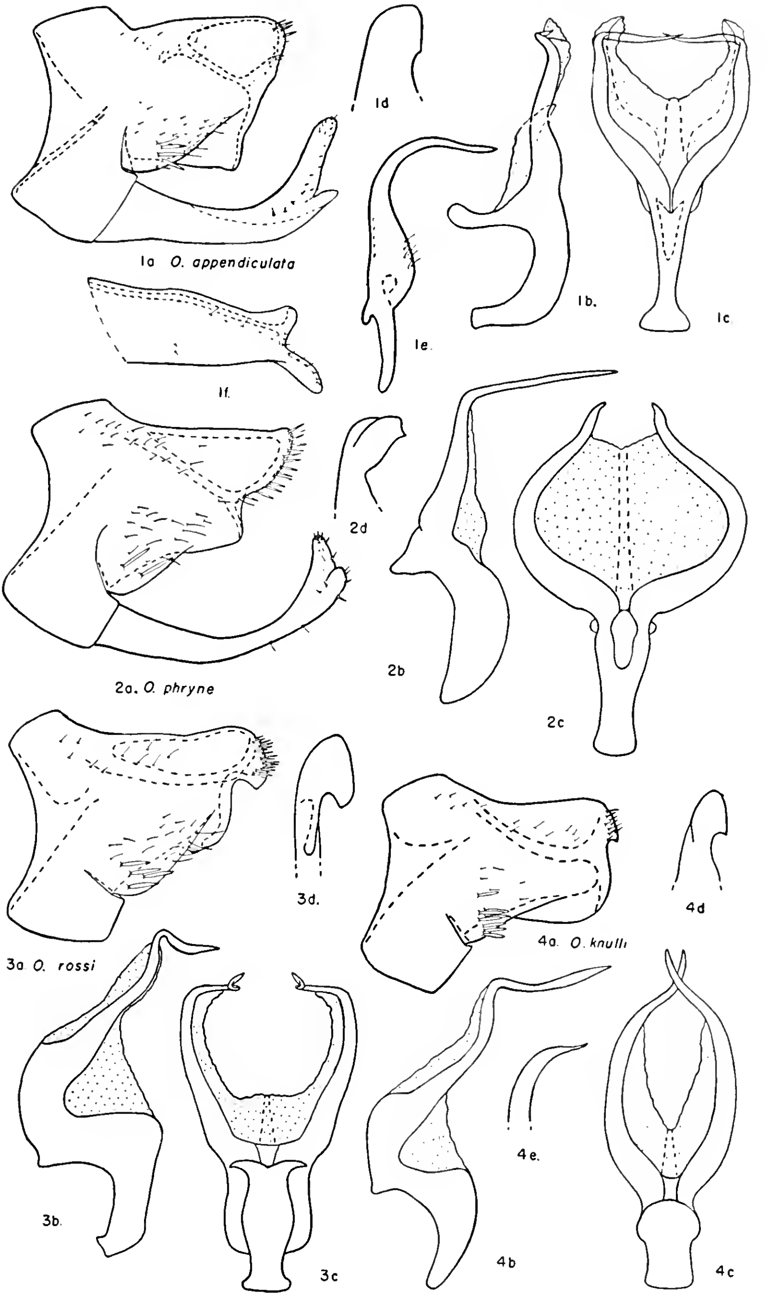

1a O. appendiculata
1b.
1c
1d
1e.
1f.
2a. O. phryne
2b
2c
2d
3a O. rossi
3b.
3c
3d.
4a. O. knulli
4b
4c
4d
4e.

PLATE LXXX

FIG. 1. *Ossiannilssonola troza* (Ross and DeLong)
- 1a. Left side of pygofer, lateral aspect.
- 1b. Aedeagus, left lateral aspect.
- 1c. Aedeagus, posterior aspect.
- 1d. Left side of pygofer, dorsal angle, posterior aspect.

FIG. 2. *Ossiannilssonola flavomarginata* (Gillette and Baker)
- 2a. Left side of pygofer and left plate, lateral aspect.
- 2b. Aedeagus, left lateral aspect.
- 2c. Aedeagus, posterior aspect.
- 2d. Left side of pygofer, dorsal angle, posterior aspect.
- 2e. Right style, ventral aspect.

FIG. 3. *Ossiannilssonola quadrata* (DeLong and Johnson)
- 3a. Left side of pygofer, lateral aspect.
- 3b. Aedeagus, left lateral aspect.
- 3c. Aedeagus, posterior aspect.
- 3d. Left side of pygofer, dorsal angle, posterior aspect.
- 3e. Apex of right style, ventral aspect.

PLATE LXXX

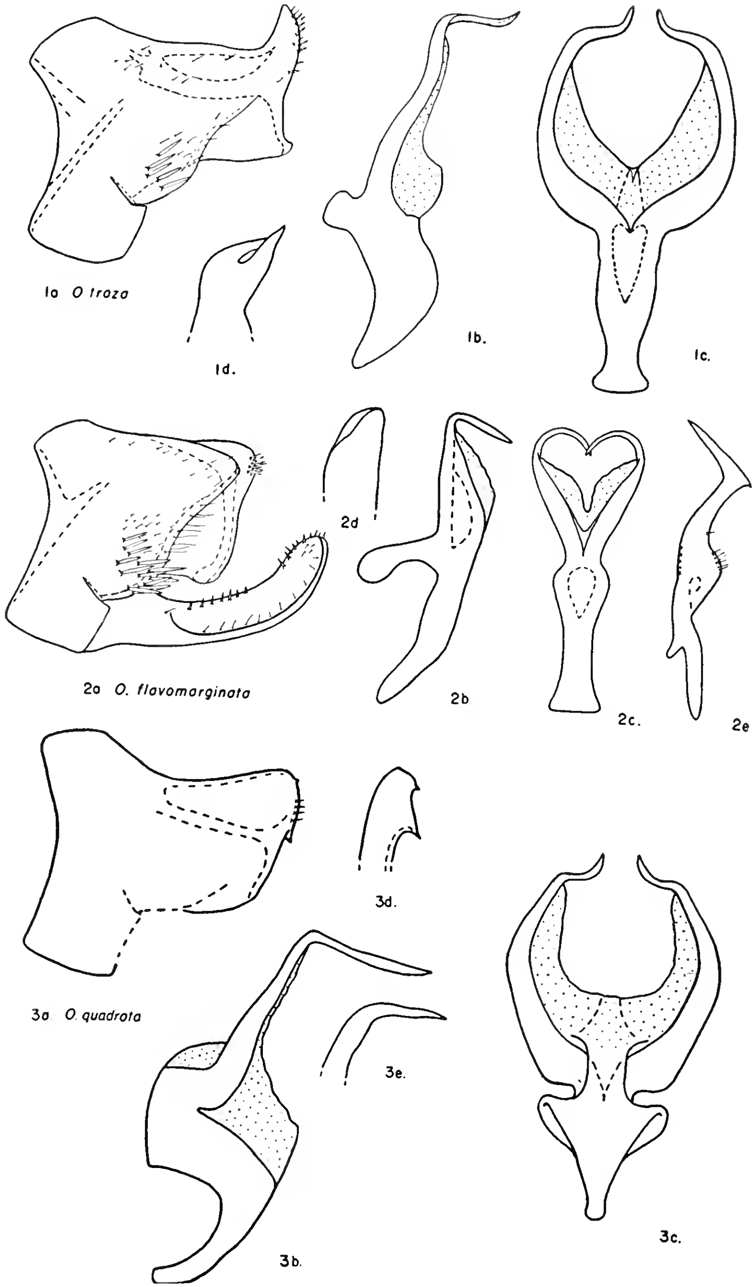

1a O troza
1b.
1c.
1d.
2a O. flavomarginata
2b
2c.
2d
2e
3a O. quadrota
3b.
3c.
3d.
3e.

PLATE LXXXI

FIG. 1. *Typhlocyba quercus* (Fabricius)
1a. Left side of pygofer and left plate, lateral aspect.
1b. Aedeagus, left lateral aspect.
1c. Aedeagus, posterior aspect.
1d. Right style, ventral aspect.
1e. Connective, ventral aspect.
1f. Left fore and hind wing.
1g. Head of male and female, dorsal aspect.

FIG. 2. *Typhlocyba oneka* Knull
2a. Left side of pygofer, lateral aspect.
2b. Aedeagus, left lateral aspect.
2c. Aedeagus, posterior aspect.
2d. Right style, ventral aspect.
2e. Connective, ventral aspect.

FIG. 3. *Typhlocyba athene* McAtee
3a. Left side of pygofer, lateral aspect.
3b. Aedeagus, left lateral aspect.
3c. Aedeagus, posterior aspect.

FIG. 4. *Typhlocyba arsinoe* McAtee
4a. Left side of pygofer, lateral aspect.
4b. Aedeagus, left lateral aspect.
4c. Aedeagus, posterior aspect.

PLATE LXXXI

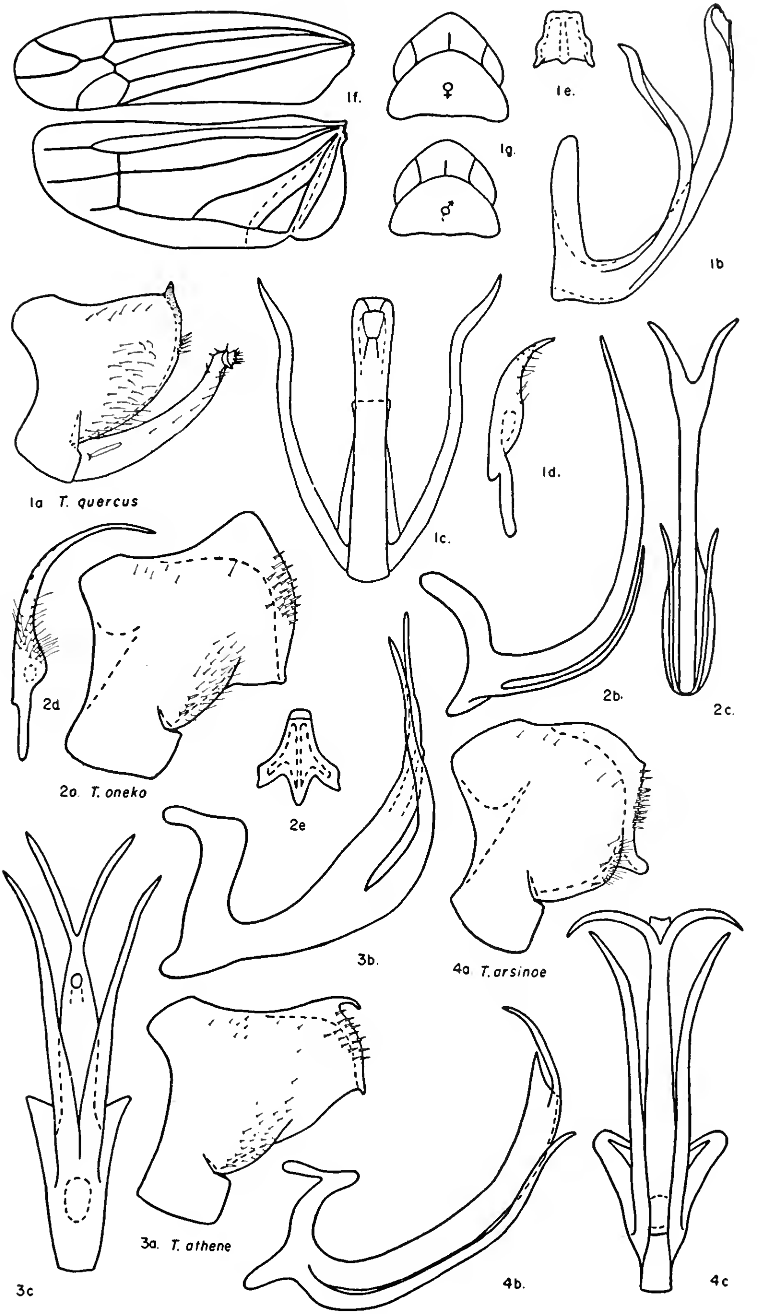

1f.
1e.
♀
1g.
♂
1b
1a T. quercus
1c.
1d.
2d
2a. T. oneko
2e
2b.
2c.
3b.
4a T. arsinoe
3c
3a. T. athene
4b.
4c

PLATE LXXXII

FIG. 1. *Typhlocyba modesta* Malloch
1a. Left side of pygofer, lateral aspect.
1b. Aedeagus, left lateral aspect.
1c. Aedeagus, posterior aspect.
1d. Right style, ventral aspect.
1e. Connective, ventral aspect.

FIG. 2. *Typhlocyba medleri* sp. nov.
2a. Left side of pygofer, lateral aspect.
2b. Aedeagus, left lateral aspect.
2c. Aedeagus, posterior aspect.
2d. Right style, ventral aspect.
2e. Connective, ventral aspect.

FIG. 3. *Typhlocyba hockingensis* Knull
3a. Left side of pygofer, lateral aspect.
3b. Aedeagus, left lateral aspect.
3c. Aedeagus, posterior aspect.
3d. Aedeagus, dorsal aspect.
3e. Right style, ventral aspect.
3f. Connective, ventral aspect.

FIG. 4. *Typhlocyba pomaria* McAtee
4a. Left side of pygofer, lateral aspect.
4b. Aedeagus, left lateral aspect.
4c. Aedeagus, posterior aspect.
4d. Right style, ventral aspect.
4e. Connective, ventral aspect.

PLATE LXXXII

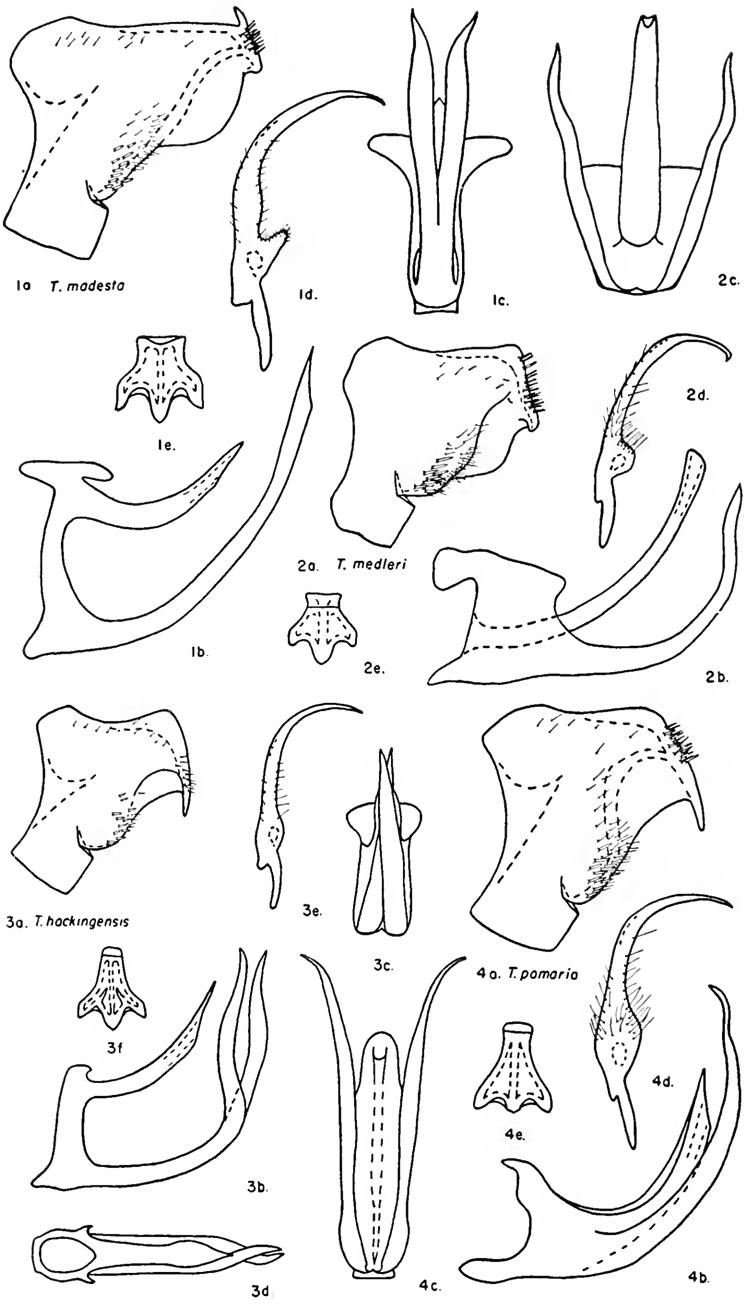


PLATE LXXXIII

FIG. 1. *Typhlocyba attenuata* sp. nov.
1a. Left side of pygofer, lateral aspect.
1b. Aedeagus, left lateral aspect.
1c. Aedeagus, posterior aspect.
1d. Right style, ventral aspect.
1e. Connective, ventral aspect.
FIG. 2. *Typhlocyba rubriocellata* Malloch
2a. Left side of pygofer, lateral aspect.
2b. Aedeagus, left lateral aspect.
2c. Aedeagus, posterior aspect.
2d. Right style, ventral aspect.
2e. Connective, ventral aspect.
FIG. 3. *Typhlocyba surcula* DeLong and Johnson
3a. Left side of pygofer, lateral aspect.
3b. Aedeagus, left lateral aspect.
3c. Aedeagus, posterior aspect.
3d. Right style, ventral aspect.
3e. Connective, ventral aspect.
FIG. 4. *Typhlocyba andromache* McAtee
4a. Left side of pygofer, lateral aspect.
4b. Aedeagus, left lateral aspect.
4c. Aedeagus, posterior aspect.
4d. Right style, ventral aspect.
4e. Connective, ventral aspect.

PLATE LXXXIII

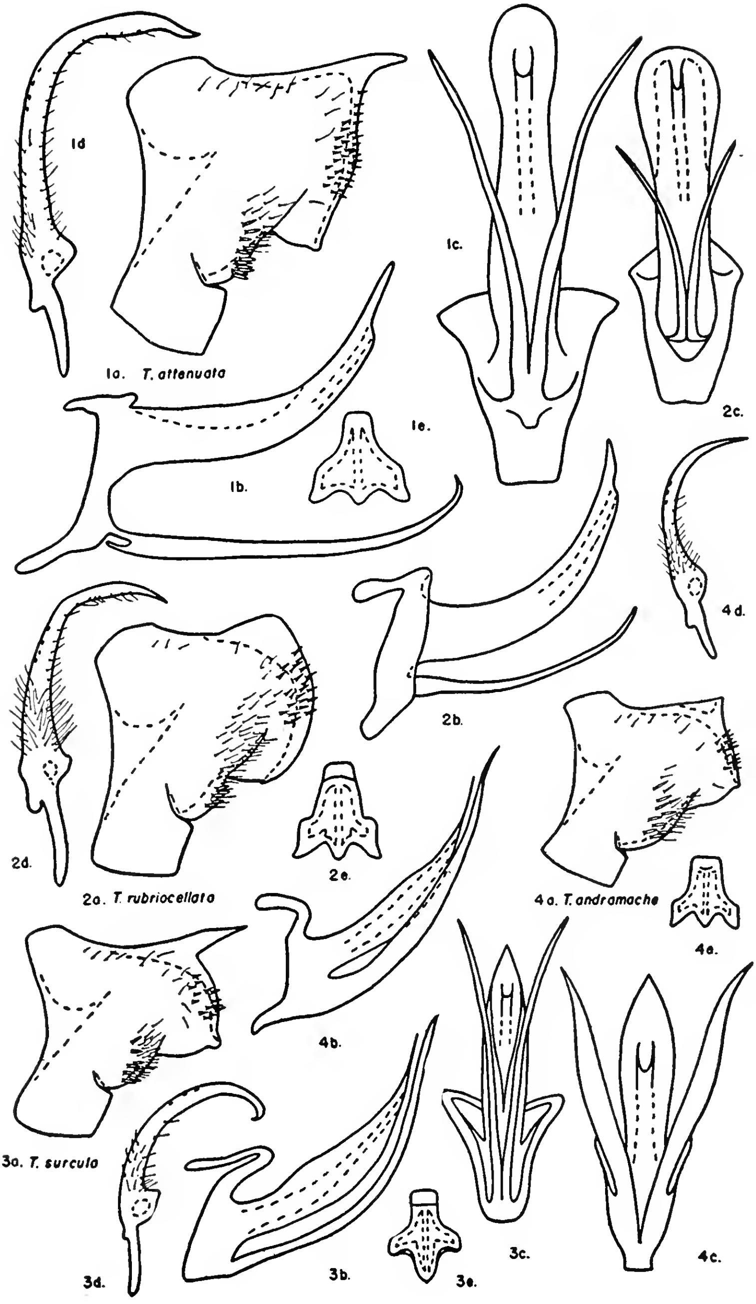


PLATE LXXXIV

FIG. 1. *Typhlocyba melite* McAtee
- 1a. Left side of pygofer, lateral aspect.
- 1b. Aedeagus, left lateral aspect.
- 1c. Aedeagus, posterior aspect.
- 1d. Right style, ventral aspect.
- 1e. Connective, ventral aspect.

FIG. 2. *Typhlocyba alabamaensis* sp. nov.
- 2a. Left side of pygofer, lateral aspect.
- 2b. Aedeagus, left lateral aspect.
- 2c. Aedeagus, posterior aspect.

FIG. 3. *Typhlocyba shawneeana* Knull
- 3a. Left side of pygofer, lateral aspect.
- 3b. Aedeagus, left lateral aspect.
- 3c. Aedeagus, posterior aspect.
- 3d. Right style, ventral aspect.

FIG. 4. *Typhlocyba transviridis* sp. nov.
- 4a. Left side of pygofer, lateral aspect.
- 4b. Aedeagus, left lateral aspect.
- 4c. Aedeagus, posterior aspect.
- 4d. Right style, ventral aspect.

PLATE LXXXIV

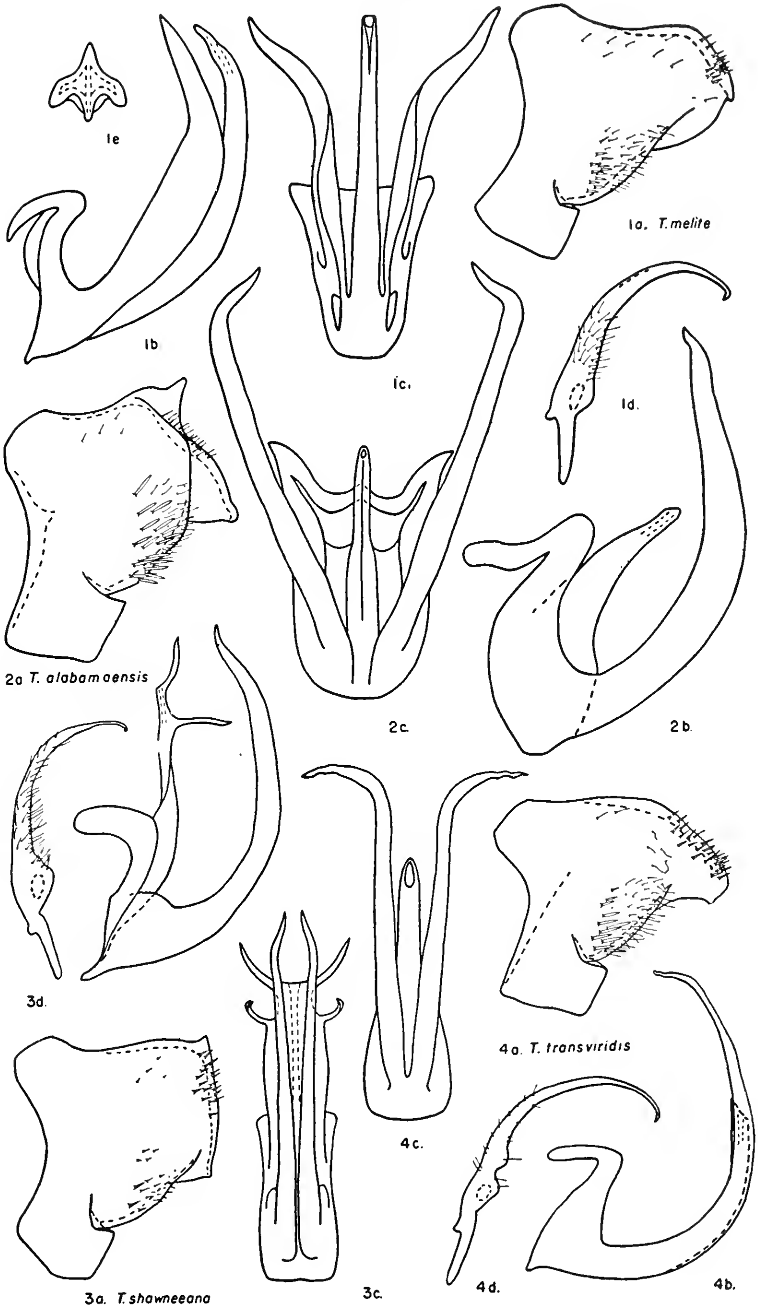


PLATE LXXXV

FIG. 1. *Typhlocyba putmani* Knull
1a. Left side of pygofer, lateral aspect.
1b. Aedeagus, left lateral aspect.
1c. Aedeagus, posterior aspect.
1d. Right style, ventral aspect.
1e. Connective, ventral aspect.
FIG. 2. *Typhlocyba cassiopeia* Knull
2a. Left side of pygofer, lateral aspect.
2b. Aedeagus, left lateral aspect.
2c. Aedeagus, posterior aspect.
2d. Right style, ventral aspect.
2e. Connective, ventral aspect.
FIG. 3. *Typhlocyba crassa* DeLong and Johnson
3a. Left side of pygofer, lateral aspect.
3b. Aedeagus, left lateral aspect.
3c. Aedeagus, posterior aspect.
3d. Right style, ventral aspect.
3e. Connective, ventral aspect.

PLATE LXXXV

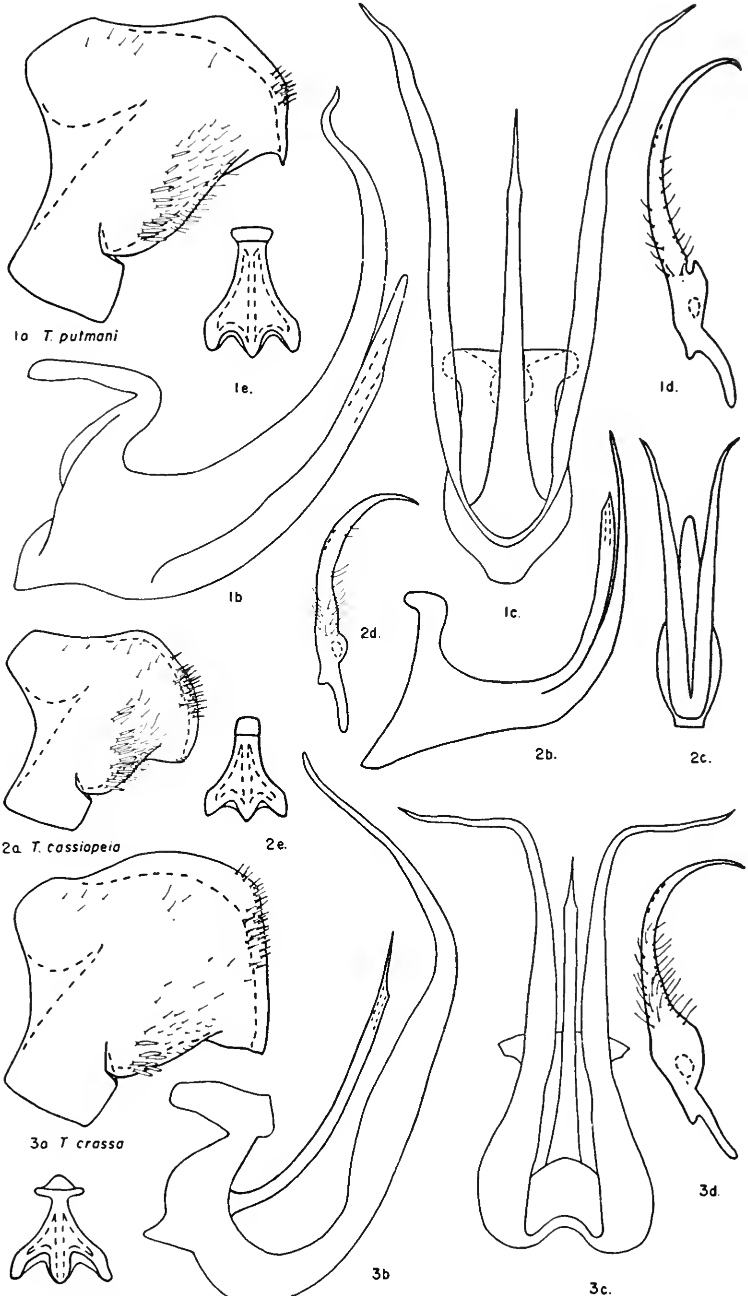

1a T. putmani
1e.
1d.
1b
1c.
2d.
2b.
2c.
2a T. cassiopeia
2e.
3a T crassa
3d.
3e
3b
3c.

PLATE LXXXVI

FIG. 1. *Typhlocyba sollisa* Ross and DeLong
1a. Left side of pygofer, lateral aspect.
1b. Aedeagus, left lateral aspect.
1c. Aedeagus, posterior aspect.
FIG. 2. *Typhlocyba tortosa* Ross and DeLong
2a. Left side of pygofer, lateral aspect.
2b. Aedeagus, left lateral aspect.
2c. Aedeagus, posterior aspect.
2d. Right style, ventral aspect.
FIG. 3. *Typhlocyba persephone* McAtee
3a. Left side of pygofer, lateral aspect.
3b. Aedeagus, left lateral aspect.
3c. Aedeagus, posterior aspect.
3d. Right style, ventral aspect.
3e. Right style, apex, lateral aspect.
3f. Right style, apex, posterior aspect.
3g. Connective, ventral aspect.
FIG. 4. *Typhlocyba niobe* McAtee
4a. Left side of pygofer, lateral aspect.
4b. Aedeagus, left lateral aspect.
4c. Aedeagus, posterior aspect.

PLATE LXXXVI

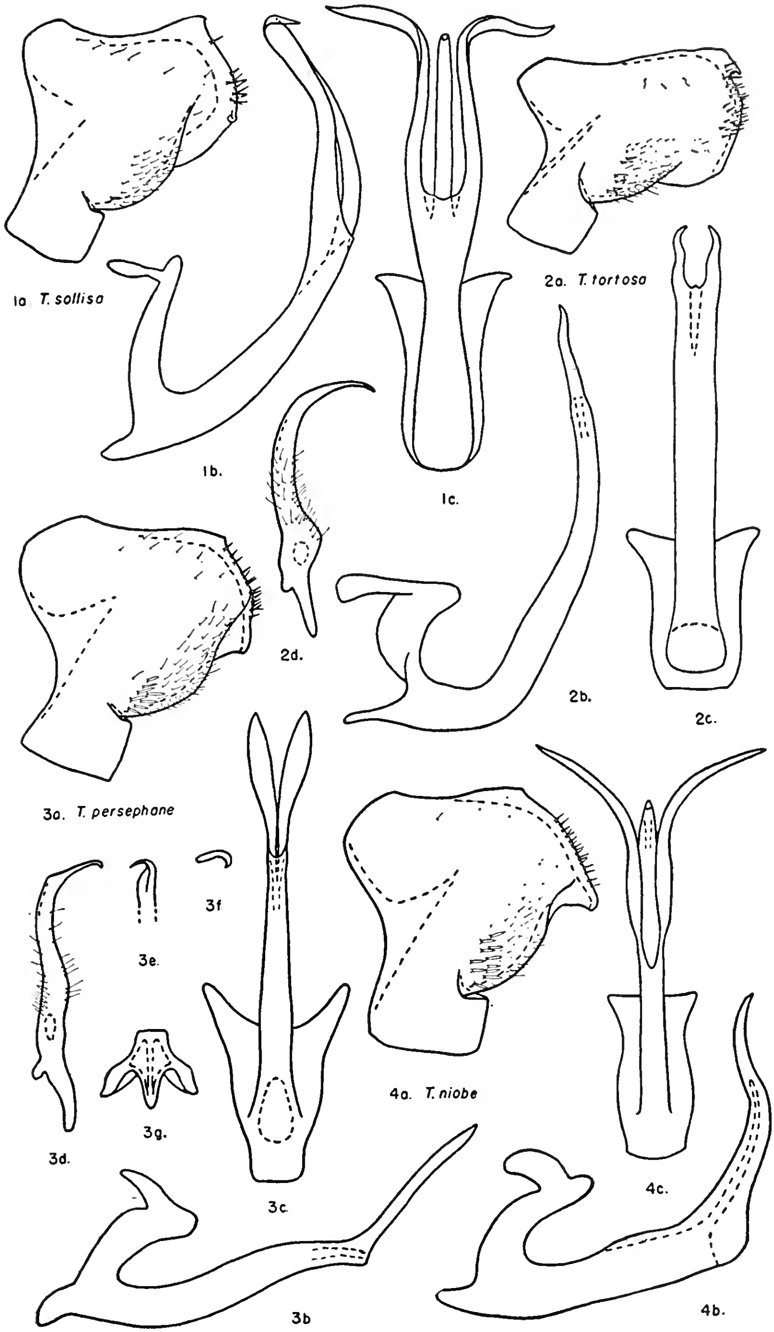


PLATE LXXXVII

FIG. 1. *Typhlocyba inflata* sp. nov.
1a. Left side of pygofer, lateral aspect.
1b. Aedeagus, left lateral aspect.
1c. Aedeagus, posterior aspect.
1d. Right style, ventral aspect.
1e. Connective, ventral aspect.

FIGS. 2-13: Eighth abdominal sternite, female. a. Ventral, b. Lateral aspect.

FIG. 2. *Henribautia nigricephala* (Beamer)
FIG. 3. *Ribautiana piscator* (McAtee)
FIG. 4. *Ribautiana ulmi* (Linnaeus)
FIG. 5. *Mcateecana sexnotata* (Van Duzee)
FIG. 6. *Ossiannilssonola berenice* (McAtee)
FIG. 7. *Ossiannilssonola flavomarginata* (Gillette and Baker)
FIG. 8. *Typhlocyba quercus* (Fabricius)
FIG. 9. *Typhlocyba attenuata* sp. nov.
FIG. 10. *Typhlocyba persephone* McAtee
FIG. 11. *Typhlocyba modesta* Gibson
FIG. 12. *Typhlocyba pomaria* McAtee
FIG. 13. *Edwardsiana rosae* (Linnaeus)

PLATE LXXXVII

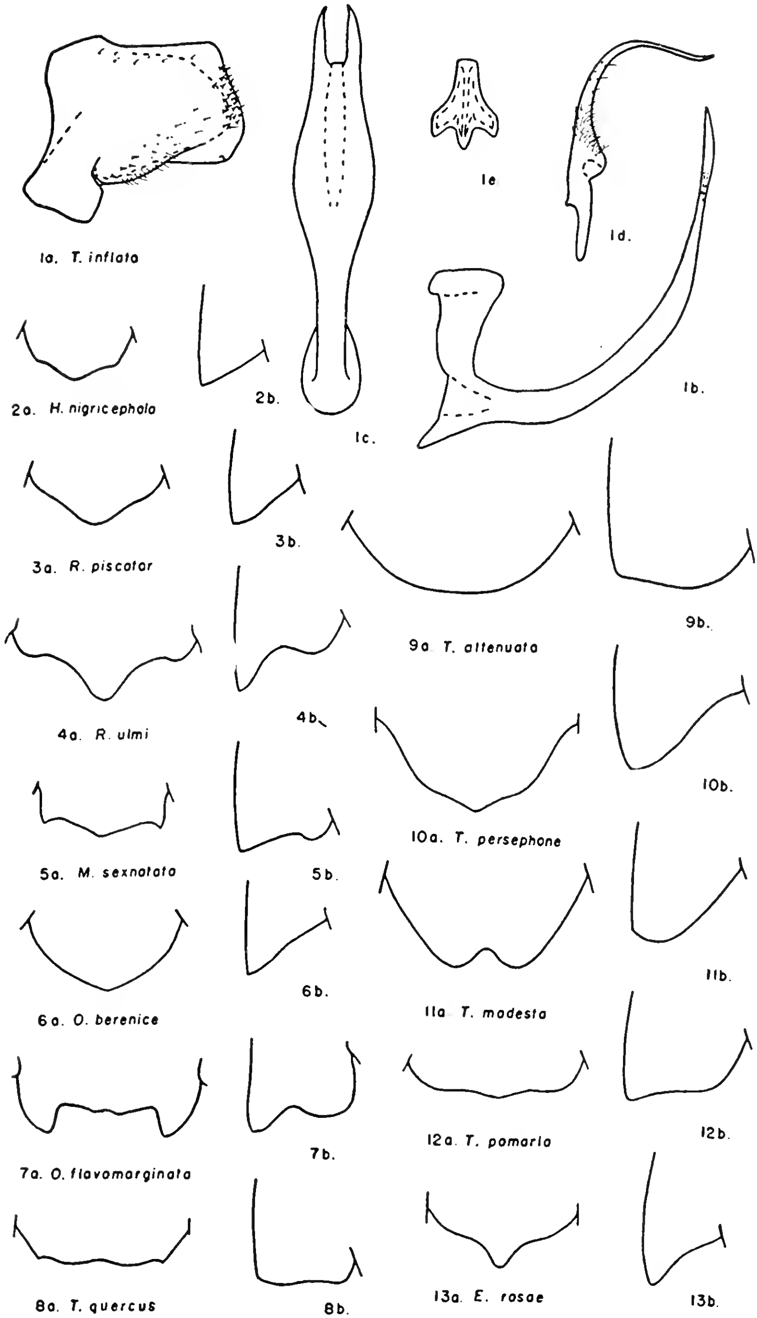


PLATE LXXXVIII

FIG. 1. *Empoa albicans* Walsh
- 1a. Left side of pygofer, lateral aspect.
- 1b. Aedeagus, left lateral aspect.
- 1c. Aedeagus, posterior aspect.
- 1d. Right style, ventral aspect.
- 1e. Connective, ventral aspect.

FIG. 2. *Empoa spinosa* (Beamer)
- 2a. Left side of pygofer, lateral aspect.
- 2b. Aedeagus, left lateral aspect.
- 2c. Aedeagus, posterior aspect.
- 2d. Right style, ventral aspect.
- 2e. Connective, ventral aspect.

FIG. 3. *Empoa querci* Fitch
- 3a. Left side of pygofer, lateral aspect.
- 3b. Aedeagus, left lateral aspect.
- 3c. Aedeagus, posterior aspect.
- 3d. Right style, ventral aspect.
- 3e. Connective, ventral aspect.

PLATE LXXXVIII

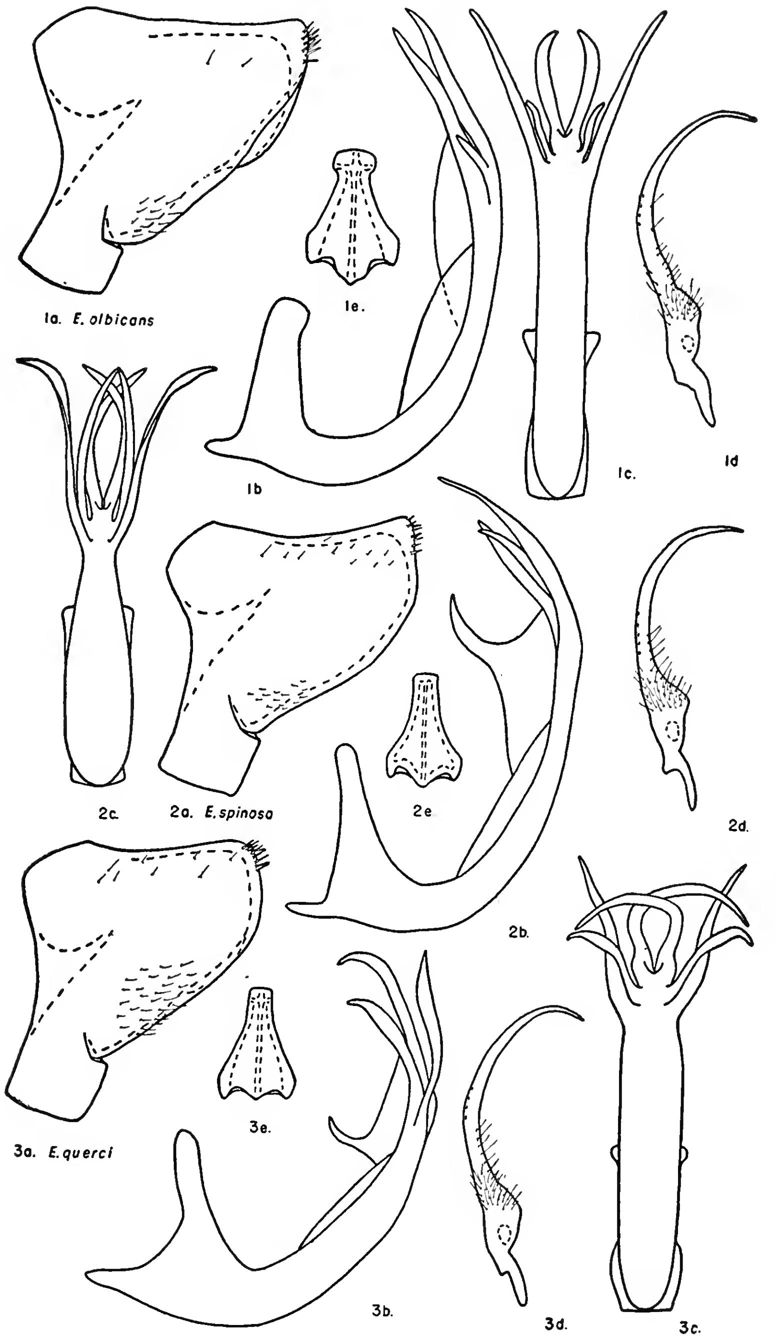


PLATE LXXXIX

FIG. 1. *Edwardsiana lethierryi* (Edwards)
1a. Left side of pygofer, lateral aspect.
1b. Aedeagus, left lateral aspect.
1c. Aedeagus, anterior aspect.

FIG. 2. *Edwardsiana rosae* (Linnaeus)
2a. Left side of pygofer, lateral aspect.
2b. Aedeagus, left lateral aspect.
2c. Aedeagus, anterior aspect.
2d. Right style, ventral aspect.
2e. Connective, ventral aspect.
2f. Apex of aedeagus, left lateral aspect, *rosae* variation.
2g. Apex of aedeagus, anterior aspect, *rosae* variation.

FIG. 3. *Edwardsiana bergmani* var. *ariadne* (McAtee)
3a. Left side of pygofer, lateral aspect, (Maine specimen).
3b. Aedeagus, left lateral aspect, (Maine specimen).
3c. Aedeagus, anterior aspect, (Maine specimen).
3d. Left side of pygofer, lateral aspect, (Montana specimen).
3e. Aedeagus, left lateral aspect, (Montana specimen).
3f. Aedeagus, anterior aspect, (Montana specimen).

FIG. 4. *Edwardsiana bergmani* var. *bergmani* (Tullgren)
4a. Aedeagus, left lateral aspect, (Swedish specimen).
4b. Aedeagus, anterior aspect, (Swedish specimen).

PLATE LXXXIX

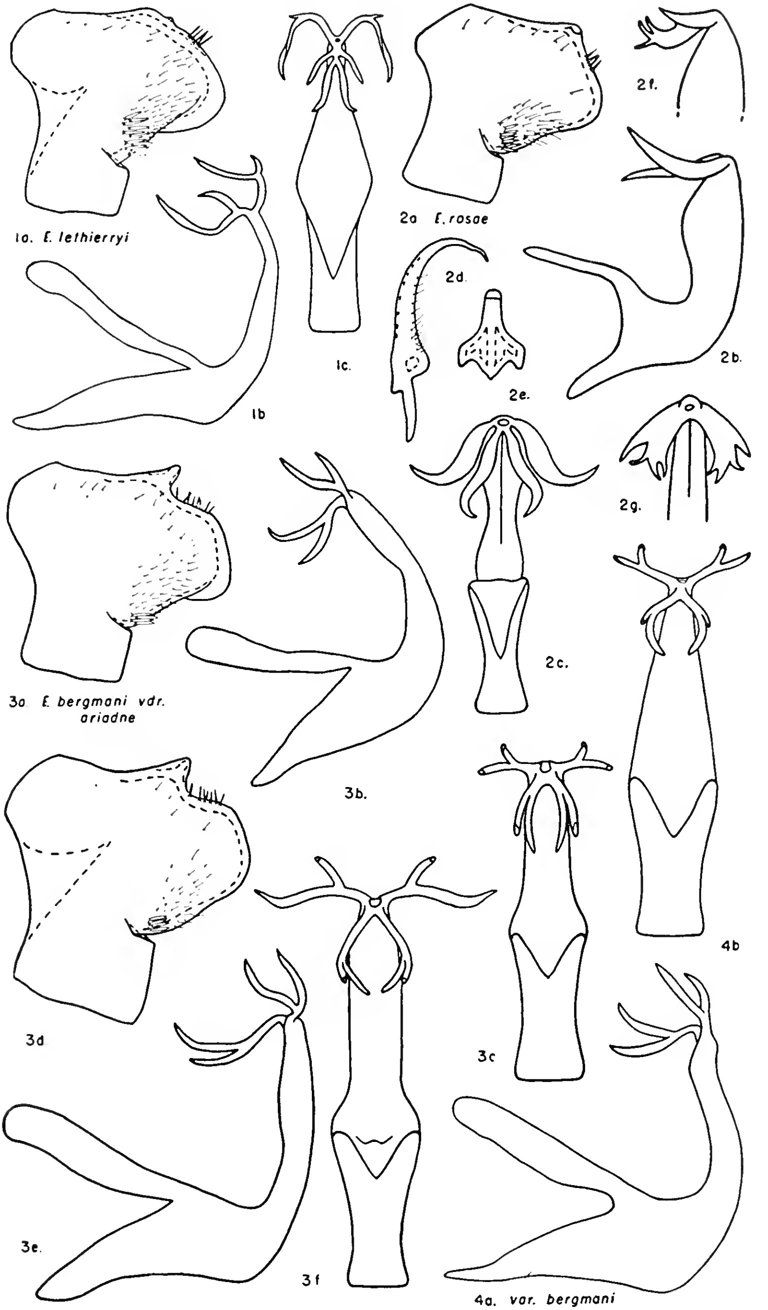


PLATE XC

FIG. 1. *Edwardsiana expanda* (DeLong and Johnson)
1a. Left side of pygofer, lateral aspect.
1b. Aedeagus, left lateral aspect.
1c. Aedeagus, anterior aspect.
1d. Apex of aedeagus, left lateral aspect (abnormal specimen).
FIG. 2. *Edwardsiana frustrator* (Edwards)
2a. Left side of pygofer, lateral aspect.
2b. Aedeagus, left lateral aspect.
2c. Aedeagus, anterior aspect.
FIG. 3. *Edwardsiana plebeja* (Edwards)
3a. Left side of pygofer, lateral aspect.
3b. Aedeagus, left lateral aspect.
3c. Aedeagus, anterior aspect.
FIG. 4. *Edwardsiana prunicola* (Edwards)
4a. Left side of pygofer, lateral aspect.
4b. Aedeagus, left lateral aspect.
4c. Aedeagus, anterior aspect.
FIG. 5. *Edwardsiana candidula* (Kirschbaum)
5a. Left side of pygofer, lateral aspect.
5b. Aedeagus, left lateral aspect.
5c. Aedeagus, anterior aspect.
FIG. 6. *Edwardsiana australis* (Froggatt)
6a. Left side of pygofer, lateral aspect.
6b. Aedeagus, left lateral aspect.
6c. Aedeagus, anterior aspect.

PLATE XC

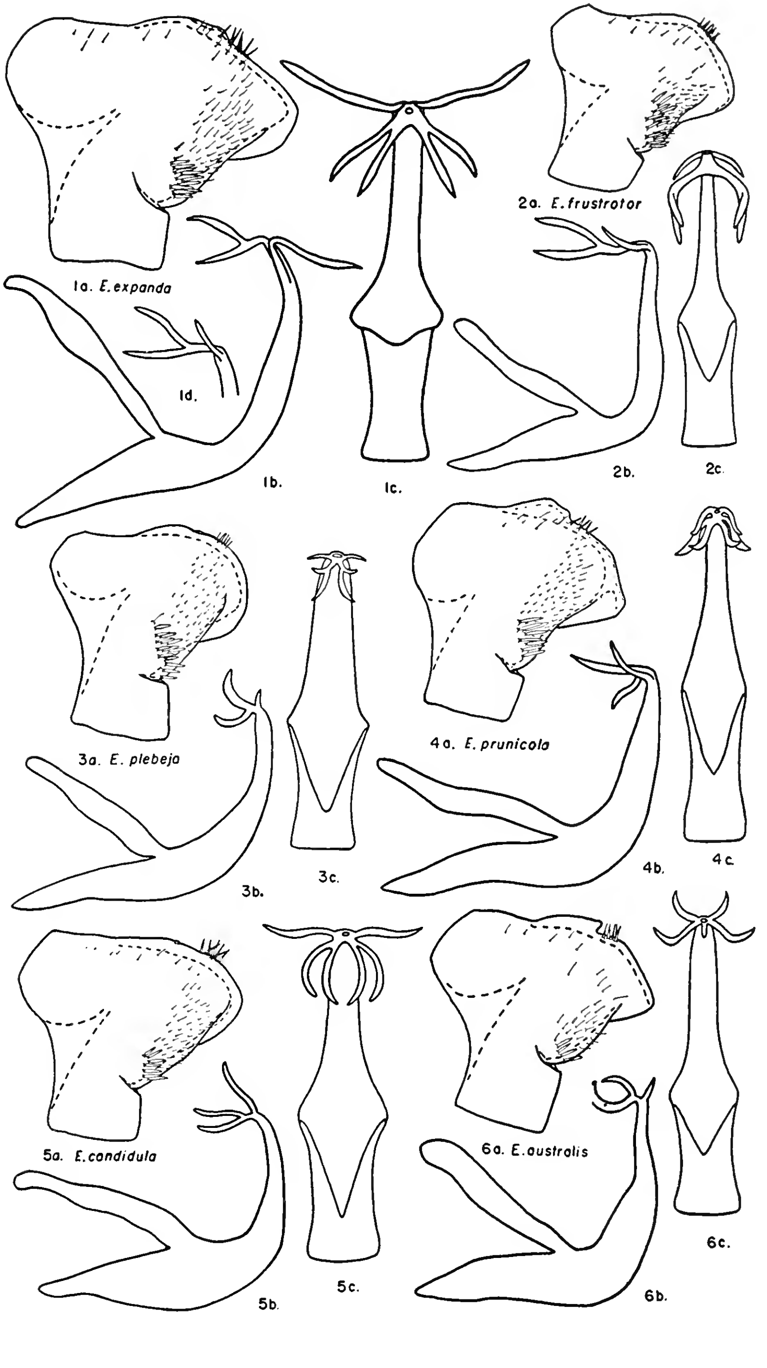

1a. E. expanda
1b.
1c.
1d.
2a. E. frustrator
2b.
2c.
3a. E. plebeja
3b.
3c.
4a. E. prunicola
4b.
4c.
5a. E. candidula
5b.
5c.
6a. E. australis
6b.
6c.

PLATE XCI

FIG. 1. *Edwardsiana projecta* sp. nov.
- 1a. Left side of pygofer, lateral aspect.
- 1b. Aedeagus, left lateral aspect.
- 1c. Aedeagus, anterior aspect.
- 1d. Aedeagus, apex, posterodorsal aspect.

FIG. 2. *Edwardsiana pseudocommissuralis* sp. nov.
- 2a. Left side of pygofer, lateral aspect.
- 2b. Aedeagus, left lateral aspect.
- 2c. Aedeagus, anterior aspect.

FIG. 3. *Edwardsiana dejecta* sp. nov.
- 3a. Left side of pygofer, lateral aspect.
- 3b. Aedeagus, left lateral aspect.
- 3c. Aedeagus, anterior aspect.

FIG. 4. *Edwardsiana dorsti* (Ossiannilsson)
- 4a. Left side of pygofer, lateral aspect.
- 4b. Aedeagus, left lateral aspect.
- 4c. Aedeagus, anterior aspect.

PLATE XCI

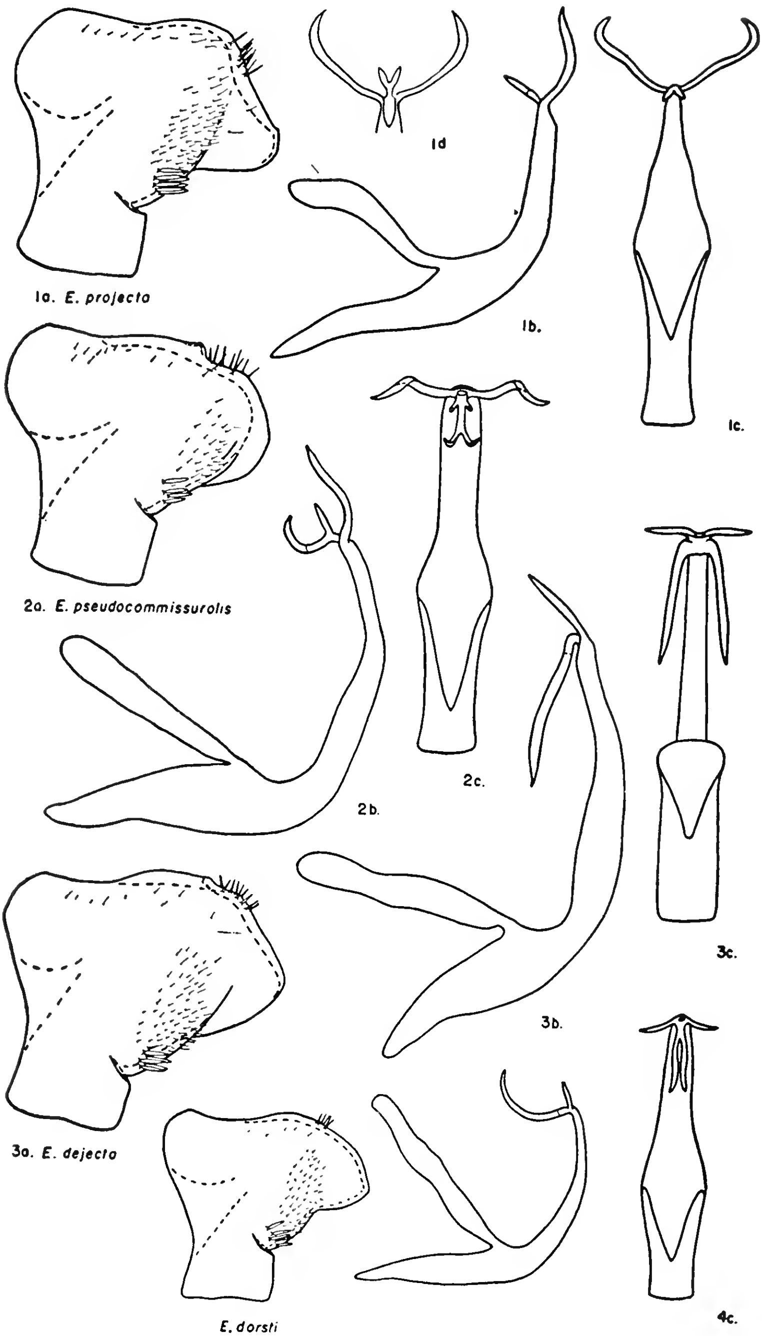
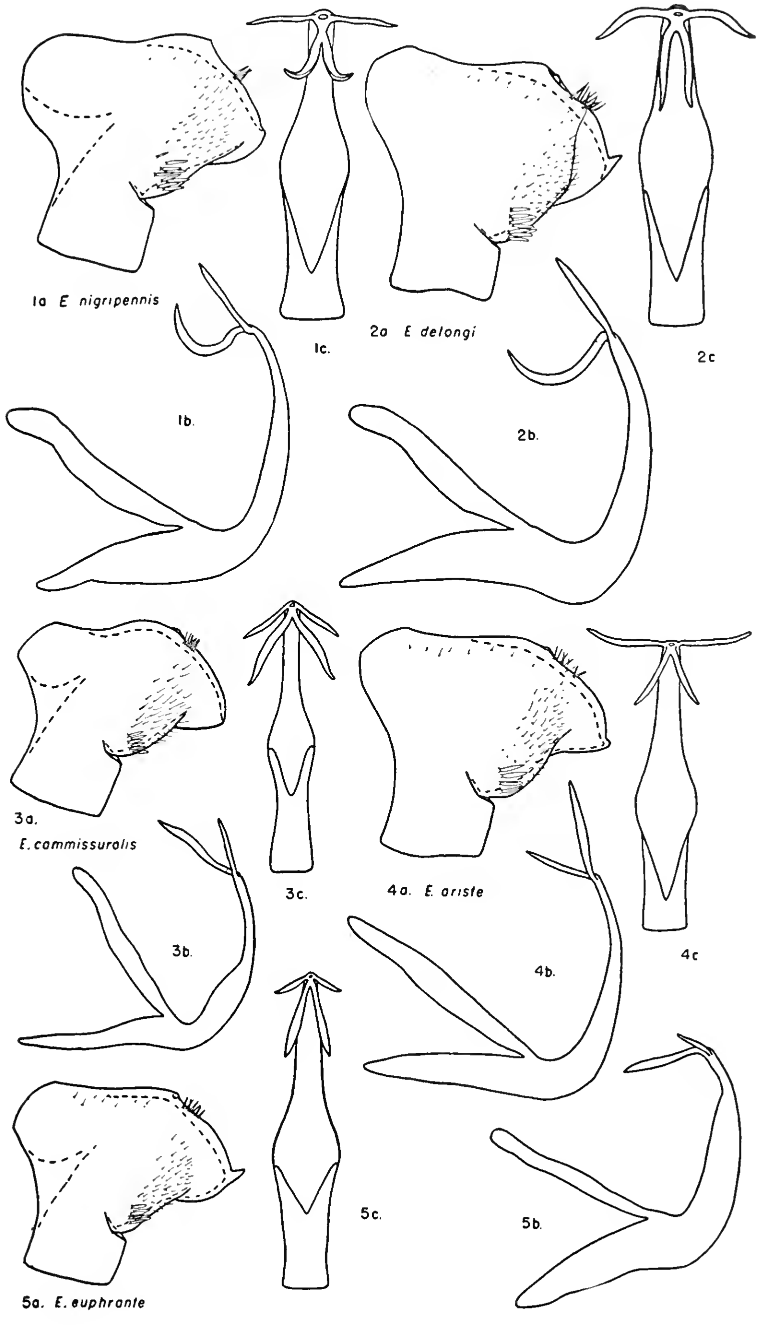

1a. E. projecta
1d
1b.
1c.
2a. E. pseudocommissuralis
2c.
2b.
3c.
3b.
3a. E. dejecta
E. dorsti
4c.

PLATE XCII

FIG. 1. *Edwardsiana nigripennis* sp. nov.
1a. Left side of pygofer, lateral aspect.
1b. Aedeagus, left lateral aspect.
1c. Aedeagus, anterior aspect.
FIG. 2. *Edwardsiana delongi* sp. nov.
2a. Left side of pygofer, lateral aspect.
2b. Aedeagus, left lateral aspect.
2c. Aedeagus, anterior aspect.
FIG. 3. *Edwardsiana commissuralis* (Stål)
3a. Left side of pygofer, lateral aspect.
3b. Aedeagus, left lateral aspect.
3c. Aedeagus, anterior aspect.
FIG. 4. *Edwardsiana ariste* (McAtee)
4a. Left side of pygofer, lateral aspect.
4b. Aedeagus, left lateral aspect.
4c. Aedeagus, anterior aspect.
FIG. 5. *Edwardsiana euphrante* (McAtee)
5a. Left side of pygofer, lateral aspect.
5b. Aedeagus, left lateral aspect.
5c. Aedeagus, anterior aspect.

PLATE XCII



1a E nigripennis
1b.
1c.
2a E delongi
2b.
2c
3a.
E. commissuralis
3b.
3c.
4a. E. ariste
4b.
4c
5a. E. euphronte
5b.
5c.

THE UNIVERSITY OF KANSAS
SCIENCE BULLETIN

VOL. XXXV, PT. II] SEPTEMBER 10, 1953 [No. 10

The Ambrysus [1] of Mexico (Hemiptera, Naucoridae)

BY

IRA LA RIVERS [2]

FAMILY NAUCORIDAE (Fallen) 1814

SUBFAMILY AMBRYSINAE Usinger 1941

GENUS AMBRYSUS Stål 1862

(Logotype *signoreti* Stål)

Ambrysus Stål 1862, Stet. Ent. Zeit. 23:459; 1865, Hemip. Afr., 3:174; 1876, Enum. Hemip., 5:141, 143.
Ambrysus, Uhler, 1872, Hayden's Surv. Terr., Rept. for 1871:423; 1876, Bull. U.S.G.S. 1:337; 1877, Wheeler's Rept. Chief Eng. for 1877:1331; 1884, in Kings. Nat. Hist., 2:249, 260; 1886, Brook. Ent. Soc.; 1894, Proc. Calif. Acad. Sci., ser. 2, 4:291.
Ambrysus, Berg, 1879, Hemip. Argent. enum. spec. nov. desc., 8vo.
Ambrysus, Gillette and Baker, 1895, Hemip. Colo. :63.
Ambrysus, Montandon, 1897, Bull. Paris Mus. d'Hist. Nat. 3:124; 1897, Verh. zool.-bot. Ges. Wien 47:6; 1897, Bull. Soc. Sci. Buc.-Roum. 7(3-4):282; 1909, *ibid*, 17(5-6):316, 18(1):43; 1910, *ibid*, 18(5-6):180, 19(3):438.
Ambrysus, Champion, 1900, Biol. Centr.-Amer., Heterop. 2:355-358.
Ambrysus, Kirkaldy, 1906, Trans. Amer. Ent. Soc., 32:151.
Ambrysus, Kirkaldy and Bueno, 1908, Proc. Ent. Soc. Wash., 10:185.
Ambrysus, Snow, 1906, Trans. Kans. Acad. Sci., 20(1):180.
Ambrysus, Van Duzee, 1916, Proc. N. Y. Ent. Soc.; 1917, U. C. Ent. Bull. 2:458.
Ambrysus, Hungerford, 1919, Univ. Kans., Sci. Bull., 11:198.
Ambrysus, Usinger, 1941, Ann. Ent. Soc. Amer. 34(1):11, 15; 1946, Univ. Kans., Sci. Bull., 31(1):185.
Ambrysus, La Rivers, 1949, Bull. S. Calif. Acad. Sci., 47(3):103; 1949, Ann. Ent. Soc. Amer., 41(3):371; 1950, Pan-Pac. Ent., 26(1):19.

Because of the superficial, external similarity between many of the species, it is convenient to characterize the genus in some detail, making it possible to eliminate much repetitive material in the individual species descriptions:

1. Dr. Usinger in Univ. of Kansas Science Bull. XXXI, pp. 182-210, 1946, described some new species of Ambrysus from the Frances Huntington Snow Collections and this paper is the culmination and with its illustrated key is a companion work to be used with "A Revision of the Genus Ambrysus in the United States" by Ira La Rivers *in* the Univ. of California Publications in Entomology VIII, No. 7, pp. 277-338, 1951, and is based to a considerable extent upon Univ. of Kansas material.—H. B. Hungerford.

2. Department of Biology, University of Nevada, Reno, Nevada.

51—6490

General appearance: small and rotund to large and ovate—size 6-16 mm. long, 3.5-8.0 mm. wide. Dorsum generally distinctly bicolored, the head and prothorax slightly lighter in color than the remainder, emboliar edges usually lighter than hemelytra, the latter with or without mottling. Venter generally lighter than abdomen, darkening somewhat in anterior half of body, with or without median, anterior mottling.

Head: glistening and impunctate to roughened and strongly punctate, greenish, yellowish, brown or combinations of these colors, varying from smoothly curved between the eyes to distinctly protuberant before eyes. Eyes generally much darker in color than head, brown to black, often drying in pinned specimens to a pearly gray; outer and posterior margins either forming a continuous curvature, or producing an angulation at point of contact. Labrum same color as front of head, or darker; mouthparts generally darkening at tip.

Pronotum: varying from nearly impunctate and glistening to rough and strongly punctate, and in color from greenish through yellow to deep black-brown. Combined length of pronotum and head varying from more than two thirds greatest pronotal width to distinctly less than two thirds such width A thin, transverse, dark posterior pronotal line prominently present, the remainder of the posterior pronotal border behind the line predominantly whitish in color. Lateral pronotal edges varying from evenly curving caudad to nearly straight; also varying from smooth to serrate. Posterior pronotal angles may be lacking (*i. e.*, well rounded) or sharply prominent. Venter generally darker medially, with yellow pile prominent about centrum and posterior edge.

Scutellum: always strongly shagreened with shallow but dense punctation, each puncture whitish at bottom. Varying in color from unicolorously dark-brown to various mottlings of light brown and yellow, in some cases, predominantly yellow.

Hemelytra: nearly always with some glisten, punctate, each puncture the seat of a white spot, varying in color from unicolorous dark-brown to a well-developed mottled pattern of brown and light, bright yellow, the embolium almost always distinctly and conspicuously lighter than the rest of hemelytra. Hemelytra may strongly or weakly expose the lateral connexival edges, and may or may not attain abdominal tip.

Venter: the prothoracic venter has been discussed above. Remainder of venter is generally distinctly bicolored, the abdomen golden to brown due to the short, golden hydrofuge pelt, and lighter in color than the velvety-appearing meso- and metathoracic venters, which latter may have rich brown mottling centrally. Connexival segments may exhibit various combinations of spination or nonspination on posterolateral angles; if spined, the first, and often the first and second angles are generally nonspinose.

Legs: Prolegs—coxa elongate, globular, green, yellow or brown, smooth, glistening, darkening at distal tips, flattened to receive heel of femur; trochanter well developed, smooth, green, yellow or brown, with tufts of yellow hairs on anterior edge; femur smooth, glistening, green, yellow or brown, widest near proximal end, narrowing rapidly to distal end, *i. e.*, typically incrassate, and with characteristic short, very dense mat of hairs along front border which serves as a resting groove for the tibia when closed against femur; tibia very long, slender, smooth, yellow to brown, occasionally greenish, curved most strongly in distal part where, with the single tarsal segment, it forms a continuous, curved, grasping instrument—combined tibia-tarsus-claw, when closed, either slightly exceeding or slightly shorter than, adjacent edge of femur.

Mesolegs—coxa long, greenish, yellow or brownish, somewhat angularly globular, beset with short, dense golden pile, slightly curved from posterior end and weakly laterad, to anterior end, the outer face flat for reception of basal part of femur; trochanter large, similar in color to coxa, smooth distally, pilose proximally; femur very long, narrow, smooth, similar in color to coxa, glistening, compressed dorsoventrally, some golden pilosity on outer length; tibia greenish, yellow or light-brown, smooth, glistening, narrow, strongly armed with longitudinal rows of strong, reddish-brown spines, arranged in series along the four rounded "angles" formed by the slight dorsoventral compression of tibia—distal end ventrally with from one and one-half to a maximum of eight complete or partial transverse rows of spines set across tibial width, the last row at extreme distal tip; tarsus slender, smooth, glistening, green to yellow, pilose beneath, three-segmented, the first segment minute and difficult to see, even in ventral view, terminating in two claws of about same color as tarsus, darkening at tips, generally only weakly or moderately curved.

Metalegs—coxa swollen, globular, green, yellow or light brown, well haired with short, dense golden pile, flattened ventrolaterally for reception of basal part of femur; trochanter well developed, similar in color to coxa, pilose proximally, smooth and glistening distally; femur long, narrow, smooth, glistening, green, yellow or brown, dorsoventrally compressed, weakly spinulose along outer margin, and bearing a thin mat of short, yellow pile on inner margin; tibia long, narrow, glistening, yellow or green, thickly beset with brownish-red spines as in mesotibia, but spines longer, more prominent, and more evidently unequal in size, long and short spines alternating, arranged along four "corners" formed by the slight dorseventral flattening—distal end ventrally with from one and one-half to a maximum of eight partial or complete transverse rows of spines set across width of tibia, the last row at extreme tibial apex—inner margin cushioned with a solid, dense mat of long, silky golden swimming hairs; tarsus slim, smooth, long, narrow, green to yellow and brown, three segmented, the first segmented difficult to see, spinulose and pilose beneath, with two claws markedly darkening at tips and weakly to moderately curved.

KEY TO THE MEXICAN SPECIES OF AMBRYSUS

1. Prosternum fused to propleura, both on the same plane 2*

———Prosternum free from propleura, most definitely so medially, where prosternum disappears posteriorly beneath fore edge of propleura 3

2(1). Male genital process short, somewhat platelike, roundly capitate, distinctly less than twice as long as wide; female subgenital plate-apex widely concave, the concavity armed with two small teeth or projections near middle. (Pl. 93, fig. 1) .... *pygmaeus*

———Male genital process moderately long, parallel-sided to slightly narrowing towards tip, distinctly more than twice as long as wide; female subgenital plate not so constructed. (Pl. 93, fig. 2) .... *circumcinctus caliginosus*

3(1). Female with two elevated almost peglike angles arising from caudal edge of sternite V at lateral anterior edges of subgenital plate; connexiva spineless; prosternal ridge subequal in length to union of propleura along median line; female subgenital plate tipped with a low, blunt angle; male genital process short, foot-shaped, strongly turned externally. (Pl. 93, figs. 3 and 4) .... *melanopterus*

———Female lacking the two elevated angles on caudal edge of sternite V; species without the remaining combination of characters 4

4(3). Lateral edges of abdominal segments III-IV strongly and distinctly serrate in contrast to smooth edges of segments I-II; small, rotund species (species generally with some development of the laterocaudal angle on the female Vth sternite, from a thin, sharp spine to a broad, low but definite sinuosity) 5

———Lateral edges of all abdominal segments smooth or, if serrate, the serration is gradually developed anteriorly to posteriorly 10

* Numbers refer to figures, pls. XCIII and XCIV.

5(4). Males completely lacking a genital process or any indication of such a process, the point usually occupied by it on caudal edge of tergite V being smoothly rounded 6

———Males always with some indication of the genital process, from a definite angle or short, stubby process to a fully developed hook 8

6(5). Female subgenital plate quadrisinuate at apex, the lateral shoulder-sinuosities low, the central sinuosities prominent, appearing as a medially cleft process; female V sternite bispinated at left posterolateral edge, the usual connexival spine accompanied by an angulate projection arising inward from the laterocaudal margin of the sternite (=laterocaudal spine or angle). (Pl. 93, fig. 5) .... *parviceps*

———Female subgenital plate simply and strongly concave at apex; Vth female sternite unispinate at left posterolateral edge due to loss of outer, true connexival spine, its place occupied by only a smooth curve .... (*pudicus*) 7

7(6). Depth of concavity at apex of female subgenital plate less than 50% of width of concavity; smaller, measuring 7.0-7.5 mm. in length. (Pl. 93, fig. 6) .... *pudicus pudicus*

———Depth of concavity at apex of female subgenital plate more than 50% of width of concavity; larger, measuring 7.5-9.0 mm. in length. (Pl. 93, fig. 7) .... *pudicus barberi*

8(5). Posterolateral connexival spine of female abdominal segment V absent, laterocaudal process spinelike, very prominent; female subgenital plate quadriangulate at apex, the lateral shoulders subdued, the central angles prominent (*i. e.*, extending more caudad). (Pl. 93, fig. 8) ...... *abortus*

———Posterolateral connexival spine of female abdominal segment V present, laterocaudal process subdued, either a low, blunt angle or a rounded sinuosity; female subgenital plate smoothly and weakly concave at apex in *A. hungerfordi hungerfordi*, most angulate in *A. h. angularis*, (*hungerfordi*) 9

9(8). Female subgenital plate smoothly and evenly rounded at apex, tip concave; laterocaudal angle low, rounded, much closer to posterolateral spine than to base of subgenital plate. (Pl. 93, figs. 9 and 10) .... *hungerfordi hungerfordi*

———Female subgenital plate slightly more angulate at apex, the sinuosities on each side of the median terminal concavity being flat-topped; laterocaudal angle low but rather sharp, about midway between connexival spine and base of subgenital plate. (Pl. 93, figs. 11 and 12) ..... *hungerfordi triunfo*

———Female subgenital plate with terminal outline more quadrisinuate, nearly angulate, but rather than sinuosities on each side of median terminal concavity being flat-topped or rounded, they are blunt-angulate; laterocaudal angle absent, unmarked by even a sinuosity along the border. (Pl. 93, figs. 13 and 14) .... *hungerfordi angularis*

10(4). Posterior slope behind median prosternal ridge with two tuberculations on each side of median line directly behind caudal end of median ridge, producing a longitudinal median trough- or indentation-effect; female possessing a strong, broad and rather blunt laterocaudal angle; male genital process large and strongly boot-shaped, the sole of the boot straight; tip of female subgenital plate broadly, weakly and simply concave; large species. (Pl. 93, figs. 15 and 16), *puncticollis*

——Posterior slope behind median prosternal ridge flat; at most, with a few weak transverse rugosities which never produce a median longitudinal furrow; females lacking the laterocaudal angle; species without the remaining combination of characters 11

11(10). Combined length of pronotum and head more than two-thirds greatest pronotal width; head and pronotum highly polished, smooth and glistening, without evidences of punctation. (Pl. 93, fig. 17) . . . . . *pulchellus*

——Combined length of pronotum and head less than two thirds greatest pronotal width; head and pronotum always with some discernible punctation, even though shiny 12

12(11). Female subgenital plate the most distinctive in the genus for this area, semitubular in shape, narrowing sharply from base to apex, and protruding caudad of abdominal tip; valvulae, when projecting beyond subgenital tip, seen to be a rather sharp, smooth, double-pointed ovipositor. (Pl. 93, fig. 18) . . . . . *vanduzeei*

——Female subgenital plate not so constructed and never projecting beyond abdominal tip; valvulae, when projecting, are hirsute 13

13(12). Female subgenital plate dominantly concave at apex, *i. e.*, regardless of degree of development of lateral terminal angles, whether rounded or spinose, a well-marked concavity occupies the apex and is at least half as wide as the subgenital plate at that point 14

——Female subgenital plate variously shaped, multisinuate at apex, but never with a dominant concavity 15

14(13). Female subgenital plate simply and broadly concave at apex, lateral angles simple and sharp, but not spinose; male genital process broadened and somewhat spatulate. (Pl. 93, fig. 19) . . . . . *buenoi*

——Female subgenital plate complexly and broadly concave at apex, lateral angles set inward from edge and prolonged caudad into strong, narrow, but not particularly sharp, spines; male genital process narrow, nonspatulate. (Pl. 93, fig. 20) . . . . . *mormon australis*

15(13). Lateral angles of female subgenital plate-apex rounded, generally shorter (*i. e.*, more cephalad in position) than median angles or sinuosities 16

————Lateral angles of female subgenital plate-apex pointed, angulate or spinose, shorter or longer than median angles or sinuosities 24

16(15). Apex of female subgenital plate asymmetrical, from ventral view, with right side extending farther caudad than left side, all angles rounded, the apex trisinuate (male genital process short and moderately broad). (Pl. 94, fig. 21) . . . . *scalenus*

————Apex of female subgenital plate symmetrical, one side of plate not longer than the other side 17

17(16). Male genital process short, narrow, moderately curved; female subgenital plate weakly quadrisinuate at apex, the lateral angles low (*i. e.*, more cephalad in position), the median angles extending more caudad and appearing almost as a single bluntly rounded tip. (Pl. 94, fig. 22) . . . . *convexus*

————Without the above combination of characters 18

18(17). Embolia remarkably inflated, almost angularly so—width of embolia 43 ± 1% of emboliar length (male genital process very short and broad, female subgenital plate with lateral apical angles low, median angles projecting more caudad, not prominent). (Pl. 94, figs. 23, 24) . . . . *inflatus*

————Embolia never so inflated (species without remaining combination of characters) 19

19(18). Male genital process short but very broad at apex, decidedly boot-shaped, with a well-developed toe; female subgenital plate-apex with lateral angles lower than median angles; large, comparatively narrow species with a proportionately large head, noticeable, however, only during direct comparisons between species. (Pl. 94, fig. 25) . . . . *magniceps*

————Without the above combination of characters 20

20(19). Lateral and median angles of female subgenital plate-apex on the same plane, *i. e.*, a line drawn through their four tips being approximately a straight line 21

————Lateral angles of female subgenital plate-apex shorter than median angles or sinuosities, *i. e.*, the median angles project more caudad than the laterals 22

21(20). Male genital process weakly curved, proportionately broad, width of process averaging 48% of process-length (using greatest width in apical half of process, and curving length of process from tip to base along inner margin). (Pl. 94, fig. 26) . . . . *portheo*

————Male genital process moderately curved, proportionately slender, width of process averaging 28% of process-length. (Pl. 94, fig. 27) . . . . *signoreti*

22(20). Male genital process simply and weakly capitate, the inner terminal corner but slightly more prominent than outer terminal corner. (Pl. 94, fig. 28) . . . . *hydor*

————Male genital process noncapitate, inner terminal corner rounded or angulate, in the former case, strongly produced over outer terminal angle . . . . (*lunatus*) 23

23(22). Male genital process rather goosehead or doghead-shaped, the inner terminal corner bluntly prolonged; female subgenital plate-apex with median angles only moderately produced caudad of lateral angles. (Pl. 94, fig. 29), *lunatus lunatus*

——— Male genital process parallel-sided to apex, where the inner terminal corner is sharply angulate, no wider at apex than over stem; female subgenital plate-apex with median angles rather markedly produced caudad of lateral angles. (Pl. 94, fig. 30) . . . . . *lunatus menoides*

24(15). Female subgenital plate asymmetrical on left side, where a prominent flap occupies the border beyond (laterad of) the left lateral angle; right border scarcely produced. (Pl. 94, fig. 31) . . . . . *dilatus*

——— Female subgenital plate not markedly or noticeably asymmetrical from one lateral border to the other 25

25(24). Lateral apical angles of female subgenital plate long and sharp, spinosely produced, extending considerably caudad of low, rounded, median angles; male genital process large, long, and slimly goosehead-shaped, the inner terminal corner strongly produced, the narrowly rounded end nearly overlapping adjacent edge of the process-bearing sternite. (Pl. 94, fig. 32) . . . . . *cosmius*

——— Lateral apical angles of female subgenital plate shorter than, or even with, the median angles; species without such a male genital process 26

26(25). Lateral apical angles of female subgenital plate lower than median angles or sinuosities (*i. e.*, more cephalad in position than the medians). (Pl. 94, fig. 33) . . . . . *guttatipennis*

——— Lateral apical angles of female subgenital plate approximately even with the median sinuosities 27

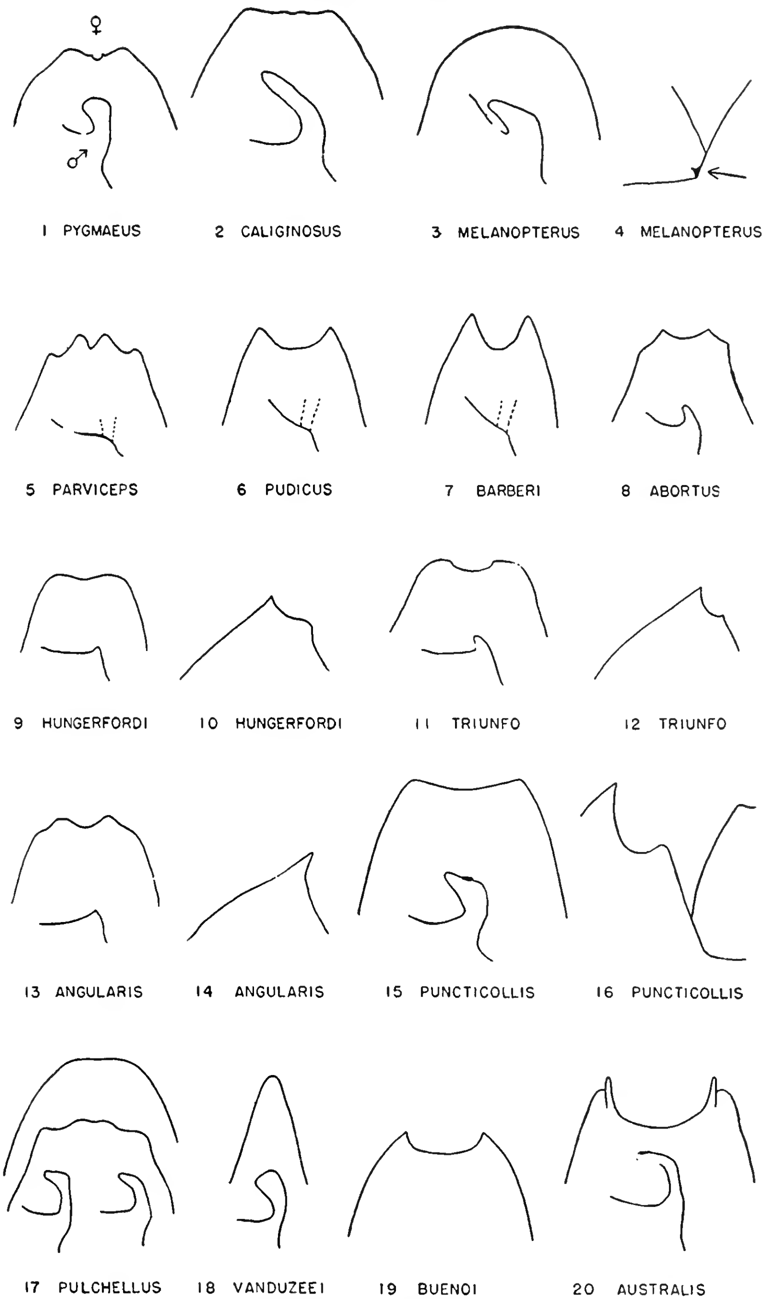
27(26). Lateral apical angles of female subgenital plate long, comparatively narrow, sharp and spinosely produced, even with median, low-rounded angles or sinuosities; median angles set close together; male genital process progressively narrowing to tip, inner terminal corner enormously produced into a straight-edged long process, somewhat like a greatly exaggerated, thin foot. (Pl. 94, fig. 34) . . . . . *fuscus*

——— Lateral apical angles of female subgenital plate short, blunt, often hardly angulate, even with median, low-rounded angles (*i. e.*, level with the medians); median angles wide-spaced, as close, or closer to, lateral angles (as, than) to each other; male genital process not so shaped 28

28(27). Male genital process weakly curved, proportionately broad, width of process averaging 48% of length of process (using greatest width in apical half of process, and curving length of process from tip to base along inner margin) . . . . . *portheo*

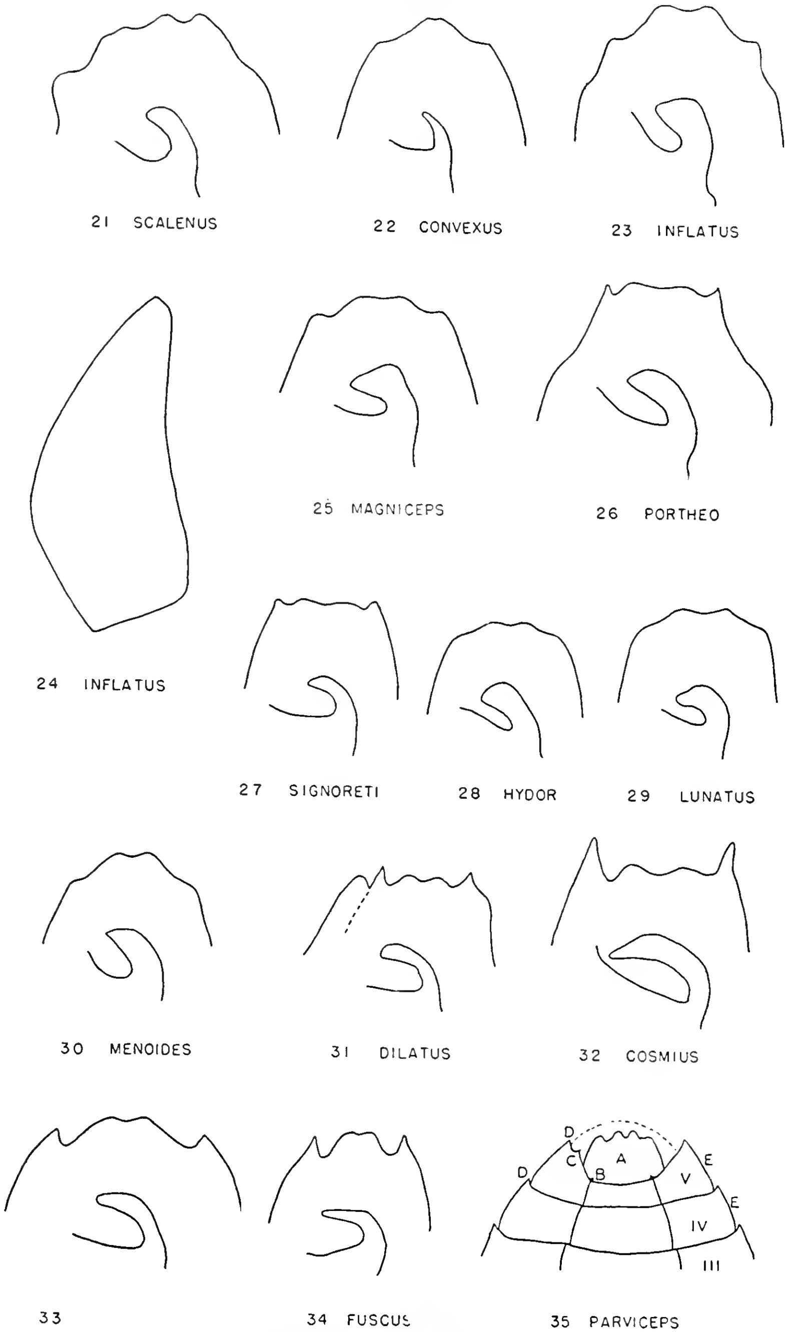
——— Male genital process moderately curved, proportionately more slender, width of process averaging 28% of process-length . . . . . *signoreti*

PLATE XCIII



MEXICAN *AMBRYSUS*

PLATE XCIV



MEXICAN *AMBRYSUS*

DESCRIPTIONS OF SPECIES

Ambrysus pygmaeus sp. nov.

General appearance: small for the genus, slim, streamlined—size 7.0-7.5 mm. long, 3.75-4.0 mm. wide. Dorsum unicolorously deep brownish; entire surface densely, shallowly, roughly and coarsely punctate, shiny. Venter unicolorous, slightly darker anteriorly.

Head: densely and coarsely punctate, strongly but smoothly protuberant between eyes. Eyes blackish, bulging markedly above head surface, the most prominent in this respect of the entire genus, resulting in a "popeyed" appearance. Head ratios are:

(1) total length to width (including eyes), 57::79 (72%)
(2) anterior distance between eyes to posterior distance, 37::52 (71%)
(3) anterior distance between eyes to inner eye length, 37::30 (77%)
(4) posterior distance between eyes to greatest length of head posterior to this line, 52::22 (42%).

Pronotum: roughly, coarsely punctulate, a slight transverse rugosity evident in anterior central part just posterior to greatest penetration of head into pronotum; lateral edges microscopically serrate, moderately curved from front to hind angles—percent of curvature, expressed in terms of straight-line distance between anterior and posterior lateral angles and greatest vertical distance between this baseline and line of curvature, is 12-13% (av. 80::10). Dorsal pronotal ratios are:

(1) width between anterior angles to width between posterior angles, or, in this case, widest part of pronotum, which, unlike most members of the genus, is not synonymous with posterolateral angles, but is slightly anterior to them, is 81::143 (57%)
(2) median length to greatest width, 46::143 (32%)
(3) distance between anterior and posterior angles on same side to perpendicular distance between anterior angle and baseline of pronotum, 67::75 (89%).

Scutellum: unicolorous reddish-brown, rough-punctate. In normal position, *i. e.*, approximately on a plane surface with remainder of body, ratio of three sides, anterior and two laterals, is 96::68::68.

Hemelytra: uniform, deep, reddish-brown, densely punctate. Embolium long, narrow (length to width 81::20 = 25%), peculiarly shaped in that the anterior end is nearly as wide as the posterior end, whereas in all other Ambrysi known to me, the anterior end is characteristically and conspicuously narrower than the posterior. Hemelytra rather strongly exposing lateral connexiva, and not quite attaining abdominal tip.

Venter: deep reddish-brown. Connexival segments nonspinose, edges black, nonserrate, curvature weak but present.

Legs: Prolegs—brownish to yellow; ratio of length to greatest width of ventral surface of femur 75::51 (68%): combined tibiotarsus, when closed, slightly exceeding adjacent (proximal) end of femur, but not conspicuously so.

Mesolegs—yellow to brown; femur stout for the genus, ratio of length to median width of ventral surface 71::14 (20%)—1.80 mm. long; tibia comparatively stout for the genus—distal end ventrally with two prominent transverse rows of spines set in solid rows across tibial apex, the last row at extreme tip—ratio of length to median width 91::12 (13%)—length 1.60 mm.

Metalegs—yellow to brown; femur stout for the genus, ratio of length to median width of ventral surface 86::15 (17%)—length 2.0 mm. Tibia stout for the genus, distal end ventrally with two prominent transverse rows of spines set in solid rows across tibial width, the last row at extreme tibial apex—ratio of length to median width of ventral surface 86::7.5 (9%)—length 1.5 mm.

Distribution: see types.

Type locality data: MEXICO—México (Temescaltepec), 5(vi)33, H. E. Hinton—R. L. Usinger.

Location of types: holotypic male and allotype in the collections of the California Academy of Sciences, San Francisco; four paratypes in the Snow Museum, University of Kansas, Lawrence; six paratypes in the collection of Robert L. Usinger, Berkeley, California; two paratypes in the collection of the writer, Reno, Nevada.

This small species is perhaps the most distinctive member of the *oblongulus* group of *Ambrysus* and a more exact knowledge of its position in the group waits on further collecting, particularly in southern Mexico, south to Costa Rica.

Ambrysus circumcinctus caliginosus Usinger

Ambrysus caliginosus Usinger 1946, Univ. Kans., Sci. Bull. 31(1):190.

General appearance: moderately small, slim, streamlined—size 9.0-9.5 mm. long, 5.0-5.25 mm. wide. Dorsum weakly bicolored, lighter anteriorly; entire surface coarsely punctate. Venter uniformly deep reddish-brown, with some vaguely lighter areas anteriorly.

Head: yellowish-brown, coarsely punctate, distinctly but smoothly protuberant before eyes. Eyes rather prominently protuberant above head surface. Head widely and deeply set into anterior pronotal border. Head ratios are:

(1) total length to width, 60::85 (88%)
(2) anterior distance between eyes to posterior distance, 39::57 (68%)

(3) anterior distance between eyes to inner eye margin, 39::31 (74%)
(4) posterior distance between eyes to greatest length of head posterior to this line 57::23 (40%).

Pronotum: brownish, coarsely punctate, extreme edge blackish; lateral edges distinctly, minutely and closely serrate, moderately curved—percent of curvature 12-13% (av. 95::12). Dorsal pronotal ratios are:

(1) width between anterior angles to greatest width of pronotum (see *A. pygmaeus* for qualifications applicable here), 44::89 (49%)
(2) median length to greatest width 31::89 (35%)
(3) distance between anterior angles and point of widest spread of pronotum on the same side to perpendicular distance between anterior angle and baseline of pronotum 41::48 (85%).

Scutellum: deep, uniform reddish-brown, minutely punctulate; ratio of three sides 123::88::88.

Hemelytra: uniform punctate; blackish in color with seven distinct lighter areas as follows: (*a*) two at bases of elytra; (*b*) embolia; (*c*) one medially just behind scutellum; (*d*) two in posterior third of hemelytra. Embolium long, narrow (length-to-width 118::27 = 23%), shaped somewhat as in *A. pygmaeus* but anterior third not as wide, proportionately. Hemelytra strongly exposing connexiva, and just barely attaining abdominal tip to falling just short of tip.

Venter: deep reddish-brown. Connexiva spineless, characterized by a slight but definite increase in lateral projection of posterolateral angles from anterior to posterior. Connexiva distinctly but minutely serrate, particularly on posterior segments.

Legs: Prolegs—yellow-brown; ratio of length to greatest width of ventral femoral surface 92::54 (58%); combined tibiotarsus, when closed, slightly, but definitely, overlapping adjacent (proximal) end of femur.

Mesolegs—yellow-brown; femur somewhat stout for the genus, ratio of length to median width of ventral surface 95::12 (13%)—length 2.40 mm.; tibia somewhat stout, distal end ventrally with two prominent transverse rows of spines set in solid rows across width of tibia, the last row at extreme tip—ratio of length to median width 78::8 (10%)—length 2.10 mm.

Metalegs—yellow-brown; femur comparatively stout, ratio of length to median width 110::18 (16%)—length 2.85 mm. Tibia somewhat stout, distal end ventrally with two prominent transverse rows of spines set solidly across tibial apex, the last row at extreme tibial end—ratio of length to median width of ventral surface 116::9 (8%)—length 3.0 mm.

Recorded distribution: central Mexico (Usinger 1946).

Type locality data: MEXICO—"México (Tejupilco), June 18-21, 1933, H. E. Hinton and R. L. Usinger" (Usinger 1946).

Location of types: "Holotype, male, and allotype, female (California Academy of Sciences)," (Usinger 1946), San Francisco.

Specimens examined: the types and several paratypes from the type locality, the latter in the Usinger collection, Berkeley, California.

I am unable to separate *caliginosus* from *circumcinctus* on purely structural characters, and although they seem relatively distinct when examined side by side, the basis for such distinction, size and color, is not reliable in *Ambrysus;* the smaller specimens of *caliginosus* grade into the larger specimens of *circumcinctus* in both respects, and the male and female accessory genitalia, so valuable in species delineation throughout the remainder of the genus, are not even subspecifically distinct. At the present, we can only regard *caliginosus* as the southern unit of *circumcinctus,* which latter was originally described by Montandon from a population centering on Kerrville, Texas, not far from the Mexican border (1910). In all probability, *A. circumcinctus circumcinctus* occurs in northern Mexico as well, but is so far unreported. *A. c. circumcinctus* averages smaller and lighter than *A. c. caliginosus,* a fact which does not disturb any of our theories concerning the changes undergone by a homogeneous population as it proceeds from the tropics into colder regions to the north.

Ambrysus melanopterus Stål

Ambrysus melanopterus Stål 1862, Stet. Ent. Zeit. 23:459; 1876, Enum. Hemipt. 5:143.
Ambrysus melanopterus, Uhler, 1876, Bull. U.S.G.S. 1:337.
Ambrysus melanopterus, Montandon, 1897, Verh. zool.-bot. Ges. Wien, 57:12, 19; 1909, Bull. Soc. Sci. Buc.-Roum. 17(5-6):316.
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Ambrysus melanopterus, Kirkaldy and Bueno, 1908, Proc. Ent. Soc. Wash. 10:186.
Ambrysus melanopterus, Van Duzee, 1917, Univ. Calif. Publ. Ent. 2:458.
Ambrysus melanopterus, Hungerford, 1919, Univ. Kans., Sci. Bull. 11:201.
Ambrysus melanopterus, La Rivers, 1949, Bull. S. Calif. Acad. Sci. 47(3):108; 1951; Univ. Calif. Publ. Ent. 8(7):295-297.

General appearance: slightly more than medium-sized for the genus, moderately slim, and streamlined—size 10-12 mm. long, 5.5-6.5 mm. wide. Dorsum strongly mottled anteriorly, unicolorous brownish posteriorly, entire surface minutely rugose-punctulate. Venter lighter posteriorly.

Head: weakly punctate, longitudinally streaked with alternate black-brown and yellowish stripes, smoothly but distinctly protuberant between eyes. Eyes very slightly protuberant above head surface, outer and posterior margins meeting at posterolateral corner of eye in a blunt, but definite, angle, and not blending uniformly, smoothly and evenly into one continuous curvature as in the preceding species; basal or posterior eye margin conspicuously rimmed with a chitinous bar or raised edge which projects slightly laterad as posterolateral eye angle to form a weak but discernible angle, in marked contrast to other members of the genus in this area. Head ratios are:

(1) total length to width 68::115 (59%)
(2) anterior distance between eyes to posterior distance 42::62 (68%)
(3) anterior distance between eyes to inner eye length 42::42
(4) posterior distance between eyes to greatest length of head posterior to this line 62::22 (38%).

Pronotum: shallowly punctate laterally, weakly but distinctly transversely rugulose behind deepest head penetration; lateral edges narrowly pale-yellow, inwardly bordered by a wider area of rich deep brown or black, this bordered in turn inwardly by a pale area well supplied with small, conspicuous, uniform, brownish-black spots which may coalesce at one or two places to form short streaks —the centrum is characterized by a "V"-shaped yellowish area occupied centrally by a dark-brown spot; edges smooth, non-serrate, moderately curved — percent of curvatures 10-12% (av. 128::14); posterolateral angles distinct but rounded. Dorsal pronotal ratios are:

(1) width between anterior angles to width between posterior angles 56::115 (49%)
(2) median length to greatest width 44::15 (38%)
(3) distance between anterior and posterior angles on same side to perpendicular distance between anterior angle and baseline of pronotum, 64::60 (94%).

Scutellum: black, minutely punctulate, ratio of three sides 82::61::62.

Hemelytra: deep brown to black, minutely punctulate; embolium long, narrow (length-to-width 138::30 = 22%), markedly longitudinally bicolored, outer third light. Hemelytra moderately exposing connexiva, and not quite, to just, attaining abdominal tip.

Venter: bicolored, abdomen appearing lighter than remainder. Connexiva spineless at posterolateral angles, edges smooth, non-serrate; curvature discernible but weak.

Legs: Prolegs—yellow to brown; ratio of length to greatest width of ventral surface of femur 120::72 (62%); combined tibiotarsus, when closed, quite markedly overlapping adjacent (proximal) end of femur.

Mesolegs—yellow to brown; femur long, narrow, ratio of length to median width of ventral surface 113::18 (16%)—length 3.0 mm.; tibia narrow, distal end ventrally with two prominent, transverse rows of spines set in solid rows across width of tibia, the last row at extreme tip—ratio of length to median width 99::8 (9%)—length 2.5 mm.

Metalegs—yellow to brown; femur narrow, ratio of length to median width of ventral surface 132::20 (15%)—length 3.1 mm.; tibia narrow, distal end ventrally with two prominent transverse rows of spines set solidly across tibial width, the last row at extreme tip—ratio of length to median width of ventral surface, 150::10 (7%)—length 3.7 mm.

Recorded distribution: southern Mexico to southwestern United States.

Type locality data: "Mexico."

Location of type: Royal Stockholm Museum, Sweden.

Specimens examined: GUATEMALA: — *Panzos,* (iv)20, Jordan (USNM). MEXICO:—Chiapas (*Mt. Obando*) (quiet pool of small, swift stream), 15 (iv)40, el. 3,000 ft., H. M. Smith (UK); Guerrero (*S. of Chilpancingo* between Cajones and Rincón), 1 (vii)32, H. M. Smith (UK); México (*Tejupilco*), 3(vii)33, H. E. Hinton—R. L. Usinger (RLU); Tres Marias Islands (*Maria Madre Island,* Arroyo Hondo), 17(v)25, G. D. Hanna (RLU). UNITED STATES:—Arizona: Santa Cruz County (*Patagonia*), 7(ix)38, C. L. Hubbs & family (UM).

Judged solely on the basis of the material examined, this distinctive species does not seem to be particularly common anywhere, but its center of distribution is patently Mexico.

Ambrysus parviceps Montandon

Ambrysus parviceps Montandon 1897, Verh. zool.-bot. Ges. Wien, 47:17; 1909, Bull. Soc. Sci. Buc.-Roum. 17(5-6):320.
Ambrysus parviceps, Champion, 1900, Biol. Centr.-Amer., Heter., 2:356.
Ambrysus parviceps, Usinger, 1946, Univ. Kans., Sci. Bull., 31(1):188.
Ambrysus infuscatus Usinger 1946, Univ. Kans., Sci. Bull., 31(1):188.

General appearance: small, rotund species—size 8.0-8.5 mm. long, 5.5-6.0 mm. wide. Dorsum strongly mottled, lighter anteriorly. Venter light golden-yellow, well furred, dark blotched anteriorly.

Head: groundcolor light yellow, with longitudinal darker, obscure blacker markings superimposed; shiny, impunctate; front widely and smoothly protuberant between eyes. Eyes with posterolateral angle discernible, a chitinous bar bordering posterior eye margin; from behind, eyes only slightly protuberant above head surface. Head ratios are:

(1) total length to width 57::80 (71%)
(2) anterior distance between eyes to posterior distance 36::46 (78%)
(3) anterior distance between eyes to inner eye margin 36::37
(4) posterior distance between eyes to greatest length of head posterior to this line 46::14 (30%)
(5) anterior distance between eyes to greatest length of head anterior to this line 36::8 (17%).

Pronotum: highly polished, impunctate or nearly so; groundcolor light yellow with varied mottling of suffuse brownish; edges smooth, unserrate, densely set with long, yellowish hairs; percent of curvature of pronotal edge 20% (av. 50::10); posterolateral angles usually present but not conspicuous and not obviously at widest point of pronotum. Dorsal pronotal ratios are:

(1) width between anterior angles to width between posterior angles, 42::100 (42%)
(2) median length to greatest width 28::100 (28%)
(3) distance between anterior angle and posterior angle on same side to perpendicular distance between anterior angle and baseline of pronotum 45::45.

Scutellum: reddish-brown, lighter along lateral margins; shiny, shallowly punctate; ratio of three sides 67::49::47.

Hemelytra: color of scutellum, with same shagreenation of white-spotted punctation. Embolium long, of normal width (length-to-width 104::33 = 32%), light yellow in anterior two thirds; in unrubbed specimens, a conspicuous mat of long, yellow pilosity borders lateral edge. Hemelytra moderately exposing connexiva, and just attaining abdominal tip.

Venter: Connexiva spinose, the posterolateral angles sharp on all segments except I; edges of segments I-II absolutely smooth, unserrated, edges of remaining segments serrate, becoming progressively stronger caudally.

Legs: Prolegs — whitish to yellow; ratio of length to greatest width of ventral surface of femur 66::45 (68%); combined tibiatarsus, when closed, not overlapping adjacent (proximal) end of femur.

Mesolegs—whitish to yellow; femur long, narrow, ratio of length to median width of ventral surface 81::16 (20%)—length 2.1 mm.; tibia narrow, distal end ventrally with one complete, transverse row of spines set in a solid row across extreme tip, instead of the usual two rows—in this case, the second row is reduced to two or three spines on each side, leaving the middle section bare—ratio of length to median width 97::15 (15%)—length 1.5 mm.

Metalegs—whitish to yellow; femur long, ratio of length to median width 115::19 (17%)—length 2.60 mm.; tibia long, distal end ventrally with one complete prominent row of spines set in a solid row across the extreme tip instead of the usual two rows—in this case, the second row is reduced to two or three spines on each side, leaving the middle section bare—ratio of length to median width of ventral surface 115::8 (7%)—length 2.50 mm.

Recorded distribution: central Mexico.

Type locality data: "Mexique."

Location of types: "K. K. Hofmuseum, Vienna, Austria."

Specimens examined: MEXICO:—Chihuahua (*Rio San Pedro* between Chihuahua and Naica), 22(vi)34, Smith and Dunkle (UK); (*Corriente*), 24(viii)37, H. D. Thomas (UK); Guerrero (438 kilom. S. of México [City]), 1(xi)36, H. D. Thomas (UK); (*Acapulco*), 12(vii)37, H. D. Thomas (UK); (*Acapulco*), 28(viii)38, L. I. Lipovsky (UK); Michoacán (*Uruapan*) (El Sabino) 28(vii)36, H. D. Thomas (UK); México (*Tejupilco*), 15(vi)33, H. E. Hinton —R. L. Usinger (RLU).

The types of *A. infuscatus* in the California Academy of Sciences, San Francisco, have been examined as well as paratypes of the same name in the Usinger collection, Berkeley, California. Dr. Usinger was able to compare a specimen of *A. infuscatus* with the type of *A. parviceps* in Vienna, and noted the synonymy.

Ambrysus pudicus pudicus Stål

Ambrysus pudicus Stål 1862, Stet. Ent. Zeit., 23:460.
Ambrysus pudicus, Uhler, 1894, Proc. Calif. Acad. Sci., ser. 2, 4:291.
Ambrysus pudicus, Montandon, 1897, Verh. zool.-bot. Ges. Wien, 47:12, 17; 1909, Bull. Soc. Sci. Buc.-Roum. 17(5-6):320.
Ambrysus pudicus, Champion, 1900, Biol. Centr.-Amer., Heteropt. 2:356.
Ambrysus pudicus, Van Duzee, 1917, Univ. Calif. Publ. Ent. 2:458.
Ambrysus pudicus, Usinger, 1946, Univ. Kans., Sci. Bull., 31(1):187.
Ambrysus pudicus, La Rivers, 1949, Bull. S. Calif. Acad. Sci. 47(3):108.

General appearance: small, rotund—size 7.0-7.5 mm. long, 4.5 mm. wide. Dorsum strongly bicolored, light and glistening anteriorly. Venter light yellowish, well furred with hydrofuge pile.

Head: groundcolor light yellow; shiny, impunctate, with longitudinal brown streaking on centrum; front widely but smoothly protuberant between eyes. Eyes somewhat triangular, the straight inner and outer margins forming two sides of the triangle, the smoothly curved posterior margin connecting the two; chitinous bar bordering posterior eye margin quite conspicuous; viewed behind, eyes only slightly protuberant above head surface. Head ratios are:

(1) total length to width (including eyes) 53::78 (68%)
(2) anterior distance between eyes to posterior distance 33::48 (69%)
(3) anterior distance between eyes to inner eye margin 33::32
(4) posterior distance between eyes to greatest length of head posterior to this line 48::18 (38%)
(5) anterior distance between eyes to greatest length of head anterior to this line 33::4.5 (14%).

Pronotum: highly polished, impunctate; groundcolor light yellowish, with a varied mottling of suffuse brownish areas and dots; lateral edges absolutely smooth, sparsely pilose, and smoothly curved from anterior to posterior angles, percent of curvature 12-13% (av. 85::11); posterolateral angles rather prominent for this section of the genus, representing approximately the widest point of pronotum, and distinctly posterior to the thin, transverse posterior pronotal line. Dorsal pronotal ratios are:

(1) width between anterior angles to width between posterior angles 78::165 (47%)
(2) median length to greatest width 54::165 (33%)
(3) distance between anterior angle and posterior angle on same side to perpendicular distance between anterior angle and baseline of pronotum 77::79 (97%).

Scutellum: glistening but minutely punctate; blackish, whitish along edges; ratio of three sides 115::74::70.

Hemelytra: brownish-black, somewhat lighter along scutellar margins, generally with two well-defined light spots on border between membrane and corium, and lighter on embolium; shining but coarsely punctate. Embolium long, of normal width (length-to-width 94::30 = 32%), light yellow in anterior two thirds; edge variably equipped with long, golden hairs. Hemelytra narrowly exposing connexiva, which are densely pilose, with an occasional longer yellow hair interspersed; hemelytra generally slightly exceeding abdominal apex.

Venter: bicolored, abdomen lighter yellow than sterna; connexiva sharply, finely spinose except segment I, the posterolateral angles produced; edges of abdominal segments I-II smooth, glabrous, in contrast to marked pilosity and serration of remaining segments.

Legs: Prolegs—whitish to yellow; ratio of length to greatest width of ventral femoral surface 72::46 (64%); combined tibia-tarsus, when closed, markedly overlapping adjacent (proximal) end of femur.

Mesolegs—whitish to yellow; femur long, narrow, ratio of length to median width of ventral surface 68::12 (18%)—length 1.60 mm.; tibia narrow, distal end ventrally with two prominent transverse rows of spines set in solid rows across tibial width, the last row at extreme tip—ratio of length to median width 84::10 (12%)—length 1.35 mm.

Metalegs—yellow to white; femur long, narrow, ratio of length to median width of ventral surface 84::15 (18%)—length 2.10 mm.; tibia long, narrow, distal end ventrally with two prominent transverse rows of spines set in solid rows across tibial width, the last row at extreme tibial apex—ratio of length to median width of ventral surface 86::6 (7%)—length 2.30 mm.

Recorded distribution: California, Wyoming and Mexico.

Type locality data: "Mexico."

Location of types: Royal Stockholm Museum, Sweden.

Specimens examined: MEXICO:—Guerrero (*Acapulco*), 28(viii) 38, L. I. Lipovsky (UK); (*Río Papagato*, 387 km. S. of México [City]), 31(x)36, H. D. Thomas (UK); (438 km. S. of México [City]), 1(xi)36, H. D. Thomas (UK); México (*Tejupilco*), 20(vi) 33, H. E. Hinton and R. L. Usinger (RLU). GUATEMALA:—*Sanarate*, Kellerman (MCZ).

There is little doubt in my mind that the United States records of this species in the literature are in error. In all probability several species have been confused as *A. pudicus* in the United States. The California records are probably based on *A. californicus*, while small specimens of *A. mormon*, in light of our present knowledge, could be the only material upon which Wyoming records of *A. pudicus* could be based. *A. woodburyi* could also have been easily confused with *A. pudicus* in the early, primitive stages of *Ambrysus* taxonomy.

Ambrysus pudicus barberi Usinger

Ambrysus barberi Usinger 1946, Univ. Kans., Sci. Bull. 31(1):189.

General appearance: a medium-sized subspecies, nearly immaculate—size 7.5-9.0 mm. long and 4.75-6.0 mm. wide.

Head: ratios are:

(1) total length to width 61::89 (69%)
(2) anterior distance between eyes to posterior distance 40::55 (73%)
(3) posterior distance between eyes to greatest length of head posterior to this line 55::19 (35%).

Pronotum: ratios (dorsal) are:

(1) width between anterior angles to width between posterior angles 52::106 (49%)

(2) median length to distance between posterior angles 35::106 (33%)
(3) width between anterior angles to distance between anterior angle and posterior baseline of pronotum 52::50 (96%).

Scutellum: ratio of three sides 69::50::49.

Hemelytra: essentially as in *A. pudicus pudicus.*

Venter: Connexival posterolateral angles distinctly but weakly spinose except those of segment I, and increasing slightly but progressively posteriorly in size. Connexival margins very strongly serrate on all segments except I-II which are always perfectly smooth.

Legs: as in *A. pudicus pudicus,* but larger.

Recorded distribution: northeastern Mexico (Usinger 1946).

Type locality data: "Victoria, Tampico, Mexico, December 10, 1909, F. E. Bishopp, collector" (Usinger 1946).

Location of types: "Holotype, male and allotype, female (U. S. National Museum)" (Usinger 1946).

Specimens examined: MEXICO:—Tamaulipas (*Victoria*), 10(xii) 09, F. C. Bishopp (USNM) (= allotype), (5 mi. S. of *Victoria*), 5(xi)36, H. D. Thomas (UK); México (*Tejupilco*), 15(vi)33, H. E. Hinton and R. L. Usinger (RLU). (The allocation of the type locality, *Victoria,* to "Tampico" in the original description should be changed to *Victoria* in *Tamaulipas,* as indicated above.) UNITED STATES:—Texas (Hidalgo County—*McAllen*), 20(xi)32, L. D. Tuthill (UK).

The larger *A. pudicus barberi,* with our present knowledge, must be considered the northern component of *A. pudicus,* the smaller typical subspecies seemingly a central Mexico-to-Central American entity.

Ambrysus abortus sp. nov.

General appearance: small, rotund species—size 7.5 mm. long, 5.25 mm. wide. Dorsum generally lighter anteriorly, darker and mottled posteriorly, glistening. Venter generally light, with conspicuous dark areas anteriorly.

Head: groundcolor light yellow, shining, glistening, impunctate, with two rather faded, median, longitudinal rows of brown dots on centrum; front widely but smoothly protuberant before eyes. Eyes with posterior bordering chitinous bar somewhat inflated at posterolateral angles and extending slightly laterad; eyes but slightly sinuous above general head surface. Head ratios are:

(1) total length to width 53::82 (65%)
(2) anterior distance between eyes to posterior distance 34::48 (71%)
(3) anterior distance between eyes to inner eye margin 34::35

(4) posterior distance between eyes to greatest length of head posterior to this line 48::15 (31%)
(5) anterior distance between eyes to greatest length of head anterior to this line 34::3.5 (10%).

Pronotum: shiny but not polished, irregularly punctate; ground-color light yellow with a varied mottling of suffuse brown spots; lateral edges smooth, unserrate, conspicuously set with long but not dense yellowish hairs; percent of curvature 14% (av. 85::12); posterolateral angles quite prominent and definite, constituting widest part of pronotum, and are definitely situated posterior to the thin, transverse, posterior pronotal line. Dorsal ratios are:

(1) width between anterior angles to width between posterior angles 42::94 (45%).
(2) median length to greatest width 26::94 (28%)
(3) distance between anterior angle and posterior angle on same side to perpendicular distance between anterior angle and baseline of pronotum 43::42.

Scutellum: blackish with a reddish tinge; lateral edges narrowly light yellow, surface shiny, but not polished, densely, shallowly and roughly punctate. Ratio of three sides 61::41::41.

Hemelytra: suffusedly mottled with light and dark; punctured as is scutellum. Embolium short and broad for the genus, length-to-width 91::33 (36%), bicolored, anterior three fourths light yellow; in unrubbed specimens a thin line of long, sparse yellow hairs along outer edge which, in older individuals, may be entirely rubbed off. Hemelytra moderately exposing connexiva, and just attaining abdominal tip.

Venter: abdominal venter light yellow with a dense coat of short hydrofuge hairs, sterna darker. Connexival posterolateral spines distinguishable on all segments except I, the spines very definitely becoming progressively larger caudad; spination is more in the nature of an acute elongation of the angles than true spination; all lateral connexiva except I-II strongly dentate.

Legs: Prolegs—whitish; ratio of length to greatest width of ventral femoral surface 64::41 (64%); combined tibia-tarsus, when closed, just attaining adjacent (proximal) end of femur.

Mesolegs—whitish; ratio of length to median width of ventral femoral surface 70::15 (21%)—length 2.0 mm.; distal tibial end ventrally with two transverse rows of spines set across tip, the distal row completely solid across apex, the second or proximal row not quite extending the full tibial width, leaving a gap near the outer or anterior end—however, the second row is strong enough to be considered a full row, in contrast to the condition described for

A. parviceps and *A. hungerfordi* where this row fades out medially and the spinal remnants are considered as only secondary armature —ratio of length to median width 58::9 (16%)—length 1.25 mm.

Metalegs—whitish; ratio of length to median width of ventral femoral surface 95::16 (17%) — length 2.25 mm.; distal tibial end ventrally with two prominent transverse rows of spines set across tip, the distal row completely solid across apex, the second or proximal row not extending the full tibial width, leaving a gap near the outer or anterior end—ratio of length to median width 95::8 (8%)—length 2.25 mm.

Distribution: see types.

Type locality data: Mexico:—México (*Tejupilco*), 15(vi)33, H. E. Hinton and R. L. Usinger.

Location of types: Holotypic male and allotype in the collections of the California Academy of Sciences, San Francisco; four paratypes in the Snow Museum, University of Kansas, Lawrence [three paratypes from the type locality, one paratype from *Corriente*, 24(viii)37, H. D. Thomas (Mexico)]; fourteen paratypes (type locality) in the collection of Robert L. Usinger, Berkeley, California; two paratypes (type locality) in the collection of the writer, Reno, Nevada.

Ambrysus hungerfordi hungerfordi Usinger

Ambrysus hungerfordi Usinger 1946, Univ. Kans., Sci. Bull. 31(1):192.

General appearance: small, rotund species — size 7.0-7.75 mm. long, 4.75-5.00 mm. wide. Dorsum bicolored, lighter anteriorly, glistening but not polished. Venter strongly contrastingly colored with blackish-browns, yellows, and, in some specimens, greenish.

Head: groundcolor light yellow, often with a greenish cast, shiny, impunctate; front widely but smoothly protuberant between eyes. Eyes somewhat angular at posterolateral angle in some specimens, caused by an angularity of the caudal-bordering chitinous bar; viewed from behind, eyes insignificantly protuberant above head surface. Head ratios are:

(1) total length to width 52::80 (71%)
(2) anterior distance between eyes to posterior distance 31::45 (69%)
(3) anterior distance between eyes to inner eye margin 31::35 (88%)
(4) posterior distance between eyes to greatest length of head posterior to this line, 45::13 (29%)
(5) anterior distance between eyes to greatest length of head anterior to this line 31::4 (13%).

Pronotum: shiny, but not polished, roughly and shallowly punctate; groundcolor light yellowish-brown, often with a greenish cast, with a varied mottling of suffuse brownish areas; edges smooth, unserrate, conspicuously set with long, but not dense, yellowish hairs; percent of curvature of pronotal edge 15% (86::13); postero-lateral angles usually present, but not conspicuous, and approximately at widest point of pronotum. Dorsal ratios are:

(1) width between anterior angles to width between posterior angles 41::87 (47%)
(2) median length to greatest width 29::87 (33%)
(3) distance between anterior angle and posterior angle on same side to perpendicular distance between anterior angle and baseline of pronotum 39::40.

Scutellum: deep reddish-brown, shiny but not polished, roughly punctate; ratio of three sides 117::74::73.

Hemelytra: darker than scutellum, weakly variegate-blackish and brownish, often with a greenish tinge, punctation as in scutellum. Embolium tending to be somewhat short and wide for the genus, length-to-width 83::30 (36%), light on the anterior two thirds; a thin but conspicuous line of long, sparse yellow hairs along outer edge. Hemelytra moderately exposing lateral connexival margins, and just attaining abdominal apex.

Venter: Connexival posterolateral angles sharply, rather finely spinose, the spination quite evident on all segments except I; however, segment I, instead of completely lacking a spine, as is usual, has a minute, microscopically sharp posterolateral angle, an unusual condition for this section of the genus; all connexiva except I-II are strongly and markedly dentate or serrate, and the posterior half of segment II may show incipient serration under very high magnification.

Legs: Prolegs—yellow, yellow-brown, or greenish; ratio of length to greatest femoral width (ventral surface), 102::65 (64%); combined tibia-tarsus, when closed, not distinctly overlapping adjacent (proximal) end of femur.

Mesolegs—yellow, yellow-brown, or greenish; ratio of femoral length to median width of ventral surface 71::13 (18%)—length 1.85 mm.; tibial distal end ventrally with one complete, prominent, transverse row of spines set in a solid row across extreme tip (as in *A. parviceps*), instead of the usual two—in this case, the second row is reduced to two-three spines on each side, leaving the middle section free—ratio of length to median width 82::14 (17%)—length 1.40 mm.

Metalegs—yellow, yellow-brown to greenish; ratio of femoral length to median width of ventral surface 93::15 (16%)—length

2.20 mm.; tibial transverse apical spination same as for mesolegs—ratio of length to median width 92::9 (10%)—length 2.20 mm.

Recorded distribution: Several localities in Mexico (Usinger 1946), one of which (Tejupilco in México), refers rather to *A. abortus.*

Type locality data: "San Antonio, Mexico, July 15, 1927, R. H. Beamer" (Usinger 1946).

Location of types: "Holotype, male, and allotype, female (Snow Museum, University of Kansas) . . . A series of paratypes collected at the same place by both R. H. Beamer and P. A. Readio" (Usinger 1946).

Specimens examined: Mexico:—Michoacán (*San Antonio*), 15 (vii)27, P. A. Readio (UK) (paratypes); Sonora (*Álamos*) (Buropaco District), 23 (x)34, H. S. Gentry (RLU), (*Navajoa*), 5(iii)30, D. Wright (RLU); (*San Bernardo*) (Río Mayo Arroyo), 2(iii)35 (RLU).

Future collecting will probably show that this subspecies occurs in extreme southwestern United States, as well.

Ambrysus hungerfordi triunfo subsp. nov.

Identical to the typical subspecies in all essential respects, differing chiefly in the structure of the tip of the female subgenital plate (see illustration).

Distribution: see types.

Type locality data: Mexico:—Baja California (*Between San José del Cabo and Triunfo*) (Albatross Expedition), 1911 (RLU).

Location of types: Holotype male and allotype in collections of California Academy of Sciences, San Francisco; paratypes in the collection of Robert L. Usinger, Berkeley, California.

Ambrysus hungerfordi angularis subsp. nov.

Identical to the typical subspecies in all essential respects, differing chiefly in the structure of the tip of the female subgenital plate (see illustration).

Distribution: see types.

Type locality data: Mexico:—Guerrero (*Rio Agua* 437 kilom. S. of México [City]), 31(x)36, H. D. Thomas (UK).

Location of types: Holotype male and allotype in the Snow Museum, University of Kansas, Lawrence.

When the variable population of *A. hungerfordi* has been adequately sampled over its range, the two above-described subspecies will very likely fade into the general background of the species; at the moment they are useful in depicting what are probably the limits of variation in the species, and will stand as distinct until more collecting brings to light such intermediate forms as exist in the populations.

Ambrysus puncticollis Stål

Ambrysus puncticollis Stål 1876, Enum. Hemipt. 5:143.
Ambrysus puncticollis, Montandon, 1897, Verh. zool.-bot. Ges. Wien, 48:13, 20; 1909, Bull. Soc. Sci. Buc.-Roum. 17(5-6):322.
Ambrysus puncticollis, Van Duzee, 1917, Univ. Calif. Publ. Ent. 2:459.
Ambrysus puncticollis, Hungerford, 1919, Univ. Kans., Sci. Bull. 11:199, 203.
Ambrysus puncticollis, La Rivers, 1949, Bull. S. Calif. Acad. Sci. 47(3):108.

General appearance: large for the genus, comparatively long and narrow—size 13.0-15.5 mm. long, 7.0-9.0 mm. wide. Dorsum weakly bicolored, lighter and glistening anteriorly. Venter yellowish to golden, lighter posteriorly.

Head: smooth, polished, impunctate; groundcolor yellow-brown, two longitudinal median rows of brown dots occupying centrum; front conspicuously protuberant between eyes. Eyes, viewed behind, slightly but definitely protuberant above head surface. Head ratios are:

(1) total length to width 42::66 (64%)
(2) anterior distance between eyes to posterior distance 29::42 (69%)
(3) posterior distance between eyes to greatest length of head posterior to this line 42::16 (38%).

Pronotum: glistening, polished, rather densely set with small, shallow impressions; groundcolor yellow-brown, suffuse brown areas and dots occupying centrum; lateral edges smooth, unserrate, usually with a very few, moderately long hairs; percent of lateral curvature 13% (av. 75::10); posterior lateral angles well rounded, distinctly posterior to thin, posterior, transverse pronotal line. Dorsal ratios are:

(1) width between anterior angles to greatest pronotal width 68::138 (49%)
(2) median length to greatest width 54::138 (39%)
(3) width between anterior angles to distance between anterior angle and posterior baseline of pronotum 68::75 (91%).

Scutellum: deep reddish-brown, more reddish than hemelytra; surface shiny but not polished, shagreened with dense, shallow and rough punctation; ratio of three sides 90::62::62.

Hemelytra: generally dark brown with a reddish tinge, some lightening along emboliar margin; surface shiny but not polished, shagreened as is scutellum. Embolium long and narrow for the genus, length-to-width 82::23 (28%), with no marginal pilosity. Hemelytra rather strongly exposing lateral connexival edges, which bear some pilosity of yellow hairs more or less concentrated at the segmental junctures; hemelytra just, or not quite, attaining abdominal tip.

Venter: Connexival posterolateral spines large and prominent on all segments except I, which is spineless; connexival edges smooth, unserrate, weakly curved.

Legs: Prolegs—yellow to amber, often with a greenish tinge; ratio of femoral length to greatest width of ventral surface 89::51 (74%); combined tibiotarsus, when closed, slightly but definitely exceeding adjacent (proximal) end of femur.

Mesolegs—yellow to amber, occasionally with a greenish tinge; ratio of femoral length to median width of ventral surface 70::12 (17%)—length 3.0 mm; tibia distally and ventrally with two prominent, complete, transverse rows of spines set solidly across apex—ratio of length to median width of ventral surface is 116::11 (9%)—length 3.0 mm.

Metalegs—yellow to amber, occasionally greenish; ratio of length to median width of femur 81::14 (17%), comparatively stout for the genus—length 3.50 mm.; tibial apical transverse spination same as for mesolegs—ratio of length to median width of ventral surface 114::8 (7%)—length 5.0 mm.

Recorded distribution: southwestern United States.

Type locality data: "Texas."

Location of types: Royal Stockholm Museum, Sweden.

Specimens examined: Mexico:—Sonora (*Álamos*) (Buropaco District), 23(x)34, H. S. Gentry (RLU); (*San Antonio Colonial*), 15(vii)27, P. A. Readio (UK). United States:—Arizona—Coconino County (*Bill Williams Fork*, August, F. H. Snow) (UK); Maricopa County 7(viii)27, P. A. Readio (UK); Yavapai County (*Camp Verde*), 2(ix)38, C. L. Hubbs & Family (UM); (*Tonto Creek*), 15(ix)36, Hubbs-Schultz (UM). Texas—Bexar County (*Helotes*), 1(vii)17, P. A. Munz (UK).

Labels on specimens which have come to me from other parts of the United States show that *A. puncticollis* and *A. melanopterus* have been commonly confused in the past, and it is no longer certain how much of that confusion has shown up in the literature in the way of erroneous distributional listings.

Ambrysus pulchellus Montandon

Ambrysus pulchellus Montandon 1897, Verh. zool. bot. Ges. Wien, 47:11, 16; 1909, Bull. Soc. Sci. Buc.-Roum. 17(5-6):319.
Ambrysus pulchellus, Champion, 1900, Biol. Centr.-Amer. Hemip. 2:354-361.
Ambrysus pulchellus, Van Duzee, 1917, Univ. Calif. Publ. Ent. 2:458.
Ambrysus pulchellus, Hungerford, 1919, Univ. Kans., Sci. Bull. 11:198, 200.
Ambrysus pulchellus, Usinger, 1946, Univ. Kans., Sci. Bull. 31(1):187.
Ambrysus nitidulus Montandon 1909, Bull. Soc. Sci. Buc.-Roum. 17(5-6):319, 326.

Ambrysus nitidulus, Usinger, 1946, Univ. Kans., Sci. Bull. 31(1):187.
Ambrysus pulchellus pallidulus Montandon 1910, Bull. Soc. Sci. Buc.-Roum. 18 (5-6):189.
Ambrysus pulchellus pallidulus, Van Duzee, 1917, Univ. Calif. Publ. Ent. 2:458.
Ambrysus pulchellus pallidulus, Hungerford, 1919, Univ. Kans., Sci. Bull. 11:198, 200.
Ambrysus pallidulus, Usinger, 1946, Univ. Kans., Sci. Bull. 31(1):187.
Ambrysus pulchellus, La Rivers, 1951, Univ. Calif. Publ. Ent. 8(7):303-306.

General appearance: rather small for the genus, quite narrow—size 7.0-9.5 mm. long, 4.5-5.5 mm. wide. Dorsum generally lighter anteriorly, but the contrast with the posterior is not striking or sharp; glistening, polished anteriorly, shagreened posteriorly. Venter generally uncontrastingly colored, but slightly darker anteriorly.

Head: groundcolor extremely variable, from light yellow through darker browns to a bright green; polished, impunctate; front is advanced before the eyes, but the outline of head-front and outer eye margins forms a completely smooth semicircle. Eyes absolutely flush with head surface from behind, with no perceptible protuberance. Head ratios are:

(1) total length to width 66::10 (66%)
(2) anterior distance between eyes to posterior distance 43::55 (78%)
(3) anterior distance between eyes to inner eye margin 43::40 (93%)
(4) posterior distance between eyes to greatest length of head posterior to this line 55::20 (36%)
(5) anterior distance between eyes to greatest length of head anterior to this line 43::5 (12%).

Pronotum: shiny, polished, impunctate; groundcolor yellow through brown to green, entire centrum, including anterior border, mottled with brown spots, only the "V" area immediately behind region of deepest head penetration free from the mottling. Lateral edges smooth, unserrate, in unrubbed specimens with some moderately long, sparse, yellow hairs along edge, discernible only with considerable magnification; percent of lateral pronotal curvature 13% (av. 90::12); posterolateral angles weak to lacking as definite entities, always situated posterior to transverse posterior pronotal line, not evidently at widest point of pronotum. Dorsal ratios are:

(1) width between anterior angles to width between posterior angles 50::84 (60%)
(2) medial length to greatest width 34::84 (40%)
(3) distance between anterior angle and posterior angle on same side to perpendicular distance between anterior angle and baseline of pronotum 44::49 (89%).

The comparative increase in width of the anterior pronotal end is significant in this group.

Scutellum: reddish-brown to blackish (even in greenish specimens), shiny but not polished, shagreened with dense, shallow, rough punctation; ratio of three sides 57::44::43.

Hemelytra: deep reddish-brown to black, laterally with some greenish cast in greenish specimens (but not in all such specimens); shagreenation as in scutellum. Embolium very long and narrow for the genus, length to width 115::31 (27%), to normal, 95::30 (32%); lighter in anterior two thirds; in unrubbed specimens with a few sparse yellow hairs along outer edge. Hemelytra rather markedly exposing lateral connexiva, and just attaining abdominal tip.

Venter: Connexival posterolateral angles all slightly produced except those of segment I, but this weak prolongation detectable only with considerable magnification; all lateral edges smooth, nonserrate.

Legs: Prolegs—whitish to amber; ratio of length to greatest width of ventral femoral surface 76::53 (70%); combined tibia-tarsus, when closed, just slightly, if at all, overlapping adjacent (proximal) end of femur.

Mesolegs—whitish-yellow; femur long, narrow, ratio of length to median width of ventral surface 78::16 (21%)—length 2.0 mm; tibia long, narrow, distal end ventrally with one prominent, complete transverse row of spines set solidly across apex; remnants of the usual second row proximal to the distal row are present in sufficient quantity to form a partial second row which extends approximately halfway across tibia, with other half of tibia bare and lacking even an isolated spine which could be postulated as a remnant of the same row (as are present in such as *A. hungerfordi*)—ratio of length to median width of ventral surface 68::7 (10%)—length 1.85 mm.

Metalegs—whitish-yellow; femur long, narrow, ratio of length to median width 96::20 (21%)—length 2.80 mm.; tibia long, narrow, terminal transverse spination as in mesotibia—ratio of length to median width 119::9 (8%)—length 2.90 mm.

Recorded distribution: Texas to Guatemala.

Type locality data: "Guatemala."

Location of types: "collection du Musee de Hambourg." (Germany).

Specimens examined: Guatemala: — *Los Amatos,* Kellerman (MCZ). Mexico:—Chiapas (*La Libertad*), 1(i)38, O. U. Louis (500 m. above sea level) (UK); Michoacán (*Uruapan*) (*El Sabino*), 28(vii)36, H. D. Thomas (UK); Morelos (*Río Amacuza,* 133 km. S. of México [City]), 14(x)36, H. D. Thomas (UK); Tamaulipas (*Forlón,* 3½ miles W. of), 8(viii)34, Smith & Dunkle (UK), (*Vic-*

toria, 5 miles S. of), (xi)36, H. D. Thomas (UK). UNITED STATES: —Arizona—Cochise County, 29(vii)27, R. H. Beamer (UK). Texas —Kerr County 8(iv)39, D. Millspaugh (RLU); Sutton County (*Roosevelt*), 21(iv)24, J. O. Martin (RLU); Uvalde County (*Concan*), 6(vii)36, M. B. Jackson (UK); Valverde County (*Del Rio*), 8(vii)38, R. I. Sailer (UK).

As would be expected of a species with as wide a range as this one, there is considerable variation in the population, which has been by no means adequately sampled.

Ambrysus vanduzeei Usinger

Ambrysus vanduzeei Usinger 1946, Univ. Kans., Sci. Bull. 31(1):207.

General appearance: somewhat less than medium size, with a moderate amount of contrasting mottling; size 8.0-9.5 mm. long and 5.5-6.0 mm. wide. Dorsum moderately mottled with brown and yellow, lighter anteriorly. Venter light yellow with no conspicuous darkening.

Head: groundcolor yellow with a variable development of brownish suffusions; shiny, smooth, minutely punctulate; front slightly protuberant before eyes, and with a suggestion of truncation. Viewed posteriorly, eyes flush with head surface, no protuberance evident. Head ratios are:

(1) total length to width 67::103 (65%)
(2) anterior distance between eyes to posterior distance 45::62 (73%)
(3) width between anterior angles to distance between anterior angle and posterior baseline of pronotum 52::46 (88%).

Scutellum: dark reddish-brown, with or without a median longitudinal stripe; shiny but not polished, shagreened with dense, shallow punctation; ratio of three sides 64::45::44.

Hemelytra: varying from hardly, to moderately contrastingly mottled with yellow and blackish-brown; surface shagreened as in scutellum; embolium approximately average in length and width for the genus (length to width 106::36 = 34%), rarely with detectable, sparse, marginal pilosity—anterior two thirds light yellowish. Hemelytra moderately strongly exposing lateral connexival margins, which have conspicuous marginal pilosity. Posterolateral connexival angles rather weakly angulate-produced, nonspinose; hemelytra fully attaining abdominal tip.

Venter: connexival angles can be generally characterized as weakly angulate-produced, progressing in size and relative development anteriorly to posteriorly; all are angulate-produced except those of segment I, which are weakly right-angulate. Connexival margins very strongly serrate on all segments except I, weakening anteriorly on segment II.

Legs: Prolegs—whitish to yellowish; ratio of length to greatest width of femoral ventral surface 86::54 (63%); combined tibia-tarsus, when closed, just attaining, or slightly exceeding, adjacent (proximal) end of femur.

Mesolegs—yellowish-white; ratio of length to median width of ventral femoral surface 79::15 (19%)—length 2.0 mm.; tibial distal end ventrally with two prominent transverse rows of spines, the terminal row set solidly across tibial apex, the secondary or proximal row incomplete on outer or anterior edge, half, or slightly more than half the length of terminal row—ratio of length to median width of ventral surface 69::10 (15%)—length 2.0 mm.

Metalegs—ratio of femoral length to median width of ventral surface 108::18 (17%)—length 2.90 mm.; tibial apical transverse spination as in mesotibia—ratio of length to median width of ventral surface 64::6 (9%)—length 3.0 mm.

Recorded distribution: Baja California, Mexico.

Type locality data: "Mulege, Baja California, May 14, 1921, E. P. Van Duzee" (Usinger 1946).

Location of types: "Holotype, male and allotype, female (California Academy of Sciences)" (Usinger 1946).

Specimens examined: MEXICO: — Baja California (*La Purísima Cañon* between La Purísima and Comondú), 24(v)47, -LaR (L), (*Mulege*), 14(v)21, E. P. Van Duzee (RLU), (*San Luis Gonzaga*), 22-23(v)47, -LaR (L). The types have also been examined.

This unique little species is representative of a type seemingly restricted to the long peninsula of Baja California, and has no counterpart in the rest of the genus except the equally unique *A. ochraceus* from South America; both species possess attenuated and prolonged female subgenital plates, with corresponding valvulae development. Probably these ovipositors are used to insert eggs into plant tissues, or hide eggs in crevices or other inaccessible spots, rather than to merely glue them to underwater surfaces, as seems to be common with most species of *Ambrysus.*

Ambrysus buenoi Usinger

Ambrysus buenoi Usinger 1946, Univ. Kans., Sci. Bull. 31(1):199.
Ambrysus buenoi, La Rivers, 1951, Univ. Calif. Publ. Ent., 8(7):310-312.

General appearance: medium-sized species, 8.5-10.0 mm. long and 5.5-6.0 mm. wide. Dorsum yellowish-brown, varying on the one hand toward deep reddish, and on the other to greenish, suffusions; scutellum may stand out somewhat more darkly than remainder, and head and prothorax may be somewhat lighter than hemelytra in general. Venter dark reddish-brown, darkening anteriorly and medially.

Head: amber to yellowish with greenish tints, smooth, shiny, polished, microscopically very irregularly punctulate. Front of head very weakly protuberant between eyes. Eyes, viewed posteriorly, weakly but distinctly protuberant above head surface. Head ratios are:

(1) total length to width 66::103 (64%)
(2) anterior distance between eyes to posterior distance 45::65 (75%)
(3) anterior distance between eyes to inner eye-margin 45::41 (89%)
(4) posterior distance between eyes to greatest length of head posterior to this line 65::22 (34%).

Pronotum: glistening but not polished, densely, shallowly punctulate; color amber to light-yellow, in the latter case often with a tinge of green; lateral edges smooth, unserrate, in unrubbed specimens with a sparse line of yellow hairs present. Percent of curvature 14% (av. 98::14), posterolateral angles well rounded. Dorsal ratios are:

(1) width between anterior angles to greatest pronotal width 54::102 (53%)
(2) median length to greatest width 33::102 (32%)
(3) width between anterior angles to distance between anterior angle and posterior baseline of pronotum 54::51 (94%).

Scutellum: deep reddish, either same color as hemelytra or darker, but not contrastingly so; surface shiny but not polished, shagreened with dense, shallow, punctation; ratio of three sides 70::50::50.

Hemelytra: uniformly reddish-brown, often with a greenish cast; surface shiny but not polished, shagreened as is scutellum. Embolium somewhat narrow, length to width 61::18 (30%), a faint marginal pilosity usually present. Hemelytra rather markedly exposing lateral connexival edges, which have some marginal pilosity, and not quite attaining abdominal tip.

Venter: Abdominal venter deep reddish-brown, covered with a golden pelt of short, dense hydrofuge hairs; meso- and meta-sterna darker due to lack of the pelt. Connexival posterolateral angles mediumly spinose except segment I, spines progressively increasing in size posteriorly; connexival edges smooth, unserrate, moderately pilose.

Legs: Prolegs—light yellow, amber or greenish; ratio of length to greatest width of femur 84::54 (64%); combined tibia-tarsus, when closed, just attaining, or slightly exceeding adjacent (proximal) end of femur.

Mesolegs—amber to green; ratio of femoral length to median width of ventral surface 90::18 (20%)—length 2.25 mm.; tibia with distal end ventrally with one prominent, transverse row of spines set solidly across tip—remnants of the usual second, proximal row present as a half row on inner or posterior half of tibia—ratio of length to median width of ventral surface 72::8 (11%)—length 1.95 mm.

Metalegs—amber to green; ratio of length to median width of ventral femoral surface 59::10 (17%)—length 2.75 mm.; distal end of tibia ventrally with the same type of transverse spination as mesotibia—ratio of length to median width of ventral surface 130::9 (7%)—length 3.25 mm.

Recorded distribution: southern Texas.

Type locality data: "Rio Grande, Brewster Co., Texas, June 13-17, 1908, Mitchell and Cushman collectors" (Usinger 1946).

Location of types: "Holotype, male (U. S. National Museum). . . . Allotype, female, and a male and female paratype, same data as type" (Usinger 1946) in the Usinger collection.

Specimens examined: MEXICO:—*San Antonio,* 15(vii)28, R. H. Beamer (RLU). UNITED STATES:—the allotype and the two paratypes (see above).

Ambrysus mormon australis subsp. nov.

General appearance: rather large subspecies, 10.0-12.0 mm. long and 6.5-7.5 mm. wide. Dorsum nearly always lighter anteriorly, often with a pronounced mottling of anterior part of hemelytra; shiny but not polished, variously shagreened. Venter generally entirely yellowish to deep-amber.

Head: light-yellow through brown, some specimens with a greenish tint, usually with some longitudinal brownish markings in center; minutely, densely and shallowly punctulate, shiny; front of head slightly protuberant before eyes, and with a suggestion of truncation. Eyes, viewed posteriorly, only slightly protuberant above general head surface. Ratios are:

(1) total length to width 41::62 (66%)
(2) anterior distance between eyes to posterior distance 28::38 (74%)
(3) posterior distance between eyes to greatest length of head posterior to this line 38::14 (37%).

Pronotum: shiny but not polished, densely, shallowly and roughly punctate; groundcolor yellow to brownish, occasionally with green developing laterally, usually with a variable development of brown mottling and suffusions on disc; lateral edges smooth, unserrate, with an occasional sparse yellow pilosity; percent of lateral pronotal curvature 13% (av. 67::9); posterolateral angles well rounded. Dorsal ratios are:

(1) width between anterior angles to greatest pronotal width 62::127 (49%)
(2) median length to greatest width 38::127 (30%)
(3) width between anterior angles to distance between anterior angle and posterior baseline of pronotum 62::58 (94%).

Scutellum: brown, often with a reddish cast, to black, with a variable development of yellowing posteriorly; shiny, markedly rough-shagreened with dense, shallow punctation; ratio of three sides 84::63::62.

Hemelytra: deep brownish to jet-black, usually with enough yellow-spotting to give a mild mottled effect; some greenish lights evident occasionally; shiny, shagreened as is scutellum. Embolium comparatively longer and narrower than that of the typical subspecies, ratio of length to width always less than 35% (av. 72::24 = 33%) (in *A. m. mormon*, length to width varies from 36% [55::20] to 39% [72::28]). Hemelytra rather strongly exposing lateral connexival edges, which have a variable amount of marginal, rather short, pilosity; posterolateral connexival angles always well developed, generally so strongly so as to represent one of the maxima for the genus in this respect; hemelytra not quite, to just, attaining abdominal tip.

Venter: connexival posterolateral angles are strongly spinose on all segments except I, which is entirely lacking in any angular prolongation; margins generally quite smooth, occasionally somewhat rough, but never distinctly dentate or serrate; connexival border bearing spines increases progressively in width posteriorly in contradistinction to another condition so commonly found in the genus, viz., that in which the border is more or less uniform in width over most of its length, then bends rather abruptly inward under shadow of spine of adjacent segment. Female subgenital plate-apex is distinctively different from that of the typical subspecies, with a much greater development of the two lateral angles into long, more or less parallel-sided processes several times longer than wide. Also, in general, *A. m. australis* is a slimmer form than *A. m. mormon*.

Legs: Prolegs — yellow, amber or greenish; ratio of length to greatest width of ventral femoral surface 54::33 (62%); combined tibia-tarsus, when closed, just attaining, or slightly exceeding, adjacent (proximal) end of femur.

Mesolegs—yellow, amber or greenish; ratio of length to median width of ventral femoral surface 58::10 (17%)—length 2.90 mm.; tibial distal end ventrally with two prominent, transverse rows of spines, the terminal row set solidly across apex, the secondary or proximal row incomplete on outer or anterior edge, about two thirds length of complete, terminal row—ratio of length to median width of ventral surface 48::6 (13%)—length 2.30 mm.

Metalegs—yellow, amber or greenish; ratio of length to median width of ventral femoral surface 74::13 (18%)—length 3.45 mm.; tibial distal transverse spination as in mesotibia—ratio of length to median width of ventral surface 83::6 (7%)—length 4.30 mm.

Distribution: see types.

Type locality data: MEXICO:—Chihuahua (*Río San Pedro* between Chihuahua and Naica), 22(vi)34, Smith and Dunkle (UK).

Location of types: Holotype male, allotype and two paratypes in the Snow Museum, University of Kansas, Lawrence; one paratype each in the collections of Robert L. Usinger, Berkeley, California, and the writer, Reno, Nevada.

Ambrysus scalenus sp. nov.

General appearance: a strongly contrastingly mottled species, of rather more than medium size, 10.0-12.5 mm. long, 6.5-8.0 mm. wide. Dorsum strongly mottled with yellow and brown, shiny, conspicuously lighter anteriorly. Venter uniformly very light, almost whitish-yellow, with no darkening except vague spots at lateral connexival abdominal angles.

Head: groundcolor whitish yellow to amber with a variable development of brownish or reddish spotting and streaking; shiny, smooth, minutely punctulate. Head front slightly protuberant before eyes, latter absolutely flush with head surface, when viewed posteriorly. Head ratios are:

(1) total length to width 82::134 (61%)
(2) anterior distance between eyes to posterior distance 68::80 (85%)
(3) posterior distance between eyes to greatest length of head posterior to this line 80::21 (26%).

Pronotum: shiny, smooth, minutely punctate; groundcolor whitish yellow to yellow, often with a faint roseate tinge; a variable development of brown mottling and dotting on disc; lateral edges smooth, unserrate, nonpilose; percent of lateral curvature 16% (av. 63::10), posterolateral angles well rounded. Dorsal ratios are:

(1) width between anterior angles to width between posterior angles 70::133 (53%)
(2) median length to greatest width 44::133 (33%)

(3) width between anterior angles to distance between anterior angle and posterior baseline of pronotum 70::62 (89%).

Scutellum: dark reddish-brown to blackish, conspicuously marked with yellow along lateral edges; shiny, shagreened with dense, shallow punctation; ratio of three sides 85::62::61.

Hemelytra: strongly and contrastingly mottled with brown and yellow, shiny but not polished, shagreened as is scutellum. Embolium about normal in width for the genus, length to width 144::45 (31%), with no noticeable marginal pilosity. Hemelytra very strongly exposing lateral connexival margins; posterolateral connexival angles rather inconspicuous, but present, angulate-produced. Hemelytra just attaining abdominal tip.

Venter: Connexival posterolateral angles markedly angulate-produced, but hardly truly spinose, except angles of segment I; angles increasing slightly but progressively in size posteriorly; connexival margins distinctly but minutely serrate from segment III posteriorly, occasionally weakly evident posteriorly on segment II, lacking on I.

Legs: Prolegs—whitish yellow to amber; ratio of length to greatest femoral width of ventral surface 99::67 (69%); combined tibia-tarsus, when closed, just attaining adjacent (proximal) end of femur.

Mesolegs—whitish yellow to amber; ratio of length to greatest width of ventral femoral surface 105::23 (22%)—length 2.50 mm.; tibia with distal end ventrally with two prominent, transverse rows of spines, the terminal row set solidly across apex, the secondary or proximal row incomplete on outer or anterior edge, slightly more than half the length of terminal row—ratio of length to median width of ventral surface 90::11 (12%)—length 2.20 mm.

Metalegs—whitish to yellowish; ratio of length to median width of ventral femoral surface 140::25 (18%)—length 3.50 mm.; tibia with distal end ventrally with two prominent, transverse rows of spines as in mesotibia—ratio of length to median width of ventral surface 152::13 (9%)—length 4.0 mm.

Distribution: see types.

Type locality data: MEXICO:—Michoacán (*Uruapan,* El Sabino), 28(vii)36, H. D. Thomas (UK).

Location of types: Holotype male, allotype and a large series of paratypes in the Snow Museum, University of Kansas, Lawrence; paratypes in the collections of Robert L. Usinger, Berkeley, California and the writer, Reno, Nevada.

Ambrysus convexus Usinger

Ambrysus convexus Usinger 1946, Univ. Kans., Sci. Bull. 31(1):196.

General appearance: small, very convex, not conspicuously mottled, compact, species—size 9.0-10.0 mm. long, 6.0 mm. wide. Dorsum deep blackish-brown, with vague, uncontrasting mottling; shiny, lighter anteriorly. Venter deep amber to blackish, darker anteriorly, legs of some specimens outstandingly green.

Head: groundcolor light to deep-yellow, with conspicuous deep brownish areas forming a definite pattern of brownish streaks and suffusions; shiny, glistening, comparatively strongly punctate; front slightly protuberant before eyes, and suggestively truncate. Eyes slightly but distinctly protuberant above head surface when viewed posteriorly. Head ratios are:

(1) total length to width 66::104 (63%)
(2) anterior distance between eyes to posterior distance 46::64 (72%)
(3) posterior distance between eyes to greatest length of head posterior to this line 64::19 (30%).

Pronotum: shiny but rough, conspicuously, coarsely, densely and shallowly punctate; groundcolor yellow-brown, darkening on disc except centrally, but with no pattern development. Lateral edges smooth, unserrate, nonpilose; percent of lateral curvature 17% (av. 96::16), posterolateral angles well rounded. Dorsal ratios are:

(1) width between anterior angles to width between posterior angles 52::101 (51%)
(2) median length to greatest width 33::101 (33%)
(3) width between anterior angles to distance between anterior angle and posterior baseline of pronotum 52::50 (96%).

Scutellum: blackish, generally with a very deep reddish suffusion; shiny, rough-shagreened with dense, coarse, shallow punctation; ratio of three sides 71::51::50.

Hemelytra: deep-brown, membrane black, some lightening in color laterally, but no mottling of any kind; shiny, shagreened as in scutellum. Embolium normal in proportions, length to width 108::35 (32%), no marginal pilosity; hemelytra strongly exposing lateral connexival margins, which have very short, sparse, marginal pilosity; posterolateral connexival angles somewhat bluntly produced, distinctly nonspinose; hemelytra attaining, to not quite attaining, abdominal tip.

Venter: Connexival posterolateral angles nonspinose, I, II, III right-angulate, IV a slightly smaller angle (*i. e.,* in degrees, not over-all size), V about the same (in degrees only), but larger in size; all angles increase progressively in size posteriorly, and extend laterally a little more prominently with progression caudally; connexival margins weakly microdentate on posterior segments, smooth on anterior segments.

Legs: Prolegs—yellowish-green to deep amber; ratio of length to greatest width of ventral femoral surface 80::52 (65%); combined tibia-tarsus, when closed, just attaining adjacent (proximal) end of femur.

Mesolegs — yellow-green to amber; ratio of length to greatest width of femoral ventral surface 84::15 (18%)—length 2.10 mm.; tibia with distal end ventrally with two transverse rows of spines, the terminal row prominent, set solidly across apex, the secondary or proximal row very incomplete, only half or less the length of terminal row (i. e., extending half or less across tibial apex)—ratio of length to median width of ventral surface 72::8 (11%)—length 2.00 mm.

Metalegs — yellow-green to amber; ratio of length to greatest width of femoral ventral surface 109::17 (16%)—length 2.85 mm.; distal tibial transverse spination as in mesotibia—ratio of length to median width of ventral surface 70::7 (10%)—length 3.25 mm.

Recorded distribution: central Mexico.

Type locality data: "Real de Arriba, District of Temascaltepec, Mexico, May 25, 1933, H. E. Hinton and R. L. Usinger" (Usinger 1946).

Location of types: "Holotype, male and allotype, female (California Academy of Sciences)" (Usinger 1946).

Specimens examined: the types and several paratypes, the latter in the Usinger collection, Berkeley, California.

Ambrysus inflatus sp. nov.

General appearance: a well-mottled, robust, large, species—10.0-11.5 mm. long, 7.25-8.25 mm. wide. Dorsum generally well and contrastingly mottled, lighter anteriorly; shiny but not polished, variously shagreened. Venter entirely yellow, with no dark markings.

Head: groundcolor light yellow, variously mottled with brownish suffusions and dots; glistening, but minutely roughened; front slightly protuberant before eyes, with a suggestion of truncation. Eyes, viewed from behind, slightly but distinctly protuberant above general head surface. Head ratios are:

(1) total length to width 42::65 (65%)
(2) anterior distance between eyes to posterior distance 33::39 (85%)
(3) posterior distance between eyes to greatest length of head posterior to this line 39::11 (28%).

Pronotum: shiny but not polished, conspicuously, densely, shallowly and roughly punctate; groundcolor light yellow, no green tints of any kind evident on the specimens at my disposal, usually with a variable development of brown mottling on the disc varying from a brownish suffusion to a definite pattern of brown dots. Lateral edges smooth, unserrate, with no detectable pilosity; percent of lateral curvature 13% (av. 62::8), posterolateral angles rather prominent, usually tending more towards angularity than to rounding, definitely set at widest point of pronotum and slightly caudad of transverse pronotal posterior line. Dorsal ratios are:

(1) width between anterior angles to width between posterior angles 65::128 (51%)
(2) median length to greatest width (width between posterior angles in this case) 42::128 (33%)
(3) width between anterior angles to distance between anterior angle and posterior baseline of pronotum 65::56 (86%).

Scutellum: shiny, markedly rough-shagreened with dense, shallow, punctation; color reddish-brown, with varying amounts of light yellow mottling invading disc from the three angles; ratio of three sides 80::58::57.

Hemelytra: deep reddish-brown usually with enough yellow-spotting to give a mild mottled effect; shiny but not polished, shagreened as in scutellum. Embolium with the most unusual type of inflation in the entire genus, furnishing the diagnostic characteristic of this species—embolium exceptionally stout for the genus (although not quite attaining the maximum in this respect), length to width 75::30 (40%); outer edge, instead of exhibiting the usual smooth curvature, is almost angulate, an abrupt and pronounced change of direction occurring at about three fifths of the distance from the cephalad end (see illustration); no significant pilosity along margin. Hemelytra strongly exposing lateral connexival edges, and attaining abdominal tip.

Venter: Connexival posterolateral angles strongly spinose on all segments except I; angle of segment I, however, is generally sharply right-angulate and projects weakly laterad in contrast to most such angles in other species with this spinal pattern in which segment I angle is either rounded and/or completely obliterated in the general contour of the lateral body margin; connexival margins with some semidentate irregularities visible only under high magnification, but never actually serrate or dentate.

Legs: Prolegs—light yellow to amber; ratio of length to greatest width of ventral femoral surface 52::34 (65%); combined tibia-tarsus, when closed, generally slightly but distinctly exceeding adjacent (proximal) end of femur.

Mesolegs—whitish to yellow; ratio of length to greatest width of ventral femoral surface 55::12 (22%)—length 2.65 mm.; tibial distal end ventrally with two prominent, transverse rows of spines, the terminal row set solidly across apex, the secondary or proximal row incomplete on outer or anterior edge, about two thirds length of complete, terminal row—ratio of length to median width of ventral surface 95::9 (9%)—length 2.35 mm.

Metalegs—whitish to yellow; ratio of length to greatest width of ventral femoral surface 76::13 (17%)—length 3.55 mm.; tibial distal transverse spination as in mesotibia—ratio of length to greatest width of ventral surface 82::7 (9%)—length 4.00 mm.

Distribution: see types.

Type locality data: MEXICO:—Jalisco (*Cojumatlán*), 9(ix)38, H. D. Thomas (UK).

Location of types: Holotypic male, allotype and several paratypes in the Snow Museum, University of Kansas, Lawrence; one paratype each in the collections of Robert L. Usinger, Berkeley, California, and the writer, Reno, Nevada.

Ambrysus magniceps sp. nov.

General appearance: well-mottled, compact, strongly convex, rather large species—size 11.0-12.5 mm. long and 7.0-7.5 mm. wide. Dorsum rather strongly yellow and brown mottled, shiny, polished, lighter anteriorly. Venter nearly entirely yellow to amber.

Head: groundcolor yellow to yellow-brown with brownish streaks, suffusions and dotting; surface glistening, microscopically, insignificantly punctate; front of head slightly protuberant before eyes, with a suggestion of truncation. Eyes, viewed posteriorly, perfectly flush with head surface. Head ratios are:

(1) total length to width 48::75 (64%)
(2) anterior distance between eyes to posterior distance, 35::45 (78%)
(3) posterior distance between eyes to greatest length of head posterior to this line 45::12 (27%).

Pronotum: shiny but not polished, minutely, almost smoothly microreticulate mediolaterally, micropunctulate medially; groundcolor yellow-brown with a variable development of brown mottling and dotting on disc. Lateral edges smooth, unserrate, with no detectable pilosity; percent of lateral curvature 14% (av. 72::10), posterolateral angles well rounded. Dorsal ratios are:

(1) width between anterior angles to width between posterior angles 74::133 (56%)

(2) median length to greatest width 50::133 (38%)
(3) width between anterior angles to distance between anterior angle and posterior baseline of pronotum 74::68 (92%).

Scutellum: shiny but not polished, shagreened with dense, shallow punctation; color brown to deep reddish-brown, with varying amounts of yellow invading disc from the three angles; ratio of three sides 87::62::60.

Hemelytra: black-brown, often with deep red tints, with enough yellow spotting to give a moderately strong mottled effect; shiny but not polished, shagreened as in scutellum. Embolium long and narrow, length to width 80::23 (29%), no conspicuous marginal pilosity. Hemelytra strongly exposing lateral connexival margins, which are very sparsely pilose; hemelytra not quite, or just, attaining abdominal tip.

Venter: connexival posterolateral angles nonspinose, very slightly produced laterally from the general body contour as quite sharp, slightly less than 90° angles, angle of segment I the least definite and least produced; connexival margins minutely serrate, serration absent from segment I, weak on II, well developed on remaining connexiva.

Legs: Prolegs—yellow to amber; ratio of length to greatest width of femoral ventral surface 57::40 (70%); combined tibia-tarsus, when closed, just about attaining adjacent (proximal) end of femur.

Mesolegs—yellow, greenish or amber; ratio of length to greatest median width of ventral femoral surface 58::13 (22%)—length 2.85 mm.; tibial distal end ventrally with two prominent, transverse rows of spines, the terminal row set solidly across apex, the secondary or proximal row incomplete on outer or anterior edge, about two-thirds length of complete, terminal row — ratio of length to median width of ventral surface 104::11 (11%)—length 2.55 mm.

Metalegs—yellow, greenish to amber; ratio of length to median width of ventral femoral surface 75::14 (20%)—length 3.50 mm.; distal tibial transverse spination as in mesotibia—ratio of length to median width of ventral surface 86::8 (9%)—length 4.20 mm.

Distribution: see types.

Type locality data: Mexico:—México (*Tejupilco*), 15-17(vi)33, H. E. Hinton and R. L. Usinger (RLU).

Location of types: Holotype male and allotype in collections of California Academy of Sciences, San Francisco; paratypes in the collections of Robert L. Usinger, Berkeley, California, and the writer, Reno, Nevada.

Ambrysus portheo sp. nov.

General appearance: a large, well-mottled species; 12.5-13.5 mm. long and 8.25-9.25 mm. wide. Dorsum usually contrastingly mottled with yellows and browns, generally somewhat lighter anteriorly, shiny. Venter light yellowish without conspicuous dark areas, often with a greenish tinge anteriorly.

Head: smooth, shiny, minutely punctulate; color yellow to yellow-brown with a variable development of brown suffusions and dottings; head front slightly protuberant before eyes, and distinctly truncate. Eyes, viewed posteriorly, absolutely flush with head surface. Head ratios are:

(1) total length to width 51::78 (65%)
(2) anterior distance between eyes to posterior distance 41::47 (87%)
(3) posterior distance between eyes to greatest length of head posterior to this line 47::14 (30%).

Pronotum: shiny, smooth, minutely punctulate; groundcolor light yellow to yellow with a variable development of brown suffusions and dots. Lateral pronotal edges smooth, unserrate, in unrubbed specimens with some sparse pilosity; percent of lateral curvature 14% (av. 77::11), posterolateral angles weakly distinct, not quite lost in the general rounding of pronotum. Dorsal ratios are:

(1) width between anterior angles to width between posterior angles 79::157 (50%)
(2) median length to greatest width 53::157 (34%)
(3) width between anterior angles to distance between anterior angle and posterior baseline of pronotum 79::71 (90%).

Scutellum: light reddish-brown, generally lined laterally with yellow; shiny but not polished, shagreened with dense, shallow punctation; ratio of three sides 103::73::72.

Hemelytra: reddish- to blackish-brown, generally rather well mottled with yellow; shiny but not polished, shagreened as is scutellum. Embolium slightly short and stout for the genus, length to width 85::30 (35%), with some sparse, marginal pilosity. Hemelytra rather strongly exposing lateral connexiva, which have some marginal pilosity; hemelytra attaining abdominal tip.

Venter: connexival posterolateral angles sharply, distinctly spinose except those of segment I (which are, however, in contradistinction to the usual condition for the genus, minutely and sharply right-angulate, distinctly produced laterad of the general body outline), all spines slightly but progressively increasing in size posteriorly; connexival margins distinctly but minutely serrate on all segments except I, occasionally weakening considerably on segment II.

Legs: Prolegs—whitish to amber; ratio of length to greatest width of ventral femoral surface 64::43 (67%); combined tibia-tarsus, when closed, generally slightly exceeding adjacent (proximal) end of femur.

Mesolegs—whitish to yellow; ratio of length to median width of ventral femoral surface 65::13 (20%)—length 3.0 mm.; tibial distal end ventrally with two prominent, transverse rows of spines, the terminal row set solidly across apex, the secondary or proximal row incomplete on outer or anterior margin, approximately half or more the length of complete, terminal row—ratio of length to median width of ventral surface 60::7 (12%)—length 2.55 mm.

Metalegs—whitish to yellow; ratio of length to median width of ventral femoral surface 87::15 (17%)—length 4.0 mm.; tibial terminal transverse spination as in mesotibia—ratio of length to median width of ventral surface 99::7 (7%)—length 5.0 mm.

Distribution: see types.

Type locality data: Mexico:—Coahuila (*Saltillo,* H. D. Thomas) (UK).

Location of types: Holotypic male, allotype and several paratypes in the Snow Museum, University of Kansas, Lawrence; one paratype each in the collections of Robert L. Usinger, Berkeley, California, and the writer, Reno, Nevada.

The relationship between this species and *A. lundbladi* (see the discussion following *A. fuscus*) cannot be determined with certainty until the male characteristics of *A. lundbladi* are known. With more representative material to base judgment on, it may be necessary to combine the two species. Also concerned in this immediate picture is the still unrecognized *A. signoreti.* When the collecting of Mexican Ambrysus material has been comprehensive enough to provide an adequate taxonomic sampling of the populations of these three species, it may be found that the name *signoreti* may have to be applied to the entire assemblage; the problem hinges primarily upon the limits of variability involved, which are still unknown.

Ambrysus signoreti Stål

Ambrysus signoreti Stål 1862, Stet. Ent. Zeit. 23:450; 1876, Enum. Hemipt. 5:143.

Ambrysus signoreti, Uhler, 1872, Hayden Surv. Terr., Rept. for 1871:423; 1876, Bull. U.S.G.S. 1:337; 1877, Wheeler Rept. Chief Eng. for 1877:1331; 1884, Stand. Nat. Hist. 2:260; 1894, Proc. Calif. Acad. Sci., ser. 2, 4:291.

Ambrysus signoreti, Gillette and Baker, 1895, Hemipt. Colo., p. 63.

Ambrysus signoreti, Montandon, 1897, Verh. zool-bot. Ges. Wien. 47:13, 23; 1909, Bull. Soc. Sci. Buc.-Roum. 17:323.

Ambrysus signoreti, Champion, 1900, Biol. Centr.-Amer., Hemipt. 2:358.

Ambrysus signoreti, Snow, 1906, Trans. Kans. Acad. Sci. 20(1):180.
Ambrysus signoreti, Van Duzee, 1917, Univ. Calif. Publ. Ent. 2:459.
Ambrysus signoreti, Hungerford, 1919, Univ. Kans., Sci. Bull. 11:202.
Ambrysus signoreti, Usinger, 1946, Univ. Kans., Sci. Bull. 31(1):185, 203.
Ambrysus signoreti, La Rivers, 1949, Bull. S. Calif. Acad. Sci. 47(3):108.

This species has been consistently misrepresented in the United States literature dealing with Ambrysi, and its status in European literature dealing with the Mexican fauna is hardly better. In the large amount of material gathered for this study, I have been unable to place it definitely, and the present unavailability of the original Stål description leaves me no recourse at present but to reproduce a Montandon description of the species for what it is worth. Fortunately, Dr. Usinger was able to make camera lucida drawings of the male and female accessory genitalic structures, the former from the type in Vienna, the latter from an associated female in Vienna and another in the British Museum. His notes on the Vienna and Stockholm specimens may be useful to others pursuing the same problem:

Stockholm Museum—"*Ambrysus signoreti* Stål, 1 male, Mexico. Stal. Type? . . . this should be the type, according to the Enumeratio. *Puncticollis, pudicus* and *guttatipennis* are all represented by 'types' with red labels. This differs from the others in that it bears no label in Stål's handwriting. It is closest to *lundbladi* . . . but is larger, flatter above, almost perfectly oval, the pronotum very broad. The connexival angles are only slightly produced, about as in *lundbladi*. Of the genital plates figured, it is most like *occidentalis*."

Vienna museum—"*Ambrysus signoreti* Stål. The type is a male with no genital capsule. It is labelled 'Mexico, coll. Signoret,' '*Poeyi* Guer. det. Signoret,' '*Signoreti* Stål,' '*Am. signoreti* Stål det. Montd.,' and 'type' in red. A second specimen which appears to be conspecific is labelled 'Mexico, 1869,' and '*Amb. signoreti* Stål, det. Montd.' This is a female. These are the same as a female in the British Museum with the following labels: 'Belim, Mexico, 1871,' and '63,' 'KK Hof. M. Wien, A. Handlirsch,' '*Ambrysus signoreti* Stal 1896,' and 'Montandon coll. 1901—233.' These also appear to be the same as the 'type' in Stockholm."

Dr. Usinger's camera lucida drawings of the accessory genitalic apparati make it possible to include the species in the key with reasonable accuracy, but the best available description of the animal at the moment is that of Montandon (1897):

"Plus grand et de forme plus élargie que les autres espèces; 13.7 mm de longueur sur 8.8 mm de largeur. Sa teinte jaunâtre claire avec de grandes taches brunes sur les élytres lui donne un aspect très reconnaissable à première vue. Le clavus jaunâtre pâle avec une petite tache brune vers las base et une vers l'extrémité. Le marge élytrale est obtusément sinuée derrière l'embolium, ce dernier très élargi, jaunâtre sur toute sa largeur sur les trois quarts basilaires, brunâtre sur le quart postérieur; les segments du connexivum bruns sur le tiers basilaire, jaunâtres ensuite. Le sillon transversal du pronotum bien visible, mais assez superficiel et un peu interrompu au milieu; la partie postérieure du pronotum derrière le sillon, très-pâle, lisse à ponctuation très fine, concolore et peu dense."

There is little doubt that the records of *A. signoreti* for the United States have been based on other species (*A. occidentalis, A. arizonus* and probably *A. mormon*), since there is no evidence that it occurs there. In Mexico proper, from the sparse available evidence, *A. signoreti* seems to be closest to *A. portheo,* and future material may show the latter to be a variable unit of the *A. signoreti* population *per se.* The accessory genitalic structures of the two, however, denote two separable entities with present material.

Ambrysus hydor sp. nov.

General appearance: a strongly contrastingly mottled species; 10.5-12.75 mm. long and 7.0-8.5 mm. wide. Dorsum strongly mottled with yellow and brown, shiny, lighter anteriorly. Venter more or less uniformly light yellow to greenish, vaguely darker at lateral connexival angles of abdomen.

Head: groundcolor whitish-yellow to reddish-amber with a variable development of deep brownish or blackish spotting and streaking; shiny, smooth, minutely punctulate. Front of head slightly protuberant before eyes, with a suggestion of truncation. Eyes, viewed posteriorly, essentially flush with head surface. Dorsal head ratios are:

(1) total length to width 45::70 (64%)
(2) anterior distance between eyes to posterior distance 34::42 (81%)
(3) posterior distance between eyes to greatest length of head posterior to this line 42::11 (26%).

Pronotum: shiny, smooth, minutely punctulate; groundcolor whitish-yellow to amber with a variable development of brownish mottling and dotting on disc. Lateral edges smooth, unserrate, very weakly pilose marginally in unrubbed specimens; percent of pronotal lateral curvature 14% (av. 66::9), posterolateral angles well-rounded. Dorsal ratios are:

(1) width between anterior angles to width between posterior angles 72::138 (52%)

(2) median length to greatest width 50::138 (36%)
(3) width between anterior angles to distance between anterior angle and posterior baseline of pronotum 72::62 (86%).

Scutellum: dark reddish to blackish-brown, with yellow markings; shiny but not polished, shagreened with dense, shallow punctation; ratio of three sides 94::69::67.

Hemelytra: strongly and contrastingly mottled with black and yellow, the black often showing reddish lights laterally. Embolium somewhat short and stout for the genus, length to width 151::54 (36%), rarely with detectable, sparse, marginal pilosity. Hemelytra very strongly exposing lateral connexival margins, which are conspicuously pilose; hemelytra just, or not quite, attaining abdominal tip.

Venter: Connexival posterolateral angles strongly and grossly spinose, except segment I, which is, at most, but slightly right-angulate, generally quite blunt, not at all produced; connexival margins distinctly, strongly but somewhat minutely dentate or serrate on all segments except I and occasionally II.

Legs: Prolegs—white, amber or green; ratio of length to greatest width of ventral femoral surface 105::73 (70%); combined tibia-tarsus, when closed, just attaining adjacent (proximal) end of femur.

Mesolegs—white, amber or green; ratio of length to greatest width of ventral femoral surface 62::12 (19%)—length 2.80 mm.; tibial distal end ventrally with two prominent, transverse rows of spines, the terminal row set solidly across apex, the secondary or proximal row incomplete on outer or anterior edge, half, or slightly more than half, the length of the terminal, complete, row—ratio of length to median width of ventral surface 98::9 (9%)—length 2.50 mm.

Metalegs—white, amber or green; ratio of length to greatest width of ventral femoral surface 80::14 (18%)—length 3.75 mm.; tibial distal transverse spination as in mesotibia—ratio of length to median width of ventral surface 86::7 (8%)—length 4.0 mm.

Distribution: see types.

Type locality data: Holotype male, MEXICO:—Morelos (*Río Amacuza,* 133 kilom. S. of México [City]), 14(x)36, H. D. Thomas (UK). Allotype female, MEXICO:—Jalisco (*Unión de Tula*), 16(ix)38, H. D. Thomas (UK).

Location of types: Holotype, allotype and paratypes from MEXICO:—Guerrero (*La Sabana,* 226 kilom. S. of México [City]), 20(x)36, H. D. Thomas; (*Puente de Ixtla*), 12(vii)36, H. D.

Thomas; Jalisco (*Unión de Tula*), 16(ix)38, H. D. Thomas; Michoacán (*Uruapan*) (El Sabino), 28(vii)36, H. D. Thomas in the Snow Museum, University of Kansas, Lawrence; paratypes from MEXICO:—México (*Tejupilco*), 19(vi)33, H. E. Hinton and R. L. Usinger in the collection of Robert L. Usinger, Berkeley, California; and MEXICO:—Michoacán (*Uruapan*) (El Sabino), 28(vii)36, H. D. Thomas in the author's collection, Reno, Nevada.

Ambrysus lunatus lunatus Usinger

Ambrysus lunatus Usinger 1946, Univ. Kans., Sci. Bull. 31(1):303.
Ambrysus lunatus La Rivers, 1951, Univ. Calif. Publ. Ent., 8(7):326-328.

General appearance: a widely variable subspecies, both in size and color; 8.5-11.5 mm. long and 6.0-8.0 mm. wide. Dorsum strongly and contrastingly mottled with yellow and brown, moderately shiny, generally not conspicuously lighter anteriorly. Venter light yellow or greenish to amber, without dark markings, generally lighter posteriorly.

Head: groundcolor whitish yellow to amber, often with a greenish tinge, with a variable development of deep brown streaking; shiny, glistening, micropunctate. Front of head slightly protuberant before eyes, either smoothly rounded, or with a faint suggestion of truncation. Eyes, viewed posteriorly, practically flush with head surface. Head ratios are:

(1) total length to width 74::117 (63%)
(2) anterior distance between eyes to posterior distance 60::71 (85%)
(3) posterior distance between eyes to greatest length of head posterior to this line 71::21 (30%).

Pronotum: shiny, smooth, conspicuously but minutely punctate; groundcolor golden yellow to light yellowish-green with a variable development of brown mottling and dotting on disc. Lateral edges smooth, unserrate, occasionally with weakly discernible marginal pilosity; percent of lateral curvature 13% (av. 62::8), posterolateral angles well rounded. Dorsal ratios are:

(1) width between anterior angles to width between posterior angles 62::120 (52%)
(2) median length to greatest width 41::120 (34%)
(3) width between anterior angles to distance between anterior angle and posterior baseline of pronotum 62::58 (94%).

Scutellum: conspicuously light and dark banded (neither color predominating) with light yellow and light to dark brown, often with a greenish tinge; shiny but not polished, shagreened with dense, shallow punctation; ratio of three sides 74::54::53.

Hemelytra: strongly and contrastingly mottled with brown and yellow and green; shiny, but not polished, shagreened as in scutellum. Embolium rather wide and short for the genus, length to width 132::46 (35%), with sparse inconspicuous marginal pilosity. Hemelytra very strongly exposing lateral connexival margins, and just, to not quite, attaining abdominal tip.

Venter: Connexival posterolateral angles markedly spinose except those of segment I which is, at most, but slightly right-angulate-produced; connexival margins distinctly but very minutely serrate on posterior segments, smooth anteriorly.

Legs: Prolegs—yellow, amber or greenish; ratio of length to greatest width of ventral femoral surface 95::61 (64%); combined tibia-tarsus, when closed, generally slightly, but definitely, exceeding adjacent (proximal) end of femur.

Mesolegs—yellowish, amber or green; ratio of length to greatest width of ventral femoral surface 96::18 (19%)—length 2.45 mm.; tibial distal end ventrally with two prominent, transverse rows of spines, the terminal row set solidly across apex, the secondary or proximal row incomplete on outer or anterior edge, about half the length of complete, terminal row—ratio of length to median width of ventral surface 82::10 (12%)—length 2.25 mm.

Metalegs—yellowish, amber or greenish; ratio of length to greatest width of ventral femoral surface 133::22 (16%)—length 3.20 mm.; tibial distal transverse spination as in mesotibia—ratio of length to greatest width of ventral surface 148::13 (9%)—length 3.90 mm.

Recorded distribution: southern Texas.

Type locality data: "Tom Greene County, Texas, July 15, 1928, R. H. Beamer, collector" (Usinger 1946).

Location of types: "Holotype, male, and allotype, female (Snow Museum, University of Kansas)" (Usinger 1946).

Specimens examined: UNITED STATES:—New Mexico—Eddy County 12(vii)27, R. H. Beamer (UK). Texas—Menard County 19(vii)28, R. H. Beamer (UK); Kerr County 9(iv)39, D. Millspaugh (UK); Travis County 10(iv)39, D. Millspaugh (UK); Valverde County (*Del Rio*), 8(vii)38, D. W. Craik, 8(vii)38, R. I. Sailer (UK).

Future collecting will undoubtedly extend the range of this subspecies into northern Mexico.

Ambrysus lunatus menoides subsp. nov.

General appearance: one of the most strongly and contrastingly mottled units of the genus, medium-sized, 8.5-12.0 mm. long and 6.0-7.0 mm. wide.

Head: essentially as in the typical subspecies. Ratios are:

(1) total length to width 67::108 (62%)
(2) anterior distance between eyes to posterior distance 56::68 (82%)
(3) posterior distance between eyes to greatest length of head posterior to this line 68::21 (31%).

Pronotum: essentially as in the typical subspecies. Ratios are:

(1) width between anterior angles to width between posterior angles 57::105 (54%)
(2) median length to greatest width, 35::105 (33%)
(3) width between anterior angles to distance between anterior angle and posterior baseline of pronotum 57::52 (91%).

Hemelytra: essentially as in *A. l. lunatus.* Embolium rather wide and short for the genus, length to width 123::42 (34%).

Venter: connexival posterolateral angles weakly spinose except those of segment I; angle I right-angulate, slightly produced laterad; angle II prominent, but hardly truly spinose, being more in the nature of angulate-produced, the angle approximately 45°; angle III slightly larger than II, approximately transitional between angulate-produced and true spinosity; IV spinose, larger than III; connexival margins generally distinctly but very minutely serrate on all margins except those of segment I, which are smooth.

Legs: essentially as in *A. l. lunatus.*

Distribution: see types.

Type locality data: MEXICO:—Puebla (*Tehuacan,* 18-25(vii)37, H. D. Thomas) (UK).

Location of types: Holotypic male, allotype, a large series of paratypes from the type locality, and paratypes from MEXICO:—Puebla (*Puebla,* 18(vii)37, H. B. Thomas) (UK) in the Snow Museum, University of Kansas, Lawrence; paratypes from the type locality in the collections of Robert L. Usinger, Berkeley, California, and the writer, Reno, Nevada; paratypes from MEXICO:—Chiapas (*Ixtapa,* 27(iv)41, I. J. Cantrall) (UM) in the Museum of Zoology, University of Michigan, Ann Arbor.

The distinctive differences between *A. l. lunatus* and *A. l. menoides* lie in the terminal aspects of the female subgenital plates and in the male genital processes, as illustrated.

Ambrysus dilatus Montandon

Ambrysus dilatus Montandon 1910, Bull. Soc. Sci. Buc.-Roum. 18(5-6):190.
Ambrysus dilatus, Usinger, 1946, Univ. Kans., Sci. Bull. 31(1):198, 199.
Ambrysus hintoni Usinger 1946, Univ. Kans., Sci. Bull. 31(1):206.

General appearance: medium-sized, moderately well-mottled species; 9.5-11.0 mm. long and 6.0-6.5 mm. wide. Dorsum usually well mottled, but often uncontrastingly so, and varying from distinctly lighter anteriorly than posteriorly to nearly uniformly mottled overall, shiny. Venter yellowish to deep reddish with no distinctive dark areas, somewhat lighter posteriorly.

Head: light-yellowish to deep reddish-brown with a variable development of brown dotting and suffusions; shiny, minutely but slightly roughened and punctulate. Front of head slightly protuberant before eyes, and weakly truncate. Eyes, viewed posteriorly, absolutely flush with head surface. Head ratios are:

(1) total length to width 71::117 (61%)
(2) anterior distance between eyes to posterior distance 54::67 (81%)
(3) posterior distance between eyes to greatest length of head posterior to this line 67::20 (30%).

Pronotum: shiny, smooth, minutely punctulate; color yellowish to reddish-brown with a variable development of brown suffusions and dots; lateral edges smooth, unserrate, in unrubbed specimens with some sparse marginal pilosity; percent of lateral curvature 14% (av. 58::8), posterolateral angles quite evident, but somewhat rounded, not distinctly angulate. Dorsal ratios are:

(1) width between anterior angles to width between posterior angles 63::117 (54%)
(2) median length to greatest width 39::117 (33%)
(3) width between anterior angles to distance between anterior angle and posterior baseline of pronotum 63::55 (87%).

Scutellum: deep reddish-brown, often with a blackish aspect, nearly always lighter in color at the angles, and occasionally bisected by a longitudinal, median yellow line; shiny but not polished, shagreened with dense, shallow punctation; ratio of three sides 78::56::55.

Hemelytra: largely blackish-brown to brownish, generally uncontrastingly mottled; shiny, shagreened as is scutellum. Embolium about average in proportions for the genus, length to width 68::22 (32%), usually with some marginal pilosity. Hemelytra rather strongly exposing lateral connexival margins, which have some marginal pilosity; posterolateral connexival angles rather minutely and distinctly angulate-produced, but not truly spinose; hemelytra fully attaining abdominal tip.

Venter: connexival posterolateral angles, except those of segment I, distinctly and sharply, minutely, angulate-produced, but hardly to be considered truly spinose, slightly but progressively increasing in size caudally; connexiva generally discernibly serrate with high magnification, at least on posterior segments.

Legs: Prolegs—whitish to amber; ratio of length to greatest width of ventral femoral surface 96::68 (69%); combined tibia-tarsus, when closed, either just attaining adjacent (proximal) end of femur, or distinctly exceeding it.

Mesolegs—whitish to deep amber; ratio of length to greatest width of ventral femoral surface 95::19 (20%)—length 2.50 mm.; tibial distal end ventrally with two prominent, transverse rows of spines, the terminal row set solidly across apex, the secondary or proximal row incomplete on outer or anterior edge, approximately two thirds the length of the complete row—ratio of length to median width of ventral surface 86::11 (13%)—length 2.10 mm.

Metalegs—whitish to amber; ratio of length to greatest width of ventral femoral surface 126::29 (23%)—length 3.10 mm.; tibial distal transverse spination as in mesotibia—ratio of length to greatest width of ventral surface 140::12 (9%)—length 3.50 mm.

Recorded distribution: central Mexico, "Mexico." Montandon gave only the broad designation "Mexico" when describing the species, but Usinger's type locality data for *A. hintoni* provides more specific data: "Tejupilco, District of Temescaltepec, México, June 30, 1933. . . . H. E. Hinton and R. L. Usinger" (Usinger 1946). The types of *A. hintoni* are "Holotype, male and allotype, female (California Academy of Sciences)" (Usinger 1946).

Specimens examined: MEXICO: — Michoacán (near *Chinapa*), 5(ix)38, H. D. Thomas (UK); México (*Tejupilco*), 15(vi)33, H. E. Hinton and R. L. Usinger, paratypes (RLU); (*Corriente*), 24(viii)37, H. D. Thomas (UK). The types of *A. hintoni* have also been examined. "Mexico:" a "cotype" of *A. dilatus* in the collection of the U. S. National Museum, simply labelled "Mexico," established the synonymy of *A. hintoni.* The terminal structure of the female subgenital plate is so distinctive in the species that it was a simple matter to recognize the synonymy.

Ambrysus cosmius sp. nov.

General appearance: a large, rather well-mottled species; 12.0-14.5 mm. long and 8.0-9.25 mm. wide. Dorsum generally noticeably but not contrastingly mottled with light and dark browns, usually lighter anteriorly, and shiny. Venter whitish to amber, with no distinctive dark areas, slightly lighter posteriorly.

Head: light-yellow to yellowish-brown, often with a greenish cast and with a variable development of brown dotting and suffusions; shiny, micropunctulate. Head front slightly protuberant before eyes, and suggestively truncate. Eyes, viewed from behind, absolutely flush with head surface. Head ratios are:

(1) total length to width 51::80 (64%)
(2) anterior distance between eyes to posterior distance 42::52 (81%)
(3) posterior distance between eyes to greatest length of head posterior to this line 52::14 (27%).

Pronotum: shiny, smooth, micropunctulate; groundcolor whitish-yellow to yellow-brown with a variable development of brown suffusions and dots. Lateral edges smooth, unserrate, in unrubbed specimens with some sparse pilosity. Percent of lateral curvature 14% (av. 78::11), posterolateral angles weakly evident, but nearly lost in the general rounding of pronotum. Dorsal ratios are:

(1) width between anterior angles to width between posterior angles 80::158 (51%)
(2) median length to greatest width 58::158 (31%)
(3) width between anterior angles to distance between anterior angle and posterior baseline of pronotum 80::75 (94%).

Scutellum: yellow-brown to deep reddish-brown, mottled with light yellows; shiny but not polished, shagreened with dense, shallow punctation; ratio of three sides 105::74::74.

Hemelytra: reddish-brown to blackish, generally uncontrastingly mottled; shiny, shagreened as in scutellum. Embolium about average in proportions for the genus, length to width 93::29 (32%), in unrubbed specimens usually with some marginal pilosity. Hemelytra rather strongly exposing lateral connexival margins, and not quite, to fully, attaining abdominal tip.

Venter: Connexival posterolateral angles somewhat variable in spinosity, but always with strong, well-developed spines; as is usual, the angles of segment I are entirely nonspinose and nonangulate-produced; spines slightly but progressively increasing in size caudad; connexival margins distinctly serrate, most strongly so caudally, never so on segment I, and occasionally only weakly so on segment II.

Legs: Prolegs—white, yellow or greenish; ratio of length to greatest width of ventral femoral surface 59::39 (66%); combined tibia-tarsus, when closed, generally slightly exceeding adjacent (proximal) end of femur.

Mesolegs—white, yellow, amber or greenish; ratio of length to median width of ventral femoral surface 59::13 (22%)—length 2.50 mm.; tibial distal end ventrally with two prominent, tranverse rows of spines, the terminal row set solidly across tibial apex, the secondary or proximal row incomplete on outer or anterior edge, approximately three fourths or more the length of complete row—ratio of length to median width of ventral surface 54::7 (13%)—length 2.50 mm.

Metalegs—whitish to amber, often with a greenish tinge; ratio of length to median width of ventral femoral surface 93::18 (20%)—length 4.5 mm.; tibial distal transverse spination as in mesotibia—ratio of length to median width of ventral surface 102::9 (9%)—length 5.0 mm.

Distribution: see types.

Type locality data: Mexico:—México (*Tejupilco,* 19(vi)33, H. E. Hinton and R. L. Usinger) (RLU).

Location of types: Holotypic male, and allotype in the collections of the California Academy of Sciences, San Francisco; paratypes from the type locality in the collection of Robert L. Usinger, Berkeley, California; paratypes from Mexico:—Guerrero (*Chilapa,* 29(x)30, L. Schultze) (UK), (*Tecpan,* 2(iv)30, L. Schultze) (UK); Morelos (*Acatlipa,* 88 km. on highway from México [City] to Acapulco, 6(v)45, J. G. Shaw) (UK), (*Morelos,* 14(vii)36, H. D. Thomas) (UK); Oaxaca (*Oaxaca,* 25(viii)37, H. D. Thomas) (UK), in the Snow Museum, University of Kansas, Lawrence.

A. cosmius stood in the Usinger collection for many years as *A. signoreti,* and its true status was not determined until Dr. Usinger was able to examine the European types of *A. signoreti.*

Ambrysus guttatipennis Stål

Ambrysus guttatipennis Stål 1862, Enum. Hemipt. 5:143.
Ambrysus guttatipennis, Montandon, 1897, Verh. zool.-bot. Ges. Wien. 47:13, 22; 1909, Bull. Soc. Sci. Buc.-Roum. 17:322.
Ambrysus guttatipennis, Champion, 1900, Biol. Centr.-Amer. Hemipt. 2:356.
Ambrysus guttatipennis, Van Duzee, 1917, Univ. Calif. Publ. Ent. 2:459.
Ambrysus guttatipennis, Hungerford, 1919, Univ. Kans., Sci. Bull. 11:203.
Ambrysus guttatipennis, Usinger, 1946, Univ. Kans., Sci. Bull. 31(1):202.
Ambrysus guttatipennis, La Rivers, 1949, Bull. S. Calif. Acad. Sci. 47(3):108.

General appearance: a large, well-mottled species; 10.5-13.5 mm. long and 7.0-8.5 mm. wide. Dorsum rather well and contrastingly mottled with yellowish and brown or black, usually lighter anteriorly. Venter yellow to amber, darker about thoracic centrum, lighter posteriorly.

Head: yellow-brown with a variable development of brown dotting and suffusion; shiny, micropunctulate. Head front slightly protuberant before eyes, and quite truncate. Eyes, viewed posteriorly, absolutely flush with head surface. Head ratios:

(1) total length to width 45::73 (62%)
(2) anterior distance between eyes to posterior distance 32::43 (74%)
(3) posterior distance between eyes to greatest length of head posterior to this line 43::13 (30%).

Pronotum: shiny, smooth, micropunctulate; groundcolor yellow-brown with a variable development of brown suffusions and dots; lateral edges smooth, unserrate, in unrubbed specimens with some sparse pilosity; percent of lateral curvature 16% (av. 76::12), posterolateral angles well rounded. Dorsal ratios are:

(1) width between anterior angles to width between posterior angles 73::145 (50%)
(2) median length to greatest width 50::145 (34%)
(3) width between anterior angles to distance between anterior angle and posterior baseline of pronotum 73::71 (97%).

Scutellum: deep reddish-brown, often with a blackish tinge; shiny but not polished, shagreened with dense, shallow punctation; ratio of three sides 98::69::68.

Hemelytra: reddish to blackish-brown, generally rather well-mottled with yellow; shiny, shagreened as is scutellum. Embolium about average in proportions, length to width 82::26 (32%), usually with some marginal pilosity. Hemelytra moderately exposing lateral connexival margins, which have prominent pilosity. Hemelytra just attaining abdominal tip.

Venter: connexival posterolateral angles rather shortly but distinctly angulate-produced, but not spinose, all angles slightly but progressively increasing in size caudally; there is even a suggestion of this angular-production in the angle of segment I, which angle seldom shows the spinal formula of the remaining angles but is nearly always more or less contoured in with the general outline of the body; connexival margins distinctly serrate on all segments except I, most strongly so posteriorly.

Legs: Prolegs—amber; ratio of length to greatest width of ventral femoral surface 64::42 (66%); combined tibia-tarsus, when closed, distinctly exceeding adjacent (proximal) end of femur.

Mesolegs—amber; ratio of length to greatest width of ventral femoral surface 61::11 (18%)—length 2.90 mm.; distal tibial end ventrally with two prominent, transverse rows of spines, the terminal row set solidly across tibial apex, the secondary or proximal row incomplete on outer or anterior margin, approximately two thirds or more the length of the complete, terminal row—ratio of length to median width of ventral surface 51::8 (16%)—length 2.50 mm.

Metalegs—amber; ratio of length to greatest width of ventral femoral surface 83::14 (17%)—length 4.0 mm.; tibial distal transverse spination as in mesotibia—ratio of length to greatest width of ventral surface 94::7 (8%)—length 4.5 mm.

Recorded distribution: Arizona and Mexico.

Type locality data: "Mexico."

Location of types: Royal Stockholm Museum, Sweden.

Specimens examined: MEXICO:—México (*Real de Arriba*), 25 (v) 33, H. E. Hinton and R. L. Usinger (RLU).

The United States records for this species (Arizona) are very probably based on examples of *A. arizonus* and *A. occidentalis,* and possibly *A. mormon.* There is no evidence at the present time that *A. guttatipennis* even approaches the southwestern United States.

Ambrysus fuscus Usinger

Ambrysus fuscus Usinger 1946, Univ. Kans., Sci. Bull. 31(1):198.

General appearance: a very dark, blackish, totally immaculate species of rather small size, 8.75-9.5 mm. long and 5.5-6.0 mm. wide. Dorsum rough, blackish-brown, more or less unicolorous, shiny. Venter blackish-brown, lighter posteriorly.

Head: deep blackish-brown, generally with a readily discernible, subdermal pair of thin, black, median streaks; shiny but minutely roughened and punctulate. Front of head slightly protuberant before eyes, and distinctly truncate. Eyes, viewed posteriorly, slightly but definitely protuberant above head surface. Ratios are:

(1) total length to width 73::107 (68%)
(2) anterior distance between eyes to posterior distance 53::67 (79%)
(3) posterior distance between eyes to greatest length of head posterior to this line 67::25 (37%).

Pronotum: shiny, but conspicuously roughened and punctate; dark reddish and blackish brown, occasionally showing a faint, vague lightening laterally. Lateral edges smooth, unserrate, in unrubbed specimens with rather conspicuous, but comparatively sparse marginal pilosity. Percent of lateral curvature 19% (av. 105::20), posterolateral angles well rounded. Dorsal ratios are:

(1) width between anterior angles to greatest pronotal width 56::103 (54%)
(2) median length to greatest width 35::103 (34%)
(3) width between anterior angles to distance between anterior angle and posterior baseline of pronotum 56::51 (91%).

Scutellum: blackish, occasionally reddish around edges and often becoming light yellow at the angles; shiny but not polished, shagreened with dense, shallow punctation; ratio of three sides 70::50::50.

Hemelytra: uniformly immaculate blackish-brown, always with discernible, although sometimes vague, lightening in emboliar region; shiny, shagreened as in scutellum. Embolium slightly less than normal in proportions for the genus, length to width 129::40 (31%), usually with some marginal pilosity. Hemelytra moderately exposing lateral connexival margins, which are conspicuously pilose. Hemelytra fully attaining, or exceeding, abdominal tip.

Venter: connexival posterolateral angles nonspinose, increasing progressively in size and slight laterad projection from anterior to posterior; all angles except those of segment I distinctly but minutely projecting laterad due to undercutting of adjacent margin of posterior connexival margin, those of I more or less forming a smooth contour with anterolateral angle of segment II; all remaining posterolateral connexival angles right-angulate except those of IV which are acute angles; connexival margins weakly and irregularly serrate, such serration decreasing anteriorly and totally undemonstrable on margin of segment I.

Legs: Prolegs—yellow-brown; ratio of length to greatest width of ventral femoral surface 93::62 (67%); combined tibia-tarsus, when closed, distinctly exceeding adjacent (proximal) end of femur.

Mesolegs—yellow to brown; ratio of length to greatest width of ventral femoral surface 87::17 (20%)—length 2.0 mm.; tibial distal end ventrally with two prominent, transverse rows of spines, the terminal row set solidly across apex, the secondary or proximal row incomplete on outer or anterior edge, half, or slightly more than half the length of terminal row—ratio of length to greatest width of ventral surface 78::11 (14%)—length 2.0 mm.

Metalegs—yellow to reddish-brown; ratio of length to greatest width of ventral femoral surface 56::10 (18%)—length 2.70 mm.; tibial distal transverse spination as in mesotibia—ratio of length to greatest width of ventral surface 68::6 (9%)—length 3.10 mm.

Recorded distribution: central Mexico.

Type locality data: "Real de Arriba, District of Temescaltepec, Mexico, July 10, 1933, H. E. Hinton and R. L. Usinger" (Usinger 1946).

Location of types: "Holotype, male, and allotype, female (California Academy of Sciences)" (Usinger 1946).

Specimens examined: the types and several paratypes from the type locality, the latter in the Usinger collection, Berkeley, California.

It is not practicable, at present, to incorporate the two Usingerian species, *A. sonorensis* and *A. lundbladi,* into the above structure, since both are known only from a single type specimen, a male in the case of the former, a female in the latter case, both described in 1946. *A. sonorensis* was described from "San Bernardo, Rio Mayo, State of Sonora, Mexico, March 2, 1935, H. S. Gentry collector" (Usinger 1946), while the type locality for *A. lundbladi* is "State of Morelos, Mexico, May 30, 1897, Koebele collection" (Usinger 1946). For detailed descriptions of these, the reader is referred to Usinger's 1946 paper.

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EXPLANATION OF FIGURE 35, PLATE XCIV

Ventral surface of female abdominal tip region

A—subgenital plate.
B—subgenital plate anterolateral angles.
C—laterocaudal connexival angle (secondary or interior posterolateral connexival angle).
D—posterolateral connexival angles (primary or exterior posterolateral connexival angles).
E—connexival margins.
III, IV, V—connexival areas of abdominal segments of these numbers.
FIG. 33, pl. XCIV is *guttatipennis*.

PLATE XCV

(A)—*Ambrysus pygmaeus* La Rivers, × 6.
(B)—*Ambrysus melanopterus* Stål, × 6.
(C)—*Ambrysus puncticollis* Stål, × 6.
(D)—*Ambrysus parviceps* Montandon, × 6.

PLATE XCV

PLATE XCVI

(E)—*Ambrysus pudicus pudicus* Stal, × 6.
(F)—*Ambrysus pudicus barberi* Usinger, × 6.
(G)—*Ambrysus abortus* La Rivers, × 6.
(H)—*Ambrysus hungerfordi* Usinger, × 6.

PLATE XCVI

E

F

G

H

PLATE XCVII

(J)—*Ambrysus pulchellus* Montandon, × 6.
(K)—*Ambrysus vanduzeei* Usinger, × 6.
(L)—*Ambrysus buenoi* Usinger, × 6.
(M)—*Ambrysus mormon australis* La Rivers, × 6.

PLATE XCVII

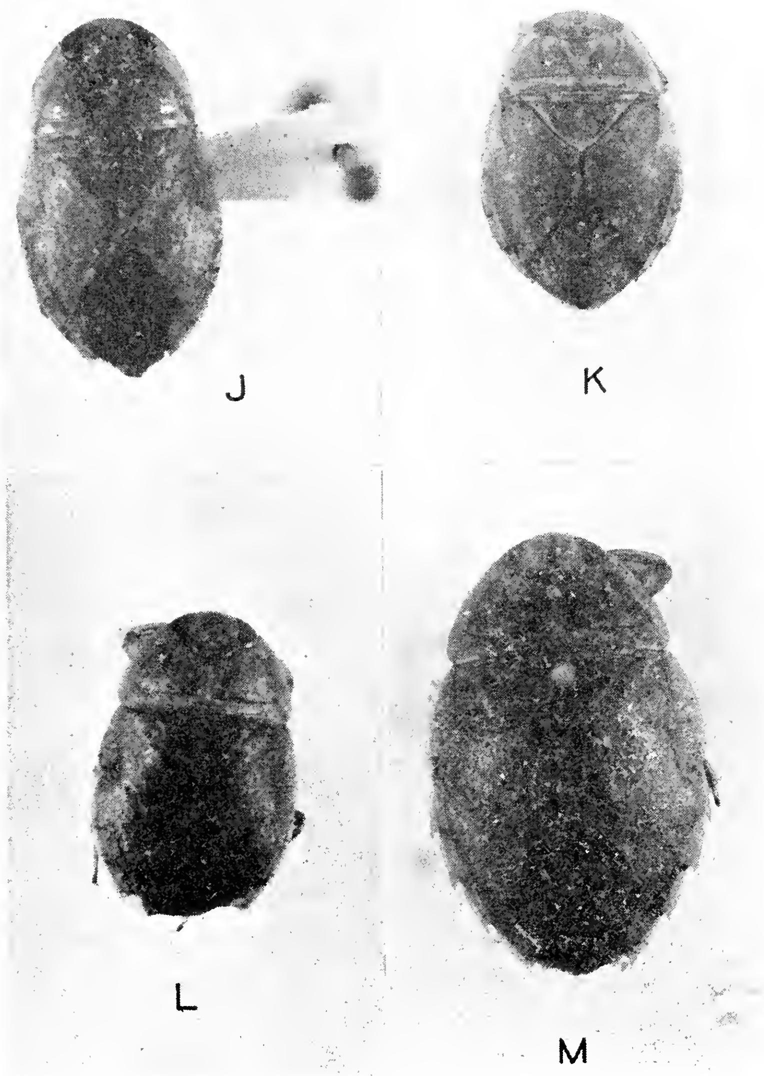


PLATE XCVIII

(N)—*Ambrysus scalenus* La Rivers, × 6.
(O)—*Ambrysus convexus* Usinger, × 6.
(P)—*Ambrysus inflatus* La Rivers, × 6.
(Q)—*Ambrysus magniceps* La Rivers, × 6.

PLATE XCVIII

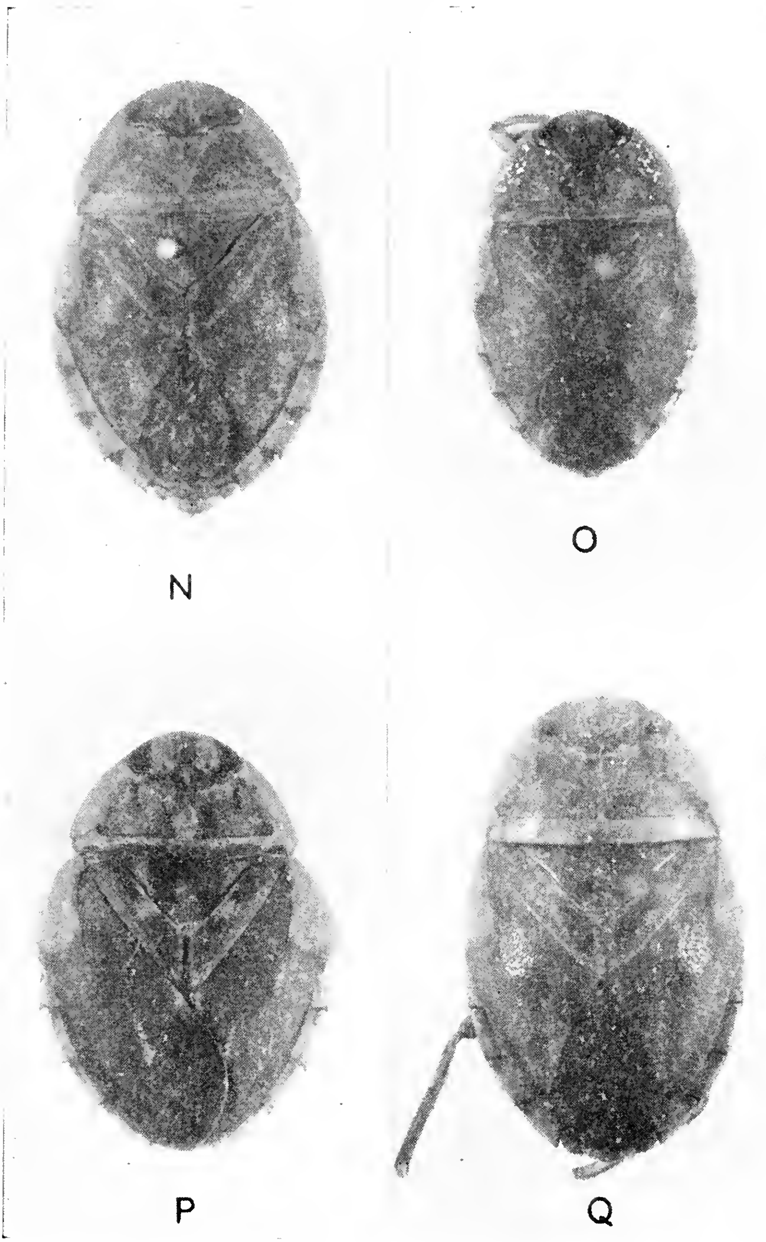


PLATE XCIX

(R)—*Ambrysus portheo* La Rivers, × 6.
(S)—*Ambrysus hydor* La Rivers, × 6.
(T)—*Ambrysus lunatus lunatus* Usinger, × 6.
(U)—*Ambrysus lunatus menoides* La Rivers, × 6.

PLATE XCIX

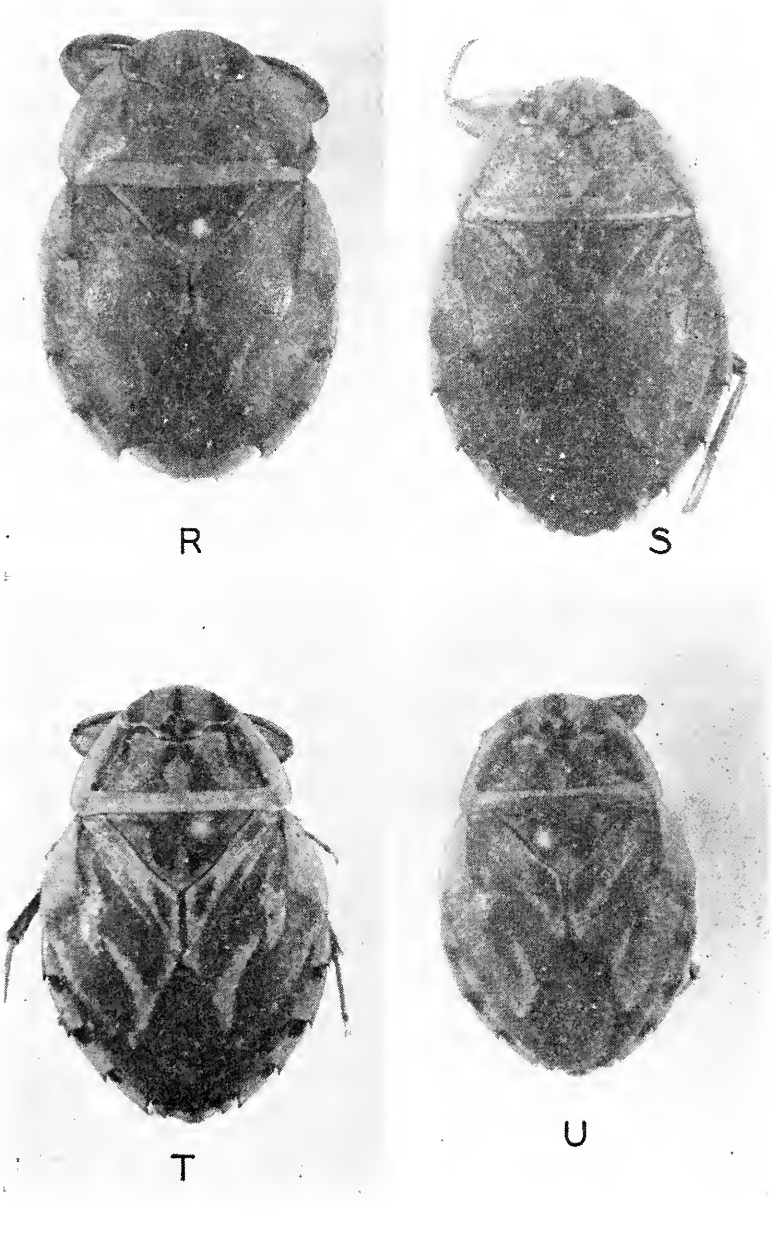
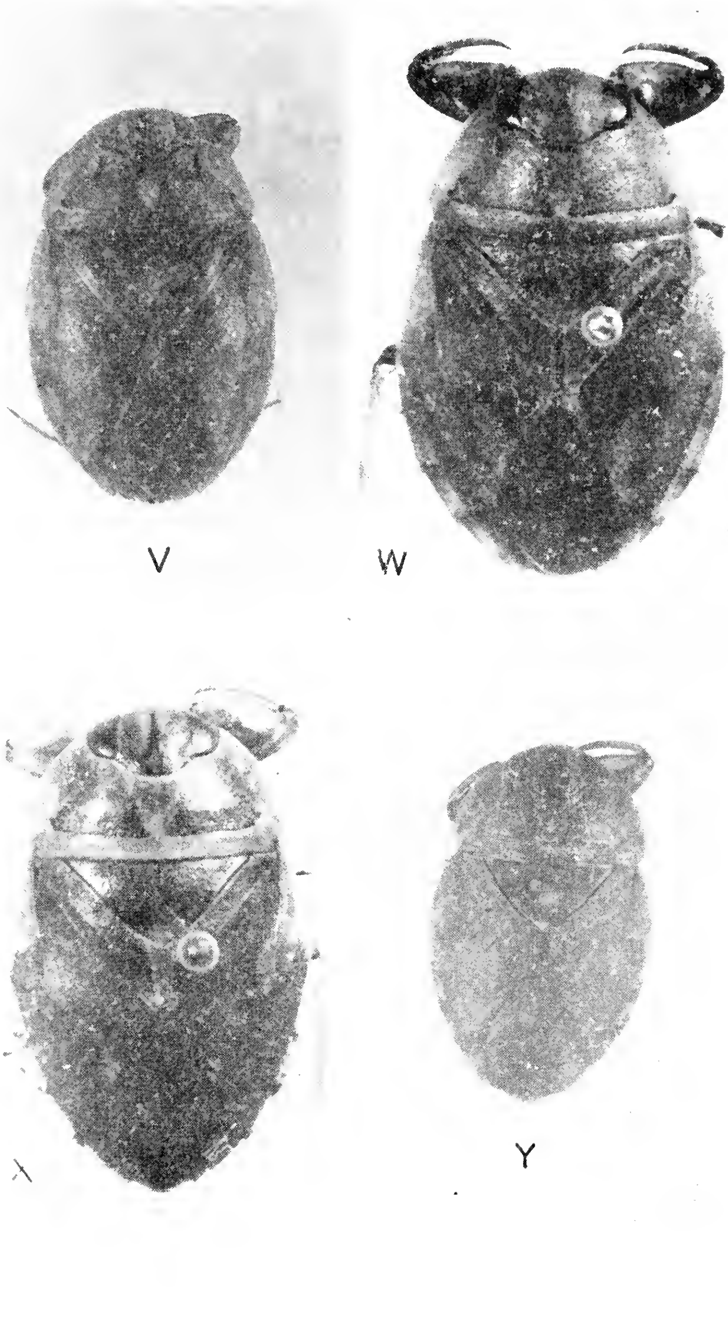


PLATE C

(V)—*Ambrysus dilatus* Montandon, × 6.
(W)—*Ambrysus cosmius* La Rivers, × 6.
(X)—*Ambrysus guttatipennis* Stål, × 6.
(Y)—*Ambrysus fuscus* Usinger, × 6.

PLATE C



V W

X Y

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A Revision of the Genus Buenoa (Hemiptera Notonectidae)

BY

Fred S. Truxal

TABLE OF CONTENTS

ABSTRACT: This paper constitutes a revision of the genus *Buenoa* (Notonectidae, Hemiptera). Although it is primarily taxonomic in nature, material on the biology of the genus is included.

Prior to this work, twenty-two species were known. Twenty-two new species are described in this paper and all old species are redescribed. Two new subspecies have been designated. Three species are placed in synonomy.

The new species are: *B. absidata* (South America), *B. tarsalis* (South America), *B. rostra* (West Indies, South America), *B. uhleri* (United States, Mexico), *B. omani* (United States, Mexico), *B. macrotrichia* (South America), *B. nitida* (South America), *B. mutabilis* (West Indies, South America), *B. arida* (United States), *B. speciosa* (United States, Mexico), *B. gracilis* (Mexico, Central America, West Indies, South America), *B. communis* (South America), *B. artafrons* (United States), *B. confusa* (Canada, United States, Mexico, West Indies), *B. incompta* (South America), *B. oculata* (South America), *B. thomasi* (Mexico), *B. alterna* (Mexico), *B. unguis* (South America),

B. excavata (South America), *B. hungerfordi* (United States, Mexico), *B. distincta* (Mexico).

New subspecies designated: *B. antigone antigone* (Kirkaldy), *B. antigone carinata* (Champion).

Species placed in synonomy are: *B. naias* (Kirkaldy), *B. dentipes* Jaczewski, *B. mallochi* Jaczewski.

Up to and including this paper (exclusive of synonyms) there have been described forty species and two subspecies of *Buenoa*.

INTRODUCTION

This paper is the result of a taxonomic study of the genus *Buenoa*. Its primary purpose is to compile and revise previous knowledge concerning the genus and to present additional information made available by the present study. The genus now includes forty species, twenty-two of which are new.

Approximately 28,000 specimens of *Buenoa* were examined during the study. The types of all the species were studied except those of well-known species and those which have been lost or destroyed. Completion of this paper was made possible only by the full co-operation of a number of institutions and entomologists who made available their type material. I was extremely fortunate in having at my disposal material compared with types in European museums by Dr. H. B. Hungerford in 1928, as well as notes and sketches concerning these species.

Large series of many species were of great value in alleviating confusion concerning species with both brachypterous and macropterous forms and polytypic species where geographic variation occurs.

ACKNOWLEDGMENTS

I am deeply indebted to Dr. H. B. Hungerford for suggesting this study and for the encouragement and guidance he so readily gave. I sincerely appreciate the helpful criticisms and numerous suggestions so willingly offered by Dr. C. D. Michener, Dr. R. H. Beamer, Dr. Kathleen Doering, and Dr. R. E. Beer, all of the University of Kansas. I wish to thank my wife, Mrs. Margaret D. Truxal, for typing much of this paper.

A great majority of the material studied is located in the Francis Snow Entomological Collections. In addition, I am deeply grateful for material made available by the following museums and collections, without which this study would have been impossible: United States National Museum; American Museum of Natural History; British Museum (Natural History); Muséum National

D'Histoire Naturelle, Paris; Zoologisches Museum der Humboldt-Universität, Berlin; Das Zoologische Staatsinstitut und Zoologische Museum, Hamburg; Naturhistorisches Museum Zoologische Abteilung, Vienna; Rijksmuseum van Natuurlijke Historie, Leiden; Museo Argentino de Ciencias Naturales, Buenos Aires; University of Michigan; Tulane University; California Academy of Sciences; J. C. Lutz Collection, Philadelphia, Pennsylvania; C. J. Drake Collection, Ames, Iowa.

BIOLOGY OF THE GENUS BUENOA

The information concerning the biology of *Buenoa* has been based upon *B. margaritacea* studied in the vicinity of Lawrence, Kansas, unless otherwise indicated.

Habitat

Buenoa is found for the most part in freshwater pools, lakes, and ponds. Some species are found along the shores of slow and fast flowing streams. Most members of this genus inhabit the open water although many are found in water with aquatic vegetation. Only seven species have been found that have brachypterous forms which are incapable of flying from temporary pools or ponds.

Activity

Members of this genus in their various stages of development have been taken in temperate climates during every month of the year. Upon breaking the ice from ponds during the month of December, adult *Buenoa* have been seen swimming sluggishly in the water below. The *Buenoa* swim gracefully on their backs in almost perfect equilibrium with the water. However, immediately after replenishing their air supply at the surface, the insect must use vigorous strokes with its hind legs to descend. Soon thereafter, it is able to again attain its equilibrium with the water.

Food

As to food habits, *Buenoa* are predaceous, feeding largely upon Entomostraca and mosquito larvae which they hold in the crib formed by the bristles arming the fore legs. When these small animals pass within view, the *Buenoa* makes a sudden dash to capture them. If missing on the first attempt, no further effort appears to be made. Bare (1928) reports that upon dissecting the abdomen of an adult female, he found what appeared to be *Spirogyra* chloroplasts in the mid-gut. He states that *Buenoa,* therefore, may feed upon algae when other food is not available.

Mating

As in the case of *Anisops*, adult male *Buenoa* possess various stridulatory areas which are used in courtship prior to mating. Hungerford (1924) described the chirping sounds made by *B. limnocastoris* in the laboratory at Douglas Lake, Michigan. The serenade is similar to the sound produced when one draws a nail quickly across the teeth of a rubber comb. The stridulating male follows beneath and behind the female for a few moments and when within a half inch or so of the female, the chirping changes to a hum and is followed by a sudden dash to embrace her. If she eludes him, the male begins all over again or transfers his attentions to another.

Oviposition

Oviposition in temperate areas of the United States appears to commence as early as the latter part of April and continues into August. The eggs are placed individually within the stems of aquatic plants with a portion of the surface exposed. The female is equipped with a pair of ovipositor valves armed with rows of sharp teeth for the purpose of excavating holes in plant tissue. It is not yet known whether the same female lays more than one egg in a day. The total number of eggs that a female lays has not been determined but as many as twelve eggs have been dissected from the abdomen of a single individual. The eggs are elongate and at least a portion of the surface is covered with fine hexagonal reticulations. The eggs hatch in slightly less than two weeks.

Immature Stages

Buenoa undergoes five nymphal instars as do the majority of aquatic Hemiptera. Wing pads appear first in the third stage nymph. Some indication of sex is noted in the form of the seventh abdominal sternum in the third, fourth, and fifth stage nymphs. Adulthood is reached in slightly less than two months in the laboratory. There is more than one generation a year. The insect overwinters as an adult.

DISTRIBUTION AND PHYLOGENY

The insects belonging to the genus *Buenoa* are limited to the Neotropical region and southern portions of the Nearctic region. The geographical range extends from Canada, through the United States, Mexico, Central America, South America, and the West Indies. Its counterpart in the Eastern Hemisphere, *Anisops*, extends through Africa, Madagascar and neighboring islands, the

Mediterranean area, extending eastward to the islands of the South Pacific, thence northward into China and Japan. The relationship between these two genera is very close. *Buenoa* appears to be the more primitive. This conclusion is based primarily on the fact that the males of *Buenoa* possess an extra segment in the front tarsus. *Anisops* is the only genus of the Notonectidae in which the males have only a single segment in the front tarsus. The antiquity of the differentiation between *Buenoa* and *Anisops* is unknown.

Because of the abundance and diversity of *Buenoa* in the tropics and the smaller number of species in America North of Mexico, one might speculate as to a Neotropical origin with subsequent invasion of the Nearctic area. There are several possibilities as to the period and manner of this invasion.

The present distribution pattern of the genus suggests that these insects invaded North America from the south, possibly late enough in Tertiary times so that temperate climates no longer reached the Bering Strait area. If this is the case, the geographical isolation of *Buenoa* and *Anisops* must have resulted from migration over water and the dating of the differentiation is impossible. It is desirable to point out that there are species in both genera that must repeatedly migrate over water to maintain their specific identity. Examples of *Anisops* illustrating this are *A. nasuta* Fieber, known from New Guinea, Celebes, Friendly Islands, Australia, and Guam; *A. batillifrons* Lundblad, known from Formosa, Iriomote Island, Hainan Island, Burma, Assam, India, Philippine Islands, and Okinawa Island; *A. tahitiensis* Lundblad, known from Guadalcanal, New Guinea, Andaman Islands, New Hebrides, Philippine Islands, and Okinawa Island. Examples of *Buenoa* illustrating this are *B. gracilis,* known from Mexico, Honduras, Panamá, Cuba, Jamaica, Puerto Rico, St. Croix Island, Grenada Island, and Perú; *B. scimitra,* known from the United States, Mexico, Cuba, Jamaica, and Puerto Rico; *B. albida,* known from the United States, Mexico, and Puerto Rico. If repeated transfer over a few hundred miles of water is possible, then transfer over thousands of miles of water once in millions of years is likely.

If one argues against the migration over water to explain the differentiation of *Buenoa* and *Anisops* another suggestion is possible. *Buenoa* might have occurred in North America early in the Tertiary (Eocene) when a warm climate extended over most of the North American continent. At this time, one might assume that the genus migrated across the Bering Strait region to later give rise to *Anisops*. The adaptability to warm climates would have allowed the *Buenoa* to occur in the Bering Strait region and to cross to the Old World at a time in the early Tertiary when this area was warm. At a later period these forms isolated by continental separation and cold northern climates diverged to form the *Anisops* of the Eastern Hemisphere and the *Buenoa* of the Western Hemisphere.

It is desirable to point out that although *Buenoa* is more primitive than *Anisops*, there is no certainty that America is where the *Buenoa-Anisops* group arose. On the contrary, the possibility exists that *Buenoa* or a common ancestor, was once holarctic and was replaced in the Old World by a more specialized type, *Anisops*.

The most widely distributed species within the genus is *B. margaritacea*. Its range extends from Manitoba, Canada, in the north to Tamaulipas, Mexico, in the south and from New York in the east to California in the west. The greatest North-South distribution is shown by two closely related species, *B. limnocastoris* and *B. confusa*. These species range from Manitoba, Canada, in the north to Florida and Grand Cayman Island in the south.

It is interesting to note the distribution pattern of the species within the genus. The range of the genus has been divided into eight geographical subdivisions as follows: (1) Canada, (2) Northern half of the United States (further divided into Northeast and Northwest), (3) Southern half of the United States (further divided into Southeast and Southwest), (4) Mexico, (5) Central America, (6) West Indies, (7) Tropical South America, and (8) Temperate South America. The area boundaries have been arbitrarily indicated in some cases. The United States has been divided into North and South by the parallel of 40° N. latitude. This same area has been further divided into East and West by the eastern borders of Montana, Wyoming, Colorado, and New Mexico. South America has been divided into tropical and temperate areas by arbitrarily selecting the parallel of 30° S. latitude. The number of species in each area is indicated as follows: (1) Canada, 4 sp.; (2) Northern half of the United States, 4 sp. (Northeast, 4 sp.; Northwest, 0 sp.); (3) Southern half of the United States, 11 sp. (Southeast, 7 sp.; Southwest, 6 sp.); (4) Mexico, 19 sp.; (5) Central America, 8 sp.; (6) West Indies, 11 sp.; (7) Tropical South America, 23 sp.; (8) Temperate South America, 2 sp. The above information indicates that the area of greatest abundance is Tropical South America. As will be shown below, the area of greatest structural diversity is also Tropical South America.

Buenoa is a morphologically monotonous group with few characters. These characters vary within definitely circumscribed limits. It is the combinations of these few characters which make recognition of the various species possible. Tables 1, 2, and 3 show the way in which certain of these characters are correlated. Actually, the striking fact is the lack of correlation. No two characters are correlated better than those indicated in the tables. They are seemingly meaningless recombinations and, therefore, the establishment of a phylogeny is difficult or impossible.

TABLE 1. *Scatter diagram showing the relationship between the number of sclerotized ridges in the femoral stridulatory area and the ratio of the width of the synthlipsis to the anterior width of the vertex in* Buenoa. *Figures within grid indicate numbers of species.*

No. Ridges In Femoral Stridulatory Area	0–1/15	1/15–2/15	2/15–3/15	3/15–4/15	4/15–5/15	5/15–6/15	6/15–7/15	7/15–8/15	8/15–9/15	9/15–10/15	10/15–11/15	11/15–12/15	12/15–13/15	13/15–14/15	14/15–15/15
70–75															
65–70															
60–65										1					
55–60						1									
50–55															
45–50															
40–45															
35–40								1							
30–35								1							
25–30				1						1					
20–25								2							
15–20						1	1	4							
10–15					1			2			1				1
5–10				1	2			4							
0–5	3	1	2		2			5		1					

WIDTH OF SYNTHLIPSIS: WIDTH OF VERTEX

Table 2. *Scatter diagram showing the relationship between the number of teeth in the tibial comb and the number of sclerotized ridges in the femoral stridulatory area in* Buenoa. *Figures within grid indicate numbers of species.*

No. Ridges in Femoral Stridulatory Area \ No. Teeth in Tibial Comb	0–5	5–10	10–15	15–20	20–25	25–30	30–35	35–40	40–45	45–50	50–55	55–60	60–65	65–70	70–75
70–75															
65–70															
60–65					1										
55–60					1										
50–55															
45–50															
40–45															
35–40							1								
30–35						1									
25–30							1			1					
20–25								2							
15–20					1	2	2	1							
10–15							3	1		1					
5–10						2	2		2		1				
0–5			2	7	1	3	1								

No. Teeth in Tibial Comb

Table 3. *Scatter diagram showing the relationship between the ratio of the width of the head to the width of the vertex and the ratio of the width of the synthlipsis to the width of the vertex in* Buenoa. *Figures within grid indicate numbers of species.*

Width of Head: Width of Vertex \ Width of Synthlipsis: Width of Vertex	0–1/15	1/15–2/15	2/15–3/15	3/15–4/15	4/15–5/15	5/15–6/15	6/15–7/15	7/15–8/15	8/15–9/15	9/15–10/15	10/15–11/15	11/15–12/15	12/15–13/15	13/15–14/15	14/15–15/15
9–10								1			1				
8–9										1					
7–8					1			1							
6–7	1			2	1	2		9							1
5–6	2		1		3		1	6		1					
4–5			1					2		1					
3–4		1													
2–3															
1–2															
0–1															

Width of Synthlipsis: Width of Vertex

Some features, however, can be established as probably primitive. Some examples: the moderate width of the synthlipsis, a moderate number of sclerotized teeth in the stridulatory areas, and possession of a gland-like structure located laterally on the first abdominal segment. On the other hand, other features can almost certainly be termed specialized. Some examples are: holoptic eyes, a wide or narrow synthlipsis, intermediate tarsal emargination, the bizarre shape of the rostral prong, and a large spine on the caudo-sinistral margin of the seventh abdominal tergum which lies horizontally.

In the absence of fossils and due to the few useful characters and the baffling way in which they are combined and recombined, no complete scheme of relationships for the species of *Buenoa* can be devised at present. However, certain forms stand out as obviously specialized branches of the tree. These branches are as follows:

1	2	3	4
hungerfordi	amnigenus	excavata	unguis
distincta	salutis		
macrophthalma	oculata		

On the other hand, there are forms which are presumably relatively primitive. These groups are as follows:

1	2	3
antigone	pallens	margaritacea
femoralis	pallipes	uhleri
ida	platycnemis	scimitra
crassipes	omani	albida
absidata	nitida	
arizonis	mutabilis	
tarsalis	macrotrichia	

The greatest abundance of the specialized forms is found in tropical South America. This is shown by the following distribution of these forms: (1) Southwest United States, 1 sp.; (2) Mexico, 2 sp.; (3) West Indies, 2 sp.; (4) Tropical South America, 7 sp.; (5) Temperate South America, 1 sp. The distribution of the species with the most primitive combination of characters is as follows: (1) Canada, 1 sp.; (2) Northeast United States, 1 sp.; (3) Southeast United States, 2 sp.; (4) Southwest United States, 1 sp.; (5) Mexico, 9 sp.; (6) Central America, 6 sp.; (7) West Indies, 7 sp.; (8) Tropical South America, 10 sp.

The distribution pattern of *Buenoa* in the United States appears to substantiate the hypothesis that the group invaded this region by way of the Mexican Plateau. The abundance of species in New Mexico and Arizona and the absence of species in the Northwest compared to the greater numbers in the Southwest is an interesting problem. This distribution pattern is found in many groups of plants and animals, a flora and fauna largely peculiar to the old Mexican Plateau ranging northward into Arizona and New Mexico. Seemingly the *Buenoa* adapted to the environmental conditions of this old plateau region have remained, for no obvious reason, in this area of the United States and Mexico. These species are undoubtedly adapted to an arid environment, whereas those species found in the southeastern United States are obviously adapted to humid conditions. The latter forms are also found, for the most part, in the humid areas of Mexico, Central America, and the West Indies. Since it is not clear how humidity would limit the distribution of aquatic insects, other environmental factors are probably involved. In any case, it is interesting that an aquatic group shows the same distributional pattern as many terrestrial groups.

It is obvious that *Buenoa* is influenced in its distribution by cold. The present northern limit of the genus is approximately 52° N. latitude. *Buenoa* was undoubtedly more widespread in the past when a warm climate extended over most of North America. It is logical to assume that as the cold climate progressed southward during the Tertiary, these insects were also pushed southward. Thus, one might have the explanation of the present northern limit of this genus in Canada.

GEOGRAPHICAL VARIATION

It is interesting to note that in spite of wide ranges, a striking feature in *Buenoa* is the lack of geographical variation in most species studied. There are only three good examples that are obvious. One case is primarily an example of size variation. In the two species with the greatest North-South distribution, *B. limnocastoris* and *B. confusa*, one finds a size variation from a large northern form to a small southern form as indicated in tables 4 and 5. This type of geographical variation is comparable to that found in warm-blooded vertebrates where the populations that live in a cooler climate tend to be larger than those that live in a warm district (Bergmann's rule).

Although too few specimens of *B. limnocastoris* were available for this study, it is interesting to note that it parallels *B. confusa*, where many specimens were available, in its size variation pattern. The difference in the mean body lengths between widely separated localities is statistically significant.

TABLE 4. *North-South distribution of* B. confusa *with variations of body lengths of brachypterous specimens.*

Collection localities (North-South)	Total specimens	Range and mean body lengths in mm. (mean in bold-face)	
		Males	Females
Manitoba & Alberta, Can.	9	5.65—**5.78**—5.85	6.04—**6.51**—6.82
South Dakota	4	5.26—**5.39**—5.52	5.39—**6.07**—6.76
Minnesota	8	5.07—**5.32**—5.78	......**5.31**......
Michigan	40	4.74—**5.01**—5.39	4.87—**5.19**—5.65
Connecticut	13	5.20—**5.52**—5.26	5.20—**5.46**—5.72
New York & New Jersey	8	4.81—**5.07**—5.26	4.94—**5.11**—5.39
Kansas	25	4.94—**5.05**—5.20	5.13—**5.28**—5.52
Texas	2	......**4.87**......	......**4.94**......
Mississippi & Alabama	8	4.42—**4.51**—4.61	4.55—**4.59**—4.68
Georgia	40	4.16—**4.48**—4.68	4.42—**4.60**—4.87
Florida	40	4.16—**4.58**—5.00	4.29—**4.61**—5.33

TABLE 5. *North-South distribution of* B. limnocastoris *with variations of body lengths of brachypterous specimens.*

Collection localities (North-South)	Total specimens	Range and mean body lengths in mm. (mean in bold-face)	
		Males	Females
Quebec, Canada	2	......**6.17**......	......**6.37**......
Minnesota	11	5.85—**6.01**—6.17	5.95—**6.05**—6.43
Michigan	40	5.65—**5.88**—5.98	5.72—**6.00**—6.30
Maine & New Jersey	2	......**5.52**......	......**5.65**......
Virginia	2	......**5.59**......	......**5.98**......
Georgia & Florida	19	4.74—**4.99**—5.07	4.81—**5.48**—5.86

Within these two species, one also finds a variation in the development of flight wings with consequent changes in the thorax and hemelytra. The wings are either fully developed or very short, there being no intermediate condition. This feature is indicated in tables 6 and 7 and the differences in percentage from any one locality to another is statistically highly significant. There is no correlation between the development of the flight wings and the sex or season of the year. It is interesting to note that the long-winged forms have been recorded only in the northern and southern portions of the geographic ranges of these species. A possible explanation of this phenomenon is not available at the present time.

Table 6. *North-South distribution of* B. confusa *with variation in development of flight wings.*

Collection localities (North–South)	Total no. specimens	Percentage of short-winged forms
Manitoba and Alberta, Canada	28	32%
North Dakota and South Dakota	16	25%
Minnesota	9	89%
Michigan	210	100%
Connecticut	13	100%
New York and New Jersey	8	100%
Kansas	29	100%
Texas	5	40%
Louisiana	33	0%
Mississippi and Alabama	11	72%
Georgia	85	88%
Florida	239	71%
Grand Cayman Island, W. I.	3	0%

Table 7. *North-South distribution of* B. limnocastoris *with variation in development of flight wings.*

Collection localities (North–South)	Total no. specimens	Percentage of short-winged forms
Quebec, Canada	2	100%
Minnesota	11	72%
Michigan	148	99%
Maine, New Jersey and Virginia	4	100%
Georgia	2	50%
Florida	21	85%

A third case of geographical variation is an example of a polytypic species *B. antigone,* which has broken up into geographical races, each differing in minor morphological characteristics. There is very little difference between the neighboring races, but the peripheral forms or the two extremes are very distinct. Not only does one find a size difference but also variations in the divergence of the lateral margins of the notocephalon anterior to the synthlipsis, and slight differences in the form of the rostral prong, pronotum, femoral stridulatory area, and hind femur. Intergrades between the two extremes are evident. The large form of *B. antigone* is confined to the southern portions of the United States, Mexico, and south as far as British Honduras. The small form ranges from Mexico, the West Indies, and throughout Central and South America south to Argentina. More detailed data concerning the distribution pattern are given under the species description.

TAXONOMY OF THE GENUS BUENOA

Much confusion has existed in the classification of the *Buenoa* as a result of poor descriptions based primarily on color patterns and inaccurate determinations. Most of the papers dealing with this genus are isolated descriptions of species. Little work of a general nature has been published.

BRIEF HISTORY OF THE TAXONOMY OF THE BUENOA

The genus *Buenoa* was erected by Kirkaldy in 1904. He included in this genus all the species formerly included in *Anisops* that inhabit the Western Hemisphere and possess a two-segmented front tarsus in the male. He retained the name *Anisops* for the Eastern Hemisphere forms that possess a one-segmented front tarsus in the male. In this paper Kirkaldy recognized ten former *Anisops* species as belonging to the *Buenoa,* placed two species in synonomy, and described two species as new. He designated *B. antigone* (Kirkaldy) as the genotype.

The first *Buenoa* species was described in 1803 by Fabricius in "Systema Rhyngotorum" as *Notonecta pallipes.* Almost forty-eight years later, in 1851, Fieber described the next three species of *Buenoa* to be made known as *Anisops platycnemis, A. femoralis,* and *A. macrophthalmus.* In the same publication Fieber described *A. elegans,* a name which has for a generation been erroneously applied to *Buenoa confusa* described below.

In 1879, twenty-seven years later, Berg and White added two more species. These were *A. fuscipennis* Berg and *A. amnigenus* White. Some time later, 1899, Kirkaldy described *A. antigone* which he later (1904) designated as the genotype of his new genus *Buenoa,* and *A. naias* which the present writer has relegated to synonomy under *B. fuscipennis* (Berg).

In 1901, Champion introduced, with some success, the use of structural characteristics for species determination in describing four new species, *A. albidus, A. crassipes, A. pallens,* and *A. carinatus.* All of these were *Buenoa. A. carinatus* was later placed in synonomy with *B. antigone* by Kirkaldy (1904) but is here considered a subspecies of that species.

Kirkaldy in 1904 established the genus *Buenoa,* described two new species, *B. ida* and *B. salutis,* and placed *B. carinata* and *B. macrophthalma* in synonomy with *B. antigone. B. macrophthalma,* however, is easily distinguished from *B. antigone* and is a good species, while *B. carinata* should, as already indicated, be recognized as a subspecies of *B. antigone.*

In 1908, J. R. de la Torre-Bueno found that the *Buenoa* known to a generation of entomologists as *B. platycnemis* was actually an undescribed species which he designated *B. margaritacea.*

Not until fourteen years later, in 1923, do additional new species appear in the literature. In this year Hungerford described *B. limnocastoris.* One year later, 1924, he described another species, *B. macrotibialis.*

Bare in 1925 described a widespread species, *B. scimitra,* and three years later, in 1928, Jaczewski described three new species, *B. dentipes, B. mallochi,* and *B. paranensis,* all from the state of Paraná, Brazil. The present writer has found that *B. dentipes* is in synonomy with *B. fuscipennis,* and *B. mallochi* is in synonomy with *B. salutis.* Finally in 1931, *B. arizonis* was described by Bare.

The present study is the first generic revision since Kirkaldy's paper in 1904. Every species except *B. paranensis* Jaczewski has been accounted for. The types of this species have been destroyed.

Technique of Identification

To facilitate accurate and rapid interpretation of the species descriptions, it is desirable to mention certain techniques and terminology used by this writer. As indicated previously, in most species only the males possess adequate structural characters for specific separation. The female, however, can usually be correlated with the male by general resemblance to the male, and various structural details.

The characters and terminology used in the key to the species are, for the most part, self-explanatory or indicated in the illustrations. The reader, however, should be familiar especially with the method used in making the various measurements.

The measurements of the head and pronotum have been made from above the dorsal surface of the insect when held in a horizontal position with the transverse and longitudinal axes horizontal. The length of the rostral prong is determined by placing the insect in such a position that the rostral prong is horizontal. The measurement is then taken from the base of the rostral prong to the apex along a median longitudinal line. The length of the third rostral segment is measured along the frontal surface.

Seldom will it be necessary to make observations of the stridulatory area or chaetotaxy of the front leg to make specific determinations. When such a study is desired the front leg must be removed and cleared. Removal of the leg is best accomplished by placing the bent point of a fine dissecting needle at the base of the coxa or trochanter on its inner surface and rotating the needle outward.

The writer finds that this procedure works better on a dry specimen than on one that has been relaxed. It is desirable on occasions to observe only the femoral stridulatory area. This is easily accomplished by relaxing the insect and pulling the leg to a position perpendicular to the body. Best results in this relaxing procedure are obtained by touching the specimen with a camel's-hair brush that has been dipped in five per cent alcohol or a relaxing fluid consisting of alcohol (95%), 106 cc.; distilled water, 98 cc.; benzol, 14 cc.; ethylacetate, 38 cc.

The illustrations in this paper show only those characters that the writer feels are of particular taxonomic importance. For example, the thick covering of hair-like setae on the inner surface of the leg is omitted so as not to obscure the larger characteristic setae.

Family Characteristics of the Notonectidae

The family Notonectidae is composed of aquatic forms differing from all other such insects, except Pleidae and Helotrephidae, in the habit of swimming on their backs. They are deep-bodied, flat ventrally, and convex dorsally. The eyes are large, reniform, and twice sinuate. Ocelli are absent in this family. The antennae, which are usually hidden from above, consist of three or four segments, and arise on the latero-ventral surface of the head. The beak is four-segmented. The hind pair of legs is more or less flattened and heavily fringed for swimming, while the front and middle pairs are adapted for grasping. The tarsi are two or three segmented except for the one-segmented fore tarsi of the male *Anisops*. The tarsi possess two apical claws which are prominent except on the hind legs where they are greatly reduced and inconspicuous. The pronotum is transverse, convex, and usually narrower anteriorly. The abdomen possesses a prominent longitudinal midventral keel, having hairs at least along its lateral margins. Together with the hairs along the sides of the venter, they cover the two longitudinal troughs forming air chambers.

Key to the Genera of Notonectidae

(Modified from Hungerford, 1933)

The family Notonectidae consists of eight genera which may be classified by the following key: *

A. Hemelytral commissure without definite hair-lined pit at anterior end . . . . (Subfamily Notonectinae)

B. Intermediate femur with anteapical pointed protuberance and antennae 4-segmented . . . . (Tribe Notonectini)

C. Anterolateral margins of prothorax not foveate. *Notonecta*

CC. Anterolateral margins of prothorax foveate . . *Enithares*

BB. Intermediate femur without anteapical pointed protuberance and antennae 3- or 4-segmented . . . . (Tribe Nychini)

C. Sides of prothorax not foveate, the lateral ledge straight. Infracoxal plates bare but margined with hair. Intermediate tarsus with two well-defined segments and a very small basal one in both sexes. *Neonychia*

CC. Sides of prothorax foveate, the lateral ledge curving downward to embrace the fovea. Infracoxal plates covered with hair. Intermediate tarsus with one well-defined segment, except in males of *Nychia.*

D. Antennae 3-segmented . . . . *Nychia*

DD. Antennae 4-segmented . . . . *Martarega*

AA. Hemelytral commissure with definite hair-lined pit at anterior end . . . . (Subfamily Anisopinae)

B. Ventral abdominal keel not extending onto last abdominal segment. Male genital capsule cleft behind. Males without stridular protuberance on front tibia. Females with short gonapophyses . . . . *Paranisops*

BB. Ventral abdominal keel extending onto last abdominal segment. Male genital capsule closed behind. Males with stridular protuberance on front tibia. Females with long subspatulate gonapophyses.

C. Male with anterior tarsus 2-segmented . . . . *Buenoa*

CC. Male with anterior tarsus 1-segmented . . . . *Anisops*

DESCRIPTION OF THE GENUS BUENOA

(Genotype *Buenoa antigone* Kirkaldy, 1904)

1901. *Anisops*, Champion, G. C. Biologia Centrali Americana, Heteroptera, vol. II, p. 371.
1904. *Buenoa* Kirkaldy, G. W. Wiener Ent. Zeitung, vol. XXIII, pp. 120-135.
1909. *Buenoa*, Torre-Bueno, J. R. de la. Jr. New York Ent. Soc., vol. XVII, pp. 74-75.
1917. *Buenoa*, Hungerford, H. B. Ent. News, vol. XXVIII, pp. 175-176.
1919. *Buenoa*, Hungerford, H. B. Univ. Kansas Sci. Bull., vol. XI, pp. 41-42, 173 and 177.
1923. *Buenoa*, Hale, H. M. Records South Australian Mus., vol. II, p. 399.
1924. *Buenoa*, Hungerford, H. B. Ann. Ent. Soc. Am., vol. XVII, p. 225.
1926. *Buenoa*, Blatchley, W. S. Heteroptera Eastern N. Am., p. 1056.
1928. *Buenoa*, Bare, C. O. Univ. Kansas Sci. Bull., vol. XVIII, pp. 265-349.
1928. *Buenoa*, Jaczewski, T. Ann. Mus. Zool. Polonici, vol. VII, p. 123.

This genus is very similar to its counterpart in the Old World, the genus *Anisops.* It is readily distinguishable from all other genera of the Notonectidae by the combination of characters noted in the key. In addition it differs from its close relative, *Anisops,* by possessing in all males (except *B. fuscipennis, B. hungerfordi, B. distincta,* and *B. macrophthalma*) a small gland-like struc-

* See 1949. Truxal, F. S. Jr. Kansas Ent. Soc., vol. XXII, p. 2. Key under A-BB-C, should read "sides of prothorax *not* foveate."

ture located laterally on the first abdominal segment. Male genitalic characters as indicated by Truxal (1952) and the femoral stridulatory area on the front femur of most males also aid in distinguishing *Buenoa* from *Anisops.*

The members of this genus are long, slender insects, and more or less conical in cross-section. The widest portion of the body is usually at a point midway of the longitudinal axis. The head is somewhat rounded anteriorly and closely connected to the thorax. The posterior margins of the eyes invade the pronotum. The eyes are large and not holoptic [except *B. amniginus* (White)]. As seen from above, the notocephalon is usually sulcate medianly. The labrum is small, triangular, and covered with many fine hair-like setae. The rostrum is four-segmented, the third segment of the male prolonged laterally into prongs which aid in stridulation. The pronotum is trapezoidal in shape and wider than long. The metathorax is the largest segment of the entire body. The legs each have the same number of segments. All have a large coxa, small trochanter, femur, tibia, two distinct tarsal segments, and two tarsal claws at the end of the distal tarsal segment. The hemelytra are generally hyaline and distinctly divided into clavus, corium, and membrane, except in brachypterous forms.

The male genital capsule, as in other members of the family, is composed of the ninth abdominal segment. Its tergum is narrow and bridgelike while the sternum is strongly developed, boat-like in shape, and fused posteriorly. The genital claspers are asymmetrical, the left one being larger and hooked at the apex. The genitalic characters are not important in species determination.

An interesting phenomenon of the internal anatomy of this genus is the presence of haemoglobin cells in the abdomen as found by Hungerford (1922). They are grouped about the tracheal trunks which have their connections with the spiracles of the third to the seventh abdominal segments, inclusive. Similar cells were found by Poisson (1925) in the genus *Anisops.*

To the worker particularly interested in the morphology of the *Buenoa*, reference should be made to Bare (1928). This study applies to *B. margaritacea* Torre-Bueno in particular. Bare's text figures, illustrating both internal and external structures, are well done.

KEY TO THE MALES OF BUENOA

1. Synthlipsis wide, one half or more the anterior width of vertex 2
   Synthlipsis narrow, less than one half the anterior width of vertex 24

2.(1) Rostral prong longer than third rostral segment 3
Rostral prong equal to or shorter than third rostral segment .. 20
3.(2) Rostral prong with base originating laterally at or near distal end of third rostral segment. (Pl. CVI, fig. 47b) 4
Rostral prong with base not originating laterally at or near distal end of third rostral segment. (Pl. CXIII, fig. 66b) .. 12
4.(3) Over 7 mm. in length 5
Less than 7 mm. in length 7
5.(4) Tylus strongly inflated with shallow median depression forming two lateral protuberances (Pl. CVI, fig. 47b); pronotum strongly convex .... *B. arizonis* Bare (p. 1387)
Tylus slightly inflated and smoothly rounded; pronotum not strongly convex 6
6.(5) Rostral prong with posterior margin distinctly sinuate (Pl. XII, fig. 63c); interocular cephalic space narrow. (Pl. CII, fig. 16) .... *B. speciosa* n. sp. (p. 1437)
Rostral prong with posterior margin almost straight; interocular cephalic space relatively wide. (Pl. CII, fig. 15), *B. crassipes* (Champion) (p. 1385)
7.(4) Head approximately half to more than half the length of pronotum along median longitudinal axis 8
Head approximately one third to less than one third the length of pronotum along median longitudinal axis 10
8.(7) Tylus slightly inflated, with wide median depression; lateral margins of frons distinctly divergent anteriorly and posteriorly .... *B. albida* (Champion) (p. 1412)
Tylus inflated, smoothly rounded; lateral margins of frons almost parallel 9
9.(8) Pronotum distinctly tricarinate; head equal to or wider than humeral width of pronotum, *B. macrotibialis* Hungerford (p. 1446)
Pronotum unimpressed, not tricarinate; head distinctly narrower than humeral width of pronotum, *B. macrotrichia* n. sp. (p. 1429)
10.(7) Rostrum robust with posterior margin of rostral prong distinctly sinuate (Pl. CVII, fig. 50b); tylus only slightly inflated .... *B. rostra* n. sp. (p. 1395)
Rostrum not robust and posterior margin of rostral prong almost straight; tylus distinctly inflated 11
11.(10) Greatest width of head approximately five times the anterior width of vertex; as viewed from above, vertex protuberant, *B. absidata* n. sp. (p. 1391)
Greatest width of head approximately six times the anterior width of vertex; as viewed from above, vertex slightly indented .... *B. pallipes* (Fabricius) (p. 1418)
12.(3) Posterior margin of hind femur with more than forty setae in ventral row 13
Posterior margin of hind femur with forty or less setae in ventral row 14

13.(12) Greatest width of head more than seven times the anterior width of vertex; interocular cephalic space narrow,
B. artafrons n. sp. (p. 1444)
Greatest width of head less than seven times the anterior width of vertex; interocular cephalic space relatively wide,
B. pallens (Champion) (p. 1414)
14.(12) Over 7.75 mm. in length; posterior margin of hind femur with less than thirty, large setae in ventral row 15
Less than 7.75 mm. in length; posterior margin of hind femur with thirty or more, small setae in ventral row 17
15.(14) Greatest width of head approximately seven times the anterior width of vertex; head at least half the length of pronotum along median longitudinal axis,
B. femoralis (Fieber) (p. 1382)
Greatest width of head six times or less the anterior width of vertex; head one third the length of pronotum along median longitudinal axis 16
16.(15) Pronotum almost unimpressed, not tricarinate; length of fore femur two times the width at apex; approximately twenty-five teeth in tibial comb . . . . *B. ida* Kirkaldy (p. 1383)
Pronotum tricarinate; length of fore femur three times or more the width at apex; forty to fifty teeth in tibial comb,
B. antigone (Kirkaldy) (p. 1367)
17.(14) Pronotum distinctly tricarinate; fore femur narrowed at apex. (Pl. CVII, fig. 49a) 18
Pronotum almost unimpressed, not distinctly tricarinate; fore femur widened at apex. (Pl. CXI, fig. 60a) 19
18.(17) Intermediate leg with first tarsal segment deeply emarginate on inner margin. (Pl. CVII, fig. 49b),
B. tarsalis n. sp. (p. 1392)
Intermediate leg with margins of first tarsal segment straight,
B. uhleri n. sp. (p. 1409)
19.(17) Rostrum with frontal surface protruding at base of rostral prong (Pl. CXI, fig. 60b); interocular cephalic space relatively wide; approximately thirty teeth in tibial comb and seven sclerotized ridges in femoral stridulatory area,
B. nitida n. sp. (p. 1430)
Rostrum with frontal surface flat, not protruding; interocular cephalic space narrow; approximately sixteen teeth in tibial comb and four sclerotized ridges in femoral stridulatory area . . . . *B. omani* n. sp. (p. 1426)
20.(2) Stridulatory area absent on inner surface of fore femur 21
Stridulatory area present on inner surface of fore femur 22
21.(20) Over 8 mm. in length; greatest width of head less than five times the anterior width of vertex; spine from caudo-sinistral margin of seventh abdominal tergite large and sickle-shaped, horizontal. (Pl. CII, fig. 14),
B. hungerfordi n. sp. (p. 1483)
Less than 8 mm. in length; greatest width of head six or more times the anterior width of vertex; spine from caudo-

sinistral margin of seventh abdominal tergite small and straight, vertical. (Pl. CII, fig. 11),
B. alterna n. sp. (p. 1474)

22.(20) Synthlipsis more than half the anterior width of vertex; greatest width of head more than seven and one half times the anterior width of vertex . . . . *B. arida* n. sp. (p. 1435)

Synthlipsis approximately half to less than half the anterior width of vertex; greatest width of head less than seven and one half times the anterior width of vertex 23

23.(22) Over 8½ mm. in length; posterior margin of hind femur with less than thirty, large setae in ventral row,
B. ida Kirkaldy (p. 1383)

Less than 8½ mm. in length; posterior margin of hind femur with more than thirty, small setae in ventral row,
B. margaritacea Torre-Bueno (p. 1397)

24.(1) Stridulatory area present on inner surface of fore femur 25

Stridulatory area absent on inner surface of fore femur 42

25.(24) Fore femur narrowed at apex, with length more than three times the width at apex. (Pl. CXII, fig. 64a) 26

Fore femur widened at apex, with length three times or less the width at apex. (Pl. CXI, fig. 60a) 34

26.(25) Rostral prong equal to or shorter than third rostral segment . . 27

Rostral prong longer than third rostral segment 29

27.(26) Synthlipsis less than one third the anterior width of vertex; fore tibia with four short, peg-like setae on inner surface at apex (Pl. CXII, fig. 64d); femoral stridulatory area with six to nine sclerotized ridges . . *B. gracilis* n. sp. (p. 1439)

Synthlipsis one third or more the anterior width of vertex; fore tibia without short, peg-like setae on inner surface at apex; femoral stridulatory area with fifteen or more sclerotized ridges 28

28.(27) Fore femur with long, conspicuous, sword-shaped stridulatory area consisting of more than forty sclerotized ridges; fore femur not accuminate at apex. (Pl. CVIII, fig. 52a),
B. scimitra Bare (p. 1404)

Fore femur with small, subtriangular to oval stridulatory area consisting of less than twenty-five sclerotized ridges; fore femur accuminate at apex. (Pl. CVIII, fig. 51a),
B. margaritacea Torre-Bueno (p. 1397)

29.(26) Pronotum distinctly tricarinate 30

Pronotum almost unimpressed, not distinctly tricarinate 33

30.(29) Synthlipsis less than one third the anterior width of vertex; femoral stridulatory area with more than twenty-five sclerotized ridges . . . . *B. communis* n. sp. (p. 1442)

Synthlipsis more than one third the anterior width of vertex; femoral stridulatory area with less than twenty-five sclerotized ridges 31

31.(30) Tylus slightly inflated with wide median depression,
B. albida (Champion) (p. 1412)

Tylus slightly inflated, smoothly rounded 32

32.(31) Over 8 mm. in length; greatest width of head more than six and one half times the anterior width of vertex, *B. femoralis* (Fieber) (p. 1382)

Less than 8 mm. in length; greatest width of head less than six and one half times the anterior width of vertex, *B. uhleri* n. sp. (p. 1409)

33.(29) Posterior margin of hind femur with less than forty setae in ventral row; greatest width of head six and one half times the anterior width of vertex..... *B. mutabilis* n. sp. (p. 1432)

Posterior margin of hind femur with more than forty setae in ventral row; greatest width of head six times the anterior width of vertex... *B. pallens* (Champion) (p. 1414)

34.(25) Head equal to or slightly wider than humeral width of pronotum 35

Head narrower than humeral width of pronotum 39

35.(34) Pronotum strongly inflated, with median length equal to humeral width; greatest width of head less than six times the anterior width of vertex, *B. limnocastoris* Hungerford (p. 1450)

Pronotum not strongly inflated, with median length three fourths to less than three fourths the humeral width; greatest width of head six or more times the anterior width of vertex 36

36.(35) Pronotum almost unimpressed, not tricarinate; rostral prong with base originating laterally midway to near proximal end of third rostral segment 37

Pronotum tricarinate, median carina distinct; rostral prong with base originating laterally at distal end of third rostral segment 38

37.(36) Interocular cephalic space very narrow (Pl. CII, fig. 16); femoral stridulatory area with approximately sixty, fine, sclerotized ridges .... *B. arida* n. sp. (p. 1435)

Interocular cephalic space relatively wide (Pl. CII, fig. 15); femoral stridulatory area with six to nine, thick, sclerotized ridges .... *B. nitida* n. sp. (p. 1430)

38.(36) Greatest width of head seven or more times the anterior width of vertex .... *B. confusa* n. sp. (p. 1453)

Greatest width of head six and one half times the anterior width of vertex ...... *B. macrotibialis* Hungerford (p. 1446)

39.(34) Rostrum robust, with posterior margin of rostral prong distinctly sinuate. (Pl. CVII, fig. 50b) .. *B. rostra* n. sp. (p. 1395)

Rostrum not robust and posterior margin of rostral prong almost straight 40

40.(39) Pronotum distinctly tricarinate, *B. platycnemis* (Fieber) (p. 1421)

Pronotum almost unimpressed, not distinctly tricarinate.... 41

41.(40) Less than 6 mm. in length; greatest width of head more than six times the anterior width of vertex; fore femur with large, spatulate setae on inner posterior margin. (Pl. CX, fig. 59a) .... *B. macrotrichia* n. sp. (p. 1429)

Over 6 mm. in length; greatest width of head six times or less the anterior width of vertex; fore femur with small setae on inner posterior margin. (Pl. CXI, fig. 60a), *B. nitida* n. sp. (p. 1430)

42.(24) Greatest width of head five times or less the anterior width of vertex 43

Greatest width of head more than five times the anterior width of vertex 49

43.(42) Rostral prong equal to or longer than third rostral segment . . . 44

Rostral prong shorter than third rostral segment 47

44.(43) Over 7 mm. in length; tylus strongly inflated with median depression forming two lateral protuberances. (Pl. CXVI, fig. 79b) . . . . *B. macrophthalma* (Fieber) (p. 1480)

Less than 7 mm. in length; tylus flat or slightly inflated and smoothly rounded 45

45.(44) Eyes holoptic or synthlipsis extremely narrow, less than one tenth the anterior width of vertex 46

Eyes not holoptic, synthlipsis wide, one third to more than one third the anterior width of vertex, *B. thomasi* n. sp. (p. 1473)

46.(45) Eyes holoptic; greatest width of head less than three times the anterior width of vertex; over 4 mm. in length, *B. amnigenus* (White) (p. 1462)

Eyes not holoptic, synthlipsis extremely narrow; greatest width of head more than three times the anterior width of vertex; less than 4 mm. in length, *B. salutis* Kirkaldy (p. 1469)

47.(43) Front leg with inner tarsal claw shield-like at base (Pl. XV, fig. 78a); synthlipsis narrow, approximately one fifth the anterior width of vertex . . . . *B. unguis* n. sp. (p. 1476)

Front leg with inner tarsal claw gradually tapering from base to apex; synthlipsis wide, approximately half the anterior width of vertex 48

48.(47) Less than 8 mm. in length; trochanter of front leg with prominent tubercle on posterior margin (Pl. CXIV, fig. 71a); spine from caudo-sinistral margin of seventh abdominal tergite small and straight, vertical. (Pl. CII, fig. 7), *B. fuscipennis* (Berg) (p. 1460)

Over 8 mm. in length; trochanter of front leg with posterior margin smoothly rounded; spine from caudo-sinistral margin of seventh abdominal tergite large and sword-shaped, horizontal. (Pl. CII, fig. 13) . . . . *B. distincta* n. sp. (p. 1485)

49.(42) Synthlipsis one fourth to more than one fourth the anterior
Synthlipsis less than one fourth the anterior width of vertex . . 53
width of vertex 50

50.(49) Over 8 mm. in length; tylus strongly inflated with median depression forming two lateral protuberances (Pl. CXVI, fig. 79b); rostral prong extremely long. (Pl. CXVI, fig. 79b) . . . . *B. macrophthalma* (Fieber) (p. 1480)

Less than 8 mm. in length; tylus not inflated or inflated and smoothly rounded; rostral prong relatively short. (Pl. CXVI, fig. 71b) 51

51.(50) Trochanter of front leg with prominent tubercle on posterior margin (Pl. XIV, fig. 71a); fore tibia with base and apex approximately same width .. *B. fuscipennis* (Berg) (p. 1460)

Trochanter of front leg with posterior margin smoothly rounded; fore tibia with base distinctly wider than apex .. 52

52.(51) Greatest width of head less than six times the anterior width of vertex; fore tibia with approximately seventeen stout, club-shaped setae on inner surface at apex. (Pl. CXV, fig. 76d) .... *B. thomasi* n. sp. (p. 1473)

Greatest width of head six times or more the anterior width of vertex; fore tibia without area of club-shaped setae on inner surface at apex .... *B. alterna* n. sp. (p. 1474)

53.(49) Tylus strongly excavate with short anteromedial ridge. (Pl. CXV, fig. 75b) .... *B. excavata* n. sp. (p. 1479)

Tylus not excavate, smoothly rounded 54

54.(53) Synthlipsis one fifteenth the anterior width of vertex; pronotum not tricarinate; intermediate leg with first tarsal segment emarginate on inner surface. (Pl. CXIV, fig. 72d) .... *B. oculata* n. sp. (p. 1467)

Synthlipsis one fifth the anterior width of vertex; pronotum tricarinate; intermediate leg with margins of first tarsal segment straight .... *B. incompta* n. sp. (p. 1466)

Buenoa antigone (Kirkaldy)

(Pl. CIII, fig. 30; Pl. CIV, figs. 42, 43)

This variable species is divisible into two subspecies as indicated in the following pages.

Size: Male, length 7.80 mm. to 8.97 mm., greatest body width 2.46 mm. to 2.79 mm.; female, length 8.25 mm. to 9.75 mm., greatest body width 2.60 mm. to 3.12 mm.

Color: General facies testaceous to dark brown. Head, pronotum, thoracic venter, and limbs sordid white to testaceous. Scutellum rufo-testaceous to testaceous with base, brown to black. Abdomen usually black except ventral keel and portions of connexivum and dorsum, testaceous to light brown. This species somewhat variable in color with some specimens entirely sordid white to testaceous.

Male Structural Characteristics: As viewed from above, outline of head laterally rounded, anteriorly truncate with vertex indented; greatest width of head five and one-half to slightly more than six times the anterior width of vertex and less than humeral width of pronotum; synthlipsis one-half to two-thirds the anterior width of vertex; along median longitudinal axis, head is approximately one-third the length of pronotum; notocephalon slightly sulcate, with lateral margins variable in amount of divergence anterior to synthlipsis; tylus slightly inflated; labrum with basal width not quite twice its median length and apex bluntly rounded; rostral prong (pl. CIV, figs. 42b, 43b) distinctly longer than third rostral segment, with base originating laterally midway to near proximal end of third rostral segment, and with apex bluntly rounded. Pronotum with its median length approximately three-fifths its humeral width; disk with two elongate depressions toward the middle and a large subtriangular depression on each side, thus appearing tricarinate; lateral margins divergent; posterior margin convex, medianly concave. Scutellum large, with median length greater than that of pronotum. Fore femur (pl. CIV, figs. 42a, 43a) neither wide nor greatly thickened at apex; triangular stridulatory area somewhat variable, consisting of seventeen to thirty-two sclerotized ridges, located medianly. Fore tibia (pl. CIV, figs. 42a, 43a) with stridulatory comb (pl. CIV, figs. 42c, 43c) consisting of forty-one to fifty-one teeth; apical teeth thicker and slightly narrower than basal. Chaetotaxy of male front leg as shown on Plate CIV. Male genital claspers normal. Spine from caudo-sinistral margin of seventh abdominal tergite with apical half very narrow and apex strongly acuminate.

Female Structural Characteristics: As viewed from above, outline of head laterally rounded, anteriorly truncate with vertex indented at least at lateral margins; greatest width of head six to seven times the anterior width of vertex and distinctly less than humeral width of pronotum; synthlipsis one-half to two-thirds the anterior width of vertex; along median longitudinal axis, head is one-fourth to one-third the length of pronotum; notocephalon slightly sulcate, with lateral margins variable in amount of divergence anterior to synthlipsis; tylus slightly inflated. Pronotum with its median length approximately half its humeral width; disk usually with two shallow, elongate depressions toward the middle forming a faint median carina, not tricarinate; lateral margins divergent; posterior margin convex, medianly concave. Scutellum large, with median length distinctly greater than that of pronotum. Female ovipositor of normal shape (pl. CIII, fig. 30) with teeth arranged in two longitudinal rows, one inner row of few, large teeth and one long outer row of smaller teeth; approximately four to nine small, lateral, toothlike setae near apex.

Nomenclatorial Notes: On examination of large series of specimens of the species known as *B. antigone* (Kirkaldy) and *B. carinata* (Champion), one finds many intergrades between the two. This fact was primary in assisting the author to conclude that we are dealing with one variable species divisible into two subspecies.

Comparative Notes: Superficially this species somewhat resembles *B. tarsalis* n. sp. Examination of the male, however, will show distinct differences. This species differs from *B. tarsalis* in having synthlipsis wider, first tarsal segment of intermediate leg not emarginate, hind femur more robust, and differences in the rostral prong, femoral stridulatory area, and tibial comb.

Buenoa antigone antigone (Kirkaldy)

(Pl. CIV, fig. 42)

1899. *Anisops antigone* Kirkaldy, G. W. The Entomologist, vol. XXXII, p. 30.
1904. *Buenoa antigone,* Kirkaldy, G. W. Wiener Ent. Zeit., vol. XXIII, pp. 120, 122, and 134 (description establishing *B. antigone* as genotype and *A. carinatus* Champion as nov. syn.).
1906. *Buenoa antigone,* Kirkaldy, G. W. Trans. Am. Ent. Soc., vol. XXXII, p. 153 (listed).
1909. *Buenoa antigone,* Kirkaldy, G. W. and Torre-Bueno, J. R. de la. Proc. Ent. Soc. Wash., vol. X, p. 200 (catalogue).
1916. *Buenoa antigone,* Van Duzee, E. P. New York Ent. Soc., p. 51 (check list).
1917. *Buenoa antigone,* Van Duzee, E. P. Cat. Hemiptera Am. North of Mexico, p. 454 (catalogue).
1919. *Buenoa antigone,* Hungerford, H. B. Univ. Kansas Sci. Bull., vol. XI, p. 174 (brief note on synonomy).
1923. *Buenoa antigone,* Torre-Bueno, J. R. de la. Univ. of Iowa Studies in Nat. Hist., 10:3, p. 35.
1940. *Buenoa antigone,* Hungerford, H. B. Ent. Month. Mag., vol. LXXVI, p. 256 (ecological note).

Size: Male, length 7.80 mm. to 7.99 mm., greatest body width 2.46 mm. to 2.60 mm.; female, length 8.25 mm. to 8.51 mm., greatest body width 2.60 mm. to 2.79 mm.

Color: General facies testaceous. Head, pronotum, thoracic venter, and limbs testaceous. Scutellum usually ochraceous, brown at base. Abdominal dorsum testaceous to brown; venter brown to black with connexivum usually testaceous.

Male Structural Characteristics: As viewed from above, greatest width of head more than six times the anterior width of vertex; synthlipsis one half to two thirds the anterior width of vertex; notocephalon with margins almost parallel to moderately divergent anterior to synthlipsis; rostral prong (pl. CIV, fig. 42b) with base originating laterally at proximal end of third rostral segment. Pronotum with its median length approximately three fifths its humeral width; disk with two elongate, shallow depressions toward the middle and a large subtriangular, shallow depression on each side, thus appearing faintly tricarinate. Fore femur (pl. CIV, fig. 42a) with triangular stridulatory area consisting of approximately fifteen to twenty-three sclerotized ridges. Fore tibia (pl. CIV, fig. 42a) with stridulatory comb (pl. CIV, fig. 42c) consisting of approximately forty-one teeth.

Female Structural Characteristics: As viewed from above, greatest width of head approximately six times the anterior width of vertex; synthlipsis slightly more than half the anterior width of vertex; along median longitudinal axis, head is approximately one third the length of pronotum; notocephalon with margins almost parallel to moderately divergent anterior to synthlipsis. Female ovipositor with approximately four or five very small, lateral tooth-like setae near apex.

Nomenclatorial Notes: Mr. C. O. Bare labeled a long series of *B. antigone* as types and paratypes, using a manuscript name based on the country of origin, Paraguay. As such paratypes may have been widely distributed, it seems desirable to point out that the name has not been, and should not be, validated by publication.

Comparative Notes: This subspecies differs from *B. antigone carinata* (Champion) in being less robust, margins of notocephalon less divergent anterior to synthlipsis, and in the shape and number of sclerotized ridges in femoral stridulatory area.

Location of Types: The type female and two other female specimens labeled "St. Andrew, Jamaica, C. B. Taylor, 20/IX, 98" (type locality and determined by Kirkaldy) from the G. W. Kirkaldy Collection, are now in the Francis Huntington Snow Entomological Collections, University of Kansas.

Data on Distribution: Recorded from Mexico, Guatemala, West Indies (Cuba, Cayman Islands, Haiti, Jamaica, Puerto Rico, St. Croix Island), Brazil, Ecuador, Peru, Bolivia, Paraguay, and Argentina. Specimens from the following localities have been examined:

MEXICO: *Tamaulipas:* 5 m. S. Ciudad Victoria, Nov. 5, 1936, H. D. Thomas, 35 males, 49 females.

Veracruz: Minatitlán, Sept. 22, 1936, H. D. Thomas, 20 males, 18 females.

Chiapas: Hda. La Libertad, Sept. 1, 1937, H. D. Thomas, 2 males, 3 females; La Libertad, Jan. 1, 1938, Octavio Utrilla Louis, 2 males, 4 females; Comitán, Jan. 18, 1938, Octavio Utrilla L., 25 males, 30 females.

Campeche: Hda. Encarnation, 12 m. S. Pital, Oct. 15, 1936, H. M. Smith, 11 males, 13 females.

GUATEMALA: El Salto, Escuintla, 1934, F. X. Williams, 1 male.

WEST INDIES: *Cuba:* Camagüey, July 2, 1923, J. Acuda, 1 male, 2 females; Soledad, Feb. 14, 1925, J. G. Myers, 1 male; Havana, Bot. Garden, Jan. 1925, P. J. Bermudez, 10 males; Havana Prov., Catalina, Nov. 27, 1933, P. J. Bermudez, 23 males, 16 females.

Cayman Islands: Cayman Brac, Earthquake hole, May 22, 1938, Lewis and Thompson (Oxford Univ. Bio. Exp.), 6 males, 6 females; Grand Cayman, Booby Creek, June 23, 1938, Lewis and Thompson (Oxford U. Bio. Exp.), 1 male; Grand Cayman, Cow-well, near Pedro Castle, Aug. 4, 1938, Lewis and Thompson (Oxford U. Bio. Exp.), 1 male, 1 female.

Haiti: Port au Prince, March, 1927, G. N. Wolcott, 1 male, 4 females.

Jamaica: St. Andrew, Sept. 20, 1898, C. B. Taylor, 3 females; Claremont, Feb., 1928, Lilly G. Perkins, 41 males, 49 females; Baron Hill Trelawny, Feb., 1928, L. G. Perkins, 130 males, 196 females; Claremont, Baron Hill Trelawny, March and April, 1928, L. G. Perkins, 139 males, 248 females; Baron Hill Trelawny, Nov. and Dec., 1928, L. G. Perkins, 1 male, 1 female; Lumsden Tydenbam, St. Ann, Feb., 1928, L. G. Perkins, 4 males, 2 females.

Puerto Rico: Camuy-Isabela, May 12, 1935, Julio Garcia Diaz, 2 males, 4 females; Cabo Rojo, June 9, 1937, J. A. Ramos, 1 male, 2 females.

St. Croix: Christiansted, 1941, H. A. Beatty, 8 males, 5 females.

BRAZIL: *Rio Grande do Norte:* Ouro Branco, No. 258, Stillman Wright, 1 female; Caicó, No. 327, Stillman Wright, 1 female; Caicó, No. 12637, Stillman Wright, 7 females.

São Paulo: Rio S. Paulo, Dec. 26, 1944, Wygd., 1 male, 11 females; Oct., 1947, Fritz Plaumann, 1 male, 2 females.

Santa Catarina: Nova Teutonia, Dec., 1946, Fritz Plaumann, 1 male, 2 females; Nova Teutonia, May, 1948, Fritz Plaumann, 93 males, 113 females.

PERU: Dept. Junín, Prov. Tarma, Palmapaca Jungle, Oct. 19 to 26, 1940, F. Woytkowski, 17 males, 18 females; Dept. San Martín, Feb. 16, 1947, Felix Woytkowski, 101 males, 62 females, 3 nymphs.

PARAGUAY: Villarrica, May 16, 1923, Fran. Schade, 3 females; Sept. to Dec., 1923, Fran. Schade, 57 males, 108 females; Jan. to March, 1924, Fran. Schade, 40 males, 43 females; April 16, 1924, Fran. Schade, 10 females; July 8, 1924, Fran. Schade, 13 males, 6 females; Sept. 21, 1924, Fran. Schade, 23 males, 19 females; Jan., 1926, Fran. Schade, 1 male, 1 female; Oct. 29, 1929, Fran. Schade, 1 male, 1 female; Caraveni, June 15, 1924, F. Schade, 4 males, 6 females; Feb. 15, 1925, F. Schade, 3 males; Oct. 30, 1924, F. Schade, 4 males, 6 females; Feb. 16, 1925, F. Schade, 1 male, 12 females; Estero Grande, Nov. 1, 1924, F. Schade, 6 males; Melinesque, June 20 to 28, 1935, F. Schade, 2 males, 9 females.

ARGENTINA: Prov. de Salta, Dept. Metau, 13 males, 9 females; Salta, 1 male, 1 female.

All specimens listed above are in the Francis Huntington Snow Entomological Collections, University of Kansas, Lawrence, Kansas.

The specimens collected in the States of Tamaulipas, Veracruz, and Chiapas, Mexico, overlap the area of *B. antigone carinata*. However, this region along the Gulf of Mexico south through the State of Chiapas, shows a varied ecology and these records are not surprising.

Buenoa antigone carinata (Champion)

(Pl. CIV, fig. 43)

1901. *Anisops carinatus* Champion, G. C. Biologia Centrali Americana, Heteroptera, vol. II, p. 372, pl. 22, fig. 12.
1904. *Anisops carinatus*, Uhler, P. R. Proc. U. S. Nat. Mus., vol. XXVII, p. 364 (listed).
1904. *Buenoa carinata*, Kirkaldy, G. W. Wiener Ent. Zeit., vol. XXIII, pp. 122 and 134 (listed as synonym of *B. antigone*).
1909. *Buenoa carinata*, Kirkaldy, G. W. and Torre-Bueno, J. R. de la. Proc. Ent. Soc. Wash., vol. X, p. 200 (catalogue).
1909. *Buenoa carinata*, Torre-Bueno, J. R. de la. Jr. New York Ent. Soc., vol. XVII, p. 75 (listed).
1914. *Buenoa carinata*, Barber, H. G. Bull. Am. Mus. Nat. Hist., vol. XXXIII, p. 499 (listed).
1916. *Buenoa carinata*, Van Duzee, E. P. New York Ent. Soc., p. 51 (check list).
1917. *Buenoa carinata*, Van Duzee, E. P. Cat. Hemiptera Am. North of Mexico, p. 454 (catalogue).
1919. *Buenoa carinata*, Hungerford, H. B. Univ. Kansas Sci. Bull., vol. XI, pp. 174-175 (key and description).
1925. *Buenoa carinata*, Bare, C. O. Ent. News, vol. XXXVI, p. 228 (key).
1926. *Buenoa carinata*, Blatchley, W. S. Heteroptera or True Bugs of Eastern North America, pp. 1057-1058 (key and description).
1928. *Buenoa carinata*, Bare, C. O. Univ. Kansas Sci. Bull., vol. XVIII, No. 3, p. 268 (key).
1948. *Buenoa carinata*, Hynes, H. B. N. Trans. Roy. Ent. Soc. London, vol. XCIX, p. 354 (distribution note).

Size: Male, length 7.94 mm. to 8.97 mm., greatest body width 2.60 mm. to 2.79 mm.; female, length 8.77 mm. to 9.75 mm., greatest body width 2.92 mm. to 3.12 mm.

Color: General facies testaceous to dark brown. Head, pronotum, thoracic venter, and limbs sordid white to testaceous. Scutellum rufo-testaceous to testaceous with base brown to black; metathoracic dorsum brown to black. Abdomen usually black except ventral keel, margins of connexivum, and last two or three segments, testaceous. This subspecies somewhat variable in color with some specimens entirely sordid white to testaceous.

Male Structural Characteristics: As viewed from above, greatest width of head approximately five and one half times the anterior width of vertex; synthlipsis approximately two thirds the anterior width of vertex; notocephalon with margins distinctly divergent anterior to synthlipsis; rostral prong (pl. CIV, fig 43b) with base originating laterally midway of third rostral segment. Pronotum with its median length approximately five-ninths its humeral width; disk with two elongate depressions toward the middle and a large subtriangular depression on each side, thus appearing distinctly tricarinate. Fore femur (pl. CIV, fig. 43a) with subtriangular to oblong stridulatory area consisting of approximately twenty-nine to thirty-three sclerotized ridges. Fore tibia (pl. CIV, fig. 43a) with stridulatory comb (pl. CIV, fig. 43c) consisting of approximately fifty to fifty-two teeth.

Female Structural Characteristics: As viewed from above, greatest width of head approximately seven times the anterior width of vertex; synthlipsis slightly less than two thirds the anterior width of vertex; along median longitudinal axis, head is approximately one fourth the length of pronotum; notocephalon with margins distinctly divergent anterior to synthlipsis. Female ovipositor with approximately eight or nine small, lateral, toothlike setae near apex.

Comparative Notes: This subspecies differs from *B. antigone antigone* (Kirkaldy) in being more robust, margins of notocephalon more divergent anterior to synthlipsis, and in the shape and number of scletorized ridges in femoral stridulatory area.

Location of Types: Type series is located at the British Museum, London. Homotype male, compared with type by H. B. Hungerford, labeled "Colima, Vulcano, Mex., L. Conrad", now in the Francis Huntington Snow Entomological Collections, University of Kansas.

Data on Distribution: Recorded from United States (fide Uhler and Blatchley and doubtful), Mexico, Guatemala, and British Honduras (fide Champion). Specimens from the following localities have been examined:

MEXICO: *Sonora:* 2 mi. E. of Guirecoba, Apr. 30, 1939, C. Sibley, 1 male, 3 females.

Sinaloa: Badiraguato, Mar. 30, 1937, A. Dampf, 1 male, 1 female.

Durango: San Antonio near El Salto, June 10, 1937, Meldon Embury, 2 males.

Tamaulipas: 5 mi. S. Ciudad Victoria, Nov. 5, 1936, H. D. Thomas, 1 female.

Jalisco: 20 mi. S. Guadalajara, Sept. 10, 1938, H. D. Thomas, 2 males, 2 females; Chapala, Sept. 11, 1938, H. D. Thomas, 1 male, 1 female; Guadalajara-Tequila Rd., 28 mi. N. Jalisco, Sept. 13, 1938, H. D. Thomas, 1 female; 15 mi. S. W. Lake Chapala, Sept. 14, 1938, H. D. Thomas, 2 females; 15 mi. down Autlán Rd., Sept. 14, 1938, H. D. Thomas, 1 female; Tecolotlán, Sept. 15, 1938, H. D. Thomas, 5 males, 8 females; Unión de Tula, Sept. 16, 1938, H. D. Thomas, 1 female; Jct. Guadalajara Hwy. and road to Autlán, Sept. 17, 1938, H. D. Thomas, 11 males, 11 females.

Guanajuato: 10 mi. N. E. León, Aug. 17, 1932, Hobart Smith, 3 females.

Veracruz: Jalapa, May 18, 1930, Creaser-Gordon, 1 male.

Michoacán: 10 mi. down Chinapa Rd., Sept. 5, 1938, H. D. Thomas, 6 males, 4 females; Zamora, Sept. 8, 1938, H. D. Thomas, 19 males, 20 females.

Colima: Vulcano, L. Conrad, 1 male.

Guerrero: Río Balsas, Jct. Acapulco Mex. Hwy., June 24, 1932, Hobart Smith, 2 females; Puente de Ixtla, July 12, 1937, H. D. Thomas, 4 females; Iguala, Oct. 7, 1936, H. D. Thomas, 9 males, 15 females; Palo Blanco, kil. 338 S. Mex. City, Oct. 10, 1936, H. D. Thomas, 1 female; Petaquillas, kil. 320 S. Mex. City, Oct. 21, 1936, H. D. Thomas, 1 male; Salto de Valadez, kil. 325 S. Mex. City, Oct. 30, 1936, H. D. Thomas, 12 males, 13 females; Tierra Colo., kil. 377 S. Mex. City, Oct. 31, 1936, H. D. Thomas, 5 males, 6 females; Río Balsas, kil. 259 S. Mex. City, Oct. 31, 1936, H. D. Thomas, 23 males, 16 females; Acapulco, kil. 442 S. Mex. City, Nov. 1, 1936, H. D. Thomas, 50 males, 63 females.

Morelos: Río Amacuzac, kil. 133 S. Mex. City, Oct. 14, 1936, H. D. Thomas, 6 males, 13 females; Cuernavaca, Oct. 1-17, 1936, H. D. Thomas, 1 male, 3 females; Acatlipa, kil. 84 S. Mex. City, Oct. 17, 1936, H. D. Thomas, 2 females.

Chiapas: Hda. La Libertad, Sept. 1, 1937, H. D. Thomas, 49 males, 39 females; La Libertad, Jan. 1, 1938, Octavio Utrilla Louis, 83 males, 96 females; San Vicente, Jan. 4, 1938, Octavio Utrilla Louis, 4 females.

All specimens listed above are in the Francis Huntington Snow Entomological Collections, University of Kansas, Lawrence, Kansas.

Buenoa femoralis (Fieber)

(Pl. CII, fig. 4; pl. CV, fig. 44)

1851. *Anisops femoralis* Fieber, F. X. Abhandlungen Köngl. Böhmischen Gesellschaft Wissenschaften, vol. VII, p. 483.
1904. *Buenoa femoralis*, Kirkaldy, G. W. Wiener Ent. Zeit., vol. XXIII, pp. 120 and 134 (listed).
1909. *Buenoa femoralis*, Kirkaldy, G. W. and Torre-Bueno, J. R. de la. Proc. Ent. Soc. Washington, vol. X, p. 200 (listed).
1928. *Buenoa femoralis*, Jaczewski T. Ann. Mus. Zool. Polonici, vol. VII, pp. 123-125 (description and illustrations).
1939. *Buenoa femoralis*, Barber, H. G. New York Acad. Sci., vol. XIV, p. 420.

Size: Male, length 8.32 mm. to 8.64 mm., greatest body width 2.66 mm. to 2.73 mm.; female, length 8.72 mm. to 8.90 mm., greatest body width 2.60 mm. to 2.72 mm.

Color: General facies pale testaceous to nigro-violaceous. Head portions of pronotum, thoracic venter, and limbs sordid white to testaceous. Scutellum, and portions of metathoracic dorsum and abdomen, black. Ventral abdominal keel, most of connexivum, and lateral portions of last two segments, testaceous. Posterior half of hemelytron, except for membrane, black. This species varies in color from specimens that are entirely testaceous to specimens that are almost entirely nigro-violaceous.

Male Structural Characteristics: As viewed from above, outline of head laterally rounded, anteriorly truncate with vertex indented; greatest width of head approximately seven times the anterior width of vertex and less than humeral width of pronotum; synthlipsis approximately half the anterior width of vertex; along median longitudinal axis, head is slightly less than half the length of pronotum; tylus inflated; labrum with basal width almost twice its median length and apex bluntly rounded; rostral prong (pl. CV, fig. 44b) much longer than third rostral segment, with base originating laterally midway of third rostral segment, and with apex moderately rounded. Pronotum with its median length less than three fifths its humeral width; disk with two elongate depressions toward the middle and a large subtriangular depression on each side, thus appearing tricarinate; lateral margins divergent; posterior margin convex, medianly concave. Scutellum large with median length distinctly greater than that of pronotum. Fore femur (pl. CV, fig. 44a) slightly widened at apex; triangular stridulatory area consisting of approximately seventeen sclerotized ridges. Fore tibia (pl. CV, fig. 44a) with stridulatory comb (pl. CV, fig. 44c) consisting of approximately thirty-four or thirty-five teeth which are of same size and thickness. Chaetotaxy of male front leg as shown on Plate CV. Male genital claspers normal. Spine from caudo-sinistral margin of seventh abdominal tergite (pl. CII, fig. 4) with apical half narrow and apex acuminate.

Female Structural Characteristics: As viewed from above, outline of head laterally rounded, anteriorly truncate with vertex indented; greatest width of head approximately seven times the anterior width of vertex and less than humeral width of pronotum; synthlipsis approximately half the anterior width of vertex; along median longitudinal axis, head is less than half the length of pronotum; tylus inflated. Pronotum with its median length slightly less than half its humeral width; disk only slightly impressed and occasionally not at all; lateral margins divergent; posterior margin convex, medianly concave. Scutellum large with median length much greater than that of pronotum. Female ovipositor of normal shape with teeth arranged in two longitudinal rows; one inner row of few, large teeth and one long outer row of smaller teeth; approximately seven or eight small, lateral, toothlike setae near apex.

Comparative Notes: Superficially this species closely resembles *B. crassipes* (Champion). Examination of the male, however, will show distinct differences. This species differs from *B. crassipes* in the shape and armature of the fore and hind femora, the shape of the tibial comb, and the lateral origin of the base of the rostral prong. *Buenoa femoralis* is a little larger than *B. crassipes.*

Location of Types: The type specimen, a somewhat damaged male, labeled "Porto Rico, Moritz", is located at the Berlin Museum.

Data on Distribution: Recorded from Puerto Rico, Brazil, and Peru. Specimens from the following localities have been examined:

PERU: Vicinity Sani Beni, muddy pool in shady jungle, Oct. 16, 1935, F. Woytkowski, 3 males, 4 females; vicinity Sani Beni, muddy pool in shady jungle, Oct. 17, 1935, F. Woytkowski, 38 males, 56 females; Oct. 24, 1935, F. Woytkowski, 111 males, 128 females; Dept. Ayacucho, Prov. La Mar., Sivia jungle, stagnant boggy pool, June 20-23, 1941, F. Woytkowski, 2 males, 1 female.

All specimens listed above are in the Francis Huntington Snow Entomological Collections, University of Kansas, Lawrence, Kansas.

Buenoa ida Kirkaldy

(Pl. CV, fig. 45)

1904. *Buenoa ida* Kirkaldy, G. W. Wiener Ent. Zeit., vol. XXIII, pp. 121, 122 and 134.

1909. *Buenoa ida,* Kirkaldy, G. W. and Torre-Bueno, J. R. de la. Proc. Ent. Soc. Washington, vol. X, p. 200 (catalogue).

Size: Male, length 9.16 mm. to 9.62 mm., greatest body width 2.73 mm. to 2.82 mm.; female, length 9.29 mm. to 9.94 mm., greatest body width 3.12 mm. to 3.25 mm.

Color: General facies fuscous. Head, pronotum, thoracic venter, and limbs testaceous. Scutellum brown to black with apex testaceous; metathoracic dorsum testaceous to brown. Abdomen black except ventral keel, margins of connexivum, and last one or two segments, testaceous. Posterior half of hemelytra, except membrane, usually black.

Male Structural Characteristics: As viewed from above, outline of head laterally rounded, anteriorly truncate with vertex usually slightly indented; greatest width of head slightly more than five times the anterior width of vertex and less than humeral width of pronotum; synthlipsis approximately half the anterior width of vertex; along median longitudinal axis, head is approximately one third the length of pronotum; notocephalon slightly sulcate; tylus not inflated; labrum with basal width one third greater than its median length and apex bluntly rounded; rostral prong (pl. CV, fig. 45b) longer than third rostral segment, with base originating laterally near proximal end of third rostral segment, and with apex bluntly rounded. Pronotum with its median length approximately one half its humeral width; disk with two elongate, shallow depressions toward the middle and a large, subtriangular, shallow depression on each side, thus appearing faintly tricarinate; lateral margins divergent; posterior margin convex, medianly concave. Scutellum large, with median length distinctly greater than that of pronotum. Fore femur (pl. CV, fig. 45a) wide and somewhat thickened at apex; long, curved, triangular stridulatory area consisting of approximately thirty-four or thirty-five sclerotized ridges. Fore tibia (pl. CV, fig. 45a) with stridulatory comb (pl. CV, fig. 45c) consisting of approximately twenty-two to twenty-four thick teeth; apical teeth slightly thicker than basal. Chaetotaxy of male front leg as shown on Plate CV. Male genital claspers normal. Spine from caudo-sinistral margin of seventh abdominal tergite with apical half narrow and apex strongly acuminate.

Female Structural Characteristics: As viewed from above, head is laterally rounded, anteriorly truncate with vertex indented only at lateral margins; greatest width of head approximately five and one half times the anterior width of vertex and less than humeral width of pronotum; synthlipsis slightly more than half the anterior width of vertex; along median longitudinal axis, head is approximately one fourth the length of pronotum; notocephalon sulcate; tylus not inflated. Pronotum with its median length slightly more than half its humeral width; disk usually unimpressed, occasionally with a feeble median carina; lateral margins divergent; posterior margin convex, medianly concave. Scutellum large, with median length distinctly greater than that of pronotum. Female ovipositor of normal shape with teeth arranged in two longitudinal rows; one inner row of few, large teeth and one long outer row of smaller teeth; approximately eight or nine small, lateral, toothlike setae near apex.

Comparative Notes: Superficially this species resembles *B. antigone carinata* (Champion). Examination of the male, however, will show distinct differences. This species differs from *B. antigone carinata* in the shape of the fore femur, the femoral stridulatory area, and the shape and number of teeth of the tibial comb. The pronotum of *B. antigone carinata* is more distinctly tricarinate than that of *B. ida,* and the size and coloration are different in the two species.

Location of Types: Dr. G. W. Kirkaldy states that the type is in his collection. The Kirkaldy Collection is now located in the Francis Huntington Snow Entomological Collections, University of Kansas, but the type has been lost or destroyed. A series of three specimens, 2 males and 1 female, were located in the remnants of the Kirkaldy Collection. Two of these are labeled "Uruguay," the type locality, and one is labeled "Guatemala." I have selected a male from Uruguay as a neoholotype.

Data on Distribution: Recorded from Mexico, Guatemala, and Uruguay. Specimens from the following localities have been examined:

MEXICO: *Chiapas:* L. Tepancuapan, Aug. 28, 1937, H. D. Thomas, 3 males, 7 females; Comitán, Jan. 18-20, 1938, Octavio Utrilla L., 12 males, 7 females.

GUATEMALA: No locality, Breddin (Kirkaldy Coll.), 1 female.

URUGUAY: No locality, E. Autran (Kirkaldy Coll.), 1 male, 1 female.

All specimens listed above are in the Francis Huntington Snow Entomological Collections, University of Kansas, Lawrence, Kansas.

Buenoa crassipes (Champion)

(Pl. CII, fig. 9; pl. CVI, fig. 46)

1901. *Anisops crassipes* Champion, G. C. Biologia Centrali Americana, Heteroptera, vol. II, p. 374.

1904. *Buenoa crassipes,* Kirkaldy, G. W. Wiener Ent. Zeit., vol. XXIII, pp. 121 and 134 (listed).

1909. *Buenoa crassipes,* Kirkaldy, G. W. and Torre-Bueno, J. R. de la. Proc. Ent. Soc. Washington, vol. X, p. 200 (catalogue).

1928. *Buenoa crassipes,* Jaczewski, T. Annales Musei Zoologici Polonici, vol. VII, pp. 125-126 (description).

Size: Male, length 7.15 mm. to 7.67 mm., greatest body width 2.27 mm. to 2.40 mm.; female, length 7.28 mm. to 8.12 mm., greatest body width 2.27 mm. to 2.47 mm.

Color: General facies testaceous to a shining nigro-violaceous. Head, portions of pronotum, thoracic venter, and limbs sordid white to testaceous. Scutellum, metathoracic dorsum, and abdomen black, except for ventral keel, portions of connexivum and lateral portions of last two segments, testaceous. Basal portion of hemelytral membrane usually black. This species variable in color.

Male Structural Characteristics: As viewed from above, outline of head laterally rounded, anteriorly truncate with vertex indented; greatest width of head approximately six and one half times the anterior width of vertex and slightly less than humeral width of pronotum; synthlipsis approximately half the anterior width of vertex; along median longitudinal axis, head is approximately two fifths the length of pronotum; notocephalon medianly sulcate; tylus slightly inflated; labrum with basal width slightly greater than its median length, and apex bluntly rounded; rostral prong (pl. CVI, fig. 46b) much longer than third rostral segment, with base originating laterally near distal end of third rostral segment, and with apex moderately rounded. Pronotum with its median length approximately three fifths its humeral width; disk almost unimpressed, not tricarinate; lateral margins slightly divergent; posterior margin convex, medianly concave. Scutellum large, with median length greater than that of pronotum. Fore femur (pl. CVI, fig. 46a) wide and somewhat thickened at apex; triangular stridulatory area variable consisting of approximately ten wide or sixteen narrow sclerotized ridges. Fore tibia (pl. CVI, fig. 46a) with wide stridulatory comb (pl. CVI, figs. 46c, 46d) consisting of approximately thirty to thirty-four thick teeth; apical teeth much wider than basal, with width of comb somewhat variable. Chaetotaxy of male front leg as shown on Plate CVI. Male genital claspers normal. Spine from caudo-sinistral margin of seventh abdominal tergite (pl. CII, fig. 9) with apical two thirds very narrow and apex extremely acuminate.

Female Structural Characteristics: As viewed from above, outline of head laterally rounded, anteriorly truncate with vertex indented; greatest width of head approximately five and one half times the anterior width of vertex and less than humeral width of pronotum; synthlipsis approximately half the anterior width of vertex; along median longitudinal axis, head is slightly more than one third the length of pronotum; notocephalon medianly sulcate; tylus slightly inflated. Pronotum with its median length approximately half its humeral width; disk unimpressed; lateral margins divergent; posterior margin convex, medianly concave. Scutellum large with median length distinctly greater than that of pronotum. Female ovipositor of normal shape with teeth arranged in two longitudinal rows; one inner row of large teeth, one outer row of small teeth, and a few small teeth intermingled with the two rows medianly; approximately seven or eight small, lateral, toothlike setae near apex.

Comparative Notes: Superficially this species closely resembles *B. femoralis* (Fieber). Examination of the male, however, will show distinct differences. This species differs from *B. femoralis* in the shape and armature of the fore and hind femora, the shape of the tibial comb, and the lateral origin of the base of the rostral prong. *Buenoa crassipes* is a little smaller than *B. femoralis.*

Location of Types: The original type series from Guatemala, is located at the British Museum, London.

Data on Distribution: Recorded from Guatemala, Costa Rica, Ecuador, and Brazil. Specimens from the following localities have been examined:

COSTA RICA: San José, Purchased June 1931, Heinrich Schmidt, 6 males, 20 females; San José, June & July 1931, Heinrich Schmidt, 10 males, 11 females; San José, Purchased 1932, Heinrich Schmidt, 58 males, 82 females; Rio Virilla, Dec. 26, 1931, Heinrich Schmidt, 21 males, 33 females; Rio Torres, Feb. 10, 1932, Heinrich Schmidt, 1 male, 1 female, 1 nymph; Río Sarapiquí, Heinrich Schmidt, 8 males, 8 females.

ECUADOR: Tungurahua Vale Baños, Jan. 1, 1923, F. X. Williams, 4 females, 22 nymphs; Tena, Feb. 28, 1923, F. X. Williams, 3 nymphs.

BRAZIL: *Santa Catarina:* Nova Teutonia, Dec. 1946, Fritz Plaumann, 34 males, 20 females; Nova Teutonia, May 1948, Fritz Plaumann, 23 males, 42 females.

All specimens listed above are in the Francis Huntington Snow Entomological Collections, University of Kansas, Lawrence, Kansas.

Buenoa arizonis Bare

(Pl. CII, fig. 10; Pl. CIII, figs. 29, 32; Pl. CVI, fig. 47)

1928. *Buenoa arizonis* Bare, C. O. Univ. Kansas Sci. Bull., vol. XVIII, p. 342, pl. 54 (figured only).
1931. *Buenoa arizonis*, Bare, C. O. Pan-Pacific Ent., vol. VII, No. 3, pp. 115-118 (description).
1942. *Buenoa arizonis*, Hutchinson, G. E. American Jr. Sci., vol. CCXL, p. 336 (morphology note).

Size: Male, length 8.45 mm. to 8.80 mm., greatest body width

2.56 mm. to 2.73 mm.; female, length 8.45 mm. to 8.83 mm., greatest body width 2.68 mm. to 2.81 mm.

Color: General facies testaceous to dark brown. Head, pronotum, thoracic venter, and limbs testaceous. Scutellum black with lateral and hind margins yellowish; metathoracic dorsum brown to black. Abdomen usually entirely black except ventral keel, margins of connexivum, and last two to three segments, testaceous. Some specimens entirely sordid white to testaceous.

Male Structural Characteristics: As viewed from above, outline of head laterally rounded, anteriorly truncate with vertex indented; greatest width of head approximately six times the anterior width of vertex and less than humeral width of pronotum; synthlipsis approximately as wide as anterior width of vertex; along median longitudinal axis, head is approximately one fifth the length of pronotum; notocephalon usually slightly sulcate; tylus strongly inflated with shallow median depression forming two lateral protuberances; labrum short, basal width almost twice its median length with apex bluntly rounded; rostral prong (pl. CVI, fig. 47b) distinctly longer than third rostral segment, with base originating laterally near distal end of third rostral segment, and with apex bluntly rounded. Pronotum strongly convex with its median length approximately one fifth greater than humeral width; disk with two elongate depressions toward the middle and a subtriangular depression on each side, thus appearing tricarinate; lateral margins divergent; posterior margin convex, very slightly concave medianly. Scutellum with median length approximately one fifth less than that of pronotum. Fore femur (pl. VI, fig. 47a) wide and somewhat thickened at apex; oblong stridulatory area consisting of approximately thirteen to fourteen sclerotized ridges. Fore tibia (pl. VI, fig. 47a) with stridulatory comb (pl. VI, fig. 47c) consisting of approximately forty-two to fifty teeth; apical teeth thicker and slightly narrower than basal. Chaetotaxy of male front leg as shown on Plate VI. Male genital claspers normal (pl. III, fig. 29). Spine from caudo-sinistral margin of seventh abdominal tergite (pl. II, fig. 10) with apical half very narrow and apex strongly acuminate.

Female Structural Characteristics: As viewed from above, outline of head laterally rounded, anteriorly truncate with vertex indented; greatest width of head approximately six times the anterior width of vertex and less than humeral width of pronotum; synthlipsis approximately three fifths the anterior width of vertex; along median longitudinal axis, head is slightly more than one fifth the length of pronotum; notocephalon usually slightly sulcate; tylus not strongly inflated and without median depression. Pronotum strongly convex with its median length approximately two thirds its humeral width; disk only slightly impressed and occasionally not at all; lateral margins divergent; posterior margin convex, very slightly concave medianly. Scutellum with median length slightly less than that of pronotum. Female ovipositor (pl. III, fig. 32) of normal shape with teeth arranged in two longitudinal rows; one inner row of few, large teeth and one long outer row of smaller teeth; approximately seven or eight small, lateral, tooth-like setae near apex.

Comparative Notes: This species is nearest in general appearance to *B. antigone* (Kirkaldy). *Buenoa arizonis* Bare differs from this species in the number and size of setae on hind femur, the form of the male pronotum, and in having the tylus of the male strongly inflated. Differences also occur in the fore leg of the male.

Location of Types: Holotype male (on slides) and allotype female, Superstition Mts., Arizona, Nov. 7, 1922, P. A. Glick, in the Francis Huntington Snow Entomological Collections. Paratypes distributed as follows: (1) 1 male, Superstition Mts., Arizona, Nov. 7, 1922, P. A. Glick; 3 males, 5 females, Baboquivari Mts., Arizona, F. H. Snow; 17 males, 49 females, Santa Cruz Co., Arizona, Aug. 4, 1927, P. A. Readio, R. H. Beamer, & L. D. Anderson; 11 males, 20 females, Gila Co., Arizona, July 6, 1927, P. A. Readio, R. H. Beamer, & L. D. Anderson; 1 female, Cochise Co., Arizona, July 29, 1927, R. H. Beamer; 1 male, Santa Rita Mts., Arizona, July 25, 1927, R. H. Beamer, in Francis Huntington Snow Entomological Collections, University of Kansas; (2) 19 specimens in the C. O. Bare Collection; (3) 3 specimens in California Academy of Sciences Collection, and (4) 5 specimens in the U. S. National Museum.

Data on Distribution: Recorded from the United States and Mexico. In addition to type series, specimens from the following localities have been examined:

U. S. A.: *Arizona:* Tucson, July 20, 1932, R. H. Beamer, 3 males, 1 female; Baboquivari Mts., Oct., 1934, Frank Blanchord, 1 male; Baboquivari Mts., July 18, 1932, R. H. Beamer & R. H. Beamer, Jr., 4 males, 11 females; Baboquivari Mts., July 24, 1941, B. Hodgden, 27 males, 39 females; Arabaca, July 6, 1941, B. Hodgden, 1 female; Miami, July 6, 1941, E. L. Todd, 1 female; Sunnyside Canyon, Huachuca Mts., July 9, 1940, L. C. Kuitert, 2 males; Ruby, July 13, 1940, L. C. Kuitert, 18 males, 35 females; Ruby, July 27-28, 1941, B. Hodgden, 6 males, 28 females.

MEXICO: *Sonora:* San Bernardo, Río Mayo, Oct. 14, 1934, H. S. Gentry, 15 males, 5 females; Buropaco Dist., Alamos, Oct. 23, 1934, H. S. Gentry, 4 males; Conejos Dist., Alamos, Oct. 26, 1934, H. S. Gentry, 32 males, 28 females; Arroyo de los Mescales, Río Mayo, Feb. 16, 1935, H. S. Gentry, 44 males, 85 females; Salitial, Río Mayo, Feb. 23, 1935, H. S. Gentry, 26 males, 56 females; Tepoca S. Charibo, Mar. 9, 1935, H. S. Gentry, 34 females; 2 mi. E. of Guerocoba, Apr. 30, 1939, C. Sibley, 5 females.

Chihuahua: Carimechi, Río Mayo, Dec. 12, 1934, H. S. Gentry, 63 males, 126 females; San Luis Babarocos, Dec. 30, 1934, H. S. Gentry, 35 males, 26 females.

Jalisco: Guadalajara, Tequila Rd., 28 mi. N. Jalisco, Sept. 13, 1938, H. D. Thomas, 28 females; 15 mi. S. W. of Lake Chapala, Sept. 14, 1938, H. D. Thomas, 1 male; Tecolotlán, Sept. 15, 1938, H. D. Thomas, 4 males, 41 females; 20 mi. S. Tecolotlán, Sept. 16, 1938, L. J. Lipovsky, 2 males, 5 females; Sept. 17, 1938, H. D. Thomas, 1 female.

Michoacán: 10 mi. down Chinapa Rd., Sept. 5, 1938, H. D. Thomas, 2 females; S. side L. Cuitzeo, July 7, 1947, T. H. Hubbell, 1 male, 1 female.

Puebla: Near Zapotitlán, July 26, 1932, Hobart Smith, 1 male, 1 female.

Morelos: Cuernavaca, Oct. 1-17, 1936, H. D. Thomas, 92 males, 185 females; Acatlipa, kil. 84 S. of Mex. City, Oct. 17, 1936, H. D. Thomas, 23 males, 34 females.

Guerrero: Río Balsas, Jct. Acapulco Mex. Hwy., June 24, 1932, Hobart Smith, 2 males, 11 females; Iguala, Oct. 7, 1936, H. D. Thomas, 42 males, 121 females; Palo Blanco, kil. 338 S. Mex. City, Oct. 10, 1936, H. D. Thomas, 1 female; Taxco, kil. 175 S. Mex. City, Oct. 10, 1936, H. D. Thomas, 26 males, 27 females; Salto de Valadez, kil. 325 S. Mex. City, Oct. 30, 1936, H. D. Thomas, 13 males, 20 females; Río Balsas, 259 kil. S. Mex. City, Oct. 31, 1936, H. D. Thomas, 161 males, 212 females; Tierra Colo., kil. 377 S. Mex. City, Oct. 31, 1936, H. D. Thomas, 13 males, 19 females; Acapulco, kil. 442 S. of Mex. City, Nov. 1, 1936, H. D. Thomas, 20 males, 15 females; Sacacorjuca, kil. 216 S. Mex. City, H. D. Thomas, 15 males, 33 females.

All specimens listed above are in the Francis Huntington Snow Entomological Collections, University of Kansas, Lawrence, Kansas.

Buenoa absidata n. sp.

(Pl. CVII, fig. 48)

Size: Male, length 5.85 mm. to 6.56 mm., greatest body width 1.56 mm to 1.75 mm.; female, length 5.78 mm. to 6.95 mm., greatest body width 1.56 mm. to 2.01 mm.

Color: General facies sordid white to gray. Head and pronotum sordid white to yellowish white. Thoracic venter and limbs pale testaceous to light brown; scutellum varies from entirely sordid white, to black with apex and lateral margins yellowish white; metathoracic dorsum yellowish white to mostly black. Abdomen black except ventral keel and portions of connexivum and dorsum, sordid white to testaceous. Some specimens entirely sordid white except abdomen, mostly black. This species variable in color.

Male Structural Characteristics: As viewed from above, outline of head rounded with vertex slightly protuberant; greatest width of head approximately five times the anterior width of vertex and slightly less than humeral width of pronotum; synthlipsis half the anterior width of vertex; along median longitudinal axis, head is approximately one third the length of pronotum; notocephalon distinctly sulcate; tylus inflated; labrum with basal width slightly more than twice its median length and apex bluntly rounded; rostral prong (pl. CVII, fig. 48b) long, distinctly longer than third rostral segment, with base originating laterally at distal end of third rostral segment, and with apex moderately rounded. Pronotum long, with its median length two thirds to three fourths its humeral width; disk with two elongate depressions toward the middle and a large subtriangular depression on each side, thus appearing distinctly tricarinate; lateral margins slightly divergent; posterior margin convex, medianly concave. Scutellum with median length distinctly less than that of pronotum. Fore femur (pl. CVII, fig. 48a) wide and somewhat thickened at apex; long, triangular stridulatory area consisting of approximately seventeen to twenty-two sclerotized ridges. Fore tibia (pl. CVII, fig. 48a) with stridulatory comb (pl. CVII, fig. 48c) consisting of approximately thirty-nine to forty-two teeth; apical teeth thicker and slightly narrower than basal. Chaetotaxy of male front leg as shown on Plate VII. Male genital claspers normal. Spine from caudo-sinistral margin of seventh abdominal tergite normal, tapering gradually from base to strongly acuminate apex.

Female Structural Characteristics: As viewed from above, outline of head rounded with vertex slightly protuberant; greatest width of head four and one half to five times the anterior width of vertex and less than humeral width of pronotum; synthlipsis approximately half the anterior width of vertex; along median longitudinal axis, head is one third to two fifths the length of pronotum; notocephalon distinctly sulcate; tylus inflated. Pronotum with its median length slightly more than half its humeral width; disk usually with two shallow, elongate depressions toward the middle forming a faint median carina, not tricarinate; lateral margins divergent; posterior margin convex, medianly concave. Scutellum large, with median length equal to or greater than that of pronotum. Female ovipositor of normal shape with teeth arranged in two irregular, longitudinal rows which merge in proximal third of ovipositor valve; one inner row of large teeth and one outer row of smaller teeth; approximately six or seven small, lateral, toothlike setae near apex.

Comparative Notes: Superficially this species somewhat resembles *B. arizonis* Bare. Examination of the male, however, will show distinct differences. This species differs from *B. arizonis* in its distinctly smaller size, in having head smaller in proportion to pronotum, tylus less inflated and not medianly depressed, and distinct differences in rostral prong and femoral stridulatory area.

Location of Types: Holotype male, allotype female, 26 male and 26 female paratypes, Dept. Lima, Lagunas Villa, Peru, June 8 to July 1, 1934, F. Woytkowski. The type series is in the Francis Huntington Snow Entomological Collections, University of Kansas.

Data on Distribution: Known only from Peru. In addition to type series, specimens from the following localities have been examined:

PERU: Dept. Lima: Lagunas Villa, June 8 to July 15, 1934, F. Woytkowski, 37 males, 43 females; Lurín, Nov. 3-5, 1934, F. Woytkowski, 128 males, 146 females; Vicinity Pacasmayo, May 19-20, 1936, F. Woytkowski, 26 males, 20 females; Chilca, Jan. 31, 1937, F. Woytkowski, 6 males, 42 females.

All specimens listed above are in the Francis Huntington Snow Entomological Collections, University of Kansas, Lawrence, Kansas.

Buenoa tarsalis n. sp.

(Pl. CVII, fig. 49)

Size: This species varies considerably in size within the same population. Male, length 6.24 mm. to 7.15 mm., greatest body width 1.62 mm. to 1.95 mm.; female, length 6.30 mm. to 8.06 mm., greatest body width 1.95 mm. to 2.53 mm.

Color: General facies sordid white to testaceous. Head, pronotum, and most of thoracic venter and limbs, sordid white, portions of thoracic venter and limbs sometimes light brown to black. Scutellum sordid white to pale testaceous, occasionally with two anterolateral brown to black areas; metathoracic dorsum sordid white to light brown. Abdomen black except ventral keel and portions of connexivum and dorsum, sordid white.

Male Structural Characteristics: As viewed from above, outline of head rounded with anterior margin of vertex slightly indented to continuous with that of eyes; greatest width of head five and one half to six times the anterior width of vertex and slightly less than humeral width of pronotum; synthlipsis approximately half the anterior width of vertex; along median longitudinal axis, head is two fifths to one half the length of pronotum; notocephalon slightly sulcate; tylus inflated; labrum with its basal width more than twice its median length and apex bluntly rounded; rostral prong (pl. CVII, fig. 49c) slightly longer than third rostral segment, with base originating laterally near proximal end of third rostral segment, and with apex moderately to bluntly rounded. Pronotum with its median length approximately three fifths its humeral width; disk with two elongate depressions toward the middle and a large subtriangular depression on each side, thus appearing tricarinate; lateral margins divergent; posterior margin convex, medianly concave. Scutellum large, with median length slightly greater than that of pronotum. Fore femur (pl. CVII, fig. 49a) relatively narrow at apex, not greatly thickened; oblong stridulatory area consisting of approximately seventeen to twenty-three sclerotized ridges. Fore tibia (pl. CVII, fig. 49a) with stridulatory comb (pl. CVII, fig. 49d) consisting of approximately thirty-two to forty teeth; apical teeth thicker and slightly narrower than basal. Intermediate leg with first tarsal segment (pl. CVII, fig. 49b) deeply emarginate on inner margin. Chaetotaxy of male front leg as shown on Plate CVII. Male genital claspers normal. Spine from caudo-sinistral margin of seventh abdominal tergite with apical half very narrow and apex strongly acuminate.

Female Structural Characteristics: As viewed from above, outline of head rounded with anterior margin of vertex usually continuous with that of eyes; greatest width of head approximately five times the anterior width of vertex and less than humeral width of pronotum; synthlipsis slightly less than half the anterior width of vertex; along median longitudinal axis, head is approximately two fifths the length of pronotum; notocephalon sulcate; tylus slightly inflated. Pronotum with its median length slightly less than half its humeral width; disk with two elongate depressions toward the middle forming a median carina, occasionally with a shallow, subtriangular depression on each side, thus appearing faintly tricarinate; lateral margins divergent; posterior margin convex, medianly concave. Scutellum large, with median length distinctly greater than that of pronotum. Female ovipositor of normal shape with teeth arranged in two longitudinal rows which merge in proximal third of ovipositor valve; one inner row of large teeth and one outer row of smaller teeth; approximately seven to nine small, lateral, toothlike setae located in a row extending from apex to midway of ovipositor valve.

Comparative Notes: Superficially this species resembles *B. antigone antigone* (Kirkaldy). Examination of the male, however, will show distinct differences. This species differs from *B. antigone antigone* in having synthlipsis narrower, first tarsal segment of intermediate leg strongly emarginate, hind femur less robust, and differences in the rostral prong, femoral stridulatory area, and tibial comb.

Location of Types: Holotype male, allotype female, 18 male and 20 female paratypes, Rio Sao Paulo Road, State of Rio de Janeiro, Brazil, June 19, 1945, Wygodzinsky. The type series is in the Francis Huntington Snow Entomological Collections, University of Kansas.

Data on Distribution: Known only from Brazil. In addition to type series, specimens from the following localities have been examined:

BRAZIL: *Pará:* Marco Belém, Jan. 1, 1947, L. & M. Deane, 16 males, 21 females, 5 nymphs.

Ceará: Agua Verde, July 6, 1937, S. Wright, 17 males, 38 females; Fortaleza, Aug. 3, 1937, S. Wright, 1 female; Lavras, Artificial lake, Aug. 23, 1937, S. Wright, 1 male; Lagôa Frexeiras, Nr. Maranguape, Sept., 1937, S. Wright, 11 males, 5 females; Primavera, Oct. 28, 1937, S. Wright, 4 males, 8 females; Choró, Oct. 29, 1937, S. Wright, 2 males, 4 females; Maranguape, Nov. 3-4, 1937, S. Wright, 4 males, 8 females.

Rio Grande do Norte: Ouro Branco, No. 258, S. Wright, 3 females.

Parahiba: Campina Grande, Nos. 43 & 212, S. Wright, 3 males, 12 females; Pocinhos, Nos. 197 & 5582, S. Wright, 1 male, 6 females; Santa Luzia, No. 260, S. Wright, 1 male, 5 females; Souza, No. 5530, S. Wright, 14 males, 3 females.

Pernambuco: Caruaru, No. 403, S. Wright, 8 males, 14 females; Pesqueira, No. 434, S. Wright, 3 females; Rio Branco, No. 445, S.

Wright, 4 females; Belém, No. 643, S. Wright, 5 males, 10 females; Itaparica, No. 818, S. Wright, 4 males, 3 females.

Rio de Janeiro: Rio Sao Paulo Road, June 19, 1945, Wygodzinsky, 19 females; Rio Sao Paulo Road, Feb., 1945, P. Wygodzinsky, 10 males, 26 females.

All specimens listed above are in the Francis Huntington Snow Entomological Collections, University of Kansas, Lawrence, Kansas.

Buenoa rostra n. sp.

(Pl. CVII, fig. 50)

Size: Male, length 5.78 mm. to 6.50 mm., greatest body width 1.62 mm. to 1.85 mm.; female, length 5.80 mm. to 6.21 mm., greatest body width 1.62 mm. to 1.88 mm.

Color: General facies sordid white to testaceous. Head, pronotum, thoracic venter, and limbs sordid white to pale testaceous. Scutellum sordid white to yellowish-white; metathoracic dorsum varies from entirely yellowish white to mostly dark brown. Abdomen black except ventral keel and portions of connexivum and dorsum, yellowish white. This species variable in color.

Male Structural Characteristics: As viewed from above, outline of head laterally rounded, anteriorly truncate with vertex indented; greatest width of head five and one half to six and one half times the anterior width of vertex and slightly less than humeral width of pronotum; synthlipsis one third to one half the anterior width of vertex; along median longitudinal axis, head is one fourth to one third the length of pronotum; notocephalon sulcate; tylus slightly inflated; labrum with basal width not quite twice its median length and apex bluntly rounded; rostrum very robust; rostral prong (pl. VII, fig. 50b) distinctly longer than third rostral segment, with base originating laterally at distal end of third rostral segment, and with apex bluntly rounded. Pronotum large, with its median length approximately two thirds its humeral width; disk usually with two elongate depressions posteriorly and toward the middle and a subtriangular depression on each side, thus appearing tricarinate posteriorly; lateral margins almost parallel; posterior margin convex, medianly concave. Scutellum large but with median length less than that of pronotum. Fore femur (pl. CVII, fig. 50a) wide and somewhat thickened at apex; subtriangular stridulatory area consisting of approximately fourteen to seventeen sclerotized ridges. Fore tibia (pl. CVII, fig. 50a) with stridulatory comb (pl. CVII, fig. 50c) consisting of approximately twenty-seven to twenty-eight teeth; apical teeth thicker and slightly wider and taller than basal.

Chaetotaxy of male front leg as shown on Plate CVII. Male genital claspers normal. Spine from caudo-sinistral margin of seventh abdominal tergite with apical third very narrow and apex strongly acuminate.

Female Structural Characteristics: As viewed from above, outline of head laterally rounded, anteriorly truncate with vertex slightly indented; greatest width of head five and one half to six and one half times the anterior width of vertex and less than humeral width of pronotum; synthlipsis one third to one half the anterior width of vertex; along median longitudinal axis, head is approximately two fifths the length of pronotum; notocephalon sulcate; tylus slightly inflated. Pronotum with its median length approximately half its humeral width; disk unimpressed; lateral margins divergent; posterior margin convex, medianly concave. Scutellum large, with median length distinctly greater than that of pronotum. Female ovipositor of normal shape with teeth arranged in two longitudinal rows which merge proximally to form a single irregular row; one inner row of large teeth and one outer row of smaller teeth; approximately seven or eight small, lateral, tooth-like setae near apex.

Variation Within Species: This species varies considerably in the proportional size of the head, anterior width of vertex, and synthlipsis. The greatest contrast is shown between a series from Venezuela and one from Trinidad. The former is larger and usually darker than the latter.

Comparative Notes: Superficially this species somewhat resembles the pale form of *B. crassipes* (Champion). Examination of the male, however, will show distinct differences. This species differs from *B. crassipes* in its smaller size, in having the pronotum longer and more convex, and in the distinctly different rostral prong and tibial comb (pl. C, figs. 50b, 50c).

Location of Types: Holotype male, allotype female, 3 male and 6 female paratypes, Trinidad, British West Indies, Sept. 27, 1931, W. E. Broadway. The type series is in the Francis Huntington Snow Entomological Collections, University of Kansas.

Data on Distribution: Known only from the West Indies (Trinidad) and Venezuela. In addition to type series, specimens from the following localities have been examined:

VENEZUELA: No locality, July 3, 1897, A. Speyer, 1 male, 1 female (F. H. Snow Coll.), 4 males, 8 females (Hamburg Mus.); San Esteban, Nov. 22, 1939, Pablo J. Anduze, 1 male, 3 females (F. H. Snow Coll.).

Buenoa margaritacea Torre-Bueno

(Pl. CIII, fig. 33; pl. CVIII, fig. 51)

1882. *Anisops platycnemis,* Uhler, P. R. Standard Nat. Hist., vol. II, p. 253.
1891. *Anisops platycnemis,* Summers, H. E. Bull. Agr. Exp. Sta. Tennessee, vol. IV, p. 82.
1902. *Anisops platycnemis,* Torre-Bueno, J. R. de la. Jr. New York Ent. Soc., vol. X, p. 236 (description).
1904. *Anisops platycnemis,* Kirkaldy, G. W. Wiener Ent. Zeit., vol. XXIII, p. 123 (description).
1908. *Buenoa margaritacea,* Torre-Bueno, J. R. de la. Jr. New York Ent. Soc., vol. XVI, p. 238 (*B. margaritacea* nom. nov. = *platycnemis,* Uhler, Bueno, *et auct., nec.* Fieber).
1909. *Buenoa margaritacea,* Torre-Bueno, J. R. de la. Jr. New York Ent. Soc., vol. XVII, pp. 75-77 (key, notes, and synonomy).
1910. *Buenoa margaritacea,* Smith, J. B. Cat. Insects New Jersey, edn. 3, p. 170 (catalogue).
1910. *Buenoa margaritacea,* Torre-Bueno, J. R. de la. Jr. New York Ent. Soc., vol. XVIII, p. 33 (listed and ecological note).
1914. *Buenoa margaritacea,* Barber, H. G. Bull. American Mus. Nat. Hist., vol. XXXIII, p. 499 (listed).
1916. *Buenoa margaritacea,* Van Duzee, E. P. New York Ent. Soc., p. 51 (check list).
1917. *Buenoa margaritacea,* Van Duzee, E. P. Cat. Hemiptera Am. North of Mexico, p. 454 (catalogue).
1917. *Buenoa margaritacea,* Hungerford, H. B. Ent. News, vol. XXVIII, pp. 174-183 (biological notes).
1917. *Buenoa margaritacea,* Hungerford, H. B. Ent. News, vol. XXVIII, p. 271 (biological note).
1917. *Buenoa margaritacea,* Parshley, H. M. Occasional Papers of Boston Soc. Nat. Hist., vol. VII, p. 113 (listed).
1919. *Buenoa margaritacea,* Hungerford, H. B. Univ. Kansas Sci. Bull., vol. XI, pp. 1-328 (biology, taxonomy, and key).
1919. *Buenoa margaritacea,* Hungerford, H. B. Univ. Kansas Sci. Bull., vol. XI, pp. 329-333 (morphological note).
1922. *Buenoa margaritacea,* Parshley, H. M. South Dakota State College Tech. Bull., No. 2, p. 22.
1922. *Buenoa margaritacea,* Hungerford, H. B. Canadian Ent., vol. LXIV, pp. 262-263 (morphological note).
1923. *Buenoa margaritacea,* Torre-Bueno, J. R. de la. Guide to Insects of Connecticut, part 4, p. 407.
1923. *Buenoa margaritacea,* Hungerford, H. B. Ent. News, vol. XXXIV, pp. 150-151 (biological note).
1923. *Buenoa margaritacea,* Hale, H. M. Records South Australian Mus., vol. II, p. 399 (notes).
1923. *Buenoa margaritacea,* Torre-Bueno, J. R. de la. Connecticut State Geol. and Nat. Hist. Survey Bull., No. 34, p. 407 (key and notes).
1924. *Buenoa margaritacea,* Hungerford, H. B. Ann. Ent. Soc. Am., vol. XVII, pp. 223 and 325 (biology and taxonomic notes).
1925. *Buenoa margaritacea,* Bare, C. O. Ent. News, vol. XXXVI, pp. 225-228 (key and taxonomic notes).
1925. *Buenoa margaritacea,* Hungerford, H. B. and Beamer, R. H. Ent. News, vol. XXXVI, pp. 264 and 297 (listed and notes).
1926. *Buenoa margaritacea,* Bare, C. O. Ann. Ent. Soc. Am., vol. XIX, pp. 93-101 (biological notes).
1926. *Buenoa margaritacea,* Blatchley, W. S. Heteroptera or True Bugs of Eastern North America, pp. 1057-1058 (description and key).
1926. *Buenoa margaritacea,* Clark, L. B. Canadian Ent., vol. LVIII, pp. 203-204 (listed and distributional note).
1928. *Buenoa margaritacea,* Bare, C. O. Univ. Kansas Sci. Bull., vol. XVIII, pp. 265-349 (taxonomy, biology, and morphology).

1928. *Buenoa margaritacea*, Torre-Bueno, J. R. de la. Cornell Univ. Agr. Exp. Station, Memoir 101, p. 139 (listed).
1939. *Buenoa margaritacea*, Millspaugh, D. D. Field and Laboratory, vol. VII, p. 78.
1942. *Buenoa margaritacea*, Rice, L. A. Tennessee Acad. Sci., vol. XVII, pp. 55, 62, and 63 (listed and biology).
1942. *Buenoa margaritacea*, Hutchinson, G. E. American Jr. Sci., vol. CCXL, p. 336 (morphological note).

Size: This species varies considerably in size within the same population. Male, length 6.01 mm. to 7.36 mm., greatest body width 1.50 mm. to 2.14 mm.; female, length 6.63 mm. to 8.25 mm., greatest body width 1.95 mm. to 2.40 mm.

Color: General facies sordid white to dark brown. Head, pronotum, most of thoracic venter and usually metathoracic dorsum, and limbs, sordid white to testaceous; portions of thoracic venter and metathoracic dorsum often light brown to black; scutellum yellowish to testaceous, occasionally with two anterolateral black spots. Abdominal dorsum varying from testaceous anteriorly and black posteriorly to almost entirely black; abdominal venter black except keel, portions of connexivum, and sometimes last one or two segments, testaceous. This species varies considerably in color.

Male Structural Characteristics: As viewed from above, outline of head rounded with vertex occasionally indented at lateral margins; greatest width of head five and one half to six and one half times the anterior width of vertex and distinctly less than humeral width of pronotum; synthlipsis approximately half the anterior width of vertex; along median longitudinal axis, head is two fifths to three fifths the length of pronotum; notocephalon usually slightly sulcate dorsally; tylus not inflated; labrum with basal width approximately twice its median length and apex bluntly rounded; rostral prong (pl. CVIII, fig. 51c) short, shorter than third rostral segment, with base originating laterally at proximal end of third rostral segment, and with apex bluntly rounded. Pronotum with its median length approximately three fifths its humeral width; disk often only laterally impressed, usually with two very shallow, elongate depressions toward the middle and a large subtriangular depression on each side, thus appearing faintly tricarinate; lateral margins divergent; posterior margin convex, medianly concave. Scutellum large, with median length equal to or slightly greater than that of pronotum. Fore femur (pl. CVIII, fig. 51a) narrow, not thickened at apex; subtriangular to oval stridulatory area consisting of approximately fifteen to eighteen sclerotized ridges. Fore tibia (pl. CVIII, fig. 51a) with stridulatory comb (pl. CVIII, fig. 51b) consisting of approximately twenty-three to twenty-six teeth which increase slightly in thickness from base to apex. Chaetotaxy of male front leg as shown on Plate CVIII. Male genital claspers normal. Spine from caudo-sinistral margin of seventh abdominal tergite with apical half very narrow and apex strongly acuminate.

Female Structural Characteristics: As viewed from above, outline of head rounded with vertex occasionally indented at lateral margins; greatest width of head five to six times the anterior width of vertex and less than humeral width of pronotum; synthlipsis approximately half the anterior width of vertex; along median longitudinal axis, head is approximately two fifths the length of pronotum; notocephalon not sulcate; tylus not inflated. Pronotum with its median length approximately three fifths its humeral width; disk usually unimpressed, occasionally with a shallow, subtriangular depression on each side, not tricarinate; lateral margins divergent; posterior margin convex, medianly concave. Scutellum large, with median length distinctly greater than that of pronotum. Female ovipositor (pl. CIII, fig. 33) of normal shape with teeth arranged in two longitudinal rows; one inner row of large teeth which merges proximally with long outer row of small teeth; approximately four small, lateral, toothlike setae near apex.

Variation Within Species: As is indicated under measurements of length, this species varies a great deal in size; there is also considerable variation in the proportional size of the pronotum. This variation is not correlated with distribution and the variants occur within the same population.

Comparative Notes: Superficially this species closely resembles *B. scimitra* Bare. Examination of the male, however, will show distinct differences. This species differs from *B. scimitra* in the shape of the fore femur, the femoral stridulatory area, and the rostral prong. In general, *B. margaritacea* is slightly larger in size than the above mentioned species.

Nomenclatorial Notes: Mr. J. R. de la Torre-Bueno (1908) in designating *B. margaritacea* as a new name for "*platycnemis,* Uhler, Bueno, *et auct., nec* Fieber" states that, "The Buenoa known to a generation of American entomologists as *Anisops platycnemis* was an undescribed species." He does not proceed to describe *B. margaritacea* but states that the descriptions by Uhler (1882), Bueno (1902) and Kirkaldy (1904) "will enable anyone to identify this species with certainty." The main distinguishing factor in the above mentioned descriptions is the size. *Buenoa platycnemis* Fieber is a small species whereas *B. margaritacea* is a relatively large species.

Location of Types: To the knowledge of this author, no types were designated by J. R. de la Torre-Bueno for *B. margaritacea.* If types were established, they have subsequently been lost or destroyed. A series of three specimens, 2 males, 1 female, were located in the remnants of the Bueno collection now in the Francis Huntington Snow Entomological Collections of the University of Kansas. These specimens are from Maryland, U. S. A., in the general vicinity of Bueno's collecting, and where Uhler states, "I have found it late in October." I have selected one of these males as a neoholotype and the female as a neoallotype.

Data on Distribution: Recorded from Canada, United States, and Mexico. Specimens from the following localities have been examined:

U. S. A.: *Minnesota:* St. Paul, Sept. 23, 1918, R. F. Hussey, 1 female (U. of Mich.); St. Paul, June 19, 1921, H. B. Hungerford, 3 females; St. Paul, July 28-31, 1921, H. B. Hungerford, 4 males, 3 females.

Michigan: Berrien Co., Sept. 2, 1919, R. F. Hussey, 5 males, 8 females (U. of Mich.); Livingston Co., Aug. 9, 1938, I. J. Cantrall, 1 female (U. of Mich.).

South Dakota: Blunt, July 19, 1937, C. L. Johnston, 1 female; Brookings Co., Aug. 11, 1939, H. C. Severin and W. Eakins, 2 females.

New York: West Point, Apr. 19, 1909, W. Robinson, 2 females (U.S.N.M.).

Pennsylvania: Philadelphia, Oct. 18, 1908, G. M. Greene, 1 female (U.S.N.M.).

Illinois: Lake Forest, S. G. Needham, 2 females (U.S.N.M.); P. R. Uhler Collection, 1 male, 1 female (U.S.N.M.).

Maryland: Patuxent, Aug. 2, 1879, P. R. Uhler, 1 male, 1 female (Bueno Coll.); Baltimore, Sept. 4, 1897, P. R. Uhler, 1 male (Bueno Coll.).

Colorado: Lamar, July 22, 1927, P. A. Readio, 2 males, 8 females; Lamar, Aug. 20, 1927, P. A. Readio, 9 males; Hadley, Sept. 22, 1927, P. A. Readio, 1 male; Denver, P. R. Uhler collection, 1 female (U.S.N.M.).

California: Santa Ana, July 30, 1932, J. D. Beamer, 1 female, 1 nymph; Laguna Beach, July 25, 1933, R. H. Beamer, 3 males, 4 females; Idyllwild, Aug. 3, 1935, Jack Beamer, 1 female; Campo, June 18, 1940, R. H. Beamer, 1 male; Stanford University, March 16, 1915, 1 female.

Kansas: Doniphan Co., Aug. 23, 1921, W. J. Brown, 5 males, 1 female; Doniphan Co., Aug. 24-25, 1921, Robert Guntert, 2 males, 1 female; July 23, 1924, E. P. Breakey, 1 female; Atchison Co., July 15-17, 1924, E. P. Breakey, 8 males, 16 females; Atchison Co., July 15, 1924, Beamer, 4 males, 7 females; Pottawatomie Co., Crevecoeur, 1 female (U.S.N.M.); Leavenworth Co., June 1923, E. P. Breakey, 3 females; Shawnee Co., May 26, 1923, H. B. Hungerford, 3 females; Shawnee Co., June 27, 1923, H. B. Hungerford, 3 males; Douglas Co., April 7, 1909, 1 male; Douglas Co., Aug. 2, 1909, 3 males, 5 females; Douglas Co., 1916, H. B. Hungerford, 1 male, 1 female; Douglas Co., May 17, 1920, H. B. Hungerford, 5 males, 2 females; Douglas Co., Feb. 23, 1921, H. B. Hungerford, 1 female; Douglas Co., Apr. 8, 1921, H. B. Hungerford, 1 male, 4 females; Douglas Co., June 3, 1921, W. J. Brown, 1 male, 1 female; Douglas Co., Nov. 3, 1922, H. B. Hungerford, 1 female; Douglas Co., May 20, 1923, C. O. Bare, 15 males, 5 females; Douglas Co., Sept. 28, 1924, C. O. Bare, 59 males, 55 females; Douglas Co., Oct. 25, 1924, C. O. Bare, 11 males, 17 females; Douglas Co., Nov. 19-20, 1924, C. O. Bare, 85 males, 78 females; Douglas Co., Apr. 5. 1925, C. O. Bare, 4 males, 48 females; Douglas Co., May 6, 1925, C. O. Bare, 8 males, 2 females; Douglas Co., Beamer, 2 males, 48 females; Osage Co., June 1923, Beamer, 2 males, 5 females; Saline Co., July 14, 1923, L. C. Woodruff, 4 females; Saline Co., July 15-18, 1923, R. H. Beamer, 2 males, 8 females; Franklin Co., March 20, 1926, Wesley Clanton, 1 female (U. of Mich.); Lyon Co., June 14, 1923, C. O. Bare, 1 female; Lyon Co., June 15, 1923, W. J. Brown, 1 female; Lyon Co., June 18, 1923, H. Darby, 1 female; Linn Co., Apr. 14, 1923, H. B. Hungerford, 1 female; Bourbon Co., 1915, R. H. Beamer, 1 male; Reno Co., Aug. 27, 1925, W. J. Brown, 2 males, 4 females; Reno Co., July 2, 1927, P. A. Readio, 1 male, 2 females; Reno Co., July 3, 1927, L. D. Anderson, 1 male; Gray Co., July 9-15, 1917, 1 female; Cherokee Co., Aug. 15, 1920, H. B. Hungerford, 1 female; Cherokee Co., Aug. 18, 1920, R. H. Beamer, 3 females; Montgomery Co., 1916, R. H. Beamer, 3 females; Comanche Co., June 19, 1927, H. B. Hungerford, 3 males, 2 females; Morton Co., Aug. 3, 1924, C. O. Bare, 1 male, 15 females.

Missouri: St. Louis, July, 1910, J. F. Abbott, 1 male; St. Louis, Oct., 1911, F. J. Abbott, 1 female.

Virginia: Great Falls, Jan. 9, 1906, D. H. Clemons, 1 female (U.S.N.M.); Vienna, Sept. 19, 1931, P. W. Oman, 58 males, 61 females; Vienna, Sept. 19, 1931, P. W. Oman, 1 male, 3 females (U.S. N.M.).

Tennessee: Murfreesboro, Aug. 29, 1929, Greaser Becker, 1 female; Knoxville, 1 female (U. S. N. M.).

Oklahoma: Cimarron Co., July 5, 1926, T. H. Hubbell, 2 males, 24 females (U. of Mich.); Ardmore, Apr. 14, 1923, H. B. Hungerford, 1 male, 17 females; Osage Co., June 23, 1936, W. F. Blair, 1 female (U. of Mich.).

New Mexico: Torrance Co., June, 1925, C. H. Martin, 9 males, 31 females; Torrance Co., July 19, 1925, C. H. Martin, 4 females; Torrance Co., Sept., 1925, C. H. Martin, 18 males, 16 females; Estancia, Aug. 25 to Sept. 6, 1925, C. H. Martin, 21 males, 25 females; Chaves Co., July 8, 1927, R. H. Beamer, 1 male, 2 females; Santa Cruz, Aug. 4, 1927, R. H. Beamer, 1 male, 3 females; Santa Cruz, Aug. 4, 1927, P. A. Readio, 6 males, 7 females; Santa Cruz, Aug. 20, 1927, L. D. Anderson, 11 males, 4 females; Socorro Co., Aug. 8, 1927, P. A. Readio, 1 male, 11 females; Otero Co., June 28, 1931, L. K. Gloyd, 2 males, 5 females (U. of Mich.); Wagon Mound, July 18, 1936, M. B. Jackson, 2 females; Santa Fe, July 20, 1936, J. D. Beamer, 1 female.

Arizona: Cochise Co., July 29, 1927, R. H. Beamer, 7 males, 30 females; Gila Co., Aug. 5, 1927, L. D. Anderson, 2 males, 4 females; Gila Co., Aug. 5, 1927, R. H. Beamer, 5 males, 19 females; Gila Co., Aug. 6, 1927, P. A. Readio, 6 males, 3 females; Navajo Co., Aug. 15, 1927, Anderson and Readio, 6 males, 10 females; Navajo Co., Aug. 15, 1927, R. H. Beamer, 2 males, 1 female; Apache Co., Aug. 16, 1927, R. H. Beamer, 9 males, 11 females; Apache Co., Aug. 16, 1927, P. A. Readio, 10 males, 4 females; Apache Co., Aug. 16, 1927, L. D. Anderson, 2 females; Coconino Co., July 1, 1929, L. D. Anderson, 1 female; Baboquivari Mts., July 16, 1932; R. H. Beamer, Jr., 5 males, 18 females; Baboquivari Mts., July 24, 1941, B. Hodgden, 12 males, 57 females; Tuscon, July 20, 1932, R. H. Beamer, 2 males, 12 females; Douglas, Apr. 21, 1933, W. W. Jones, 1 female (U. S. N. M.); Douglas, Aug., F. H. Snow, 1 male; Yavapai Co., June 9, 1937, L. K. Gloyd, 1 female (U. of Mich.); Ruby, July 13, 1940, D. E. Hardy, 1 male, 1 female; Ruby, July 27, 1941, B. Hodgden, 2 females; Miami, Aug. 6, 1941, E. L. Todd, 45 males, 20 females; Miami, Aug. 6, 1941, B. Hodgden, 20 males, 9 females; Fort Grant, H. G. Hubbard, 1 female (U. S. N. M.).

Arkansas: Scott Co., Aug. 23, 1928, R. H. Beamer, 3 females; Fayetteville, Apr. 23-28, 1930, 4 females; Saline Co., July 7, 1950, R. H. Beamer, 1 male.

South Carolina: Organsburg, Sept. 2, 1914, W. J. Brown, 1 female.

Georgia: Atlanta, March 14, 1933, P. W. Fattig, 1 female (U. S. N. M.).

Mississippi: Agricultural College, Oct., 1895, W. E. Weed, 1 female (P. R. Uhler Coll.); Agricultural College, June 20, 1919, J. B. Ray, 1 female; Fulton, July 14, 1930, R. H. Beamer, 1 female.

Louisiana: Baton Rouge, March 9, 1929, R. M. DeCoursey, 1 female.

Texas: Brownsville, June 5, 1904, H. S. Barber, 2 males, 1 female (U. S. N. M.); Brownsville, Aug. 1919, 2 females (U. S. N. M.); Kerrville, Apr. 12, 1907, F. C. Pratt, 1 female (U. S. N. M.); Victoria, Dec. 27, 1910, J. D. Mitchell, 1 female (U. S. N. M.); Eastland Co., May 12-26, 1921, Grace Wiley, 26 males, 29 females; Colorado Co., March 30, 1922, 4 females; Colorado Co., Apr. 3-24, 1922, Mrs. Grace Wiley, 3 males, 39 females; Colorado Co., May 5-19, 1922, Grace Wiley, 1 male, 7 females; Tulsa Co., March 16-21, 1922, Grace Wiley, 1 male, 4 females; Randall Co., July 7, 1927, R. H. Beamer, 4 males, 23 females; Valentine, July 13, 1927, R. H. Beamer, 13 males, 15 females; Valentine, July 12, 1938, D. W. Craik, 1 male, 1 female; Presidio Co., July 16, 1927, R. H. Beamer, 6 males, 17 females; El Paso Co., July 17, 1927, L. D. Anderson, 1 female; Sulton Co., July 20, 1928, J. G. Shaw, 3 males; Sulton Co., Aug. 20, 1928, A. M. James, 3 males, 5 females; Kendall Co., July 22, 1928, R. H. Beamer and J. G. Shaw, 1 male, 5 females; Jim Wells Co., July 24, 1928, R. H. Beamer, 6 males, 6 females; Alfred, July 24, 1928, R. H. Beamer, 1 male; Bee Co., July 25, 1928; R. H. Beamer, 1 male; Hidalgo Co., July 28, 1928, J. G. Shaw, 3 males; Hidalgo Co., July 30, 1928, R. H. Beamer, 1 male, 4 females; Hidalgo Co., Aug. 3, 1928, J. G. Shaw, 14 males, 9 females; Starr Co., July 30, 1928, J. G. Shaw, 33 males, 32 females, 3 nymphs; Cameron Co., Aug. 13, 1928, A. M. James, 1 female; Bowie Co., Aug. 16, 1928, R. H. Beamer, 1 male; Brewster Co., Apr. 15, 1930, O. C. Poling, 2 males (U. of Mich.); Fulfurrias, Nov. 2, 1932, L. D. Tuthill, 2 males; Sinton, Nov. 8, 1932, L. D. Tuthill, 1 male, 1 female; McAllen, Nov. 20, 1932, L. D. Tuthill, 1 male; McAllen, Dec. 30, 1945, R. H. Beamer, 2 females; Marathon, July 9, 1938, R. I. Sailer, 4 males, 6 females; Davis Mts., July 12, 1938, D. W. Craik, 2 males, 1 female; Cypress Mills, Chittenden, 1 female (U. S. N. M.); Texas, P. R. Uhler Collection, 2 females (U. S. N. M.).

MEXICO: *Chihuahua:* Juárez, June 18, 1931, Smith and Dunkie, 1 male.

Coahuila: Satillo, Nov. 21, 1932, L. D. Tuthill, 7 males, 14 females.

Tamaulipas: San José, Apr., 1910, Bueno Collection, 1 male, 1 female.

All specimens listed above are in the Francis Huntington Snow Entomological Collections, University of Kansas, Lawrence Kansas, unless otherwise indicated.

Buenoa scimitra Bare

(Pl. CII, fig. 6; pl. CVIII, fig. 52)

1925. *Buenoa scimitra* Bare, C. O. Ent. News, vol. XXXVI, pp. 226-228.
1926. *Buenoa scimitra,* Bare, C. O. Ann. Ent. Soc. America, vol. XIX, p. 93 (biological note).
1926. *Buenoa scimitra*, Blatchley, W. S. Heteroptera or True Bugs of Eastern North America, pp. 1057-1059 (key and description).
1928. *Buenoa scimitra*, Bare, C. O. Univ. Kansas Sci. Bull., vol. XVIII, p. 268 (key).
1948. *Buenoa scimitra*, Hynes, H. B. N. Trans. Roy. Ent. Soc. London, vol. XCIX, p. 354 (distributional note).

Size: This species varies considerably in size within the same population. Male, length 5.46 mm. to 6.50 mm., greatest body width 1.56 mm. to 1.82 mm.; female, length 5.85 mm. to 7.50 mm., greatest body width 1.69 mm. to 2.15 mm.

Color: General facies sordid white to fuscous. Head, anterior portion of pronotum, most of thoracic venter, and limbs sordid white to testaceous. Posterior portion of pronotum white to hyaline; scutellum orange to reddish yellow, occasionally with anterolateral portions black; metathoracic dorsum with lateral portions sordid white to testaceous, remaining area light brown to black. Abdomen black except ventral keel and portions of connexivum and dorsum, testaceous. Some specimens entirely sordid white to testaceous except most of abdomen, black. This species variable in color.

Male Structural Characteristics: As viewed from above, outline of head rounded with vertex indented, often at lateral margins only; greatest width of head six to six and one half times the anterior width of vertex and less than humeral width of pronotum; synthlipsis slightly more than one third the anterior width of vertex; along median longitudinal axis, head is two fifths to one-half the length of pronotum; notocephalon sulcate dorsally; tylus inflated; labrum with basal width approximately twice its median length and apex bluntly rounded; rostral prong (pl. CVIII, figs. 52b, 52c) shorter than third rostral segment, with base originating laterally at a point midway to near proximal end of third rostral segment, and with apex bluntly rounded. Pronotum with its median length approximately three fifths its humeral width; disk with two elongate depressions toward the middle and a large, subtriangular depression on each side, thus appearing tricarinate; lateral margins divergent; posterior margin convex, medianly concave. Scutellum large, with median length equal to or greater than that of pronotum. Fore femur (pl. CVIII, fig. 52a) wide and somewhat thickened at apex; large, sword-shaped stridulatory area consisting of approximately sixty fine, sclerotized ridges. Fore tibia (pl. CVIII, fig. 52a) with stridulatory comb (pl. CVIII, fig. 52d) consisting of approximately nineteen to twenty-two teeth; all teeth approximately same thickness. Chaetotaxy of male front leg as shown on Plate CVIII. Male genital claspers normal. Spine from caudo-sinistral margin of seventh abdominal tergite (pl. CII, fig. 6) with apical half narrow and apex strongly acuminate.

Female Structural Characteristics: As viewed from above, outline of head rounded with vertex indented at lateral margins; greatest width of head five to five and one half times the anterior width of vertex and less than humeral width of pronotum; synthlipsis approximately two fifths the anterior width of vertex; along median longitudinal axis, head is two fifths to one half the length of pronotum; notocephalon sulcate dorsally; tylus slightly inflated. Pronotum with its median length approximately three fifths its humeral width; disk with two shallow, elongate depressions toward the middle and a shallow, subtriangular depression on each side, thus appearing faintly tricarinate; lateral margins divergent; posterior margin convex, medianly concave. Scutellum large, with median length greater than that of pronotum. Female ovipositor of normal shape with teeth arranged in two longitudinal rows; one inner row of few, large teeth and one long outer row of smaller teeth; approximately three or four small, lateral, toothlike setae near apex.

Variation Within Species: As is indicated under measurements of length, this species varies a great deal in size; there is also considerable variation in the proportional size of the pronotum. This variation is not due to distributional factors since it occurs within the same population. Due to the fact that all characters used in species determination are identical in these variable forms, no specific separation appears justified.

Comparative Notes: Superficially this species closely resembles *B. margaritacea* Torre-Bueno. Examination of the male, however, will show distinct differences. This species differs from *B. margaritacea* in having the fore femur distinctly wider at apex, the femoral stridulatory area long and sword-shaped, and the rostral prong longer.

Location of Types: Holotype male, allotype female, 20 male paratypes, Douglas Co., Kansas, May 20, 1923, Oct. 25, 1924, Nov. 19, 1924, C. O. Bare; other paratypes: 4 males, Colorado Co., Texas, May 19, 1922, Grace Wiley. The type series is in the Francis Huntington Snow Entomological Collections, University of Kansas.

Data on Distribution: Recorded from the United States, Mexico, and the West Indies (Cuba, Jamaica, Puerto Rico). In addition to type series, specimens from the following localities have been examined:

U. S. A.: *Kansas:* Doniphan Co., Aug. 14, 1921, R. Guntert, 1 female; Doniphan Co., Aug. 23, 1921, W. J. Brown, 1 female; Atchison Co., July 15-17, 1924, E. P. Breakey, 2 males, 1 female; Shawnee Co., May 6, 1923, H. B. Hungerford, 2 females; Douglas Co., May 17, 1920, 1 male; Douglas Co., Nov. 3-7, 1922, H. B. Hungerford, 14 males, 44 females; Douglas Co., Nov. 3, 1922, R. Guntert, 5 males, 35 females; Douglas Co., May 20, 1923, C. O. Bare, 3 females; Douglas Co., Sept. 28, 1924, C. O. Bare, 115 males, 40 females; Douglas Co., Oct. 25, 1924, C. O. Bare, 60 males, 87 females; Douglas Co., Nov. 19-20, 1924, C. O. Bare, 38 males, 36 females; Douglas Co., Oct. 10, 1925, C. O. Bare, 1 male, 1 female; Saline Co., July 18, 1923, R. H. Beamer, 1 female; Cherokee Co., Aug., 1920, H. B. Hungerford and R. H. Beamer, 4 females; Cherokee Co., Dec. 1922, R. H. Beamer, 1 male, 1 female; Montgomery Co., 1916, R. H. Beamer, 1 male; Comanche Co., June 19, 1927, H. B. Hungerford, 2 males; Morton Co., July 20, 1924, C. O. Bare, 3 males, 3 females.

Virginia: New Church, July 15, 1934, L. D. Anderson, 1 male, 1 female.

California: Palo Alto, March 17, 1892, G. W. Kirkaldy Coll., 4 females; Lagoon Lake, Reade, Dec. 24, 1922, J. G. Needham, 6 females; Lagoon Lake, Aug. 24, 1925, J. G. Needham, 1 male; Lagoon Lake, Dec. 24, 1925, J. G. Needham, 10 males, 3 females; Calipatria, Apr. 4, 1924, Warewick Benedict, 4 females; Tehama Co., Apr. 14, 1928, Jean Linsdale, 1 male, 8 females; Holtville, July 2, 1929, Beamer and Anderson, 1 male, 3 females; San Diego Co., July 7, 1929, L. D. Anderson, 1 male; San Diego Co., Apr. 19, 1930, C. & D. Martin, 1 female; Marin Co., Aug. 3, 1929, L. D. Anderson, 12 males, 4 females; Campo, Aug. 25, 1932, H. W. Capps, 3 males, 3 females; Berkeley, Apr. 26, 1933, Jean Linsdale, 5 males, 6 females; Laguna Beach, July 25, 1933, R. H. Beamer, 58 males, 85 females; Red Bluff, June 27, 1935, Jack Beamer, 13 males, 8 females; Red Bluff, June 27, 1935, Jean Russell, 2 males, 4 females; Anza, Aug. 6, 1935, R. H. Beamer, 1 female; El Centro, July 24, 1938, R. H. Beamer and D. W. Craik, 1 male, 6 females; Arroyo Seco, Aug. 8, 1938, R. I. Sailer, 2 males, 5 females; Jamesburg, Aug. 11, 1938, D. W. Craik, 2 males, 1 female.

Oklahoma: Tuko Co., Mar. 21, 1922, Grace Wiley, 2 males, 2 females.

Tennessee: Fentress Co., Aug. 17, 1922, T. H. Hubbell, 5 males, 4 females (U. of Mich.).

Arizona: Pima Co., July 27, 1927, R. H. Beamer, 1 male; Cochese Co., July 29, 1927, R. H. Beamer, 35 males, 41 females; Santa Cruz Co., Aug. 4, 1927, R. H. Beamer and L. D. Anderson, 5 males, 4 females; Santa Cruz Co., Aug. 4, 1927, P. A. Readio, 12 males, 5 females; Gila Co., Aug. 6, 1927, P. A. Readio, 1 male, 1 female: Yavapai Co., June 3, 1937, L. K. Gloyd, 2 females (U. of Mich.); Ruby, July 27, 1941, B. Hodgden, 2 males, 1 female; Arivaca, July 10, 1947, L. D. Beamer, 2 males, 1 female.

New Mexico: Socorro Co., Aug. 8, 1927, L. D. Anderson, 14 males, 7 females; Socorro Co., Aug. 18, 1927, P. A. Readio, 9 males, 9 females; Belen, July 20, 1936, W. D. Field, 3 males, 3 females.

Arkansas: Scott Co., Aug. 23, 1928, R. H. Beamer, 1 male, 21 females; Fayetteville, Apr. 24, 1930, 9 females; Arkansas Co., Sept. 4, 1930, D. Isely, 3 males, 7 females.

South Carolina: Orangeburg, Sept. 2, 1914, 1 male, 1 female.

Texas: Brownsville, 1875, 1 male, 3 females (Berlin Mus.); Brownsville, Feb. 27, 1895, C. H. T. Townsend, 1 male (U.S.N.M.); Brownsville, Dec. 29, 1945, R. H. Beamer, 1 male, 1 female; Victoria, July 7, 1915, J. D. Mitchell, 3 males, 4 females (U.S.N.M.); Eastland Co., May 23-24, 1921, Grace Wiley, 5 males, 9 females; Eastland Co., June 16, 1921, Grace Wiley, 1 male; Eastland Co., May 14-25, 1927, Grace Wiley, 4 males, 2 females; Colorado Co., Apr. 3-24, 1922, Grace Wiley, 38 males, 30 females; Colorado Co., May 16-19, 1922, Grace Wiley, 11 females; Presidio Co., July 16, 1927, P. A. Readio, 2 males, 3 females; Valentine, July 13, 1927, R. H. Beamer, 3 males, 2 females; Palo Pinto Co., July 14, 1928, R. H. Beamer, 1 female; Sutton Co., July 20, 1928, J. G. Shaw, 4 males, 1 female; Sutton Co., Aug. 20, 1928, A. M. James, 3 males, 11 females; Sutton Co., Aug. 20, 1928, J. G. Shaw, 1 female; Kendall Co., July 22, 1928, R. H. Beamer, 1 female; Kendall Co., July 22, 1928, J. G. Shaw, 6 males, 2 females; Jim Wells Co., July 24, 1928, R. H. Beamer, 19 males, 20 females; Alfred, July 24, 1928, R. H. Beamer, 5 males, 7 females; Brooks Co., July 25, 1928, R. H. Beamer, 1 female; Bee Co., July 25, 1928, R. H. Beamer, 3 females; Hidalgo

Co., July 28, 1928, J. G. Shaw, 3 females; Hidalgo Co., Aug. 3, 1928, J. G. Shaw, 1 male; Hidalgo Co., July 30, 1929, R. H. Beamer, 1 male, 6 females; Hidalgo Co., Nov. 22, 1932, L. D. Tuthill, 1 male; Starr Co., July 30, 1928, J. G. Shaw, 8 males, 15 females; Starr Co., July 5, 1938, R. I. Sailer, 13 males, 10 females; Cameron Co., Aug. 3, 1928, J. G. Shaw, 2 females; Cameron Co., Aug. 13, 1928, A. M. James, 3 males, 3 females; Brazoria Co., Aug. 12, 1928, L. D. Beamer, 25 males, 16 females; Brown Co., Aug. 16, 1928, L. D. Beamer, 5 males, 9 females; Leon Co., July 12, 1931, Delevan, 1 male (U. of Mich.); Falfurrias, Nov. 2, 1932, L. D. Tuthill, 34 males, 17 females; Falfurrias, Jan. 1, 1946, L. D. Beamer, 11 males, 10 females; Beasley, Nov. 7, 1932, L. D. Tuthill, 1 male, 4 females; Sinton, Nov. 8, 1932, L. D. Tuthill, 5 males, 5 females; McAllen, Nov. 20, 1932, L. D. Tuthill, 6 males, 7 females; Del Rio, 1937, H. D. Thomas, 2 males, 10 females; Peeler, June 22, 1938, D. W. Craik, 1 female; Progress, July 1, 1938, R. I. Sailer, 1 male; Marathon, July 9, 1938, R. I. Sailer, 1 male, 1 female.

Louisiana: Winn Co., July 14, 1918, G. R. Pilate, 8 males, 6 females, 6 nymphs (U. of Mich.); St. Tammany Co., Feb. 25, 1923, T. H. Hubbell, 1 female (U. of Mich.); Creole, June 18, 1948, E. L. Todd, 1 male, 2 females.

Mississippi: Vicksburg, July 19, 1921, C. J. Drake, 1 male, 1 female; Woodville, July 26, 1921, C. J. Drake, 1 male, 1 female.

Alabama: Crawford, July 24, 1930, Paul W. Oman, 2 males, 3 females.

Georgia: Baker Co., Feb. 12, 1928, C. H. Martin, 8 males, 8 females; Baker Co., Dec. 23, 1946, L. W. Morgan, 41 males, 39 females; Okefenokee Swp., July 30, 1934, P. M. McKinstry, 1 male, 18 females; Okefenokee Swp., Aug. 3, 1934, M. E. Griffith, 49 males, 52 females; Okefenokee Swp., Aug. 3, 1934, R. H. Beamer, Jr., 3 males, 10 females; Okefenokee Swp., Aug. 3, 1934, R. H. Beamer, 22 males, 20 females; Okefenokee Swp., July 25-27, 1939, R. H. and J. D. Beamer, 6 males, 20 females; Newton, Mar. 19, 1947, R. H. Beamer, 5 males, 12 females.

Florida: Cocoanut Grove, Aug. 9, 1930, R. H. Beamer and P. W. Oman, 35 males, 30 females; Ft. Meade, Aug. 13, 1930, R. H. Beamer, 8 males, 14 females; Wakulla Sprs. July 14, 1934, R. H. Beamer, 3 males, 7 females; Hilliard, July 28, 1934, R. H. Beamer, 1 male; Sanford, Aug. 8, 1939, J. D. Beamer, 2 males, 3 females; L. Matecumba Key, Mar. 14, 1947, R. H. Beamer, 8 males, 6 females.

MEXICO: *Tamaulipas:* San José, Apr. 1910, 6 males, 2 females; Victoria, Nov. 5, 1936, H. D. Thomas, 2 males, 15 females.

Mexico: Mexico, July 11, 1938, L. J. Lipovsky, 2 males, 1 female.

WEST INDIES: *Cuba:* Havana, Jan. 25, 1932, P. J. Bermudez, 2 females.

Jamaica: Baron Hill Trelawny, Feb,, 1928, L. G. Perkins, 5 males, 20 females; Baron Hill Trelawny, Dec. 24, 1928, L. G. Perkins, 1 female; Claremont, Baron Hill Trelawny, Mar. 4, 1928, L. G. Perkins, 1 female.

Puerto Rico: Cabo Rojo, June 9, 1937, J. A. Ramos, 4 males, 2 females.

All specimens listed above are in the Francis Huntington Snow Entomological Collections, University of Kansas, Lawrence, Kansas, unless otherwise indicated.

Buenoa uhleri n. sp.

(Pl. CIII, fig. 31; pl. CVIII, fig. 53)

Size: This species varies considerably in size within the same population. Male, length 6.50 mm. to 7.67 mm., greatest body width 1.82 mm. to 2.27 mm.; female, length 6.95 mm. to 8.19 mm., greatest body width 1.88 mm. to 2.47 mm.

Color: General facies sordid white to gray. Head, pronotum, most of thoracic venter, and limbs sordid white to pale testaceous. Scutellum usually orange with an irregular area of black at base; metathoracic dorsum black with lateral areas yellowish white. Abdominal venter light brown to black except keel and portions of connexivum, yellowish white; abdominal dorsum varies from black to mostly yellowish white with small light brown to black areas. Some specimens entirely sordid white to pale testaceous except most of abdominal venter and portions of abdominal dorsum, light brown to black. This species variable in color.

Male Structural Characteristics: As viewed from above, outline of head rounded with anterior margin of vertex continuous with that of eyes, occasionally indented at lateral margins; greatest width of head approximately five and one half times the anterior width of vertex and distinctly less than humeral width of pronotum; synthlipsis half the anterior width of vertex; along median longitudinal axis, head is approximately one fourth the length of pronotum; notocephalon sulcate; tylus slightly inflated; labrum with basal width not quite twice its median length and apex bluntly rounded; rostral prong (pl. CVIII, fig. 53b) slightly longer than third rostral segment, with base originating at proximal end of third rostral segment, and with apex bluntly rounded. Pronotum long, with its median length more than two thirds its humeral width; disk with two elongate depressions toward the middle and a large subtriangular depression on each side, thus appearing distinctly tricarinate; lateral margins slightly divergent; posterior margin convex, medianly concave. Scutellum with median length distinctly less than that of pronotum. Fore femur (pl. CVIII, fig. 53a) neither wide nor greatly thickened at apex; oblong stridulatory area consisting of approximately nineteen to twenty-four sclerotized ridges. Fore tibia (pl. CVIII, fig. 53a) with stridulatory comb (pl. CVIII, fig. 53c) consisting of approximately thirty-five to thirty-eight teeth; apical teeth narrower and slightly taller than basal. Chaetotaxy of male front leg as shown on Plate CVIII. Male genital claspers normal. Spine from caudo-sinistral margin of seventh abdominal tergite normal, tapering gradually from broad base to acuminate apex.

Female Structural Characteristics: As viewed from above, outline of head rounded with anterior margin of vertex continuous with that of eyes, occasionally vertex slightly protuberant; greatest width of head approximately five times the anterior width of vertex and distinctly less than humeral width of pronotum; synthlipsis slightly less than half the anterior width of vertex; along median longitudinal axis, head is approximately one third the length of pronotum; notocephalon sulcate; tylus slightly inflated. Pronotum with its median length approximately three fifths its humeral width; disk usually with two shallow, elongate depressions toward the middle and a shallow, subtriangular depression on each side, thus appearing faintly tricarinate, occasionally with median carina only; lateral margins divergent; posterior margin convex, medianly truncate to slightly concave. Scutellum with median length less than that of pronotum. Female ovipositor (pl. CIII, fig. 31) of normal shape with teeth arranged in two longitudinal rows which merge proximally; one inner row of few, large teeth and one long, outer row of smaller teeth; approximately two small, lateral, toothlike setae near apex.

Comparative Notes: Superficially this species somewhat resembles *B. margaritacea* Torre-Bueno. Examination of the male, however, will show distinct differences. This species differs from *B. margaritacea* in having the fore femur wider and more robust, and in the form of the pronotum, rostral prong, femoral stridulatory area, and tibial comb. *Buenoa uhleri* is usually larger and more robust than *B. margaritacea.*

Nomenclatorial Notes: This species was first recognized as new by Mr. C. O. Bare who labeled a series as types and paratypes using the manuscript name *B. uhleri*. As such paratypes may have been widely distributed, it seems desirable to point out that the name was not validated by publication. However, to avoid confusion, the name suggested by C. O. Bare has been retained by this author.

Location of Types: Holotype male, allotype female, 27 male and 33 female paratypes, Michoacán, Mexico, Sept. 1-8, 1938, H. D. Thomas and L. J. Lipovsky, in the Francis Huntington Snow Entomological Collections, University of Kansas; other paratypes: 1 male and 1 female, Penón, Mexico, D. F., Oct. 27, 1898, P. R. Uhler Collection, in the U. S. National Museum.

Data on Distribution: Known only from the United States and Mexico. In addition to type series, specimens from the following localities have been examined:

U. S. A.: *California:* Lagoon, Lake Reade, Aug. 17, 1925, J. G. Needham, 1 male, 1 female.

Texas: Sanderson, Sept., 1937, H. D. Thomas, 18 males, 18 females.

MEXICO: *Durango:* Durango City, May 30, 1937, Meldon Embury, 1 female.

Tamaulipas: Ciudad Victoria, Nov. 5, 1936, H. D. Thomas, 1 female.

Zacatecas: Los Potosí, Aug. 8, 1944, Henry Thomas, 9 males, 53 females.

San Luis Potosí: Cerritos, June 2, 1930, Creaser-Gordon, 1 male, 3 females (U. of Mich.); San Luis Potosí, Aug. 7-8, 1944, H. D. Thomas, 7 males, 6 females.

Aguascalientes: 5 mi. S. Aguascalientes, July 16, 1934, Smith and Dunkle, 2 males, 4 females; Aguascalientes, Aug. 9, 1944, Henry Thomas, 2 males, 30 females.

Jalisco: Jalisco, Sept. 14, 1938, H. D. Thomas, 11 males, 11 females, Tecolotán, Sept. 5-17, 1938, H. D. Thomas, 2 males, 6 females.

Guanajuato: 10 mi. N. E. León, Aug. 17, 1932, Hobart Smith, 1 male, 32 females.

Veracruz: Bilimek, 1883, 13 females (Berlin Mus.).

Hidalgo: Agua Fría, Aug. 27, 1944, Henry Thomas, 14 males, 16 females; Real del Monte, Sept. 23, 1938, H. D. Thomas, 2 males.

Michoacán: Pátzcuaro, Aug. 31, 1938, H. D. Thomas, 3 males, 4 females; Zacapú, Sept. 1, 1938, H. D. Thomas and L. J. Lipovsky, 1 male, 45 females; Morelia, Sept. 3-4, 1938, H. D. Thomas, 27 males, 57 females; 10 mi. down Chinapa road, Sept. 5, 1938, H. D. Thomas, 1 male, 6 females; Carapán, Sept. 2-8, 1938, H. D. Thomas, 4 males, 80 females; L. Cuitzeo, July 7, 1947, T. H. Hubbell, 8 males, 9 females.

Federal District: Mexico, Apr. 22-25, 1910, Bueno Collection, 3 males; Lago de Chapultepec, 1933, L. Ancona H., 1 male, 2 females; Xochimilco, June 21, 1934, H. Hinton, 5 females; Lake Texcoco, July 26, 1937, 5 females; Mexico, Sept. 17, 1938, 1 male, 1 female; Mexico, A. Dampf, 1 male, 1 female.

Puebla: Río Frió, July 26, 1932, Hobart Smith, 1 female; Tehuacán, July 18-25, 1937, H. D. Thomas, 2 males, 4 females; Tehuacán, Aug. 5-15, 1937, H. D. Thomas, 1 male, 2 females; Cacaloapan, July 22, 1937, H. D. Thomas, 14 males, 40 females; Puebla, July 25, 1937, H. D. Thomas, 3 males, 2 females; Puebla, Aug. 16, 1937, H. D. Thomas, 2 males, 7 females.

Guerrero: Petaquillas, Oct. 21, 1936, H. D. Thomas, 1 male, 3 females; Salto de Valadez, Oct. 30, 1936, H. D. Thomas, 10 males, 10 females.

Oaxaca: Posita, Aug. 24, 1937, H. D. Thomas, 4 females.

Chiapas: Hda. La Libertad, Sept. 1, 1937, H. D. Thomas, 1 male, 3 females; Tuxtla Gutiérrez, Aug. 27, 1939, H. D. Thomas, 1 male, 1 female; San Vicente, Jan. 4, 1938, Octavio Utrilla L., 1 male, 3 females.

All specimens listed above are in the Francis Huntington Snow Entomological Collections, University of Kansas, Lawrence, Kansas, unless otherwise indicated.

Buenoa albida (Champion)

(Pl. CIX, fig. 54)

1901. *Anisops albidus* Champion, G. C. Biologia Centrali Americana, Heteroptera, vol. II, pp. 371 and 373, pl. 22, fig. 14.
1904. *Buenoa albida*, Kirkaldy, G. W. Wiener Ent. Zeit., vol. XXIII, pp. 121 and 134 (listed and states "wahrscheinlich mit *A. platycnemis* identisch")
1909. *Buenoa albida*, Kirkaldy, G. W. and Torre-Bueno, J. R. de la. Proc. Ent. Soc. Washington, vol. X, p. 200 (catalogue).
1909. *Buenoa albida*, Torre-Bueno, J. R. de la. Jr. New York Ent. Soc., vol. XVII, p. 75 (listed).
1916. *Buenoa albida*, Van Duzee, E. P. New York Ent. Soc., p. 51 (check list).
1917. *Buenoa albida*, Van Duzee, E. P. Cat. Hemiptera America North of Mexico, p. 454 (catalogue).
1919. *Buenoa albida*, Hungerford, H. B. Univ. Kansas Sci. Bull., vol. XI, pp. 174-175 (key and description).
1923. *Buenoa albida*, Torre-Bueno, J. R. de la. Univ. of Iowa Studies in Nat. Hist., 10:3, p. 35.
1935. *Buenoa albida*, Bare, C. O. Ent. News, vol. XXXVI, No. 8, p. 228 (key).
1939. *Buenoa albida*, Millspaugh, D. D. Field and Laboratory, vol. VII, No. 2, p. 78.

Size: Male, length 5.85 mm. to 6.04 mm., greatest body width

1.69 mm. to 1.75 mm.; female, length 5.85 mm. to 6.50 mm., greatest body width 1.62 mm. to 1.82 mm.

Color: General facies sordid white. Head, thoracic venter, and limbs pale testaceous. Scutellum usually rufo-testaceous. Abdominal venter black with keel and connexivum pale testaceous; abdominal dorsum testaceous with transverse black bands or completely black with last two segments pale testaceous. Some specimens entirely sordid white.

Male Structural Characteristics: As viewed from above, outline of head rounded with vertex slightly indented; greatest width of head more than six times the anterior width of vertex and less than humeral width of pronotum; synthlipsis approximately half the anterior width of vertex; along median longitudinal axis, head is approximately half the length of pronotum; tylus slightly inflated, with wide median depression forming two short, lateral carinae; labrum short, basal width twice its median length with apex bluntly rounded; rostral prong (pl. CIX, fig. 54b) longer than third rostral segment, with base originating laterally at distal end of third rostral segment, and with apex sharply rounded. Pronotum with its median length slightly less than two thirds its humeral width; disk with two elongate depressions toward the middle and a large subtriangular depression on each side, thus appearing tricarinate; lateral margins divergent; posterior margin convex, medianly concave. Scutellum large, with median length slightly greater than that of pronotum. Fore femur (pl. CIX, fig. 54a) neither wide nor greatly thickened at apex; oblong stridulatory area consisting of approximately thirty-five to forty sclerotized ridges. Fore tibia (pl. CIX, fig. 54a) with stridulatory comb (pl. CIX, fig. 54c) consisting of approximately thirty-four to thirty-six teeth which increase slightly in height and thickness from base to apex. Chaetotaxy of male front leg as shown on Plate CIX. Male genital claspers normal. Spine from caudo-sinistral margin of seventh abdominal tergite normal, tapering gradually from broad base to acuminate apex.

Female Structural Characteristics: As viewed from above, outline of head rounded; greatest width of head approximately five times the anterior width of vertex and less than humeral width of pronotum; synthlipsis less than half the anterior width of vertex; along median longitudinal axis, head is less than half the length of pronotum; tylus very slightly inflated and without median longitudinal depression. Pronotum with its median length less than two thirds its humeral width; disk only slightly impressed and occasionally not at all; lateral margins divergent; posterior margin convex, medianly concave. Scutellum large with median length greater than that of pronotum. Female ovipositor of normal shape with teeth arranged in two longitudinal rows; one inner row of larger teeth and one long outer row of smaller teeth; approximately four very small, lateral, toothlike setae near apex.

Comparative Notes: Superficially this species closely resembles *B. scimitra* Bare. Examination of the male, however, will show distinct differences. This species differs from *B. scimitra* in the shape of the rostral prong, in having the tylus medianly depressed, and in the shape of the stridulatory area on the fore femur.

Location of Types: The original type series is located at the British Museum, London. Holotype male now on slides. Homotype male, compared with type by Dr. W. E. China of the British Museum, labeled "Mata Capestra, Ver., Mex., 10/1926, M. F. 1077, received from Dr. Dampf 1932," now in the Francis Huntington Snow Entomological Collections, University of Kansas.

Data on Distribution: Recorded from the United States, Mexico, and Puerto Rico. Specimens from the following localities have been examined:

MEXICO: *Sonora:* Salitial Río Mayo, Feb. 23, 1935, H. S. Gentry, 1 male.

Sinaloa: Mazatlán, May, 1934, H. Hinton, 5 males, 8 females, 2 nymphs.

Veracruz: Mata Capestra, Oct., 1926, 1 male, 1 female.

Hidalgo: Agua Fría, Aug. 27, 1944, H. D. Thomas, 1 male.

Morelos: Cuernavaca, Oct. 5, 1936, H. D. Thomas, 1 male.

Guerrero: Salto de Valadez, Oct. 30, 1936, H. D. Thomas, 1 male, 1 female.

PUERTO RICO: Cabo Rojo, June 9, 1937, J. A. Ramos, 3 males, 2 females; Isabela, May 12, 1935, Julio Garcia Diaz, 17 males, 6 females; Río Piedras exp. sta., May 23, 1935, Julio Garcia Diaz, 5 nymphs; Cartagena Lagoon, Aug. 10, 1935, Julio Garcia Diaz, 1 male, 6 females.

All specimens listed above are in the Francis Huntington Snow Entomological Collections, University of Kansas, Lawrence, Kansas.

Buenoa pallens (Champion)

(Pl. CII, figs. 5, 11; pl. CIX, fig. 55)

1901. *Anisops pallens* Champion, G. C. Biologia Centrali Americana, Heteroptera, vol. II, p. 374.

1904. *Buenoa pallens*, Kirkaldy, G. W. Wiener Ent. Zeit., vol. XXIII, pp. 121 and 134 (listed).

1909. *Buenoa pallens,* Kirkaldy, G. W. and Torre-Bueno, J. R. de la. Proc. Ent. Soc. Washington, vol. X, p. 201 (catalogue).
1940. *Buenoa pallens,* Hungerford, H. B. Ent. Monthly Mag., vol. LXXVI, p. 256 (listed and ecological note).

Size: This species varies considerably in size. Male, length 5.52 mm. to 6.89 mm., greatest body width 1.49 mm. to 1.56 mm.; female, length 5.98 mm. to 7.15 mm., greatest body width 1.75 mm. to 2.01 mm.

Color: General facies pale testaceous to nigro-violaceous. In pale specimens, head, thorax, and limbs sordid white to testaceous with abdomen black except ventral keel, portions of connexivum, and last one or two segments, testaceous. In dark specimens, head, anterior portion of pronotum, most of thoracic venter, and limbs sordid white to testaceous. Posterior portion of pronotum black; scutellum usually entirely black, occasionally with apex testaceous; metathoracic dorsum black. Abdomen black except ventral keel, portions of connexivum and occasionally last one or two segments, testaceous. This species variable in color.

Male Structural Characteristics: As viewed from above, outline of head laterally rounded, anteriorly truncate with vertex indented; greatest width of head approximately six times the anterior width of vertex and less than humeral width of pronotum; synthlipsis two fifths to three fifths the anterior width of vertex; along median longitudinal axis, head is two fifths to three fifths the length of pronotum; notocephalon sulcate dorsally at least; tylus slightly inflated; labrum with basal width not quite twice its median length and apex bluntly rounded; rostral prong (pl. CIX, figs. 55b, 55c) slightly variable, longer than third rostral segment, with base originating laterally midway of third rostral segment, and with apex moderately rounded. Pronotum with its median length approximately half its humeral width; disk usually unimpressed, occasionally with a shallow, subtriangular depression on each side, very seldom appearing tricarinate; lateral margins divergent; posterior margin convex, medianly concave. Scutellum large, with median length distinctly greater than that of pronotum. Fore femur (pl. CIX, fig. 55a) neither wide nor thickened at apex; triangular to subtriangular stridulatory area consisting of approximately sixteen to twenty-two sclerotized ridges. Fore tibia (pl. CIX, fig. 55a) with stridulatory comb (pl. CIX, figs. 55e, 55f) consisting of approximately twenty-four to thirty-eight teeth; apical teeth thicker than basal. Chaetotaxy of male front leg as shown on Plate CIX. Male genital claspers normal. Spine from caudio-sinistral margin of seventh abdominal tergite (pl. CII, figs. 5, 11) small, tapering gradually from base to strongly acuminate apex.

Female Structural Characteristics: As viewed from above, outline of head laterally rounded, anteriorly truncate with vertex indented; greatest width of head approximately five and one half times the anterior width of vertex and less than humeral width of pronotum; synthlipsis approximately half the anterior width of vertex; along median longitudinal axis, head is one third to one half the length of pronotum; notocephalon sulcate dorsally; tylus not inflated. Pronotum with its median length approximately half its humeral width; disk unimpressed or occasionally with feeble median carina; lateral margins divergent; posterior margin convex, slightly concave medianly. Scutellum large, with median length distinctly greater than that of pronotum. Female ovipositor of normal shape with teeth arranged in two longitudinal rows; one inner row of few, large teeth and one outer row of smaller teeth; approximately three or four small and obscure, lateral, toothlike setae near apex.

Variation Within Species: As is indicated under measurements of length, this species varies a great deal in size, there is also some variation in the proportional size of the pronotum and head, and in the rostral prong and femoral stridulatory area. The greatest contrast is shown between a series from Costa Rica and one from Ecuador. The former is a small form, the males seldom more than 5.70 mm. in length; the males of the latter form are approximately 6.80 mm. in length. It is the opinion of this author that these forms all belong to one variable species.

Comparative Notes: Superficially the dark form of this species closely resembles *B. pallipes* (Fabricius) and *B. mutabilis* n. sp. Examination of the male, however, will show distinct differences. This species differs from *B. pallipes* in having the fore femur narrow and not thickened at apex, rostral prong shorter and originating laterally midway of the third rostral segment, and pronotum shorter and not distinctly tricarinate. *Buenoa pallens* differs from *B. mutabilis* in having the notocephalon distinctly wider, and fore femur narrower and less thickened at apex. *B. mutabilis* is a smaller species.

Location of Types: The original type series from Guatemala, is located in the British Museum, London.

Data on Distribution: Recorded from Mexico, Guatemala, Costa Rica, West Indies (Islands of St. Thomas, St. Croix, Guadeloupe, Dominica, Grenada, and Trinidad), Colombia, Ecuador, Brazil, Peru, and Chile. Specimens from the following localities have been examined:

MEXICO: *Colima:* Colima, 1 female.

Morelos: Cuernavaca, Oct. 5-17, 1936, H. D. Thomas, 40 males, 126 females.

Oaxaca: Posita, Aug. 24, 1937, H. D. Thomas, 5 males, 6 females; Oaxaca, Aug. 25, 1937, H. D. Thomas, 11 males, 30 females.

Chiapas: Mt. Obando, Apr. 15, 1940, H. M. Smith, 2 males, 3 females.

Yucatan: Motul, July 26, 1932, E. R. Creaser, 1 female, (U. of Mich.); Yunca, July 29, 1932, E. P. Creaser, 1 male, 1 female, (U. of Mich.).

GUATEMALA: Petén, San Andrés Lake, Dec. 10, 1925, Dampf, 1 male; El Salto Escuintla, 1934, F. X. Williams, 3 males, 3 females.

COSTA RICA: San José, Purchased June, 1931, Heinrich Schmidt, 4 males, 20 females; San José, June and July, 1931, Heinrich Schmidt, 6 males, 12 females; San José, Purchased 1932, Heinrich Schmidt, 6 males, 4 females; Río Virilla, Dec. 26, 1931, Heinrich Schmidt, 25 males, 14 females.

PANAMA: Tabernilla, June 20, 1907, Aug. Busck (U.S.N.M.), 1 female; Panama, Jan. 31, 1911, 1 male (U.S.N.M.); La Chorrera, May 15, 1912, Aug. Busck, 1 female (U.S.N.M.); Sona, May, 1914, J. Zetek, 1 female.

WEST INDIES: *St. Thomas:* March 11, 1925, F5029, 2 females (A.M.N.H.).

St. Croix: Christiansted, June, 1941, H. A. Beatty, 3 males, 12 females; 1941, H. A. Beatty, 4 males, 3 females (U.S.N.M.).

Guadeloupe: A Kirkaldy remnant, 1 female.

Dominica: Laudet, June 13, 1911, 7 males, 2 females (A.M.N.H.).

Grenada: Mount Gay Est., H. H. Smith, 3 males (U.S.N.M.).

Trinidad: January, Aug. Busck, 1 male (U.S.N.M.).

COLOMBIA: Cali, 3 males, 2 females (U.S.N.M.).

ECUADOR: Baños, March, 1936, Clarke McIntyre, 1 male, 3 females; Baños, Runtun Lake, June, 1936, Clarke McIntyre, 3 males, 12 females.

BRAZIL: *Amazonas:* Ireng R. to Roraima, Aug. 13, 1911, 1 male (A.M.N.H.).

Minas Geraes: 1897, Fruhstorfer, 1 male (Berlin Mus.).

PERU: Dept. Cajamarca, May 26 to June 17, 1936, F. Woytkowski, 117 males, 127 females; Dept. Amazones, San Ildefonso, July 29, 1936, F. Woytkowski, 12 males, 11 females; Dept. Amazonas, Vic. Chachapoyas, Aug. 4-10, 1936, F. Woytkowski, 44 males, 46 females.

CHILE: Magdalena I., May 19, 1925, H. H. Keifer, 3 males, 1 female (Cal. Acad. Sci.).

All specimens listed above are in the Francis Huntington Snow Entomological Collections, University of Kansas, Lawrence, Kansas, unless otherwise indicated.

Buenoa pallipes (Fabricius)

(Pl. CIX, fig. 56)

1803. *Notonecta pallipes* Fabricius, J. C. Systema Rhyngotorum, p. 103.
1868. *Anisops pallipes*, Stal, C. Kongliga Svenska Vetenskaps-Akademien Handlingar, vol. VII, p. 137 (description).
1901. *Anisops pallipes*, Champion, G. C. Biologia Centrali Americana, Heteroptera, vol. II, pp. 371-372 (description and gives *B. platycnemis* as synonym of *A. pallipes*).
1904. *Buenoa pallipes*, Kirkaldy, G. W. Wiener Ent. Zeit., vol. XXIII, pp. 123 and 134 (listed).
1909. *Buenoa pallipes*, Kirkaldy, G. W. and Torre-Bueno, J. R. de la. Proc. Ent. Soc. Washington, vol. X, p. 201 (catalogue).
1909. *Buenoa pallipes*, Torre-Bueno, J. R. de la. Jr. New York Ent. Soc., vol. XVII, p. 75 (listed).
1913. *Buenoa pallipes*, Perkins, R. C. L. Fauna Hawaiiensis, vol. I, p. cciii (ecology and distributional note).
1913. *Buenoa pallipes*, Kirkaldy, G. W. Fauna Hawaiiensis, vol. II, p. 555 (listed).
1939. *Buenoa pallipes*, Barber, H. G. New York Acad. Sci., vol. XIV, p. 421.
1939. *Buenoa pallipes*, Hungerford, H. B. Ann. Ent. Soc. America, vol. XXXII, p. 588 (recorded from Costa Rica).
1944. *Buenoa pallipes*, Williams, F. X. Proc. Hawaiien Ent. Soc., vol. XII, pp. 193-194 (biology note).
1948. *Buenoa pallipes*, Zimmerman, E. C. Insects of Hawaii, vol. III, pp. 232-233 (biology note).

Size: Male, length 5.52 mm. to 6.22 mm., greatest body width 1.56 mm. to 1.95 mm.; female, length 5.62 mm. to 6.50 mm., greatest body width 1.69 mm. to 1.95 mm.

Color: General facies sordid white to black. Head, pronotum, thoracic venter, and limbs sordid white to testaceous; pronotum occasionally black with anterior portion testaceous and carinae rufescent. Scutellum usually black or fuscous, with apex more or less testaceous; metathoracic dorsum testaceous to black. Abdomen usually black except ventral keel, portions of connexivum, and terminal segment, testaceous. Pale specimens entirely sordid white to testaceous except abdominal venter, black. This species variable in color.

Male Structural Characteristics: As viewed from above, outline of head laterally rounded, anteriorly truncate with vertex slightly indented, strongly indented just above tylus; greatest width of head six to six and one half times the anterior width of vertex and less than humeral width of pronotum; synthlipsis quite narrow but approximately half the anterior width of vertex; along median longitudinal axis, head is slightly less than one third the length of pronotum; notocephalon sulcate dorsally; tylus inflated; labrum with basal width distinctly greater than its median length and apex bluntly rounded; rostral prong (pl. CIX, fig. 56b) distinctly longer than third rostral segment, with base originating laterally near distal end of third rostral segment, and with apex moderately rounded. Pronotum with its median length approximately two-thirds its humeral width; disk with two elongate depressions toward the middle and a large, subtriangular depression on each side, thus appearing distinctly tricarinate; lateral margins slightly divergent; posterior margin convex, medianly concave. Scutellum with median length distinctly less than that of pronotum. Fore femur (pl. CIX, fig. 56a) wide and somewhat thickened at apex; oblong to subtriangular stridulatory area consisting of approximately seventeen sclerotized ridges. Fore tibia (pl. CIX, fig. 56a) with narrow stridulatory comb (pl. CIX, fig. 56c) consisting of approximately thirty-four teeth, apical teeth thicker than basal. Chaetotaxy of male front leg as shown on Plate CIX. Male genital claspers normal. Spine from caudo-sinistral margin of seventh abdominal tergite tapering gradually from base to strongly acuminate apex.

Female Structural Characterisitics: As viewed from above, outline of head laterally rounded, anteriorly truncate with vertex slightly indented, strongly indented just above tylus; greatest width of head approximately six times the anterior width of vertex and less than humeral width of pronotum; synthlipsis approximately half the anterior width of vertex; along median longitudinal axis, head is one fourth to one third the length of pronotum; notocephalon slighty sulcate; tylus usually not inflated. Pronotum with its median length approximately half its humeral width; disk usually unimpressed, occasionally with a faint median carina; lateral margins divergent; posterior margin convex, medianly concave. Scutellum large, with median length distinctly greater than that of pronotum. Female ovipositor of normal shape with teeth arranged in two irregular, longitudinal rows intermingling medianly; one inner row of large teeth and one outer row of smaller teeth; approximately six or seven small, lateral, toothlike setae near apex.

Variation Within Species: As is indicated under measurements of length, this species varies somewhat in size; there is also some variation in the proportional size of the pronotum.

Comparative Notes: Superficially this species closely resembles

B. platycnemis (Fieber) and *B. pallens* (Champion). Examination of the male, however, will show distinct differences. This species differs from *B. pallens* in having the fore femur wide and thickened at apex, and the pronotum distinctly longer and tricarinate. *Buenoa pallipes* differs from *B. platycnemis* in having the pronotum longer with posterior margin more concave medianly, the frons narrower, and slight differences in the fore femur and rostral prong. *Buenoa platycnemis* is less robust.

Location of Types: The type is located at the Museum of Lund, Sweden.

Data on Distribution: Recorded from Hawaii (fide Zimmerman and Perkins), Mexico, Honduras, Costa Rica, Panama, West Indies (Jamaica, Puerto Rico, St. Thomas, Guadeloupe, St. Vincent), Colombia, Peru, and Paraguay. Specimens from the following localities have been examined:

MEXICO: *Oaxaca:* Papaloápan, Mar. 4, 1939, M. & E. Gordon, 1 male, 2 females (U. of Mich.).

Chiapas: San Vicente, Jan. 4, 1938, Octavio Utrilla L., 1 male, 2 females.

HONDURAS: Tela, Apr. 1, 1923, T. H. Hubbell, 4 males, 1 female (U. of Mich.); Tela, March 1-15, 1936, John Deal, 76 males, 93 females.

COSTA RICA: San Isidro del Gen., Feb., 1939, Dean L. Rounds, 1 male, 1 female.

WEST INDIES: *Jamaica:* Montego Bay, Mar. 11, 1911, 1 male (A. M. N. H.); Lumsden Tydenham, St. Ann, Feb., 1928, L. G. Perkins, 3 males, 7 females; Baron Hill Trelawny, Feb., 1928, L. G. Perkins, 2 males, 2 females; Claremont, Feb., 1928, L. G. Perkins, 1 male, 1 female; Bath St. Thomas, Mar. 29, 1937, Chester Roys, 8 males, 19 females; St. Andrew, Dec. 3, 1946, G. B. Thompson, 3 males, 2 females; St. Andrew, Apr. 15-16, 1947, G. B. Thompson, 1 male, 1 female, 1 nymph.

Puerto Rico: Coamo Springs, July 17-19, 1914, 3 males (A. M. N. H.).

St. Thomas: Sulphur River, Apr. 3, 1937, Chester Roys, 15 males, 40 females.

Guadeloupe: St. Anne, Louis Mesmin, 1 male, 1 female.

COLOMBIA: Cali, 1 male, 1 female (U. S. N. M.).

PERU: Dept. Amazonas, Vic. Guayabamba, Aug. 14-19, 1936, F. Woytkowski, 67 males, 70 females.

PARAGUAY: Villarrica, Dec. 6, 1923, Fran. Schade, 4 males; Villarrica, Oct. 9, 1924, Fran. Schade, 1 male; Villarrica, Dec. 16, 1924, Fran. Schade, 19 males; Villarrica, Nov. 20, 1929, Fran. Schade, 1 male, 1 female; Caraveni, June 15, 1924, Fran. Schade, 2 females; Estero Grande, Nov. 1, 1924, Fran. Schade, 3 males; Melinesque, Dept. Caruga, Dec., 1925, Fran. Schade, 3 males; Melinesque, June 28, 1935, Fran. Schade, 3 males, 2 females.

All specimens listed above are in the Francis Huntington Snow Entomological Collections, University of Kansas, Lawrence, Kansas, unless otherwise indicated.

Buenoa platycnemis (Fieber)

(Pl. X, fig. 57)

1851. *Anisops platycnemis* Fieber, F. X. Abhandlungen Köngl. Böhmischen Gesellschaft Wissenschaften, vol. VII, Series 5, p. 485.
1899. *Anisops platycnemis*, Kirkaldy, G. W. The Entomologist, vol. XXXII, p. 30.
1901. *Anisops platycnemis*, Champion, G. C. Biologia Centrali Americana, Heteroptera, vol. II, pp. 371-372 (gives *A. platycnemis* as synonym of *B. pallipes*).
1904. *Buenoa platycnemis*, Kirkaldy, G. W. Wiener Ent. Zeit., vol. XXIII, p. 134 (listed and description of *B. margaritacea* under name *B. platycnemis*).
1905. ? *Buenoa platycnemis*, Snow, F. H. Trans. Kansas Acad. Sci., vol. XX, p. 153 (recorded from Texas).
1908. *Buenoa platycnemis*, Torre-Bueno, J. R. de la. Jr. New York Ent. Soc., vol. XVI, p. 238 (listed).
1909. *Buenoa platycnemis*, Torre-Bueno, J. R. de la. Jr. New York Ent. Soc., vol. XVII, pp. 75-77 (key, notes, and synonomy).
1914. *Buenoa platycnemis*, Van Duzee, E. P. Trans. San Diego Soc. Nat. Hist., vol. II, p. 33 (listed).
1916. *Buenoa platycnemis*, Van Duzee, E. P. New York Ent. Soc., p. 51 (check list).
1917. *Buenoa platycnemis*, Van Duzee, E. P. Cat. Hemiptera America North of Mexico, p. 455 (catalogue).
1917. *Buenoa platycnemis*, Hungerford, H. B. Ent. News, vol. XXVIII, p. 176 (key).
1919. *Buenoa platycnemis*, Hungerford, H. B. Univ. Kansas Sci. Bull., vol. XI, pp. 174 and 176 (description, key, and notes).
1923. *Buenoa platycnemis*, Torre-Bueno, J. R. de la. Connecticut State Geol. and Nat. Hist. Survey Bull., No. 34, p. 407 (key and notes).
1923. *Buenoa platycnemis*, Hungerford, H. B. Ent. News, vol. XXXIV, p. 151 (note).
1924. *Buenoa platycnemis*, Hungerford, H. B. Ann. Ent. Soc. America, vol. XVII, p. 225 (note on mistaken identification).
1925. *Buenoa platycnemis*, Bare, C. O. Ent. News, vol. XXXVI, p. 228 (distributional note).
1925. *Buenoa platycnemis*, Hungerford, H. B. and Beamer, R. H. Ent. News, vol. XXXVI, p. 297 (note).
1928. *Buenoa platycnemis*, Bare, C. O. Univ. Kansas Sci. Bull., vol. XVIII, p. 268 (note).
1928. ? *Buenoa platycnemis*, Torre-Bueno, J. R. de la. Cornell Univ. Agr. Experiment Station, Memoir 101, p. 139 (listed).
1939. ? *Buenoa platycnemis*, Millspaugh, D. D. Field and Laboratory, vol. VII, p. 78.

Size: This species varies considerably in size. Male, length 4.55 mm. to 5.35 mm., greatest body width 1.36 mm. to 1.62 mm.;

female, length 5.00 mm. to 5.43 mm., greatest body width 1.49 mm. to 1.75 mm.

Color: General facies sordid white to black. Head, pronotum, thoracic venter, and limbs sordid white to testaceous. Scutellum sordid white to testaceous with base brown to black; metanotum usually brown to black with portions testaceous. Abdominal dorsum usually brown to black with portions testaceous; abdominal venter black except keel, portions of connexivum, and last one or two segments, testaceous. Pale specimens entirely sordid white except most of abdomen, black. This species variable in color.

Male Structural Characteristics: As viewed from above, outline of head laterally rounded, anteriorly truncate with vertex usually slightly indented; greatest width of head five and one half to six times the anterior width of vertex and less than humeral width of pronotum; synthlipsis slightly less than half the anterior width of vertex; along median longitudinal axis, head is approximately two fifths the length of pronotum; notocephalon slightly sulcate; tylus slightly inflated; labrum with basal width not quite twice its median length and apex bluntly rounded; rostral prong (pl. CX, fig. 57b) long, much longer than third rostral segment, with base originating laterally and protruding anteriorly at distal end of third rostral segment, and with apex moderately rounded. Pronotum with its median length approximately two thirds its humeral width; disk with two elongate depressions toward the middle and a large subtriangular depression on each side, thus appearing tricarinate; lateral margins divergent; posterior margin convex, medianly truncate. Scutellum with median length less than that of pronotum. Fore femur (pl. CX, fig. 57a) wide and somewhat thickened at apex; oblong to subtriangular stridulatory area consisting of approximately eleven to fourteen sclerotized ridges. Fore tibia (pl. CX, fig. 57a) wide with stridulatory comb (pl. CX, fig. 57c) consisting of approximately thirty to thirty-five teeth; apical teeth thicker and narrower than basal. Chaetotaxy of male front leg as shown on Plate CX. Male genital claspers normal. Spine from caudo-sinistral margin of seventh abdominal tergite with apical one third very narrow and apex strongly acuminate.

Female Structural Characteristics: As viewed from above, outline of head laterally rounded, anteriorly truncate with vertex often indented at lateral margins; greatest width of head five to five and one half times the anterior width of vertex and less than humeral width of pronotum; synthlipsis slightly less than half the anterior width of vertex; along median longitudinal axis, head is one third to one half the length of pronotum; notocephalon sulcate; tylus slightly inflated. Pronotum with its median length approximately half its humeral width; disk unimpressed, occasionally with faint median carina; lateral margins divergent; posterior margin convex, usually medianly truncate. Scutellum large, with median length greater than that of pronotum. Female ovipositor of normal shape with teeth arranged in two longitudinal rows; one inner row of large teeth and one outer row of small teeth; approximately three small, lateral, toothlike setae near apex.

Variation Within Species: As is indicated under measurements of length, this species varies considerably in size; there is also some variation in the proportional size of head and pronotum.

Comparative Notes: Superficially this species closely resembles *B. pallipes* (Fabricius) and *B. nitida* n. sp. Examination of the male, however, will show distinct differences. This species differs from *B. pallipes* in having the pronotum shorter with posterior margin more truncate medianly, the frons wider, and slight differences in the fore femur and rostral prong. *Buenoa platycnemis* differs from *B. nitida* in having a tricarinate pronotum, more sclerotized ridges in the femoral stridulatory area, and in the form of the rostral prong, fore femur, and tibial comb. *Buenoa platycnemis* is smaller and less robust than the above mentioned species.

Nomenclatorial Notes: One finds in the literature and collections, many species masquerading under the name *Buenoa platycnemis.* This situation is primarily the result of misidentifications by several distinguished hemipterists. The confusion surrounding this species serves to illustrate the necessity for the worker to have access to type material.

Location of Types: The type, a male, labeled "Portorico St. Thomas Moritz", is located at the Berlin Museum.

Data on Distribution: Many United States records for this species have been erroneously cited in the literature. *Buenoa platycnemis* is, for the most part, a Neotropical species. From the study of a vast amount of material, this author finds that for the United States, only Texas and Florida are represented in its distribution. Recorded also from Mexico, Panama, Canal Zone, Costa Rica, West Indies (Cuba, Grand Cayman, Haiti, Jamaica, Mona, Puerto Rico, St. Thomas, St. Croix, and Martinique), Pearl Island, Darien, Colombia, Venezuela, Brazil, and Peru. Specimens from the following localities have been examined:

U. S. A.: *Texas:* McAllen, Nov. 20, 1932, L. D. Tuthill, 6 males, 4 females; Brownsville, June 29, 1938, R. I. Sailer, 1 male; Progress, July 1, 1938, R. I. Sailer, 7 males, 5 females; Star Co., July 5, 1938, R. I. Sailer, 3 males, 4 females; Falfurrias, Jan. 1, 1946, L. D. Beamer, 2 males, 2 females.

Florida: L. Matecumba Key, Mar. 14, 1947, R. H. Beamer and L. D. Beamer, 5 males, 6 females.

MEXICO: *Sonora:* Río Mayo, Arroyo de los Mescales, Feb. 16, 1935, H. S. Gentry, 8 males, 19 females.

Jalisco: Guadalajara, Sept. 13, 1938, H. D. Thomas, 1 female; 15 mi. down Autlán Rd., Sept. 14, 1938, H. D. Thomas, 2 males, 1 female; 15 mi. S. W. Lake Chapala, Sept. 14, 1938, H. D. Thomas, 1 male.

Veracruz: Carrizal, Aug. 6, 1932, A. Dampf, 1 female; Minatitlán, Sept. 22, 1936, H. D. Thomas, 7 females.

Michoacán: El Sabino Uruapan, July 30, 1936, H. D. Thomas, 19 males, 19 females; Zamora, Sept. 8, 1938, H. D. Thomas, 1 male; L. Cuitzeo, July 7, 1947, T. H. Hubbell, 2 males, 3 females.

Federal District: Xochimilco, June 21, 1934, H. Hinton, 1 male, 3 females; Mexico City, July 7, 1937, H. D. Thomas, 6 males, 16 females; Mexico City, 1937, H. D. Thomas, 6 males, 2 females.

Morelos: Cuernavaca, Oct. 5, 1936, H. D. Thomas, 4 males, 3 females.

Guerrero: Iguala, Oct. 7, 1936, H. D. Thomas, 8 males, 14 females; Palo Blanco, Oct. 10, 1936, H. D. Thomas, 1 male, 2 females; Tierra Colo., Oct. 31, 1936, H. D. Thomas, 4 males, 3 females; Río Agua, Oct. 31, 1936, H. D. Thomas, 1 male; Acapulco, Nov. 1, 1936, H. D. Thomas, 6 males, 19 females.

Chiapas: Huixtla, Nov. 9, 1932, A. Dampf, 1 female; Suchiate, Nov. 16-17, 1932, A. Dampf, 1 male, 3 females.

Campeche: Ciudad del Carmen, Sept. 18, 1936, H. D. Thomas, 6 males, 13 females; Hda. Encarnation, Oct. 15, 1936, H. D. Thomas, 6 males, 5 females.

Yucatan: Chichén-Itzá, June 6-27, 1932, E. P. Creaser, 1 male, 2 females, 2 nymphs (U. of Mich.); Chichén-Itzá, Aug. 29, 1936, H. D. Thomas, 2 males; Pisté, June 22, 1932, E. P. Creaser, 2 females (U. of Mich.); Mérida, Jalal Aguada, July 22, 1932, E. P. Creaser, 3 males, 5 females, 1 nymph (U. of Mich.); Mérida, July 28, 1932, E. P. Creaser, 10 males, 5 females, 2 nymphs (U. of Mich.).

PANAMA: Old Panama, Jan. 31, 1911, Aug. Busck, 3 females (U. S. N. M.); Soná, May, 1914, J. Zetek, 3 males, 7 females (U. S. N. M.); Cano Saddle, Gatún L., Aug. 6, 1923, R. C. Shannon, 1 male

(U. S. N. M.); Las Palmas, Dec. 21, 1944, A. W. Lindquist, 1 male, 2 females (U. S. N. M.); San Miguel, 1 male, 2 females (U. S. N. M.).

CANAL ZONE: Ft. Clayton, 1933, R. F. Edwards, 5 males, 2 females.

COSTA RICA: San Isidro del Gen., Feb., 1939, Dean L. Rounds, 4 males, 1 female.

WEST INDIES: *Cuba:* Soledad, Feb. 14, 1925, J. G. Myers, 2 males, 5 females; Habana Bot. Garden, Jan. 25, 1932, P. J. Bermudez, 6 males, 8 females; Habana, Casa Blanca, Dec. 20, 1933, P. J. Bermudez, 7 males, 11 females; Habana, 1933, P. J. Bermudez, 31 males, 14 females; Havana Prov., Catalina, Nov. 27, 1933, P. J. Bermudez, 1 female; Matanzas, Yumurí Valley, Dec. 9, 1933, P. J. Bermudez, 1 male; P. R. Uhler Collection, 1 male (U. S. N. M.).

Grand Cayman: Cow well near Pedro Castle, Oxford U. Bio. Exp., Aug. 4, 1938, Lewis and Thompson, 11 males, 11 females.

Haiti: Attelye, Oct. 22, 1925, W. A. Hoffman, 1 male, 1 female (U. S. N. M.); Jacmel, W. A. Hoffman, 2 females (U. S. N. M.).

Jamaica: Palm Beach, Montego Bay, March 11, 1911, 6 males, 2 females (A. M. N. H.); Montego Bay, Mar. 15, 1911, 2 males (A. M. N. H.).

Mona: Feb. 21-26, 1914, 1 male (A. M. N. H.).

Puerto Rico: Culebra, Feb., 1899, Aug. Busck, 2 males (U. S. N. M.); Coamo Springs, July 17-19, 1914, 2 males, 2 females (A. M. N. H.); Mayaguez, Oct. 16, 1930, J. Landrón, 1 male (U. S. N. M.); Luquillo, July 7-8, 1932, J. Blanch, 2 males, 1 female; Luquillo, July 9, 1932, J. Blanch, 1 male, 1 female (U. S. N. M.); Iuebrada, Feb. 21, 1935, J. G. Diaz, 1 male, 2 females; Florida Road, Feb. 28, 1935, J. G. Diaz, 5 males, 10 females; Almirante Rd., March 9, 1935, J. G. Diaz, 5 males, 8 females; Tortuguera L., Mar. 20, 1935, J. G. Diaz, 3 males, 8 females; Near Isabela, May 12, 1935, J. G. Diaz, 7 males, 2 females; Exp. Sta. Río Piedras, May 23, 1935, J. G. Diaz, 4 females; Cartagena Lagoon, Aug. 10, 1935, J. G. Diaz, 4 females; Luquillo Mts., Nov. 18, 1935, J. G. Diaz, 4 males, 8 females.

St. Thomas: Charlotte Amalie, June 2, 1917, H. Morrison, 2 males, 3 females (U. S. N. M.); St. Thomas, Mar. 11, 1925, 1 male (A. M. N. H.); St. Thomas, May 15, 1937, Chester Roys, 3 males, 3 females; St. Thomas, Feb., Aug. Busck, 1 female (U. S. N. M.); St. Thomas, Klug, 2 males (Leiden Mus.).

St. Croix: St. Croix, Apr. 4, 1925, F 5145C and F 5022, 1 male, 2 females (A. M. N. H.); St. Croix, 1941, H. A. Beatty, 2 females

(U. S. N. M.); St. Croix, No. 744, H. A. Beatty, 1 male, 2 females (U. S. N. M.).

Martinique: Fort de France, June 27, 1911, 1 female (A. M. N. H.).

COLOMBIA: Villavieja, 1944, R. A. Stirton, 22 males, 26 females; Darien, Laguna de Pita, D. Festa, 1 male (U. S. N. M.).

VENEZUELA: San Esteban, Nov. 22, 1939, Pablo J. Anduze, 4 males, 5 females.

BRAZIL: *Maranhão:* Chapada, No. 2966, 2 males, 2 females.

PERU: Vic. Guayabamba, Aug. 18, 1936, F. Woytkowski, 28 males, 23 females; Vic. Rioja, Dept. San Martín, Sept. 9 to Oct. 3, 1936, F. Woytkowski, 11 males, 11 females; Satipo, Nov., 1942, Pedro Paprzyki, 6 females.

All specimens listed above are in the Francis Huntington Snow Entomological Collections, University of Kansas, Lawrence, Kansas, unless otherwise indicated.

Buenoa omani n. sp.

(Pl. CIII, fig. 37; pl. CX, fig. 58)

Size: Male, length 5.72 mm. to 6.56 mm., greatest body width 1.62 mm. to 1.88 mm.; female, length 6.17 mm. to 6.69 mm., greatest body width 1.82 mm. to 2.08 mm.

Color: General facies sordid white to nigro-violaceous. Head, pronotum, most of thoracic venter, and limbs sordid white to pale testaceous. Scutellum black with apex and lateral margins yellow to orange; metathoracic dorsum, black. Abdomen black except ventral keel, and portions of connexivum and dorsum, sordid white to pale testaceous. Some specimens entirely sordid white except most of abdomen, black. This species variable in color.

Male Structural Characteristics: As viewed from above, outline of head laterally rounded, somewhat truncate anteriorly, with vertex slightly indented; greatest width of head seven and one half to eight times the anterior width of vertex and equal to or slightly less than humeral width of pronotum; synthlipsis approximately half the anterior width of vertex; along median longitudinal axis, head is one half to three fifths the length of pronotum; notocephalon narrow, sulcate dorsally; frons just above tylus, very narrow; tylus inflated; labrum with basal width approximately twice its median length and apex bluntly rounded; rostral prong (pl. CX, fig. 58b) slightly longer than third rostral segment, with base originating laterally at proximal end of third rostral segment, and with apex bluntly rounded. Pronotum with its median length one half to four sevenths its humeral width; disk unimpressed, occasionally with a faint median carina; lateral margins divergent; posterior margin convex, slightly concave medianly. Scutellum large, with median length greater than that of pronotum. Fore femur (pl. CX, fig. 58a) wide and thickened at apex; subtriangular stridulatory area consisting of four wide, sclerotized ridges. Fore tibia (pl. CX, fig. 58a) with stridulatory comb (pl. CX, fig. 58c) consisting of approximately sixteen teeth; apical teeth slightly thicker and usually taller than basal. Chaetotaxy of male front leg as shown on Plate CX. Male genital claspers normal. Spine from caudo-sinistral margin of seventh abdominal tergite with apical half very narrow and apex strongly acuminate.

Female Structural Characteristics: As viewed from above, outline of head rounded with vertex indented at lateral margins; greatest width of head approximately six and one half times the anterior width of vertex and less than humeral width of pronotum; synthlipsis half the anterior width of vertex; along median longitudinal axis, head is two fifths to three fifths the length of pronotum; notocephalon narrow, sulcate dorsally; frons just above tylus, narrow; tylus slightly inflated. Pronotum with its median length approximately half its humeral width; disk unimpressed; lateral margins divergent; posterior margin convex, medianly truncate to slightly concave. Scutellum large, with median length distinctly greater than that of pronotum. Female ovipositor (pl. CIII, fig. 37) of normal shape with teeth arranged in two irregular, longitudinal rows which merge in proximal third of ovipositor valve; one inner row of large teeth and one outer row of smaller teeth; approximately seven or eight small, lateral, toothlike setae near apex.

Comparative Notes: Superficially this species resembles *B. mutabilis* n. sp. and *B. alterna* n. sp. Examination of the male, however, will show distinct differences. This species differs from *B. mutabilis* in having a narrower frons, wider synthlipsis, and distinctly different femoral stridulatory area and tibial comb. *Buenoa omani* differs from *B. alterna* in having fore femur wider at apex, femoral stridulatory area present, and different rostral prong and tibial comb.

Nomenclatorial Notes: This species was first recognized as new by Mr. C. O. Bare who labeled a series as types and paratypes using the manuscript name *B. omani.* As such paratypes may have been widely distributed, it seems desirable to point out that the name was not validated by publication. However, to avoid confusion, the name suggested by Bare has been retained by this author.

Location of Types: Holotype male, allotype female, 2 male and 4 female paratypes, San Diego Co., California, July 4, 1929, L. D. Anderson; other paratypes: 1 male and 1 female, Santa Ana Co., California, July 30, 1932, J. D. Beamer; 1 male and 1 female, Alpine, California, July 9, 1929, Paul W. Oman; 1 male, Laguna Beach, California, July 25, 1933, R. H. Beamer; 1 male and 1 female, Durango, Mexico, May 30, 1937, Meldon Embury. The type series is in the Francis Huntington Snow Entomological Collections, University of Kansas.

Data on Distribution: Known only from United States and Mexico. In addition to type series, specimens from the following localities have been examined:

U. S. A.: *California:* Miramar, July 28, 1938, R. I. Sailer, 6 males, 5 females; Claremont, P. R. Uhler Collection, 3 males, 1 female (U.S.N.M.).

MEXICO: *Sonora:* Pocito, Ciudad Las Casas, Sept. 4, 1937, H. D. Thomas, 32 males, 25 females.

Tamaulipas: 5 m. N. of Ciudad Victoria, Nov. 5, 1936, H. D. Thomas, 2 males.

Jalisco: Guadalajara, 20 mi. on Tequilla Rd., Sept. 13, 1938, H. D. Thomas, 1 female.

Hidalgo: Real del Monte, Sept. 23, 1938, H. D. Thomas, 2 males; Aguas Fria, Aug. 27, 1944, H. D. Thomas, 1 male.

Michoacán: Patzcuaro, Aug. 31, 1938, H. D. Thomas, 2 males, 6 females; Patzcuaro, Sept. 2, 1938, H. D. Thomas, 2 males, 2 females; Carapa, Sept. 2, 1938, H. D. Thomas, 2 males, 1 female; L. Cuitzeo, July 7, 1947, T H. Hubbell, 2 males.

Federal District: Mexico, A. Dampf, 1 male, 1 female.

Morelos: Cuernavaca, May 21, 1898, P. R. Uhler Collection, 1 female (U.S.N.M.).

Puebla: Tehuacán, July 18-25, 1937, H. D. Thomas, 2 males, 1 female; Puebla, July 25, 1937, H. D. Thomas, 3 males, 11 females.

Oaxaca: Posita, Aug. 24, 1937, H. D. Thomas, 6 males, 8 females; Oaxaca, Aug. 25, 1937, H. D. Thomas, 1 male, 1 female.

Chiapas: San Cristóbal, Aug. 30, 1937, H. D. Thomas, 74 males, 43 females; San Cristóbal, Sept. 2, 1937, H. D. Thomas, 22 males, 13 females; San Vicente, Jan. 4, 1938, Octavio Utrilla L., 1 male.

All specimens listed above are in the Francis Huntington Snow Entomological Collections, University of Kansas, Lawrence, Kansas, unless otherwise indicated.

Buenoa macrotrichia n. sp.

(Pl. CX, fig. 59)

Size: Male, length 5.52 mm. to 5.85 mm., greatest body width 1.43 mm. to 1.62 mm.; female, length 5.59 mm. to 6.37 mm., greatest body width 1.49 mm. to 1.75 mm.

Color: General facies black. Head, anterolateral portions of pronotum, thoracic venter, and limbs sordid white to testaceous. Posterior portion of pronotum, scutellum, metathoracic dorsum, and abdomen black except ventral keel, portions of connexivum, and usually terminal segment, testaceous.

Male Structural Characteristics: As viewed from above, outline of head laterally rounded, anteriorly truncate with vertex indented; greatest width of head six and one half to seven times the anterior width of vertex and less than humeral width of pronotum; synthlipsis narrow, slightly less than half the anterior width of vertex; along median longitudinal axis, head is slightly less than half the length of pronotum; notocephalon narrow, sulcate dorsally; tylus slightly inflated; labrum with basal width not quite twice its median length and apex bluntly rounded; rostral prong (pl. CX, fig. 59b) long, distinctly longer than third rostral segment, with base originating laterally and protruding anteriorly at point midway to near distal end of third rostral segment, and with apex moderately rounded. Pronotum with its median length approximately four sevenths its humeral width; disk occasionally with two shallow, elongate depressions toward the middle forming a faint median carina, not tricarinate; lateral margins divergent; posterior margin convex, medianly concave. Scutellum large, with median length greater than that of pronotum. Fore femur (pl. CX, fig. 59a) wide and thickened at apex, with several large setae on inner posterior margin; triangular stridulatory area consisting of approximately seven to nine sclerotized ridges. Fore tibia (pl. CX, fig. 59a) with stridulatory comb (pl. CX, fig. 59c) consisting of approximately thirty-one to thirty-four teeth; apical teeth thicker than basal. Chaetotaxy of male front leg as shown on Plate CX. Male genital claspers normal. Spine from caudo-sinistral margin of seventh abdominal tergite with apical half very narrow and apex strongly acuminate.

Female Structural Characteristics: As viewed from above, outline of head rounded with vertex usually indented at lateral margins only; greatest width of head approximately five and one half times the anterior width of vertex and distinctly less than humeral width of pronotum; synthlipsis narrow, approximately two fifths the anterior width of vertex; along median longitudinal axis, head is slightly less than two fifths the length of pronotum; notocephalon narrow, slightly sulcate; tylus slightly inflated. Pronotum with its median length two fifths to one half its humeral width; disk unimpressed, occasionally with faint median carina; lateral margins divergent; posterior margin convex, medianly concave. Scutellum large, with median length distinctly greater than that of pronotum. Female ovipositor of normal shape with teeth arranged in two longitudinal rows; inner row of large teeth merges proximally with outer row of smaller teeth; approximately six or seven small, lateral, tooth-like setae near apex.

Comparative Notes: Superficially this species closely resembles *B. mutabilis* n. sp. and *B. nitida* n. sp. Examination of the male, however, will show distinct differences. This species differs from *B. mutabilis* in having the fore femur wider at apex, possessing several large setae on inner, posterior margin of fore femur, and in having fewer sclerotized ridges in femoral stridulatory area. *Buenoa macrotrichia* differs from *B. nitida* in having a narrower synthlipsis and notocephalon, a less robust pronotum, and in possessing the large setae on fore femur.

Location of Types: Holotype male, allotype female, 50 male and 50 female paratypes, Vicinity of San Pedro, Peru, May 15-29, 1935, F. Woytkowski. The type series is in the Francis Huntington Snow Entomological Collections, University of Kansas.

Data on Distribution: Known only from Peru. In addition to type series, specimens from the following localities have been examined.

PERU: Vic. Pampa Hermosa, May 1-5, 1935, F. Woytkowski, 21 males, 14 females; Vic. San Pedro, May 15-29, 1935, F. Woytkowski, 166 males, 215 females; Vic. Sani Beni, Oct. 24, 1935, F. Woytkowski, 1 female; Dept. Ayacucho, Prov. La Mar. Sivia, June 15-28, 1941, 33 males, 34 females.

All specimens listed above are in the Francis Huntington Snow Entomological Collections, University of Kansas, Lawrence, Kansas.

Buenoa nitida n. sp.

(Pl. CXI, fig. 60)

Size: Male, length 6.17 mm. to 6.82 mm., greatest body width 1.75 mm. to 1.82 mm.; female, length 6.50 mm. to 7.02 mm., greatest body width 1.95 mm. to 2.08 mm.

Color: General facies sordid white to black. Dark form with head, anterolateral portions of pronotum, most of thoracic venter, and limbs sordid white to testaceous. Posterior portion of pronotum, scutellum, metathoracic dorsum, and abdomen black, except ventral keel, portions of connexivum, and terminal segment, testaceous. Hemelytron colorless with a black band at base of membrane. Pale form usually entirely pale testaceous except most of abdomen, black. This species variable in color.

Male Structural Characteristics: As viewed from above, outline of head laterally rounded, anteriorly truncate with vertex indented; greatest width of head approximately six times the anterior width of vertex and slightly less than humeral width of pronotum; synthlipsis slightly less than half the anterior width of vertex; along median longitudinal axis, head is approximately three fifths the length of pronotum; notocephalon slightly sulcate; tylus usually not inflated; labrum with basal width not quite twice its median length and apex bluntly rounded; rostral prong (pl. CXI, fig. 60b) long, almost twice as long as third rostral segment, with base originating laterally and protruding anteriorly at point midway of third rostral segment, and with apex bluntly rounded. Pronotum wide and somewhat inflated, with its median length approximately three fifths its humeral width; disk with two shallow, elongate depressions toward the middle forming a faint median carina, not tricarinate; lateral margins in pale form only slightly divergent, more so in dark form; posterior margin convex, medianly truncate to slightly concave. Scutellum with median length less than that of pronotum in pale form, greater than that of pronotum in dark form. Fore femur (pl. CXI, fig. 60a) wide and thickened at apex; triangular stridulatory area consisting of six to nine wide, sclerotized ridges. Fore tibia (pl. CXI, fig. 60a) with stridulatory comb (pl. CXI, fig. 60c) consisting of approximately thirty-one to thirty-three teeth; apical teeth thicker than basal. Chaetotaxy of male front leg as shown on Plate CXI. Male genital claspers normal. Spine from caudo-sinistral margin of seventh abdominal tergite tapering gradually from base to strongly acuminate apex.

Female Structural Characteristics: As viewed from above, outline of head laterally rounded, anteriorly truncate with vertex indented at least at lateral margins; greatest width of head approximately six times the anterior width of vertex and less than humeral width of pronotum; synthlipsis half the anterior width of vertex; along median longitudinal axis, head is approximately half the length of pronotum; notocephalon slightly sulcate; tylus not inflated. Pronotum with its median length two fifths to one half its humeral width; disk unimpressed, occasionally with a faint median carina;

lateral margins divergent; posterior margin convex, medianly truncate to slightly concave. Scutellum large, with median length distinctly greater than that of pronotum. Female ovipositor of normal shape with teeth arranged in two longitudinal rows; inner row of large teeth merges proximally with outer row of smaller teeth; approximately two or three small, lateral, toothlike setae near apex.

Variation Within Species: A slight amount of variation exists between the light and dark forms of this species. They differ primarily in the form of the pronotum and scutellum. The light form differs from the dark in having a more robust pronotum with lateral margins less divergent and a smaller scutellum. These two forms have been taken within the same population.

Comparative Notes: Superficially this species resembles *B. macrotrichia* n. sp. and *B. platycnemis* (Fieber). Examination of the male, however, will show distinct differences. This species differs from *B. macrotrichia* in having a wider synthlipsis and notocephalon, a more robust pronotum, and in lacking the large setae on the inner posterior margin of the fore femur. *Buenoa nitida* differs from *B. platycnemis* in having fewer sclerotized ridges in the femoral stridulatory area, pronotum more robust and not tricarinate, and in the form of the rostral prong, fore femur, and tibial comb.

Location of Types: Holotype male, allotype female, 13 male and 19 female paratypes, Dept. Amazonas, Peru, Aug. 14-19, 1936, F. Woytkowski; other paratypes: 5 males and 6 females, Valão de São Pedro Tereza Santa Estado de Esperito Santo, Feb. 2, 1948, Antenor Leitao de Carvalho. The type series is in the Francis Huntington Snow Entomological Collections, University of Kansas.

Data on Distribution: Known only from Brazil and Peru. Specimens from the following localities have been examined:

BRAZIL: Valão de São Pedro Tereza Santa Estado de Esperito Santo, Feb. 2, 1948, Antenor Leitao de Carvalho, 5 males, 6 females.

PERU: Dept. Amazonas, Vic. Guayabamba, Aug. 14-19, 1936, F. Woytkowski, 15 males, 39 females; Dept. San Martín, Vic. Rioja, Sept. 9-Oct. 3, 1936, F. Woytkowski, 15 males, 25 females.

All specimens listed above are in the Francis Huntington Snow Entomological Collections, University of Kansas, Lawrence, Kansas.

Buenoa mutabilis n. sp.

(Pl. CXI, fig. 61)

Size: Male, length 5.20 mm. to 5.98 mm., greatest body width 1.43 mm. to 1.83 mm.; female, length 5.65 mm. to 6.30 mm., greatest body width 1.69 mm. to 1.88 mm.

Color: General facies pale testaceous to black. Head, anterior portion of pronotum, thoracic venter, and limbs sordid white to testaceous. Posterior portion of pronotum usually black; scutellum entitrely black, occasionally with apex sordid white to testaceous; metathoracic dorsum light brown to black. Abdomen black except ventral keel, portions of connexivum, and last one or two segments, testaceous. Pale specimens entirely sordid white to testaceous except most of abdomen, black. This species variable in color.

Male Structural Characteristics: As viewed from above, outline of head laterally rounded, anteriorly truncate with vertex indented; greatest width of head approximately six and one half times the anterior width of vertex and less than humeral width of pronotum; synthlipsis narrow, approximately one third the anterior width of vertex; along median longitudinal axis, head is one half to three fifths the length of pronotum; notocephalon slightly sulcate; tylus slightly inflated; labrum with basal width not quite twice its median length and apex bluntly rounded; rostral prong (pl. CXI, figs. 61b, 61c) variable, distinctly longer than third rostral segment, with base originating laterally and protruding anteriorly at point midway to near distal end of third rostral segment, and with apex moderately to sharply rounded. Pronotum with its median length one half to four sevenths its humeral width; disk usually with two shallow, elongate depressions toward the middle forming a faint median carina, not tricarinate; lateral margins divergent; posterior margin convex, medianly concave. Scutellum large, with median length greater than that of pronotum. Fore femur (pl. CXI, fig 61a) not greatly thickened at apex; subtriangular stridulatory area consisting of approximately ten to eighteen sclerotized ridges. Fore tibia (pl. CXI, fig. 61a) with stridulatory comb (pl. CXI, fig. 61d) consisting of approximately thirty-three to thirty-eight teeth; apical teeth thicker than basal. Chaetotaxy of male front leg as shown on Plate CXI. Male genital claspers normal. Spine from caudo-sinistral margin of seventh abdominal tergite with apical half very narrow and apex strongly acuminate.

Female Structural Characteristics: As viewed from above, head laterally rounded, anteriorly truncate with vertex indented; greatest width of head approximately six times the anterior width of vertex and distinctly less than humeral width of pronotum; synthlipsis narrow, slightly less than half the anterior width of vertex; along median longitudinal axis, head is slightly less than half the length of pronotum; notocephalon slightly sulcate; tylus not inflated. Pronotum with its median length approximately half its humeral width;

disk only faintly impressed and sometimes not at all, not tricarinate; lateral margins divergent; posterior margin convex, medianly concave. Scutellum large, with median length distinctly greater than that of pronotum. Female ovipositor of normal shape with teeth arranged in two longitudinal rows; one long inner row of large teeth and one long outer row of smaller teeth; approximately seven or eight small, lateral, toothlike setae near apex.

Variation Within Species: This species varies considerably in the form of the rostral prong; there is also some variation in the proportional size of the head and pronotum and in the form of the fore femur. The greatest contrast is shown between a series from Peru and one from Paraguay. The former is a small, pale form, the male with a relatively short, straight rostral prong; the latter is a larger, dark form, the male with a long, curved rostral prong.

Comparative Notes: Superficially this species closely resembles *B. macrotrichia* n. sp. and *B. alterna* n. sp., and somewhat resembles the dark form of *B. pallens* (Champion). Examination of the male, however, will show distinct differences. This species differs from *B. macrotrichia* in having the fore femur narrower at apex, lacking the large setae on inner, posterior margin of fore femur, and having more sclerotized ridges in femoral stridulatory area. It differs from *B. alterna* in having a femoral stridulatory area and a distinctly different rostral prong. *Buenoa mutabilis* differs from *B. pallens* in having the fore femur wider at apex, the notocephalon distinctly narrower, and the rostral prong protruding anteriorly on third rostral segment. Other minor differences also occur.

Location of Types: Holotype male, allotype female, 23 male and 19 female paratypes, Vicinity of Rioja, Dept. San Martín, Peru, Sept. 9-Oct. 22, 1936, F. Woytkowski. The type series is in the Francis Huntington Snow Entomological Collections, University of Kansas.

Data on Distribution: Known from West Indies (Haiti), Venezuela, British Guiana, Peru, and Paraguay. In addition to type series, specimens from the following localities have been examined:

WEST INDIES: *Haiti:* Port au Prince, June, 1925, W. H. Hoffman, 3 females.

VENEZUELA: Surukum, June 1941, P. J. Anduze, 14 males, 7 females, 5 nymphs.

BRITISH GUIANA: Cartabo, Mrs. Brindly, 5 females.

PERU: Vic. Pampa Hermosa, May 1-5, 1935, F. Woytkowski, 5 males; Vic. San Pedro, May 15-29, 1935, F. Woytkowski, 18 males, 17 females; Vic. San Pedro, May 15-19, 1935, F. Woytkowski, 10 males, 6 females; Vic. Sani Beni, Aug. 5, 1935, F. Woytkowski, 5 males, 2 females; Vic. Sani Beni, Sept.-Oct., 1935, F. Woytkowski, 14 males, 21 females; Rio Negro, Oct. 30, 1935, F. Woytkowski, 3 males, 2 females; Dept. Huanuco, Vic. Tingo María, May 10, 1937, F. Woytkowski, 10 males, 9 females; Dept. Huanuco, Vic. of Afilador, June 3-9, 1937, F. Woytkowski, 29 males, 6 females; Dept. Huanuco, Vic. Leonpampa, Dec. 11-30, 1937, F. Woytkowski, 37 males, 26 females; Dept. Huanuco, Loc. Shapajilla, June 1-10, 1938, F. Woytkowski, 25 males, 11 females; Peru, Dec. 12-14, 1937, F. Woytkowski, 41 males, 30 females; Peru, Oct. 8, 1940, F. Woytkowski, 40 males, 43 females; Dept. Ayacucho, Prov. La Mar. Sivia, June 15-28, 1941, F. Woytkowski, 16 males, 7 females; Satipo, Oct., 1942, Pedro Paprzyki, 25 males, 26 females.

PARAGUAY: Villarrica, Jan. 7, 1923, F. Schade, 1 male, 1 female; Villarrica, June 7-15, 1923, F. Schade, 2 females; Villarrica, July 6, 1923, F. Schade, 3 females; Villarrica, Nov. 10, 1923, F. Schade, 1 female; Villarrica, Dec. 5-6, 1923, F. Schade, 3 males, 4 females; Villarrica, Jan. 12, 1924, F. Schade, 1 female; Villarrica, Mar.-Apr., 1924, F. Schade, 1 male, 6 females; Villarrica, July 8, 1924, F. Schade, 1 male, 4 females; Villarrica, Sept. 9-Nov. 16, 1924, F. Schade, 9 females; Villarrica, Dec. 16, 1924, F. Schade, 20 males, 50 females; Villarrica, Jan., 1926, F. Schade, 23 males, 31 females; Villarrica, Mar., 1926, F. Schade, 3 males, 2 females; Estero Grande, Nov. 1, 1924, F. Schade, 1 male, 2 females; Melinesque, Dec. 1925, F. Schade, 3 females; Melinesque, June 20-28, 1935, F. Schade, 4 females.

All specimens listed above are in the Francis Huntington Snow Entomological Collections, University of Kansas, Lawrence, Kansas.

Buenoa arida n. sp.

(Pl. CXI, fig. 62)

Size: Male, length 5.33 mm. to 5.91 mm., greatest body width 1.69 mm. to 1.95 mm.; female, length 5.95 mm. to 7.41 mm., greatest body width 2.01 mm. to 2.21 mm.

Color: General facies sordid white to slate. Head, pronotum, and limbs sordid white to pale testaceous. Thoracic venter testaceous to black; scutellum black with posterolateral margins and apex sordid white to pale testaceous; metathoracic dorsum pale testaceous to black, usually appearing gray through hyalin hemelytra. Abdomen black except ventral keel and portions of connexivum and dorsum, yellowish white to pale testaceous. Hemelytra hyalin with posterior third black. Some specimens entirely sordid white except most of abdomen, black. This species variable in color.

Male Structural Characteristics: As viewed from above, outline of head rounded, vertex slightly indented; greatest width of head seven and one half to eight and one half times the anterior width of vertex and equal to or slightly less than humeral width of pronotum; synthlipsis approximately one half the anterior width of vertex; along median longitudinal axis, head is slightly more than half the length of pronotum; notocephalon sulcate dorsally; frons immediately above tylus, very narrow; tylus slightly inflated; labrum with basal width not quite twice its median length and apex bluntly rounded; rostral prong (pl. XI, fig. 62b) with length equal to that of third rostral segment, with base originating laterally near proximal end of third rostral segment, and with apex bluntly rounded. Pronotum with its median length slightly more than half its humeral width; disk with two elongate depressions toward the middle forming a median carina; lateral margins slightly divergent; posterior margin convex, slightly concave medianly. Scutellum large, with median length greater than that of pronotum. Fore femur (pl. CXI, fig. 62a) wide but not greatly thickened at apex; large, subtriangular stridulatory area consisting of approximately sixty to sixty-five fine, sclerotized ridges. Fore tibia (pl. CXI, fig. 62a) with stridulatory comb (pl. CXI, fig. 62c) consisting of approximately nineteen to twenty-two teeth; apical teeth thicker and slightly taller than basal. Chaetotaxy of male front leg as shown on Plate CXI. Male genital claspers normal. Spine from caudo-sinistral margin of seventh abdominal tergite normal, tapering gradually from base to strongly acuminate apex.

Female Structural Characteristics: As viewed from above, outline of head rounded with vertex usually indented; greatest width of head six to six and one half times the anterior width of vertex and slightly less than humeral width of pronotum; synthlipsis one half to two thirds the anterior width of vertex; along median longitudinal axis, head is approximately three fifths the length of pronotum; notocephalon sulcate dorsally; tylus slightly inflated. Pronotum with its median length approximately half its humeral width; disk with two elongate depressions toward the middle forming a median carina; lateral margins divergent; posterior margin convex, medianly truncate to slightly concave. Scutellum large, with median length distinctly greater than that of pronotum. Female ovipositor of normal shape with teeth arranged in two longitudinal rows which merge proximally; one inner row of large teeth and one outer row of smaller teeth; approximately three or four small, lateral, toothlike setae near apex.

Comparative Notes: Superficially this species somewhat resembles *B. nitida* n. sp. Examination of the male, however, will show distinct differences. This species differs from *B. nitida* in having head wider in relation to pronotum, frons just above tylus distinctly narrower, fore femur less robust, and differences in the rostral prong, femoral stridulatory area, and tibial comb.

Location of Types: Holotype male, Santa Rita Mts., Arizona, July 10, 1950, W. J. Arnold; allotype female, Santa Rita Mts., Arizona, July 9, 1947, L. D. Beamer; paratypes as follows: 3 males and 2 females, Oro Blanco Mts., Arizona, Apr. 3, 1937, Owen Bryant; 1 male, Gila Co., Arizona, Aug. 5, 1927, R. H. Beamer; 1 female, Santa Catalina Mts., Arizona, July 14, 1950, W. J. Arnold. The type series is in the Francis Huntington Snow Entomological Collections, University of Kansas.

Data on Distribution: Known only from the United States. In addition to the type series, specimens from the following localities have been examined:

U. S. A.: *Arizona:* Santa Cruz Co., Aug. 4, 1927, P. A. Readio, 1 male; Huachuca Mts., July 8, 1932, R. H. Beamer, 1 female; Oro Blanco Mts., Apr. 3, 1937, Owen Bryant, 2 males, 1 female; Catalina Mts., Oct. 27, 1941, Victor Potter, 1 male (U. of Mich.); Catalina Mts., Sabino Canyon, Hubbard Coll., 1 male, 1 female (U. S. N. M.); Arizona, P. R. Uhler Collection, 2 males, 1 female (U. S. N. M.).

All specimens listed above are in the Francis Huntington Snow Entomological Collections, University of Kansas, Lawrence, Kansas, unless otherwise indicated.

Buenoa speciosa n. sp.

(Pl. CXII, fig. 63)

Size: Male, length 8.38 mm. to 8.84 mm., greatest body width 2.40 mm. to 2.60 mm.; female, length 8.45 mm. to 9.10 mm., greatest body width 2.53 mm. to 2.66 mm.

Color: General facies pale testaceous to blackish gray. Head, pronotum, and limbs sordid white to pale testaceous. Thoracic venter testaceous to black; scutellum black with posterolateral margins and apex sordid white to testaceous; metathoracic dorsum testaceous to black, usually appearing gray through hyalin hemelytra. Abdomen black except ventral keel and portions of connexivum and dorsum, yellowish white to testaceous. Hemelytra hyalin with posterior third brown to black. Some specimens entirely sordid white to pale testaceous except most of abdomen, black. This species variable in color.

Male Structural Characteristics: As viewed from above, outline of head laterally rounded, anteriorly truncate with vertex indented; greatest width of head eight to ten times the anterior width of vertex and slightly less than humeral width of pronotum; synthlipsis three fifths to four fifths the anterior width of vertex; along median longitudinal axis, head is approximately three fifths the length of pronotum; notocephalon narrow, sulcate dorsally; tylus inflated; labrum with basal width not quite twice its median length and apex bluntly rounded; rostral prong (pl. CXII, fig. 63c) unusual in shape, distinctly longer than third rostral segment, with base originating laterally near distal end of third rostral segment, and with apex moderately rounded. Pronotum with its median length slightly more than half its humeral width; disk with two shallow, elongate depressions toward the middle forming a faint median carina; usually a subtriangular depression on each side but not appearing tricarinate; lateral margins slightly divergent; posterior margin convex, medianly truncate to slightly concave. Scutellum large, with median length usually greater than that of pronotum. Fore femur (pl. CXII, fig. 63a) wide and thickened at apex; small, triangular stridulatory area consisting of approximately eleven sclerotized ridges. Fore tibia (pl. CXII, fig. 63a) with stridulatory comb (pl. CXII, fig. 63b) consisting of approximately thirty-nine to forty-two teeth; apical teeth thicker, narrower, and taller than basal. Chaetotaxy of male front leg as shown on Plate CXII. Male genital claspers normal. Spine from caudo-sinistral margin of seventh abdominal tergite normal, tapering gradually from base to strongly acuminate apex.

Female Structural Characteristics: As viewed from above outline of head rounded with vertex indented only at lateral margins; greatest width of head seven to seven and one half times the anterior width of vertex and less than humeral width of pronotum; synthlipsis three fifths to four fifths the anterior width of vertex; along median longitudinal axis, head is slightly more than half the length of pronotum; notocephalon sulcate dorsally; tylus slightly inflated. Pronotum with its median length three sevenths to four sevenths its humeral width; disk usually unimpressed, occasionally with a faint median carina; lateral margins divergent; posterior margin convex, medianly truncate to slightly concave.

Scutellum large, with median length distinctly greater than that of pronotum. Female ovipositor of normal shape with teeth arranged in two longitudinal rows which merge proximally; one inner row of large teeth and one outer row of smaller teeth; approximately seven or eight small, lateral, toothlike setae near apex.

Comparative Notes: Superficially this species resembles *B. crassipes* (Champion). Examination of the male, however, will show distinct differences. This species differs from *B. crassipes* in having the head with eyes distinctly larger, frons just above tylus narrower, and distinct differences in the rostral prong, femoral stridulatory area and tibial comb.

Location of Types: Holotype male, allotype female, 3 female paratypes, 20 miles W. of San Luis Potosí, Mexico, Aug. 8, 1944, H. D. Thomas; other paratypes: 2 males and 1 female, San Luis Potosí, Mexico, Aug. 5, 1944, H. D. Thomas; 3 males and 1 female, Real del Monte, Hidalgo, Mexico, Sept. 23, 1938, H. D. Thomas. The type series is in the Francis Huntington Snow Entomological Collections, University of Kansas.

Data on Distribution: Known only from United States and Mexico. In addition to type series, specimens from the following localities have been examined:

U. S. A.: *Texas:* Ft. Davis, 1914, C. Thompson, 1 female (U. of Mich.); Alpine, June 5, 1927, 1 male (U.S.N.M.); Davis Mts., July 12, 1938, R. I. Sailer and D. W. Craik, 1 male, 2 females.

All specimens listed above are in the Francis Huntington Snow Entomological Collections, University of Kansas, Lawrence, Kansas, unless otherwise indicated.

Buenoa gracilis n. sp.

(Pl. CXII, fig. 64)

Size: Male, length 5.39 mm. to 6.04 mm., greatest body width 1.30 mm. to 1.49 mm.; female, length 5.52 mm. to 6.11 mm., greatest body width 1.36 mm. to 1.69 mm.

Color: General facies sordid white. Head, thoracic dorsum, most of thoracic venter, and limbs sordid white. Abdominal venter black except keel and portions of connexivum, sordid white to pale testaceous; abdominal dorsum yellowish white with irregular black area posteriorly.

Male Structural Characteristics: As viewed from above, outline of head rounded with anterior margin of vertex continuous with that of eyes; greatest width of head six to six and one half times the anterior width of vertex and slightly less than humeral width of pronotum; synthlipsis very narrow, approximately one fourth the anterior width of vertex, often carinate; along median longitudinal axis, head is approximately half the length of pronotum; notocephalon sulcate dorsally; tylus inflated; labrum with basal width approximately twice its median length and apex bluntly rounded to almost truncate; rostral prong (pl. CXII, fig. 64b) equal to or slightly shorter than third rostral segment, with base originating laterally near proximal end of third rostral segment, and with apex bluntly rounded. Pronotum long, with its median length two thirds to three fourths its humeral width; disk with two shallow, elongate depressions toward the middle and a deep, subtriangular depression on each side, thus appearing tricarinate posteriorly; lateral margins slightly divergent, occasionally parallel; posterior margin convex, distinctly concave medianly. Scutellum with median length distinctly less than that of pronotum. Fore femur (pl. CXII, fig. 64a) relatively wide, not greatly thickened at apex; subtriangular stridulatory area consisting of approximately six to nine wide, sclerotized ridges. Fore tibia (pl. CXII, fig. 64a) with stridulatory comb (pl. CXII, fig. 64c) consisting of approximately twenty-five to twenty-eight teeth; apical teeth slightly thicker and narrower than basal; approximately four short, peg-like setae (pl. CXII, fig. 64d) on inner surface of tibia at apex. Chaetotaxy of male front leg as shown on plate CXII. Male genital claspers normal. Spine from caudo-sinistral margin of seventh abdominal tergite normal, tapering gradually from base to strongly acuminate apex.

Female Structural Characteristics: As viewed from above, outline of head rounded with anterior margin of vertex continuous with that of eyes, occasionally slightly protuberant; greatest width of head approximately five times the anterior width of vertex and slightly less than humeral width of pronotum; synthlipsis narrow, approximately one fourth the anterior width of vertex; along median longitudinal axis, head is one half to two thirds the length of pronotum; notocephalon sulcate dorsally; tylus slightly inflated. Pronotum with its median length slightly less than three fifths its humeral width; disk with two shallow, elongate depressions toward the middle and occasionally a large subtriangular depression on each side, thus sometimes appearing faintly tricarinate; lateral margins divergent; posterior margin convex, distinctly concave medianly. Scutellum with median length usually greater than that of pronotum. Female ovipositor of normal shape with teeth arranged in two longitudinal rows; one inner row of large teeth and one irregular, outer row of smaller teeth; approximately six to ten small, lateral, toothlike setae near apex.

Variation Within Species: Occasionally specimens are found with flight wings not fully developed. These specimens have lateral margins of pronotum parallel, scutellum smaller, and hemelytra with claval sutures less evident and membranes smaller than the form with fully developed flight wings.

Comparative Notes: Superficially this species somewhat resembles *B. oculata* n. sp. Examination of the male, however, will show distinct differences. This species is larger than *B. oculata,* has synthlipsis wider, femoral stridulatory area present, and first tarsal segment of intermediate leg not emarginate.

Location of Types: Holotype male, allotype female, 25 male and 25 female paratypes, Region of Tarapoda, Dept. San Martín, Peru, Feb. 16, 1947, Felix Woytkowski. The type series is in the Francis Huntington Snow Entomological Collections, University of Kansas.

Data on Distribution: Known from Mexico, Honduras, Panama, West Indies (Cuba, Jamaica, Puerto Rico, St. Croix, Grenada), and Peru. In addition to type series, specimens from the following localities have been examined:

MEXICO: *Veracruz:* Minatitlán, Sept. 22, 1936, H. D. Thomas, 15 males, 16 females.

Guerrero: Río Agua, Oct. 31, 1936, H. D. Thomas, 1 male; Acapulco, July 12, 1937, H. D. Thomas, 1 male, 10 females.

Oaxaca: Papaloápan, Feb. 20, 1939, Gordon and Atz, 3 males; Papaloapán, Feb. 22, 1939, Gordon and Atz, 2 females, 2 nymphs (U. of Mich.); Arroyo Zacatispan, Mar. 4, 1943, M. & E. Gordon, 1 female (U. of Mich.).

Chiapas: La Libertad, Jan., 1938, Octavio Utrilla L., 1 male; San Vicente, Jan. 4, 1948, Octavio Utrilla L., 2 females.

Campeche: Ciudad del Carmen, Sept. 1-18, 1936, H. D. Thomas, 7 males, 14 females.

HONDURAS: Tela, La Fragua farm, March and April, 1923, T. H. Hubbell, 6 males, 3 females (U. of Mich.).

PANAMA: Soná, May, 1914, J. Zetek, 1 male.

WEST INDIES: *Cuba:* Santiago, Sept. 20, 1912, J. M. Espin, 4 males, 3 females, 1 nymph (U. S. N. M.); San Carlos Guantáname, Oct. 4-8, 1913, 2 males, 1 female, 4 nymphs (U. S. N. M.); Havana, Bot. Garden, Jan. 25, 1932, P. J. Bermudez, 17 males, 12 females.

Jamaica: Palm Beach, Montego Bay, Mar. 11, 1911, 11 males, 3 females, 1 nymph (A. M. N. H.).

Puerto Rico: Guayabal Reservoir, Feb. 20, 1934, S. Hildebrand, 6 males, 4 females (U. S. N. M.); Guinea Reservoir, Feb. 20, 1934, S. Hildebrand, 2 females (U. S. N. M.).

St. Croix: Slob Pond, 1937, H. A. Beatty, 1 male, 1 female (U. S. N. M.); St. Croix, 1941, H. A. Beatty, 2 males, 1 female (U. S. N. M.).

Grenada: Grenada, H. H. Smith, P. R. Uhler Collection, 1 male, 4 females (U. S. N. M.).

PERU: Vic. Sani Beni, Oct. 9-16, 1935, F. Woytkowski, 15 males, 11 females; Dept. San Martín, Region Tarapoto, Feb. 8, 1947, Felix Woytkowski, 24 females.

All specimens listed above are in the Francis Huntington Snow Entomological Collections, University of Kansas, unless otherwise indicated.

Buenoa communis n. sp.

(Pl. CXII, fig. 65)

Size: Male, length 5.39 mm. to 6.04 mm., greatest body width 1.49 mm. to 1.75 mm.; female, length 5.91 mm. to 6.50 mm., greatest body width 1.62 mm. to 1.95 mm.

Color: General facies testaceous to rufescent. Head, pronotum, thoracic venter, and limbs sordid white to testaceous; pronotum occasionally with median and basal portions orange. Scutellum usually orange, often with two anterolateral brown to black areas; metathoracic dorsum usually light brown to black. Abdomen light brown to black except ventral keel, portions of connexivum, and last two segments testaceous. Hemelytron with rufescent area at humeral angle. This species somewhat variable in color.

Male Structural Characteristics: As viewed from above, outline of head rounded with anterior margin of vertex continuous with that of eyes; greatest width of head six to six and one half times the anterior width of vertex and less than humeral width of pronotum; synthlipsis very narrow, one fifth to one fourth the anterior width of vertex, often carinate; along median longitudinal axis, head is two fifths to one half the length of pronotum; notocephalon narrow, slightly sulcate; tylus not inflated; labrum with basal width more than twice its median length and apex bluntly rounded; rostral prong (pl. CXII, fig. 65b) slightly longer than third rostral segment, with base originating laterally near proximal end of third rostral segment, and with apex bluntly rounded. Pronotum with its median length approximately three fifths its humeral width; disk with two elongate depressions toward the middle and a large subtriangular depression on each side, thus appearing tricarinate;

lateral margins divergent; posterior margin convex, medianly concave. Scutellum with median length equal to or slightly less than that of pronotum. Fore femur (pl. CXII, fig. 65a) neither wide nor strongly thickened at apex; oblong to subtriangular stridulatory area consisting of approximately twenty-six to thirty-one sclerotized ridges. Fore tibia (pl. CXII, fig. 65a) with stridulatory comb (pl. CXII, fig. 65c) consisting of approximately thirty-one to thirty-three teeth; apical teeth thicker and slightly narrower than basal. Chaetotaxy of male front leg as shown on Plate CXII. Male genital claspers normal. Spine from caudo-sinistral margin of seventh abdominal tergite with apical one third very narrow and apex strongly acuminate.

Female Structural Characteristics: As viewed from above, outline of head rounded with anterior margin of vertex usually continuous with that of eyes, occasionally indented at lateral margins; greatest width of head six to six and one half times the anterior width of vertex and less than humeral width of pronotum; synthlipsis very narrow, approximately one fourth the anterior width of vertex, often carinate; along median longitudinal axis, head is one third to one half the length of pronotum; notocephalon narrow, slightly sulcate; tylus not inflated. Pronotum with its median length slightly more than half its humeral width; disk with two shallow, elongate depressions toward the middle and a shallow, subtriangular depression on each side, thus appearing faintly tricarinate, occasionally with median carina only; lateral margins divergent; posterior margin convex, slightly concave medianly. Scutellum large, with median length greater than that of pronotum. Female ovipositor of normal shape with teeth arranged in two longitudinal rows; one inner row of few, large teeth that merges proximally with long outer row of smaller teeth; approximately four to seven small, lateral, toothlike setae near apex.

Comparative Notes: Superficially this species somewhat resembles *B. platycnemis* (Fieber) and *B. mutabilis* n. sp. Examination of the male, however, will show distinct differences. This species differs from *B. platycnemis* in having the fore femur narrower at apex, synthlipsis and notocephalon distinctly narrower, rostral prong shorter, and minor differences in the femoral stridulatory area and tibial comb. *Buenoa communis* differs from *B. mutabilis* in having the synthlipsis narrower, pronotum distinctly tricarinate, more sclerotized ridges in the femoral stridulatory area, and minor differences in the rostral prong and tibial comb.

Location of Types: Holotype male, allotype female, 50 male and 50 female paratypes, vicinity of João Pessoa, River Juruá, Brazil, July 10 to Sept. 20, 1936, A. M. Olalla. The type series is in the Francis Huntington Snow Entomological Collections, University of Kansas.

Data on Distribution: Known only from Brazil and Bolivia. Specimens from the following localities have been examined:

BRAZIL: *Pará:* Lago Grande, Feb., 1939, A. M. Olalla, 2 males, 2 females.

Parahiba: Vic. João Pessoa, River Juruá, July 10 to Sept. 20, 1936, A. M. Olalla, 117 males, 136 females.

BOLIVIA: Junction of Madre de Dios and Beni Rivers, Victoria, Oct., 1937, A. M. Olalla, 124 males, 142 females; R. Beni, Puerto Salinas, Nov., 1937, A. M. Olalla, 4 males, 7 females.

All specimens listed above are in the Francis Huntington Snow Entomological Collections, University of Kansas, Lawrence, Kansas.

Buenoa artafrons n. sp.

(Pl. CXIII, fig. 66)

Size: Male, length 5.20 mm. to 5.88 mm., greatest body width 1.49 mm. to 1.69 mm.; female, length 5.29 mm. to 5.98 mm., greatest body width 1.56 mm. to 1.75 mm.

Color: General facies sordid white to pale testaceous. Head, thorax, and limbs usually sordid white to testaceous. Scutellum occasionally with apex orange and two anterolateral black areas. Abdomen light brown to black except ventral keel and portions of connexivum and dorsum, pale testaceous. Thoracic and abdominal venter and limbs often entirely light brown to black. This species variable in color.

Male Structural Characteristics: As viewed from above, outline of head rounded with vertex indented; greatest width of head approximately nine times the anterior width of vertex and usually slightly greater than humeral width of pronotum; synthlipsis narrow, approximately half the anterior width of vertex; along median longitudinal axis, head is more than two thirds the length of pronotum; notocephalon narrow, sulcate dorsally; frons immediately above tylus, very narrow; tylus slightly inflated; labrum with basal width twice its median length and apex bluntly rounded; rostral prong (pl. CXIII, fig. 66b) slightly longer than third rostral segment, with base originating laterally at a point midway to near proximal end of third rostral segment, and with apex moderately to bluntly rounded. Pronotum with its median length approximately three fifths its humeral width; disk with two elongate depressions toward the middle and a large subtriangular depression on each side, thus appearing distinctly tricarinate; lateral margins slightly divergent; posterior margin convex, medianly concave. Scutellum with median length equal to that of pronotum. Fore femur (pl. CXIII, fig. 66a) neither wide nor greatly thickened at apex; subtriangular stridulatory area consisting of approximately seven wide, sclerotized ridges. Fore tibia (pl. CXIII, fig. 66a) with stridulatory comb (pl. CXIII, fig. 66c) consisting of approximately twenty-five to twenty-seven teeth; all teeth approximately same size and thickness. Chaetotaxy of male front leg as shown on Plate XIII. Male genital claspers normal. Spine from caudo-sinistral margin of seventh abdominal tergite normal, tapering gradually from base to strongly acuminate apex.

Occasionally specimens are found with flight wings more fully developed. These specimens have head narrower than humeral width of pronotum, lateral margins of pronotum more divergent, and scutellum larger. Both forms have claval sutures present in hemelytra but in the form with more fully developed flight wings, membranes are larger.

Female Structural Characteristics: As viewed from above, outline of head rounded with anterior margin of vertex continuous with that of eyes, occasionally indented at lateral margins; greatest width of head approximately seven times the anterior width of vertex and slightly less than humeral width of pronotum; synthlipsis narrow, approximately half the anterior width of xertex; along median longitudinal axis, head is slightly more than three fifths the length of pronotum; notocephalon narrow, sulcate dorsally; tylus slightly inflated. Pronotum with its median length approximately four sevenths its humeral width; disk usually with two shallow, elongate depressions toward the middle and a shallow, subtriangular depression on each side, thus appearing faintly tricarinate, occasionally with median carina only; lateral margins divergent; posterior margin convex, slightly concave medianly. Scutellum large, with median length greater than that of pronotum. Female ovipositor of normal shape with teeth arranged in two longitudinal rows which merge midway of ovipositor valve; one inner row of large teeth and one outer row of smaller teeth; approximately four or five small, lateral, toothlike setae near apex.

Occasionally specimens are found with flight wings more fully developed. These specimens have head distinctly narrower than humeral width of pronotum, lateral margins of pronotum more divergent, and scutellum larger. Both forms have claval sutures present in hemelytra but in the form with more fully developed flight wings, membranes are larger.

Comparative Notes: Superficially this species resembles *B. albida* (Champion). Examination of the male, however, will show distinct differences. This species differs from *B. albida* in having frons just above tylus narrower, tylus without a median depression, rostral prong distinctly shorter, and differences in the femoral stridulatory area and tibial comb.

Location of Types: Holotype male, allotype female, 8 male and 14 female paratypes, Cocoanut Grove, Florida, Aug. 9, 1930, R. H. Beamer and Paul W. Oman; other paratypes: 11 males and 6 females, Wildwood, Florida, Aug. 2-9, 1930, R. H. Beamer and Paul W. Oman. The type series is in the Francis Huntington Snow Entomological Collections, University of Kansas.

Data on Distribution: Known only from the United States. In addition to type series, specimens from the following localities have been examined:

U. S. A.: *Georgia:* Okefenokee Swp., July 30, 1934, R. H. Beamer, P. McKinstry, and M. E. Griffith, 15 males, 7 females.

Florida: Sanford, Aug. 4, 1930, Paul W. Oman, 2 males, 1 female; Cocoanut Grove, Aug. 9, 1930, R. H. Beamer and Paul W. Oman, 1 male, 19 females.

All specimens listed above are in the Francis Huntington Snow Entomological Collections, University of Kansas, Lawrence, Kansas.

Buenoa macrotibialis Hungerford

(Pl. CIII, fig. 38; pl. CXIII, fig. 67)

1924. *Buenoa macrotibialis* Hungerford, H. B. Ann. Ent. Soc. America, vol. XVII, No. 2, p. 225.

1925. *Buenoa macrotibialis*, Bare, C. O. Ent. News, vol. XXXVI, No. 8, p. 228 (key).

1926. *Buenoa macrotibialis*, Blatchley, W. S. Heteroptera or True Bugs of Eastern North America, pp. 1057 and 1060 (key and description).

1928. *Buenoa macrotibialis*, Bare, C. O. Univ. Kansas Sci. Bul., vol. XVIII, No. 3, p. 268 (key).

1942. *Buenoa macrotibialis*, Hutchinson, G. E. American Jr. Sci., vol. CCXL, p. 336 (morphological note).

Size: This species varies considerably in size within the same population. Male, length 5.85 mm. to 6.50 mm., greatest body width 1.49 mm. to 1.69 mm.; female, length 5.91 mm. to 7.00 mm., greatest body width 1.75 mm. to 2.08 mm.

Color: General facies sordid white to testaceous. Head and limbs testaceous to black. Prothorax sordid white with a smoky to black area on each side above the margin; scutellum testaceous to colorless; metathoracic dorsum and thoracic venter testaceous with portions light brown to black. Abdominal dorsum testaceous with a light brown to black area usually located posteriorly; abdominal venter black with keel, portions of connexivum, and occasionally last segment, testaceous. Hemelytron sordid white with black band covering humeral angle and extending along anterior margin of wing for approximately one fourth its length and occasionally another very small smoky to black area at tip of corium limited usually to edge of wing. This species somewhat variable in color.

Male Structural Characteristics: As viewed from above, outline of head rounded with anterior margin of vertex continuous with that of eyes; greatest width of head approximately six and one half times the anterior width of vertex and usually equal to humeral width of pronotum; synthlipsis half, or slightly less than half, the anterior width of vertex; along median longitudinal axis, head is approximately three fifths the length of pronotum; notocephalon slightly sulcate dorsally; tylus inflated; labrum small, with basal width more than twice its median length and apex bluntly rounded; rostral prong (pl. CXIII, fig. 67b) long, much longer than third rostral segment, with base originating laterally at distal end of third rostral segment causing this segment to protrude anteriorly over terminal segment, and with apex bluntly rounded. Pronotum with its median length approximately three fourths its humeral width; disk with two elongate depressions toward the middle and a large subtriangular depression on each side, thus appearing tricarinate; lateral margins slightly divergent; posterior margin convex, medianly truncate to slightly concave. Scutellum relatively small, elevated, but depressed near anterior margin by a transverse groove; median length distinctly less than that of pronotum. Fore femur (pl. CXIII, fig. 67a) wide and somewhat thickened at apex; obscure, triangular stridulatory area consisting of approximately seven to nine irregular, sclerotized ridges. Fore tibia (pl. CXIII, fig. 67a) with stridulatory comb (pl. CXIII, fig. 67c) consisting of approximately fifty-four to fifty-six teeth; apical teeth thicker and narrower than basal. Chaetotaxy of male front leg as shown on Plate CXIII. Male genital claspers normal. Spine from caudo-sinistral margin of seventh abdominal tergite normal, tapering gradually from broad base to acuminate apex.

A single macropterous form has been seen by this author. This specimen has head distinctly narrower than humeral width of pronotum; pronotum with lateral margins more divergent; scutellum larger; hemelytra with claval sutures present and large membranes; fully developed flight wings.

Female Structural Characteristics: As viewed from above, outline of head rounded with anterior margin of vertex continuous with that of eyes or slightly indented at lateral margins; greatest width of head approximately six times the anterior width of vertex and usually equal to humeral width of pronotum; synthlipsis slightly less than half the anterior width of vertex; along median longitudinal axis, head is approximately two thirds the length of pronotum; notocephalon slightly sulcate dorsally; tylus inflated. Pronotum with its median length approximately three fifths its humeral width; disk with two elongate depressions toward the middle and a shallow, subtriangular depression on each side, thus appearing faintly tricarinate with median carina distinct; lateral margins divergent; posterior margin convex, medianly truncate. Scutellum relatively small, elevated, but depressed near anterior margin by a shallow transverse groove; median length less than that of pronotum. Female ovipositor (pl. CIII, fig. 38) of normal shape with teeth arranged in two longitudinal rows; one short inner row of few, large teeth and one long outer row of small teeth with a few teeth located medianly and intermingled with the two rows; approximately six or seven small, lateral, toothlike setae near apex.

No macropterous female forms have been seen by this author. This form undoubtedly exists, however, and one would assume that it differs from the brachypterous form in the same characteristics as mentioned for the male.

Comparative Notes: Superficially this species resembles *B. limnocastoris* Hungerford and *B. confusa* n. sp. Examination of the male, however, will show distinct differences. This species differs from *B. limnocastoris* and *B. confusa* in the shape and chaetotaxy of the fore femur and tibia, the femoral stridulatory area and the shape and length of rostral prong. It also differs from *B. limnocastoris* in having the pronotum not inflated, tylus not as prominent, and scutellum not as reduced. It differs also, from *B. confusa,* in that the eyes are not as close together.

Location of Types: Holotype male, allotype female, Bryant's Bog, Douglas Lake, Michigan, Aug. 1-3, 1923, H. B. Hungerford; paratypes as follows: 1 male and 6 females, Pelican Rapids, Minnesota, Aug. 22, 1922, H. B. Hungerford; 2 males and 6 females, Bryant's Bog, Douglas Lake, Michigan, Aug. 3-17, 1923, H. B. Hungerford; 5 males and 6 females, Bryant's Bog, Douglas Lake, Michigan, July 29, 1923, H. B. Hungerford. The above series is in the Francis Huntington Snow Entomological Collections, University of Kansas. Other paratypes collected by H. B. Hungerford are located at University of Michigan, University of Minnesota, U. S. National Museum, and in the following private collections: J. R. de la Torre-Bueno (now at the University of Kansas), C. J. Drake, W. E. Hoffmann, H. B. Hungerford (now in the Francis Huntington Snow Entomological Collections), R. F. Hussey, and H. M. Parshley.

Data on Distribution: Recorded from Canada and United States. In addition to the type series, specimens from the following localities have been examined:

CANADA: *Manitoba:* Cowan, Aug. 7, 1937, H. T. Peters, 1 male brachypterous.

Quebec: Aqueduc Lake, July 23, 1949, Howard Loeb, 1 male and 1 female brachypterous.

Nova Scotia: July 28, 1947, D. Livingston, 2 male brachypterous.

U. S. A.: *Minnesota:* Minnehaha Creek, Hennepin Co., July 9, 1921, H. B. Hungerford, 1 female brachypterous; Pelican Rapids, Aug. 22, 1922, H. B. Hungerford, 1 female brachypterous; Benson, Aug. 23, 1922, H. B. Hungerford, 5 males and 2 females brachypterous.

Michigan: Cheboygan Co., July 27, 1918, R. F. Hussey, 3 females brachypterous (U. of Mich.); Cheboygan Co., Aug. 14, 1918, R. F. Hussey, 2 females brachypterous (U. of Mich.); Huron Co., Sand Point, June 22, 1922, R. F. Hussey, 6 males and 4 females brachypterous, 1 nymph (U. of Mich.); Douglas Lake, Bryant's Bog, July 17, 1923, H. B. Hungerford, 1 female brachypterous; Douglas Lake, Bryant's Bog, Aug. 1, 1923, H. B. Hungerford, 2 females brachypterous; Douglas Lake, Bryant's Bog, Aug. 3, 1923, H. B. Hungerford, 11 females brachypterous; Douglas Lake, Bryant's Bog, July 30, 1924, H. B. Hungerford, 1 male brachypterous; Douglas Lake, Aug. 6, 1924, H. B. Hungerford, 5 males and 43 females brachypterous; Douglas Lake, Bryant's Bog, July 24, 1925, H. B. Hungerford, 1 male and 9 females brachypterous; Douglas Lake, Bryant's Bog, Aug. 8, 1925, H. B. Hungerford, 1 male and 9 females brachypterous.

South Dakota: Weta, July 18, 1937, R. H. Beamer and C. L. Johnston, 1 male macropterous, 1 male brachypterous.

All specimens listed above are in the Francis Huntington Snow Entomological Collections, University of Kansas, Lawrence, Kansas, unless otherwise indicated.

Buenoa limnocastoris Hungerford

(Pl. CII, fig. 8; pl. CIII, fig. 40; pl. CXIII, fig. 68)

1923. *Buenoa limnocastoris* Hungerford, H. B. Ent. News, vol. XXXIV, No. 5, pp. 150-152.
1924. *Buenoa limnocastoris*, Hungerford, H. B. Ann. Ent. Soc. America, vol. XVII, No. 2, pp. 223-227 (discussion of biology and taxonomy).
1925. *Buenoa limnocastoris*, Bare, C. O. Ent. News, vol. XXXVI, No. 8, p. 228 (key).
1926. *Buenoa limnocastoris*, Blatchley, W. S. Heteroptera or True Bugs of Eastern North America, pp. 1057, 1059 and 1060 (key and description).
1928. *Buenoa limnocastoris*, Bare, C. O. Univ. Kansas Sci. Bull., vol. XVIII, No. 3, p. 268 (key).

Size: This species varies considerably in size from its most northern range, Quebec, Canada, to its most southern range, Florida. Male, length 4.77 mm. to 6.17 mm., greatest body width 1.30 mm. to 1.62 mm.; female, length 5.00 mm. to 6.37 mm., greatest body width 1.50 mm. to 1.95 mm.

Color: General facies sordid white to testaceous. Head and limbs testaceous to black. Prothorax sordid white with a smoky to black area on each side above the margin; scutellum sordid white to colorless; metathoracic dorsum and thoracic venter testaceous with portions light brown to black. Abdominal dorsum testaceous with a light brown to black area located posteriorly; abdominal venter testaceous, with portions of connexivum black or black with keel and portions of connexivum testaceous. Hemelytron sordid white with black band covering humeral angle and extending along anterior margin of wing for approximately one third its length and another large subtriangular black area at tip of corium, extending across wing. This species somewhat variable in color.

Male Structural Characteristics: As viewed from above, outline of head rounded with lateral margins of vertex slightly indented; greatest width of head approximately five and one half times the anterior width of vertex and greater than humeral width of pronotum; synthlipsis approximately one third the anterior width of vertex; along median longitudinal axis, head is slightly less than half the length of pronotum; notocephalon slightly sulcate dorsally; tylus inflated; labrum very short, basal width approximately three times its median length with apex bluntly rounded; rostral prong (pl. CXIII, fig. 68b) distinctly longer than third rostral segment, with base originating laterally at distal end of third rostral segment, and with apex bluntly rounded. Pronotum with its median length equal to its humeral width; in lateral view, strongly arched and inflated with a deep depression laterally near posterior margin;

disk with two shallow, elongate depressions toward the middle and a shallow, subtriangular depression on each side, thus appearing faintly tricarinate; lateral margins divergent; posterior margin convex, medianly truncate. Scutellum small, elevated, but depressed near anterior margin by a transverse groove; median length much less than that of pronotum. Fore femur (pl. CXIII, fig. 68a) widened but with anterior margin sharply curved at apex; obscure, subtriangular stridulatory area consisting of approximately six or seven sclerotized ridges. Fore tibia (pl. CXIII, fig. 68a) with stridulatory comb (pl. CXIII, fig. 68c) consisting of approximately forty to forty-five teeth; apical teeth thicker and narrower than basal. Chaetotaxy of male front leg as shown on Plate CXIII. Male genital claspers normal. Spine from caudo-sinistral margin of seventh abdominal tergite normal (pl. CII, fig. 8), tapering gradually from broad base to acuminate apex; length variable.

Macropterous forms are occasionally found. These specimens have head narrower than humeral width of pronotum; pronotum not as strongly inflated; scutellum much larger and without transverse depression near anterior margin; hemelytra with claval sutures present and large membranes; fully developed flight wings.

Female Structural Characteristics: As viewed from above, outline of head rounded with lateral margins of vertex slightly indented; greatest width of head five to six times the anterior width of vertex and usually equal to or greater than humeral width of pronotum; synthlipsis approximately one third the anterior width of vertex; along median longitudinal axis, head is approximately one half the length of pronotum; notocephalon slightly sulcate dorsally; tylus inflated. Pronotum with its median length approximately two thirds its humeral width; not strongly arched or inflated as in male and without lateral depression near posterior margin; disk usually faintly tricarinate, occasionally with only median carina; lateral margins divergent; posterior margin convex, medianly truncate. Scutellum small, elevated, but depressed near anterior margin by a shallow transverse groove; median length distinctly less than that of pronotum. Female ovipositor (pl. CIII, fig. 40) of normal shape with teeth arranged in two longitudinal rows; one very short inner row of few, large teeth and one long, irregular outer row of small teeth with a few teeth located medianly and intermingled with the two rows; one or two small, lateral, toothlike setae near apex.

Macropterous forms are occasionally found. These specimens have head distinctly narrower than humeral width of pronotum; pronotum wider and stronger; scutellum much larger with its median length greater than that of pronotum and without transverse depression near anterior margin; hemelytra with claval sutures present and large membranes; fully developed flight wings.

Variation Within Species: As is indicated under measurements of length, this species varies a great deal in size; there is also some variation in the proportional size of the pronotum. The greatest contrast is shown between several series from Canada, Minnesota, and Michigan, and a series from Florida. The former is a large form, the males seldom less than 6 mm. in length; the males of the latter form are approximately 5 mm. in length.

Comparative Notes: Superficially this species somewhat resembles *B. macrotibialis* Hungerford. Examination of the male, however, will show distinct differences. This species differs from *B. macrotibialis* in the shape and chaetotaxy of the fore femur and tibia, the femoral stridulatory area, the shape and length of rostral prong, and in having the pronotum strongly inflated. The latter character, especially, will also separate this species from *B. confusa* n. sp., which it also somewhat resembles.

Location of Types: Described from a series taken near Maple Hill, Cook County, Minnesota, Aug. 12, 1922 by H. B. Hungerford. Holotype male in University of Minnesota Collection, allotype female in the Francis Huntington Snow Entomological Collections, University of Kansas, and paratypes at University of Minnesota, University of Kansas, U. S. National Museum, and the following private collections: J. R. de la Torre-Bueno (now at University of Kansas), C. J. Drake, W. E. Hoffmann, H. B. Hungerford (now in Francis Huntington Snow Entomological Collections), R. F. Hussey, and H. M. Parshley.

Data on Distribution: Recorded from Canada and the United States. In addition to type series, specimens from the following localities have been examined:

CANADA: *Quebec:* Beattie Lake, Aug. 11, 1949, H. Loeb, 1 male and 1 female brachypterous.

U. S. A.: *Minnesota:* Cook County, Beaver Dam, Aug. 12, 1922, H. B. Hungerford, 1 male and 1 female macropterous, 5 females brachypterous; Cook Co., Beaver Dam, Aug. 12, 1922, W. E. Hoffmann, 3 male brachypterous; Pelican Rapids, Aug. 22, 1922, H. B. Hungerford, 1 female macropterous.

Michigan: Cheboygan Co., July 29, 1918, 1 male brachypterous (U. of Mich.); Cheboygan Co., Aug. 19, 1918, R. F. Hussey, 1 male and 6 females brachypterous (U. of Mich.); Huron Co., Sand Point, June 22, 1922, R. F. Hussey, 2 males and 1 female brachypterous, 1 nymph (U. of Mich.); Douglas Lake, June 29, 1923, H. B. Hungerford, 1 male brachypterous; Douglas Lake, Sedge Point Pool, July 3-24, 1923, H. B. Hungerford, 20 males and 38 females brachypterous; Douglas Lake, Bessey Creek, July 18, 1923, H. B. Hungerford, 2 males brachypterous; Douglas Lake, Mud Lake, July 31, 1923, H. B. Hungerford, 1 female brachypterous; Douglas Lake, Sedge Point Pool, Aug. 15, 1923, H. B. Hungerford, 1 male and 4 females brachypterous, 1 nymph; Douglas Lake, Bryant's Bog, Aug. 17, 1923, H. B. Hungerford, 1 female brachypterous; Douglas Lake, Nickols pond, July 22, 1924, H. B. Hungerford, 2 females brachypterous; Douglas Lake, July 27 to Aug. 8, 1924, H. B. Hungerford, 19 males and 45 females brachypterous; Douglas Lake, Bryant's Bog, July 30, 1925, H. B. Hungerford, 1 female brachypterous; Douglas Lake, July 29, 1926, H. B. Hungerford, 1 male macropterous, 1 male and 2 females brachypterous.

Maine: Bridgton, Aug. 20, 1934, R. H. Beamer, 1 male brachypterous.

New Jersey: P. R. Uhler Collection, 1 female brachypterous (U.S.N.M.).

Virginia: Virginia Beach, Aug. 11, 1934, M. E. Griffith, 1 male and 1 female brachypterous.

Georgia: Okefenokee Swamp, Aug. 3, 1934, M. E. Griffith, 1 male macropterous; Okefenokee Swamp, July 27, 1931, J. D. Beamer, 1 male brachypterous.

Florida: Ponce de Leon, July 13, 1934, R. H. Beamer, 1 male and 1 female macropterous, 5 males and 12 females brachypterous; Wakulla Springs, July 14, 1934, P. A. McKinstry and R. H. Beamer, 1 male and 1 female macropterous.

All specimens listed above are in the Francis Huntington Snow Entomological Collections, University of Kansas, Lawrence, Kansas, unless otherwise indicated.

Buenoa confusa n. sp.

(Pl. CII, fig. 20; pl. CIII, fig. 34; pl. CXIV, fig. 69)

1894. *Anisops elegans*, Uhler, P. R. Proc. California Acad. Sci., vol. IV, p. 293 (distributional note).
1894. *Anisops elegans*, Uhler, P. R. Proc. Zoological Soc. London, p. 223 (descriptive and distributional note).
1908. *Buenoa elegans*, Torre-Bueno, J. R. de la. Jr. New York Ent. Soc., vol. XVI, p. 238 (listed).
1909. *Buenoa elegans*, Kirkaldy, G. W. and Torre-Bueno, J. R. de la. Proc. Ent. Soc. Washington, vol. X, p. 200 (catalogue).
1909. *Buenoa elegans*, Torre-Bueno, J. R. de la. Jr. New York Ent. Soc., vol. XVII, pp. 75-77 (key and notes).
1910. *Buenoa elegans*, Smith, J. B. Catalogue Insects New Jersey, edn. 3, p. 170.

1912. *Buenoa elegans,* Torre-Bueno, J. R. de la. Canadian Ent., vol. XLIV, p. 213 (listed).
1914. *Buenoa elegans,* Parshley, H. M. Psyche, vol. XXI, p. 140 (listed).
1916. *Buenoa elegans,* Van Duzee, E. P. New York Ent. Soc., p. 51 (check list).
1917. *Buenoa elegans,* Hungerford, H. B. Ent. News, vol. XXVIII, p. 176 (key).
1917. *Buenoa elegans,* Parshley, H. M. Occasional Papers Boston Soc. Nat. Hist., vol. VII, p. 113 (listed).
1917. *Buenoa elegans,* Van Duzee, E. P. Catalogue Hemiptera America North of Mexico, p. 455.
1919. *Buenoa elegans,* Hungerford, H. B. Univ. Kansas Sci. Bull., vol. XI, pp. 173-176 (description and key).
1919. *Buenoa elegans,* Hungerford, H. B. Univ. Kansas Sci. Bull., vol. XI, p. 332 (figure).
1921. *Buenoa elegans,* Parshley, H. M. Proc. British Columbia Ent. Soc., No. 18, p. 24.
1923. *Buenoa elegans,* Torre-Bueno, J. R. de la. Guide to Insects of Connecticut, part 4, p. 407.
1923. *Buenoa elegans,* Hungerford, H. B. Ent. News, vol. XXXIV, pp. 150-152 (notes).
1923. *Buenoa elegans,* Torre-Bueno, J. R. de la. Connecticut State Geol. and Nat. Hist. Survey Bull., No. 34, p. 407 (key and notes).
1924. *Buenoa elegans,* Hungerford, H. B. Ann. Ent. Soc. America, vol. XVII, pp. 225-226 (notes).
1925. *Buenoa elegans,* Hungerford, H. B. and Beamer, R. H. Ent. News, vol. XXXVI, pp. 272 and 297 (notes).
1925. *Buenoa elegans,* Bare, C. O. Ent. News, vol. XXXVI, pp. 225 and 228 (key and note).
1926. *Buenoa elegans,* Bare, C. O. Ann. Ent. Soc. America, vol. XIX, pp. 96-97 (biological note).
1926. *Buenoa elegans,* Blatchley, W. S. Heteroptera or True Bugs of Eastern North America, pp. 1057 and 1059 (key and description).
1928. *Buenoa elegans,* Torre-Bueno, J. R. de la. Cornell Univ. Agricultural Exp. Station, Memoir 101, p. 139 (listed).
1928. *Buenoa elegans,* Bare, C. O. Univ. Kansas Sci. Bull., vol. XVIII, pp. 268 and 241-243 (key and figures).
1940. *Buenoa elegans,* Hungerford, H. B. Ent. Monthly Magazine, vol. LXXVI, p. 256 (note).
1942. *Buenoa elegans,* Rice, L. A. Tennessee Acad. Sci., vol. XVII, pp. 55 and 63 (notes).
1942. *Buenoa elegans,* Hutchinson, G. E. American Jr. Sci., vol. CCXL, pp. 335-338 (notes and figures).
1948. *Buenoa elegans,* Hynes, H. B. N. Trans. Royal Ent. Soc. London, vol. XCIX, p. 354 (distributional note).

Size: This species varies considerably in size from its most northern range, Manitoba, Canada, to its most southern range, Florida and the Cayman Islands. Male, length 4.16 mm. to 5.78 mm., greatest body width 1.10 mm. to 1.49 mm.; female, length 4.29 mm. to 7.00 mm., greatest body width 1.30 mm. to 1.62 mm.

Color: General facies sordid white to pale testaceous. Head, pronotum, scutellum, most of thoracic venter, and limbs sordid white to testaceous. Metathoracic dorsum usually sordid white with a light brown to black, longitudinal stripe on each side. Abdominal venter light brown to black except keel and portions of connexivum, pale testaceous; abdominal dorsum usually sordid white to testaceous with a lateral, light brown to black area near posterior end. Hemelytron hyalin, usually with a black band covering humeral angle and extending along anterior margin of wing for approximately one fourth its length, and a light brown to black area at tip of corium. This species somewhat variable in color.

Male Structural Characteristics: As viewed from above, outline of head rounded with anterior margin of vertex continuous with that of eyes; head large with eyes prominent; greatest width of head seven to seven and one-half times the anterior width of vertex and greater than humeral width of pronotum; synthlipsis narrow, approximately one third the anterior width of vertex; along median longitudinal axis, head is five sevenths to six sevenths the length of pronotum; notocephalon narrow, slightly sulcate dorsally; tylus inflated; labrum with basal width approximately twice its median length and apex bluntly rounded; rostral prong (pl. CXIV, fig. 69b) distinctly longer than third rostral segment, with base originating laterally at distal end of third rostral segment, and with apex bluntly rounded. Pronotum with its median length approximately two thirds its humeral width; disk with two elongate depressions toward the middle and a large subtriangular depression on each side, thus appearing tricarinate; lateral margins divergent; posterior margin convex, medianly truncate. Scutellum elevated but depressed near anterior margin by a transverse groove; median length less than that of pronotum. Fore femur (pl. CXIV, fig. 69a) wide, somewhat thickened at apex; obscure, subtriangular stridulatory area consisting of approximately five or six sclerotized ridges. Fore tibia (pl. CXIV, fig. 69a) with stridulatory comb (pl. CXIV, fig. 69c) consisting of forty to fifty teeth; apical teeth thicker and narrower than basal. Chaetotaxy of male front leg as shown on Plate CXIV. Male genital claspers (pl. CII, fig. 20) normal. Spine from caudo-sinistral margin of seventh abdominal tergite normal, tapering gradually from broad base to acuminate apex; length variable.

Macropterous forms are occasionally found. These specimens have head distinctly narrower than humeral width of pronotum; pronotum with lateral margins more divergent; scutellum larger; hemelytra with claval sutures present and large membranes; fully developed flight wings.

Female Structural Characteristics: As viewed from above, outline of head rounded with anterior margin of vertex continuous with that of eyes; eyes prominent; greatest width of head six to six and one half times the anterior width of vertex and slightly greater than humeral width of pronotum; synthlipsis narrow, approximately one third the anterior width of vertex; along median longitudinal axis, head is approximately five sixths the length of pronotum; notocephalon narrow, slightly sulcate dorsally; tylus slightly inflated. Pronotum with its median length approximately three fifths its humeral width; disk usually with two shallow, elongate depressions toward the middle and a shallow, subtriangular depression on each side, thus appearing faintly tricarinate; lateral margins divergent; posterior margin convex, medianly truncate. Scutellum slightly elevated but depressed near anterior margin by a shallow, transverse groove; median length equal to or slightly greater than that of pronotum. Female ovipositor (pl. CIII, fig. 34) of normal shape with teeth arranged in three longitudinal rows; one very short inner row of few, large teeth, one median row of normal teeth, and one long outer row of smaller teeth which merges proximally with median row; approximately four or five small, lateral, toothlike setae near apex.

Macropterous forms are occasionally found. These specimens have head distinctly narrower than humeral width of pronotum; pronotum wider and stronger with lateral margins more divergent; scutellum much larger with its median length distinctly greater than that of pronotum and without transverse depression near anterior margin; hemelytra with claval sutures present and large membranes; fully developed flight wings.

Variation Within Species: As is indicated under measurements of length, this species varies a great deal in size; there is also some variation in the proportional size of the pronotum and head. The greatest contrast is shown between two series from Manitoba, Canada, and Storrs, Connecticut, and several series from Florida and the Cayman Islands. The former is a large form, the male seldom less than 5.75 mm. in length; the males of the latter form are approximately 4.50 mm. in length. Due to the fact that all characters used in species determination are identical in these two forms, no specific separation appears justified. It is the opinion of this author that the immediate environment, including such factors as food source, temperature of water, salinity of water, etc., are responsible for these variations.

Comparative Notes: Superficially this species resembles *B. macrotibialis* Hungerford. Examination of the male, however, will show distinct differences. This species differs from *B. macrotibialis* in having a narrower synthlipsis, distinctly shorter pronotum, a much less robust front leg, and differences in the femoral stridulatory area and rostral prong.

Nomenclatorial Notes: One finds in the literature and collections that this species has been masquerading under the name *Buenoa elegans* (Fieber). On examining notes and sketches accumulated on Fieber's type (Berlin Museum) by Dr. H. B. Hungerford in 1928, the validity of *B. elegans* appeared to be questionable. Through the kindness of Dr. S. v. Kéler of the Berlin Museum, the type specimen, a male, was made available to me for study. *Anisops elegans* Fieber is a good *Anisops* species. The *Buenoa* known to a generation of entomologists as *Buenoa elegans* (Fieber) was, therefore, an undescribed species. The confusion surrounding this species serves to illustrate the necessity for the worker to have access to type material. The *A. elegans* type was sent to Dr. George T. Brooks who determined the specimen as *A. apicalis* Stål, an African species. In Fieber's original description, he gives the locality as "Aus Amerika." The type is labeled "Brasil Coll. Germ." Due to the fact that *Anisops* is an Old World genus and the type has been determined *A. apicalis,* an African species, it would seem that the label on Fieber's type specimen is in error.

Location of Types: Holotype male, allotype female, 23 male and 24 female paratypes, Douglas Co., Kansas, Nov. 3-7, 1922, H. B. Hungerford and Robert Guntert. The type series is in the Francis Huntington Snow Entomological Collections, University of Kansas.

Data on Distribution: Recorded from Canada, United States, Mexico (fide Uhler), and West Indies (Grand Cayman, Grenada). In addition to type series, specimens from the following localities have been examined:

CANADA: *Alberta:* Red Deer R., Aug. 3, 1937, H. T. Peters, 4 males and 5 females brachypterous.

Manitoba: Cowan, Aug. 7, 1937, R. H. Beamer, H. T. Peters, and C. L. Johnston, 12 males and 7 females macropterous.

U. S. A.: *North Dakota:* Fargo, July 26, 1937, C. L. Johnston, 1 male macropterous.

South Dakota: Weta, July 18, 1937, R. H. Beamer, H. T. Peters, and C. L. Johnston, 1 male and 1 female brachypterous, 7 males and 4 females macropterous; Waubay, Blue Dog Lake, Sept. 14, 1939, H. C. Severin, 1 male and 1 female brachypterous.

Minnesota: Cook Co., Aug. 12, 1922, H. B. Hungerford, 2 males brachypterous, 1 female macropterous; Benson, Aug. 23, 1922, H. B. Hungerford, 4 males and 2 females brachypterous.

Michigan: Cheboygan Co., July 27 to Aug. 14, 1918, R. F. Hussey, 2 males and 3 females brachypterous (U. of Mich.); Cheboygan Co., July 27, 1936, H. B. Hungerford, 1 male and 1 female brachypterous; Berrien Co., June 30, 1919, R. F. Hussey, 2 males and 1 female brachypterous (U. of Mich.); Berrien Co., Sept. 2, 1919, R. F. Hussey, 5 males and 5 females brachypterous (U. of Mich.); Ann Arbor, July 30, 1921, R. F. Hussey, 1 male and 1 female brachypterous (U. of Mich.); Douglas L., Bryant's Bog, July 3-31, 1923, H. B. Hungerford, 28 males and 18 females brachypterous, 2 nymphs; Douglas L., Bryant's Bog, Aug. 1-17, 1923, H. B. Hungerford, 36 males and 57 females brachypterous, 2 nymphs; Douglas L., Bryant's Bog, July 30, 1924, H. B. Hungerford, 1 male brachypterous; Douglas L., Bryant's Bog, H. B. Hungerford, July 24, 1925, 9 males and 15 females brachypterous; Douglas L., Bryant's Bog, Aug. 12, 1925, H. B. Hungerford, 7 males and 6 females brachypterous; Douglas L., Sedge Point Pool, Aug. 15, 1923, 1 male brachypterous.

New York: Huntington, May, 1909, Bueno Collection, 1 male brachypterous; White Plains, Sept. 28, 1924, J. R. de la Torre-Bueno, 1 male and 1 female brachypterous.

Connecticut: Storrs, Aug. 13, 1946, R. H. Beamer, 6 males and 7 females brachypterous.

New Jersey: Ft. Lee Dist., Sept. 18, 1904, 1 male and 2 females brachypterous; Rancoca, Aug. 29, 1927, E. M. Benton, 2 females brachypterous, 1 nymph.

District of Columbia: Washington, Aug. 20, 1893, P. R. Uhler, 1 female brachypterous (U.S.N.M.).

Kansas: Douglas Co., Nov. 3-7, 1922, H. B. Hungerford and Robert Guntert, 1 male and 5 females brachypterous, 2 nymphs; Douglas Co., Nov. 3, 1922, H. B. Hungerford, 1 male brachypterous; Douglas Co., Sept. 28, 1924, C. O. Bare, 1 male brachypterous; Cherokee Co., Larson's Creek, Aug. 18, 1923, R. H. Beamer, 8 males and 10 females brachypterous; Atchison Co., July 15, 1924, E. P. Breaky, 1 female brachypterous; Doniphan Co., July 20, 1924, R. H. Beamer, 2 males brachypterous.

Virginia: Great Falls, Jan. 9, 1906, D. H. Clemons, 1 female macropterous (U. S. N. M.)

Texas: Cedar Lane, Aug. 9, 1928, R. H. Beamer, 1 male and 1 female macropterous; Orange Co., Aug. 14, 1928, R. H. Beamer, 1 female macropterous; Rockport, Jan. 1, 1946, L. D. Beamer, 2 males brachypterous.

Louisiana: Baton Rouge, June, 1905, A. W. Morril, 1 female macropterous (U. S. N. M.); Creole, June 18, 1948, E. L. Todd, 7 males and 26 females macropterous.

Mississippi: Shuqualak, July 16, 1930, Paul W. Oman, 1 male brachypterous; Bay St. Louis, July 9, 1934, R. H. Beamer, 3 females macropterous.

Alabama: Grand Bay, July 11, 1934, R. H. Beamer and P. A. McKinstry, 3 males and 4 females brachypterous.

Georgia: Okefenokee Swp., July 30, 1934, J. D. Beamer, M. E. Griffith, and P. McKinstry, 4 males and 15 females brachypterous, 1 male and 2 females macropterous; Okefenokee Swp., Aug. 3, 1934, R. H. Beamer, 26 males and 15 females brachypterous, 1 male macropterous, 3 nymphs; Okefenokee Swp., July 25-27, 1939, R. H. and J. D. Beamer and E. G. Wegenek, 5 males and 9 females brachypterous, 4 males and 2 females macropterous, 1 nymph; Okefenokee Swp., Aug. 1, 1939, J. D. Beamer, 1 female brachypterous.

Florida: Archer, July 31, 1930, R. H. Beamer, Paul W. Oman, and J. Nottingham, 6 males and 12 females brachypterous, 7 males and 11 females macropterous; Yankeetown, July 31, 1930, R. H. Beamer, J. Nottingham, and L. D. Tuthill, 3 males and 3 females brachypterous, 3 males and 3 females macropterous; Inverness, Aug. 1, 1930, Paul W. Oman and J. Nottingham, 3 males and 4 females brachypterous, 1 male and 3 females macropterous; Wildwood, Aug. 2, 1930, R. H. Beamer, Paul W. Oman, and L. D. Tuthill, 34 males and 29 females brachypterous, 3 males and 2 females macropterous; Sanford, Aug. 4, 1930, R. H. Beamer and Paul W. Oman, 26 males and 17 females brachypterous, 1 male and 2 females macropterous, 3 nymphs; Cocoanut Grove, Aug. 9, 1930, R. H. Beamer and Paul W. Oman, 14 males and 10 females brachypterous, 2 males and 5 females macropterous, 8 nymphs; Ft. Mead, Aug. 13, 1930, Paul W. Oman, 4 males and 3 females brachypterous, 3 nymphs; Plant City, Aug. 15, 1930, Paul W. Oman, 1 female brachypterous; Plant City, July 14, 1939, P. B. Lawson and R. H. Beamer, 6 males and 4 females macropterous; Hilliard, July 28, 1934, R. H. Beamer, 2 males and 3 females macropterous; Old Town, July 11, 1939, P. B. Lawson, 1 female macropterous; La Belle, July 16, 1939, P. B. Lawson and R. H. Beamer, 6 males and 3 females macropterous; Lacoochee, Aug. 9, 1939, J. D. Beamer, 1 female brachypterous, 1 female macropterous.

WEST INDIES: *Grand Cayman:* Georgetown, Apr. 17, 1926, C. B. Lewis and G. H. Thompson, 1 male and 2 females macropterous.

All specimens listed above are in the Francis Huntington Snow Entomological Collections, University of Kansas, Lawrence, Kansas, unless otherwise indicated.

Buenoa fuscipennis (Berg)

(Pl. CII, fig. 7; pl. CIII, fig. 28; pl. CXIV, fig. 71)

1879. *Anisops fuscipennis* Berg, C. Hemiptera Argentina, pp. 198-199 (described from Argentina).
1899. *Anisops naias* Kirkaldy, G. W. Entomologist, vol. XXXII, p. 194 (described from Chile). New Synonomy.
1904. *Buenoa naias*, Kirkaldy, G. W. Wiener Ent. Zeit., vol. XXIII, pp. 120 and 134 (listed). New Synonomy.
1904. *Buenoa fuscipennis*, Kirkaldy, G. W. Wiener Ent. Zeit., vol. XXIII, pp. 120 and 134 (listed).
1909. *Buenoa naias*, Kirkaldy, G. W. and Torre-Bueno, J. R. de la. Proc. Ent. Soc. Washington, vol. X, p. 200 (catalogue).
1909. *Buenoa fuscipennis*, Kirkaldy, G. W. and Torre-Bueno, J. R. de la. Proc. Ent. Soc. Washington, vol. X, p. 200 (catalogue).
1928. *Buenoa dentipes* Jaczewski, T. Ann. Musei Zoologici Polonici, vol. VII, pp. 127-129 (described from Brazil). New Synonomy.
1935. *Buenoa naias*, De Carlo, J. A. Revista Chilena de Historia Natural, p. 110 (catalogue).

Size: Male, length 6.82 mm. to 7.21 mm., greatest body width 1.82 mm. to 2.01 mm.; female, length 7.02 mm. to 7.28 mm., greatest body width 1.95 mm. to 2.08 mm.

Color: General facies testaceous to fuscous. Head, thoracic dorsum, portions of thoracic venter, abdominal dorsum, and limbs, testaceous. Portions of thoracic venter and abdominal dorsum light brown to black. Abdominal venter black except ventral keel, posterior margins of segments, and portions of connexivum, testaceous.

Male Structural Characteristics: As viewed from above, outline of head rounded with lateral margins of vertex indented; greatest width of head approximately five times the anterior width of vertex and distinctly less than humeral width of pronotum; synthlipsis slightly less than half the anterior width of vertex; along median longitudinal axis, head is approximately half the length of pronotum; tylus inflated; labrum short, basal width approximately a third greater than its median length with apex moderately rounded; rostral prong (pl. CXIV, fig. 71b) shorter than third rostral segment, with base originating laterally at proximal end of third rostral segment, and with apex bluntly rounded. Pronotum with its median length slightly more than half its humeral width; disk unimpressed; lateral margins divergent; posterior margin convex, medianly concave. Scutellum large, with median length distinctly greater than that of pronotum. Trochanter of fore leg with prominent tubercle on posterior margin. Fore femur (pl. CXIV, fig. 71a) neither wide nor thickened at apex; without stridulatory area but with row of short, thick setae on posterior margin of inner surface. Fore tibia (pl. CXIV, fig. 71a) with stridulatory comb (pl. CXIV, fig. 71c) consisting of approximately eleven thick teeth of uniform size. Chaetotaxy of male front leg as shown on Plate CXIV. Intermediate tibia with row of short, thick setae located parallel with inner, anterior margin in apical half. Male genital claspers (pl. CIII, fig. 28) abnormal in shape. Spine from caudo-sinistral margin of seventh abdominal tergite (pl. II, fig. 7) short and thick, tapering gradually from broad base to acuminate apex.

Female Structural Characteristics: As viewed from above, outline of head rounded with vertex slightly protuberant; greatest width of head approximately four and one half times the anterior width of vertex and less than humeral width of pronotum; synthlipsis approximately half the anterior width of vertex; along median longitudinal axis, head is more than half the length of pronotum; tylus slightly inflated. Pronotum with its median length approximately half its humeral width; disk unimpressed; lateral margins divergent; posterior margin convex, medianly concave. Scutellum large with median length distinctly greater than that of pronotum. Female ovipositor of normal shape with teeth arranged in three longitudinal rows; one short inner row of larger teeth, one outer row of smaller teeth, and one median row of relatively large teeth which originates in apical fourth of valve and intermingles with outer row proximally; approximately eight or nine small, lateral, toothlike setae near apex in an irregular row.

Comparative Notes: Superficially this species somewhat resembles *B. margaritacea* Torre-Bueno and *B. scimitra* Bare. Examination of the male, however, will show distinct differences. This species differs from *B. margaritacea* and *B. scimitra* in having a tubercle on the trochanter of the front leg, in having a row of short, thick setae on the intermediate tibia, and in lacking a stridulatory area on the femur of the front leg.

Nomenclatorial Notes: A small series of specimens from Argentina, compared with the types of *B. fuscipennis* by Dr. J. A. De Carlo, assisted the author to conclude that *B. naias* Kirkaldy and *B. dentipes* Jaczewski are identical with this species. *Buenoa naias* and *B. dentipes* are hereby placed in synonomy with *B. fuscipennis* (Berg) 1879.

Location of Types: The original type series from Argentina, is located at the Museo de La Plata, Argentina. Homotype male, "Prov. Buenos Aires, Oct. 27, 1898. S. Venturi," compared with the type by Dr. J. A. De Carlo of the Museo Argentino de C. Naturales, is now in the Francis Huntington Snow Entomological Collections, University of Kansas.

Data on Distribution: Recorded from Venezuela (fide Kirkaldy & Bueno), Brazil, Bolivia, Chile, Paraguay, Uruguay, and Argentina. Specimens from the following localities have been examined:

BRAZIL: Nova Teutonia, May 1948, Fritz Plaumann, 1 male.

BOLIVIA: Villa Montes, Nov. 1917, 1 female.

CHILE: Icaño-Río Salado, Santiago del Estero, 1865, 1 male, 1 female; Vina del Mar, Nov. 15, 1920, 3 females; Vina, 1921, Alfredo Faz, 1 female; Santiago, Quinto Normal, Aug. 30, 1922, Alfredo Faz, 20 males, 28 females; Quinta Normal, Oct. 26, 1922, Alfredo Faz, 1 male, 3 females; Santiago, Laguna de la Quinta Normal, Dec. 20, 1922, Alfredo Faz, 28 males, 24 females; Santiago, Sept. 2, 1923, Alfredo Faz, 16 males, 10 females; Santiago, Alfredo Faz, 6 males, 4 females; Termas Cauquenes, Dec. 15, 1922, Alfredo Faz, 217 males, 186 females.

PARAGUAY: Villarrica, Jan. 7, 1923, Fran. Schade, 11 females; Villarrica, June 6-15, 1923, Fran. Schade, 8 males, 10 females; Villarica, Dec. 15, 1923, Fran. Schade, 1 female; Villarrica, Sept. 20, 1924, Fran. Schade, 2 males, 4 females; Villarrica, July 8, 1924, Fran. Schade, 1 male; Villarrica, Sept. 26, 1931, Fran. Schade, 2 males, 1 female; Estero Grande, Nov. 1, 1924, Fran. Schade, 1 female.

URUGUAY: Maldonado, 1885, C. Darwin, 2 females (British Mus.); Paso de arriera, Rivera, Jan. 13, 1933, C. S. Carbonell, 1 male (U.S.N.M.).

ARGENTINA: Argentina, Apr. 13, 1897, G. Wiengreen, 1 female (Hamburg Mus.); Prov. Buenos Aires, Oct. 27, 1898, S. Venturi, 1 male, 1 female; Buenos Aires, Oct. 15, 1920, P. Frank, 2 males, 1 female, 1 nymph (Hamburg Mus.); Córdoba, June 5, 1907, 2 males; Dept. de Luján San Luis, Sept. 1934, 2 males; Carcaraña, 1 male; Esperanza, Bred., 1 female (Kirkaldy Coll.); Salta, 1 male, 1 female.

All specimens listed above are in the Francis Huntington Snow Entomological Collections, University of Kansas, Lawrence, Kansas, unless otherwise indicated.

Buenoa amnigenus (White)

(Pl. CIII, fig. 36; pl. CXIV, fig. 70)

1879. *Anisops amnigenus* White, F. B. Trans. Ent. Soc. London, Pt. IV, p. 271.
1904. *Buenoa amnigenus*, Kirkaldy, G. W. Wiener Ent. Zeit., vol. XXIII, pp. 120 and 134 (listed and states "die Type ist verloren gegangen").
1909. *Buenoa amnigenus*, Kirkaldy, G. W. and Torre-Bueno, J. R. de la. Proc. Ent. Soc. Washington, vol. X, No. 3-4, p. 200 (listed).

Size: Male, length 4.77 mm. to 5.39 mm., greatest body width

1.26 mm. to 1.40 mm.; female, length 4.81 mm. to 5.85 mm., greatest body width 1.37 mm. to 1.54 mm.

Color: General facies sordid white. Head, thorax, and abdominal dorsum testaceous. Limbs testaceous to brown. Abdominal venter black with connexivum light brown to black.

Male Structural Characteristics: As viewed from above, outline of head rounded with vertex protuberant; greatest width of head approximately five times the anterior width of vertex and less than humeral width of pronotum; inner margins of eyes contiguous posteriorly; along median longitudinal axis, head is approximately two thirds the length of pronotum; frons wide; tylus not inflated; labrum very short, basal width more than twice its median length with apex bluntly rounded; rostral prong (pl. CXIV, fig. 70c) slightly longer than third rostral segment, with base originating laterally at proximal end of third rostral segment, and with apex sharply rounded. Pronotum with its median length slightly more than half its humeral width; disk unimpressed; lateral margins divergent; posterior margin convex, medianly concave. Scutellum large, with median length greater than that of pronotum. Fore femur (pl. CXIV, fig. 70a) neither wide nor greatly thickened at apex; stridulatory area absent. Fore tibia (pl. CXIV, fig. 70a) with stridulatory comb (pl. CXIV, fig. 70b) consisting of approximately twenty-eight to thirty teeth which increase in height from base to apex. Chaetotaxy of male front leg as shown on Plate CXIV. Male genital claspers normal. Spine from caudo-sinistral margin of seventh abdominal tergite tapering, with apical half very narrow and apex acuminate.

Brachypterous forms are occasionally found. These specimens have pronotum narrower, scutellum smaller, and hemelytra that lack claval sutures.

Female Structural Characteristics: As viewed from above, outline of head rounded with vertex slightly protuberant; greatest width of head approximately four times the anterior width of vertex and less than humeral width of pronotum; synthlipsis very narrow, approximately one twentieth the anterior width of vertex; along median longitudinal axis, head is more than half the length of pronotum; frons wide; tylus not inflated. Pronotum with its median length approximately half its humeral width; disk unimpressed; lateral margins divergent; posterior margin convex, medianly concave. Scutellum large with median length distinctly greater than that of pronotum. Female ovipositor (pl. CIII, fig. 36) of normal shape with teeth arranged in three longitudinal rows; one inner row of large teeth, one short outer row of smaller teeth, and one median row of relatively large teeth which originates in apical fourth of valve rather than at apex; approximately seven small, lateral, tooth-like setae near apex.

Brachypterous forms are occasionally found. These specimens have pronotum narrower, scutellum smaller, and hemelytra that lack claval sutures.

Comparative Notes: This species is nearest in general appearance to *B. gracilis* n. sp. Examination of the male, however, will show distinct differences. This species differs from *B. gracilis* in having the eyes contiguous posteriorly in the male, in lacking the stridulatory area on the fore femur, and in having the frons immediately above the tylus wide.

Location of Types: Dr. G. W. Kirkaldy (1904) states that "die Type ist verloren gegangen", however, Dr. H. B. Hungerford in 1928, examined the holotype male at the British Museum, London. Dr. Hungerford states that there are two specimens, male and female, which belong to the Perthshire Museum, Scotland. The holotype male bears the label "Manáos, on board at light, Aug. 1875". Homotype male, compared with type by Dr. H. B. Hungerford of the University of Kansas, labeled "Paraguy S. A., Villarrica, Loma, 7/6/23, Fran. Schade", now in the Francis Huntington Snow Entomological Collections, University of Kansas.

Data on Distribution: Recorded from British Guiana, Brazil, Peru, Bolivia, and Paraguay. Specimens from the following localities have been examined:

BRITISH GUIANA: Georgetown Demerara, Botanic Gardens, July 26, 1932, S. Harris, 1 female brachypterous.

BRAZIL: *Amazonas:* Manáos, Manacapurú, Mar. 1928, S. M. Klages, 14 males and 26 females macropterous, 10 males and 28 females brachypterous; Manáos region, Rio Negro, Oct. 1935, A. M. Olalla, 60 males and 36 females macropterous, 18 males and 11 females brachypterous, 2 nymphs; Manáos, July 29, 1924, Flores (Bueno Coll.), 3 males and 1 female macropterous; Reg. de Itacoatiara, Jan. 3, 1936, A. M. Olalla, 35 males and 19 females macropterous; Reg. de Itacoatiara (Nrte.), Jan., 1936 to Apr., 1936, A. M. Olalla, 8 females macropterous; Vic. João Pessoa (São Phelipe), River Juruá, July 10, 1936 to Sept. 20, 1936, A. M. Olalla, 28 males and 44 females macropterous, 14 males and 13 females brachypterous; Castanha region, Rio Purús, Sept., 1935, A. M. Olalla, 18 males and 16 females macropterous, 8 males and 30 females brachypterous; Vic. Santo Antônio, River Eiru, Sept. 25, 1936 to Oct. 7, 1936, A. M. Olalla, 27 females macropterous, 8 males and 12 females brachypterous.

Ceará: Bom Acud Successo nr. Maranguape, Nov. 4, 1937, Stillman Wright, 3 females brachypterous; Artificial Lake nr. Russas, July 22, 1937, Stillman Wright, 6 females macropterous, 1 male and 3 females brachypterous; Roadside pool nr. Primavera, Oct. 28, 1937, Stillman Wright, 1 female brachypterous; Roadside pool nr. Sobral, Oct. 26, 1937, Stillman Wright, 1 female macropterous; Pacatuba, Acude Piripaú, Aug. 1937, Stillman Wright, 1 male and 1 female brachypterous.

Rio Grande do Norte: Caico, No. 327, Stillman Wright, 2 males and 1 female macropterous, 3 males and 11 females brachypterous.

Parahiba: Souza, Stillman Wright, 2 females macropterous, 1 female brachypterous; Alagoa do Monteiro, Stillman Wright, 2 females macropterous, 18 females brachypterous; Areia, Stillman Wright, 10 females brachypterous; Santa Luzia, Stillman Wright, 1 female macropterous, 7 females brachypterous.

Pernambuco: Vila Bela, No. 5467, Stillman Wright, 3 males brachypterous.

Matto Grosso: Corumbá, March, Lowland, 1 male macropterous.

Paraná: Lago Grande, Feb. 1939, A. M. Olalla, 4 females macropterous, 24 males and 23 females brachypterous.

PERU: Dept. Huánuco, Loc. Shapajilla, July, 1938, F. Woytkowski, 5 males brachypterous.

BOLIVIA: Victoria, R. Beni, Junction of Madre de Dios and Beni rivers, Oct., 1937, A. M. Olalla, 1 male and 2 females macropterous; El Consuelo, R. Beni, Jan., 1938, A. M. Olalla, 4 males and 10 females macropterous, 12 males and 16 females brachypterous; Las Pampas, R. Beni, Mojos, April, 1938, A. M. Olalla, 1 male and 1 female macropterous, 7 males and 3 females brachypterous; Las Pampas, R. Beni, Mojos, May, 1938, A. M. Olalla, 1 male and 1 female macropterous, 8 males and 3 females brachypterous; Santa Ana del Yacuma, Feb., 1938, A. M. Olalla, 1 male macropterous, 2 males and 2 females brachypterous; Prov. del Sara, Nov. 30, 1912, Steinbach, 1 male macropterous.

PARAGUAY: Villarrica, Loma, July 6, 1923, Fran. Schade, 1 male macropterous.

All specimens listed above are in the Francis Huntington Snow Entomological Collections, University of Kansas, Lawrence, Kansas.

Buenoa incompta n. sp.

(Pl. CXIV, fig. 73)

Size: Male, length 5.00 mm. to 5.20 mm., greatest body width 1.30 mm. to 1.36 mm.; female, length 5.39 mm. to 5.78 mm., greatest body width 1.36 mm. to 1.49 mm.

Color: General facies sordid white to pale testaceous. Head and pronotum sordid white. Thoracic venter and limbs sordid white to brown. Scutellum sordid white, often with two anterolateral brown areas; metathoracic dorsum pale testaceous to light brown. Abdominal venter black except keel and portions of connexivum sordid white; abdominal dorsum yellowish white with irregular areas of black.

Male Structural Characteristics: As viewed from above, outline of head rounded with anterior margin of vertex continuous with that of eyes; greatest width of head approximately five and one half times the anterior width of vertex and less than humeral width of pronotum; synthlipsis very narrow, approximately one fifth the anterior width of vertex, often carinate; along median longitudinal axis, head is one half to three fifths the length of pronotum; notocephalon slightly sulcate dorsally; tylus slightly inflated; labrum with basal width not quite twice its median length and apex moderately rounded; rostral prong (pl. CXIV, fig. 73b) equal to or slightly longer than third rostral segment, with base originating laterally near proximal end of third rostral segment, and with apex bluntly rounded. Pronotum with its median length approximately three fifths its humeral width; disk with two elongate depressions toward the middle and a large subtriangular depression on each side, thus appearing tricarinate; lateral margins divergent; posterior margin convex, medianly concave. Scutellum large but with median length less than that of pronotum. Fore femur (pl. CXIV, fig. 73a) neither wide nor greatly thickened at apex; without stridulatory area. Fore tibia (pl. CXIV, fig. 73a) with stridulatory comb (pl. CXIV, fig. 73c) consisting of approximately twenty-seven to thirty teeth; apical teeth thick and both apical and basal teeth wider and taller than those in center. Fore tarsus with claws more slender and less dissimilar than usual. Chaetotaxy of male front leg as shown on Plate CXIV. Male genital claspers normal. Spine from caudo-sinistral margin of seventh abdominal tergite with apical half very narrow and apex strongly acuminate.

Female Structural Characteristics: As viewed from above, outline of head rounded with anterior margin of vertex continuous with that of eyes; greatest width of head five and one half to six times the anterior width of vertex and less than humeral width of pronotum; synthlipsis very narrow, one sixth to one fifth the anterior width of vertex, often carinate; along median longitudinal axis, head is approximately half the length of pronotum; notocephalon slightly sulcate dorsally; tylus not inflated. Pronotum with its median length slightly more than half its humeral width; disk usually with two shallow, elongate depressions toward the middle forming a faint median carina, not tricarinate; lateral margins divergent; posterior margin convex, medianly concave. Scutellum large, with median length slightly greater than that of pronotum. Female ovipositor of normal shape with teeth arranged in two longitudinal rows which merge proximally; one inner row of few, large teeth and one long, outer row of smaller teeth; approximately three or four small, lateral, toothlike setae near apex.

Comparative Notes: Superficially this species resembles *B. communis* n. sp. Examination of the male, however, will show distinct differences. This species differs from *B. communis* in its smaller size, in having synthlipsis narrower, and in lacking femoral stridulatory area.

Location of Types: Holotype male, allotype female, 26 male and 26 female paratypes, vicinity of João Pessoa, River Juruá, Brazil, July 10 to Sept. 20, 1936, A. M. Olalla. The type series is in the Francis Huntington Snow Entomological Collections, University of Kansas.

Data on Distribution: Known only from Brazil and Bolivia. In addition to type series, specimens from the following localities have been examined:

BRAZIL: *Amazonas:* Vic. Santo Antonio, Sept. 25 to Oct. 17, 1936, A. M. Olalla, 8 males, 9 females.

Parahiba: Vic. João Pessoa, River Juruá, July 10 to Sept. 20, 1936, A. M. Olalla, 45 males, 67 females.

BOLIVIA: Victoria, Rio Beni, October, 1937, A. M. Olalla, 40 males, 37 females; Las Pampas, Rio Beni, April, 1938, A. M. Olalla, 1 male, 1 female.

All specimens listed above are in the Francis Huntington Snow Entomological Collections, University of Kansas, Lawrence, Kansas.

Buenoa oculata n. sp.

(Pl. CIII, fig. 26; pl. CXIV, fig. 72)

Size: Male, length 4.74 mm. to 5.13 mm., greatest body width 1.17 mm. to 1.30 mm.; female, length 4.81 mm. to 5.33 mm., greatest body width 1.23 mm. to 1.36 mm.

Color: General facies sordid white. Head, most of pronotum, thoracic venter, and limbs sordid white. Pronotum often with median and posterior portions orange; scutellum varies from sordid white to orange; metathoracic dorsum sordid white to pale testaceous. Abdominal venter black except keel, portions of connexivum, and last one or two segments, sordid white; abdominal dorsum yellowish white with a median, irregular black area.

Male Structural Characteristics: As viewed from above, outline of head rounded with anterior margin of vertex continuous with that of eyes; greatest width of head approximately five and one half times the anterior width of vertex and equal to or slightly greater than humeral width of pronotum; synthlipsis extremely narrow, approximately one fifteenth the anterior width of vertex; along median longitudinal axis, head is approximately three fourths the length of pronotum; notocephalon slightly sulcate dorsally; tylus slightly inflated; labrum with basal width not quite twice its median length and apex bluntly rounded; rostral prong (pl. CXIV, fig. 72b) slightly longer than third rostral segment, with base originating laterally at a point midway to near proximal end of third rostral segment, and with apex moderately to bluntly rounded. Pronotum with its median length approximately three fifths its humeral width; disk with two shallow, elongate depressions toward the middle forming a faint median carina; lateral margins divergent; posterior margin convex, medianly concave. Scutellum large, with median length greater than that of pronotum. Fore femur (pl. CXIV, fig. 72a) neither wide nor greatly thickened at apex; without stridulatory area. Fore tibia (pl. CXIV, fig. 72a) with stridulatory comb (pl. CXIV, fig. 72c) consisting of approximately twenty-four to twenty-seven teeth; apical teeth slightly wider, taller, and thicker than basal. Intermediate leg with first tarsal segment (pl. CXIV, fig. 72d) slightly emarginate on inner margin. Chaetotaxy of male front leg as shown on Plate CXIV. Male genital claspers (pl. CIII, fig. 26) normal. Spine from caudosinistral margin of seventh abdominal tergite normal, tapering gradually from base to strongly acuminate apex.

Female Structural Characteristics: As viewed from above, outline of head rounded with anterior margin of vertex continuous with that of eyes; greatest width of head five and one half to six times the anterior width of vertex and less than humeral width of pronotum; synthlipsis extremely narrow, approximately one fifteenth the anterior width of vertex; along median longitudinal axis, head is three fourths to four fifths the length of pronotum; notocephalon slightly sulcate dorsally; tylus not inflated. Pronotum with its median length approximately half its humeral width; disk usually unimpressed, occasionally with a faint median carina; lateral margins divergent; posterior margin convex, medianly truncate to slightly concave. Scutellum large, with median length distinctly greater than that of pronotum. Female ovipositor of normal shape with teeth arranged in two longitudinal rows; one inner row of few, large teeth and one long outer row of smaller teeth; approximately two or three small, lateral, toothlike setae near apex.

Comparative Notes: Superficially this species closely resembles *B. amnigenus* (White). Examination of the male, however, will show distinct differences. This species differs from *B. amnigenus* in having the eyes not quite holoptic, frons just above tylus narrower, tylus slightly inflated, and intermediate leg with first tarsal segment emarginate on inner margin.

Location of Types: Holotype male, allotype female, 6 male and 3 female paratypes, vicinity of Rioja, Dept. San Martín, Peru, Sept. 9 to Oct. 3, 1936, F. Woytkowski; other paratypes: 1 male and 4 females, Boquerón del Padre Abad, Dept. Loreta, Peru, Aug. 3-8, 1946, F. Woytkowski. The type series is in the Francis Huntington Snow Entomological Collections, University of Kansas.

Data on Distribution: Known only from type series.

Buenoa salutis Kirkaldy

(Pl. CIII, fig. 39; pl. CXV, fig. 74)

1904. *Buenoa salutis* Kirkaldy, G. W. Wiener Ent. Zeit., vol. XXIII, p. 124.
1909. *Buenoa salutis*, Kirkaldy, G. W. and Torre-Bueno, J. R. de la. Proc. Ent. Soc. Washington, vol. X, p. 201 (catalogue).
1928. *Buenoa mallochi* Jaczewski, T. Ann. Musei Zoologici Polonici, vol. VII, pp. 129-130 (described from Brazil). New synonomy.

Size: Male, length 3.38 mm. to 3.70 mm., greatest body width 1.07 mm. to 1.17 mm.; female, length 3.70 mm. to 4.35 mm., greatest body width 1.10 mm. to 1.30 mm.

Color: General facies sordid white to pale testaceous. This species entirely sordid white to testaceous except abdomen mostly brown to black. Metathoracic dorsum often with a light brown to black, longitudinal stripe on each side. Hemelytra hyalin, often with a light brown to black area at tip of corium.

Male Structural Characteristics: As viewed from above, outline of head rounded with vertex protuberant; greatest width of head approximately three and one half times the anterior width of vertex and equal to or slightly less than humeral width of pronotum; synthlipsis very narrow, less than one tenth the anterior width of vertex; along median longitudinal axis, head is slightly less than the length of pronotum; notocephalon wide, sulcate dorsally; tylus flat, not inflated; labrum short, with basal width more than twice its median length and apex moderately to bluntly rounded; rostral prong (pl. CXV, figs. 74b, 74c) variable, equal to or slightly longer than third rostral segment, with base originating laterally near proximal end of third rostral segment, and with apex moderately to bluntly rounded. Pronotum with its median length two fifths to one half its humeral width; disk usually with two shallow, elongate depressions toward the middle forming a faint median carina; lateral margins slightly divergent; posterior margin slightly convex, medianly concave. Scutellum large, with median length distinctly greater than that of pronotum. Fore femur (pl. CXV, fig. 74a) narrow and not thickened at apex; without stridulatory area. Fore tibia (pl. CXV, fig. 74a) with stridulatory comb (pl. CXV, fig. 74d) consisting of approximately eighteen to twenty teeth; teeth approximately same size and thickness. Chaetotaxy of male front leg as shown on Plate CXV. Male genital claspers normal. Spine from caudo-sinistral margin of seventh abdominal tergite normal, tapering gradually from broad base to acuminate apex.

Macropterous forms are occasionally found. These specimens have head distinctly narrower than humeral width of pronotum; pronotum with lateral margins more divergent; scutellum larger; hemelytra with claval sutures present and large membranes; fully developed flight wings.

Female Structural Characteristics: As viewed from above, outline of head rounded with vertex protuberant; greatest width of head approximately three and one half times the anterior width of vertex and slightly less than humeral width of pronotum; synthlipsis very narrow, one ninth to one seventh the anterior width of vertex; along median longitudinal axis, head is approximately equal to the length of pronotum; notocephalon wide, usually sulcate dorsally; tylus flat, not inflated. Pronotum with its median length approximately two fifths its humeral width; disk usually unimpressed, occasionally with a faint median carina; lateral margins divergent; posterior margin slightly convex, medianly concave. Scutellum large, with median length distinctly greater than that of pronotum. Female ovipositor (pl. CIII, fig. 39) of normal shape with teeth arranged in three longitudinal rows; one inner row of large teeth, one median row of normal teeth, and one outer row of smaller teeth; approximately four to seven small, lateral, toothlike setae near apex.

Macropterous forms are occasionally found. These specimens have head distinctly narrower than humeral width of pronotum; pronotum with lateral margins more divergent; scutellum much larger; hemelytra with claval sutures present and large membranes; fully developed flight wings.

Variation Within Species: As is indicated under measurements of length, this species varies somewhat in size; there is also considerable variation in the proportional size of notocephalon, synthlipsis, and pronotum. The greatest contrast is shown between a series from Itaquaquecetupa, Brazil and one from San Esteban, Venezuela. The former is a larger form, with a slightly wider synthlipsis, and a less curved rostral prong.

Comparative Notes: This is our smallest *Buenoa* species. Superficially it somewhat resembles *B. amnigenus* (White). Examination of the male, however, will show distinct differences. This species differs from *B. amnigenus* in having a wider notocephalon, and in the form of the rostral prong, fore femur, and tibial comb. *Buenoa salutis* is much smaller than *B. amnigenus.*

Nomenclatorial Notes: Mr. C. O. Bare labeled a series of *B. salutis* as types and paratypes, using a manuscript name based on the state of origin, Amazonas, Brazil. As such paratypes may have been widely distributed, it seems desirable to point out that the name has not been, and should not be, validated by publication.

Examination of large series of *B. salutis* has led to the conclusion that *B. mallochi* Jaczewski is a variant of this species and is therefore placed in synonomy with *B. salutis.*

Location of Types: The type, a macropterous female, labeled "I. du Salut, Mus. Paris, Gayane, Pingi 1882", is located at the Paris Museum. A cotype, also a macropterous female and labeled as above, is now in the Francis Huntington Snow Entomological Collections, University of Kansas.

Data on Distribution: Recorded from Venezuela, British Guiana, French Guiana, Brazil, Bolivia and Paraguay. Specimens from the following localities have been examined:

VENEZUELA: San Esteban, Jan. 15, 1940, Pablo J. Anduze, 4 males and 5 females brachypterous, 1 nymph.

BRITISH GUIANA: Lamaha Conservancy, Demerara, July 23, 1932, S. Harris, 12 males and 12 females brachypterous, 22 males and 25 females macropterous, 5 nymphs; Georgetown Bot. Gardens, Oct. 23, 1937, S. Harris, 5 females macropterous; Georgetown Bot. Gardens, Nov. 6, 1937, S. Harris, 4 males macropterous.

FRENCH GUIANA: Iles du Salut, 1882, Pingi, 1 female macropterous; Ile Royale, April, 1913, Planchon, 1 male brachypterous, 1 male macropterous; Charvein, July, Coll. Le Moult, 1 male and 2 females macropterous (U.S.N.M.); Charvein, September, Coll. Le Moult, 1 female macropterous (U.S.N.M.).

BRAZIL: *Amazonas:* Manacapurú, Manáos, March, 1928, S. M. Klages, 2 males and 3 females brachypterous, 4 females macropterous; Rio Negro, Manáos, Oct., 1935, A. M. Olalla, 9 males and 12 females brachypterous, 1 male and 3 females macropterous.

Pará: Santarém, Dec. 11, 1909, No. 4043, 2 females macropterous (Carnegie Mus.).

Ceará: Nr. Icó, artificial Lake, July 22, 1937, S. Wright, 1 male brachypterous; Lagôa, Fortaleza, Aug. 3, 1937, S. Wright, 1 male brachypterous.

Parahiba: Santa Luzia, No. 245 & 260, S. Wright, 3 males and 2 females brachypterous; Vic João Pessoa, River Juruá, July 10 and Sept. 20, 1936, A. M. Olalla, 1 male and 5 females brachypterous.

Pernambuco: Triumfo, No. 5475, 11017, and 11395, S. Wright, 9 males and 2 females brachypterous, 1 male macropterous.

São Paulo: São Paulo, Aug. 7, 1927, E. D. Townsend, 4 females brachypterous; São Paulo, Nov., 1928, E. D. Townsend, 3 females brachypterous; Itaqüaquecetupa, July, 1933, W. O. Townsend, 16 males and 46 females brachypterous; Itaqüaquecetupa, E. Townsend, 105 males and 130 females brachypterous, 4 females macropterous, 7 nymphs; Ypirango, R. Spitz, 2 females brachypterous; Pirassununga water reservoir, July 30, 1940, H. Kleerekoper, 7 males and 4 females brachypterous.

Rio Grande do Sul: Porto Alegre, July 1941, H. Kleerekoper, 13 males and 8 females brachypterous; Near Porto Alegre, Aug., 1941, H. Kleerekoper, 4 males and 4 females brachypterous.

BOLIVIA: Prov. del Sará, Nov. 3, 1912, Steinbach; 1 female macropterous; Río Beni, Victoria, Oct., 1937, A. M. Olalla, 2 males brachypterous, 1 male macropterous; Río Beni, Consuelo, Jan., 1938, A. M. Olalla, 2 females macropterous; Río Beni, Las Pampas, Mojos, Apr. & May, 1938, A. M. Olalla, 7 males and 4 females brachypterous, 9 males and 2 females macropterous; Santa Ana del Yacuma, Feb., 1938, A. M. Olalla, 3 males and 5 females brachypterous; Santa Rosa del Yacuma, Feb., 1938, A. M. Olalla, 2 males and 2 females brachypterous, 1 female macropterous; Puerto Suárez, No. 3844, J. Steinbach, 3 males and 3 females macropterous (Carnegie Mus.).

PARAGUAY: Villarrica, Dec., 1923, Fran. Schade, 1 male and 1 female brachypterous; Villarrica, Apr. 16, 1924, Fran. Schade, 1 male macropterous; Albovena Srojoguasi, Dec., 1926, Fran. Schade, 1 male and 4 females brachypterous, 1 nymph; Reimoser, Centurión, 3 females macropterous (Berlin Mus.).

All specimens listed above are in the Francis Huntington Snow Entomological Collections, University of Kansas, Lawrence, Kansas, unless otherwise indicated.

Buenoa thomasi n. sp.

(Pl. CIII, fig. 25; pl. CXV, fig. 76)

Size: Male, length 5.26 mm. to 5.72 mm., greatest body width 1.49 mm. to 1.69 mm.; female, length 5.46 mm. to 6.04 mm., greatest body width 1.69 mm. to 1.82 mm.

Color: General facies sordid white to gray. Head, pronotum, most of thoracic venter, and limbs sordid white to pale testaceous. Scutellum usually pale testaceous, occasionally with base brown to black; metathoracic dorsum pale testaceous to black. Abdomen black except ventral keel and portions of connexivum and dorsum, sordid white to testaceous. Some specimens entirely sordid white to testaceous except portions of abdomen, black. This species variable in color.

Male Structural Characteristics: As viewed from above, outline of head rounded with vertex usually indented at lateral margins; greatest width of head approximately five to five and one half times the anterior width of vertex and less than humeral width of pronotum; synthlipsis one third to one half the anterior width of vertex; along median longitudinal axis, head is one half to two thirds the length of pronotum; notocephalon usually sulcate dorsally; tylus slightly inflated; labrum with basal width not quite twice its median length and apex bluntly rounded; rostral prong (pl. CXV, fig. 76c) equal to or longer than third rostral segment, with base originating laterally midway of third rostral segment, and with apex bluntly rounded. Pronotum with its median length approximately three fifths its humeral width; disk with two elongate depressions toward the middle and a large subtriangular depression on each side, thus appearing tricarinate; lateral margins divergent; posterior margin convex, slightly concave medianly. Scutellum with median length equal to or greater than that of pronotum. Fore femur (pl. CXV, fig. 76a) relatively narrow and not greatly thickened at apex; without stridulatory area. Fore tibia (pl. CXV, fig. 76a) with stridulatory comb (pl. CXV, fig. 76b) consisting of approximately twenty-four to thirty-six teeth; apical teeth thicker than basal; ten to seventeen short, stout, club-shaped setae (pl. CXV, fig. 76d) on inner surface of tibia at apex. Chaetotaxy of male front leg as shown on Plate CXV. Male genital claspers (pl. CIII, fig. 25) normal. Spine from caudo-sinistral margin of seventh abdominal tergite tapering gradually from base to strongly acuminate apex.

Female Structural Characteristics: As viewed from above, outline of head rounded with vertex usually indented at lateral margins; greatest width of head five to five and one half times the anterior width of vertex and less than humeral width of pronotum; synthlipsis one third to one half the anterior width of vertex; along median longitudinal axis, head is three fifths to two thirds the length of pronotum; notocephalon sulcate dorsally; tylus slightly inflated. Pronotum with its median length approximately half its humeral width; disk with two shallow, elongate depressions toward the middle and a shallow, subtriangular depression on each side, thus appearing faintly tricarinate, often with median carina only; lateral margins divergent; posterior margin convex, medianly truncate to slightly concave. Scutellum with median length greater than that of pronotum. Female ovipositor of normal shape with teeth arranged in two longitudinal rows which merge in proximal half of ovipositor valve; one inner row of large teeth and one outer row of smaller teeth; approximately four to six small, lateral, toothlike setae near apex.

Comparative Notes: Superficially this species resembles *B. platycnemis* (Fieber). Examination of the male, however, will show distinct differences. This species differs from *B. platycnemis* in having an area of short, stout, club-shaped setae on inner surface of fore tibia at apex, in lacking a femoral stridulatory area, and in the form of the rostral prong and tibial comb.

Location of Types: Holotype male, allotype female, 18 male and 3 female paratypes, San Luis Babarocos (= Barbacoas ?), Chihuahua, Mexico, Dec. 30, 1934, H. S. Gentry; other paratypes: 7 males and 6 females, Carimechi, Río Mayo, Chihuahua, Mexico, Jan. 6, 1935, H. S. Gentry. The type series is in the Francis Huntington Snow Entomological Collections, University of Kansas.

Data on Distribution: Recorded from Mexico and known only from type series.

Buenoa alterna n. sp.

(Pl. CIII, fig. 35; pl. CXV, fig. 77)

Size: Male, length 5.65 mm. to 5.98 mm., greatest body width 1.56 mm. to 1.62 mm.; female, length 6.30 mm. to 6.76 mm.; greatest body width 1.88 mm. to 2.08 mm.

Color: General facies sordid white to gray. Head, pronotum, thoracic venter, and limbs sordid white to testaceous. Scutellum with basal portion black, apical portion yellow to orange; metathoracic dorsum usually black with broad, median, transverse yellow to orange band, occasionally entirely black. Abdomen black except ventral keel and portions of connexivum and dorsum, sordid white to testaceous. Hemelytra colorless but with black portions of thorax and abdomen shining through giving a gray appearance to the specimen. Some specimens entirely sordid white to testaceous except portions of abdomen, black.

Male Structural Characteristics: As viewed from above, outline of head rounded with anterior margin of vertex continuous with that of eyes, occasionally indented at lateral margins; greatest width of head six to six and one half times the anterior width of vertex and less than humeral width of pronotum; synthlipsis narrow, approximately half the anterior width of vertex; along median longitudinal axis, head is approximately three fifths the length of pronotum; notocephalon narrow, slightly sulcate dorsally; tylus not inflated; labrum with basal width slightly more than twice its median length and apex bluntly rounded; rostral prong (pl. CXV, fig. 77b) short, shorter than third rostral segment, with base originating laterally at proximal end of third rostral segment, and with apex bluntly rounded. Pronotum with its median length slightly more than half its humeral width; disk usually with two shallow, elongate depressions toward the middle forming a faint median carina, not tricarinate; lateral margins divergent; posterior margin convex, medianly truncate to slightly concave. Scutellum large, with median length greater than that of pronotum. Fore femur (pl. CXV, fig. 77a) neither wide nor strongly thickened at apex; without stridulatory area. Fore tibia (pl. CXV, fig. 77a) with stridulatory comb (pl. CXV, fig. 77c) consisting of approximately fifteen to nineteen teeth; apical teeth slightly thicker than basal. Chaetotaxy of male front leg as shown on Plate CXV. Male genital claspers normal. Spine from caudo-sinistral margin of seventh abdominal tergite tapering gradually from base to strongly acuminate apex.

Female Structural Characteristics: As viewed from above, outline of head rounded with anterior margin of vertex continuous with that of eyes; greatest width of head five and one half to six times the anterior width of vertex and less than humeral width of pronotum; synthlipsis slightly less than half the anterior width of vertex; along median longitudinal axis, head is one half to three fifths the length of pronotum; notocephalon slightly sulcate dorsally; tylus not inflated. Pronotum with its median length slightly less than half its humeral width; disk usually unimpressed, occasionally with faint median carina; lateral margins divergent; posterior margin convex, medianly truncate to slightly concave. Scutellum large, with median length distinctly greater than that of pronotum. Female ovipositor (pl. III, fig. 35) of normal shape with teeth arranged in three longitudinal rows which merge proximally; one inner row of large teeth, one short median row of normal teeth, and one long outer row of small teeth; approximately five or six small, lateral, toothlike setae near apex.

Comparative Notes: Superficially this species resembles *B. mutabilis* n. sp. and *B. omani* n. sp. Examination of the male, however, will show distinct differences. This species differs from *B. omani* in having tylus not inflated, frons just above tylus wider, fore femur narrow at apex, and in lacking a femoral stridulatory area. *Buenoa alterna* differs from *B. mutabilis* in having a distinctly different rostral prong and in lacking a femoral stridulatory area.

Location of Types: Holotype male, allotype female, 6 male and 5 female paratypes, Puebla, Mexico, July 25, 1937, H. D. Thomas; other paratypes: 4 males, Hda. La Libertad, Chiapas, Mexico, Sept. 1, 1937, H. D. Thomas; 1 male and 4 females, Los Potosí, Zacatecas, Mexico, Aug. 8, 1944, H. D. Thomas. The type series is in the Francis Huntington Snow Entomological Collections, University of Kansas.

Data on Distribution: Known only from Mexico. Specimens from the following localities have been examined:

MEXICO: *Zacatecas:* Los Potosí, Aug. 8, 1944, Henry Thomas, 4 males.

Hidalgo: Real del Monte, Sept. 23, 1938, H. D. Thomas, 1 male, 2 females.

Puebla: Puebla, July 25, 1937, H. D. Thomas, 7 males, 6 females.

Chiapas: Hda. La Libertad, Sept. 1, 1937, H. D. Thomas, 1 male, 4 females.

All specimens listed above are in the Francis Huntington Snow Entomological Collections, University of Kansas, Lawrence, Kansas.

Buenoa unguis n. sp.

(Pl. CXV, fig. 78)

Size: This species varies considerably in size within the same population. Male, length 5.90 mm. to 7.07 mm., greatest body width 1.49 mm. to 1.75 mm.; female, length 5.85 mm. to 7.10 mm., greatest body width 1.62 mm. to 1.88 mm.

Color: General facies sordid white to pale testaceous. Head, thorax, and limbs sordid white to pale testaceous; scutellum occasionally with two anterolateral brown to black areas. Abdominal venter black except keel and portions of connexivum, yellowish white; abdominal dorsum brown to black with anterior portion usually yellowish white to pale testaceous.

Male Structural Characteristics: As viewed from above, outline of head rounded with anterior margin of vertex slightly indented to continuous with that of eyes; greatest width of head four and one half to five times the anterior width of vertex and less than humeral width of pronotum; synthlipsis narrow, one sixth to one fifth the anterior width of vertex; along median longitudinal axis, head is approximately three fifths the length of pronotum; notocephalon sulcate; tylus flat, depressed longitudinally forming distinct lateral carinae; labrum with basal width more than twice its median length; rostrum with a distinct, median, longitudinal carina; rostral prong (pl. CXV, fig. 78c) short, distinctly shorter than third rostral segment, with base originating laterally at proximal end of third rostral segment, and with apex bluntly rounded. Pronotum with its median length approximately four sevenths its humeral width; disk with two elongate depressions toward the middle forming a median carina, occasionally with a shallow, subtriangular depression on each side, appearing faintly tricarinate; lateral margins divergent; posterior margin convex, slightly concave medianly. Scutellum large, with median length greater than that of pronotum. Fore femur (pl. CXV, fig. 78a) narrow, somewhat thickened at apex; without stridulatory area. Fore tibia (pl. CXV, fig. 78a) with stridulatory comb (pl. CXV, fig. 78b) consisting of approximately nineteen to twenty teeth, with four or five long setae at apex; apical teeth are slightly thicker than basal. Fore tarsus (pl. CXV, fig. 78d) robust with unusual tarsal claws. Chaetotaxy of male front leg as shown on Plate CXV. Male genital claspers normal. Spine from caudo-sinistral margin of seventh abdominal tergite normal, tapering gradually from base to a curved, strongly acuminate, apex.

Female Structural Characteristics: As viewed from above, outline of head rounded with anterior margin of vertex continuous with that of eyes; greatest width of head four and one half to five times the anterior width of vertex and less than humeral width of pronotum; synthlipsis narrow, one seventh to one fifth the anterior width of vertex; along median longitudinal axis, head is two fifths to three fifths the length of pronotum; notocephalon slightly sulcate; tylus flat, depressed longitudinally forming faint lateral carinae.

Pronotum with its median length slightly less than half its humeral width; disk with two, shallow elongate depressions toward the middle forming a faint median carina; lateral margins divergent; posterior margin convex, medianly concave. Scutellum large, with median length greater than that of pronotum. Female ovipositor of normal shape with teeth arranged in two longitudinal rows; one inner row of large teeth and one outer row of smaller teeth; approximately three or four small, lateral, toothlike setae near apex.

Comparative Notes: Superficially this species somewhat resembles *B. albida* (Champion) and *B. gracilis* n. sp. Examination of the male, however, will show distinct differences. This species differs from *B. albida* and *B. gracilis* in having a distinctly shorter rostral prong, rostrum with a median carina, fore femur without stridulatory area, and distinct differences in the tibial comb, fore tarsus and tarsal claws.

Location of Types: Holotype male, allotype female, 40 male and 40 female paratypes, Vicinity of Rioja, Dept. San Martín, Perú, Sept. 9 to Oct. 3, 1936, F. Woytkowski. The type series is in the Francis Huntington Snow Entomological Collections, University of Kansas.

Data on Distribution: Known from Brazil, Peru, Bolivia, Paraguay, and Argentina. In addition to type series, specimens from the following localities have been examined:

BRAZIL: *Pará:* Lago Grande, Feb., 1939, A. M. Olalla, 7 males 5 females.

Ceará: Agua Verde, July 6, 1937, S. Wright, 16 males, 13 females; Russas, July 22, 1937, S. Wright, 2 males, 2 females; Sobral, Oct. 26, 1937, S. Wright, 3 males, 12 females; Primavera, Oct. 28, 1937, S. Wright, 2 males, 18 females; Cheré, Oct. 29, 1937, S. Wright, 2 females; Maranguape, Nov. 3, 1937, S. Wright, 2 males, 1 female; Bom Acude Successo, Nov. 4, 1937, S. Wright, 3 males, 10 females; Sobral, Nov. 26, 1937, S. Wright, 3 males, 19 females.

Rio Grande do Norte: Ouro Branco, No. 258, S. Wright, 2 males; Caico, No. 327, S. Wright, 1 male.

Perahiba: Souza, No. 5530, S. Wright, 1 male, 1 female.

Pernambuco: Belém, No. 643, S. Wright, 1 male; Itapissuma, Oct. 25, 1946, F. S. Barbosa, 2 males, 2 females.

Minas Geraes: Bello Horizonte, Apr., 1935, D. M. Cochran, 3 males, 1 female (U.S.N.M.).

Rio de Janeiro: São Paulo Road, June 19, 1945, Wygodzinsky, 1 male, 1 female.

PERU: Vic. Rioja, Dept. San Martín, Sept. 9 to Oct. 3, 1936, F. Woytkowski, 37 females.

BOLIVIA: Junction of Madre de Dios and Beni Rivers, Victoria, Oct., 1937, A. M. Olalla, 32 males, 45 females; Santa Ana del Yacuma, Feb., 1938, A. M. Olalla, 17 males, 15 females; Rio Beni, Las Pampas, Mojos, April and May, 1938, A. M. Olalla, 8 males, 4 females.

PARAGUAY: Estancia Postillón, Puerto Max a. Río Paraguay, Mar. 9, 1905, Louis Des Arts, 2 males, 1 female (Hamburg Mus.).

ARGENTINA: Chaco, No. 7726, 1 male.

All specimens listed above are in the Francis Huntington Snow Entomological Collections, University of Kansas, Lawrence, Kansas, unless otherwise indicated.

Buenoa excavata n. sp.

(Pl. CII, fig. 12; pl. CXV, fig. 75)

Size: Male, length 4.55 mm., greatest body width 1.30 mm.; known only from the male.

Color: General facies sordid white. Head, pronotum, most of thoracic venter, and scutellum sordid white. Portions of thoracic venter orange to brown; metathoracic dorsum colorless to sordid white. First two pairs of legs testaceous to nigro-violaceous; hind legs mostly yellowish white. Abdomen black with anterior portion of connexivum orange. Hemelytron colorless except for nigro-violaceous band covering humeral angle and extending along anterior margin of wing for approximately one third its length and a large black area at tip of corium.

Male Structural Characteristics: As viewed from above, outline of head rounded with anterior margin of vertex continuous with that of eyes; eyes almost holoptic; greatest width of head approximately five and one half times the anterior width of vertex and slightly less than humeral width of pronotum; synthlipsis extremely narrow, approximately one fifteenth the anterior width of vertex; a'ong median longitudinal axis, head is distinctly longer than pronotum; notocephalon indented at synthlipsis, sulcate anterodorsally; tylus deeply excavate with a short antero-medial ridge; labrum distinctly inflated, with basal width more than twice its median length and apex truncate; rostral prong (pl. CXV, fig. 75b) as long as third rostral segment, with base originating laterally near proximal end of third rostral segment, and with apex moderately rounded. Pronotum short, with its median length approximately two fifths its humeral width; disk unimpressed, not carinate; lateral margins divergent; posterior margin convex, slightly concave medianly. Scutellum large, with median length distinctly greater than that of pronotum. Fore femur (pl. CXV, fig. 75a) neither wide nor greatly thickened at apex; without stridulatory area. Fore tibia (pl. CXV, fig. 75a) angulate anteriorly, with stridulatory comb (pl. CXV, fig. 75c) consisting of approximately seventeen teeth; apical teeth thicker than basal; a swollen area on inner surface of tibia at apex, densely covered with fine setae. Chaetotaxy of male front leg as shown on Plate CXV. Male genital claspers normal. Spine from caudo-sinistral margin of seventh abdominal tergite (pl. CII, fig. 12) unusually wide for most of length; apical one fourth narrow and apex strongly acuminate.

Only the brachypterous male is known for this species.

Comparative Notes: This species is quite distinct and its relationship to the other species of the genus is obscure. The deeply excavate tylus, the inflated labrum, and the form of the fore tibia separates *B. excavata* from all other species.

Location of Types: Holotype male (brachypterous), Santa Elena Boquerón Padre Abad, Dept. Loreto, Peru, Aug. 8, 1946, F. Woytkowski. Holotype is in the Francis Huntington Snow Entomological Collections, University of Kansas.

Data on Distribution: Known only from type.

Buenoa macrophthalma (Fieber)

(Pl. CII, fig. 3; pl. CIII, fig. 27; pl. CXVI, fig. 79)

1851. *Anisops macrophthalmus* Fieber, F. X. Abhandlungen Köngl. Böhmischen Geselschaft Wissenschaften, vol. VII, Folge 5, pp. 482-483.
1904. *Buenoa macrophthalma*, Kirkaldy, G. W. Wiener Ent. Zeit., vol. XXIII, pp. 121-122, and 134 (taxonomic notes).
1930. *Buenoa macrophthalma*, Wolcott, G. N. Jr. Agriculture Univ. Puerto Rico, vol. XX, p. 149.
1939. *Buenoa macrophthalma*, Barber, H. G. New York Acad. Sci., vol. XIV, p. 420.

Size: This species varies considerably in size due to the larger macropterous forms. Male, length 8.51 mm. to 10.85 mm., greatest body width 2.47 mm. to 3.18 mm.; female, length 9.10 mm. to 9.75 mm., greatest body width 2.73 mm. to 2.92 mm.

Color: The brachypterous and macropterous forms vary in color as well as in other characteristics. The general facies of the former is sordid white to testaceous while the latter is black. The body of the brachypterous form is entirely sordid white to testaceous except for abdominal venter, portions of connexivum, and laterally above connexivum on dorsum of abdomen, black. The macropterous form has head, anterior portions of pronotum, thoracic venter, and limbs, mostly testaceous to light brown. Scutellum, metathoracic dorsum, and abdomen black except for ventral keel and margins of connexivum, testaceous. Hemelytron black except for an area behind humeral angle and a wide band along the claval suture, colorless.

Male Structural Characteristics: As viewed from above, outline of head laterally rounded, anteriorly truncate with vertex indented especially at its lateral margins; greatest width of head approximately five and one half times the anterior width of vertex and usually slightly less but occasionally equal to or greater, than humeral width of pronotum; synthlipsis less than one third the anterior width of vertex; along median longitudinal axis, head almost as long as pronotum; notocephalon sulcate dorsally; tylus strongly inflated with median depression forming two lateral protuberances; labrum with basal width approximately two thirds greater than its median length and apex bluntly rounded; rostral prong (pl. CXVI, fig. 79a) extremely long, much longer than third rostral segment, with base originating laterally at distal end of third rostral segment, and with apex moderately rounded. Pronotum with its median length slightly more than half its humeral width; disk usually with two elongate depressions toward the middle and a shallow, subtriangular depression on each side, thus appearing faintly tricarinate; lateral margins divergent; posterior margin slightly convex, medianly concave. Scutellum with median length distinctly greater than that of pronotum. Fore femur (pl. CXVI, fig. 79b) wide and thickened at apex; without stridulatory area. Fore tibia (pl. CXVI, fig. 79b) with stridulatory comb (pl. CXVI, fig. 79b) consisting of approximately seventeen thick teeth of uniform size. Chaetotaxy of male front leg as shown on Plate CXVI. Male genital claspers (pl. CIII, fig. 27) abnormal in shape. Spine from caudo-sinistral margin of seventh abdominal tergite (pl. II, fig. 3) relatively short and thick, tapering gradually from broad base to acuminate apex.

Macropterous forms are occasionally found. These specimens are black and larger in size than the brachypterous forms. They have head distinctly narrower than humeral width of pronotum; pronotum with lateral margins more divergent; scutellum larger; hemelytra with claval sutures present and large membranes; fully developed flight wings.

Female Structural Characteristics: As viewed from above, outline of head laterally rounded, anteriorly truncate with vertex indented only at lateral margins; greatest width of head five to five and one half times the anterior width of vertex and less than humeral width of pronotum; synthlipsis approximately one third the anterior width of vertex; along median longitudinal axis, head almost as long as pronotum; notocephalon sulcate dorsally; tylus inflated. Pronotum with its median length less than half its humeral width; disk only slightly impressed, usually not tricarinate; lateral margins divergent; posterior margin slightly convex, medianly concave. Scutellum with median length distinctly greater than that of pronotum. Female ovipositor of normal shape with teeth arranged in two longitudinal rows; one very short inner row of approximately seven large teeth and one long outer row of small teeth; approximately four or five small, lateral, toothlike setae near apex.

Macropterous forms are occasionally found. These specimens are black and larger in size than the brachypterous forms. They have head distinctly narrower than humeral width of pronotum; pronotum with lateral margins more divergent; scutellum larger; hemelytra with claval sutures present and large membranes; fully developed flight wings.

Variation Within Species: As is indicated under measurements of length, this species varies a great deal in size; there is also some variation in the proportional size of the pronotum. The greatest contrast is shown between males of series from Jamaica, B. W. I., and Cuba. The former is a small form, the males are seldom more than 8.50 mm. in length, lack a short longitudinal carina on inner surface of intermediate tibia at the base, and have normal and similar claws on intermediate tarsus; the males of the latter form are approximately 10 mm. in length, have a short longitudinal carina on inner surface of intermediate tibia at the base, and have one long, narrow, distorted claw and a short, broad, flat claw on intermediate tarsus. Due to the fact that all important and constant characters used in species determination are identical in these two forms, no specific separation appears justified.

Comparative Notes: Superficially this species resembles *B. hungerfordi* n. sp. Examination of the male, however, will show distinct differences. The form of the rostral prong alone will serve to distinguish this species from all others. It differs from *B. hungerfordi* not only in the form of the rostral prong, but also in having a strongly inflated tylus, the fore femur greatly thickened at apex, a distinct tibial stridulatory comb, and a difference in the form of the tarsal claws on fore and intermediate legs.

Location of Types: The type specimen, a male, from Port au Prince, Haiti, is located at the Berlin Museum. This specimen is leucochromatic and I assume therefore, a brachypterous form.

Homotype male, labeled "Adjuntas, P. R., June 8-13, 1915", compared with type by Dr. H. B. Hungerford, University of Kansas, now located in the Francis Huntington Snow Entomological Collections, University of Kansas.

Data on Distribution: Recorded from West Indies—(Cuba, Haiti, Jamaica, and Puerto Rico). Specimens from the following localities have been examined:

WEST INDIES: *Cuba:* Cuba, Feb. 2, 1932, Ernesto Pujals y de Quesada, 1 male and 2 females macropterous, 2 males and 1 female brachypterous.

Jamaica: St. Andrew, Shooters Hill, Dec. 3, 1946, G. B. Thompson, 1 female brachypterous; St. Andrew, Hermitage, Feb. 14, 1947, G. B. Thompson, 1 male brachypterous.

Puerto Rico: Adjuntas, June 8-13, 1915, 1 male macropterous; Maricao R., Stn. Maricao, Feb. 20, 1934, S. Hildebrand, 1 female macropterous, 1 male brachypterous (U.S.N.M.); Ponce, Río Finca, July 12, 1934, R. G. Oakley, 1 female macropterous (U.S.N.M.); Lares Guajataca R., Mar. 22, 1935, Julio Garcia Diaz, 1 female macropterous, 1 male and 3 females brachypterous, 2 nymphs.

All specimens listed above are in the Francis Huntington Snow Entomological Collections, University of Kansas, Lawrence, Kansas, unless otherwise indicated.

Buenoa hungerfordi n. sp.

(Pl. CII, figs. 14, 21; pl. CIII, figs. 23, 41; pl. CXVI, fig. 80)

Size: Male, length 10.01 mm. to 10.79 mm., greatest body width 2.99 mm. to 3.12 mm.; female, length 9.94 mm. to 10.20 mm., greatest body width 3.12 mm. to 3.51 mm.

Color: General facies yellowish white to black. Head, most of pronotum, thoracic venter, and limbs yellowish white to pale testaceous. Pronotum usually with a median, subtriangular, light brown to black area; scutellum usually black with posterolateral margins yellowish white; metathoracic dorsum light brown to black. Abdomen black except ventral keel and portions of connexivum and dorsum, yellowish white. Hemelytra hyalin with posterior half light brown to black. Some specimens entirely yellowish white to pale testaceous except most of abdomen, black. This species variable in color.

Male Structural Characteristics: As viewed from above, outline of head laterally rounded, anteriorly truncate with vertex protuberant; greatest width of head four and one half times the anterior width of vertex and less than humeral width of pronotum; synthlipsis wide, approximately two thirds the anterior width of vertex; along median longitudinal axis, head is slightly less than half the length of pronotum; notocephalon wide, sulcate dorsally; tylus inflated, distinctly pilose; labrum pilose, with basal width not quite twice its median length and apex bluntly rounded; rostral prong (pl. CXVI, fig. 80b) short, distinctly shorter than third rostral segment, with base originating laterally near proximal end of third rostral segment, and with apex moderately to bluntly rounded. Pronotum with its median length slightly less than half its humeral width; disk with two shallow, elongate depressions toward the middle forming a faint median carina; lateral margins divergent; posterior margin convex, medianly concave. Scutellum large, with median length greater than that of pronotum. Fore femur (pl. CXVI, fig. 80a) neither wide nor greatly thickened at apex; without stridulatory area. Fore tibia with stridulatory comb (pl. CXVI, fig. 80a) consisting of approximately fifteen to seventeen thick teeth; all teeth approximately same size and thickness. Tarsal claws of fore leg dissimilar; one with narrow, acuminate apex and the other with blunt, slightly bifurcate apex. Chaetotaxy of male front leg as shown on Plate CXVI. Male genital claspers (pl. CIII, fig. 23) abnormal in shape. Spine from caudo-sinistral margin of seventh abdominal tergite (pl. CII, fig. 14) broad, sickle-shaped, lying horizontally rather than in usual vertical position.

Female Structural Characteristics: As viewed from above, outline of head laterally rounded, anteriorly truncate with vertex protuberant; greatest width of head three and one half times the anterior width of vertex and distinctly less than humeral width of pronotum; synthlipsis wide, approximately half the anterior width of vertex; along median longitudinal axis, head is slightly more than half the length of pronotum; notocephalon wide, sulcate dorsally; tylus inflated, not pilose. Pronotum with its median length approximately two fifths its humeral width; disk with two shallow, elongate depressions toward the middle forming a faint median carina; lateral margins divergent; posterior margin convex, medianly concave. Scutellum large, with median length distinctly greater than that of pronotum. Female ovipositor (pl. CIII, fig. 41) abnormal in shape with teeth arranged in a long, irregular, curved row; approximately two or three small, lateral, toothlike setae.

Variation Within Species: Occasionally specimens are found with flight wings not fully developed. These specimens are pale in color with pronotum narrower and lateral margins less divergent, scutellum smaller, and hemelytral membranes smaller than the form with fully developed flight wings. Both forms have claval sutures present in the hemelytra.

Comparative Notes: Superficially this species resembles *B. macrophthalma* (Fieber) and *B. distincta* n. sp. Examination of the male, however, will show distinct differences. This species differs from *B. macrophthalma* in having the tylus less inflated, rostral prong much shorter, fore femur narrower at apex, and differences in the tibial comb and tarsal claws. *Buenoa hungerfordi* differs from *B. distincta* in having the tylus distinctly more pilose, spine from caudo-sinistral margin of seventh abdominal tergite sickle-shaped, differences in the genital capsule as shown on Plate CII, and in its larger size.

Location of Types: Holotype male, allotype female, 1 male and 2 female paratypes, Conejos, Dist. Alamos, Sonora, Mexico, Oct. 26, 1934, H. S. Gentry; other paratypes: 2 males and 3 females, Arroyo S. Marcial, District Alamos, Sonora, Mexico, Oct. 28, 1934, H. S. Gentry; 1 male, L. Tepancuapan, Chiapas, Mexico, Aug. 28, 1937, H. D. Thomas; 1 male, Sabino Canyon, Arizona, U. S. A., July 12, 1932, R. H. Beamer. The type series is in the Francis Huntington Snow Entomological Collections, University of Kansas.

Data on Distribution: Known only from United States and Mexico. In addition to type series, specimens from the following localities have been examined:

U. S. A.: *Arizona:* Catalina Mts., Sept. 29, 1941, Victor Potter, 2 males, 2 females (U. of Mich.).

MEXICO: *Chihuahua:* Carimechi, Río Mayo, Dec. 12, 1934, H. S. Gentry, 1 female; San Luis Babarocos (= Barbacoas ?), Dec. 30, 1934, H. S. Gentry, 1 female.

All specimens listed above are in the Francis Huntington Snow Entomological Collections, University of Kansas, Lawrence, Kansas, unless otherwise indicated.

Buenoa distincta n. sp.

(Pl. CII, figs. 13, 22; pl. CIII, fig. 24; pl. CXVII, fig. 81)

Size: Male, length 8.45 mm., greatest body width 2.27 mm.; known only from the male.

Color: General facies gray. Head, pronotum, most of thoracic venter, and limbs sordid white to pale testaceous. Scutellum black with apex and lateral margins yellowish white; metathoracic dorsum black, appearing gray through hyalin hemelytra. Abdomen black except ventral keel and portions of connexivum and dorsum, yellowish white. Hemelytra hyalin with membrane light brown to black.

Male Structural Characteristics: As viewed from above, outline of head laterally rounded, anteriorly truncate with vertex protuberant; greatest width of head approximately four and one half times the anterior width of vertex and distinctly less than humeral width of pronotum; synthlipsis slightly less than half the anterior width of vertex; along median longitudinal axis, head is approximately four sevenths the length of pronotum; notocephalon wide, sulcate dorsally; tylus slightly inflated; labrum with basal width not quite twice its median length and apex moderately rounded; rostral prong (pl. CXVII, fig. 81c) short, shorter than third rostral segment, with base originating laterally near proximal end of third rostral segment, and with apex bluntly rounded. Pronotum with its median length slightly less than half its humeral width; disk with two elongate depressions toward the middle forming a median carina; lateral margins divergent; posterior margin convex, medianly concave. Scutellum large, with median length distinctly greater than that of pronotum. Fore femur (pl. CXVII, fig. 81a) neither wide nor greatly thickened at apex; without stridulatory area. Fore tibia (pl. CXVII, fig. 81a) with stridulatory comb (pl. CXVII, fig. 81b) consisting of approximately fourteen thick teeth; all teeth approximately same size and thickness. Tarsal claws of fore leg dissimilar; one with narrow, acuminate apex and the other with blunt, slightly bifurcate apex. Chaetotaxy of male front leg as shown on Plate CXVII. Male genital claspers (pl. CIII, fig. 24) abnormal in shape. Spine from caudo-sinistral margin of seventh abdominal tergite (pl. CII, fig. 13) sword-shaped, lying horizontally rather than in usual vertical position.

Comparative Notes: Superficially this species resembles *B. hungerfordi* n. sp. Examination of the male, however, will show distinct differences. This species differs from *B. hungerfordi* in having the tylus distinctly less pilose, spine from caudo-sinistral margin of seventh abdominal tergite straight and sword-shaped, differences in the genital capsule as shown on Plate II, and in its smaller size.

Location of Types: Holotype male, Acapulco, Gro., Mexico, July 12, 1937, H. D. Thomas. The holotype is in the Francis Huntington Snow Entomological Collections, University of Kansas.

Data on Distribution: Known only from type.

Buenoa paranensis Jaczewski

(Pl. CXVII, fig. 82)

1928. *Buenoa paranensis* Jaczewski, T. Ann. Musei Zoologici Polonici, vol. VII, pp. 126-127.

This species was not present in the material at my disposal. Dr. T. Jaczewski's types which were located at the Warsaw Museum, Poland, have been destroyed. The following is a copy of the original description and copies of Jaczewski's figures are included among the illustrations.

"Colour yellowish white, eyes dark, abdomen partly black beneath and above.

Head with eyes distinctly wider than pronotum in front, as wide as posterior width of the latter [Fig. 82f]. Synthlipsis about 3 times narrower than the greatest width of the notocephalon. Frontal arch very feebly convex, not projecting between the eyes. Eyes strongly convex and prominent in both sexes. Notocephalon in front with two distinct longitudinal swellings and a shallow mediane groove between them. Prongs of the third rostral joint of the ♂ ♂ comparatively long, straight, gradually tapering towards their end [Fig. 82e].

Pronotum about 1½ times longer than the head, and about 1⅔ times as wide as long. Scutellum somewhat (about 1/6) longer than pronotum. Pronotum in both sexes evenly convex, without any longitudinal keels. Claval orifice about 3/7 of the length of the scutellum.

Relative length of the various parts of the legs, measured in percentages of the length of the corresponding femora, as follows:

	Femur	Tibia	Tarsus 1 + 2	Tarsus 3
Front legs ♂ :	100	116,7	57,4	31,1
Front legs ♀ :	100	126,5	58,5	32,1
Int. legs:	100	79,5	34,2	27,2
Hind legs:	100	84,1	31,1	30,6

The ratio of length of the femora of the three pairs of legs appears as follows:

Fr. fem.: Int. fem.: Hind fem. = 100: 160,4: 246,3.

Front legs of the ♂ ♂ shaped as shown on fig. [82d]. Femora with a triangular stridulatory area about the middle of their anterior surface. Tibial prong with about 25 setaceous teeth.

Lateral (sinistral) spine of the seventh abdominal tergite of the ♂ ♂ moderately long [Fig. 82c], thick in its basal portion, very thin and strongly pointed towards the apex.

Gonapophyses of the ♂ ♂ shaped as shown on fig. [82].

Length 6-6,25 mm.

Rio da Areia, a fairly large pond in the forest; 27.III. 1922, 45 ad., 9 larvae. A slide prepared of one of the ♂ ♂ is chosen as the type.

This species differs at once from the two preceding ones by its smaller size, by the more slender body and by the sexual characters of the ♂ ♂."

Dr. Jaczewski refers in the above paragraph to *B. crassipes* (Champion) and *B. femoralis* (Fieber).

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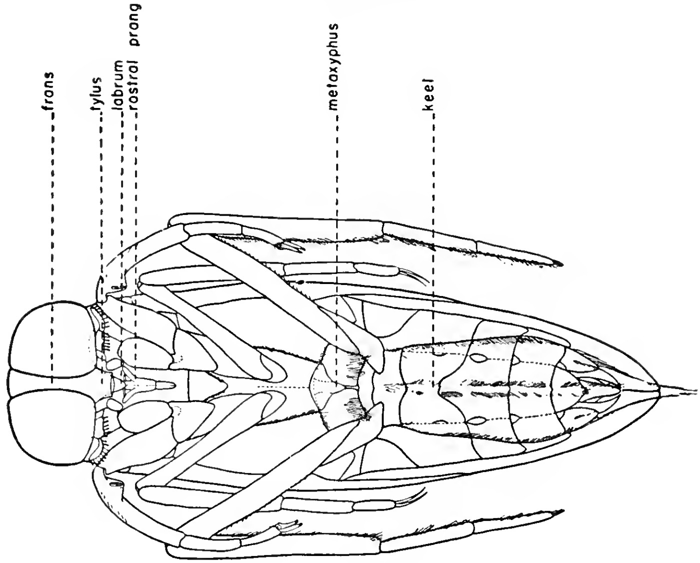
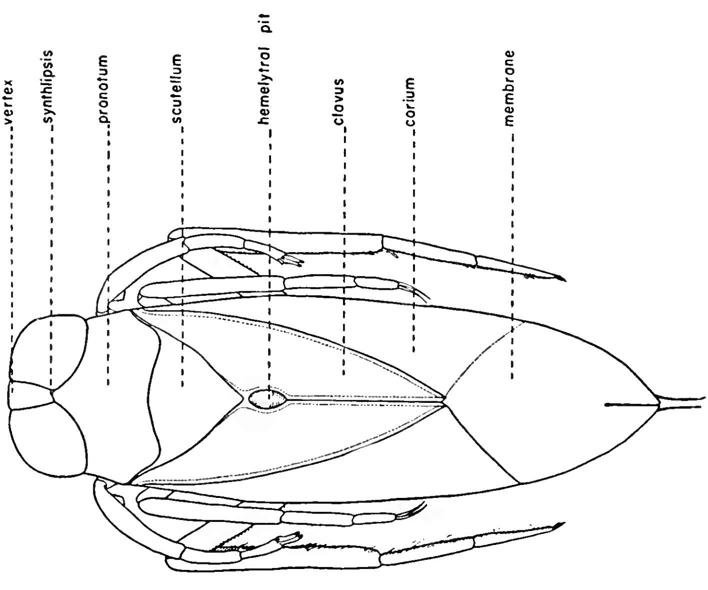
PLATE CI

FIG. 1. Male Buenoa—dorsal aspect.
FIG. 2. Male Buenoa—ventral aspect.

PLATE CI



2. Male Buenoa(venter)



1. Male Buenoa(dorsum)

PLATE CII

FIG. 3. *Buenoa macrophthalma* (Fieber). Spine from caudo-sinistral margin of seventh abdominal tergite of male.

FIG. 4. *Buenoa femoralis* (Fieber). Spine from caudo-sinistral margin of seventh abdominal tergite of male.

FIG. 5. *Buenoa pallens* (Champion). Spine from caudo-sinistral margin of seventh abdominal tergite of male.

FIG. 6. *Buenoa scimitra* Bare. Spine from caudo-sinistral margin of seventh abdominal tergite of male.

FIG. 7. *Buenoa fuscipennis* (Berg). Spine from caudo-sinistral margin of seventh abdominal tergite of male.

FIG. 8. *Buenoa limnocastoris* Hungerford. Spine from caudo-sinistral margin of seventh abdominal tergite of male.

FIG. 9. *Buenoa crassipes* (Champion). Spine from caudo-sinistral margin of seventh abdominal tergite of male.

FIG. 10. *Buenoa arizonis* Bare. Spine from caudo-sinistral margin of seventh abdominal tergite of male.

FIG. 11. *Buenoa pallens* (Champion). Spine from caudo-sinistral margin of seventh abdominal tergite of male.

FIG. 12. *Buenoa excavata* n. sp. Spine from caudo-sinistral margin of seventh abdominal tergite of male.

FIG. 13. *Buenoa distincta* n. sp. Spine from caudo-sinistral margin of seventh abdominal tergite of male.

FIG. 14. *Buenoa hungerfordi* n. sp. Spine from caudo-sinistral margin of seventh abdominal tergite of male.

FIG. 15. Cephalic aspect showing wide interocular cephalic space.

FIG. 16. Cephalic aspect showing narrow interocular cephalic space.

FIG. 17. Diagram showing method of measuring rostral prong.

FIG. 18. Diagram showing method of measuring width of head, vertex, and synthlipsis.

FIG. 19. Diagram showing method of measuring length of fore femur and width at apex.

FIG. 20. *Buenoa confusa* n. sp. Male genital capsule.

FIG. 21. *Buenoa hungerfordi* n. sp. Male genital capsule.

FIG. 22. *Buenoa distincta* n. sp. Male genital capsule.

PLATE CII

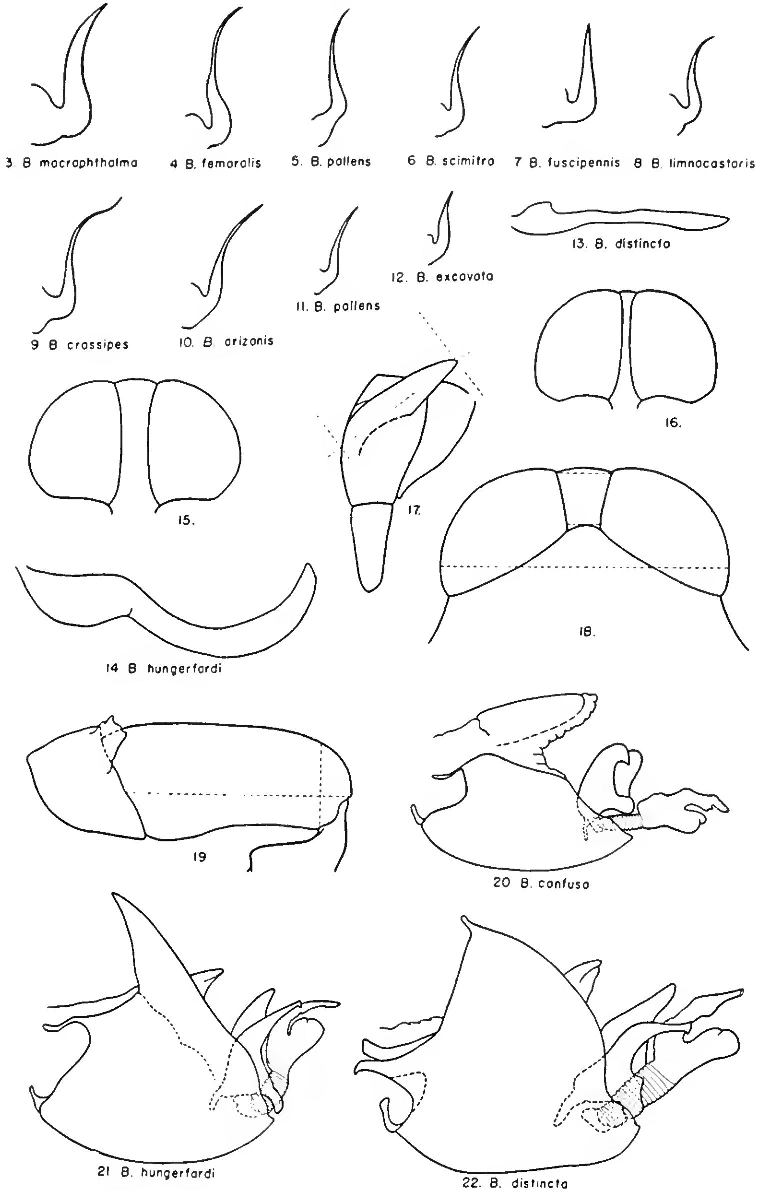

3. B. macrophthalma
4. B. femoralis
5. B. pallens
6. B. scimitra
7. B. fuscipennis
8. B. limnocastoris
9. B. crassipes
10. B. arizonis
11. B. pallens
12. B. excavata
13. B. distincta
14. B. hungerfordi
15.
16.
17.
18.
19
20. B. confusa
21. B. hungerfordi
22. B. distincta

PLATE CIII

FIG. 23. *Buenoa hungerfordi* n. sp.
23a. Left genital clasper.
23b. Right genital clasper.
FIG. 24. *Buenoa distincta* n. sp.
24a. Left genital clasper.
24b. Right genital clasper.
FIG. 25. *Buenoa thomasi* n. sp.
25a. Left genital clasper.
25b. Right genital clasper.
FIG. 26. *Buenoa oculata* n. sp.
26a. Left genital clasper.
26b. Right genital clasper.
FIG. 27. *Buenoa macrophthalma* (Fieber).
27a. Left genital clasper.
27b. Right genital clasper.
FIG. 28. *Buenoa fuscipennis* (Berg).
28a. Left genital clasper.
28b. Right genital clasper.
FIG. 29. *Buenoa arizonis* Bare.
29a. Left genital clasper.
29b. Right genital clasper.

FIG. 30. *Buenoa antigone* (Kirkaldy). Laterodorsal view of left ovipositor valve.

FIG. 31. *Buenoa uhleri* n. sp. Laterodorsal view of left ovipositor valve.

FIG. 32. *Buenoa arizonis* Bare. Laterodorsal view of left ovipositor valve.

FIG. 33. *Buenoa margaritacea* Torre-Bueno. Laterodorsal view of left ovipositor valve.

FIG. 34. *Buenoa confusa* n. sp. Laterodorsal view of left ovipositor valve.

FIG. 35. *Buenoa alterna* n. sp. Laterodorsal view of left ovipositor valve.

FIG. 36. *Buenoa amnigenus* (White). Laterodorsal view of left ovipositor valve.

FIG. 37. *Buenoa omani* n. sp. Laterodorsal view of left ovipositor valve.

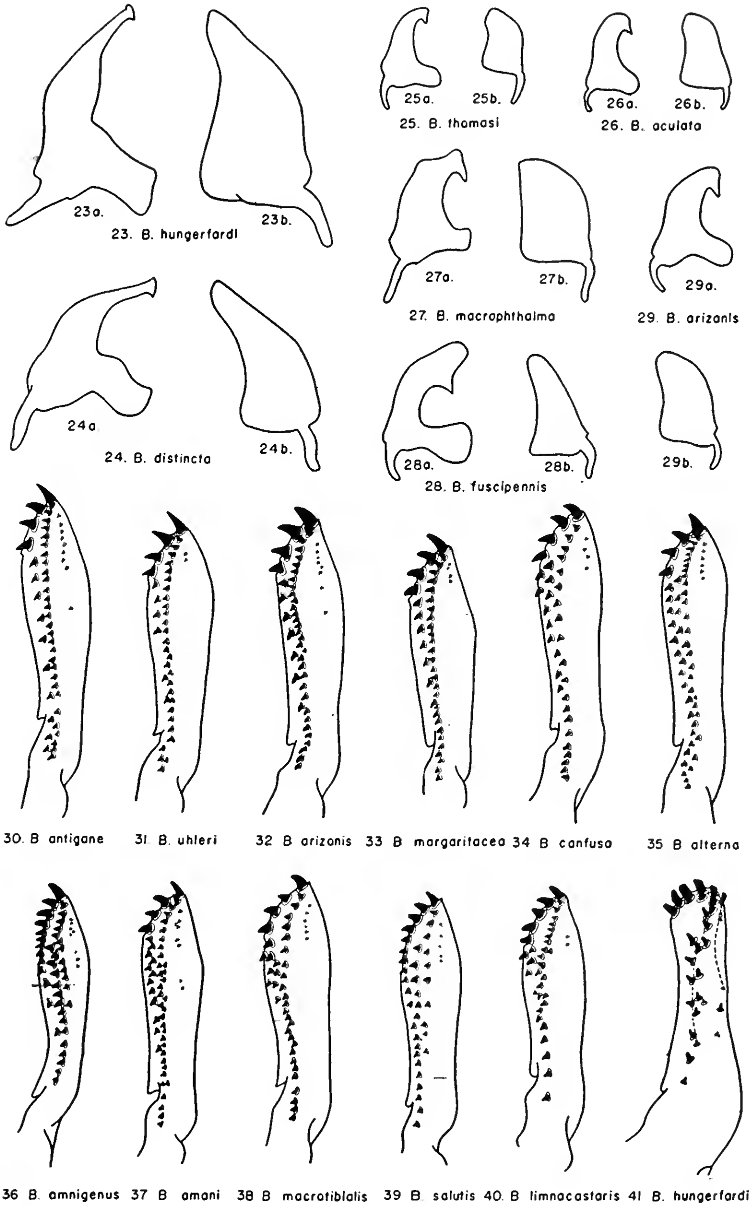
FIG. 38. *Buenoa macrotibialis* Hungerford. Laterodorsal view of left ovipositor valve.

FIG. 39. *Buenoa salutis* Kirkaldy. Laterodorsal view of left ovipositor valve.

FIG. 40. *Buenoa limnocastoris* Hungerford. Laterodorsal view of left ovipositor valve.

FIG. 41. *Buenoa hungerfordi* n. sp. Laterodorsal view of left ovipositor valve.

PLATE CIII



23a. 23b. 23. B. hungerfordi
24a. 24b. 24. B. distincta
25a. 25b. 25. B. thomasi
26a. 26b. 26. B. oculata
27a. 27b. 27. B. macrophthalma
29a. 29b. 29. B. arizonis
28a. 28b. 28. B. fuscipennis

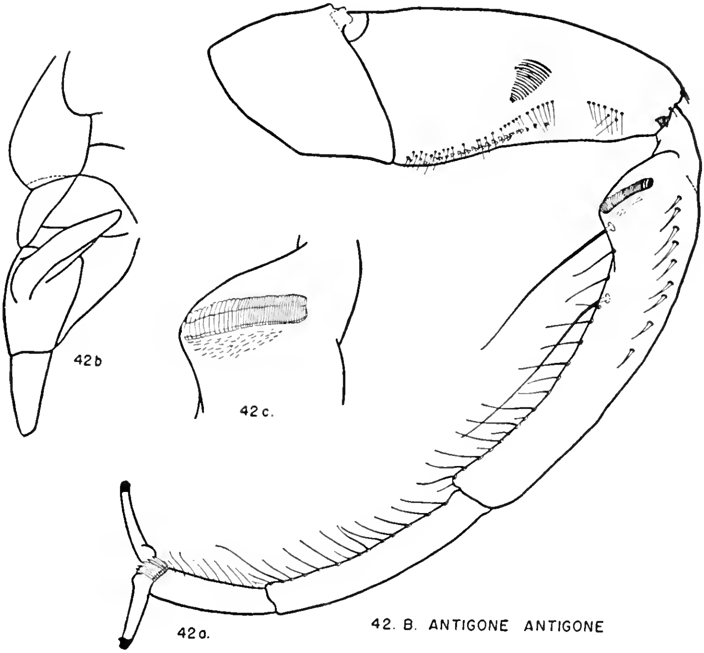
30. B antigone 31 B. uhleri 32 B arizonis 33 B margaritacea 34 B confusa 35 B alterna

36 B. amnigenus 37 B omani 38 B macrotibialis 39 B salutis 40. B limnocastoris 41 B. hungerfordi

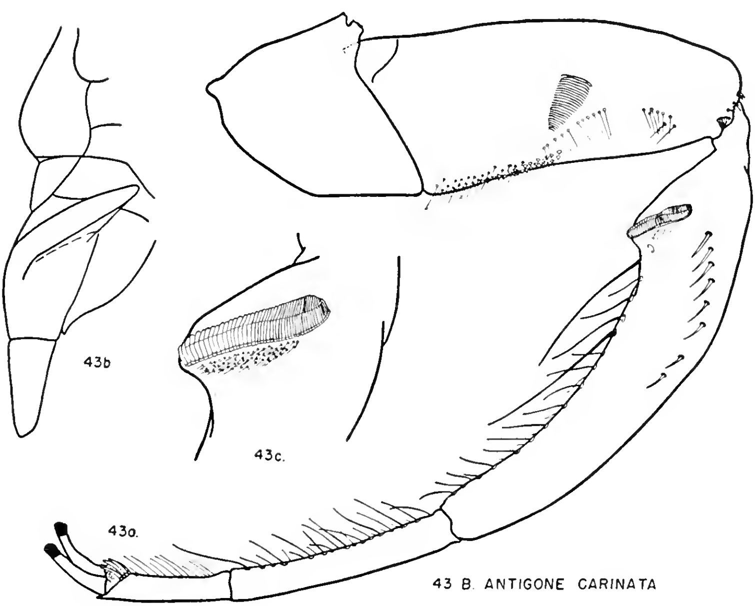
PLATE CIV

FIG. 42. *Buenoa antigone antigone* (Kirkaldy).
42a. Inner surface view of male left fore leg.
42b. Left lateral view of male rostrum and tylus.
42c. Enlarged view of left tibial stridulatory comb.
FIG. 43. *Buenoa antigone carinata* (Champion).
43a. Inner surface view of male left fore leg.
43b. Left lateral view of male rostrum and tylus.
43c. Enlarged view of left tibial stridulatory comb.

PLATE CIV



42. B. ANTIGONE ANTIGONE

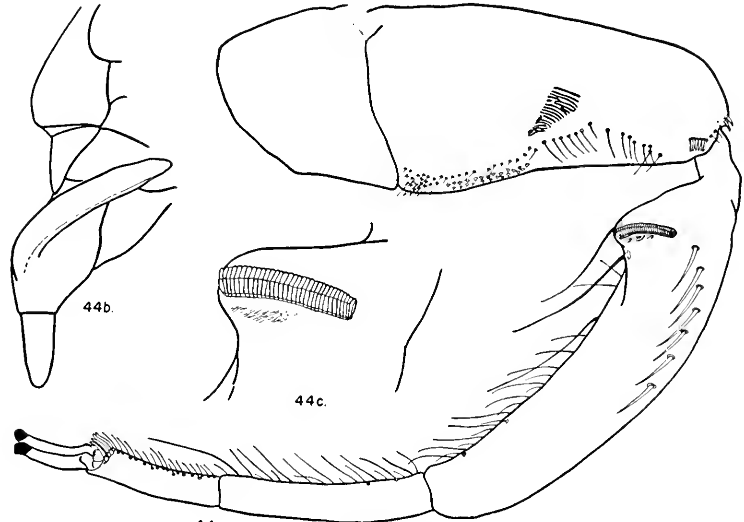


43 B. ANTIGONE CARINATA

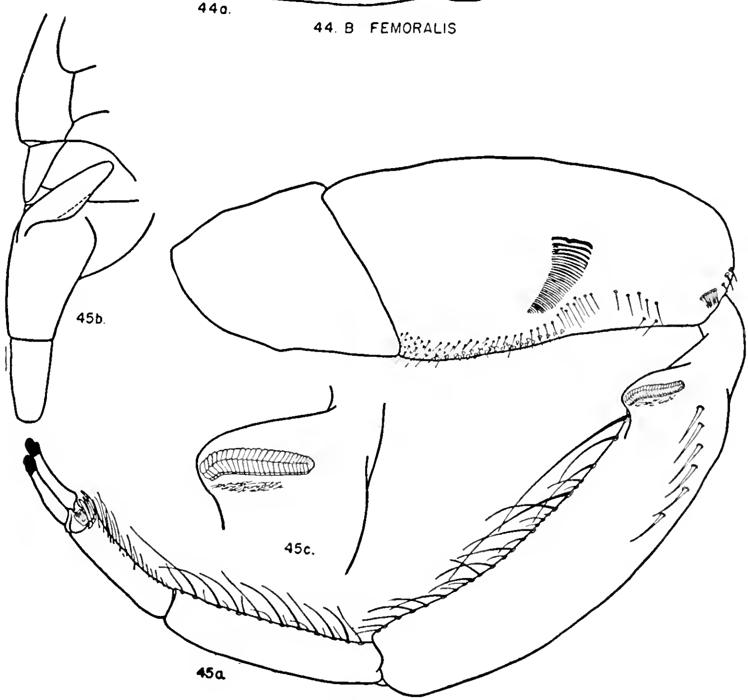
PLATE CV

FIG. 44. *Buenoa femoralis* (Fieber).
44a. Inner surface view of male left fore leg.
44b. Left lateral view of male rostrum and tylus.
44c. Enlarged view of left tibial stridulatory comb.
FIG. 45. *Buenoa ida* Kirkaldy.
45a. Inner surface view of male left fore leg.
45b. Left lateral view of male rostrum and tylus.
45c. Enlarged view of left tibial stridulatory comb.

PLATE CV



44. B FEMORALIS

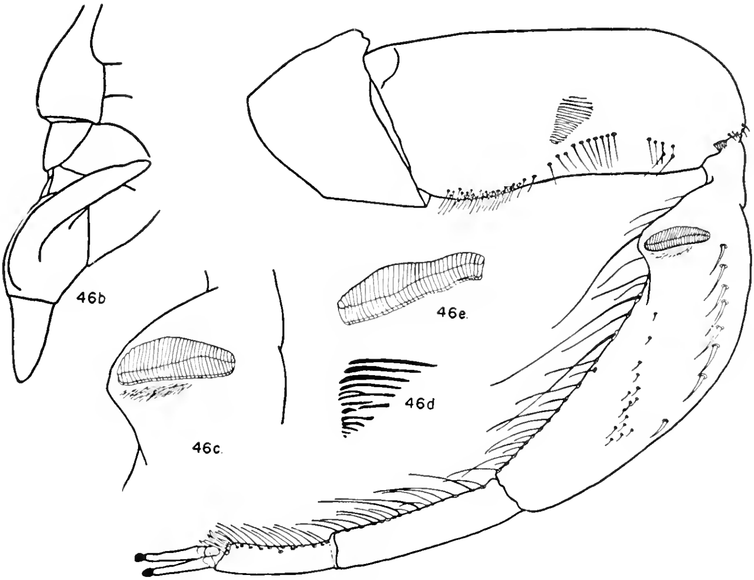


45. B. IDA

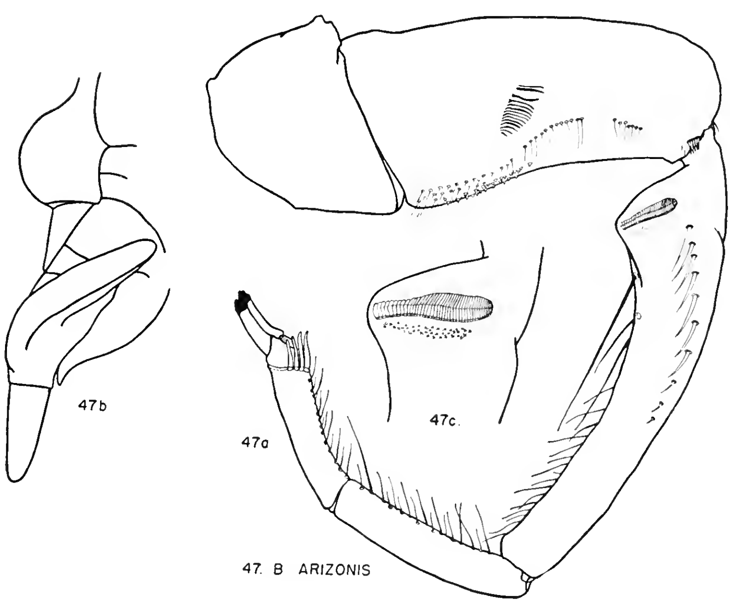
PLATE CVI

FIG. 46. *Buenoa crassipes* (Champion).
46a. Inner surface view of male left fore leg.
46b. Left lateral view of male rostrum and tylus.
46c. Enlarged view of left tibial stridulatory comb.
46d. Enlarged view of variable form of femoral stridulatory area.
46e. Enlarged view of variable form of tibial stridulatory comb.
FIG. 47. *Buenoa arizonis* Bare.
47a. Inner surface view of male left fore leg.
47b. Left lateral view of male rostrum and tylus.
47c. Enlarged view of left tibial stridulatory comb.

PLATE CVI



46. B CRASSIPES



47. B ARIZONIS

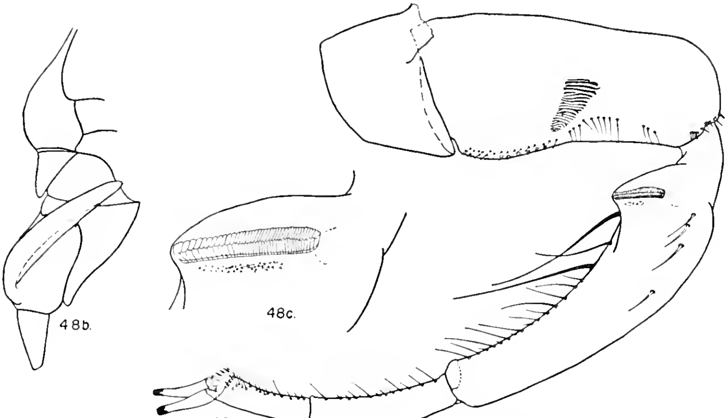
PLATE CVII

FIG. 48. *Buenoa absidata* n. sp.
48a. Inner surface view of male left fore leg.
48b. Left lateral view of male rostrum and tylus.
48c. Enlarged view of left tibial stridulatory comb.

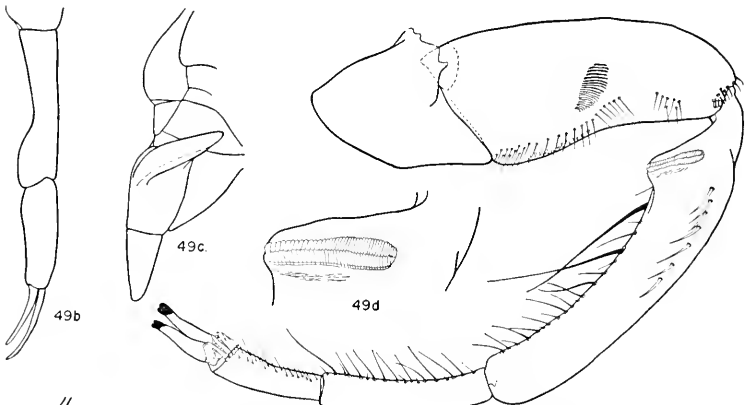
FIG. 49. *Buenoa tarsalis* n. sp.
49a. Inner surface view of male left fore leg.
49b. Inner surface view of intermediate tarsus of male.
49c. Left lateral view of male rostrum and tylus.
49d. Enlarged view of left tibial stridulatory comb.

FIG. 50. *Buenoa rostra* n. sp.
50a. Inner surface view of male left fore leg.
50b. Left lateral view of male rostrum and tylus.
50c. Enlarged view of left tibial stridulatory comb.

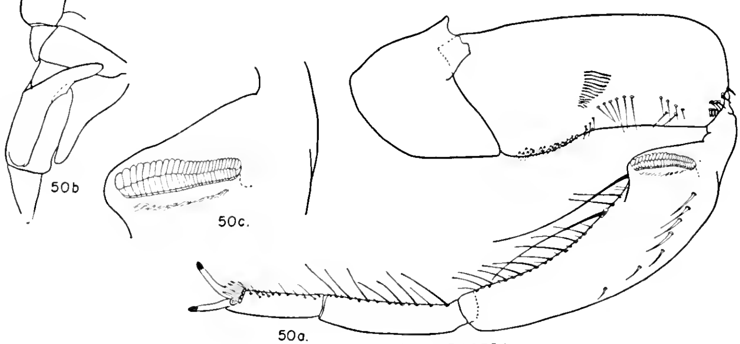
PLATE CVII



48 B ABSIDATA



49. B. TARSALIS



50. B. ROSTRA

PLATE CVIII

FIG. 51. *Buenoa margaritacea* Torre-Bueno.
51a. Inner surface view of male left fore leg.
51b. Enlarged view of left tibial stridulatory comb.
51c. Left lateral view of male rostrum and tylus.

FIG. 52. *Buenoa scimitra* Bare.
52a. Inner surface view of male left fore leg.
52b. Left lateral view of variable form of male rostral prong.
52c. Left lateral view of male rostrum and tylus.
52d. Enlarged view of left tibial stridulatory comb.

FIG. 53. *Buenoa uhleri* n. sp.
53a. Inner surface view of male left fore leg.
53b. Left lateral view of male rostrum and tylus.
53c. Enlarged view of left tibial stridulatory comb.

PLATE CVIII

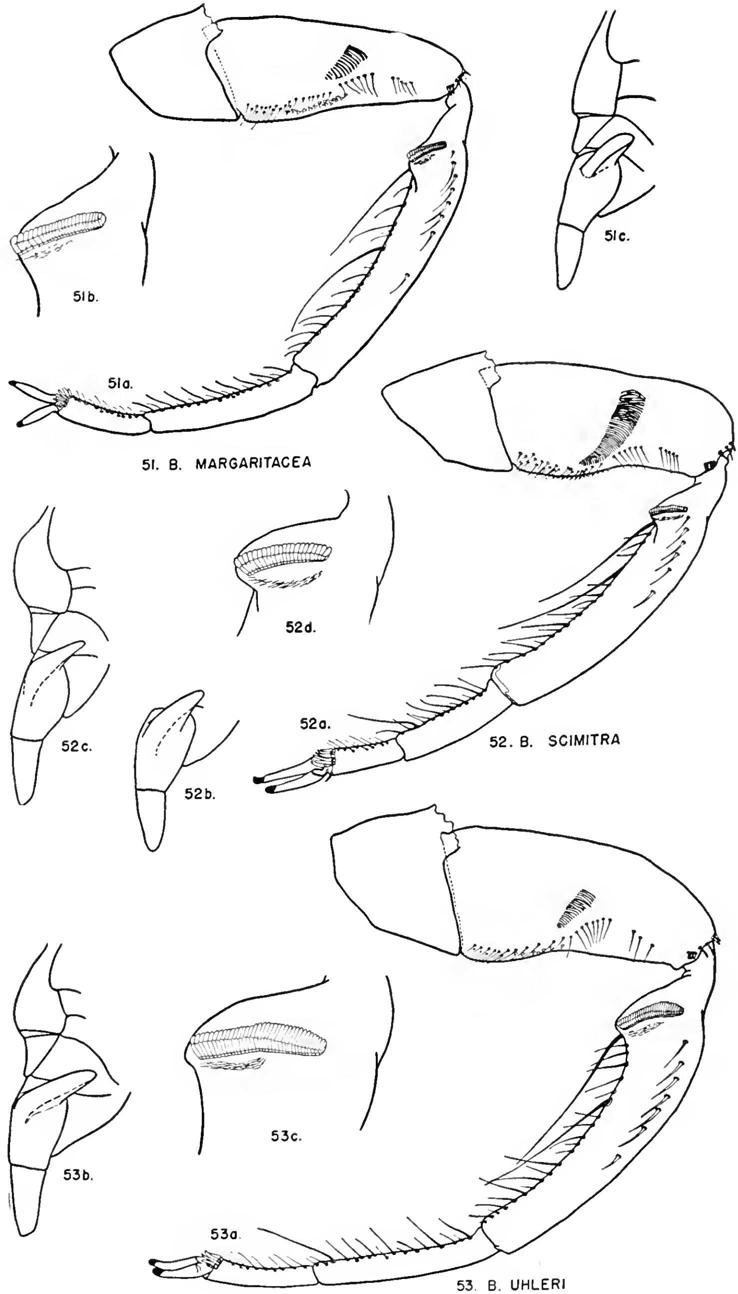

51a.
51b.
51c.
51. B. MARGARITACEA
52a.
52b.
52c.
52d.
52. B. SCIMITRA
53a.
53b.
53c.
53. B. UHLERI

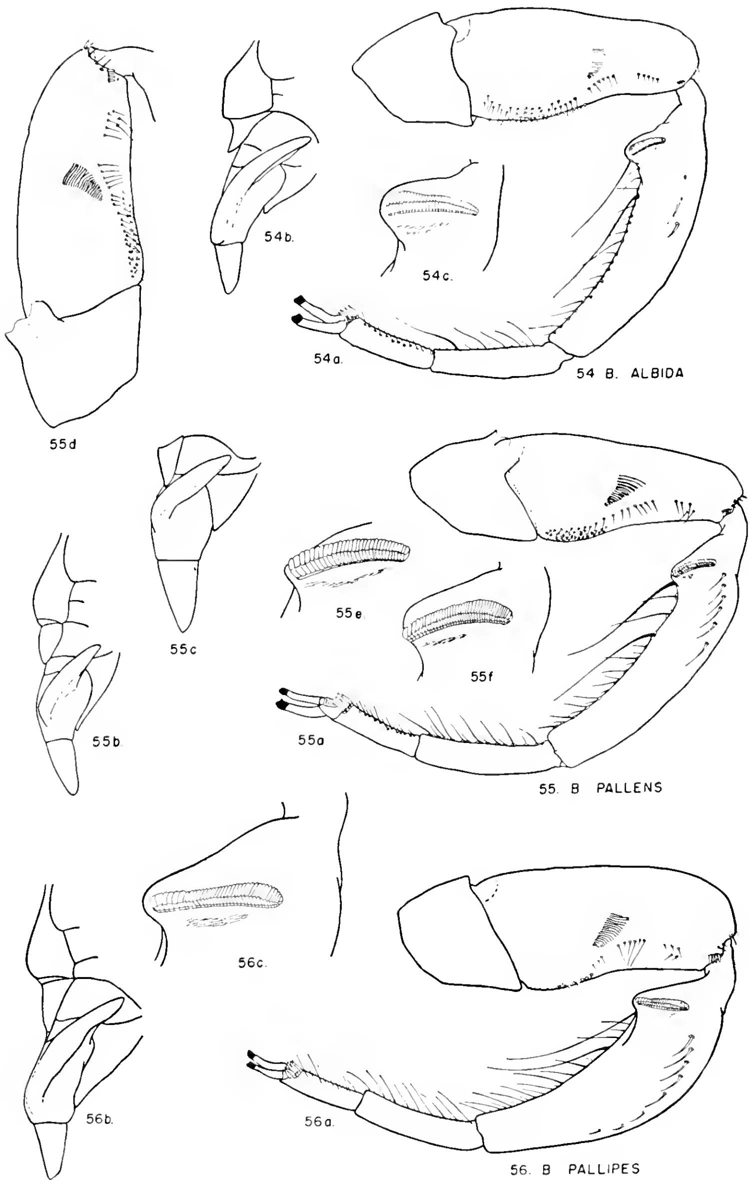
PLATE CIX

FIG. 54. *Buenoa albida* (Champion).
54a. Inner surface view of male left fore leg.
54b. Left lateral view of male rostrum and tylus.
54c. Enlarged view of left tibial stridulatory comb.

FIG. 55. *Buenoa pallens* (Champion).
55a. Inner surface view of male left fore leg.
55b. Left lateral view of male rostrum and tylus.
55c. Left lateral view of variable form of male rostral prong.
55d. Inner surface view of variable form of male fore femur.
55e. Enlarged view of left tibial stridulatory comb.
55f. Enlarged view of variable form of tibial stridulatory comb.

FIG. 56. *Buenoa pallipes* (Fabricius).
56a. Inner surface view of male left fore leg.
56b. Left lateral view of male rostrum and tylus.
56c. Enlarged view of left tibial stridulatory comb.

PLATE CIX

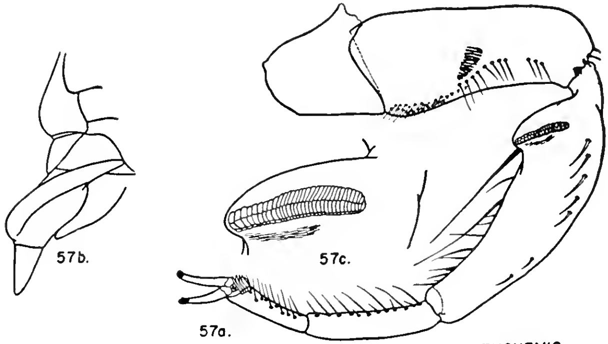


55d
54b.
54c.
54a.
54 B. ALBIDA
55c
55e
55f
55b
55a
55. B PALLENS
56c.
56b.
56a.
56. B PALLIPES

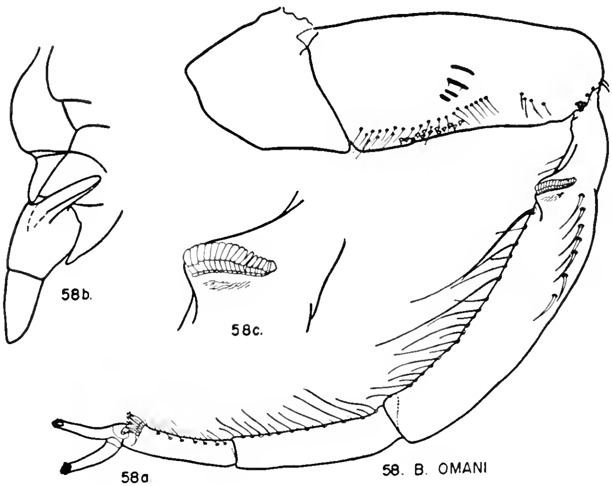
PLATE CX

FIG. 57. *Buenoa platycnemis* (Fieber).
57a. Inner surface view of male left fore leg.
57b. Left lateral view of male rostrum and tylus.
57c. Enlarged view of left tibial stridulatory comb.
FIG. 58. *Buenoa omani* n. sp.
58a. Inner surface view of male left fore leg.
58b. Left lateral view of male rostrum and tylus.
58c. Enlarged view of left tibial stridulatory comb.
FIG. 59. *Buenoa macrotrichia* n. sp.
59a. Inner surface view of male left fore leg.
59b. Left lateral view of male rostrum and tylus.
59c. Enlarged view of left tibial stridulatory comb.

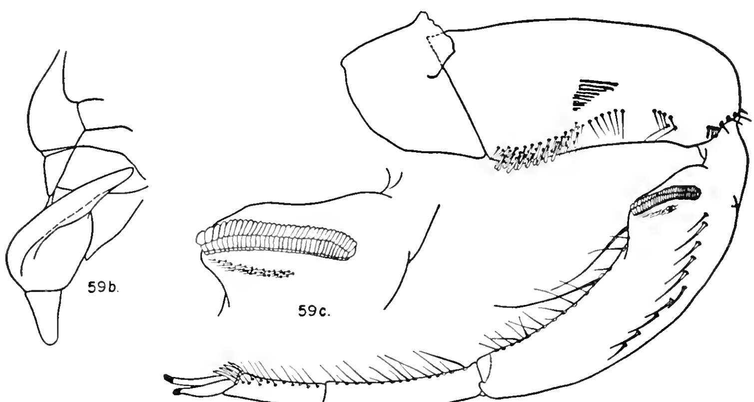
PLATE CX



57. B. PLATYCNEMIS



58. B. OMANI



59. B. MACROTRICHIA

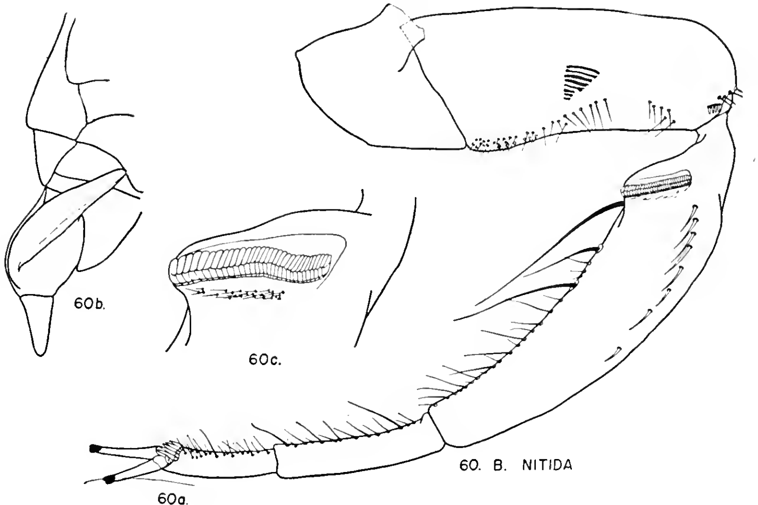
PLATE CXI

FIG. 60. *Buenoa nitida* n. sp.
- 60a. Inner surface view of male left fore leg.
- 60b. Left lateral view of male rostrum and tylus.
- 60c. Enlarged view of left tibial stridulatory comb.

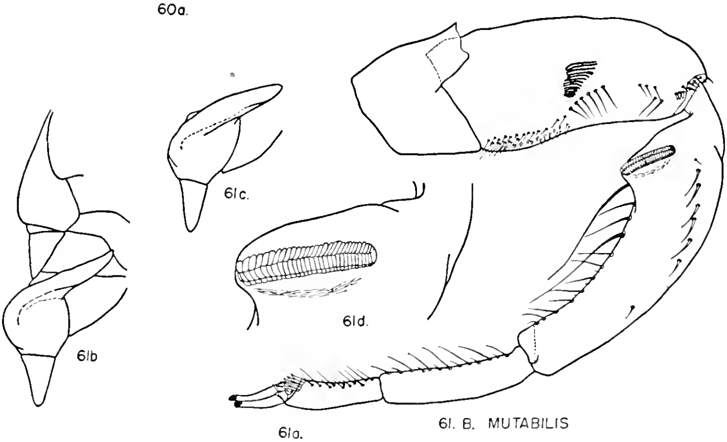
FIG. 61. *Buenoa mutabilis* n. sp.
- 61a. Inner surface view of male left fore leg.
- 61b. Left lateral view of male rostrum and tylus.
- 61c. Left lateral view of variable form of male rostral prong.
- 61d. Enlarged view of left tibial stridulatory comb.

FIG. 62. *Buenoa arida* n. sp.
- 62a. Inner surface view of male left fore leg.
- 62b. Left lateral view of male rostrum and tylus.
- 62c. Enlarged view of left tibial stridulatory comb.

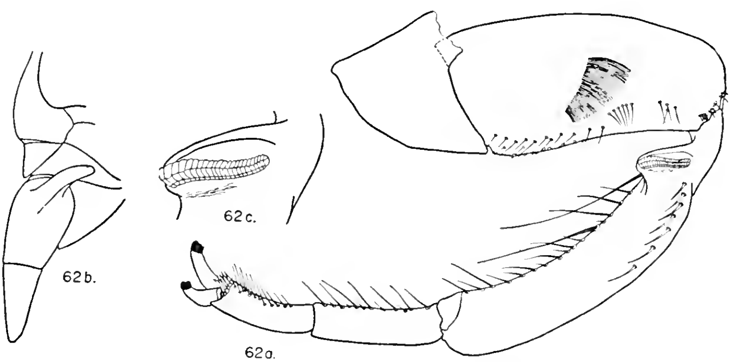
PLATE CXI



60. B. NITIDA



61. B. MUTABILIS



62. B. ARIDA

PLATE CXII

FIG. 63. *Buenoa speciosa* n. sp.
63a. Inner surface view of male left fore leg.
63b. Enlarged view of left tibial stridulatory comb.
63c. Left lateral view of male rostrum and tylus.

FIG. 64. *Buenoa gracilis* n. sp.
64a. Inner surface view of male left fore leg.
64b. Left lateral view of male rostrum and tylus.
64c. Enlarged view of left tibial stridulatory comb.
64d. Enlarged view of peg-like setae on inner surface of fore tibia.

FIG. 65. *Buenoa communis* n. sp.
65a. Inner surface view of male left fore leg.
65b. Left lateral view of male rostrum and tylus.
65c. Enlarged view of left tibial stridulatory comb.

PLATE CXII

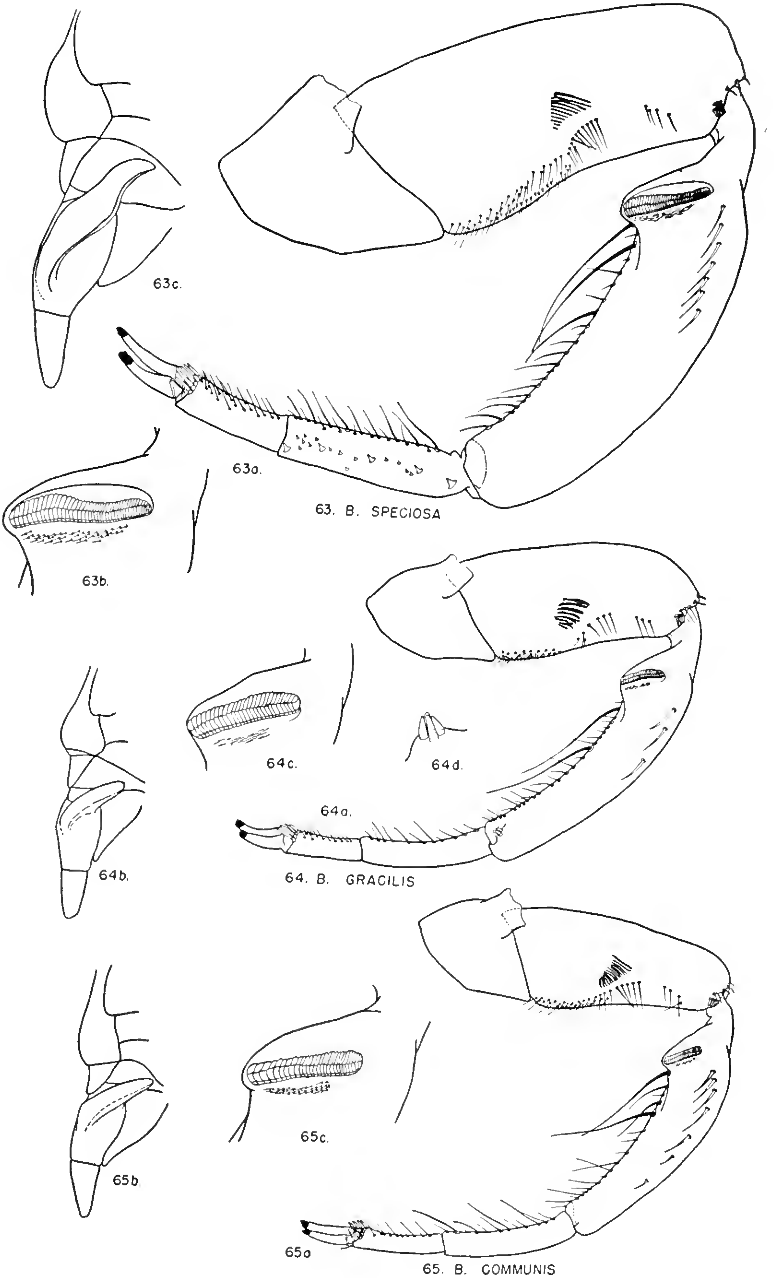

63c.
63a.
63. B. SPECIOSA
63b.
64c.
64d.
64a.
64b.
64. B. GRACILIS
65c.
65b.
65a
65. B. COMMUNIS

PLATE CXIII

FIG. 66. *Buenoa artafrons* n. sp.
66a. Inner surface view of male left fore leg.
66b. Left lateral view of male rostrum and tylus.
66c. Enlarged view of left tibial stridulatory comb.

FIG. 67. *Buenoa macrotibialis* Hungerford.
67a. Inner surface view of male left fore leg.
67b. Left lateral view of male rostrum and tylus
67c. Enlarged view of left tibial stridulatory comb.

FIG. 68. *Buenoa limnocastoris* Hungerford.
68a. Inner surface view of male left fore leg.
68b. Left lateral view of male rostrum and tylus.
68c. Enlarged view of left tibial stridulatory comb.

PLATE CXIII

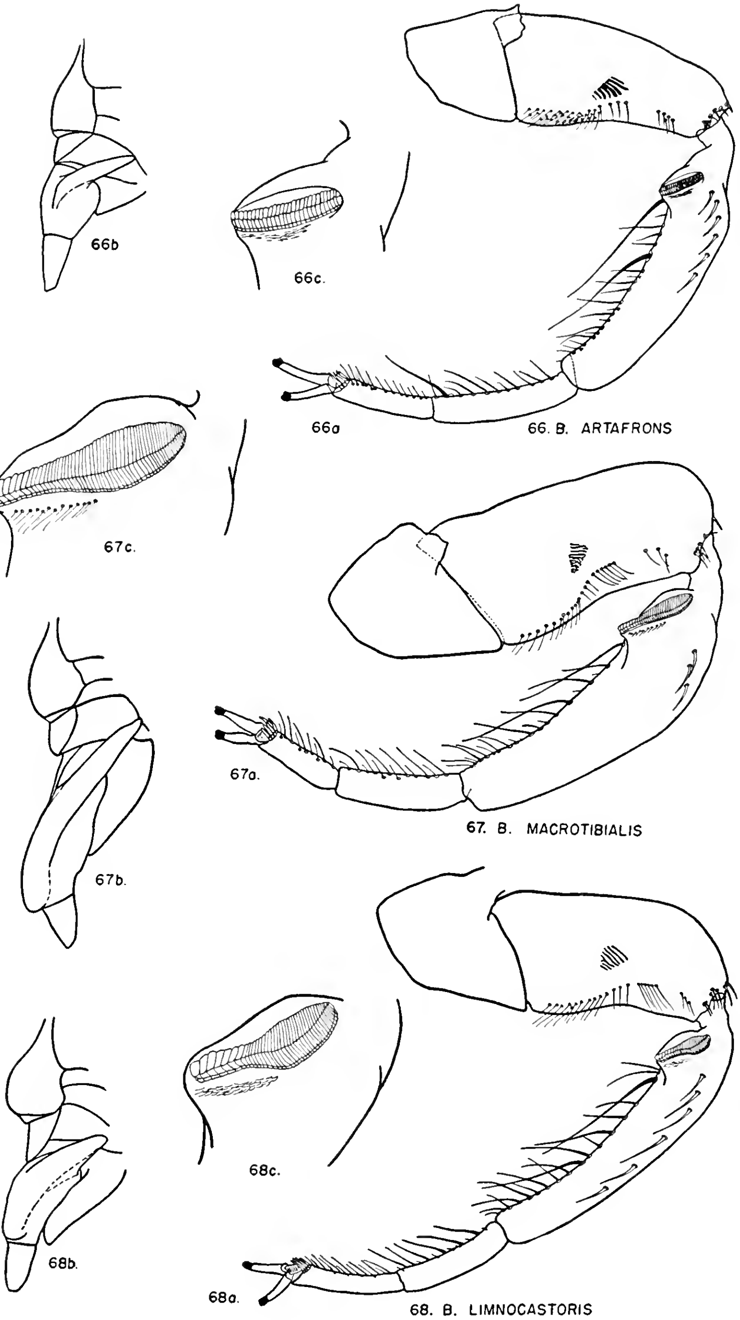

66b
66c.
66a
66. B. ARTAFRONS
67c.
67b.
67a.
67. B. MACROTIBIALIS
68b.
68c.
68a.
68. B. LIMNOCASTORIS

PLATE CXIV

FIG. 69. *Buenoa confusa* n. sp.
69a. Inner surface view of male left fore leg.
69b. Left lateral view of male rostrum and tylus.
69c. Enlarged view of left tibial stridulatory comb.
FIG. 70. *Buenoa amnigenus* (White).
70a. Inner surface view of male left fore leg.
70b. Enlarged view of left tibial stridulatory comb.
70c. Left lateral view of male rostrum and tylus.
FIG. 71. *Buenoa fuscipennis* (Berg).
71a. Inner surface view of male left fore leg.
71b. Left lateral view of male rostrum and tylus.
71c. Enlarged view of left tibial stridulatory comb.
FIG. 72. *Buenoa oculata* n. sp.
72a. Inner surface view of male left fore leg.
72b. Left lateral view of male rostrum and tylus.
72c. Enlarged view of left tibial stridulatory comb.
72d. Inner surface view of intermediate tarsus of male.
FIG. 73. *Buenoa incompta* n. sp.
73a. Inner surface view of male left fore leg.
73b. Left lateral view of male rostrum and tylus.
73c. Enlarged view of left tibial stridulatory comb.

PLATE CXIV

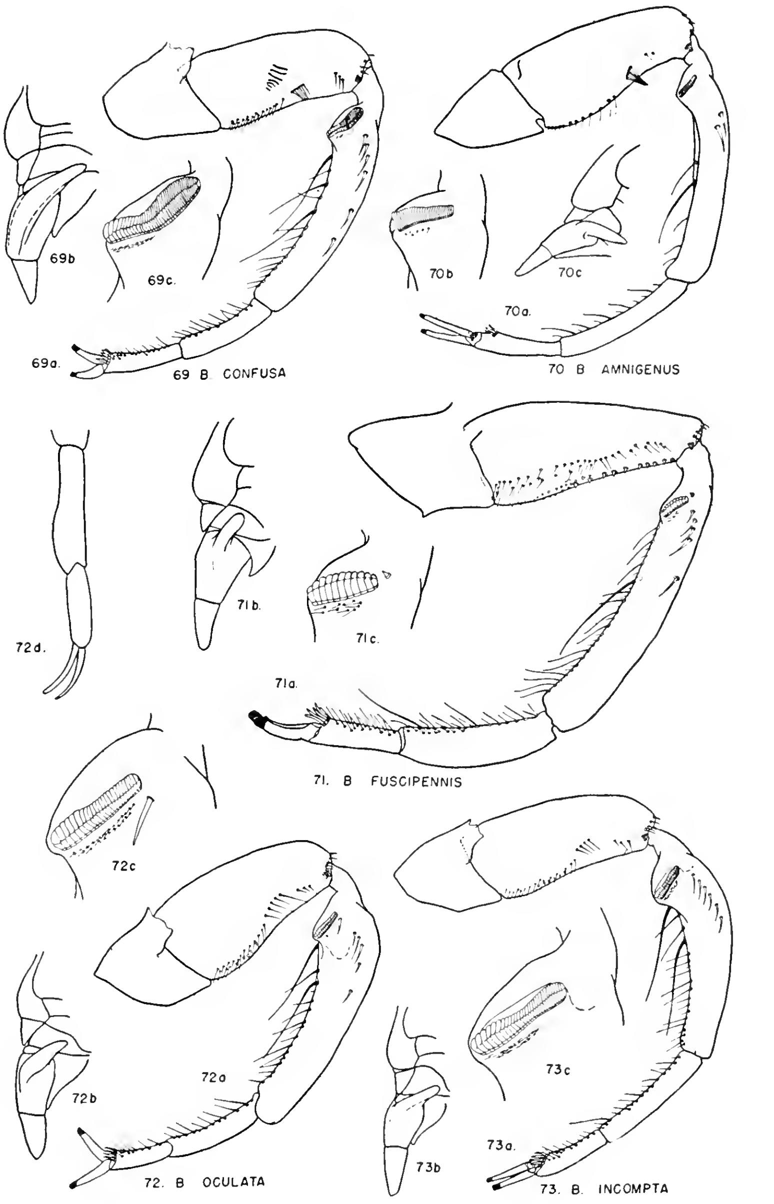

69b
69c.
69a.
69 B. CONFUSA
70b
70c
70a.
70 B AMNIGENUS
72d.
71b.
71c.
71a.
71. B FUSCIPENNIS
72c
72a
72b
72. B OCULATA
73c
73a.
73b
73. B. INCOMPTA

PLATE CXV

FIG. 74. *Buenoa salutis* Kirkaldy.
- 74a. Inner surface view of male left fore leg.
- 74b. Left lateral view of male rostrum and tylus.
- 74c. Left lateral view of variable form of male rostral prong.
- 74d. Enlarged view of left tibial stridulatory comb.

FIG. 75. *Buenoa excavata* n. sp.
- 75a. Inner surface view of male left fore leg.
- 75b. Left lateral view of male rostrum and tylus.
- 75c. Enlarged view of left tibial stridulatory comb.

FIG. 76. *Buenoa thomasi* n. sp.
- 76a. Inner surface view of male left fore leg.
- 76b. Enlarged view of left tibial stridulatory comb.
- 76c. Left lateral view of male rostrum and tylus.
- 76d. Enlarged view of club-like setae on inner surface of fore tibia.

FIG. 77. *Buenoa alterna* n. sp.
- 77a. Inner surface view of male left fore leg.
- 77b. Left lateral view of male rostrum and tylus.
- 77c. Enlarged view of left tibial stridulatory comb.

FIG. 78. *Buenoa unguis* n. sp.
- 78a. Inner surface view of male left fore leg.
- 78b. Enlarged view of left tibial stridulatory comb.
- 78c. Left lateral view of male rostrum and tylus.
- 78d. Enlarged view of male fore tarsus.

PLATE CXV

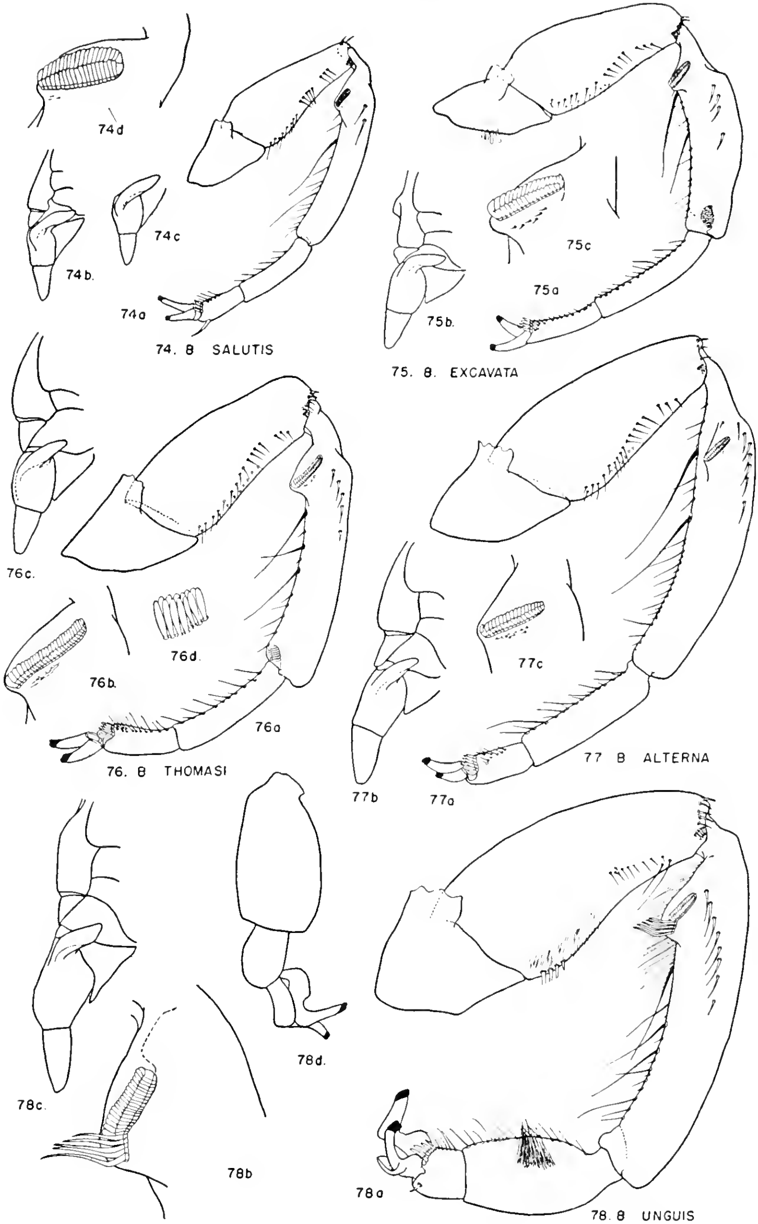
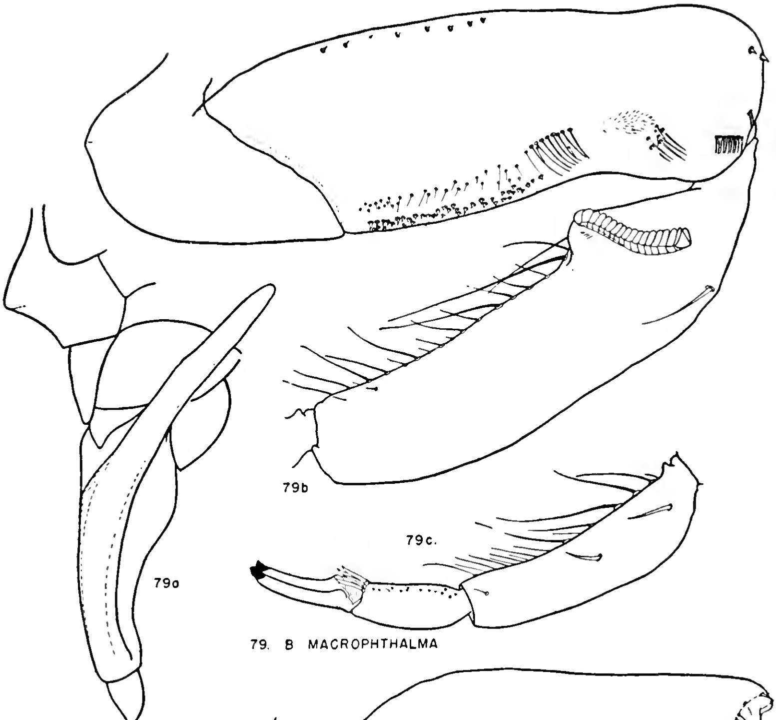

74d
74c
74b.
74a
74. B SALUTIS
75c
75a
75b.
75. B. EXCAVATA
76c.
76d.
76b.
76a
76. B THOMASI
77c
77 B ALTERNA
77b
77a
78d.
78c.
78b
78a
78. B UNGUIS

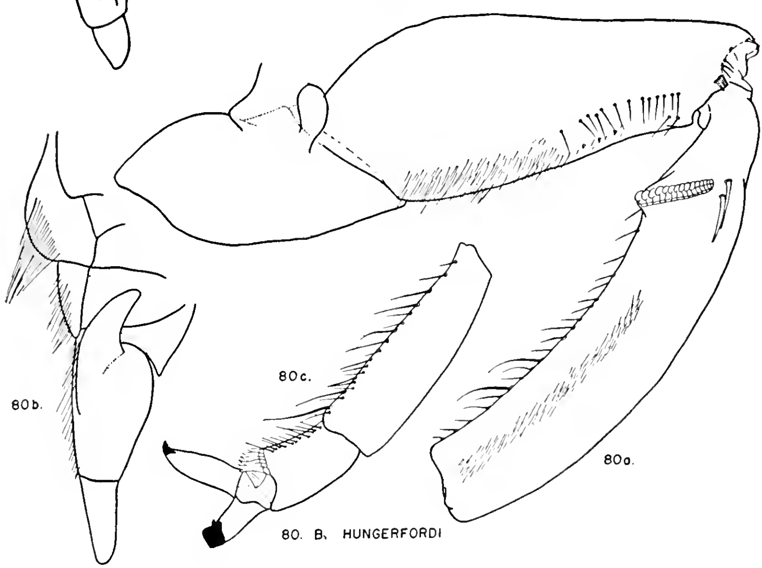
PLATE CXVI

FIG. 79. *Buenoa macrophthalma* (Fieber).
79a. Left lateral view of male rostrum and tylus.
79b. Inner surface view of femur and tibia of male fore leg.
79c. Inner surface view of male fore tarsus.
FIG. 80. *Buenoa hungerfordi* n. sp.
80a. Inner surface view of femur and tibia of male fore leg.
80b. Left lateral view of male rostrum and tylus.
80c. Inner surface view of male fore tarsus.

PLATE CXVI



79. B MACROPHTHALMA



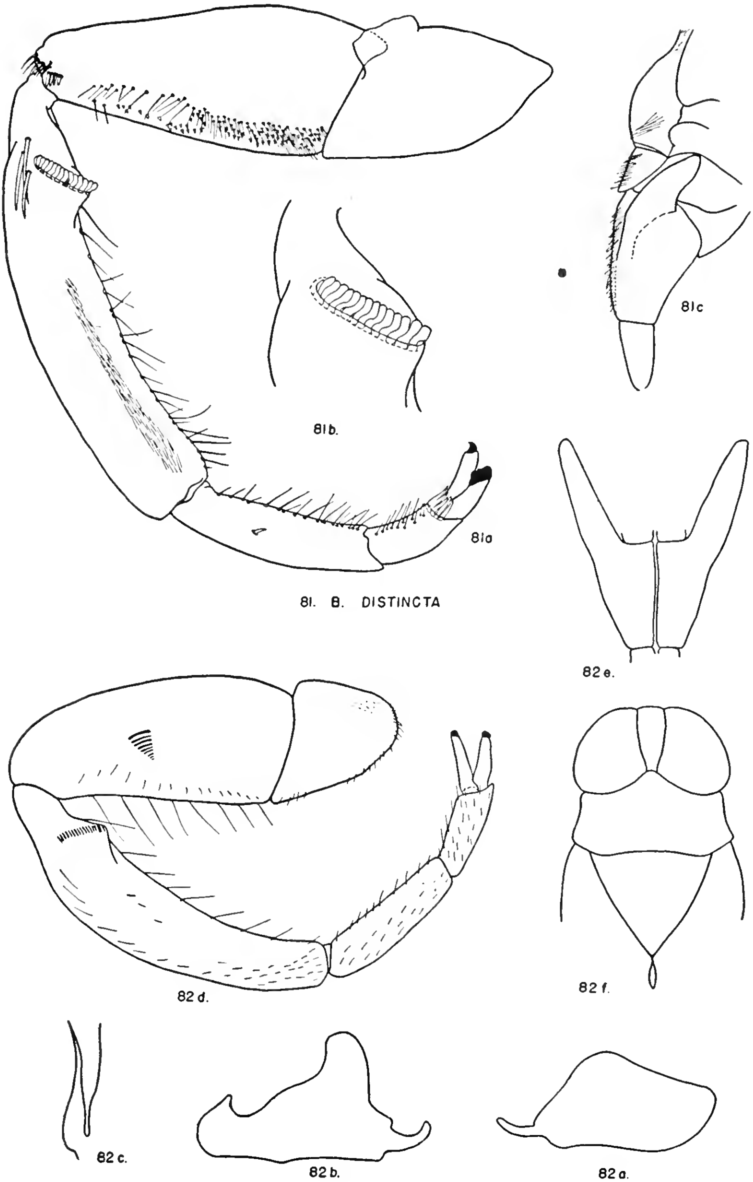
80. B. HUNGERFORDI

PLATE CXVII

FIG. 81. *Buenoa distincta* n. sp.
- 81a. Inner surface view of male right fore leg.
- 81b. Enlarged view of right tibial stridulatory comb.
- 81c. Left lateral view of male rostrum and tylus.

FIG. 82. *Buenoa paranensis* Jaczewski.
- 82a. Right genital clasper of male.
- 82b. Left genital clasper of male.
- 82c. Spine from caudo-sinistral margin of seventh abdominal tergite of male.
- 82d. Inner surface view of male right fore leg.
- 82e. Frontal view of male third rostral segment.
- 82f. Dorsal view of head, pronotum, and scutellum.

PLATE CXVII



81. B. DISTINCTA

82. B. PARANENSIS

THE UNIVERSITY OF KANSAS
SCIENCE BULLETIN

VOL. XXXV, PT. II] SEPTEMBER 10, 1953 [No. 12

A Review of the Lizards of Ceylon

BY

EDWARD H. TAYLOR

ABSTRACT.—The paper deals with the lizard fauna of Ceylon exclusive of the family Scincidae. The material studied is that in the United States National Museum, and that in the Edward H. Taylor—Hobart M. Smith collection (Lawrence, Kansas). Since the species of skinks were treated recently, keys, but not descriptions are included for this Family.

In the total lizard fauna six families, twenty-four genera and sixty-two species and subspecies are represented.

TABLE OF CONTENTS

INTRODUCTION

This paper concludes my study of the Ceylonese Squamata * contained in the United States National Museum and those in the Edward H. Taylor-Hobart M. Smith collection. A study of the amphibians is being pursued at the present time.

The material in these collections (approximately 1367 specimens) has recently been augmented by a collection presented by Mr. W. W. A. Phillips, Esq., noted mammalogist of Tonacombe Estates, Namunukula, Ceylon. The lizards from the latter collection are reported in this paper. The snakes from the collection are being reported under another title ** in this journal.

While this paper treats of the lizards, exclusive of the family Scincidae, I have, however, listed the genera and species of the scincs, reprinting also keys published in a previous paper (*loc. cit.*).

The recent papers of Mr. P. E. P. Deraniyagala and the recent monograph of Malcolm Smith, (The Fauna of British India, including Ceylon and Burma. Reptilia and Amphibia vol. II, Sauria), have been of great help in this study.

---

* Papers previously published are: Taylor, Comments on Ceylonese snakes of the genus Typhlops, with descriptions of new species. Univ. Kansas Sci. Bull., vol. 31, pt. 2, Nov. 1, 1947, pp. 283-298, text-figs. 1-3. Taylor, Ceylonese lizards of the family Scincidae. Univ. Kansas Sci. Bull., vol. 33, pt. 2, March 20, 1950, pp. 481-518, text figs. 1-8.
Taylor, A brief review of Ceylonese snakes. Univ. Kansas Sci. Bull., vol. 33, pt. 2, March 20, 1950, pp. 519-603, pls. 12-25, text-figs. 1-3.

** Report on a small collection of snakes from Uva Province, Ceylon.

DISTRIBUTION OF ASIATIC LIZARD GENERA

Table of Lizard genera for South Asia.

	Africa	West Asia	India	Ceylon	East Asia	East Ind. Arch.
Teratoscincus		x	x		x	
Stenodactylus	x	x	x			
Alsophylax	x	x	x		x (Tibet)	
Gymnodactylus	x	x	x	x	x	x (Aust.)
Agamura		x	x			
Pristurus	x	x	x			
Cnemaspis			x	x	x	x
Calodactylodes			x			
Ptyodactylus	x	x	x			
Phyllodactylus					x	
Dravidogecko			x			
Hemidactylus	x	x	x	x	x	x (Aust.)
Cosymbotus			x	x	x	x
Peropus				x	x	x
Hemiphyllodactylus			x	x	x	x
Gekko			x		x	x
Lepidodactylus				x		x
Ptychozoon					x	x
Phelsuma					Andaman Is.	
Teratolepis			x			
Lophopholis			x	x		
Eublepharis		x	x		x	
Draco			x		x	x
Sitana			x	x		
Otocryptis			x	x		
Ptyctolaemus			x			
Cophotis				x		x
Ceratophora				x		
Lyriocephalus				x		
Goniocephalus					x	x
Mictopholis			x			
Oriocalotes			x			
Japalura					x	x
Salea			x			
Calotes			x	x	x	x
Psammophilus			x			
Agama	x	x	x			
Phrynocephalus		x	x			
Physignathus					x	x (Papuasia) x (Aust.)
Leiolepis					x	x
Uromastix		x	x			
Mabuya	x	x	x	x	x	x
Dasia			x	x	x	x
Lygosoma					x	x
Sphenomorphus			x	x	x	x
Ateuchosaurus					x	
Leiolopisma	x	x	x		x	x
Ablepharus		x	x			
Riopa	x		x	x	x	x
Tropidophorus			x		x	x
Ristella			x			

DISTRIBUTION OF ASIATIC LIZARD GENERA—*Concluded*

	Africa	West Asia	India	Ceylon	East Asia	East Ind. Arch.
Ophioscincus	......	......	......	......	x	....
Eumeces	x	x	x	......	x	....
Scincus	x	x	x	......	....	....
Ophiomorus	......	x	x	......	....	....
Chalcides	x	x	......	......	....	....
Barkudia	......	......	x	......	....	....
Sepsophis	......	......	x	......	....	....
Chalcidoseps	......	......	......	x	....	....
Nessia	......	......	......	x	....	....
Dibamus	......	......	......	......	x	x
Takydromus	......	......	......	......	x	....
Acanthodactylus	x	x	x	......	....	....
Cabrita	......	......	x	x	....	....
Ophisops	x	x	x	......	....	....
Eremias	x	x	x	......	....	....
Ophisaurus	x	x	x	......	x	x
Varanus	x	x	x	x	x	x
Chamaeleon	x	x	x	x	....	....

Of the 69 genera appearing in the South Asian list, some 23 have been found to occur in Ceylon and approximately 41 are known to occur in territory formerly regarded as India. However when one considers that *Lyriocephalus, Ceratophora* and *Chalcidoseps* are presumably endemic in Ceylon, and *Peropus* and *Cophotes* presumably do not occur in India, only 18 genera (less than one-half) of the 41 known in India occur in Ceylon.

There is a large number of genera largely confined to Africa and southwest Asia which enter India in the drier regions in the northwest, and their further distribution eastward is seemingly limited by their adaptation to relatively low rainfall. In this group are *Teratoscincus, Stenodactylus, Alsophylax, Agamura, Pristurus, Ptyodactylus, Eublepharis, Agama, Phrynocephalus, Uromystax, Eumeces, Scincus, Ophiomorus, Chalcides, Acanthodactylus, Ophisops, Eremias* and *Chamaeleon.*

A few genera seem to have entered the Indian territory from the east, among which *Calotes, Dasia,* and *Tropidophorus* may be mentioned.

A few genera bespeak a considerable age, and such groups as *Varanus, Ophisaurus, Leiolopisma,* and *Mabuya,* widespread as they are, seemingly have obliterated the evidence of their route of movement in Asia.

TAXONOMIC TREATMENT

KEY TO SUBORDERS OF REPTILIA (treated in this work)

Tongue terminally club-shaped, greatly extensile; skin covered with flattened or rounded tubercles; fingers and toes webbed together in groups of two and three, the groups opposed; eye except pupil covered by a thick granular single lid, each eye independently movable . . . . Rhiptoglossa

Tongue not club-shaped, fingers and toes maintain freedom of individual movement; when present not webbed together into groups; eye usually with an upper and lower lid . . . . Sauria

Of the groups of reptiles treated in this paper a total of six families are represented. The Gekkonidae and Scincidae are widespread cosmopolitan families; the Agamidae, Lacertidae and Varanidae are old world; the Chamaeleonidae occur in Africa and Madagascar with one species entering southwestern Asia and Ceylon.

The Varanidae have formerly been represented in the new world by the Genera *Saniwa, Palaeosaniwa,* and *Parasaniwa.* The past history extends from the Upper Cretaceous to the Oligocene. The Chamaeleonidae likewise appear to have been present formerly in the new world based on the Genus *Chamaeleo* in the Upper Cretaceous.

There is no evidence of the presence of the Lacertidae or the Agamidae, the latter being replaced in the Western Hemisphere by the Iguanidae.

Two other Asiatic families are the Anguidae and Dibamidae, neither of which are known to enter Ceylon. The former is represented by the same genus in North America. The Dibamidae have presumably never reached the Western Hemisphere.

SUBORDER SAURIA

KEY TO CEYLONESE FAMILIES OF SAURIA

1. Scales on top of head large, arranged symmetrically 2
   No large symmetrical scales on top of head 3
2. Scales on entire body cycloid, imbricate, smooth or keeled, with osteodermal plates; no femoral or preanal pores; pleurodont; tongue feebly nicked, covered with imbricate scalelike papilla, *Scincidae*
   Imbricating dorsal and lateral scales on body, strongly differentiated from ventral scales; no osteodermal plates; pleurodont; femoral pores; tongue forked, anteriorly covered with imbricate papillae, or plicae . . . . *Lacertidae*
3. Body scales imbricate; tongue rather broad and short, smooth or with villose papillae; eyes with movable lids; acrodont *Agamidae*
   Body skin tubercular or granular, rarely with some imbricating dorsal scales; eyes without or with movable lids; pleurodont . . 4

4. Tongue broad, short, covered with villose papillae, eyes without movable lids; femoral and preanal pores usually present; scales granular or tubercular, rarely imbricating .... *Gekkonidae*
   Tongue long and slender, deeply forked, retractile into a sheath; back with rounded scales, nonimbricate .... *Varanidae*

FAMILY GEKKONIDAE

Eight genera of the Gekkonidae are represented in the fauna of Ceylon. Some fourteen other genera occur in Asia, a few of which are known in India. In most cases the genera known to occur in Ceylon also occur in India and often the same species is found in both areas. The genera *Lepidodactylus* and *Peropus* are exceptions, neither being known in India. I suspect that India received *Hemiphyllodactylus* from the same outside source, as did Ceylon.

KEY TO THE CEYLONESE GENERA OF GEKKONIDAE

1. Digits bent at an angle, and not or but little dilated 2
   Digits not bent at an angle, and more or less dilated 3
2. Pupil round; small adult lizards under 40 mm. .... *Cnemaspis*
   Pupil vertical; larger, adult lizards more than 40 mm. .. *Gymnodactylus*
3. Dorsal scales imbricate .... *Lophopholis*
   Dorsal scales not imbricate 4
4. A lateral cutaneous flap or expansion on sides of body; claws on all digits .... *Cosymbotus*
   No lateral cutaneous flap; digits variable 5
5. Terminal phalanges of four outer digits joined to the dilated terminal portion and not arising angularly .... *Lepidodactylus*
   Terminal phalanges of four outer digits free, rising angularly from the dilated portion 6
6. Inner digit well developed, with terminal phalanx clawed; lamellae under toes distinctly divided .... *Hemidactylus*
   Inner digit variable without or with only a very small claw 7
7. Inner digit well developed, lacking a free terminal phalanx, the claw small and often concealed; lamellae divided .... *Peropus*
   Inner digit represented by a vestige without a free terminal phalanx, clawless or with a minute claw; lamellae, part divided, part single .... *Hemiphyllodactylus*

Genus GYMNODACTYLUS Spix

Gymnodactylus Spix, Specimen novum Lacerta Brasil., 1825, p. 17, pl. 17, fig. 1 (type of genus *Gymnodactylus geckoides*).

This genus which has its greatest development in South Asia, the East Indies and the Philippines has four representatives known in Ceylon, two of which *Gymnodactylus triedrus* and *Gymnodactylus frenatus* are endemic. The latter species is the largest of the genus in Asia, perhaps in the entire range. *Gymnodactylus collegalensis* on the other hand is one of the smallest species of the genus.

Deraniyagala has recently described a species, *Gymnodactylus yakhuna* from the Island.

KEY TO CEYLONESE SPECIES OF GYMNODACTYLUS

1. Body above with small equal granules; no femoral pores 2
   Granules on back intermixed with numerous larger keeled or rounded tubercles; femoral pores present 3
2. Smaller, 40 mm.; the dark bands on body equal to or shorter than the light interspaces; dark spots subrectangular, in two transverse rows on body; a large, curving, dark, occipital spot; black dots abundant on light interspaces; a few feebly enlarged subcaudals .... *yakhuna*
   Larger, adults, 50-53 mm.; head flecked or dimly spotted; a pair of occipital spots; neck and body with seven pairs of black spots, bordered by lighter brown, or tan; tail, dorsally with a few dark, transverse flecks, ventrally with seven or eight black bars, separated by cream spots .... *collegalensis*
3. Granules of back intermixed with larger, keeled, trihedral tubercles; three or four femoral pores; length, snout to vent, to 65 mm. .... *triedrus*
   Granules of back intermixed with large, rounded tubercles; males with four to six preanal pores .... *frenatus*

Gymnodactylus collegalensis Beddome

Gymnodactylus collegalensis Beddome, Madras Month. Journ. Med. Sci., vol. 2, 1870, p. 173 (type locality, Balarangams, near Yelandur, Mysore, India); Smith, The fauna of British India, including Ceylon and Burma; Reptilia and Amphibia, vol. 2, Sauria, 1935, pp. 56-57, pl. 1, figs. B1, B2.

Gymnodactylus nebulosus (*part.*) Boulenger, the Fauna of British India, including Ceylon and Burma; Reptilia and Batrachia, 1895, pp. 64-65; Annandale, Spolia Zeylanica, 1906, p. 189 (18 mi. N. Kandy) Deraniyagala, Ceylon Journ. Sci., B., vol. 16, 1932, p. 293, pl. 59.

Diagnosis: A small species, snout-to-vent length 54 mm.; tail 36; limbs short, the leg not reaching axilla; scales on dorsum small uniform except for a few on distal part of flanks and on back between hind legs; no preanal or femoral pores; more than 50 rows of subcircular ventral scales, not or but scarcely imbricating; whorls on tail scarcely discernible, each with six rows of small scales and without larger spiny scales.

Description of species: (From E.H.T.-N.M.S. No. 30483, 12-16 mi. N Trincomalee, Ceylon.) Rostral 2.2 mm. wide, 1.5 mm. high; nostril surrounded by rostral, internasal, and three or four postnasals, the first labial excluded; scales on snout rather irregular, much larger than on occiput, distinctly larger than dorsal granules; rostral bordered by four nearly equal-sized scales; the internasals widely separated; ten supralabials, six to a point below middle of orbit; infralabials, 9, 8; forty granules across head between the edges of eyelids; granules uniform on dorsum and sides except for about 20 scattered, larger, conical tubercles on flanks and between hind limbs; mental relatively small, its labial border equal or a little less than the labial border of rostral; a median pair of postmentals, their common suture longer than the suture of one with the mental, each touching one labial; second pair of postmentals small, touching first and second labials; two or three rows of scales nearest labial series somewhat enlarged; scales on chin granular, subconical; scales on venter granular, subconical, not imbricating, about 58 rows on ventral surface, not differentiated from adjoining lateral scales; scales of preanal region larger, flattened, somewhat imbricating, lacking trace of femoral or preanal pores; tail showing whorls, each with about six transverse rows of flattened scales, all more or less imbricating, their surfaces finely striated or corrugated; on under surface of tail scales slightly larger, the median row not distinguishable from adjoining scales; no larger tubercles on tail; fingers slightly angular, the distal half scarcely narrower than proximal; scales on basal portion enlarged at least one half to two thirds of width of digit and extending onto palm; the formula of scales from claw to base of fingers one to five is: 7, 11, 12, 12, 11; one or more scales may be divided; scale formula for toes: 8, 12, 16, 14, 14, with certain ones divided; hind leg reaches to within one millimeter of axilla.

Color: Rich brown, with head flecked or dimly spotted with darker color and a pair of distinct spots on occiput; neck and body with seven pairs of small irregular black spots, bordered with much lighter brown; upper and lower labials cream, with blackish brown spots; chin cream with a series of brown, vermiform flecks or spots; belly dirty white, with some scattered pigment; tail with a few dark, transverse flecks; under surface of tail with seven or eight black bars separated by cream spots; sides nearly uniform brown.

Measurements in mm.: Snout to vent, 45; tail, 37; arm, 16; leg, 20.2; axilla to groin, 22.5; width of head, 10.6; length of head, 13.

Remarks: All specimens of this species in the collections were found along the beach north of Trincomalee (12-16 mi.) under masses of coral and about a plant, *Zanzeveria zeylanica,* growing in sand and coral along the beach. Here they are very inconspicuous. They are seemingly confined to regions of low elevation in Ceylon. The species is known to occur also in southern India.

DATA ON GYMNODACTYLUS COLLEGALENSIS, FROM CEYLON*

Number	30466	30484	30475	30454	30471	30470	30467	30482	30483	30470
Sex	♂	♀	♀	♀	♀	♂	♂	♂	♂	♂
Length	53	52.3	52	51	50	46	45	44	44	41.5
Tail	......	......	......	35.5	32.5	......	......	......	38	......
Head, long	15.3	16	15	16	16	14.2	15	14.3	14.4	14
Head, wide	11	11	10.5	10.3	10	10	9.2	10	10	9
Axilla to groin	29.2	27	27	27	25	23	22.5	19	22	20
Arm	17.5	17.5	17	16	17.6	16	15.2	16	16	16
Leg	22	21.5	21.5	21.5	21.5	20	20	20.3	21.4	18.5
Supralabials	9-9	11-11	10-10	9-9	9-9	10-9	10-11	10-10	9-9	11-12
Infralabials	8-9	8-9	9-10	9-9	9-9	8-8	9-8	8-7	8-9	9-9

* All specimens from 12 m. N Trincomalee, Ceylon, in E. H. Taylor-H. M. Smith collection.

Gymnodactylus yakhuna Deraniyagala

Gymnodactylus yakhuna Deraniyagala, Proc., 32dn. Indian Science Congress, III, (Abstracts) 1945, p. 114; Spolia Zeylanica, vol. 24, part 2, Dec. 22, 1945, pp. 100-102 (type locality, Kalivila, Northwestern Province, Ceylon) ("forma *typica*").

?*Gymnodactylus yakhuna* variety *zonatus* Deraniyagala, Spolia Zeylanica, vol. 24, pt. 2, Dec. 22, 1945, p. 101 (type locality, Manampitiya, Ceylon).

I am somewhat confused by the recent treatment of a small species of *Gymnodactylus* by Deraniyagala. It is described as *G. yakhuna*. Concerning it, Deraniyagala states: "—The Ceylon gecko also exists as two color varieties, and it is possible that further examination might reveal them to be subspecifically distinct. To be in keeping with the procedure adapted for *Gymnodactylus collegalensis* [by Smith 1935, pp. 56-57, pl. 1, figs. B1, B2] it is now proposed to designate the spotted variety as the 'forma typica' and confer the name of *zonatus* upon the banded one."

I presume that the form previously recorded as *G. collegalensis* occurring in Ceylon is regarded as a synonym of *G. yakhuna*. Unfortunately I have not been able to examine specimens of this latter species (or the color varieties) and cannot judge the merit of distinguishing these from *collegalensis* by name. Nevertheless, it would appear that a species differing from *yakhuna* occurs on the east coast, and this is recognized in this paper as *G. collegalensis*.

Diagnosis: Head rather heavy; snout slightly longer than distance between eye and ear; body and tail subcylindrical; no lateral fold; middle of tail as thick as neck; limb short; supralabials, 10-9, infralabials, 9-7; rostral subrectangular touching two supranasals that are separated by a single median scale; dorsal granules rounded, sometimes two or three enlarged ones on each side near the hips; mental subpentagonal followed by two enlarged postmentals that are broadly in contact with one another mesially; ventrals subimbricate, some apt to be subhexagonal in shape; caudals and subcaudals imbricate, a few may be somewhat enlarged; subdigital lamellae equal to half width of basal part of digit; head with an arrow-shaped, dark, median band which is interrupted in many specimens, and there are three or four supraocular dark blotches. A dark band runs laterally from snout to nape, and is confluent with its fellow; ventrally dusky gray; throat with a number of wavy dark lines running from lips to the midgular region. (Data from Deraniyagala.)

Remarks: That *Gymnodactylus yakhuna* differs materially from specimens at hand that I have designated *Gymnodactylus collegalensis,* is obvious. The specimens of the latter are larger, fully-grown adults, ranging from 45 to 53 mm., snout to vent, and none in my series displays the type of coloration recorded for *yakhuna.* Specimens referred by me to *collegalensis* are all from 12-16 miles north of Trincomalee along the shore in Eastern Province, but at a point probably as far north as the type locality of the variety *zonatus.*

The differences in the two color varieties are: *Forma typica*—there are two crossrows of dark blotches on the body, each row consisting of two subrectangular markings. *Zonatus*—there are two crossbands on the body, which are equal to or shorter than the light interspaces.

Gymnodactylus triedrus Günther

Gymnodactylus triedrus Günther, Reptiles of British India, 1864, p. 113, (type locality, Ceylon); Boulenger, Catalogue of the Lizards in the British Museum, vol. 1, 1885, p. 38; The Fauna of British India, including Ceylon and Burma; Reptilia and Batrachia, 1890, pp. 67-68; Annandale, Jour. Asiat. Soc. Bengal, vol. 73, 1904, Suppl. p. 13; Rec. Ind. Mus., vol. 9, 1913, p. 320; Deraniyagala, Ceylon Journ. Sci., B, Vol. 16, 1932, p. 295-296, pl. 61; Smith, The Fauna of British India, including Ceylon and Burma; Reptilia and Amphibia, vol. 2, Sauria, 1935, pp. 55-56.

Geckoella punctata Gray, Proc. Zool. Soc. London, 1867, p. 99, pl. 9, (type locality, Ceylon).

Diagnosis: A large *Gymnodactylus,* the snout-to-vent measurement 62 mm.; tail 56 mm.; 12-13 supralabials, 10-11 infralabials; venter with 35 rows of cycloid, imbricating scales; body with small granular scales mixed with larger, rounded, keeled, or trihedral tubercles; toes short, the lamella on basal part scalelike, half as wide as the digit; tail with small rounded imbricate scales, those on under surface somewhat larger; three or four femoral pores.

Brown on dorsum; numerous white spots with darker edges usually present; light brown on venter.

I have not examined this species. It is endemic in Ceylon, and has not been taken elsewhere.

Gymnodactylus frenatus Günther

Gymnodactylus frenatus Günther, Reptiles of British India, 1864, p. 113, pl. 12, fig. D. (type locality, Ceylon). Boulenger, Catalogue of the Lizards in the British Museum, 2nd ed., vol. 1, 1885, p. 42; The Fauna of British India, including Ceylon and Burma; Reptilia and Batrachia, 1890, p. 68; Annandale, Spolia Zeylanica, vol. 3, Jan. 1906, p. 190 (Kandy); Henry, Ceylon Journ. Sci., B, vol. 16, 1928, p. 339; Deraniyagala, Ceylon Journ. Sci., B, 1932, pp. 294-295, pl. 41; Smith, The Fauna of British India, including Ceylon and Burma; Reptilia and Amphibia, vol. 2, Sauria, 1935, p. 49; Bhatt, Animal Life (Colombo Ceylon) 1942, pp. 122.

Diagnosis: A large lizard (head-body length 100 mm., tail 120 mm.) with dorsal scales granular, intermixed with large rounded tubercles; tail with flat scales, the basal whorls with four somewhat enlarged rounded tubercles, quickly becoming smaller on succeeding whorls; male with four to six preanal pores; 33-35 scales across belly; four or five large dark bands whose anterior and posterior borders form angles.

Description of species: (From K.U.M.N.H. No. 31258, Tonacombe Estate, Namunukula, Ceylon). A large species, the head (20 mm.) nearly as wide as long (21.5 mm.); snout-to-vent length 85 mm., tail, broken from body, the tip regenerated, 87 mm.; rostral large, its width (4.7 mm.) greater than its height (2.3 mm.), a median entrant suture more than half height of scale, the upper edges curving toward middle; internasals large, separated by a median scale and followed by one somewhat enlarged; nostril surrounded by rostral, first labial, two or three postnasals and the internasal, the latter almost excluded; scales on snout variable in size in several areas; fifty scales across snout between the fourth labials; a depression somewhat behind nostrils and a well-defined median depression beginning at about posterior level of orbits and extending onto frontal region, narrowing between orbits; approximately 48 scales between outer edges of eyelids at middle of orbit, small, irregular with a few larger flat rounded tubercles intermixed; supralabials, 9-10; infralabials, 8-8; scales adjoining labials somewhat enlarged, at least anteriorly; mental border on lip greater than rostral border, the sides of mental being nearly straight, forming approximately a right angle posteriorly. A pair of postmentals forming a median suture as long as their sutures with mental, bordering first labial for about half its length; on each side a small outer postmental touching two labials; two or three scales following somewhat enlarged; chin scales small, circular, rather regular; ear diameter less than half eye diameter; distance from ear to eye a little greater than distance from eye to nostril; ventrolateral folds more or less distinct; scales of occiput and dorsum small, with about 14 irregular, longitudinal rows of larger rounded, flat, rarely slightly keeled, tubercles; the three or four basal whorls of tail may have as many as six tubercles, but reduce posteriorly to scales that are not or scarcely differentiated; 6 transverse rows of small scales on each whorl; on ventral surface two widened scales to each whorl; abdominal scale rows, 30-33, cycloid, imbricate; an enlarged row of femoro-preanal scales the inner two of the series bearing preanal pores in the male, separated by three scales mesially; males with three enlarged flattened tubercular scales on each side of tail base; bases of angular digits widened, bearing single, transverse lamellae, 7 to 9 in number; on both hands and feet lamellae continue below metacarpals and metatarsals for some distance; all digits clawed; hind leg long, reaching axilla when adpressed.

Color: Above gray, the top of head with small spots or marbling of brown; a light-edged, brown band from behind each eye unites with a dorsal brown spot on beginning of neck; three brown W-shaped blotches on back of body which are separated by gray bands with some indefinite brown flecks; arms and legs banded or mottled; tail with regular broad bands of brown or black; grayish below on chin and venter, everywhere peppered with black pigment.

Remarks: The single specimen at hand is from an elevation of 4000 ft. on the Tonacombe Estate, Namunukula, Ceylon (Uva Hills), W. W. A. Philipps, collector.

The species is endemic in Ceylon and has not been taken elsewhere.

Genus CNEMASPIS Strauch

Cnemaspis Strauch, Mem. Acad. St. Petersburg, vol. 35 (7), 1887, p. 41 (type of genus, *Cnemaspis boulengeri*).

This genus is represented by at least four forms in Ceylon. Certain of these are regarded as variable and Malcolm Smith (1930) throws some doubt on the validity of certain forms recognized by Deraniyagala and Boulenger. Probably the last word cannot be said on the matter until rather large series are available from various parts of Ceylon and south India. Only then can one properly evaluate the differences in populations. It seems likely that size of the animals may be a specific character. Measurements offered by Smith for *kandiana* are considerably greater than any specimens in my series of thirteen. Whether the forms here considered are to be regarded as species or subspecies will depend on more material than has been collected. I have regarded them as of specific rank, but without conviction.

Key to Forms of Cnemaspis in Ceylon

1. Femoral pores less than five (rarely five) median subcaudals not strongly enlarged 3
   Femoral pores five or more; median subcaudals much enlarged . . 2
2. Femoral pores eight to fifteen . . . . *jerdoni*
   Femoral pores eight or less . . . . *podihuna*
3. No keeled scales on ventral neck region or abdomen; femoral pores three or four; preanal pores two to four . . . . *gracilis*
   Keeled scales on ventral neck region or on both neck and abdomen 4
4. Ventral nuchal scales keeled over a greater or lesser area; abdominal and subcaudal scales smooth; femoral pores, three to five; preanal pores, two to four . . . . *kandiana*
   Keeled scales on entire nuchal, ventral and ventrolateral areas, as well as under tail; femoral pores 3; preanal pores absent (in specimen examined) . . . . *tropidogaster*

Cnemaspis podihuna Deraniyagala

Cnemaspis podihuna Deraniyagala, Journ. Royal Asiat. Soc. (Ceylon branch) no. 97, 1944, pp. 226-227, 1 fig. (type locality).
? *Gymnodactylus scalpensis* Ferguson, Reptile Fauna of Ceylon, Colombo, 1877, pp. 1-30.

Diagnosis: Femoral pores five; preanal pores four; subcaudal scales strongly enlarged; tail with small lateral spines; some enlarged lateral spinelike scales on the sides; nine supralabials; six or seven infralabials.

I have not examined specimens of this species. It appears to be closest to *Cnemaspis jerdoni.* The type locality of the latter is unknown. Ferguson has described a form from Ceylon (without specific locality) which he named *scalpensis.* Unfortunately the type is lost. There is a possibility that *podihuna* is a synonym of *scalpensis.*

Cnemaspis jerdoni (Theobald)

Gymnodactylus jerdoni Theobald, Catalogue of the Reptiles in the Asiatic Society Museum, 1868, p. 31 (type locality not stated, India by inference).
Gonatodes jerdoni Boulenger, Catalogue of the Lizards in the British Museum, vol. 1, 1885, p. 71; The Fauna of British India, including Ceylon and Burma; Reptilia and Batrachia, 1890, p. 78. Deraniyagala, Ceylon Journ. Sci. B, vol. 16, pt. 3, 1932, pp. 298-299.
Cnemaspis jerdoni Smith, The Fauna of British India, including Ceylon and Burma; Reptilia and Amphibia, vol. 2, Sauria, 1935, pp. 74-75.

Diagnosis: This species is similar to *gracilis* in general scale characters: the postmentals two or three; tail cylindrical; median subcaudal scales larger than others. A series of five to fifteen femoral pores on each side; ventral scales cycloid, smooth. Gray brown clouded with darker. Small lateral spines white, sometimes a black spot on back of occiput; "Snout to vent, 40 mm., tail 44 mm."

Cnemaspis gracilis (Beddome)

Gymnodactylus gracilis Beddome, Madras Month. Journ. Med. Sci., vol. 1, 1870, p. 32 (type locality, Palghat Hills, Madras, India).
Gonatodes gracilis Boulenger, Catalogue of the Snakes of the British Museum, vol. 1, 1885, p. 70, pl. 6, fig. 5; The Fauna of British India, including Ceylon and Burma, 1890, p. 78; Hora, Rec. Indian Mus., vol. 28, part 3, 1926, pp. 191-192, pl. 7, fig. 7, test fig. 3 a. (Indian Records only).
Gonatodes kandianus gracilis Deraniyagala, Ceylon Journ. Sci., B, vol. 16, 1932, p. 297.
Cnemaspis gracilis Smith, The Fauna of British India, including Ceylon and Burma; Reptilia and Amphibia vol. 2, Sauria, 1935, p. 74. (Hills of Ceylon) ("Doubtfully distinct from *kandianus* perhaps only a varietal form not correlated with geographical distribution").

Diagnosis: This form differs from the species *kandiana* in having two instead of three scales bordering the mental. Scales on the neck are larger, smooth, lacking keels; scales under basal part of foot smaller; grayish or brownish above, the back of occiput with darker spots; sometimes a series of light vertebral spots present. A forest form.

Cnemaspis kandiana (Kelaart)

Gymnodactylus Kandianus Kelaart, Prod. Fauna Zeylanicae 1852 (1853), p. 186 (type locality, "Kandian-hills", [hills about Kandy, Ceylon]); Günther, Reptiles of British India, 1864, p. 114.
Gymnodactylus humei Theobald, Cat. of the Reptiles of British India, 1865, p. 89, (type locality, Kandy, Ceylon).
Gonatodes kandianus Boulenger, Catalogue of the Lizards of the British Museum, vol. 1, 1885, p. 68; The Fauna of British India, including Ceylon and Burma; Reptilia and Batrachia, 1890, pp. 77-78; Hora, Rec. Indian Mus. vol. 28, pt. 3, 1926, pp. 191-193 (Kandy and Peradeniya, Ceylon). "*G. kandianus* possesses a relatively longer and more pointed snout and three chinshields behind the mental").

Diagnosis: Small geckoes, the maximum snout-to-vent length approximately 40 mm.; tail, 45 mm.; fingers slender, the basal portion of digits with a few enlarged, flat plates; femoral pores few, widely separated from a small series of two or three preanal pores; scales on back small, somewhat keeled granules, with some scattered larger ones; on flanks, scales prominent, spinelike; belly scales imbricate; those on neck with fine keels.

Description of species: (from E.H.T.-H.M.S. No. 30517). Rostral (1.5 mm. x 9 mm.) reaches above level of nostril, which is surrounded by rostral, two postnasals and an internasal (the first labial being excluded), and the internasal forming a very small contact; latter scales separated mesially by a scale nearly as large as internasals but extending somewhat farther forward (in this specimen, partially fused to rostral); seven or (eight) supralabials, the fourth extending under front of orbit; between front part of fourth labials across snout, 28 relatively large scales; scales bordering labials not larger than snout scales; infralabials, 8-8; mental very large, its labial border considerably greater than labial border of rostral; a pair of chinshields separated mesially by a much smaller scale; second chinshields smaller, separated by three intervening scales all larger than other chin scales which are keeled on side of jaws; scales on sides of neck larger, with keels, the keeled extending on sides of neck to arm insertion; scales of venter somewhat cycloid, imbricate, smooth, in 24 rows; scales on sides keeled, while on back they are smaller, almost trihedral, with a few larger pointed scales often elevated to resemble small spines; tail with small scales arranged in eight rows to a whorl, each whorl bearing two small pairs of dorsal spines and one lateral pair; a very heavy pyramidal scale at base of tail on each side; tail regenerated (ventrally, on original tails, three scales to a whorl, every third scale being somewhat enlarged); four femoral pores placed ventroposteriorly; two preanal pores separated from femoral pores by seven or eight scales; digits with a long slender distal part and a widened basal part except on first inner finger and toe where the free basal part is missing; on basal part of four outer fingers, there are four or five widened flat scales; on toes five or six; a single large scale at base of first finger and toe; ear about one third of eye diameter; the distance between ear and eye more than a third less than distance from eye to nostril.

Color: Above dark, gray-brown with some blackish flecks tending to form a transverse band; pigment on ventral surface often arranged in half-moon groupings on posterior edges of scales; chin and throat dark (at least in males); tail indistinctly barred (when complete, the dark marks narrow).

Measurements in mm.: Snout-to-vent length, 31; tail regenerated; width of head, 5.45; length of head, 9.

Remarks: The following specimens have been examined: E.H.T.-H.M.S. Nos. 30514 Kandy; 30515-30518 Badulla; K.U.M.N.H. Nos. 31265-31275 Tonacombe Estate, Namunukula, 4000 ft. elevation, in Uva Hills.

The largest of this series of specimens measures only 31 mm. snout to vent; tails for the most part are incomplete or reproduced. No. 30514 measures 25 mm., the tail being 32 mm.

One of the specimens has only a single preanal pore, and four femoral pores. Those from Tonacombe Estate have a curving, light gray line from eye around occiput to eye, bordered anteriorly by a darker mark; mesially on occiput there is a lighter spot; behind this there is a curving darker spot; some specimens show eight or nine transverse bars on body, the dark bars being somewhat angulate or W-shaped.

Cnemaspis tropidogaster (Boulenger)

Gonatodes kandianus tropidogaster Boulenger, Catalogue of the lizards in the British Museum, vol. 1, 1885, p. 70 (type locality, Ceylon); The Fauna of British India including Ceylon and Burma; Reptilia and Batrachia, 1890, p. 78.

Diagnosis: Entire ventral surface of throat, venter and under side of tail strongly keeled; ventral scales under tail all relatively small, more or less equal in size; three femoral pores; no preanal pores (?).

Description of species: (From E.H.T.-H.M.S., No. 30246 Galle, Ceylon.) The form agrees in certain characters with *kandiana* but differs in the character of the squamation; 24 mm. snout-to-vent (tail broken and posterior part missing); nostril surrounded by rostral, an internasal and two postnasals; pair of internasals separated mesially by one scale; 29 scales across snout between fourth labials; supralabials, 7-7; infralabials, 7-8; approximately 42 scales across head between edges of eyelids at middle of orbit; scales on snout larger than on occiput, rather equal and regular; granules much finer on occiput; on body, scales nearly as large as those on snout, but keeled or trihedral with a few larger, scattered, irregularly placed tubercles; scales on arms and legs, as well as on sides and ventral surfaces, keeled, except for a few in preanal region; median scales under tail pointed, keeled and subequal, but little larger than other subcaudals, which are all strongly keeled; scales above arranged in whorls, each whorl with eight or nine rows of keeled scales and a transverse series of large pointed spines, six at least on basal whorls; a very heavy, spiny tubercle on each side at base of tail; a few lateral spines present.

Distal part of fingers compressed, the basal part wider, bearing three or four flat scales on four outer fingers; one at base of the compressed part of first finger; four or five scales under four outer toes, one under first toe; hind leg brought forward, the toes touch axilla (skin damaged so no count of abdominal scales can be made); three femoral pores; I cannot discern preanal pores.

Color: Brown or gray-brown above; a pair of irregular occipital dark spots with a lighter cream spot between them; some darker clouding on back and sides, the median region a little lighter.

Remarks: Most records of *Cnemaspis tropidogaster* are from lowland localities, while *kandiana* is from the mountainous regions or highlands. Boulenger, *loc. cit.*, regarded *tropidogaster* a variety (subspecies) of *kandiana.* Smith throws it into synomomy of *kandiana.* Deraniyagala reports it from Peradeniya however.

It seems to me that a recognition of the form is essential as a species or a subspecies. I prefer to use the former relationship since the characters seem to warrant such usage.

Genus HEMIDACTYLUS Oken

Hemidactylus Oken, Isis, 1817, p. 1183 (type of the genus, *Gecko tuberculosus*).

This very large, cosmopolitan genus is represented in Ceylon by six species. The two smaller species, *Hemidactylus frenatus,* and *Hemidactylus brookii,* the most common of the domestic geckoes, are widespread forms, the first of the two having become established in Mexico. Four other species are tree-dwelling forest geckoes, although rarely they may be found in human habitations. These are: *Hemidactylus triedrus* and *leschenaulti,* which occur also in India, *Hemidactylus depressus,* an endemic Ceylonese form unknown elsewhere, and *Hemidactylus maculatus hunae,* a Ceylonese representative of an Indian species.

KEY TO THE SPECIES OF HEMIDACTYLUS IN CEYLON

1. Dorsal tubercles usually trihedral, strongly developed, in 16-20 rows 2
   Dorsal tubercles few, rounded, not or but slightly keeled, usually confined to posterior part of back 5
2. Small forms usually less than 52 mm. snout to vent length; femoro-preanal pores, 11-15, separated by three poreless scales mesially; dorsal tubercles in 18-20 rows . . . . . . *brookii*
   Larger forms, 80-115 mm. in snout-to-vent length 3
3. Femoral pores only, 19-25 on each side; 5 transverse bands on body with median lighter spots; very large, snout to vent 115 mm. . . . . . . *maculatus hunae*
   Femoro-preanal pores; markings varied; smaller, probably not exceeding 90 mm. 4
4. Digits webbed at base; 16-19 femoro-preanal pores on each side, separated mesially; tubercles smaller . . . . . . *depressus*
   Digits free at base; preanal pores 6-9, separated mesially by one to three scales; tubercles larger . . . . . . *triedrus*
5. Dorsal tubercles reduced in number (rarely absent), smooth or faintly keeled; head and body broad; snout-to-vent length, 83 mm.; male with 10-17 femoro-preanal pores on each side, separated mesially by a distinct interval . . . . . . *leschenaulti*
   Dorsal tubercles few, usually two or three smooth rows on posterior part of back; male with a continuous series of femoro-preanal pores, 13 to 18 on each side; snout to vent, 60 mm., *frenatus*

Hemidactylus brookii Gray

Hemidactylus brookii Gray, Catalogue of the Specimens of Lizards in the collection of the British Museum, 1845, p. 153 (type locality, Borneo); Boulenger, Catalogue of the Lizards of the British Museum, vol. 1, 1885, p. 128; Deraniyagala, Ceylon Journ. Sci., B, 16, 1932, p. 300.
Hemidactylus gleadovii Boulenger, The Fauna of British India, including Ceylon and Burma; Reptilia and Batrachia, 1890, pp. 86, 87, fig. 27.
Hemidactylus maculatus? Kelaart, Prod. Fauna Zeylanica, 1852 (1853) p. 158 (Ceylon, widely distributed) (not of Duméril and Bibron).

Diagnosis: A small, widespread species with a maximum snout-to-vent length of 60 mm., the tail approximately 78 mm.; femoro-preanal pores, 11-15; scales of tail in whorls, each bearing eight or six sharp, spiny tubercles; back with 18-22 rows of trihedral tubercles; scales across abdomen cycloid, imbricate, 36-40 in number.

Description of species: (From E.H.T.-H.M.S. No. 30417.) A rather small species, the head-width in head-length, 1.5 times; diameter of ear distinctly less than half of eye-opening, its distance from eye a little less than distance between eye and nostril; width of rostral, 2.1 mm., height, 1.45 mm.; a median, entrant suture less than half height of scale; a pair of internasals separated by a pair of median scales; nostril surrounded by rostral, first labial, three postnasals and an internasal; scales on snout regular, with some variation in size, all scales larger than elsewhere on head and dorsum (exclusive of tubercles); 37 scales across snout between the fourth supralabials; approximately 43 scales between edges of upper eyelids; scales on head minute, the small intermixed tubercles reaching forward to anterior level of eye; scales of sides and dorsum small, juxtaposed, intermixed with trihedral tubercles, forming approximately 20 irregular, longitudinal rows, but diagonally the rows are relatively regular; nine or ten rows between hind legs; scales on tail arranged in whorls, seven or eight scale-rows basally to a whorl, with a transverse series of eight large spiny scales (at base) and reduced to six and later to four farther back; ventral scales on the base of the tail divided, becoming single on the fifth whorl, two scales to a whorl; the regenerated tail has very wide, ventral scales, while the scales of side and dorsal part of tail are nearly uniform and more or less keeled; a number of large tubercles on dorsal surface and hind limb; supralabials, 11-10, infralabials, 9-9; mental with a wider labial border than rostral, its sides straight, forming an acute angle behind; two pairs of chinshields, the inner, larger pair with a suture much less than half that bordering the mental, the scales touching two labial scales; outer pair smaller, touching only one labial; chin scales small, regular, cycloid, a little larger on sides; venter with larger cycloid, imbricate scales, in 38 rows at widest part of belly; a rather large tubercular scale on each side of base of tail; preano-femoral pores, 13-13, separated mesially by three scales; ventrolateral folds scarcely discernible. All digits with claws, and lamellae under basal part; terminal lamellae, fore and aft, are single, others double, arranged slightly diagonally, seven or eight on outer four toes, five on inner toe; six or seven on four outer fingers, five on inner finger, the proximal lamellae on all somewhat scalelike.

Color: Above fawn with a series of brown flecks or spots on head and a curving mark from back of eye around to back of eye on opposite side; a dark line directly back from eye to behind ear; dorsum with three moderately distinct series of spots, one series medial, the others dorsolateral; venter yellowish white; tail indistinctly barred.

Remarks: A series of specimens of this species (E.H.T.-H.M.S. Nos 30401-30417) was acquired at a point 12 to 14 miles north of Trincomalee. Most of these were collected in human habitations. One other specimen, No. 30486, E.H.T.-H.M.S. from "Ceylon," is in the collection.

There is considerable variation in color and markings, dependent on the amount of pigment. Specimens taken and preserved at night are light in color.

Hemidactylus depressus Gray

Hemidactylus depressus Gray, Zoological Miscellany, 1842, p. 58 (type locality unknown: here restricted to Ceylon); Catalogue of the Specimens of Lizards in the collection of the British Museum, 1845, p. 153; Günther, Zoology of the Erebus and Terror, vol. 2, 1874-75, p. 16, pl. 15, fig. 1 (figure of type) [not seen by me]; Boulenger, Catalogue of the Lizards in the British Museum, 2nd ed. vol. 1, 1885, p. 134; Theobald, Descriptive Catalogue of the Reptiles of British India, 1876, p. 76; Boulenger, The Fauna of British India, including Ceylon and India; Reptilia and Batrachia, 1890, p. 90-91; Haly, First Report on the Collection of Lizards in the Colombo Museum, 1886, p. 4, (Colombo, Ceylon); Méhely, Termes Füzet., vol. 20, 1897, p. 57; Deraniyagala, Ceylon Journ. Sci., B, vol. 16, 1932, p. 302, pl. 58.

Nubilia argentii Gray, Catalogue of the specimens of Lizards in the collection of the British Museum, 1845, p. 273 (type locality "Singapore", *ex errore*, corrected to and restricted to Ceylon).

Hemidactylus pieresii Kelaart, Prod. Fauna Zeylanica, vol. 1, 1852 (1853), p. 159 (type locality, Kandy, Ceylon ["The Kandian Gecko"]).

Diagnosis: Head moderately wide the maximum snout-vent length reaching 80 mm., the tail 90; scales across belly, 35; 15 to 17 femoral pores on each side, almost continuous; back with fine granules and 16 (14-18) irregular rows of trihedral tubercles; scales of tail in whorls, each whorl bearing 8 spinelike tubercles; a cream line from eye to nostril.

Description of species: (from E.H.T.-H.M.S. No. 30399). Head one and one-half times as long as wide; rostral nearly twice as wide as high, reaching distinctly higher than upper level of nostril; a pair of internasals separated mesially by two small scales (tandem); two, small, indistinct postnasals, one supralabial, the rostral and internasal complete the border of nostril; 38 small granular scales from eyelid edge across to eyelid edge at middle of eye; 48 scales from fifth labial across snout to fifth labial; scales on snout larger on interorbital area and occiput, but in latter area larger scattered scales are present; ear large, diagonal, its greatest diameter a little more than half eye diameter; ear a little closer to eye than nostril; supralabials 13-13, infralabials 10-10; scales bordering labials scarcely larger than other scales; width of mental about equal to that of rostral, the sides of mental forming an angle; first pair of postmentals touch two labials, forming a common suture as long as their sutures with the mental, the scales nearly pointed behind; outer pair of postmentals touch one labial and are very narrowly separated posteriorly, the third scale on each side being separated from the third labial by another small scale; scales on chin and throat small, nearly uniform; on belly, scales cycloid, imbricate, about thirty-six rows between indistinct dorsolateral folds; femoro-preanal pores, 17-17, separated mesially by three scales; terminal (anterior and posterior) lamellae single; other lamellae paired, arranged slightly diagonally; outer fingers with eight or nine lamellae; inner finger with six; four outer toes with nine or ten lamellae, the inner toes with six lamellae; tail with numerous whorls, bearing at base eight spiny tubercles and seven or eight rows of tiny scales; ventrally each whorl with two enlarged scales.

Color: Above light gray or brownish gray; a silvery or cream line from eye to nostril, dark bordered above and below; a black stripe from eye to near point of arm insertion and a short upward projection from it behind ear; back gray-brown with four narrow transverse markings.

Measurements in mm.: Snout-to-vent length, 69; tail length, 73 (tip regenerated); width of head, 15; length of head, 21; axilla to groin, 36; arm, 19; leg, 26.

Remarks: A series of eleven specimens have been examined: E.H.T.-H.M.S. Nos. 30393-30400 from 12 miles north of Trincomalee Ceylon; Nos. 31255-31257, 31287 Tonacombe Estate, Uva Hills, Namunukula Ceylon, W. W. A. Phillips, collector.

Hemidactylus triedrus (Daudin)

Gecko triedrus Daudin, Histoire Naturelle générale et particulière des Reptiles, vol. 4, year X (1802) pp. 155-157 (unknown locality; here fixed and restricted to Trincomalee, Ceylon).
Hemidactylus triedrus Kelaart, Prod. Faun. Zeylanica, 1852, p. 157; Günther, Reptiles of British India, p. 107; Boulenger, Catalogue of the Lizards of the British Museum (Natural History, 2nd ed., vol. 1, 1885, p. 133; Fauna of British India, including Ceylon and Burma; Reptilia and Batrachia, 1890, pp. 89-90; Méhely, Termes Füzet., vol. 20, 1897, p. 57. (Kala-Wewa; tubercular scales in 18 rows; femoral pores 7-7); Deraniyagala, Ceylon Journ. Sci., B, vol. 16, 1932, p. 303, pl. 44; Smith, The Fauna of British India, including Ceylon and Burma; Reptilia and Amphibia, vol. 2, Sauria, 1935, pp. 88-89.
Hemidactylus trihedrus Kelaart, Prod. Faun. Zeylanicae, 1852 (1853), p. 157, (rare in Ceylon; found in ant hills at Trincomalee; it lays 3 to 6 eggs.)

Diagnosis: Large, snout-to-vent length, 80 mm., tail 90 mm.; trihedral tubercles arranged in 16 to 18 longitudinal rows; femoral pores, 8-8, separated by a single scale, mesially.

Description of species: (from E.H.T.-H.M.S. No. 30418.) Head moderate, its length, 1.6 times the width; height of rostral, reaching upper level of nostril slightly more than half its transverse width; internasals separated mesially; nostril surrounded by rostral, internasal, first labial and three postnasals; supralabials, 10-10; infralabials, 8-8; 37 scales across snout between the fourth supralabials; scales between edges of eyelids, 47, extremely minute but with a few larger tubercles scattered in this region and on occiput; scales on dorsum and sides distinctly larger than those on occiput, but smaller than those on snout; trihedral tubercles especially large, measuring 1.5 mm. in length and width, and .5 mm. high, these separated from each other by from one or two rows of small scales; approximately 24 longitudinal rows of scales on venter, the ventrolateral folds being nearly obsolete; scales on chin subequal, very small; mental large its labial border much larger than labial border of rostral; first pair of postmentals touching one labial, forming a median suture much shorter than their suture with mental; outer (second) pair of postmentals small, widely separated, touching two labials; third outer postmentals touching second and third labials; auricular opening distinctly more than half length of eyes; preanal pores, 8-8, separated mesially by a single scale, and scarcely extending onto femora. All fingers with claws; second joint of fingers and toes with lamella, the distal and sometimes proximal lamellae of series single, others double, arranged diagonally; four outer fingers with eight, inner finger with six lamellae; four outer toes with eight, inner toe with seven lamellae; terminal joint arising back from edge of lamella, the joint long; scales of tail in whorls, bearing either six (on basal whorls) or four, large trihedral tubercles; about nine rows of small scales to each whorl; a pair of broad scales on ventral surface of each whorl.

Color: Above rather light, brownish-fawn, with six or seven very indistinct, transverse, darker spots, the posterior ones scarcely discernible; on edges of these spots several cream-colored trihedral tubercles; behind eye a dark stripe, bordered by three or four cream tubercles above, and below, behind this, a single row of cream tubercles extending along neck and on side, with others on back; tail nearly uniform brown (banded in young).

Remarks: I have three specimens, E.H.T.-H.M.S. Nos. 30418-30420 taken 12-15 miles north of Trincomalee, in forest. The largest specimen measures 72 mm. snout to vent; tail, 85 mm. Two specimens in the U.S.N.M., Nos. 120311 ♀ to 120313 ♂ are from Rattota, Matale District.

The two latter specimens differ but little in the characters recorded for the preceding. The male pores are 7-8, separated mesially by two scales.

Hemidactylus leschenaulti Duméril and Bibron

Hemidactylus leschenaulti Duméril and Bibron, Erpétologie générale vol. 3, 1836, p. 364 (type locality, Ceylon); Boulenger, Catalogue of the Lizards in the British Museum, 2nd ed. 1884, pp. 136-137; Fauna British India including Ceylon and Burma, Reptilia and Batrachia, 1890, pp. 91-92; Deraniyagala, Ceylon Journ. Sci., B, vol. 16, 1932, p. 301, pl. 43; Smith, the Fauna of British India. . . . Reptilia and Amphibia, vol. 2, Sauria, 1935, pp. 97-98.

Hemidactylus coctaei Kelaart, Prod. Faun, Zeylanica, 1853, p. 160, (*nec* Duméril and Bibron).

Hemidactylus pustulosus Lichtenstein and von Martens, Nomenclator Reptilium et Amphibiorum musei zoologici Berolinensis, 1856, p. 5. (type locality, Ceylon).

Hemidactylus kelaartii Theobald, Journ. Asiat. Soc. Bengal, extra number 88, 1868, p. 29 (type locality, Ceylon).

This large Indian gecko was found to be common in the lowland forests eastward and northward of Trincomalee. One smooth-barked tree species common in this vicinity, was almost certain to have a family of these lizards, the mottled gray bark rendering the lizard almost invisible. I have found no individuals of this species in human habitations.

Diagnosis: Head and body relatively broad for the length; 50 granules across head between eyelids; whorls on tail with 12-14 rows of small scales and two pairs of small flat tubercles; granules on back small with flat rounded inconspicuous tubercles; 17-18 femoral pores.

Description of species: (from E.H.T.-H.M.S. No. 30430). A large-headed, large-bodied species, reaching 92 mm. snout-vent length; tail length, 86 mm. (which is, I believe, the largest recorded specimen); rostral much wider than high, reaching up to level of middle of nostrils; a short groove enters rostral from above; internasals (separated by a minute scale, or often by two or three), a pair of postnasals and one labial helping form nostril rim; upper labials, 9-9, followed by three or four tiny scales; infralabials, 9-8; rows of scales bordering the labials both upper and lower, somewhat larger than other head scales; granules between edges of upper eyelids approximately 50; ear opening large, its diameter about 2½ times in diameter of eye; its distance from eye a little less than distance from eye to nostril; head, dorsum and sides covered with small, nearly uniform granules although those on front of head larger, irregular; median scales on back somewhat smaller than those on sides, the granules juxtaposed rather than imbricating; a few (two or four), large, rounded, flat tubercles on back between hind limbs; venter covered with cycloid, imbricating scales, approximately 50 between edges of the two slight ventrolateral folds; mental large, its labial border distinctly larger than that of rostral; a pair of median postmentals touching first labials and forming a median suture a little more than half their length; second, outer pair, smaller, touching first and second labials; femoral pores 17-18, separated mesially by six scale rows; tail with whorls, each bearing 12-14 rows of fine, juxtaposed or partially imbricating granules, and dorsally with two pairs of flat rounded tubercles, and dorsolaterally with one flattened spinelike scale; ventral scales widened, two to each whorl; posteriorly the flat rounded tubercles become more pointed and scalelike (tail partly regenerated, this without whorls or tubercles); toes widened with a double series of slightly diagonal lamellae; four outer fingers with eight or nine lamella, first toe with six, the terminal joint arising back from anterior lamella; all fingers with claws; four outer toes with eight or nine paired lamella (the terminal one always single on all digits); inner toe with six or seven lamellae.

Color: Grayish or grayish black, with dark indistinct markings forming wavy, crossbars, each lighter anteriorly, darker posteriorly and mesially; tail dark with lighter bands of cream or yellow-white; under side of tail, pigmented; a dark line from eye more or less traceable to groin on the side.

Measurements in mm.: Length, snout to vent, 92 mm.; tail length, 86; width of head, 21; length of head, 26; axilla to groin, 39; arm, 29; leg, 36.

Hemidactylus frenatus Schlegel

Hemidactylus frenatus Schlegel, in Duméril and Bibron Erpétologie Générale . . . vol. 3, 1836, p. 366 (type locality, "Java," here restricted to Batavia, Java); Kelaart, Prod. Faun. Zeylanicae, 1853, p. 161 ("found in all parts of the Island except in Newera Ellia"); Deraniyagala, Ceylon Journ. Sci., B, vol. 16, 1932, p. 299, pl. 42; Smith, The Fauna of British India, including Ceylon and Burma; Reptilia and Amphibia, vol. 2, Sauria, 1935, pp. 95-96, fig. 29.

Diagnosis: A relatively small species, snout-to-vent length 62 mm.; tail, 70 mm.; preano-femoral pores in a continuous series of 29-33 on each side; two postmentals, the second outer pair nearly as large as inner pair; body with few, scattered, rounded or feebly keeled tubercles chiefly confined to posterior part of body. Tail with whorls, each bearing a series of spinelike scales.

Description of species: Rostral nearly a half wider than high; nostril surrounded by rostral, first labial, an internasal and two postnasals; internasals separated mesially by a single scale; approximately 41 scales across head between edges of eyelids; occiput, neck and body covered with minute granules and with one or two scattered rows of rounded tubercles beginning on shoulders or perhaps not extending farther forward than middle of body; sometimes tubercles trihedral.

Tail with 10-12 rows of small scales arranged in whorls, each bearing a series of six larger spinelike scales, the outermost ventrolateral in position, and on ventral surface bearing two enlarged scales, the anterior the larger on each whorl; supralabials, 12-12, the last four very small; infralabials, 9-9; chin scales small, regular, a little larger on the sides; ventral scales cycloid, about 38 to 40 between the ventrolateral folds; however those along sides of venter nearly a half smaller than those in middle; digits with claws; inner digits very small, less than half length of the adjoining digit; lamella, eight to ten on four outer toes, six to eight on four outer fingers, five on inner finger and toe.

Color: Grayish or fawn to blackish brown, uniform or with some indistinct marking; usually a dark, light-bordered line on head; yellow or yellow-white below.

Remarks: Some specimens may have a pinkish tinge above. The color is changeable and while at night they may be nearly fawn, in daylight they may become blackish.

The species is widespread in South Asia and Indonesia about human habitations. I have not found individuals in forest, away from the proximity of such habitations.

The following Ceylonese specimens are at hand: E.H.T.-H.M.S., Nos. 30433-30463, from 12-14 mi. N of Trincomalee, Ceylon; K.U.

M.N.H., Nos. 31259-31264, Tonacombe Estates, Namunukula, Ceylon. The pore-counts vary from 29 to 33, usually in a continuous series (one exception has the series separated by one scale).

Hemidactylus maculatus hunae Deraniyagala

Hemidactylus maculatus hunae Deraniyagala, Ceylon Journ. Sci. B. vol. 20, pt. 2, Apr. 15, 1937, pp. 185-189, fig. 1 (type locality, Okanda, Eastern Province, Ceylon).

Diagnosis: A large species 105 mm. snout to vent; nineteen to twenty-five femoral pores on each side, separated mesially.

Description: Snout obtuse, as long as or longer than the distance from eye to ear; supralabials ten to twelve, the infralabials nine or ten; mental subtriangular, wider than the rostral; and usually as long as wide; postmentals two pairs, the inner enlarged; gular scales fine, granular; rostral subquadrangular, broader than high; nostril between rostral, first labial and several small scales; a pair of internasals; snout with convex scales, the occiput with granular scales and larger conical tubercles; back covered with small scales and about fifteen to twenty longitudinal rows of tubercles, which are smallest along the middorsal line and feebly trihedral; ventrals smooth, imbricate, rounded scales which grade imperceptibly into the laterals posterodorsally, immediately anterior to the hind legs; digits free, moderately dilated with almost straight, transverse lamellae, nine or ten under inner toe, eleven to thirteen under fourth toe; tail feebly depressed, with about sixty wide subcaudals and dorsally with six or four longitudinal series of tubercles which are usually low and subconical, rarely trihedral; males with nineteen to twenty-five femoral pores on each side, separated by from two to sixteen scales.

Color: Dorsally silvery gray with five broad transverse olive-brown bands from neck to rump; each band possesses a black margin and forms a rhomboid vertebral enlargement with a light center containing a black ring. Tail with about six dark rings a little wider than the interspaces; limbs with five or six irregular rings on each; two lateral bands on each side of head; ventrally white, dusted with brown especially on tail; young with dorsal crossbands without any light areas.

The type is from Okanda, Eastern Province, Ceylon. It was taken in a rock cave.

Measurements: Snout to ear, 28 mm.; snout to vent, 105 mm.; tail length, 115 mm.

Data from the type description.

Malcolm Smith has not included this form in his "Fauna," nor does he list *H. maculatus* from Ceylon.

Genus COSYMBOTUS Oken

Cosymbotus Fitzinger, Syst. Rept. 1843, pp. 19, 104 (type of genus *Stellio platyurus* Schneider); Myers, Copeia, 1943, No. 3, Oct. 15, p. 192.

Two species are recognized. The species, which occurs in Ceylon, is widely distributed in India, Indo-China, and the East Indian Archipelago.

Cosymbotus platyurus (Schneider)

Stellio platyurus Schneider, Amphib. Physiol., vol. 2, 1792, p. 30 (type locality not given [*fide* M. Smith. I have not seen this paper]).
Hemidactylus platyurus Boulenger, Catalogue of the Lizards in the British Museum, vol. 1, 1885, p. 143; The Fauna of British India, including Ceylon and Burma; Reptilia and Batrachia, 1890, p. 95.
Cosymbotus platyurus Deraniyagala, Ceylon Journ. Sci., B, vol. 15, 1932, p. 306.
Platyurus platyurus Smith, The Fauna of British India including Ceylon and Burma; Reptilia and Amphibia, vol. 2, Sauria, 1935, pp. 102-103.

Diagnosis: A medium sized gecko, the snout-vent length reaching 60 mm.; tail 65; digits webbed, broadened, with the lamellae divided below by a deep groove; all digits clawed; a narrow lateral web or fringe on each side of body; males with continuous preanal and femoral pores, 13-20 on each side; nostril between rostral, first labial, an internasal and two postnasals; back with uniform small granules; venter with smooth, cycloid scales; gray or gray-brown above, marbled or with spots, sometimes with large distinct dorsal blotches; a bar from eye onto side.

I have seen no Ceylonese specimens of this species.

Genus PEROPUS Wiegmann

Peropus Wiegmann, Nova Acta Acad. Leop. Carol., vol. 17, 1835, p. 238 (type of genus [*Peropus mutilatus*]).

A single species of the genus occurs in Ceylon.

Peropus mutilatus Wiegmann

Hemidactylus (Peropus) mutilatus Wiegmann, Nova Acta Acad. Leop. Carol., vol. 17, 1835, p. 238 (type locality, Manila, P. I.).
Gehyra mutilata Boulenger, Catalogue of the Lizards of the British Museum, vol. 1, 1885, p. 48; The Fauna of British India, including Ceylon and Burma; Reptilia and Batrachia, 1890, p. 96; Smith, The Fauna of British India, including Ceylon and Burma; Reptilia and Amphibia, vol. 2, Sauria, 1935, pp. 105-106, fig. 30.

Diagnosis: A specimen (No. 41 ♀) from Tonacombe Estate, Namunukula, Ceylon, is used as the basis of the diagnosis and description.

Three pairs of chinshields, the outer small, extending but slightly farther back than inner; digits webbed at base; seven to nine strongly oblique lamellae under fourth toe; labial border of mental equals that of rostral; head with small granules; on snout granules a little larger; dorsum with very small granular scales; scales cycloid, imbricate on venter; skin-fold on flank and on posterior margin of leg; male with 25-41 preano-femoral scales, meeting mesially.

Description: (from No. 41 Tonacombe Estate, Namunukula, Ceylon, a small species, snout-to-vent length, 51 mm., tail 50 mm.) Rostral not twice as wide as high; large internasals separated mesially; nostril surrounded by rostral, first labial, internasal and two postnasals; 47 scales across snout between fourth supralabials; 42 granules between edges of eyelids; scales on back distinct, rounded, imbricate or subimbricate, larger on sides than on middle of dorsum, and merging into scales of venter; no distinct ventrolateral fold; approximately 48 scales across venter, cycloid, imbricating; supralabials, 10-10, infralabials, 9-10, the last of both series small; labial border of mental smaller than that of rostral; two very large postmentals touching each other, their common suture twice that with the mental; each postmental touching a single labial; outer pair of postmentals slender, not extending behind first pair, touching two labials; a few enlarged scales follow second pair; ear nearly quadrangular, less than half diameter of eye. Digits with a narrow angular joint and a basal part with well-defined, paired, diagonally placed lamellae distally, the proximal lamellae being almost flat, scalelike, 10-13 on four outer fingers and toes, nine or ten on inner; claws present on all digits; skinfold or web on back of leg ample; tail flattened below, with fine scales arranged in indefinite whorls, about ten rows to each whorl.

Color: Above lavender-gray with a more or less definite series of rounded light spots on each side near middle of back and some scattered light spots on sides; scattered spots on occiput; yellowish white below.

Remarks: I have examined one other specimen from Ceylon, U.S.N.M. No. 59014 ♀ without exact locality. This specimen has a well-developed third pair of postmentals separated from labials by small granular scales.

Hemiphyllodactylus Bleeker

Hemiphyllodactylus Bleeker, Nat. Tijdschr. Ned. Ind., vol. 20, 1860, p. 327 (type of the genus, *Hemiphyllodactylus typus.*) A single representative of this genus is known in Ceylon.

Hemiphyllodactylus typus typus Bleeker

Hemiphyllodactylus typus Bleeker, Nat. Tijdschr. Ned. Ind., vol. 20, 1860, p. 327 (type locality, Gunong Paring, Java); Deraniyagala, Ceylon Journ.

Sci., B, vol. 16, 1932, p. 308; Smith, The Fauna of British India, including Ceylon and Burma; Reptilia and Amphibia, vol. 2, Sauria, 1935, pp. 107-108, (part).

Lepidodactylus ceylonensis Boulenger, Cat. Lizards of the British Museum, vol. 1, 1885, p. 164, pl. 13, fig. 3, Fauna of British India, including Burma and Ceylon, 1890, p. 98; Annandale, Journ. Asiat. Soc. Bengal, N. S., vol. 1, 1950, and Spolia Zeylanica, vol. 8, 1915, p. 239 (Ganipola near Kandy, 1,600-1,700 ft. Peradeniva.)

Diagnosis: A small, slender lizard reaching a snout-vent length of 60 mm.; tail 60 mm.; digits free, subcylindrical at base; four toes with lamellae of which the terminal portion is actually or partly divided, the terminal joint rising angularly from within the widened basal part; inner finger and toe without free distal phalanx but sometimes bearing a claw; an angular series of 10-11 preanal pores, separated from a series of 8-10 femoral pores; supralabials, 10-12; infralabials in like number; back and top of head covered with uniform small granules, without tubercles; no postmentals, but several polygonal scales present behind the mental.

I have no specimens at hand from Ceylon. I am not wholly certain that the Ceylon specimens are referable to the typical form.

Genus LEPIDODACTYLUS Fitzinger

Lepidodactylus Fitzinger, Systema Reptilium, 1843, pp. 19, 98 (type of genus, *Platydactylus lugubris*).

Amydosaurus Gray, Catalogue of the Specimens of Lizards in the collection of the British Museum, 1845, p. 162 (type, *Platydactylus lugubris*).

Whether the form of this genus occurring on Ceylon is subspecifically referable to the widespread oceanic form of *lugubris* may be doubted. I have not seen a specimen.

Lepidodactylus lugubris Duméril and Bibron

Platydactylus lugubris Duméril and Bibron, Erpétologie Générale, vol. 3, 1836, p. 304 (type locality, Tahiti); Deraniyagala, Ceylon Journ. Sci., B, vol. 15, 1929, p. 157, pl. 33; *ibid* vol. 16, 1932, p. 307, fig; Smith, The Fauna of British India, including Ceylon and Burma; Reptilia and Amphibia, vol. 2, Sauria, 1935, pp. 115-116, fig. 33 (part).

Not having examined the Ceylonese form of this genus, I follow Deraniyagala in placing it in the species *lugubris* and take data from Smith for the diagnosis.

Diagnosis: A diminutive species (snout to vent 42 mm.; tail 40 mm.), with digits webbed at base, strongly dilated, bearing transverse (or distally) strongly oblique lamellae; supralabials 11-13; mental smaller than adjacent labials; no distinct postmentals, the space occupied by some rows of polygonal scales; snout granules somewhat larger than those on head and dorsum; venter with flat, cycloid imbricate scales; 12-14 lamellae under longest toe; hind leg reaches two thirds of the distance to axilla; tail swollen at base, with a sharp denticulated edge, covered above with small subimbricate scales and below with larger imbricate scales; male with a continuous series of 25-30 preano-femoral pores which form a slight angle mesially.

Light, pinkish gray or brownish above generally with a vertebral series of paired spots, or pigment may be arranged as a sinuous marking; a dark streak from tip of snout passing through eye to ear; young may have one or more dark stripes; lower surfaces light or speckled with brown.

Genus LOPHOPHOLIS Smith and Deraniyagala

Lophopholis Smith and Deraniyagala, Ceylon Journ. Sci., B, vol. 18, 1934, p. 235 (type of genus, *Teratolepis scabriceps* Annandale).

This monotypic genus is known only from southern India and Ceylon.

Lophopholis scabriceps (Annandale)

Teratolepis scabriceps Annandale, Mem. Asiat. Soc. Bengal, vol. 1, 1906, p. 187, pl. 9, fig. 1, a-c (type locality, Ramnad, Madura District, south India).
Lophopholis scabriceps Smith and Deraniyagala, Ceylon Journ. Sci., B, vol. 18, 1934, pp. 235-236 (Mariccukatti, Northern Province, Ceylon); Smith, The fauna of British India, including Ceylon and Burma; Reptilia and Amphibia, vol. 2, Sauria, Feb. 7, 1935, pp. 124-125, fig. 37.

Diagnosis: A small gecko (snout to vent 45 mm., tail 50 mm.), the dorsum covered with imbricate scales a little larger than ventral scales; caudal scales uniform with body scales; three preanal pores on each side, separated mesially by a scale; ear subcircular, its diameter about one third of the eye diameter; supralabials, seven or eight, infralabials, six or seven; two pairs of postmentals, the inner pair largest; head with small granules; body scales slightly elongated, striated, feebly keeled; digits short; hind limb reaches about half way to axilla; tail round, tapering to a point, covered with uniform, imbricate scales.

Gray-brown with brown marking above arranged as transverse bars; below dirty whitish; known in southern India and Ceylon (one locality). (Data from Smith, 1935. I have seen no specimen.)

Family AGAMIDAE

Six genera occur of which *Lyriocephalus* and *Ceratophora* are endemic. *Cophotis* is excluded from India but a species occurs in Java and Sumatra. *Sitana, Otocryptis,* and *Calotes* occur both in India and Ceylon. Twelve genera occurring in South Asia are unknown in Ceylon.

KEY TO THE CEYLONESE GENERA OF AGAMIDAE

1. Four digits on feet, five on hands . . . . *Sitana*
   Five digits on hand and feet 2
2. Fifth toe short, not longer than first . . . . *Otocryptis*
   Fifth toe longer than first toe 3
3. A rostral appendage 4
   No rostral appendage 5
4. A strong globular protuberance on tip of snout . . . . *Lyriocephalus*
   A narrow pointed rostral protuberance, scaled or naked (reduced in female) . . . . *Ceratophora*
5. Dorsal scales enlarged, irregular, unequal; tail prehensile . . . *Cophotis*
   Dorsal scales more or less equal-sized, regularly arranged; tail greatly elongated, not prehensile . . . . *Calotes*

Genus SITANA Cuvier

Sitana Cuvier, Règne Animal, 2nd ed., vol. 2, 1829, p. 43 (type of genus, *Sitana ponticeriana*).

Only a single species of this genus is recognized.

Sitana ponticeriana Cuvier

Sitana ponticeriana Cuvier, Règne Animal, 2nd ed., vol. 2, 1829, p. 43 (type locality Pondicherry, India); Kelaart, Prodr. Faun. Zeylanicae, 1852-1853, p. 164; Boulenger, Catalogue of the Lizards in the British Museum, 2nd ed., vol. 1, 1885, pp. 270-271; The Fauna of British India, including Ceylon and Burma; Reptilia and Batrachia, 1890, pp. 114-115; Deraniyagala, Ceylon Journ. Sci. B, vol. 16, 1931, pp. 141-142; Smith, The Fauna of British India including Ceylon and Burma; Reptilia and Amphibia, vol. 2, Sauria, 1935, pp. 144-146.

Sitana minor Günther, Reptiles of British India, 1864, pp. 135-136, pl. 14, fig. A, (type locality, Madras, India) ("it is more probable that the Ceylonese *Sitana* is identical with the Madras species" [*i. e. S. minor*]).

Diagnosis: A small terrestrial agamid, with five fingers and four toes; body compressed, covered with regular keeled scales; no crest on back or neck; a strong gular appendage on throat, extending to abdomen; no femoral or preanal pores; tympanum present, visible.

Description of species: (E.H.T.-H.M.S. No. 30645 12 mi. N Trincomalee.) Rostral small, bordered laterally by a labial, and behind by five small scales; nasal large, elevated where the nostril is pierced, separated from rostral by a single scale; an elongate supranasal contiguous or imbricating with canthal scales; two median scales on anterior frontal region elevated and with a more or less continuous keel; on each side two very slight ridges may be traced back between the orbits; supraocular scales enlarged, irregular as are the occipital scales; a very fine nuchal ridge or crest; a few enlarged scales on the middle edge of upper eyelid; supralabials, 8-9; infralabials, 8-8; mental much narrower than the rostral; an enlarged gular appendage extending onto anterior part of abdomen; no femoral or preanal pores; leg long, the fourth toe reaching beyond snout; fifth toe lost; five fingers; scales on dorsum enlarged, in ten or eleven rows; adjoining scales on sides much smaller, but with a few scattered enlarged scales; scales on gular appendage enlarged, distinctly larger than ventral scales; approximately 20 rows of large ventral scales; tail rounded, the scales keeled but not arranged in distinct whorls.

Color: Above brownish, with a very indistinct lighter border on the outer row of enlarged dorsal scales; six pairs of black spots on each side, divided by the median line; sides darker with fine, light, ill-defined dots; a metallic cream spot on tympanum; venter lighter, with a black line from tip of chin back and onto the front of the gular appendage; tail very indefinitely barred.

Measurements in mm.: Length snout to vent, 51; tail, 114; head length, 15; head width, 10; axilla to groin, 25; arm, 25; leg, 50.

Remarks: The following specimens were examined: E.H.T.-H.M.S. 30628-30640, 30642, 30645, 30647-30655; Nos. 30660-30670, 30671, 30672 "Ceylon"; U.S.N.M. 58508 "Ceylon."

Genus OTOCRYPTIS Wagler

Otocryptis Wagler, Natürliches System der Amphibien, 1830, p. 150, (type of genus, *Otocryptis wiegmanni*); Wiegmann, Isis, 1831, p. 291 (type of genus, *Otocryptis bivitatta*).

This genus may be readily recognized by the greatly reduced outer toe which is smaller than the first toe. The species are terrestrial. Two species are known, one of which occurs in Ceylon, the other in southern India.

Hallowell (Proc. Acad. Nat. Sci. Philadelphia, 1860, p. 491), and Stejneger (U. S. Nat. Mus. Bull. 58, 1907) consider the possibility of a member of this genus occurring in the Riukiu Islands.

Otocryptis wiegmanni Wagler

Otocryptis wiegmanni Wagler, Natürliches System der Amphibia 1830, p. 150 (type locality, America, [*ex errore*]. Here corrected to Ceylon.

Otocryptis bivittata Wiegmann, Isis, 1831, p. 291. (type locality unknown); Peters, Monatsb. Akad. Berlin, 1860, 184 (Trincomalee, Hinida, Ratnapura, Adam's Peak); Günther, Reptiles of British India 1864, pp. 127-128; Boulenger, Catalogue of the Lizards in the British Museum, 2nd ed., vol. 1, 1885, p. 271; Haly, First Report on the collection of Lizards in the Colombo Museum, 1886, p. 6 (Ramboda and the Western Province); Theobald, Descriptive catalogue of the Reptiles of British India, 1876, p. 98. Boulenger, The Fauna of British India, including Ceylon and Burma; Reptilia and Batrachia, 1890, pp. 115-116; Green, Journ. Bombay Nat. Hist. Soc., vol. 15, 1903, p. 817. Deraniyagala, Ceylon Journ. Sci., B, vol. 16, 1931, pp. 142-143; Smith, The Fauna of British India, including Ceylon and Burma; Reptilia and Amphibia, vol. 2, Sauria, 1935, pp. 146-147. ("common at Peradeniya.")

Diagnosis: A very small outer toe; male with a very extensive gular flap extending to center of abdomen. Hind leg reaches far beyond tip of snout.

Description of species: (from E.H.T.-H.M.S. No. 30613). Length, snout to vent, 64 mm.; the length of head (19 mm.) much less than twice the width (12 mm.); rostral rather large, bordered by two labials and five scales, separated from nasal by a single prenasal; nasals large forming a mound with crater, the rim the highest part; a large supranasal, nearly as large as nasal; four canthals continuous with the elongate, broadly imbricating superciliary series; scales on snout rough, unequal, keeled, two median ones forming a short ridge beginning at posterior level of nasals; from here two smaller series of scales diverge that are continuous with the enlarged keeled scales bordering inner edge of orbits, and which continue around behind eye, the two series separated by from three to five scales; supralabials, 12-12; infralabials, 10-10; mental narrow, longer than wide, much smaller than rostral; scales around middle of body, approximately 78; all dorsal and lateral scales keeled and pointing backward and upwards; the ventral scales strongly keeled, somewhat mucronate; limbs long, the terminal joints of fingers reach beyond snout; leg brought forward, the entire free part of fourth toe extends beyond snout; 28 keeled scales under free part of fourth toe; tail cylindrical not compressed, longer than head and body. A broad "dewlap" in males beginning on chin and extending more than half length of abdomen, covered with larger keeled scales (absent in females and very young).

Color: Body dull brown to blackish brown; head blackish brown, the dewlap black on the anterior part; limbs light brown; tail indistinctly banded with broader dark bands, and narrow, dull, light bands; sides lighter, with some dull whitish marks on each side scarcely discernible unless specimen is submerged.

Measurements in mm.: Snout to vent, 64; tail (broken); width of head, 12; length of head, 19; axilla to groin, 27; arm, 30; leg, 75.5. Length of dewlap, 40; depth of dewlap, 16.

Remarks: The series of 18 specimens available in the E.H.T.-H.M.S. collection, Nos. 30610-30627, are all from 12 miles north of Trincomalee, Ceylon. Here they were found most frequently in the forest bordering on the shore. They are terrestrial, the reduced size of the outer toe presumably being a handicap in climbing.

Females are lighter brown than the males and occasionally specimens show a series of four deep-black, dorsal spots somewhat chevron-shaped; the legs and feet may be spotted black; in these the head is darker than the body; usually whitish below.

A young specimen (E.H.T.-H.M.S. 30622) has a distinct dark bar across the frontal region of head with some spots on neck.

Otocryptis sp.?

A specimen, U.S.N.M., No. 120328 from Nandana Estate, Peradeniya, Kandy District, differs considerably from the species described under the name *wiegmanni.* The differences, as seen by comparing this highland specimen with the lowland series, would seem to warrant a specific separation. The more striking differences are as follows: scales on nuchal region distinctly larger, as are the scales along the dorsum; a distinct dorsal ridge along the middle of back with crest; scales on lower half of sides directed backward and downward; gular dewlap smaller (length, 24 mm., depth, 12 mm.); head and gular fold not blackish.

I strongly suspect that two species are involved but until the characteristics of the type are ascertained one is uncertain to which of the forms the name *wiegmanni* must apply. It is presumed that *wiegmanni* and *bivitatta* have the same type.

Genus COPHOTIS Peters

Cophotis Peters, Monatsb. Akad. Wiss. Berlin, 1861, p. 1103, (type of genus, *Cophotis ceylonica*).

Cophotis is a genus containing only two species, one of which occurs in Ceylon and this chiefly in the higher regions. The other occurs in Java and Sumatra, without any known form occupying the Indian and southeastern Asiatic regions.

The Ceylon species is ovoviviparous. It may be recognized from other species by the large, scattered, flattened, dorsal scales on a strongly compressed body, by absence of femoral and preanal pores, in males, the absence of a tympanum, the presence of a short nuchal crest, a dorsal crest, and the presence of a small gular pouch.

Cophotis ceylanica Peters

Cophotis ceylanica Peters, Monatsb. Akad. Wiss. Berlin, 1861, p. 1103 (type locality, Ceylon); Günther, Reptiles of British India, 1864, p. 132, pl. 13, fig. H; Theobald, Descriptive Catalogue of the Reptiles of British India, 1876, pp. 100-101; Boulenger, Catalogue of the Lizards in the British Museum, vol. 1, 1885, p. 275; Haly, First Report on the collection of Lizards in the Colombo Museum, 1886, p. 6 (Ramboda; Le Vallon Estate); Boulenger, The Fauna of British India including Ceylon and Burma; Reptilia and Batrachia, 1890, p. 118; Willey, Spolia Zeylanicae, vol. 3, pt. 12, Apr. 1906, pp. 235-237, pl. and fig. in text; Deraniyagala, Ceylon Journ. Sci., B, vol. 16, 1931, pp. 148-149, pl. 34; Hora, Records of the Indian Museum, vol. 28, pt. 4, 1926, pp. 216-217 (Nuwara Eliya); Smith, The Fauna of British India, including Ceylon and Burma; Reptilia and Amphibia, vol. 2, Sauria, pp. 150-151, fig. 46.

Diagnosis: A small lizard (snout-to-vent length approximately

60 mm.; the tail, 85 mm.); body compressed; dorsal scales relatively large; about 33 scales around body; head slender; a discontinuous nuchal and dorsal crest; a small gular sac; five fingers and five toes; tail prehensile, curving down; tympanum hidden; no preanal or femoral pores.

Description of species: (from E.H.T-H.M.S. No. 30500, "Ceylon"). Length of head twice as long as width; snout longer than eye; head narrowed, rather pointed, the three postrostrals and three adjoining scales form an indistinct "boss or nose"; nostril in a large scale, separated from the rostral by three scales, touching the second and third labials; scales in frontal region large, irregularly elevated, with a depression between the orbits; a somewhat elevated median scale in depression; five or six enlarged supraoculars, all very irregular; a pair of enlarged tubercular scales on parietal region, behind which are two distinctly elevated tubercular scales; supralabials, 10; infralabials, 8 or 9; mental smaller than rostral; a series of irregular keeled scales extend back from lower edge of eye in temporal region; scales under chin, smooth; a small gular sac present; approximately eight lateral rows of enlarged scales pointing backward and downward, strongly imbricating, smooth or slightly keeled; lower part of sides and venter with strongly mucronate, smaller, keeled scales in about 16 rows; a nuchal crest consisting of four or five spines, separated from the dorsal crest, which consists of soft, spiny scales about fifteen in number, separated by short intervals; tail compressed, prehensile; hind leg reaching axilla; arm reaching beyond tip of snout; third and fourth toes practically of equal length.

Color: Olive green above with some lighter markings and some scattered darker markings; a light brown mark along upper lip, covering labials and adjoining scale row and extending onto shoulder; a lighter spot on back of occiput; lower labials dark brown, the throat and chin cream with scattered dark flecks, or lines; venter dirty gray-white; tail banded darker and lighter gray; some trace of darker bands low on sides.

Measurements in mm.: Snout-to-vent length, 61; tail, 79; head length, 18; head width, 9; arm, 29; leg, 30; axilla to groin, 30.

Remarks: The species is ovoviviparous. It is a highland form, known up to elevations of 7000 feet.

Ceratophora Gray

Ceratophora Gray, Illustrations of Indian Zoology, vol. 2, 1835, pl. 68, fig. 2, (type of genus: *Ceratophora stoddartii*).

Lyriocephalus (*part*) Theobald, Descriptive Catalogue of the Reptiles of British India, 1876, p. 99.

This genus, endemic in Ceylon, is represented by three species, all seemingly clearly differentiated, occupying territory at an elevation in excess of 3500 ft. All have a characteristic soft appendage protruding from the tip of the snout.

KEY TO THE SPECIES OF CERATOPHORA

1. Gular scales smaller than ventral; rostral appendage scaly, pointed . . . . *aspera*
   Gular scales larger than ventrals 2
2. Gular scales smooth or feebly keeled; lateral scales large very unequal; rostral appendage smooth pointed . . . . *stoddartii*
   Gular scales strongly keeled; lateral scales large, nearly equal; rostral appendage, compressed, suboval, covered with scales or granules . . . . *tennentii*

Ceratophorus tennentii Günther

Ceratophorus tennentii Günther, *in* Tennent, Natural History of Ceylon, 1861, p. 281, fig. (type locality, Ceylon); Reptiles of British India, 1864, pp. 130-131 (more complete description); Boulenger, Catalogue of the Lizards of the British Museum, 2nd ed., vol. 1, 1885, p. 278; Haly, First Report of the Collection of Lizards in the Colombo Museum, 1886, p. 6; Boulenger, Fauna British India, including Ceylon and Burma; Reptilia and Batrachia, 1890, p. 120; Deraniyagala, Ceylon Journal Sci., B, vol. 16, 1931, p. 145-146.
Lyriocephalus tennentii Theobald, Descriptive Catalogue of the Reptiles of British India, 1876, pp. 99-100.

Diagnosis: Head scales small, irregular; a ridge on each side of occiput; rostral appendage large in both sexes, fleshy, compressed, suboval, covered with scales and granules; supralabials, 9; infralabials, 9 or 10; gular scales feebly keeled, large, quadrangular, forming regular longitudinal series; a low toothed nuchal crest; scales on dorsum irregular and unequal in size, the larger ones feebly keeled; lateral scales equal, large, strongly imbricating, pointing upward and backward; smooth or feebly keeled; ventral scales smaller; leg reaches to eye or a little beyond; tail slightly compressed, scales keeled.

Olive above, irregularly marbled with brownish, young with an angular crossband between eyes; sometimes with white longitudinal lines; a more or less distinct, white line along hinder side of thighs. Length, 260 mm.; tail, 170; arm, 48; leg, 76. (After Boulenger, 1884.)

Tennent, in writing of the form, anticipates Günther by publishing the name and brief description as follows: "Among the specimens sent from Ceylon by Dr. Kelaart, and now in the British Museum, there is one which so remarkably differs from *C. Stoddartii*, that it attracted my attention by the peculiar form of this rostral appendage. Dr. Günther has pronounced it to be a new species; and Dr. Gray concurring in this opinion, they have done me the honour to call it *Ceratophora Tennentii*". From this statement one might suppose that the name should be attributed to Günther and Gray. However Günther refers to the Tennent reference as "Günther, in Tennent" so it would appear that Gray had no part in the naming.

Ceratophora aspera Günther

Ceratophora aspera Günther, Reptiles of British India, 1864, p. 131, pl. 13, figs. G. and G′ (type locality, Ceylon); Boulenger, Catalogue of the Lizards in the British Museum, 2nd ed., vol. 1, p. 278 (Ceylon, "south Ceylon"); The Fauna of British India, including Ceylon and Burma; Reptilia and Batrachia, 1890, p. 120; Deraniyagala, Ceylon Journ. Sci., B, vol. 16, 1931, pp. 146-147; Smith, The Fauna of British India, including Ceylon and Burma; Reptilia and Amphibia, vol. 2, Sauria, 1930, p. 154.

Lyriocephalus asper Theobald, Descriptive Catalogue of the Reptiles of British India, 1876, p. 100.

Diagnosis: A diminutive form, total length, 82 mm.; snout-to-vent length, 37 mm.; head scales small irregular, each of which forms a small tubercle; a larger tubercle behind superciliary edge; back of head with a pair of low ridges convergent anteriorly; rostral projection slender, covered with small imbricating scales, all keeled, the projection equaling head length in males, rudimentary in females; throat with small strongly keeled scales; scales on the dorsum and sides small with larger, irregular, keeled scales intercalated; no dorsal or nuchal crests, but some of the larger scales form series across the vertebral line, with their angles pointing posteriorly; ventral scales keeled; preanal region with small scales; tail not compressed, all scales keeled; hind leg reaches to, or near to orbit; brownish, marbled with darker; a rhombic light spot on rump; brown spots on arm, edged with white in male.

Ceratophora stoddartii Gray

Ceratophora stoddartii Gray, Illustrations of Indian Zoology, vol. 2, 1834, pl. 168, fig. 2 (type locality, Ceylon, Stoddart, coll.); Catalogue of the specimens of lizards in the collection of the British Museum, 1845, p. 237; Kelaart, Prod. Faunae Zeylanicae, 1852 (1853), p. 165; Günther, the Reptiles of British India, 1864, p. 129, pl. 13, fig. F, F′, F″; Boulenger, Catalogue of the Lizards in the British Museum, 2nd ed., vol. 1, 1885, p. 277; Haly, First Report on the Collection of Lizards in the Colombo Museum, 1886, p. 6, ("numerous specimens from the hill districts".); Boulenger, The Fauna of British India, including Ceylon and Burma; Reptilia and Batrachia, 1890, p. 119; Boettger, Ber. Offenb. Ver. Nat., vol. 29-32, 1892, p. 69; Willey, Spolia Zeylanica, vol. 3, 1906, p. 236; Deraniyagala, Ceylon Journ. Sci., vol. 16, B, 1931, p. 144; Smith, The Fauna of British India, including Ceylon and Burma; Reptilia and Amphibia, vol. 2, Sauria, 1935, pp. 152-153.

Lyriocephalus stoddartii Theobald, Descriptive Catalogue of the Reptiles of British India, 1876, p. 99.

There are six specimens in the collections available here and all seem to belong to *Ceratophora stoddartii.* However, there is considerable variation in this group of specimens as to character of the enlarged scales, the rostral appendage, keeling of dorsal and ventral scales, length of hind limb and coloration. Unfortunately the exact provenance of these specimens is unknown. None of these variations can be attributed to sex, since all are males. I suspect that there may be distinct geographical races represented among them.

Diagnosis: Five fingers and toes; body compressed, the scales on the sides irregular in size; in the male, a smooth, compressed or pryamidal appendage on tip of snout without any scales; tympanum hidden; no preanal or femoral pores; gular pouch absent.

Description of species: (from E.H.T.-H.M.S. 30495 "Ceylon"). Rostral appendage conical, sharply pointed, its base surrounded by a median pair of supralabials (paired rostral?) and five other small scales; nasal scale somewhat craterlike, separated from appendage by three scales, separated from its fellow by six scales; four canthal scales, the canthus rather rounded; a pair of low pyramidal scales in frontal region; supraoculars irregular, the inner row largest separated from its fellow by three small scale-rows; last four scales of inner row pass behind eye, covering an angular elevation; a pair of knobs or bosses in parietal region, covered by a few large scales and separated from each other by approximately seven scales; a transverse row of slightly elevated scales across head in front of these bosses; two large, prominent, elevated scales in temporal region above tympanum; behind eye, a row of three, large, elevated contiguous scales; supralabials, 14-14; infralabials, 13-13; a group of larger scales on edge of upper eyelid, the largest scales (3 or 4) bordering edge; mental small, separating first postmentals; scales on chin quadrangular, forming definite rows, smaller mesially, the rows nearest the labials larger than ventral scales; all ventral scales on chin and body smooth; scales on limbs very unequal with a few keeled scales; a few scales on the posterior border of arm and leg that bear small tubercles; scales on venter small, more or less regular, smooth; scales on body very irregular; a small nuchal crest beginning behind occipital bosses continues to near level of arm insertion; no dorsal crest; scales above arm largest, forming a curving row; crossing the back are series of scales somewhat larger than intervening scales; no femoral or preanal pores; fourth toe much longer than third reaching to a point near back of orbit; tail somewhat compressed, the whorls indistinct and bordered behind by larger irregular scales; the scales above and below keeled.

Color: (In preservative.) Blackish with a series of six, dim, gray lines crossing back on the larger scales; arms and legs barred with black and ultramarine; tail dimly barred with olive and gray; labials, chin, throat, and area about angles of jaws, whitish; below, olive with some scattered gray flecks; larger scales on sides ultramarine.

Measurements in mm.: Snout to vent, 80; tail, 162; length of head, 25; width of head, 15; length of rostral appendage, 105; arm, 42; leg, 64.

Remarks: There are certain variations which may be arranged in the form of a key.

1. Rostral appendage laterally compressed; scales on top of head, gular region, breast, under tail, on arms and legs, to some extent on sides and ventral surfaces, keeled; appearing between the occipital bosses is a short, denticulate, nuchal crest rising from an elevated fold about four scales high, reaching posteriorly to back level of arm insertion; a row of six, enlarged, lateral, white scales, their position marking lower edge of dim light transverse bands that follow series of slightly enlarged scales; a slight diagonal series below eye, each scale with a whitish elevated center . . "Ceylon" E.H.T.-H.M.S. No. 30494

   Rostral appendage not laterally compressed; scales on head, tail, and at least lower part of arms and legs with keels; venter, chin and neck smooth; a white lateral line present or absent; crest variable in height, length and origin 2

2. A pair of dorsolateral whitish or cream lines extending onto tail; lips and posterior jaw-angle whitish; chin and throat cream; sides darker, some of the large lateral scales lavender; arms and legs banded lavender and brown; skin on neck black; a crest begins a short distance behind occipital bosses, with approximately 10 denticulations; ventral scales smooth. "Ceylon" . . . . .U.S.N.M. 19216 ♂

   No dorsolateral lines; keeling variable, origin and length of crest variable 3

3. Scales on venter and breast, and median scales on chin, keeled; a low crest arises between occipital bosses, which are rather closely approximated; denticulated scales of crest compressed, widened at base, the ridge four scales high at highest point; the denticulations continued beyond crest; there are 14 scales in the nuchal crest and approximately 10 in dorsal crest, contiguous or more rarely narrowly separated, K.U.M.N.H. Nos. 20131-20132

   Ventral scales smooth; dorsals smooth; dorsal head scales, tail and some scales on limbs, keeled; nuchal crest rather elongate, consisting of 15 denticulate scales, with a few, low, inconspicuous median dorsal scales following; first two scales of crest paired between bosses in one, but not so in the second specimen . . . . E.H.T.-H.M.S. 30495; U.S.N.M. 19217

The single copy available to me of Gray's, Illustrations of Indian Zoology has the plate 168 missing and I cannot judge which of the above specimens show closest resemblance to the type figure. Since no specific localities are available with these specimens, it is impossible for me to determine whether these differences represent geographic variations or not. Aside from the scale differences it is possible that the living specimens may have shown considerable color and pattern differences. Collections of series of this species from very numerous localities is essential for an understanding of the meaning of this variation, and no new form should be named until adequate series are available, and compared with the type of *C. stoddartii.*

Genus LYRIOCEPHALUS Merrem

Lyriocephalus Merrem, Tentamen Systematis Amphibiorum, 1820, p. 49, (type of genus, *Lyriocephalus margaritaceus*).

A single species is known. It is endemic in the highlands of Ceylon.

Lyriocephalus scutatus Linnaeus

Lacerta scutata Linnaeus, Systema Naturae, ed. 10, 1758, p. 201, (Based on a figure in Seba, Thesaurus, vol. 1, p. 173, pl. 109, fig. 3 [type locality, "Amboyna" *ex errore.* Restricted to Ceylon.]).
Lyriocephalus margaritaceus Merrem, Tentamen Systematis Amphibiorum, 1820, p. 49 (Based on Seba).
Lyriocephalus scutatus Kelaart, Prod. Faun. Zeylanicae, 1852 (1853), p. 166; Günther, Reptiles of British India, 1864, p. 128; Theobald, Descriptive Catalogue of the Reptiles of British India, 1876, p. 99; Boulenger, Catalogue of the Lizards in the British Museum, vol. 1, 1885, pp. 281-282 (synonymy); Boulenger, The Fauna of British India including Ceylon and Burma; Reptilia and Batrachia, 1895, pp. 121-122; Deraniyagala, Ceylon Journ. Sci., B, vol. 16, 1931, p. 147-148, pl. 33, and *ibid.* vol. 17, 1932, p. 46.
Lyriocephalus macgregorii Gray, Illustrations of Indian Zoology, vol. 2, pl. 68, fig. 1.

Diagnosis: A pair of sharp high bony crests on sides of snout following the superciliary edge, terminating in a bony point behind orbit; a rounded protuberance on tip of snout.

Description of species: (from K.U.M.N.H. No. 19534). Head ridges above flare out anteriorly, the distance between them greater than posteriorly at their termination; scales on snout protuberance large, about 20 in number; scales on head variable in size; an irregular larger scale series outlines the inner dorsal part of orbit, separated from opposite series by five scale rows; three or four enlarged supraoculars; crests bordered by enlarged compressed scales, terminal one largest; rostral and two adjoining labials form part of the globular protuberance on snout; supralabials 16, infralabials about 18, the posterior scales not well differentiated; tympanum wanting; a transverse series of four compressed spines on occiput, behind which are a pair of high compressed soft spines; nostril directed outward and slightly downward; a row of 26 suborbital scales from nostril, the three posterior largest, terminating in the temporal region; a crest present, composed of soft, dorsal, serrate scales; posteriorly, the scales of the crest are separated; body covered with small, flat, imbricating scales, directed upward, with three series of larger scales on sides of neck, shoulders, and sides; below these, on sides, numerous scattered trihedral or heavily keeled scales; approximately 28 keeled ventral scale series; a strongly defined, gular pouch or fold; tail rather short, compressed, with four rows of keeled scales below; no femoral or preanal pores; five fingers and five toes, the limbs strong, well developed; hind limb reaching mouth angle; 22 scales under free part of fourth toe.

Color: Leaf green in life; gular sac yellow, the enlarged scales green; belly sometimes bluish; globular protrusion on snout, light brownish or cream.

Measurements in mm.: (from K.U.M.N.H. Nos. 19534, 19535, 19536 Ceylon respectively.) Snout to vent length, 125, 132, 154; tail, 105, 127, 152; arm, 63, 70, 77; leg, 81, 85, 105; width of head, 24, 25, 27; length of head, 34, 34, 40.

Remarks: This species has a superficial resemblance to a species of *Chamaeleon* found in Ceylon and it is perhaps on this general resemblance of the skulls that some are inclined to reduce the chamaeleon group to the status of a family, Chamaeleonidae.

Variation: A female specimen, U.S.N.M. No. 58489, from Peradeniya, Ceylon, is gray, the upper free edges of the scales being edged with brown. The rows of enlarged scales and the scattered individual scales or groups of larger keeled scales are blue. The dorsal crests are low. The enlarged scales on the tail and limbs are bluish.

A pair of sharp incisors, above and below, are present in this species.

Genus CALOTES Cuvier

Calotes Rafinesque, Anal. Nat., 1815, p. 75, nomen nudum.
Calotes Cuvier, Règne Animal, vol. 2, 1817, p. 35 (type of genus, *Lacerta calotes*).

The genus *Calotes* extends through southern Asia, throughout the Philippines and most of the East Indian Archipelago. Six clearly differentiated species occur in Ceylon.

KEY TO THE SPECIES OF CALOTES IN CEYLON

1. Scales on sides point backwards and upwards 2
   Scales on sides pointing backwards or backwards and downwards, 4
2. Two separated spines above tympanum .... *versicolor*
   A row of 8 or 9 compressed spines above tympanum .... *calotes*
4. No spines on head .... *liocephalus*
   Spines present on head 5
5. A row of spines above and somewhat behind tympanum; ventrals larger than dorsals .... *nigrilabris*
   At least two separated spines above tympanum 6
6. Lateral scales pointing backwards but not downward; no dorsal crest .... *ceylonensis*
   Lateral scales pointing backwards and downwards; a dorsal crest, *liolepis*

No less than six species of the genus *Calotes* are known to occur on the island of Ceylon, and of these four, *C. ceylonensis, nigrilabris, liolepis* and *liocephalus,* are endemic; two others occur in India also, one, *C. calotes* being confined to Southern India and the Nicobar Islands; the other, *C. versicolor,* has a very wide distribution in southern and southeastern Asia, and parts of Sumatra.

These species are arboreal, some (perhaps all) coming to the ground to deposit their eggs. I have recently described the process of nestbuilding in *Calotes calotes.**

Calotes versicolor (Daudin)

Agama versicolor Daudin, Histoire Naturelle des Reptiles, vol. 3, 1802, p. 395, pl. 44 (type locality, "India") restricted to Pondicherry, India by Smith ["terra typica"].

Calotes versicolor Kelaart, Prod. Fauna Zeylanicae, 1852 (1853), p. 170; *idem,* vol. 2, 1853 (1854), p. 7; Boulenger, Catalogue of the Lizards in the British Museum, 2nd ed. vol. 1, 1885, p. 321; Haly, First Report on the Collection of Lizards in the Colombo Museum, 1886, pp. 2, 7; Boulenger, The Reptiles of British India, . . . Reptilia and Amphibia, 1890, pp. 135, 136, fig. 42; Deraniyagala, Ceylon Journ. Sci., B, vol. 16, 1931, p. 150-151; Smith, The Fauna of British India . . ., Reptilia and Amphibia, vol. 2, Sauria, 1935, pp. 189-193.

Diagnosis: A *Calotes* with a strongly compressed body; a distinct gular sac, but lacking a pit or depression on front of shoulder; a swelling at base of tail in males that tapers regularly, the basal scales, especially dorsal ones, greatly thickened; scales on sides pointing backwards and upwards; two separated spines above tympanum, sometimes flanked by flattened, erect scales.

Description of species: (E.H.T.-H.M.S., No. 30594, 12 mi. N. Trincomalee, Ceylon). Body compressed with a rather high nuchal crest continuous with the dorsal crest; in males, cheeks strongly swollen, the forehead not concave; snout short, its length from orbit equal to distance between tympanum and eye; rostral relatively very small, less than one fifth of mental; nasal scale more than twice size of nostril, separated from the rostral by two scales; supralabials, 11-11, infralabials, 9-10; dorsal head scales smooth, irregular; mental large, sharply pointed behind; the labial border more than three times that of rostral; scale rows delimiting supraocular area scarcely distinguishable from other scales; five superciliaries; a pair of high, soft spines above tympanum, each flanked by erect, smaller, soft spines or scales; nuchal crest of flattened, somewhat curved, sharply pointed soft spines reaching a height of eleven millimeters; the dorsal crest lower, continuous, gradually diminishing in height, the scales contiguous, terminating abruptly eighteen millimeters be-

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* Taylor, Herpetologica, vol. 7, 1951, pp. 59-60.

hind level of hind leg; scales on sides of body larger than ventrals, the scales pointing backwards and upwards, all keeled; gular pouch inconspicuous, or absent, in preserved specimens; gular scales as large as ventrals, mucronate; no pit or groove on shoulder; ventrals and caudals keeled; tail rather rounded, much swollen at base; approximately 42 scale rows around body; eighteen scales about widest part of tail base in males, the dorsal scales greatly thickened with a median rounded ridge and depression on each side; scales bordering crest directed nearly vertically, tending to hold the crest erect; hind leg brought forward, the toe reaches the middle of eye; third and fourth toes nearly equal; fourth toe much longer than third.

Color: Above olive brown or grayish in males, often with scattered distinguishable flecks of bluish white; tail very dimly barred with darker spots, some scarcely discernible; venter gray-white; limbs with some darker markings.

Measurements in mm.: Length, snout to vent, 128; tail, broken; head length, 40; head width, 31; axilla to groin, 56; arm, 57; leg, 85.

Remarks: The specimens available are as follows: E.H.T.-H.M.S. Nos. F. 984, F. 989, 30592-30609, 30641, 30646, 30656, 30659, 12 miles north Trincomalee, Ceylon. U.S.N.M. No. 38283 Kandy, Ceylon; 102317-102320, 102322-120324, Clodagh Estate, Rattota, Matale District, Ceylon; K.U.M.N.H. No. 19531-19532 "Colombo," Ceylon.

Variation: The local population differs very greatly in coloration, the females often being of a dark reddish-tan color with seven, rather broad, transverse bands across back, the bands interrupted on each side by a more or less distinct cream line running from shoulder onto tail; tail barred with dark bands at least on basal half; younger, half-grown males may have similar banding on a grayish background but lacking the light line (save in very young males); chin may have some black, converging lines, and some scattered black flecks on the under side of limbs and venter.

The known distribution of this species is from Afghanistan to Hong Kong, south in India and Ceylon, occurring also in Malaya and Sumatra. There is considerable variation in this very widespread species, especially in the size of the lateral scales and the number of rows around the body, the smallest numbers being found in Indian and Ceylonese specimens. It varies too in its vertical distribution, occurring in lowlands and at elevations up to 7000 feet. Subsequent study may prove that subspecific differences exist.

Calotes calotes (Linnaeus)

Lacerta calotes Linnaeus, Systema Naturae, 10th ed. 1758, p. 207 (type locality, Ceylon).
Agama ophiomachus Merrem, Tentamen Systematis Amphibiorum, 1820, p. 51.
Calotes ophiomachus Kelaart, Prodr. Faun. Zeylanicae, 1852 (1853) p. 169; *idem,* vol. 2, 1854, p. 7; Boulenger, Catalogue of the Lizards in the British Museum, vol. 1, 1885, p. 327; Haly, First Report on the Collection of Lizards in the Colombo Museum, 1886, p. 8 (Rattota; Western and Eastern Provinces). The Fauna of British India, including Ceylon and Burma; Reptilia and Batrachia, 1890, p. 140; Deraniyagala, Ceylon Journ. Sci., B, vol. 15, 1931, p. 153.
Calotes calotes Smith, The Fauna of British India, including Ceylon and Burma; Reptilia and Amphibia, vol. 2, Sauria, pp. 201-202; Taylor, Herpetologica, 1951, p. 59 (egg laying habits).

Diagnosis: A very long-tailed species, green, with a series of narrow, transverse, bluish-white lines crossing dorsum; dorsal scales of body not larger than the ventral scales; an irregular row of compressed spines above tympanum; tail extremely long, usually at least three and one-third times snout-vent length; only 30-35 scale rows around body; a pit or depression present in advance of shoulder.

Description of species: (From E.H.T.-H.M.S. No. 30580, 12 mi. N Trincomalee, Ceylon.) Head rather short, the forehead very slightly concave; no gular fold; body compressed, rather triangular in cross section; rostral small, flanked by two labials and bordered behind by three scales, its labial border less than that of mental; nasal scale larger than rostral, at least three times area of nostril, separated from the rostral by two scales; scales on snout and head not keeled but the edges bordered by minute pores or tubercles giving them a roughened appearance; irregular scale-rows delimiting the supraocular areas, separated by three scale rows; supraocular scales, larger, irregular, about 10 or 11 in number; four superciliaries; supralabials, 10-10, the infralabials, 10-10; tympanum large, its diameter (3 mm.) slightly less than eye opening (3.2 mm.); a small pit at beginning of shoulder, covered with granular scales on black skin; scale rows on sides directed backwards and upwards, faintly keeled, not or scarcely larger than ventrals which are distinctly keeled; a pair of elongate, soft spines above tympanum each flanked by two or three, flattened, soft, erect scales, sometimes forming a continuous row above and extending somewhat anterior to tympanum level; nuchal crest composed of soft flattened spines and continuous with a short dorsal crest that rapidly diminishes in height; upper scale-row composed of mucronate, erect scales seemingly holding the crest erect; (tail in males not strongly inflated at base, the dorsal scales not especially modified); tail in females rather slender, the length in both sexes 3.32 to 3.36 times head-body length;* leg reaches to nostril.

Color: Bright green on head, body and tail, with five narrow, bluish-white lines crossing the body transversely, and one or two near base of tail; the lines as wide as a scale-row; tail dimly banded with darker and lighter in preserved specimens; males in life may show a reddish area on neck; belly light green or greenish white.

Measurements in mm.: Length, snout to vent, 91; tail, broken; length of head, 25; width of head, 17; length of snout, 8; length of orbit, 7.6; axilla to groin, 43; arm, 50; leg, 83.

Remarks: Specimens of this species available are as follows: E.H.T.-H.M.S. Nos. 30577-30591, 12 mi. N Trincomalee, Ceylon; U.S.N.M. Nos. 120316, 120321 Clodagh Estate, Rattota, Matale District, Ceylon; K.U.M.N.H. Nos. 20094 "Colombo," Ceylon; 31288, Tonacumbe Estates, Namunukula, Ceylon.

This species seemingly has the longest tail of any species in the genus, this appendage reaching a length equivalent to 3.84 times the snout-vent length. The white marks are usually visible, but during egg-laying activity all trace of this marking is lost and the color may become a dirty, blackish olive, or greenish brown.

After the eggs have been buried, the head is used for pounding the loose soil to make it firm above the nest.

Calotes liocephalus Günther

Calotes liocephalus Günther, Ann. Mag. Nat. Hist., ser. 4, vol. 9, 1872, p. 86 (type locality, Peradeniya district Ceylon); Theobald, Descriptive Catalogue of the Reptiles of British India, 1876, p. 109; Boulenger, Catalogue of the Lizards in the British Museum, 2nd ed., 1885, p. 329, pl. 26; Haly, First Report on the Collection of Lizards in the Colombo Museum, 1886, p. 8 (Agrapatanas); Boulenger, The Fauna of British India . . .; Reptilia and Batrachia, 1890, pp. 141-142; Müller, Verh. Nat. Gesellsch. Basel, vol. 8, 1889, p. 698; Deraniyagala, Ceylon Journ. Sci., B. vol. 16, 1931, p. 154-155; Smith, The Fauna of British India, including Ceylon and Burma; Reptilia and Amphibia, vol. 2, Sauria, 1935, p. 204 (Gammaduwa, Agrapatnas, Punduluoya, in the Central Provinces).

Diagnosis: This species may be diagnosed by the absence of a pair of erect spinelike scales above and anterior to tympanum; as well as by the absence of a row of compressed scales above and somewhat behind tympanum; dorsal scales smaller than *liolepis* and feebly keeled, about as large as ventral scales; gular scales as large or a little larger than ventrals; 43-50 scale-rows around middle of body; hind limb reaches to eye or nearly as far; in male head large and base of tail swollen.

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* Malcolm Smith, *loc. cit.* gives the measurement of *Calotes calotes* as: snout to vent 130 mm.; tail 500, which is 3.84 times head body length.

Male uniform green, bluish green or olivaceous above, with five or six angular, reddish-brown crossbars; upper lips and cheeks with a brown streak, or spotted with brown; sometimes dark crossbars on top of head; base of tail light olive brown, the rest of it banded light and dark; below greenish white.

Female may be uniform green except for some black markings on snout and flanks. Snout to vent, 90 mm.; tail, 250. The species is known from the Central provinces (Gammaduwa, Agrapatnas, Punduluoya).

Data from Malcom Smith (1935, p. 204).

Calotes nigrilabris Peters

Calotes rouxi Blyth, Journ. Asiat. Soc. Bengal, vol. 22, 1853, p. 647 (not of Duméril and Bibron).

Calotes (*Bronchocele*) *nigrilabris* Peters, Monatsb. Akad. Wiss. Berlin, 1860, p. 183 (type locality, "Newerelia" = ?Nuwara Eliya).

Calotes nigrilabris Günther, Reptiles of British India, 1864, pp. 143-144, pl. 40, fig. D. (Günther distinguishes two varieties, Alpha and Beta.); Boulenger, Catalogue of the Lizards of the British Museum; vol. 1, 1885, pp. 328-329 (Ceylon); Müller, Verh. Nat. Gesellsch. Basel, vol. 8, 1889, p. 698; Annandale, Spolia Zeylanica, vol. 8, pt. 30, June 1912, pp. 135-136 (Nuwara Eliya; Pattipola, alt. 6000 ft.); Deraniyagala, Ceylon Journ. Sci., B, vol. 16, 1931, p. 153-154; Smith, The Fauna of British India, including Ceylon and Burma; Reptilia and Amphibia, vol. 2, Sauria, 1935, p. 206 (Ceylon, in hills at high altitudes).

Diagnosis: A row of four or five flattened spines arising at a point above tympanum and extending behind its posterior level; a nuchal crest, and in males at least, a low, serrate, dorsal crest; scales of dorsum directed backwards and downwards; scales keeled; leg extends beyond orbit; coloration variable; an area of small tubercular scales on shoulder forming a "pit."

Description of species: Head large, areas about jaw angles rather inflated; rostral small, bordered by two labials and five postrostral scales; nasal rather large, the nostril occupying less than half its area, separated from rostral by a single scale; an elongate supranasal; four scales in canthal row, the canthal edge rather short; three superciliaries; dorsal head scales smooth, unequal; supraorbital area bordered by a row of larger, unequal scales, separated from its fellow by two scale rows; supraoculars, 15 to 17, unequal; nuchal crest rather high (beginning between a pair of slightly elongate, more or less elevated ridges on occiput); scales of crest flattened, compressed, highest at back level of head and continuous with a low serrate crest on dorsum; lateral scales distinctly smaller than ventral scales, more or less keeled, the scales pointing backward and downward; scales on side of neck pointing up or up and back; ventral scales, scales on limbs and tail keeled, mucronate, the mucrone heavy, distinct; throat with a suggestion of a pouch, the median scales slender with strong mucrones; mental with a labial border equal to that of rostral; supralabials, 9-9, infralabials, 8-8; when leg is brought forward the toes reach halfway between eye and nostril; a rather large area of fine granular scales in front of arm insertion on side of neck; base of tail swollen, surrounded by 15 rows of scales; approximately 43 scale-rows around middle of body; tympanum large.

Color: Olive or greenish in life, becoming dirty grayish blue on head and on body and limbs; back part of head and neck region gray olive; tail distinctly greenish olive; infralabials bluish; a black mark along supralabials, leaving a series of tiny bluish spots on labials; a light line below eye to tympanum bordered above by light.

MEASUREMENTS IN MILLIMETERS OF CALOTES NIGRILABRIS PETERS

Museum	EHT-HMS	USNM	USNM	USNM	EHT-HMS
Number	30502	58666	38281	38282	30503
Locality	Nuwara Eliya	"Ceylon"	Nuwara Eliya	Nuwara Eliya	Nuwara Eliya
Sex	♂	♂	♂	♀	♀
Snout-to-vent length	92	86	86	83	75
Tail length	293	264	197+?	238	205
Head length	32.2	30.5	29.5	26	25
Head width	22.3	19.2	19	15	14.6
Axilla to groin	43	36?	43	45	41
Arm	51.5	53	49	46.5	42
Leg	84	72	71	64	63.5

Remarks: The coloration varies in life but usually it is uniform green with a broad black band along the lips to behind the tympanum; tail brownish with darker-bordered light band or spots. Sometimes the lips are green as is the remainder of head and body.

A female specimen in the collection differs in being olive brown above with two chevronlike bands across shoulders pointing backwards. The remainder of the dorsum has small white spots, the tail a series of cream, brown-edged spots. The nuchal crest of the female is low, and the dorsal crest is scarcely discernible. In this specimen the toe reaches to the orbit. There are two eggs in each oviduct.

Calotes ceylonensis Müller

Calotes mystaceus ceylonensis F. Müller, Verh. Naturf. Gesellsch. Basel, vol. 8, 1887, p. 292, pl. 3 (type locality, Kumbukan-aar, southwest Ceylon).
Calotes Haly, Taprobanian, vol. 2, pt. 5, Oct. 1887, p. 133 (described, but not named).
Calotes kelaartii Nevill, Taprobanian, vol. 2, 1887, p. 134 (type locality, by inference, North Western Province, Ceylon—species named but not described. The description is that of Haly.)
Calotes ceylonensis Boulenger, The Fauna of British India, including Ceylon and Burma; Reptilia and Batrachia, 1890, pp. 139-140; Deraniyagala, Ceylon Journ. Sci., B, vol. 16, 1931, p. 151-152; Smith, The Fauna of British India including Ceylon and Burma; Reptilia and Amphibia, vol. 2, Sauria, 1935, pp. 202-203.
Calotes salcoides Werner, Verh. Zool-bot Ges. Wien, vol. 46, 1896, p. 7 (type locality, Ceylon).

Diagnosis: A diagonal, pitlike depression in front of shoulder, its surface covered by small tubercular scales; rows of scales on sides of dorsum directed backwards and downwards; two separated spines on occiput above and somewhat forward of the tympanum; a nuchal crest but no dorsal crest; scales about body, 54 to 60; none of the scale rows directed downward.

Description of species: (E.H.T.-H.M.S., No. 30576, ♀, "Ceylon"). Rostral small, flanked by two labials, bordered behind by four scales, its width a little greater than its height; nasal separated from rostral by two scales; supranasals larger than other scales on dorsal part of snout, equaling or nearly equaling the nasal; supralabials, 10-10; infralabials, 10-9; inner row of scales bordering the supralabials not strongly defined, separated by three scale-rows; supraoculars about 20, irregular; five superciliaries, canthal series of four scales partly interrupted; tympanum more than half length of eye opening; a pair of erect, soft spines above the tympanum; a low nuchal crest (female) beginning on a level with the more anterior of the two spines; depression or pit on shoulder distinct, its surface covered with small imbricating scales; scales on snout directed forward or outward, irregularly ridged; scales on nuchal region with small tubercles; on dorsum scales larger than those on ventral surface, the two rows bordering the nuchal spines largest; upper lateral rows directed back and upwards; others directed straight back, all more or less keeled; all scales on ventral regions keeled; leg reaches to tympanum; approximately 54 scales around middle of body; no gular sac.

Color: Head dark brown above; a light stripe from nostril back across area below eye to tympanum; dorsum light brown, barred with bands of varying width, those more posterior may be six scales long; sides with some brown blotches and on flanks the lighter ventral color encroaches; tail dimly barred brown and light brown; some brown flecks on chin.

Measurements in mm.: Length, snout to vent, 72; tail, 155; length of head, 21; width of head, 13; axilla to groin, 37; arm, 31; leg, 50.

Remarks: Males differ considerably in having the cheeks inflated or swollen and presumably the head scales are smoother. The nuchal crest is much higher and stronger and the base of the tail is swollen and covered with large thickened scales, the median forming a serrated edge.

The color of the male is olivaceous, the back of head and front of the dorsum being more or less pinkish or reddish in life. Some transverse darker bars may be present and a pale stripe passing from below the eye to the end of the jaw is usually discernible.

This species occurs chiefly in lowland forest in the northern half of the Island.

Calotes liolepis Boulenger

Calotes nemoricola Günther, Proc. Zool. Soc. London, 1869, p. 507 (not of Jerdon).

Calotes liolepis Boulenger, Catalogue of the Lizards in the British Museum, vol. 1, 1885, pp. 326-327 plate 25, fig. 2 (type locality, Ceylon); Nevill, Taprobanian, vol. 2, pt. 5, Oct. 1887, pp. 133-134 (Kandy, Kotmali); Boulenger, The Fauna of British India, including Ceylon and Burma; Reptilia and Batrachia, 1890, p. 140; Deraniyagala, Ceylon Journ. Sci., B, vol. 16, 1931, p. 152-153; Smith, The Fauna of British India, including Ceylon and Burma; Reptilia and Amphibia, vol. 2, Sauria, 1935, p. 203 (Punduluoya, Kandy, Gammaduwa).

Diagnosis: A species having a pair of soft, spinelike scales above and forward of tympanum; a nuchal crest narrowly separated from a short dorsal crest; scales on sides of neck pointing upward; those on sides of body pointing backward and downward; scales on chin, throat and venter with minute mucrones, and sometimes additional, minute, hairlike, posterior projections; scales about base of tail largest; leg reaches to tympanum; an area of small tubercular scales on shoulder, tending to form a pit.

Description of species: (From K.U.M.N.H. No. 19533, "Ceylon.") Rostral small bordered by two labials and three postrostrals; nostrils occupying half surface of nasal scales; nasals separated from rostral by two scales; a large supranasal; five scales on canthal edge behind nasal; scales on head as far back as occiput smooth, unequal; rows of large scales outline orbits, separated from each other by three scale-rows; three elongate superciliaries; supraorbitals very large, irregular; scales on occiput and in anterior nuchal region each bearing an elevated tubercle; approximately 32 scales around middle of body; nuchal crest with eight, soft, compressed spines, the largest five to eight millimeters in length; two soft spines, one directly above, one anterior to level of naked tympanum; area about jaw angles swollen; a short dorsal crest consisting of eight or ten, soft, small, posteriorly directed spines; scales on base of tail larger than body scales; scales on sides pointing back and downward, not keeled. Third and fourth toes nearly of equal length; toes reaching to tympanum.

Color: In preservative, head light reddish brown, the color extending to tympanum but the swollen areas at jaw angles blackish; nuchal crest and occipital spines black; dorsum blackish brown with three indistinct transverse lighter bands on back; throat and neck blackish, the anterior part of chin lighter; venter lighter than sides.

Measurements in mm.: Snout to vent, 82; tail, 212; length of head, 30.5; width of head, 19; arm, 40.5; leg, 59.

Family SCINCIDAE Gray

The Ceylonese species of this family have recently been reviewed by me, and specimens in the collections reported on. Since this paper is readily available,* I am not repeating this data here other than to repeat the keys, since workers may find it convenient to have an entire listing of the species under a single cover. The following species are known:

Mabuya bibronii
Mabuya macularia
Mabuya beddomii
Mabuya floweri
Mabuya carinata
Mabuya madarászi
Riopa punctata
Riopa singha
Dasia haliana
Sphenomorphus dussumieri
Sphenomorphus megalops
Sphenomorphus deignani
Sphenomorphus striatopunctatus
Sphenomorphus taprobanense
Sphenomorphus fallax
Sphenomorphus rufogulus
Chalcidoseps thwaitesi
Nessia burtonii
Nessia didactyla
Nessia monodactyla
Nessia bipes
Nessia sarasinorum
Nessia hikanala
Nessia layardi
Nessia deraniyagalai

KEY TO THE GENERA OF SCINCIDAE IN CEYLON

1. Palatine bones in contact or overlapping along medial palatal line, 2
   Palatine bones not in contact along medial palatal line......... 6
2. Supranasals present 3
   Supranasals absent 5

* *Ceylonese Lizards of the Family Scincidae,* Univ. of Kansas Sci. Bull., vol. 33, pt. 2, Mar. 20, 1950, pp. 481-518.

3. Scales keeled with 2 to 7 keels 4
   Scales smooth; body somewhat elongated; limbs pentadactyl, but short, widely separated when adpressed; scales smooth; lower eyelid with a semitransparent disk . . . . *Riopa*
4. Pterygoid bones not in contact, the palatal notch extending forward to level of centers of eyes; limbs pentadactyl, well developed, distinctly overlapping when adpressed; no distinct transverse bands . . . . *Mabuya*
   Pterygoid bones in contact anteriorly, the palatal notch not reaching forward to level of centers of eyes. Limbs pentadactyl, failing to touch or barely overlapping when adpressed; color pattern of transverse bands . . . . *Dasia*
5. Limbs pentadactyl, meeting, overlapping or failing to meet when adpressed; lower eyelid scaly; frontoparietal single or double; scales smooth or at most, with slight suggestion of keels or striations . . . . *Sphenomorphus*
   Limbs not pentadactyl, greatly reduced or absent; body anguiform; the nostril in rostral 6
6. Nostril in anterior part of rostral, connected to the posterior edge of scale by a groove; limbs variable, never tetradactyl . . . . *Nessia*
   Nostril near the posterior edge of rostral; limbs short, tetradactyl, *Calcidoseps*

Genus MABUYA Rafinesque

Six species occurring in Ceylon may be differentiated by the following key:

KEY TO SPECIES OF MABUYA IN CEYLON

1. A transparent disc or lower eyelid . . . . *bibronii*
   No transparent disc, but several larger transparent scales on lower eyelid 2
2. A postnasal . . . . *macularia*
   No postnasal 3
3. Scales almost smooth or with three to five very feeble keels . . *beddomii*
   Scales not smooth, each bearing 3, 5 or 7 strong keels 4
4. Scales tricarinate (or sometimes also with a small tubercle on outer edge of scale); dorsum with a paired series of black markings . . . . *floweri*
   Scales with five or seven keels (except very young which may have three); no paired series of black markings on dorsum 5
5. Larger; snout to vent, 123 mm.; adpressed hind limb to wrist or elbow . . . . *carinata*
   Smaller; snout to vent, 77 mm.; adpressed hind limb to axilla or farther . . . . *madarászi*

Genus RIOPA Gray

Two species occurring in Ceylon may be differentiated by the following key:

KEY TO THE SPECIES OF RIOPA IN CEYLON

Scales 24-26 rows, each dorsal and lateral scale with a dark spot. In young, spots forming 6 dark lines separated by light lines; tail uniform red; dorsolateral light lines from rostral, *Riopa punctata*

Scales in 28 rows; four very narrow dark lines on median scale rows; dorsolateral lines from supraoculars; vertical rows of white spots on neck and scattered white spots on the sides; a dorsolateral line from nuchal .... *Riopa singha*

Genus DASIA Gray

A single endemic species, *Dasia haliana,* occurs in Ceylon. The characters being those of the genus.

Genus SPHENOMORPHUS Fitzinger

Seven species from Ceylon are referred to this genus. They may be differentiated by the following key:

KEY TO THE SPECIES OF SPHENOMORPHUS IN CEYLON

1. Frontoparietal divided 2
   Frontoparietal single 6
2. Less than thirty scale rows about body 3
   Forty scale rows about body .... *dussumieri*
3. Parietals enclosing interparietal 4
   Parietals separated by interparietal .... *megalops*
4. Dorsal scales striated .... *deignani*
   Dorsal scales unstriated 5
5. Adpressed limbs barely overlap; prefrontals forming a common suture .... *taprobanense*
   Adpressed limbs separated by seven scales; prefrontals usually separated .... *striatopunctatus*
6. Males with sides of head and throat blue-black, each scale with a whitish spot .... *fallax*
   Males with throat bright, rosy red, lacking black color and white spots .... *rufogulus*

Genus CHALCIDOSEPS Boulenger

A single species *Chalcidoseps thwaitesi* Günther is known in Ceylon. The characters are those of the genus.

Genus NESSIA Gray

The following key will differentiate the eight forms recognized under specific names:

KEY TO THE SPECIES OF NESSIA

1. Two or four limbs present; interparietal broader than frontal (except *sarasinorum*); ear opening present 2
   Limbs absent 6

2. Limbs bearing clawed digits 3
   Limbs budlike, lacking clawed digits 4
3. Four limbs present, tridactyl; 24 scales at midbody . . . . . . *burtonii*
   Four limbs present, didactyl; 24 scales at midbody . . . . . . *didactyla*
4. Four limbs present; 24-26 scales about midbody . . . . . . *monodactyla*
   Two limbs present; scales variable 5
5. Scale rows about midbody, 28 . . . . . . *bipes*
   Scale rows about midbody, 22; interparietal narrower than frontal . . . . . . *sarasinorum*
6. Snout flattened below, projecting sharklike; frontonasal one third width of rostral; ear-opening present . . . . . . *hickanala*
   Snout not especially flat, not sharklike; frontonasal more than half length of rostral 7
7. One large elongate loreal; preoculars small; frontonasal nearly as long as rostral . . . . . . *layardi*
   Two loreals, the posterior lower than anterior; frontonasal a little more than half of rostral length . . . . . . *deraniyagalai*

Sphenomorphus fallax Peters

Lygosoma fallax Peters, Monatsb. Akad. Berlin, 1860, p. 184, (Ratnapura, Trincomalee, Ceylon); Taylor, Univ. Kansas Sci. Bull., vol. 33, pt. 2, no. 13, Mar. 20, 1950, pp. 501-504, fig. 4, A and B.

I have recently received a series of specimens from Tonacombe Estate, Namunukula, Ceylon, 4000 ft. elev. These were not available when the lizard report was made.

The specimens are K. U. M. N. H. Nos. 31276-31286. The females of the species show a fairly well-defined pair of dorsolateral lines, covering halves of two scale rows (third and fourth from middle of dorsum); this bordered laterally by a broad, dark stripe beginning at nostril, passing through eye to side of tail, one whole scale-row and two half scale-rows wide; the adjoining four rows with a narrow lighter line through their middle, the four median dorsal rows each may have a narrow indistinct, lighter line. The light lines continue on the tail; venter white.

Males with sides of head and throat blue, each scale with a milk-white or bluish white spot.

The lineation on the body is lost in older males and no trace is evident. The males seemingly are a little larger than females, with a somewhat larger head proportionally.

Family LACERTIDAE Gray

Genus CABRITA Gray

Cabrita Gray, Ann. Mag. Nat. Hist., vol. 1, 1838, p. 282, (type of genus, *Cabrita brunnea*).

This genus, which ranges in southern India is represented by a single species in Ceylon. It is presumably confined to the lower, dryer parts of northern Ceylon.

Cabrita leschenaultii Milne-Edwards

Lacerta leschenaulti Milne-Edwards, Ann. Sci. Nat. Paris, vol. 16, 1829, pp. 80, 86; pl. 6, fig. 9, (type locality, Coromandel Coast, India).
Cabrita leschenaulti Boulenger, Catalogue of the Lizards of the British Museum, 2nd ed., vol. 3, 1887, p. 70; The Fauna of British India, including Ceylon and Burma; Reptilia and Batrachia, 1890, p. 172; Monograph of the Lacertidae, vol. 2, 1921, p. 194; Deraniyagala, Ceylon Journ. Sci., B, vol. 16, 1931, p. 157, pl; Smith, The Fauna of British India including Ceylon and Burma; Reptilia and Amphibia, vol. 2, Sauria, 1935, pp. 374-375.

Diagnosis: (from Smith, *loc. cit.*) Anterior labials ridged, forming a projecting margin; upper head scales strongly keeled and finely striated; canthus rostralis sharp; a single frontonasal; nostril between two swollen nasals; one or two postnasals; prefrontals in contact mesially; frontal long and narrow touching first three supraoculars; interparietal small touching a smaller occipital; four supraoculars; dorsal scales subequal, smaller than caudals; ventrals in six longitudinal rows, in 24-28 transverse series; 42 to 50 scales around body at middle; a large preanal plate; 12-16 femoral pores on each side.

Brownish or golden above; a light stripe, edged above with black behind superciliary edge, passes along body to tail; a second light line borders upper lip, and passes along to flank; a black stripe between light lines (or green, spotted black); greenish white on venter; snout to vent, 50 mm.; tail 100 mm.

Family VARANIDAE

Genus VARANUS Merrem

Varanus Merrem, Tentamen Systematis Amphibiorum, 1820, p. 58 (type of genus, *Lacerta varia* Shaw).

This genus comprises the largest living lizards, one species reaching a length of 10 or more feet. Two species are known from Ceylon, a smaller *Varanus begalensis begalensis* Daudin, which reaches a length of nearly 6 feet, and *Varanus salvator* Laurenti, even larger, reaching a length of eight feet, four inches. These animals run rapidly, often climbing trees and often actually living in hollow trees.

KEY TO CEYLONESE SPECIES OF VARANUS

Nostril round or oval, nearer tip of snout than to orbit; abdominal scales weakly keeled, in 80 to 90 transverse rows . . *salvator salvator*
Nostril a rather narrow slit directed backwards, nearer orbit than tip of snout; abdominal scales smooth, in 90-110 transverse rows . . . . *bengalensis bengalensis*

Varanus bengalensis bengalensis (Daudin)

Tupinambis bengalensis Daudin, Histoire Naturelle des Reptiles, vol. 3, p. 67 (type locality, Bengal).
Lacerta monitor Linnaeus, Systema Naturae, ed. 10, 1758, p. 201 (type locality, India).
Monitor dracaena Kelaart, Prod. Faun. Zeylanicae, 1853, p. ——.
Varanus bengalensis Boulenger, Catalogue of the Lizards in the British Museum, 2nd ed., vol. 2, 1885, p. 310 (Ceylon); The Fauna of British India, including Ceylon and Burma; Reptilia and Batrachia, 1895, pp. 164-165 (Ceylon, "Whole of India"); Deraniyagala, Ceylon Journ. Sci., B, vol. 16, 1931, p. 161; Bhatt, Animal Life (Colombo Ceylon) 1942, pp. 118, 120 (native name only).
Varanus (*Indovaranus*) *bengalensis bengalensis* Mertens, Abh. Senckenb. Naturf. Gesellsch. No. 462, 1942, pl. 3, figs. 9, 10; pl. 11, fig. 49; pl. 13, figs. 64, 67; *ibid.* No. 465, 1942, pp. 182-184, pl. 22, figs. 160-161; pl. 25, figs. 194-196; pl. 29, figs. 232-234; pl. 32, figs. 258-259; pl. 34, figs. 285, 287; *ibid.* No. 466, pp. 334-338.

Diagnosis: A large species reaching six feet in total length; ventral scales smooth; no widened scales in supraorbital series; nostril a narrow slit, nearer orbit than to tip of snout.

Description of species: Rostral as high as wide, bordered laterally by first labials, bordered behind by a pair of postrostrals; largest scales on head form three median rows between the orbits, the adjoining rows somewhat smaller; a median groove begins two scale-lengths behind rostral and extends behind anterior level of nostril; supraorbital scales somewhat wider than other scales, one or two of which may be widened; canthus rather obtuse; supralabials, 31; approximately 34 infralabials; mental larger than rostral, followed by four somewhat enlarged scales separated by a groove which continues back for some distance; ear-opening subtriangular, the distance between eye and ear distinctly greater than distance from eye to anterior end of nostril; 32 scales between rostral and parietal; latter bearing pineal or parietal eye; between occipital and a point above the vent, 158 scales; between nuchal fold and line joining front level of legs, 104 smooth scale rows; leg when adpressed fails to reach axilla.

Digits below with transverse series of small scales, at least 30 series under the fourth toe, one row on inner edge enlarged on basal region; 20 series under first toe.

Color of young: Olive to brown with short black lines or spots, those on head longitudinal, those on body tending to form narrow transverse bands; sides, and to a lesser extent back, with small dark spots having yellow centers; a distinct black stripe behind eye; chin and neck more or less transversely marked with black; belly indistinctly marbled, with irregular transverse lines somewhat in evidence; toward distal part of tail there is a broad cream band with some darker lines or marbling (one or two specimens also have tip of the tail cream color).

Adults usually dull, blackish brown, or, recently after shedding, some yellowish may be in evidence.

Varanus salvator salvator (Laurenti)

Stellio salvator Laurenti, Specimen medicum exhibens Synopsin Reptilium emendatum, 1868, p. 56 (based on plate 88, fig. 2 in vol. 2, Seba, Thesaurus, a species of unknown provenance).

Varanus salvator Boulenger, Catalogue of the Lizards in the British Museum, 2nd ed., vol. 2, 1885, p. 314; The Fauna of British India, including Ceylon and Burma; Reptilia and Batrachia, 1890, p. 166. Deraniyagala, Ceylon Journ. Sci., B, vol. 16, 1931, p. 159; Smith, The Fauna of British India, including Ceylon and Burma; Reptilia and Amphibia, vol. 2; Sauria, 1935, pp. 406-407; Deraniyagala, Spolia Zeylanica, vol. 24, pt. 1, 1944, pp. 59-62.

Varanus salvator salvator Mertens, Abh. Senckenb. Natur. Gesellsch. no. 466, 1942, pp. 245-253; (*ibid.* Abh. 462, 1942, pl. 2, fig. 5; pl. 5, figs. 19-21; pl. 15, fig. 85; pl. 16, fig. 103.)

Diagnosis: Snout depressed at end, its length three times its height; canthus rostralis distinct but somewhat rounding; rostral small, as wide as high bordered by a pair of postrostrals; nostril round or oval in shape, much closer to tip of snout than to the eye; scales on crown of head larger than nuchal scales; four to eight median supraoculars transversely enlarged; scales of dorsal surface oval, more or less keeled; abdominal scales keeled in 85-95 rows; tail strongly compressed laterally, with a crest composed of paired scales ("doubletoothed"); tongue very long, divided, snakelike. Total length more than eight feet (2500 mm. *fide* Malcolm Smith).

Color: Adults dark brownish olive, usually indistinctly marked with transverse series of yellow spots.

SUBORDER—RHIPTOGLOSSA

Family CHAMAELEONIDAE Gray

Genus CHAMAELEON Gronovius

Chamaeleon Gronovius, Zooph. Anim., vol. 1, 1763, p. 12 (type of genus, *Lacerta chamaeleon* Linnaeus).

A single species occurs in Ceylon.

Chamaeleon zeylanicus Laurenti

Chamaeleo zeylanicus Laurenti, Specimen medicum exhibens Synopsin Reptilium emendatum, 1768, p. 46 (based on a figure in Seba, Thesaurus, vol. 1, pl. 82, fig. 3).

Chamaeleon calcaratus (*part.*) Boulenger, Catalogue of the Lizards in the British Museum 2nd ed., vol. 3, 1887, p. 445, pl. 39, fig. 2; The Fauna of British India, including Ceylon and Burma; Reptilia and Batrachia, 1890, p. 232, text figs. 66, 67; Werner, Zool. Jahrb., vol. 15, 1902, p. 332; Deraniyagala, Ceylon Journ. Sci., B, vol. 15, 1931, p. 156.

Chamaeleon zeylonicus Jerdon, Journ. Asiat. Soc. Bengal, vol. 22, 1853, p. 466; Smith, The Fauna of British India, including Ceylon and Burma; Reptilia and Amphibia, vol. 2, Sauria, Feb. 7, 1935, pp. 251-253.

Diagnosis: Foot with digits in groups of two and three opposed to each other; tongue club-shaped and extremely extensive, (nearly as long as head and body); head casque elevated posteriorly with a parietal crest, a serrated dorsal crest and a median ventral crest on chin, throat and venter.

Description of species: Head large, decorated with two elevated lateral crests beginning on the snout, following canthus rostralis to above eye, and temporal region, where they become lost on side of a high, parietal crest; parietal crest begins between eyes at their back level, and rises rapidly to the median highest point of the bony casque; latter sharply truncate on neck; width of casque at widest part slightly less than width of head at jaw angle; eyelids with a narrow median opening, closely applied to the somewhat conical eyeball; ear completely covered, but a slight depression suggests its position; diameter of bony orbit of eye equal to its distance from tip of snout; supralabials, 25-25; infralabials, 27, the last four not differentiated from other head scales; rostral and mental not differentiated from labials.

Scales on head unequal, relatively larger than scales on body and chin; body strongly compressed laterally leaving no ventral surface except a crest; dorsum likewise merely a high crest somewhat serrate, supported by neural spines of vertebrae covered with scales that are much larger than those on sides and limbs; feet with the upper three toes grouped together, directly opposed to lower two, all strongly clawed, and bound together, only the tips free; tail slender, compressed, higher than wide, decurving, prehensile.

Color: Green in life; in preservative nearly uniform blackish on body, the median dorsal crest and head somewhat grayish, the median ventral crest white or cream; palms and soles cream or yellowish, without pigment; under part of tail lighter than its sides.

Measurements in mm.: Length, snout to vent, 191; tail, 245, total length, 436; width of head, 34; head length to back level of casque, 51; back of jaw to snout tip, 40; arm, 84; leg, 84.

Remarks: A specimen (K.U.M.N.H. No. 24137, from Puttalam, Ceylon, W. C. Osman-Hill collector) has furnished the preceding description. The species is probably confined to the lower, dryer forests in the northern half of the island.

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Fourth Contribution to the Herpetology of San Luis Potosí

BY

EDWARD H. TAYLOR

ABSTRACT.—A report is made on a collection of reptiles and amphibians, containing approximately 608 specimens from San Luis Potosí, property of Louisiana State University Museum of Natural History. The collection contains a total of 71 species distributed as follows: one salamander, seventeen species of Salientia, twenty-one species of lizards, thirty-one species and subspecies of serpents, and one crocodile. The following are new records for the State: *Bufo occidentalis* Camerano (previously reported as *Bufo simus* [erroneously]); *Hemidactylus turcicus turcicus* (Linnaeus); *Sceloporus dugesi intermedius* Dugès; *Ophisaurus* sp.; *Abronia taeniata* (Wiegmann); *Rhinocheilus lecontei tessellatus* Garman; and *Crocodylus moreleti* Duméril and Bibron. Two other species, *Sceloporus serrifer cariniceps* Martin, and *Leiolopisma caudaequina* (Smith) have not appeared in the author's previous lists.

Elaphe triaspis intermedia (Boettger) was formerly reported erroneously as *Elaphe chlorosoma* (Günther). *Thamnophis cyrtopsis crytopsis* was formerly reported erronously as *Thamnophis eques eques* (Reuss). *Thamnophis eques eques* (Reuss) was formerly reported as *Thamnophis subcarinata subcarinata* Gray.

INTRODUCTION

Three recent herpetological collections, made for the Louisiana State Museum of Natural History and submitted to me for identification and study by Dr. George Lowery, form the basis for this publication.* These collections were made by personnel from the museum:

Mr. and Mrs. Richard Graber spent nearly a year in San Luis Potosí and visited several isolated mountain ranges from which no previous herpetological collections have been reported. Their chief interest was ornithology.

* Three other papers based on previous collections have been published as follows:
A preliminary account of the herpetology of the State of San Luis Potosí, Mexico, Univ. Kansas Sci. Bull., vol. 33, pt. 1, Apr. 20, 1949, pp. 169-215.
Second contribution to the herpetology of San Luis Potosí, Univ. Kansas Sci. Bull., vol. 33, pt. 2, Mar. 1950, pp. 441-457, pl. 4-9, map.
Third contribution to the herpetology of San Luis Potosí, Univ. Kansas Sci. Bull., vol. 34, pt. 2, Feb. 15, 1952, pp. 793-815, map.

Mr. Richard T. Gregg was in the country pursuing limnological studies in the summer of 1951 and obtained more than a hundred herpetological specimens.

The third collection was made by Mr. Charles Fugler, largely in 1952, while engaged in ornithological collecting.

A total of 608 specimens † is included in the material sent. When one realizes that the primary interests of the collectors were in other fields, and the herpetological specimens merely the result of chance collecting, the number is indeed large.

The materials have proved especially interesting and the number of species and subspecies represented—seventy—is especially high. A number of forms are reported from the State for the first time.

The following species are treated in this paper:

CAUDATA

Ambystoma velasci Dugès

SALIENTIA

Scaphiopus couchii Baird
Scaphiopus multiplicatus Cope
***Bufo occidentalis* Camerano
Bufo valliceps Wiegmann
Bufo horribilis Wiegmann
Bufo punctatus Baird and Girard
Leptodactylus labialis (Cope)
Syrrhophus cystignathoides (Cope)
Tomodactylus macrotympanum Taylor
Smilisca baudinii (Duméril and Bibron)
Acrodytes spilomma (Cope)
Hyla arenicolor Cope
Hyla eximia Baird
Hyla miotympanum Cope
Rana pipiens Schreber
Rana montezumae Baird

SAURIA

Hemidactylus turcicus turcicus (Linnaeus)
Anolis sallaei Günther
Phrynosoma orbiculare orbiculare (Linnaeus)
Holbrookia maculata approximans Baird
Sceloporus parvus parvus Smith
Sceloporus grammicus disparilis Stejneger
Sceloporus spinosus spinosus Wiegmann
Sceloporus variabilis variabilis Wiegmann
Sceloporus jarrovi minor Cope
**Sceloporus dugesii intermedius* Dugès

† Not including specimens being studied by Dr. Hobart M. Smith.
** Change in nomenclature of a previously reported form.
* First state record.

****Sceloporus serrifer cariniceps* Martin
Sceloporus torquatus melanogaster Cope
Eumeces lynxe lynxe Wiegmann
****Leiolopisma caudaequinae* (Smith)
Ameiva undulata podarga Smith and Laufe
Cnemidophorus sacki gularis Baird and Girard
**Ophisaurus sp.*
Gerrhonotus liocephalus infernalis Baird
Gerrhonotus liocephalus loweryi Tihen
**Abronia taeniata taeniata* (Wiegmann)
Barisia imbricata ciliaris (Smith)

SERPENTES

Leptotyphlops myopicus myopicus (Garman)
Constrictor constrictor imperator (Daudin)
Ficimia streckeri Taylor
Geophis mutitorques Cope
Lampropeltis triangulum polyzona Cope
Rhadinaea crassa Smith
**Rhinocheilus lecontei tessellatus* Garman
Salvadora lineata Schmidt
***Elaphe triaspis intermedia* (Boettger)
Elaphe flavirufa flavirufa (Cope)
Masticophis flagellum testaceus (Say)
Masticophis taeniatus ruthveni Ortenburger
Pituophis catenifer affinis Hallowell
Pituophis deppei jani (Cope)
Drymarchon corais erebennus (Cope)
Dryadophis melanolomus veraecrucis (Stuart)
Spilotes pullatus mexicanus (Laurenti)
Thalerophis mexicanus mexicanus (Duméril, Bibron, and Duméril)
***Thamnophis cyrtopsis cyrtopsis* (Kennicott)
***Thamnophis eques eques* (Reuss)
Thamnophis melanogaster canescens Smith
Thamnophis phenax Cope
***Thamnophis halophilus* Taylor
Thamnophis sirtalis proximus (Say)
Leptodeira annulata septentrionalis (Kennicott)
Leptodeira annulata taylori Smith
Leptodeira maculata (Hallowell)
Coniophanes imperialis imperialis (Kennicott)
Coniophanes fissidens proterops Cope
Crotalus triseriatus triseriatus (Wagler)
Crotalus atrox Baird and Girard

LORICATA

Crocodylus moreletii Duméril and Bibron

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* First state record.
** Change in nomenclature of a previously reported form.
*** Recently described forms.

REPORT ON SPECIMENS

CAUDATA

A single salamander is present in the collection.

Ambystoma velasci Dugès

Amblystoma velasci Dugès, La Naturaleza, ser. 2, vol. 1, 1888, p. 142 (type locality, Laguna Santa Isabel, near Guadalupe Hidalgo, D. F. Mexico).

One specimen, No. 4294, was taken at Presa Gonzales Santos, San Luis Potosí. The specimen is somewhat hardened so that accurate comparison with other forms is somewhat difficult. I have referred the species to *velasci* with some hesitation. The specimen is black with a pair of small yellow spots on the beginning of the neck and another pair near the angles of the mouth. The sides of the neck and body together have six to eight small canary-yellow spots, irregularly placed. The tail is strongly compressed with a series of five or six spots on each side on the upper part of the tail and a few scattered spots about tail-base. Some indistinct light flecks are present on the limbs. The venter is blackish with whitish or yellowish markings, the underside of the limbs dark The vomerine teeth are in two, somewhat diagonal series meeting mesially and anterior to the level of the choanae, forming a broad chevron. About 25 teeth are present on the left side, and 22 on the right, where there is a short hiatus near the choana. The tongue is well developed. The phalangeal formula is: 2, 2, 3, 2; 2, 2, 3, 4, 2. The webbing on the hand does not extend to the ends of the metacarpals. On the foot the webbing extends slightly beyond the metacarpals and on each digit continues as a diminishing fringe to near the end of the digits. Snout to front of vent, 70 mm.; tail, 54 mm.; basal depth of tail, 8 mm.; arm, 25 mm.; leg, 27 mm.

SALIENTIA

The collection of Salientia contains 239 specimens, and 16 species.

Scaphiopus couchii Baird

Scaphiopus couchii Baird, Proc. Acad. Nat. Sci. Philadelphia, vol. 7, 1854, p. 62 (type locality, Matamoros, Tamaulipas [restricted]).

The following specimens are in the collection: Nos. 5464, 5465 from Ébano; No. 4980, from 12 mi. W of Ébano, 100 ft. elev.; No. 4289, from 11 mi. W of Ébano; Nos. 4298, 4299, recently transformed specimens, that seemingly belong to this species.

Scaphiopus multiplicatus Cope

S(*caphiopus*) *multiplicatus* Cope, Proc. Acad. Nat. Sci. Philadelphia, vol. 15, 1863, p. 52 (type locality, Coyoacán, D. F. Mexico, [restricted]).

A series of the northern variant of this species (Nos. 5458-5463, 5789) was taken at Luna Media.

Bufo occidentalis Camerano

Bufo occidentalis Camerano, Atti Accad. Sci. Torino, vol. 14, 1879, p. 887 (type locality, Guanajuato, Guanajuato [restricted]).

One adult specimen, No. 4982, from Pozo del Carmen, 6500 ft. elev., is in the collection. The tympanum is distinct.

This species was formerly reported from San Luis Potosí, as *Bufo simus*.

Bufo valliceps Wiegmann

Bufo valliceps Wiegmann, Isis von Oken, vol. 26, 1833, pp. 657-659 (type locality, Veracruz, Veracruz, [restricted]).

The following numerous specimens of this species are in the collection: Nos. 4315-4318, 5432-5437, Tamazunchale; 4319-4328, 4990-4991, 5438-5441, Nacimiento del Coy; 4329-4332, Río Valles, at Valles; 4985-4986, Aqua Sonadora, 4 km. N Tanchachin; 4987, 2 mi. N Valles, 300 ft. elev.; 4988, 5455, Valles, 300 ft.; 4995-4996, 6 mi. W Ahuacatlan; 5442-5450, Ébano; 5414-5431, El Salto; 5457, Río Axtla (ferry on Xilitla Road); 5451, Luna Media; 5456, 38 km. SW Río Verde.

In a previous publication * I noted certain toads that differed from typical *valliceps* in having a narrower head. A specimen, No. 4996, from 6 mi. W of Ahuacatlan, likewise differs from the typical *valliceps*. This specimen is a large male. The head crests are thicker and the dark parotoid gland extends farther, reaching laterally to a level of the middle of the tympanum. The hands and feet are broader and the toes are slightly more webbed. Seemingly a smaller part of the femur is included in body skin. The vocal sacs open on both sides.

Bufo horribilis Wiegmann

Bufo horribilis Wiegmann, Isis von Oken, vol. 26, 1833, pp. 654-655 (type locality, Veracruz, Veracruz, [restricted]).

Nos. 4333, 4994, and 4998 are from El Nacimiento del Coy, 300 ft. elev.; Nos. 4334-4347, 4350, 4351, 4353, 4356, from Río Valles, at Valles; Nos. 4348, 4352, 4354, 4355, from El Sol Courts, Tamazunchale; No. 4357, from El Salto. Males may usually be distinguished from females by their rougher skin.

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* Univ. Kansas Sci. Bull., vol. 34, pt. 2 Feb. 15, 1952.

Bufo punctatus Baird and Girard

Bufo punctatus Baird and Girard, Proc. Acad. Nat. Sci. Philadelphia, vol. 6, 1852, p. 173 (type locality, Rio San Pedro [now Devil's River], Val Verde Co., Texas).

Six specimens are in the collection: Nos. 4311-4314, from Presa San José, 4 mi. SW of San Luis Potosí; Nos. 4290-4291, from 5 miles SW Bledos, E. Cabrera, coll.; No. 4981, Pozo del Carmen, 5600 ft. elev., J. Graber, coll.; No. 4983, Sierra San Miguel, 7500 ft. elev., R. Graber, the specimen "gray with red-brown warts"; No. 4984, 2 mi. W of Amoles, 5600 ft., R. Graber, coll.

Leptodactylus labialis (Cope)

Cystignathus labialis Cope, Proc. Amer. Philos. Soc., vol. 17, 1877, p. 90 (type locality, Potrero Viejo, Veracruz [restricted]).

A small, recently transformed specimen (No. 4961), from El Nacimiento del Coy, 300 ft. elev., collected by Jean Graber, seemingly belongs to this species although too young to make positive identification. The vomerine teeth are well developed. The color is "dark gray with darker markings."

Syrrhophus cystignathoides (Cope)

Phyllobates cystignathoides Cope, Proc. Amer. Philos. Soc., vol. 17, 1877, pp. 89-90 (type locality Potrero, near Córdoba; Veracruz, Mexico).

Two specimens of this species in the collection are from La Joya, 5 km. W of Aquismon, elev. 2500 ft., Nov. 22, collected by R. Graber. No. 4962 is "olive with black spots; black band through eye and on side of head." No. 4963 is "gray with darker spots; black on sides of head and around eye."

Tomodactylus macrotympanum Taylor

Tomodactylus macrotympanum Taylor, Univ. Kansas Sci. Bull., vol. 26, 1939 (1940) pp. 496-499, pl. 55, figs. 2, 2a, 2b, (type locality, La Placita, south of Jacala, Hidalgo, Mexico).

Three specimens, Nos. 4968, 4969, and 4970 were taken at a point 6 miles west of Ahuacatlan, at an elevation of 5200 ft. by R. Graber, July 30 and 31, 1951. "Sits in bushes about three to four feet above the ground." "Gray, almost transparent, with darker spots."

Smilisca baudinii (Duméril and Bibron)

Hyla baudinii Duméril and Bibron, Erpétologie générale, vol. 8, 1941, pp. 564-565 (type locality, Córdoba, Veracruz [restricted]).

Three specimens are in the collection: Nos. 4274, El Nacimiento del Coy, L. Guerrero, collector; Nos. 4300, 4301, El Sol Courts, Tamazunchale, R. T. Gregg, collector.

Acrodytes spilomma (Cope)

Hyla spilomma Cope, Proc. Amer. Philos. Soc., vol. 17, 1877, p. 86 (type locality, Cosomaloapam, Veracruz, Mexico).

A specimen, No. 5786, is from El Salto. The spotting on the limbs and sides of the body is typically nigropunctate.

Hyla arenicolor Cope

Hyla arenicolor Cope, Jour. Acad. Nat. Sci. Philadelphia, ser. 2, vol. 6, 1866, p. 84 (substitute name for *Hyla affinis* Baird preoccupied; type locality, Santa Rita Mts. [restricted]).

The northeastern specimens are on the whole smaller than specimens from the southern part of the range. Nos. 4966, 4967 are from 12 mi. E of Santiago, 8200 ft. elev., taken Sept. 24, 1951; Nos. 4974, 4975 are from Sierra San Miguel, 7500 ft. elev., taken Oct. 20, 1951; and No. 5785 is from 38 km. SW of Río Verde de los Piños.

Hyla eximia Baird

Hyla eximia Baird, Proc. Acad. Nat. Sci. Philadelphia, vol. 7, 1854, p. 61 (type locality, Coyoacán, Distrito Federal, Mexico [restricted]).

Four specimens in the collection are from the following localities: No. 4964, Bledos, 6200 ft. elev.; Nos. 4965, 4971, 4972, are from 10 mi. E Pozo del Carmen, 6500 ft. elev. The adults are typical.

Hyla miotympanum Cope

Hyla miotympanum Cope, Proc. Acad. Nat. Sci. Philadelphia, vol. 15, 1863, p. 49 (type locality, Jalapa, Veracruz [restricted]).

Two specimens, Nos. 5780, 5781 from Xilitla, are in the collection.

Rana pipiens Schreber

Rana pipiens Schreber, Der Naturforscher, Halle, vol. 18, 1872, p. 185, pl. 4 (Raccoon, Gloucester Co., N. J.).

The following specimens are in the collection: Nos. 4278-4284, Bledos; Nos. 4286, 5 mi. SW Bledos; No. 4288, El Nacimiento del Coy; No. 4960, Agua Sonadoro; No. 4976, Villa Reyes, Laguna de la Rusias; Nos. 4977-4979, Pozo del Carmen, 5600 ft. elev. No attempt is made to determine the subspecific relationship of these specimens.

Rana montezumae Baird

Rana montezumae Baird, Proc. Acad. Nat. Sci. Philadelphia, vol. 7, 1854, p. 61 (type locality, México, Distrito Federal, Mexico).

The following specimens are in the collection: Nos. 4302-4306, Presa Gonzales Santos, 10 mi. SW San Luis Potosí; 4307-4310, 4390, Presa San José, 4 mi. SW San Luis Potosí; 4275-4277, Bledos; 4285, 4287, 5 mi. SW Bledos in pools in mountain canyon, 7000 ft. elev.; 4973, Sierra San Miguel, 7500 ft.; 5654, Laguna de las Rusias; 5668, 5699-5671 Presa Prudentia.

SAURIA

The lizard collection contains considerably more than three hundred specimens, but all are not recorded here since certain ones are being studied by Dr. Hobart M. Smith. His report will appear elsewhere. There are 21 species represented here.

Hemidactylus turcicus turcicus (Linnaeus)

Lacerta turcicus Linnaeus, Systema Naturae, ed. 10, 1758, p. 202 (type locality, Cairo, Egypt [restricted]).

The presence of this species in the State is attested by a series of specimens from Tamazunchale, collected by Fugler (Nos. 5798-5806). They were captured in the El Sol Courts and suggest a recent introduction possib'y by tourists. Previous collecting in Tamazunchale has yielded no specimens. Specimens were previously known from 12 mi. E of Llera in Tamaulipas. These are the first records for San Luis Potosí.

Anolis sallaci Günther

Anolis sallaci Günther, Proc. Zool. Soc. London, 1859, p. 421 (type locality, Jalapa, Veracruz, Mexico [restricted]).

This species was formerly reported from the State under the name *Anolis sericeus* (Hallowell) which I now believe refers to a different species.* The present collection contains two specimens, Nos. 4209 and 5806, from Nacimiento del Coy. The latter is a female, having a white throat, which bears a purplish-red spot. The body is generally gray and lacks the broad, dorsal, cream stripe that is present in the type (also a female).

Phrynosoma orbiculare orbiculare (Linnaeus)

(Plate CXVIII)

Lacerta orbicularis Linnaeus, Systema Naturae, ed. 12, 1789, p. 1062 (*part.*) (type locality, México, D. F. Mexico [restricted]).

A specimen, No. 4944, was taken on the Sierra San Miguel, at an elevation of 7200 ft., Oct. 21, 1951, by R. Graber. The color is: "Dorsally brown with dark brown and cream colored markings; spines olive green; occipital spines pink. Ventrally blotched with blue-gray; legs yellowish."

* Taylor, Univ. Kansas Sci. Bull., vol. 34, pt. 2, Feb. 15, 1952, p. 805.

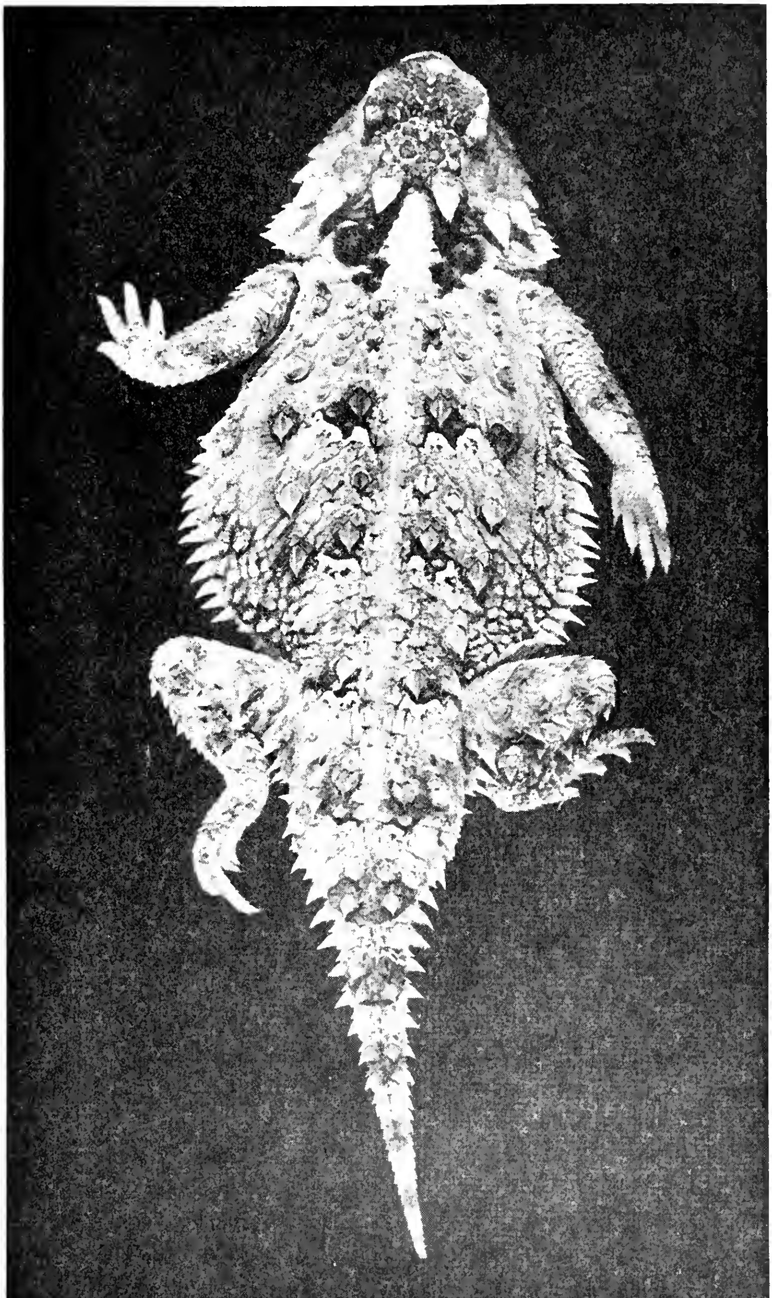

PLATE CXVIII. *Phrynosoma orbiculare orbiculare* L.S.U. No. 4944. Sierra San Miguel, S.L.P.

Holbrookia maculata approximans Baird

Holbrookia approximans Baird, Proc. Acad. Nat. Sci. Philadelphia, 1858, p. 253 type locality, Tamaulipas, Tamaulipas, Mexico [restricted]).

A mutilated female specimen, No. 5796, from Presa Gonzales Santos, is referred to this species.

Sceloporus parvus parvus Smith

Sceloporus parvus Smith, Trans. Kansas Acad. Sci., vol. 37, 1934, pp. 263-267, pl. 8, figs. 1, 3, pl. 10, fig. 10 (type locality, 5 mi. W Sabinas Hidalgo, Nuevo León, Mexico).

Six specimens are referred to the typical subspecies: Nos. 4924, ? mi. W Amoles; 4925, 4926, Sierra San Miguel, 7500-8000 ft. elev.; 4927, 12 mi. SE Santiago, 8000 ft.; 5628, 5629, approximately 1 mi. W Ciudad del Maiz.

These specimens have 14 or 15 femoral pores on each side, the series separated mesially by four scales. The scales in a dorsal row from the occipital to above vent are 63-68 and the enlarged dorsal scale rows on neck are 17 or 18. Since the specimens are discolored by formalin, the dorsolateral light line is scarcely distinguishable. The chin has light spots on a blackish ground color.

An area under the thighs in the anal region and under the tail is whitish and without pigment. In younger specimens the tail is white to the tip on the under side while the dorsal and lateral coloring of the tail is gray, much lighter than the dorsal body color.

Sceloporus grammicus disparilis Stejneger

Sceloporus disparilis Stejneger, Proc. Biol. Soc. Washington, vol. 29, 1916, pp. 227-230 (type locality, Lomita Ranch 6 mi. N Hidalgo, Texas).

A considerable series of this species is present in the collection. The following localities are represented: Nos. 4248-4254, Cerro Conejo; 4242, Cañada Grande; 4227, Bledos; 4912, 4915-4916, 6 mi. W Ahuacatlan, 5400-6500 ft. elev.; 4917, 4918, 4920-4922, Sierra Azul, 10 mi. NE Bledos, 900 ft. elev.

Sceloporus spinosus spinosus Wiegmann

Sceloporus spinosus Wiegmann, Isis von Oken, vol. 21, 1828, p. 370 (type locality, Puebla, Puebla [restricted]).

The following specimens are in the collection: Nos. 4260-4262, 4365, 4934, 4935, Laguna de las Rusias; 4237-4240, Bledos; 4241, 5 mi. SW Bledos; 4242, Cañada Grande; 4936, 10 mi. E of Pozo del Carmen; 4937, 3.5 mi. W Pozo del Carmen; 4272 (young), Villar; 5490-5499, 5539, 5794, Presa Prudentia; 5500-5511, 5529, 5532-5537, Luna Media; 5516-5521, 5523-5528, 5530, 5531, 5540, Presa Gonzales

Santos; 5515, 1½ mi. W Leoncito; 5522, Presa San José; 5512-5514, 5538-5539, Ciudad del Maiz.

Sceloporus variabilis variabilis Wiegmann

Sceloporus variabilis Wiegmann, Herpetologia Mexicana, 1834, p. 51 (type locality, Veracruz, Veracruz, Mexico [restricted]).

The following specimens are in the collection: Nos. 4236, Axtla; 4271, 2 mi. W Tamuin; 4257-4259, 5563-5573, 5600-5612, El Salto; 4267-4268, Platanito; 4931-4933, 3 mi. W Platanito, 4000 to 4600 ft. elev.; 4269, Puente de Dios; 4264, 5590, Tamazunchale; 4243, 4244, 4246, Cañada Grande; 4256, 10½ mi. W Ébano; 4263-4266, 4361-4363, 4928-4930, 5574-5585, 5616-5619, Nacimiento del Coy; 5553-5562, 5587, 5596-5599, 3 mi. W Xilitla; 5588, 5589, 5613-5615, Luna Media; 5591, 5620-5625, Valles; 5590, 5626, 5627, Cerro de la Paz; 5586, 5587, 5592-5595, approx. 24 mi. SW Río Verde, Los Piños.

Sceloporus jarrovi minor Cope

Sceloporus torquatus minor Cope, Proc. Amer. Philos. Soc., vol. 22, 1885, p. 402 (type locality, Valparaiso Mts. Zacatecas, Mexico [restricted]).

Specimens Nos. 4366, 4905, 4919, 4923 were collected 10 miles northeast of Bledos in the Sierra Azul, 9000 ft. elev.; No. 4366 at Presa San José, 4 mi. SW of San Luis Potosí.

Sceloporus dugesii intermedius Dugès

Sceloporus intermedius Dugès, La Naturaleza, vol. 4, 1877, pp. 29-34, pl. 1, figs. 21-32 (type locality, La Noria, near Zamora, hda. P. Epifanio Jiménez in Michoacán).

A series of specimens taken in southern San Luis Potosí is referred to the above species. These are: Nos. 4232, 4908, 4911, 4913, 4914, 6 mi. W Ahuacatlan, 5400 ft. elev.; 4906, Sierra Azul, 10 mi. N Bledos, 9000 ft. elev.

The latter specimen, a male, has a white chin, throat, and venter; the underside of the tail is a shade of orange.

Sceloporus serrifer cariniceps Martin

Sceloporus serrifer cariniceps Martin, Occ. Pap. Mus. Zool. Univ. Michigan, no. 543, Oct. 22, 1952, pp. 1-7 (type locality, Rancho Pano Ayuctle, along Río Sabanas, 5 mi. NE of Gomez Farias, Tamaulipas, Mexico.

No. 5550, from 6 km. E of Tamazunchale, is a typical example of this recently described species. It has been reported previously from Ébano.

Sceloporus torquatus melanogaster Cope

Sceloporus torquatus melanogaster Cope, Proc. Amer. Philos. Soc., vol. 22, 1885, pp. 400-401 (type locality, Tupátaro, Guanajuato [restricted]).

The species is represented by Nos. 4231, 4234 from 6 mi. W Ahuacatlan; 5541, 5548, Presa Prudentia; 5549, Presa San José.

Eumeces lynxe lynxe Wiegmann

Eumeces lynxe Wiegmann, Herpetologia Mexicana, 1834, pp. 36-37 (type locality El Chico, Hidalgo).

The following specimens are in the collection: Nos. 4210, 4211, 4213, Cerro Conejo at an elevation of 7000 ft.; No. 4212, Cañada Grande; No. 4942, 6 mi. W Ahuacatlan, 5400 ft. elev.; J. Graber coll. This latter specimen has "yellow stripe on dorsum, the back bronze; throat somewhat orange in color; sides black; tail bright blue; belly bluish gray."

Leiolopisma caudaequinae (Smith)

Scincella caudaequina Smith, *in* Smith and Taylor, U. S. Nat. Mus. Bull. 199, 1950, p. 158 (type locality, Salto Cola de Caballo, 25 mi. S of Mònterrey, Nuevo León, Mexico).*

Leiolopisma caudaequinae Smith, Univ. Kansas Sci. Bull., vol. 34, pt. 1, Oct. 1, 1951, pp. 195-200 (complete description).

Four specimens are in the collection: Nos. 4940 and 4941 from La Joya, 3.1 mi. W of Aquismon, 2500 ft. elev.; No. 4943, from 4 mi. W of Pendencia, 4600 ft. elev.; No. 5793, 3 mi. W of Xilitla.

The scale rows around the middle of the body are respectively, 28, 30, 28, 30; the lamellae under the fourth toe are, 18, 19, 19, 19. The last specimen is a female, distended with eggs, in which the limbs touch but do not overlap. There are 69 dorsal scales in a row from parietals to above vent. This species has been taken previously in the State from Naranjo.

Ameiva undulata podarga Smith and Laufe

Ameiva undulata podarga Smith and Laufe, Univ. of Kansas Sci. Bull., vol. 31, pt. 1, May 1, 1946, pp. 40-43, figs. 1d, 2a (type locality, 7 mi. W Victoria, Tamaulipas).

The following are in the collection: Nos. 4218, Puente de Dios, Río Santa Maria; 4228, 5700, 5701, 5769, and 3 unnumbered specimens, El Salto; 4358, 5714, 5715, 5746, 5764, 5765, Tamazunchale; 5768, Río Elera, 3.7 mi. E Tamazunchale; 5717, Nacimiento del Coy.

Cnemidophorus sacki gularis Baird and Girard

Cnemidophorus gularis Baird and Girard, Proc. Acad. Nat. Sci. Philadelphia, 1852, p. 128 (type locality, mouth of Devil's River, Texas [restricted]).

Nos. 4945-4947, Pozo del Carmen, 5600 ft. elev.; 4948-4950, from 2 mi. W of Valles, 300 ft. elev.; 5693, 5694, 5719-5722, 5750-5758, Luna Media; 5695, 5696, 5702-5704, 5723-5725, 5761, 5772, Ciudad del Maiz; 5726-5731, 5760, and four unnumbered specimens El Salto;

* The data in the key serve as a description and prevent this name from being *nomen nudum* in this publication.

5742-5744, 5774, 5775, Presa Prudentia; 5723, 5748, 5749, Valles; 5705-5708, 5732-5738, 5766, 5767, 23.75 mi. SE Río Verde (Los Piños); 5712, 5713, Presa San José; 5697-5699, 5763, Laguna de las Rusias; 5709-5711, and 2 specimens without numbers, Presa Gonzales Santos; 5747, 5771 Cerro de la Paz; 5718, 5739, 5740, 5745, 5762, one-half mi. W of Leoncito.

Ophisaurus sp.

A single specimen, No. 4886 ♂, captured seven miles south of Valles, San Luis Potosí by C. O. Peterson, Nov. 15, 1951, represents the first record for the State and one of two for Mexico. The nearest point in the United States where the genus is known to occur is Cameron and Hidalgo Counties in extreme southern Texas.

It was reported from Jalapa by Yarrow,* a record that Smith and Taylor ** believe to be incorrect. However, the finding of a specimen near Valles proves the presence of the genus in Mexico.

Diagnosis: Ground color gray, with a series of black marks forming lines on each scale-row above the lateral groove, the lines varying in width, the widest and most complete being that of the fourth from the groove, which is not wider than one half scale-row; no pigmentation below groove, but a faint peppering on edges of groove; venter pure white; ten ventral scale-rows; 14 rows between the grooves; the scales around neck behind ear, 34; scales between end of groove and ear, 17; upper labials, 12-12.

Description of species: Rostral wider than high, bordered by four internasal scales lying between the first labials, the median scale rather unequally divided; nasal small, divided, the posterior section very narrow, scarcely more than a partial rim around nostril; a well-defined supranasal; a pair of posterior internasals broadly in contact, touching the upper postnasal and the supranasal laterally; frontonasal large, more or less rounded in front, with nearly parallel sides; posterior border curving from each side to a short mesial point, barely separated from a large frontal by a rather large pair of prefrontals; frontal bordered by three of the five inner supraoculars; five small outer supraoculars; six small superciliaries; interparietal broadly in contact with the frontal, pentagonal, but generally triangular in shape, narrowing posteriorly to a point, in contact with the interoccipital; a pair of parietals border the interparietal, but are separated by three scales from the supraoculars,

* Yarrow. U. S. Nat. Mus. Bull., 24, 1884, p. 46.

** Smith and Taylor. U. S. Nat. Mus. Bull. 199, 1950, p. 194.

and touch three lateral, temporal scales; upper labials, 11-11; lower labials approximately nine; at least nine scales in the presub- and postocular series. One postnasal, two or three canthals; loreals? * a single postmental, separated from mental by inner submentals; three large paired chinshields; an inner and an outer row of submentals.

Ear small, separated from the last labial by three scales, from the beginning of the lateral groove, by 15 scales; scales in a dorsal row from parietal to above vent, 114-116; 14 dorsal scale rows, the outer, bordering lateral groove, more than half size of adjoining row; ten ventral scales, bordering lateral groove more than half size of adjoining rows; vent bordered by at least 11 scales only slightly differentiated; scales on venter, from last enlarged paired postmental to preanals, 119.

Measurements: Width of head, 15 mm.; head length to ear, 23 mm.; snout to vent, 231 mm. (tail broken and regeneration begun).

Colors: Above and on sides as far as the lateral groove, grayish to grayish white, each scale of a given row with equal-sized darker areas which together form rows of dots or discontinuous lines; the two median lines darker and more nearly continuous than adjoining rows; on each side of these two rows, are two rows of grayish-black dots; the next row on each side is the darkest and practically continuous; width of the black equaling more than half width of scale-row, while borders of this and succeeding rows whiter than those dorsally; next two rows broad but discontinuous, while the outermost bordering lateral groove is smallest, the individual dots most widely separated; just posterior to level of vent third and fourth rows of each side unite to form only a single strong stripe on each side; labials and temporals with black spots; a black spot on interoccipital, and a few small blackish flecks elsewhere on head. Below lateral groove, belly uniform, dull white.

Remarks: The genus *Ophisaurus* has recently been re-examined by Mr. Edward McKonkey who has a paper in press dealing with the genus at this writing. He suggests that I refer to this specimen as I have done, until his paper appears.

Gerrhonotus liocephalus infernalis Baird

Gerrhonotus infernalis Baird, Proc. Acad. Nat. Sci. Philadelphia, 1858, p. 255 (type locality, Devil's River, Texas).

One specimen of this species, No. 4958, was acquired at Birmania, 3 mi. S of Valles, 300 ft. elev., by C. A. Peterson, November 10, 1951.

* The front of the head has been injured and certain characters are obscured.

The specimen has the following characters: snout to vent, 137 mm., tail, 291 mm., partly regenerated; total length, 428 mm.; adpressed limbs separated by 10-11 scales; four scales bordering rostral across snout between first labials; a distinct axillary pit, the lateral nuchal pit being almost obsolete; nine transverse markings of tan, dark brown and whitish; white mark from eye to ear bordered by black above; dark marks crossing the fine scales of the lateral groove. This specimen differs from the typical *infernalis* in having two labials and four other scales bordering the rostral, and the number of scale rows approaches the number in *loweryi*.

Gerrhonotus liocephalus loweryi Tihen

Gerrhonotus liocephalus loweryi Tihen, Trans. Kansas Acad. Sci., vol. 51, 1948, pp. 302-305 (type locality, Xilitla, San Luis Potosí).

A series of five specimens, Nos. 4953-4957, are from six miles W Ahuacatlán, elevation approx. 5400 ft., Oct. 4 to 6, 1951, R. Graber, collector. The median body scale-counts are, 53, 55, 52, 54, 53 respectively. There are three scales bordering rostral across snout between the first labials. No. 4954 has a snout-vent length of 192 mm., the tail, 338 mm. The caudal scales of this specimen number 161. The head is widened in the males. The legs when adpressed are separated by 2-3 scales in males; by 4-4½ in females.

Abronia taeniata taeniata (Wiegmann)

(Plate CXIX)

Gerrhonotus taeniatus Wiegmann, Isis von Oken, vol. 21, 1828, p. 379 (type locality El Chico, Hidalgo [restricted]).

A single specimen, No. 4208, is from Llano Conejo on Cerro Conejo, collected by E. Esquibel. The specimen is somewhat discolored but when compared with the Wiegmannian figure of the type * it agrees very well. However, this specimen has somewhat less light marking on the head and labials. This is a new record for San Luis Potosí.

Barisia imbricata ciliaris (Smith)

Gerrhonotus levicollis ciliaris Smith, Proc. U. S. Nat. Mus., vol. 92, 1942, pp. 365-367 (type locality, Sierra Guadelupe, Coahuila, Mexico).

One specimen, No. 4207, 7000 feet, Cerro Conejo, measures 138 mm. snout to vent. The tail is regenerated. The color of the preserved specimen is nearly uniform olive above without markings, the head, especially the sides of head, somewhat lighter.

Two specimens, Nos. 4951, 4952, are from 10 mi. NE of Bledos

* Wiegmann, Herpetologia Mexicana, pl. 9.

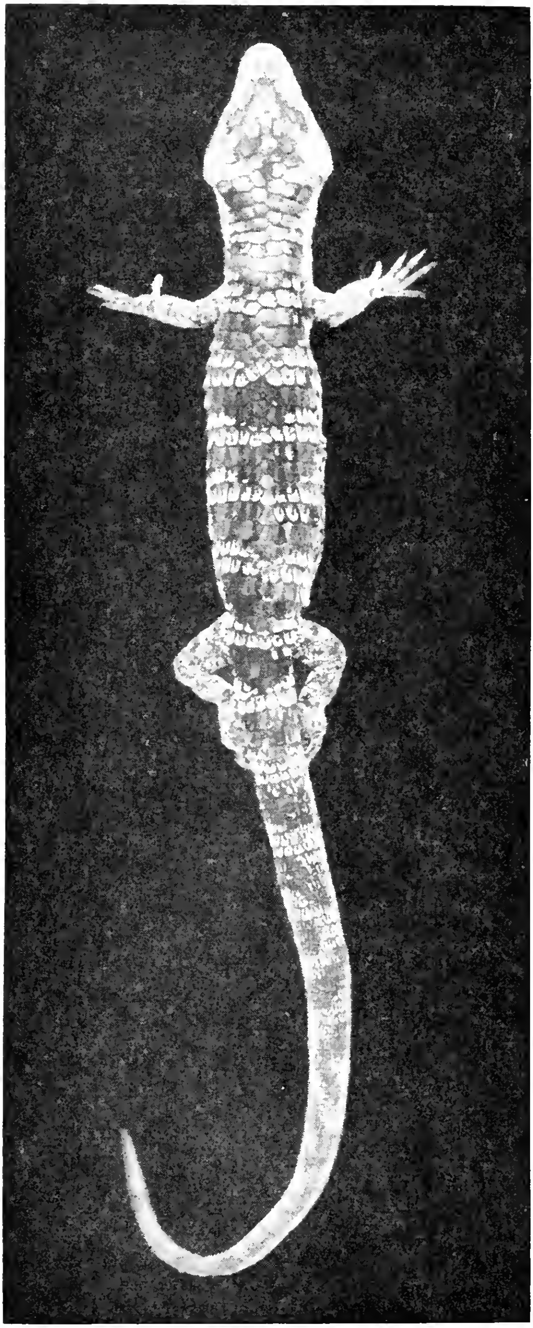

PLATE CXIX. *Abronia taeniata taeniata* L. S. U. No. 4208 Cerro Conejo S. L. P.

in the Sierra Azul, 9000 ft. elev., collectors, Jean Graber and R. Graber. The former is "dorsally brown-olive drab, ventrally pale orange; especially orange on under side of tail." The latter specimen is "olive-drab dorsally; whitish green ventrally except for tail, which is orange on under surface."

These two specimens differ somewhat from the Cerro Conejo specimen. The heads are larger, the bodies shorter. No. 4207 has the adpressed limbs separated by ten scales, the other two by five scales.

SERPENTES

The collection contains 68 specimens of snakes. For the size of the collection, the number of species is large, no less than 31 species and subspecies being represented. Three are the first records for the State.

Leptotyphlops myopicus myopicus (Garman)

Stenostoma myopicum Garman, Mem. Mus. Comp. Zool., vol. 8, 1883, pp. 6, 130, 131 (type locality, Savineto, near Tampico, Tamaulipas, Mexico).

Three specimens of this species are in the collection: Nos. 5411, Nacimiento del Coy; 5412, Cerro de la Paz; 5413, Luna Media, Fugler collector.

Constrictor constrictor imperator (Daudin)

Boa imperator Daudin, Histoire Naturelle . . . reptiles, vol. 5, 1803, pp. 150-152 (type locality, Córdoba, Veracruz, Mexico [restricted]).

A skin containing a complete head (No. 4871) is from near Corrones, 15 mi. W of Ébano, altitude 100 ft., R. Graber, collector.

Ficimia streckeri Taylor

Ficimia streckeri Taylor, Copeia, 1931, no. 1, pp. 5-7 (type locality, 3 mi. E Rio Grande City, Texas).

A single specimen (No. 5391) is from 3 mi. W of Xilitla.

Geophis mutitorques * Cope

Geophis mutitorques Cope, Proc. Amer. Philos. Soc., vol. 22, 1885, p. 384 (type locality, Zacualtipan, Hidalgo, Mexico).

A small specimen, No. 4202, from Cerro Conejo (7700 ft.), is in the collection. It is black above, while below it is black with more or less quadrangular white spots, alternating or more rarely fused. There is a nuchal collar, almost interrupted medially, widening laterally and connecting with the large whitish area on chin.

* In Taylor, Univ. Kan. Sci. Bull., vol. 33, pt. 1, Apr. 20, 1949, pp. 171, 194, this specific name is incorrectly spelled *multitorques*.

Lampropeltis triangulum polyzona Cope

Lampropeltis polyzona Cope, Proc. Acad. Nat. Sci. Philadelphia, vol. 12, 1860, p. 258, (type locality, Cuatupe, near Jalapa, Veracruz).

Two specimens, No. 4370, ♀, from El Sol Courts at Tamazunchale, and No. 4203, ♂, from 11.2 km. S of Valles, are in the collection. The black-white-black bands, 18 or 19 in number, are not or scarcely wider dorsally than laterally in No. 4203, while in the smaller (No. 4370), the bands are distinctly wider dorsally than laterally. The lengths of the two specimens are respectively, 339 mm. and 687 mm., tails, 48 mm., 88 mm.

Rhadinaea crassa Smith

Rhadinaea crassa Smith, Proc. Biol. Soc. Washington, vol. 55, 1942, pp. 190-191, figs. 4-5 (type locality, Durango, Hidalgo).

A specimen (No. 4206, R. Graber, collector), typical in practically all details, is from Cerro Conejo.

Rhinocheilus lecontei tessellatus Garman

Rhinocheilus lecontei tessellatus Garman, Mem. Mus. Comp. Zool., vol. 8, 1883, p. 74, 159 (type locality, Monclova, Coahuila, Mexico).

The first State record for this species is No. 4875, from 3.5 mi. W of Pozo del Carmen, 5600 ft. elev. — the collector, Emilio Esquibel.

The following characters obtain: snout turned up and elevated above other snout scales; internasals angular, nearly three fourths the size of prefrontals; part of rostral seen from above, equal in area to an internasal; one preocular, two postoculars; upper labials, 8-8; lower labials, 8-9; temporals, 2 + 3; first pair of chinshields longer and wider than posterior pair (on one side the second right chinshield is broken transversely); second pair of chinshields separated by two scales anteriorly, by four scales posteriorly; ventrals, 194½; anal single; subcaudals, 49 + 1 (1st divided; 2nd to 43rd single, 44th divided, 45th single, 46th to 49th divided, last terminal scale single); scale formula: 23, 23, 23, 19, 19; scales with a single apical pit. Total length, 769 mm.; tail, 92 mm. Above, black, red and yellow; 25 broad, black, dorsal blotches, separated by rosy red; 9 black spots on tail separated by rosy red; ventral surfaces pale yellow; every third or fourth ventral with black spots on outer edges.

Salvadora lineata Schmidt

Salvadora lineata Schmidt, Publ. Field Mus. Nat. Hist., Zool. Ser., vol. 24, 1940, pp. 148-150, fig. 15 (type locality Kingsville, Kleburg County, Texas).

Two specimens are in the collection (No. 4197, Ventilla, May 16, 1951, and No. 4880, 12 mi. SE of Santiago, Sept. 24, 1951, R. Graber, collector). The former has 194 ventrals and 88 subcaudals; the latter has 192 ventrals; the tip of the tail is missing; the scale formula of the latter is: 19(20), 17, 17, 13(15). The color is: "Ventrally pale yellow-white; dorsally, median stripe yellow; lateral stripes brown; sides gray-brown." The total length is 841 mm., the tail, 217 mm.

A third specimen, No. 5390, is from 1.5 mi. W Ciudad del Maíz.

Elaphe triaspis intermedia (Boettger) *

Pityophis intermedius Boettger, Ber. Offenbacher Ver. f. Naturk. Bd. 22, 1883, pp. 147-152 (type locality, Mexico).
Coluber chlorosoma Günther, Biologia Centrali-Americana, Reptilia and Batrachia, 1894, pp. 115-116, pl. 41 (type locality San Ramón, Jalisco [restricted]).

A specimen, No. 5387 from 3 mi. W of Xilitla was taken June 18, 1952.

Elaphe flavirufa flavirufa (Cope)

Coluber flavirufus Cope, Proc. Acad. Nat. Sci. Philadelphia, vol. 18, 1866 (1867) p. 319 (type locality, Campeche, Campeche, Mexico [restricted]).

A specimen, No. 4874, from Rancho Sabanal, collected by Jean Graber, Nov. 12, 1951, has the following characters: one very large preocular, reaching frontal; two postoculars; temporals, 3 + 4; upper labials, 9-9; lower labials, 12-13; ventrals, 253; subcaudals, 109 + 1; scale formula: 25, 27, 29, 23, 19. "Tan above with red-brown, black-edged spots." Head scales more or less outlined in black. A second specimen, No. 5381, is larger than the preceding and darker. It was taken at Nacimiento del Coy.

Masticophis flagellum testaceus (Say)

Coluber testaceus Say, *in* Long's Expedition to the Rocky Mountains, vol. 2, 1823, p. 48 (type locality, Pueblo, Pueblo County, Colorado [restricted]).

Two specimens, one a young, road-killed specimen, No. 5797, from Cerro de la Paz and a larger specimen (road-killed), No. 5393, from 15 mi. W of Ébano, are referred to this species.

Masticophis taeniatus ruthveni Ortenburger

Masticophis ruthveni Ortenburger, Occ. Papers, Mus. Zool. Univ. Michigan, No. 139, 1923, pp. 3-8, pls. 1-3, (part) (type locality, Brownsville, Texas).

In specimen No. 4204, from Bledos, San Luis Potosí, J. Graber, collector, there are seven upper labials, seemingly the second representing a fusion of the normal second and third. There are two preoculars, two postoculars, and eight lower labials present. The

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* For use of this name *fide* Dowling, Occ. P. Mus. Zool. U. Mich. no. 541, Oct. 10, 1951, p. 8.

anterior part of the preocular is partially divided. The scale formula is, 15, 15, 15 (14), 13; the ventrals, 199; the subcaudals, 137 + 1; and the anal divided. The specimen has a total length of 1300 mm., the tail, 290 mm.

A second specimen, No. 5396 from 38 km. southwest of Río Verde, shows the dorsal scales with white edges throughout the anterior half of the body. The outer fourth of each ventral is actually lateral and colored like the sides but it is separated from the other lateral color by narrow white dashes, distinct and forming a white line on the anterior fourth of the body but becoming obsolescent or obsolete more posteriorly. The ventral area of the ventrals is heavily peppered with gray pigment. The ventrals are 199, the subcaudals, 99 + 1, the anal divided.

Pituophis catenifer affinis Hallowell

Pityophis affinis Hallowell, Proc. Acad. Nat. Sci. Philadelphia, 1852, p. 181 (type locality [restricted] Zuni, New Mexico).

One specimen (No. 4369, ♂, 6 mi. E of El Huisacha), is present in the collection. The head is rather reddish tan without markings. The dark blotches are not of solid color and the intervening lighter spaces have almost every scale marked with black. Posteriorly on body the darker markings become brown while the intervening scales are lighter brown. On the extreme posterior part of the body and tail the blotches are brownish red, the scales flecked with black while the intervening scales are immaculate with a slight pinkish edging. There are 23 dark blotches on body and ten on tail.

Some short discontinuous lines are more or less evident on the scales of the anterior part of the body. The ventrals number 235, the subcaudals 56 + 1, while the scale formula is, 29, 25, 22. The total length is 1800 mm., the tail, 193 mm.

Pituophis deppei jani (Cope)

Arizona jani Cope, Proc. Acad. Nat. Sci. Philadelphia, vol. 12, 1860 (1861), p. 369 (type locality, Buena Vista, Coahuila, Mexico).

A specimen (No. 4876 from Amoles, San Luis Potosí, 5600 ft. elev., R. Graber, collector) has the head a light, reddish tan, the anterior half of the body, tan with black spots. The posterior half of the body is gray with red-brown spots. The ventrals are 220, the subcaudals 59 + 1. There are 24 dorsal body blotches, with seven on the tail.

No. 5383, ♀, Ciudad del Maiz, has the head light fawn, the light intervening blotches usually less than five scales long. The middle and terminal dark blotches are reddish brown, those on the posterior parts being edged with black. There are 30 dark body blotches.

No. 5382, ♂, 3 mi. north of Bledos, has the light anterior bands five scales long or longer, the median dark body spots red-tan becoming black posteriorly. There are 33 body blotches.

No. 5384 is a young specimen from Presa Prudentia. It seemingly agrees with the preceding specimen, save that there are 31 body blotches and certain differences due to youth.

It seems quite probable that there is some intergradation of characters of the two subspecies, *deppei deppei* and *deppei jani* since they show characters of both forms as delineated by Stull.*

Drymarchon corais erebennus (Cope)

Spilotes erebennus Cope, Proc. Acad. Nat. Sci. Philadelphia, vol. 12, 1860, p. 342 (type locality, Eagle Pass, Texas).

One specimen, No. 5392, is from Xilitla, collected by Fugler.

Dryadophis melanolomus veraecrucis (Stuart)

Eudryas boddaerti mexicanus Stuart, Occ. Papers Mus. Zool. Univ. Michigan, no. 254, 1933, pp. 8-9 (type locality, Zacuapan, Veracruz).

Two typical specimens, Nos. 5394 from 3 miles W of Xilitla, and 5395 from El Salto, are in the collection.

Spilotes pullatus mexicanus (Laurenti)

Spilotes mexicanus Laurenti, Specimen medicum exhibens synopsin reptilium, 1768, p. 83 (Mirador, Veracruz, [restricted]).

A single specimen, No. 4191, is from El Nacimiento del Coy, L. Guerrero, collector. The ventrals are 205, the anal single, the subcaudals 130 + 1. There are 8-8 supralabials, 8-9 infralabials with the fifth and seventh labials touching above the sixth. The scale formula is: 18(17), 18, 18, 12. The total length is 1900 mm., the tail, 730 mm.

Thalerophis mexicanus mexicanus (Duméril, Bibron, and Duméril)

Leptophis mexicanus Duméril, Bibron, and Duméril, vol. 7, pt. 1, 1854, pp. 536-537 (type locality, Potrero Viejo, Veracruz, Mexico [restricted]).

A specimen, No. 3200, ♂, taken at Nacimiento del Coy, has 166½ ventrals, the anal divided and the subcaudals, 88 + 1. The scale formula is: 15, 11, 11, the scales having single terminal pits.

A second specimen, No. 5808, was taken 1 mile W of San Felipe, July 27, 1952.

* U. S. Nat. Mus. Bull., 175, 1940, pp. 25-47.

Thamnophis cyrtopsis cyrtopsis (Kennicott)

Eutaenia cyrtopsis Kennicott, Proc. Acad. Nat. Sci. Philadelphia, vol. 12, 1860, pp. 333-334 (type locality, Rinconada, Coahuila); Smith, Copeia, 1951, No. 2, June 8, p. 138-140.

No. 4376 is from Presa Gonzalo Santos, 10 mi. W of San Luis Potosí, R. T. Gregg, collector, and No. 4878, is from 4.5 mi. N of Jesús María, 5900 feet elevation, R. Graber, collector. In this latter specimen, the ventrals are 171, the subcaudals 75 + 1. The scale formula is: 22, 21, 21, 19, 19. The coloration of this species is: "Head blue-gray, the median stripe orange-yellow, lateral stripe white. Dorsally olive-drab with yellow spots; gray with black spots ventrolaterally; gray-white ventrally."

This species was formerly recognized under the name *Thamnophis eques eques* (Reuss).

Thamnophis eques eques (Reuss)

Coluber eques Reuss, Abh. Senck. Mus., 1834, pp. 152-155, pl. 8, fig. 2 (type locality, El Limón, Totalco, Veracruz [restricted]); Smith, Copeia, 1951, no. 2, June 8, pp. 138-140, pl. 1.
Thamnophis subcarinata subcarinata Smith, Herpetologica, vol. 5, 1949, p. 64 (type locality, Guadalajara, Jalisco).
Thamnophis macrostemma macrostemma Smith and Taylor, U. S. Nat. Mus. Bull., 187, 1945, p. 163.

The unfortunate mix-up in names used for this species has been the result of a misinterpretation of the identity of the snake described by Reuss. Many authors have confused it with the snake here called *Thamnophis cyrtopsis cyrtopsis* (Kennicott).

The following specimens are in the collection: Nos. 4196, 4374, 4375, 5403, 5406, Laguna de las Rusias; No. 4870, 4 miles west of Bledos (young); No. 4879, Bledos, 6200 ft. elev.; No. 5408, Presa Prudentia.

The underside of the tail is much lighter than the ventral coloration of belly, having in life a distinctly pink color.

Thamnophis melanogaster canescens Smith

Thamnophis melanogaster canescens Smith, Zoologica, vol. 27, 1942, pp. 117-120 (type locality, Chapala, Laguna de Chapala, Jalisco, Mexico).

The following specimens are in the collection: Nos. 4377, 5397, 5402, 5404, 5405, Laguna de las Rusias; No. 4378, Presa de San José; No. 4379, Presa Gonzales Santos, 10 mi. SW of San Luis Potosí; No. 4877, Villa de Reyes, Laguna de las Rusias, 6000 ft. elev.; Nos. 5407, 5409, Presa Prudentia.

In No. 4377, ♂, small whitish dots or dashes are evident in rows on the upper edges of the third and fourth rows of scales. These may be largely on the skin between the scales, but a portion of the white covers the edge of the scale. On the sixth and seventh rows, small lighter dots are evident when the skin is stretched. The stomach of this specimen contained 12 small fish. The scale-row formula is 23, 17, 17. The ventrals are 149, the subcaudals 61. The specimen has a total length of 828 mm., the tail, 144 mm.

Nos. 4378 and 4379 are young. Each has a well-defined light line on the second scale-row. The first scale-row is light with two black spots on each scale. In these the loreal enters the eye below the single preocular.

Thamnophis phenax Cope

Eutaenia phenax Cope, Proc. Acad. Nat. Sci. Philadelphia, vol. 20, 1868, p. 134 (type locality, Córdoba, Veracruz).

A specimen of this species (No. 4198 ♂), was taken on Cerro Conejo, June 16, 1951. The specimen, while much discolored by formalin, shows clearly the black edges on the 50 dorsal blotches separated by a narrow lighter area one scale-length wide. The ventrals are 163, the subcaudals 74 + 1. There were but 36 blotches in the type of the species.

Thamnophis sirtalis proximus (Say)

Coluber proximus Say, *in* Long's Expedition to the Rocky Mountains, vol. 1, 1823, p. 187 (type locality, 3 mi. above mouth of Boyer's River, Washington County, Nebraska).

A specimen, No. 4205, was taken near Valles. The median dorsal stripe is obsolete. The scale rows are 19, 19, 17, the ventrals 152½ and the subcaudals 92. These counts place the specimen very close to the subspecific form *chalceus* and a series might demonstrate that the two forms actually intergrade in eastern San Luis Potosí.

Thamnophis halophilus Taylor

Thamnophis halophilus Taylor, Herpetologica, vol. 1, 1940, pp. 183-187, pl. 19, text fig. 1 (type locality, seven mi. N of Zacualtipan, Hidalgo).

A specimen, No. 4199, from Cerro Conejo, Llano Chico, 7600 ft., is referred to this species.

A series of lateral spots, and a series of median spots are present. Farther back, at the beginning of the second fourth of the body, are two paired series of spots on each side. Sometimes those of the upper series are contiguous or fused (more frequently not). The skin between spots is white in life. The chin is light and there are light areas on the labials below the eyes. Ventrals number 158, the subcaudals 65. The scale-row formula is: 23, 19, 19, 19, 17. One preocular and three postoculars are present. There are 8-8 supralabials, and 9-9 infralabials.

The finding of *Thamnophis phenax* Cope and *Thamnophis halophilus* on the Cerro Conejo suggests that these forms do not bear subspecific relationship to each other as is presumed in the Smith-Taylor Checklist of Snakes. Consequently I revert to the binomial forms for these names.

Leptodeira annulata septentrionalis (Kennicott)

Dipsas septentrionalis Kennicott, *in* Baird, Rep. U. S. Mex. Bound. Surv., vol. 2, 1859, Rept., p. 16, pl. 8, fig. 1 (type locality, Brownsville, Texas [restricted]).

A specimen, No. 5380, from Luna Media, has 29 quadrangular bands covering some scales of the first row. There are 15 tail bands. Anteriorly the ventral pigmentation is confined to the outer edges of the ventrals, but on the posterior fourth of the body it pushes more toward the middle of the scales. The subcaudals are sprinkled rather thickly with gray pigment. The light bands between black bands dorsally, rarely are as wide as two whole scale lengths. These bands widen a little laterally, and have but little pigment. The nuchal band has some pigment and a median, narrow, elongate, black spot.

Leptodeira annulata taylori Smith

Leptodeira annulata taylori Smith, Proc. Biol. Soc. Washington, vol. 54, 1941, p. 115 (type locality, Orizaba, Veracruz).

One specimen of this form (No. 4872) was taken at La Joya, 5 km. W of Aquismon, 2500 ft., J. Graber, collector. The specimen gives the following scale data: ventrals, 194; anal divided, subcaudals, 84 + 1; two preoculars, two postoculars; upper labials, 8-8; lower labials 10-10; temporals, 1 + 3 (1 + 2); scale formula, 21, 21, 23, 17, 16. Thirty-four dark spots on body, 21 on tail; bands on body not reaching to ventrals; no light lines bordering head scales; venter with some scattered pigment usually bordering posterior edge of each ventral; heavily pigmented under tail.

Leptodeira maculata (Hallowell)

Megalops maculatus Hallowell, Proc. Acad. Nat. Sci. Philadelphia, vol. 12, 1860 (1861), p. 468, (type locality, 5 mi. E Jalapa, [restricted]).

One specimen (No. 4201) is from Nacimiento del Coy, collected April 27, 1951, by L. Guerrero.

The ground color is dark brown, not strongly contrasted with the black blotches except on the median dorsal line, where one or more scales between spots may be entirely lacking in pigment.

There are approximately 27 dorsal blotches, none reaching the ventrals laterally, and 12 on the tail. Some of the blotches are confluent dorsally, with a complete fusion of two on one side and a separation on the other. The gray-white borders of the posterior head scales (parietals, supraoculars and frontal) are evident. The venter is immaculate. A second specimen (No. 4873 ♀) taken at Rancho Sabinal, 200 ft. elev., Nov. 10, 1951, by R. Graber, has the following characters: upper labials, 8-8; lower labials, 10-10; ventrals, 174; anal divided; subcaudals, 54 + 1; scale formula, 23, 23, 23, 19, 19. Color above dark brown with 26 black body bands and about 8 caudal bands, separated by orange-tan areas; ventrally orange-white on body and tail; some pigment spots on outer edges of certain subcaudals. A few of the blotches are confluent. Head scales partly edged with white, outer edge of parietals strongly so. Dark blotches reach to the first scale row.

A specimen, No. 5384, from El Salto, has 25 bands on body and eleven on the tail; the light neck-band is narrow, two to three scales wide, the borders parallel. The venter is immaculate. The head scales are faintly outlined with lighter color.

Coniophanes imperialis imperialis (Kennicott)

Taeniophis imperialis Kennicott, *in* Baird, Rep. U. S. Mex. Bound. Surv., vol. 2, 1859, Rept., p. 23, pl. 19, fig. 1 (type locality, Tamaulipas).

No. 5386, from Nacimiento del Coy was collected July 16, 1952. The characteristics of the subspecies *imperialis* are clearly defined, especially in the details of color and markings. The ventrals are 135. The tail is missing. The subspecies is known from Texas, southward, along the eastern lowlands, to Jalapa, where it seems to intergrade with *C. imperialis clavatus* (Peters).

Coniophanes fissidens proterops Cope

C[oniophanes] proterops Cope, Proc. Acad. Nat. Sci. Philadelphia, vol. 12, 1860, p. 249 (type locality, vicinity of Jalapa, Veracruz).

A specimen from El Salto (No. 5385), collected by Fugler is somewhat atypical. The head is dark gray, the labials light bordered above by a narrow cream line which in turn is bordered with black above, that extends to back level of the head. A gray median stripe covers three whole scale rows and edges of adjoining scales. The median row has a series of black dots visible to near end of body. The scales on sides of body are lighter, without dark or light stripes. Supra- and infralabials finely punctate with black, a distinct row of diminutive dots on the outer edges of ventrals, with other equally large flecks scattered sparsely on venter, but growing less, posteriorly. There is some trace of a light lateral caudal line darker bordered above and below. The subcaudal area is immaculate. The supralabials, 7; infralabials, 8; ventrals, 129; subcaudals, 74 + 1.

Crotalus triseriatus triseriatus (Wagler)

Urosophis triseriatus Wagler, Natürliches System der Amphibien, 1830, p. 176, (type locality, Álvarez, San Luis Potosí [restricted]).

The following characters obtain in No. 4882, Ahuacatlan, 5800 ft. elev.: ventrals 155, subcaudals 29 (1st divided, 2nd-19th single, 20th-27th divided, 28th single, 29th divided). Scale formula: 26, 23, 23, 19, 17; upper labials, 12-12, two touching the subocular; lower labials, 11-11. Anterior nasal near twice size of second; apical pits discernible on many scales. "Olive with red-brown markings; belly orange; iris yellow-orange"; no line present from eye to angle of mouth.

Crotalus triseriatus (melanistic form)

Two specimens are in the collection. The first, No. 4881, from 6 mi. W of Ahuacatlan, Aug. 3, 1951, has the following characters: ventrals 199, subcaudals 24 (1st divided, 2nd to 20th single, 21st to 24th divided), scale formula: 26(27), 23, 23, 19, 19; supralabials 12-12; infralabials 11-12; anterior nasal only about one and one-half times posterior; four rattles and a button present. Dorsally blackish with brown spots; orange near tip of tail; ventrally almost uniformly steel gray; white markings near head.

The second specimen, No. 4884, 6 mi. W Ahuacatlan, October 5, 1951, 5400 ft. elev., R. Graber, coll., has the following characters: 154 ventrals, 22 subcaudals (1st divided, 2nd to 13th undivided, 14th to 21st divided); scale formula: 27, 23, 23, 19, 17(18).

Both snakes contained partly digested specimens of *Sceloporus* (not identified).

Crotalus atrox Baird and Girard

Crotalus atrox Baird and Girard, Catalogue of North American Reptiles, 1853, pp. 5-6 (type locality, Indianola, Calhoun Co., Texas).

This species is represented by a single small specimen, No. 4883, taken at Pozo del Carmen, 5600 ft. elevation, Aug. 30, 1951, by Jean Graber. The specimen has 181 ventrals and 20 subcaudals, the terminal one divided. A button represents the rattle. The scale formula is: 23, 23, 23, 23. Blackish bands on body number 32. There are four on the tail.

LORICATA

Crocodylus moreletii Duméril and Bibron

Crocodilus moreletii Duméril and Bibron, Catalogue methodique de la collection des reptiles, 1851, p. 28 (type locality, Lake Petén, Guatemala).

Three specimens, Nos. 4371-4373 from Tanchachin, near Aquismón, R. T. Gregg, collector, are in the collection. The three specimens measure from 482-515 mm. in total length; snout-to-vent length (greatest) 245 mm. This is the first published record for the State.

COLLECTING LOCALITIES

The map below gives most of the collecting localities mentioned in the text.

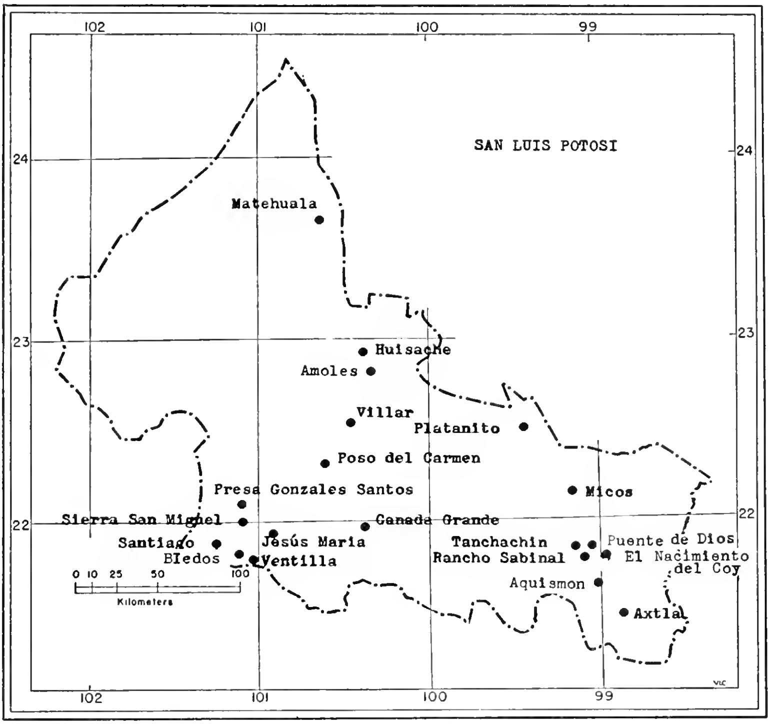

FIG. 1. Map of San Luis Potosí showing collection localities.

Amoles	22° 49′ N; 100° 20′ W
Aquismon	21° 38′ N; 99° 00′ W
Axtla	21° 27′ N; 98° 52′ W
Bledos	21° 49′ N; 101° 07′ W
Cañada Grande	21° 58′ N; 100° 23′ W
El Nacimiento del Coy	21° 47′ N; 98° 58′ W
Huisache	22° 55′ N; 100° 23′ W
Jesús Maria	21° 56′ N; 100° 54′ W
Matehuala	23° 39′ N; 100° 38′ W
Micos	22° 08′ N; 99° 10′ W
Platanito	22° 30′ N; 99° 26′ W
Poso del Carmen	22° 19′ N; 100° 37′ W
Presa Gonzales Santos	22° 06′ N; 101° 06′ W
Sabinal	21° 45′ N; 99° 06′ W
Santiago	21° 53′ N; 101° 15′ W
Sierra San Miguel	22° 00′ N; 101° 05′ W
Tanchachin	21° 50′ N; 99° 09′ W
Ventilla	21° 47′ N; 101° 02′ W
Villar	22° 32′ N; 100° 28′ W

The following localities visited by Mr. Charles Fugler are not on the map.

Presa Prudentia. A reservoir about 4 miles N of Bledos on the road to Bledos.

La Luna Media or Media Luna. A large, spring-fed area of deep lagunes, with intertwining creeks, approximately 8 miles SE of Río Verde.

38 Km. SW of Río Verde. This locality is in the mountains to the SW of Rio Verde. The distance is approximate. While in the area, we stayed at a logging camp. I can best characterize the region as one of magnolias and pines.

El Abra. A small village on the Valles-Tampico highway.

Rio Claro. 6 kms. E of Tamazunchale.

San Felipe. 1 mile W. A small village on the Valles-Tampico highway.

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A Report on a Collection of Ceylonese Serpents

BY

EDWARD H. TAYLOR

ABSTRACT.—This is a study of a collection of serpents from Numunukula, Ceylon made by Mr. W. W. A. Phillips. While several presumed new forms are pointed out none are described as new since the author has not been able to examine described types of related forms.

A well-preserved collection of reptiles and amphibians, recently received as a gift from Mr. W. W. A. Phillips, Esq., the well-known mammalogist of Namunukula, Ceylon, contains numerous interesting species.

The specimens were taken by Mr. Phillips on the Tonacombe Estates in the Uva Hills, Uva Province, Ceylon, at elevations between 3000 and 4500 feet. Altogether there are 61 specimens, distributed as follows: 22 snakes, 34 lizards, and 5 amphibians.

In this paper I am reporting on the snakes of the collection. The lizards are being treated elsewhere in a paper dealing with the Ceylonese lizard fauna, and the amphibians in a similar paper dealing with the total amphibian fauna.

I take this opportunity of expressing my gratitude to Mr. Phillips.

Pseudotyphlops philippinus (Cuvier)

Uropeltis philippinus Cuvier, Règne animal, distribué d'apres son organization, 2nd ed., vol. 2, 1829, p. 76 (type locality, "Philippines"). Wagler, Natürliches System der Amphibien, 1831, p. 194-195; Griffith, The Animal Kingdom arranged in conformity with its organization by the Baron Cuvier, vol. 9, p. 251 (footnote); Müller, Tiedemann und Treviranus Zeitschr. für physiol. Heidelberg, 1832, vol. 4, pp. 248-252, pl. 22, figs. 2, 3; pl. 21, figs. 4, 5; Gervais, Guérin, Magasin Zool. 1837, Cl. 3, pl. 13; Schinz, Naturgesch. Abbildung, Rept., 1833, p. 132; Duméril and Bibron, Erpétologie Générale, vol. 7, pt. 1, 1854, pp. 160-165, pl. 59, fig. 2, head, and 2A, tail (this contains a detailed description of the type specimen). Peters, De Serpentum Familia Uropeltaceorum, Berlin, 1861, p. 20 (places in synonymy *Uropeltis Saffragamus, U. pardalis,* and *U. grandis,* three species described by Kelaart, Prodromus Fauna Zeylanicae, vol. 2, pt. 1, 1853 (1854), pp. 15-16.)

Pseudo-typhlops philippinus Cuvier, Abbildungen neuer . . . Amphibien 1838, p. 44; Gervais, Voyage de la corvette, Favorite, vol. 5, p. 66, pl. 26; Tennent, Sketches of the Natural History of Ceylon . . . London, 1861, pp. 302-303, unnumbered figure.

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Uropeltis grandis Kelaart, Prodr. Faunae Zeylanicae, 1854, vol. 2, p. 15; Günther, The Reptiles of British India, 1864, p. 188; Beddome, Ann. Mag. Nat. Hist., ser. 5, vol. 17, 1886, p. 9; Boulenger, The Fauna of British India, Including Ceylon and Burma; Reptilia and Batrachia, 1890, p. 254; Catalogue of the Snakes in the British Museum (Natural History), vol. 1, 1893, p. 139; Green, Spolia Zeylanica 1906, p. 220; Wall, Ophidia Taprobanica, or the Snakes of Ceylon, 1921, p. 26; Journ. Bombay Nat. Hist. Soc., vol. 29, 1923, p. 354.

Uropeltis saffragamus Kelaart, Prodr. Faunae Zeylanicae 1853 (1854), p. 15 (type locality Ratnapoora near Adam's peak, Ceylon).

Uropeltis pardalis Kelaart, Prodr. Faunae Zeylanicae 1853 (1854), p. 15 (type locality, Matura, Ceylon); Gray, Proc. Zool. Soc. London 1858, pp. 263-264.

Pseudotyphlops philippinus Smith, The Fauna of British India, including Ceylon and Burma; Reptilia and Amphibia, vol. 3, Serpentes 1943, pp. 93-94, fig. 27.

The genus *Pseudotyphlops* has been considered by most writers as monotypic. Kelaart, *loc. cit.*, described three forms, that since 1861 have been placed in the synonymy of *philippinus;* or the three have been regarded as a single species under the name *grandis.* In 1861, Tennent (*loc. cit.*) suggested that *Uropeltis grandis* Kelaart (including *pardalis* and *saffragamus*) and *Uropeltis philippinus* Cuvier were synonyms, but this was disregarded for the most part until Smith (1943, *loc. cit.*) placed them under the older name. Smith makes no comments on the Kelaart species save to place them in synonymy.

Of the three forms described by Kelaart, the types of two, *U. pardalis* and *U. grandis* are in the British Museum. The type of *U. saffragamus* is presumably lost.

I regard it as probable that more than a single species (subspecies?) occurs in Ceylon and an examination of the described forms becomes necessary to ascertain which name must apply to which form. Since the descriptions are brief I am repeating them here. The material available to me does not permit a solution of the problem.

Uropeltis saffragamus

Head dark olive brown, the rest of the upper surface of a blackish brown color with bluish bronze reflections. Beneath white. A pale white spot on each side of the neck near the head. Tail deeply truncated and nearly covered with a large, flat, circular, blackish, granular shield, white and rounded beneath, and with the lower part covered with five series of small scales; the central series broader than the lateral ones, vent shields, 1-2. The neck and forepart of the body thicker. Length 9 inches.

District of Saffragam, near Adam's peak. The only specimen of this species which I have seen, is one sent by Mr. Barnes de Zilva from Ratnapoora.

Uropeltis pardalis

Head small dark olive, upper parts black with beautiful bronze reflections irregularly spotted white. Beneath yellowish white marked with large and small black spots, variously shaped; some spots pale eyed. Tail very short obliquely truncated, with a large flat orbicular granular shield. Length 6¼ inches. Circumference ¾ inches. Habitat, Matura.

I am indebted to the Rev. Mr. Ondaatje for the only specimen I have examined of this species. The black spots on the lower parts occupy more than one scale, generally two or three contiguous scales, and they are placed without any order in various directions. The chin and throat are immaculate.

Uropeltis grandis

Above dark brown with a bluish metallic lustre; anterior part of each scale with a blackish spot. Beneath a pale yellow color, spotted brown on the anterior part of scale. Head of a light olive brown color. Tail short, abruptly truncated, the truncated surface entirely covered with a larger circular granular shield. Vent scales 1-2.

Total length above I foot 7 in.; length below 1 ft. 8 in. Tail shield nearly the size of a shilling piece. Head, 8/10 inch in length; greatest circumference near neck, 2¾ in. Habitat Southern Province.

The only specimen I have seen of this very large rough tail, is one procured by Mr. Balkhuysen of the Colonial Medical Service, from Kerinday, near Matura, Ceylon.

The description given for *Uropeltis pardalis* seems to approach more closely to the description of the type specimen of *philippinus* (as presented by Duméril and Bibron, Erpét. Générale vol. 7, pt. 1, pp. 160-165).

While the dorsal head scales seem to agree in their proportions and relationships there are differences in the labials and the scales on the chin.

Flower, *loc. cit.*, p. 24, fig. 7, gives a figure showing the squamation of the chin; there is no undivided postmental and the first chinshields are regular both touching the mental.

In the specimens at hand three have the first pair of chinshields present, only the one on the left, in contact with the mental. In No. 31248, there is an undivided postmental. The subcaudal scales of males are more numerous and there is some difference in the character of scales about the vent.

No. 31250 has 5 lower labials, No. 31251 has five on one side, four on the other. In Nos. 31248 and 31249 the labials are 4, the second one being normally much larger than in Nos. 31250 and 31251.

The squamation of the head is remarkably similar in the two color forms. The following characters obtain:

Rostral forming a terminal cap on snout, dorsally extending back between nasals and partially dividing them; no internasals; suture of nasals somewhat longer than that between prefrontals; frontal six-sided, its length equal to dorsal length of rostral or length of parietal, not equal to its distance from end of snout; common parietal suture about equal to the prefrontal suture; no anterior temporal; ocular scale as high as long; the diameter of eye a little less than half length of ocular; nostril in lower anterior corner of nasal; no undivided postmental except in No. 17, a young specimen; ventral length of rostral less than dorsal length; rostral extending 2.7 mm. beyond mouth.

There is rather little variation in the character of the head scales. In No. 31249 the snout region of the head is somewhat broader than in Nos. 31250 and 31251.

Two of these Nos. 31248 and 31249 conform to the color description of *U. philippinus* and *U. pardalis* Kelaart (See Duméril and Bibron *loc. cit.* and fig.) and two Nos. 31250 and 31251 belong to the form described as *U. grandis.*

The description of these follow:

In No. 31249 ♀, the general color is deep, iridescent lavender with a darker area on each dorsal and lateral scale. The three ventral scale-rows together with the median ventral series are distinctly lighter than the dorsum, each scale, save on chin and neck, with an indefinite darker area. A paired series of darker spots (occasionally alternating or fused together) are on the ventral surface. A prominent, yellow, curving spot borders the lower part of the terminal plate border, and the labials, at least the lower part of the labials, are light colored. Length 345 mm.

A young specimen, No. 31248 ♂, measuring only 148 mm. is black above with a bluish iridescence. There is a scattering of very numerous yellow dots, no larger than a single scale, usually single but occasionally on sides suggesting narrow, irregular, transverse lines. The ventrals and three adjoining scale-rows are greenish white with numerous black spots scattered over the venter. There is no tendency to form transverse black bands, and there is no sharp line of demarkation between the dorsal dark ground and the ventral light coloration; chin and throat immaculate; labials whitish.

Nos. 31250 ♀ and 31251 ♀ measure 318 mm. and 360 mm., respectively. They are brownish above with dark markings on all scales above and below, the ventral ground color is lighter than the dorsal but the lighter areas are very indefinite and the spotting such as occurs in the preceding two specimens is absent.

Data on *Pseudotyphlops philippinus*

Number and sex	Elev. in ft.	Ventrals from mental	Subcaudal pairs	Scale rows	Length in mm.
31248 ♂	3000	140	9	22 19 19	148
31249 ♀	2000	149	6	23 19 19	345
31250 ♀	2000	144	4	22 19 19	318
31251 ♀	2000	146 anal 2	4	22 19 19	360

Since the four specimens here listed are from the same general locality, the variation cannot be regarded as geographic. Whether two forms actually are represented cannot be determined from the material at hand.

Lycodon aulicus (Linnaeus) (*var.*)

The genus *Lycodon* is known to be represented by at least three species in Ceylon. These are *Lycodon aulicus* (Linnaeus), *Lycodon osmanhilli* Taylor, and *Lycodon striatus* (Shaw)* The first two species are characterized by having angular ventral scales and nine upper labials; the third species lacks the angular scales and has only eight upper labials.

From the large synonymy of *Lycodon aulicus* presented by Boulenger † and Smith ‡ one suspects that certain of the names probably represent forms worthy of subspecific (or perhaps even specific) designation, more especially since certain of these differences presumed to be individual variation occur throughout a wide range in India and Ceylon. Series of specimens from the same locality are of course necessary to ascertain the degree of differentiation. In the collection at hand there are two specimens of *Lycodon* from southern Ceylon having a different general appearance from those at hand taken in the region north of Trincomalee § in the lowlands. With adequate material it may be possible to recognize a named form for southern Ceylon. Whether this is new, or is an Indian form extending into Ceylon cannot be stated here.

No. 31232, ♂: The following scale and color characters obtain: the ventrals, 194; anal single, (partly divided anteriorly, undivided posteriorly); subcaudals, 29 + 1; scales smooth, with a single apical pit, the outer row largest; scale formula: 17, 17, 17, 15, 15; supralabials, 9-9, the first not in contact with loreal; infralabials, 10-10, five touching first chinshields, which are scarcely as large as first lower labial; third, fourth, and fifth upper labials enter eye; preocular touches frontal; one preocular and two postoculars; frontal length less than its distance from middle of internasals; prefrontals angular laterally; internasals rounded laterally; diameter of eye, 2 mm.; distance from eye to nostril, 3.65 mm.; eye to level of tip of snout, 5 mm.; above violet-brown banded with cream becoming lighter laterally. A nuchal band separated from the first light body

* In Univ. Kan. Sci. Bull. vol. 33, pt. 2, 1950, p. 562. The scale data given under *Lycodon striatus* applies to the young paratype of *Lycodon osmanhilli* and not to this species.

† Boulenger, Cat. Snakes Brit. Mus. vol. 1, 1893, p. 325.

‡ Smith, Fauna Brit. India. Rept. and Amph. vol. 3, Serpentes 1943, p. 263-264.

§ Taylor, Univ. Kans. Sci. Bull., vol. 33, pt. 2, 1950, pp. 560-562, pl. 19, fig. 2.

band by a broad darker band covering 36 transverse scale rows; first transverse light band 3 scales wide dorsally to 5½ scales wide where it borders the ventrals; between the first and second light bands a dark band covering 36 scale-lengths; between second and third light bands (barely indicated laterally) a darker band covering 31 scale-lengths; venter white, the pigment encroaching on the ventrals slightly; scales of white bands each with some pigment.

No. 31233 ♀: This specimen has the following characters: ventrals, 196; anal divided; subcaudals, 60 + 1; scale formula: 17, 17, 17, 15, 15 (14); supralabials, 9-9; infralabials, 10-10; head scales as in specimen above; the preocular touches frontal. The color is similar to the above but it is slightly more brownish. The dark band between the neck band and first light body band, is 30 scale-lengths wide; that between the first and second light bands, 23 scale-lengths; that between the second and third light bands, 26 scale-lengths; that between third and fourth light bands, 19 scale-lengths (latter scarcely evident); there is no band of white around the snout on the upper labials, the labials being slightly lighter than scales on top of head.

Oligodon sublineatus Duméril, Bibron and Duméril

Oligodon sublineatus Duméril, Bibron and Duméril, Erpétologie Générale, vol. 7, pp. 57-58 (type locality, Ceylon).

One small specimen (No. 31242), bearing the typical coloration and markings, has 142 ventrals, the anal divided, and the subcaudals 32 + 1. On the left side, the sixth labial is excluded from the labial border. There are seven upper and seven lower labials present. The scales are smooth, a few scattered ones having single apical pits. The scale formula is 17-15-15.

The narrow diagonal lines from the fourth and fifth labials to the prefrontals are narrowly separated mesially. An elongate symmetrical light-edged mark extends from the posterior third of the frontal to a point two scale-lengths behind parietals. A pair of lateral, nuchal spots are present. Anteriorly the dark blotches on each side alternate with their fellows, and there are three rows of ventral dots or dashes, the outer ones being more nearly continuous than the inner.

Aspidura brachyorrhus * (Boie)

Scytale brachyorrhus Boie, Isis von Oken, 1827, p. 517, (type locality, Ceylon).

A female specimen, No. 31238, from Tonacombe has the following characters:

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* This name is incorrectly spelled *brachyorrhos* by Taylor (1950).

Ventrals, 149; subcaudals, 28 + 1, all divided; anal single; scale formula: 17, 17, 17, all rows smooth without keels; supralabials, 6-6; infralabials, 6-6; one preocular, two postoculars, both touching the parietal; temporals, 1 + 2; frontal hexagonal, distinctly longer than its length from tip of snout; parietals longer than their distance from tip of snout; rostral small, only slightly visible above, the head much narrowed at tip; first chinshields two and one-half times larger than the second chinshields; upper secondary temporals large; median scale following parietals also enlarged; no loreal, the prefrontals touching the second and third labials, the fourth labial alone entering orbital ring; eye small, its diameter into distance between eye and nostril, 2.2 times. Dorsally rather light fawn, the pigment varied so that a lighter stripe, covering much of the fourth and fifth rows, is discernible from the neck band to end of tail; the three outer scale-rows with scattered black pigment, darkest along the edge of the fawn stripe; median dorsal row with a little less pigment than three adjoining rows, and bearing a black spot on each fourth or fifth scale, the series extending to end of tail; a few irregular black spots on sides of neck and anterior fifth of body. Head darker anteriorly, growing light on outer posterior part of parietals and secondary upper temporal; a pair of black, nuchal spots bordered front and back by lighter color behind angles of the jaws; a median, spear-shaped, black mark from parietals extending back six scale-lengths, the three spots nearly contiguous; labials largely cream with black areas; ventrals nearly immaculate, with only an occasional fleck of pigment on their outer edges.

There is a very young specimen (No. 31238[a]) of this species in the collection, that shows no significant differences from the one described.

Haplocercus ceylonensis Günther

Haplocercus ceylonensis Günther, Catalogue of the Colubrine Snakes in the British Museum, 1858 (Feb. 12, 1859), p. 15 (type locality, Ceylon).

Two specimens are in the collection of which the first No. 31236 has the following characters: one preocular, two postoculars; scale formula, 17, 17, 17, the scales (except on the anterior fourth of body, which is smooth) strongly keeled to tip of tail; supralabials, 6-6; infralabials, 6-7; second pair of chinshields less than one half (near one third) of first pair; three or four lower labials, touching the first chinshields; ventrals, 167, the penultimate divided; anal single; subcaudals, 47 + 1, single. Head brownish followed by a somewhat irregular, darker collar; usually a series of dark dots, separated by three scale-lengths, are discernible on each side of the body throughout its length; posteriorly they are discernible only with difficulty since the body color is also dark; anterior part of ventral surfaces cream while gradually merging into pink or salmon-pink at the beginning of the second fourth of the body; subcaudal region magenta.

No. 31237. In the second specimen, taken at 4500 ft., 25 May, 1951, there is a distinct lighter band preceding the dark nuchal band; labials and first temporals cream, the sutures edged with dark; two or three light spots on sides of neck. The posterior two thirds of body salmon-pink. The row of dark spots along the sides of the body can be discerned with difficulty.

Dryophis nasutus (Lacépède)

Coluber nasutus Lacépède, Histoire Naturelle des Serpents, vol. 1, p. 100, vol. 2, p. 277, plate 4, fig. (type locality, Ceylon [restricted]).

One typical specimen No. 31239 from 4000 feet elevation, is present in the collection. The ventrals are 182, the anal divided, and the subcaudals are 154. The color is uniform dark green above, while below it is yellow green with a pair of cream lines on the outer sides of ventrals.

Natrix stolata stolata (Linnaeus)

Coluber stolatus Linnaeus, Systema Naturae, 1758, 10th ed. p. 219, (type locality, Asia).

A specimen in the collection, No. 31252, has the following characters: scale formula, 19, 19, 17; ventrals, 120; subcaudals, 72; anal divided; supralabials, 8-8; infralabials, 10-10; preocular, 1, not reaching frontal; postoculars, 3; temporals, 1 + 2 + 3; 3rd to 5th labials enter orbit; four lower labials touch first chinshields, which are (presumably abnormally) transversely divided; eye large, its diameter equal to its distance from nostril; frontal longer than its distance from tip of snout; shorter than the parietals.

Head scales largely edged with black; two yellow bars, one in front, one behind eye on side of head, each bordered by black bars; venter and under side of tail, chin and throat immaculate.

Boiga ceylonensis (Günther)

Dipsadomorphus ceylonensis Günther, Catalogue of the Colubrine Snakes in the collection of the British Museum, Feb. 12, 1858 (1859), p. 176 (type locality, Ceylon); Reptiles of British India, 1864, p. 314, pl. 23, fig. B.

Two female specimens, No. 31240 and No. 31241 are in the collection. These specimens have the following characters: Internasals as long as broad or a little longer; prefrontals nearly a half broader than long, and longer than internasals; frontal one-fifth or one-sixth longer than broad, its length greater than its distance from the tip of the snout; loreal quadrangular, a little higher than long; preocular single, high, narrowly separated from frontal (or touching); two postoculars; temporals (respectively) 2 + 4 + 4; 2 + 3 + 4; upper labials, 8-8, 8-8; lower labials, 11-12, 11-11, five or six lower labials touching first chinshields; scale formula, 19, 19, 19, 15; 19, 19, 18, 13 (in this latter specimen, the median dorsal scales becoming very large where the rows reduce to 13); ventrals, 224, 222; anal, 1, 1; subcaudals 107 + 1, 98 + 1.

There are some indefinite flecks or spots on the interorbital area and on snout; a pair of symmetrical spots with somewhat lighter, brownish centers on parietals; a black line, beginning behind eye, extends back, narrowing on the eighth labial, then widening a little and terminating behind jaw angle; a median series of dark blotches, 58(59) from occiput to vent; some twenty indefinite spots discernible on tail; on sides an equal number of rather indefinite dark marks alternating with the median series and below these is another series alternating with the preceding and opposite the median series that extends onto edges of ventrals. Venter dirty white with an indefinite row of small spots or flecks on each side, and with finer flecks or peppering over the ventrals, least dense on neck region, most dense under tail. One of the specimens No. 31241 had the remnants of a green *Calotes* in its stomach but I could not identify the species with certainty.

Boiga trigonata (Schneider)

Coluber trigonatus Schneider *in* Bechstein (Lacépède, Histoire Naturelle des Serpents, vol. 4, 1802, p. 256, pl. 40, fig. 1 (type locality, Vizagapatam, India (Based on Russel).

This specimen, (No. 31234), has the following characteristics: Scale formula: 23, 21, 21, 17, 17; ventrals, 237; anal, 1; subcaudals, 85 + 1; preoculars, 2; postoculars, 2; labials, 8-8; lower labials, 11-11; temporals, 3 + 3 + 4; scales of median row nearly a half larger than adjoining scales; upper head triangular with a pair of grayish lines beginning on supraoculars and extending from supraocular back to angle of mouth; bordering these on their inner edge, is a pair of grayish brown, darker-edged stripes that run forward and join the gray-brownish color of the snout and area in front of eyes; these stripes are separated by a narrow gray stripe running from the posterior level of eyes to the ends of the parietals where the line forks and runs back behind the mouth angles inclosing a somewhat arrow-shaped, brownish, darker-edged spot on the nape. Body generally gray-brown with approximately 59 narrow, transverse, light gray bands edged with black. The black becomes more important and may cover nearly a whole scale row as does the lighter color; spots resulting come to alternate and the bands may join a median light line that extends the greater part of length of body; on the lower body scales and outer edges of ventrals there are numerous small blackish dots rarely appearing near the mid-ventral part of venter.

Bungarus ceylonicus Günther

Bungarus ceylonicus Günther, Reptiles of British India, 1864, p. 344 (type locality, Ceylon).

A specimen (No. 31230) has the head somewhat mutilated and certain scale characters are obscured. The ventrals are 132, the anal single, the subcaudals 33 + 1. The color is black above with 18 whitish bands on the body and four on the tail. These bands are narrowed dorsally to a width of 2 to 2½ scales, but widen on the sides and on the venter to a width of four, more rarely five, ventral scales. Ventrally the intervening black areas are usually six scales wide, the ventrals involved in most cases still having some white color remaining. The black ventral markings are not present in the young, but they become increasingly important in older specimens. The first white band is separated from the head by approximately 20 black scale-rows. The first two white bands involve 10½ and 8½ ventrals respectively.

Agkistrodon hypnale (Merrem)

Cophias hypnale Merrem, Syst. Amph., 1820, p. 155 (type locality, Ceylon).

The five specimens in the collection, Nos. 31343-31347, are from Tonacombe. The ventral and subcaudal scale-counts of these are, respectively:

31343 ♂	155 ventrals	43 subcaudals
31344 ♀	153	35
31345 ♀	151	35
31346 ♀	149	35
31347 ♀	148	36

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Frogs of the Family Centrolenidae from Brasil

BY

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ABSTRACT.—This paper treats of the frogs of the genus *Cochranella*, family Centrolenidae, that are known to occur in Brasil. Twelve species are recognized, of which nine are regarded as new and described under the names, *Cochranella surda*, *C. petropolitana*, *C. lutzorum*, *C. delicatissima*, *C. bokermanni*, *C. divaricans*, *C. dubia*, *C. vanzolinii*, and *C. albotunica*. The Brazilian species, *Hylella parvula* Boulenger, *Hyla* (*Hylella*) *eurygnatha* A. Lutz, and *Hyla* (*Hylella*) *uranoscopa* L. Müller are referred to the genus *Cochranella* and the family Centrolenidae since all have the bones of the tarsus fused into a single bony shaft, similar to the tibio-fibula of all Salientia.

INTRODUCTION

For several years, as time permitted, the junior author has been preparing a report on the frogs of Brasil, but in this work she has omitted discussion of a group of small species occurring in Brasil, that in the past have been regarded as having an uncertain family relationship. Since the frogs of this group have been of especial interest to the senior author she has proposed that they be treated and published in a separate paper by the two of us.

Probably least known in the Brazilian amphibian fauna is this group of tiny frogs (28 mm. maximum snout-vent length in known Brazilian species), arboreal in habit, generally encountered clinging close to leaves of herbs and trees usually in the immediate vicinity of running water. Eggs in some, if not all, species are placed on leaves above water, the young hatching and falling into the water to continue their development.

In life most of the known species of the group are green above, the transparent flesh on the ventral surfaces permitting a fairly clear view of part of the viscera. Occasionally some yellow is

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present. On fixation, in alcohol or formalin, the green disappears rapidly and such pigment as is present is visible in chromatophores, that may be equally distributed over head and dorsum, with a strip of pigmentation on the dorsal surface of the limbs (or sometimes absent on upper arm). Sometimes the chromatophores may be segregated into spots and reticulations. The color of the pigment under a lens is lavender or purplish.

The characters and habitus of these species are for the most part those of the tree frogs of the Hylidae and Rhacophoridae, and like them, there is a cartilage intercalated between the ultimate and the penultimate phalanges. These frogs differ however from typical hylids in that the terminal phalanges bear a pair of projections, commonly described as T-shaped. Because of this particular character certain authors have regarded them as belonging to the Family Leptodactylidae—believing that the greater weight should be placed on the shape of the terminal phalanges than on other more significant characters of the animal. Others have placed them with the Hylidae. The discovery by the senior author of the fusion of the astragalus and calcaneum in this group of frogs, together with other significant characters, has caused us to treat them in a family of their own.

The Family has a range extending through eastern and southern Mexico from central Veracruz and Guerrero south to and including most if not all of Brasil and a part of the various states bordering northern and western Brasil. It comprises at least three known genera and perhaps others now unknown or unrecognized. We believe that a better understanding of the group is possible by considering it of family rank, as proposed by Taylor, using for it the name Centrolenidae.*

One will, of course, expect a large fauna of species and perhaps genera in Brasil when competent exploration for these diminutive forms has been made. In the limited exploration of Costa Rica no less than eight species are now known, representing three genera.

In United States National Museum specimens of Centrolenidae, collected in the Brazilian states of Rio de Janerio, São Paulo, Minas Geraes, and the Districto Federal, and two specimens from the zoological collections of São Paulo, we recognize some ten species. Four of these belong to a spatulate-headed section; and six to the short blunt-headed section, all seemingly referable to the genus *Cochranella*. None of these species has a humeral hook and pre-

* Taylor, Proc. Biol. Soc. Washington, vol. 64, 1951, p. 36.

sumably none has an exposed pollical spine, although one species has a pollical remnant. The vomerine teeth are absent in all of the various Brazilian species here considered.

Certain external characteristics which these species have in common are: reduced webbing on the inner fingers; the presence of an oval or somewhat circular (biscuit-shaped) palmar tubercle on the posterior part of the palm; absence of a distinct, external metatarsal tubercle; males with a vocal sac, and short or long vocal slits that are somewhat diagonally placed, not tending to parallel the line of the lower jaw, and the astragulus and calcaneum fused into a single slender shaft of bone.

Characters used to show specific differences are those of the tongue, the palatal groove, and the size of the vocal slit; size of choanae and their relative distance from each other; character of exposed tympanum or its covering, and its position with relation to the eye; size of eye, its lid, and the covering of the hidden parts of the eyeball (tunic); shape and extension of snout; head proportions; position of nostril; constriction of body behind head; size (length) of the suprascapula; anal "decoration" (*i. e.* presence of specialized granules, folds, or tubercles in the region lateral and posterior to vent); relative leg length compared to body length; webbing and character of the digits, and the character of the skin of venter (smooth, granulate or striate).

To the students of amphibians who have not had the fortune to examine these small frogs, the number of species recognized by us may seem large. We are aware that some of this material leaves much to be desired. Our experience, however, has shown that for the most part in species of this family where a series is available there is rather close conformity in characters such as body proportions, general pigmentation, anal decoration, character of webbing, etc.

It is not impossible that the eye tunic may change after long preservation and become darker. However we have no definite evidence that this occurs. In some of the species the posterior edge of the pelvic girdle seemingly extends posterior to the level of the thighs, when these are at right angles to the body; in others this is not so. We find no evidence that the method of preservation is responsible for this appearance.

In the summer of 1951, the junior author made a journey to Europe for the purpose of visiting some of the museums of Europe, and while there examined Brazilian species in London and Münich.

A few specimens which we and others had suspected of belonging to this group were X-rayed or dissected and the findings were as follows:

Hylella buckleyi Boulenger = *Cochranella buckleyi* (Boulenger)
Hylella parvula Boulenger = *Cochranella parvula* (Boulenger)
Hylella parabambae Boulenger = *Centrolene* (?) *parabambae* (Boulenger)
Hylella puncticrus Boulenger = *Centrolene prosoblepon* (Boettger)
Hylella ocellata Boulenger = *Cochranella ocellata* (Boulenger)

There is no possibility that the generic name *Hylella* could be used for any small frog of this family since the type of the genus *Hylella* is *Hylella tenera* which the junior author has recently examined and which she regards as *Hyla bipunctata.* The only other species placed in the genus by Reinhardt and Lütken was *Hylella punctatissima* and this too is a hylid frog and not a member of this family.

Three species of Centrolenid frogs have already been described from Brasil, in each case under the genus *Hyla* or *Hylella* of the Family Hylidae. These are *Hylella parvula* Boulenger,* *Hyla* (*Hylella*) *uranoscopa* L. Müller,** and *Hyla* (*Hylella*) *eurygnatha* A. Lutz.***

The junior author has examined cotypes of *H. eurygnatha* in Brasil and there are several specimens, collected by Dr. A. Lutz at the type locality, available in the collections of the United States National Museum. These unquestionably are Centrolenidae and are referable to the genus *Cochranella.* The tarsal segment has a single bone (astragalo-calcaneum), and they conform in other generic characters.

The type of *uranoscopa* was likewise examined and by dissection the presence of a single bone in the tarsal joint was verified. This species, the southernmost known is from the state of Santa Catharina and is distinctly different from new forms herein described.

An X-ray photograph of the type of *parvula,* made by the authorities of the British Museum, clearly demonstrates the presence of a single bone in the tarsus of this species. This type likewise was studied by the junior author. This species seemingly cannot be identified with any of the forms here described as new.

We wish to offer our thanks to Dr. George Myers, Sr. Antenor Leitão de Carvalho, and Mr. Jay Savage for having read the manuscript and for offering helpful suggestions. Sr. Carvalho has assisted in the preparation of the map.

* Proc. Zool. Soc. London 1894, p. 646, pl. 40, fig. 3.
** Zool. Anz., Bd. 59, 1924, pp. 234-235.
*** Compt. Rend. Mém. Soc. Biol. Paris, vol. 93, no. 21, 1925, pp. 137-138.

DESCRIPTIONS OF SPECIES

SYNOPSIS OF DESCRIBED FORMS OF COCHRANELLA IN SOUTHEASTERN BRASIL *

1. Tympanum completely concealed 2
   Tympanum partially or entirely exposed 4
2. Two outer fingers one-third to one-fourth webbed 3
   Two outer fingers with only a vestigial trace of web; *a pair of relatively large postanal pads or tubercles*, with some vertical wrinkles flanking pads laterally; eye tunic (covering concealed parts of eyeball) blackish; heel reaching to middle of eye; head rather narrow, not spatulate; chromatophores small, equally scattered on dorsum; 24 mm. . . . . *surda sp. nov.*
3. *A pair of flattened postanal pads;* eye tunic white; head short not spatulate; heel reaching to nostril; chromatophores equally distributed on dorsum; head wider than long; no pollex rudiment; 22 mm. . . . . *eurygnatha*
   Probably no postanal decoration (none mentioned); eye tunic white ("skin of eyelid like body"); heel reaching to tip of snout; head as long as wide; skin with small, pinkish dots; a distinct pollex rudiment; 25 mm. . . . . *uranoscopa*
4. Venter completely or largely striate 5
   Venter granular 6
5. *Venter entirely covered with longitudinal striae;* no special "decoration" in region lateral to, behind, or below vent; tympanum large, distinct, directed outward; head wide, somewhat spatulate; first and second fingers equal, or first slightly longer; heel reaching beyond tip of snout; eye tunic dark; pigment equally scattered; 23.5 mm. . . . . *petropolitana sp. nov.*
   Venter longitudinally striate save on posterior part where striae form irregular elongate granules; *a pair of vertical ridges curving across thighs to ventral surface behind vent;* tympanum covered with skin, but outline clearly visible, directed nearly vertically upward; head broad, spatulate, the *front sloping obliquely to lip in front of nostril;* heel to a point 2 mm. beyond tip of snout; pigment *chromatophores large, unevenly scattered on dorsum;* eye with white tunic, *lutzorum sp. nov.*
6. Tympanum directed laterad 7
   Tympanum directed wholly (or largely) upward 8
7. Tunic of eye black; tympanum covered with skin but outline clearly visible; heel to a point beyond tip of snout; no decoration in region of vent; skull not transparent; outer fingers only one-fourth webbed; 20.8 mm. . . . . *delicatissima sp. nov.*
   Eye with a brown or black tunic; tympanum covered with skin, its outline visible, directed outward; heel to a point between eye and nostril; *a pair of swellings behind vent, widely separated;* webbing between outer fingers vestigial; *pigment rather*

* Since so many significant characters of *Cochranella parvula* are not known to us, we are omitting this species from the synopsis. Its relationship may be with *delicatissima*.

equally distributed in small chromatophores; skull transparent, showing outline of brain (not impossibly a result of preservation); 20.4 mm. .... *bokermanni sp. nov.*

8. Eye with a dark tunic; no anal decoration; tympanum partly covered, directed nearly vertically upward (and slightly backward); heel to front edge of eye; head short, nonspatulate; venter smooth (?); dorsum smooth no granules evident on under side of thigh (?); *color nearly uniform lavender,* the individual chromatophores not visible to eye; 20 mm., *divaricans sp. nov.*

   Eye with a white or cream tunic; *chromatophores large not equally distributed but tending to segregate;* venter and thigh distinctly granulate 9

9. *Interorbital area elevated and sloping rather abruptly to base of snout;* nostril nearer eye than to mid-point on lip; anal decoration lacking; heel reaching to tip of snout or slightly beyond; chromatophores segregated into an indefinite pattern of spots or groups; 23.5 mm. .... *dubia sp. nov.*

   Interorbital area not elevated 10

10. *Smaller, a yellow-cream spot almost covering tympanum;* upper eyelid heavily pigmented with purple; lip bordered by a row of cream tubercles; upper arm very slender; *forearm greatly thickened,* permanently flexed (?); heel to tip of snout; very short anal flap; a pair of enlarged postanal granules; suprascapulae not especially broadened; 20 mm. .... *vanzolinii sp. nov.*

    Larger, no yellow or cream spot on tympanum; spatulate-headed; tympanum small at least partly distinct, directed outward and upward; heel reaching to a point much beyond snout; no row of tubercles on lip; forearm not especially thickened; suprascapulae very broad, prominent; 27 mm. ...... *albotunica sp. nov.*

Cochranella surda sp. nov.

(Fig. 1)

Type: U. S. National Museum No. 96916, Passo Quatro, Minas Geraes, Brasil; Zikan, coll., November 1920.

Paratype: U.S.N.M. No. 96917. Same locality and collector.

Diagnosis: A short-headed species, the eyeball blackish, the concealed parts surrounded by a dark tunic; pigment where present equally distributed, not reticulated; tympanum hidden under skin, the tympanic region nearly vertical; distance between orbits equals width of an eyelid; nostrils nearer to eyes than to median point in upper lip; dorsal skin finely corrugated, belly strongly granular; outer fingers with a web vestige (one-fifth webbed or less); terminal discs oval, the sides and tips curving, not truncate; first and second finger of approximately even length; a pair of prominent anal pads; a strong inner tarsal fold; a distinct heel ridge; heel to anterior edge of eye.

Description of type: Head width (8 mm.) greater than head length (7.1 mm.); region about nostrils swollen but no depression evident on snout or on top of head; canthal region short, the canthus rostralis absent, the loreal region not or but slightly concave, sloping obliquely to edge of lip; tip of snout, seen in profile, sloping some-

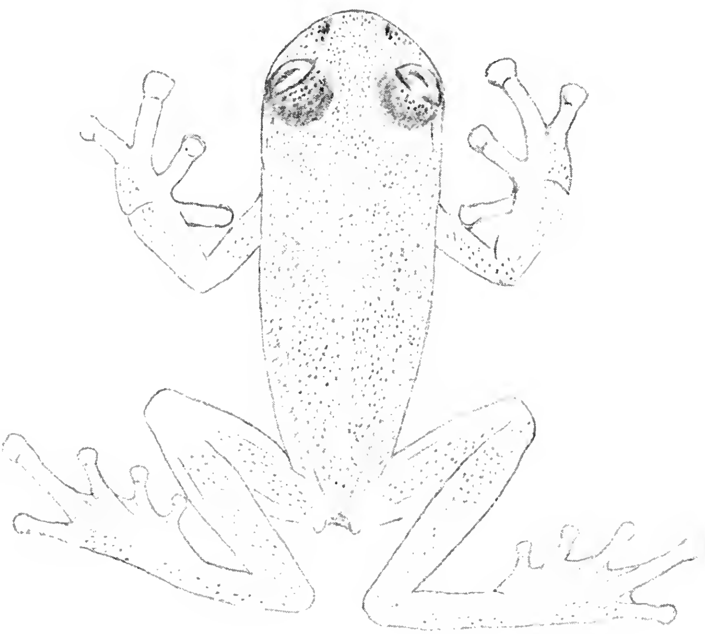


FIG. 1. *Cochranella surda* sp. nov. Type, U.S.N.M. No. 96916. Passo Quatro, Minas Geraes, Brasil.

what, the nostrils not terminal; tympanum hidden under skin with no trace of its outline; a fold above tympanic region faintly indicated; eye moderate, prominent, directed somewhat forward, its length (2.6 mm.) greater than length of snout (2.3 mm.); nostril nearer the eye than median point on upper lip, which is not notched; width of an eyelid (2 mm.) equals interorbital width; region back of eyes not or but very slightly constricted.

Choanae longer than wide; width of one (.4 mm.) in distance between them (1.8 mm.) 4½ times; a strongly defined transverse groove for openings of palatal glands close to anterior edge of choanae; no trace of vomerine teeth; tongue broader than long, not or but slightly free behind, slightly emarginate posteriorly; openings of vocal sacs short, diagonal.

Wrist extending beyond tip of snout; a very slight axillary web; first finger distinctly smaller and shorter than second; well-developed pads or discs on fingers, the tips distinctly wider than digits, the tips rounding rather than truncate, the sides rounded rather than angular; the discs transversely oval rather than subtriangular; no trace of web between first three fingers; a trace between fourth and third with a slight ridge following outer edge of third digit; a large broad metacarpal tubercle, and a well-defined, oval, palmar tubercle.

Heel to middle of eye; toes with terminal discs smaller than fingers, the first two fingers 1/3 webbed; the second and third, 1/2; the third and fourth, 3/5; the fourth and fifth, 1/2 webbed; an ill-defined inner tarsal fold; a small inner metatarsal tubercle; no distinct outer tubercle.

Skin of dorsum, seen under a lens, minutely corrugated; chin and breast smooth; venter strongly granulate, under surface of thigh granular; anal opening high; a short anal flap with a broad free edge; a pair of large postanal pads or tubercles, with some vertical wrinkling flanking them laterally.

Color: Probably green in life. In preservative transparent flesh with dorsal surface of body, head, and upper surfaces of limbs covered with nearly equally distributed, fine, purplish-lavender chromatophores; edge of lip lacking pigment; ventral and concealed surfaces transparent, whitish-flesh; eyelids surrounded by a dark purplish tunic; iris purplish.

Measurements in mm. of type and paratype

Number	96916	96917
Snout to vent	21.5	24
Width of head	8	8.5
Length of head	7.1	7.5
Length of eye	2.6	2.7
Length of snout	2.3	2.3
Arm	17	16
Hand	8.8	7.8
Leg	33.2	37.4
Tibia	11	10.4
Foot and tarsus	14	18

Cochranella eurygnatha (A. Lutz)

(Fig. 2)

Hyla (Hylella) eurygnatha A. Lutz, Compt. Rend. Mém. Soc. Biol., Paris, vol. 93, no. 21, June 19, 1925, pp. 137-138 (type locality, Serra da Bocaina, Brasil); Trabalho Inst. Oswaldo Cruz, Mar. 10, 1926, pp. 5, 12.
Centrolenella eurygnatha B. Lutz, Copeia, no. 4, 1947, p. 243.

Diagnosis: Snout short, not spatulate, the nostrils nearly terminal; eyeball surrounded by a whitish tunic; tympanum concealed under skin; belly strongly granular; outer fingers not more than one-fourth webbed, the discs much widened, curved rather than truncate; all digits with terminal grooves on hand and foot; heel to nostril; anal flap rather broad, notched mesially, flanked behind by indefinite, flattened, anal pads, with some few enlarged granules on ventral surface; no outer tarsal tubercle; a deep groove across palate for openings of palatal glands.

FIG. 2. *Cochranella eurygnatha* (A. Lutz). No. 7926 Coll. Departamento de Zoologia, Secretaria de Agricultura São Paulo Brasil; Itatiaia, Rio de Janeiro, Brasil. Actual length, snout to vent, approximately 22 mm.

Description of species: (From U.S.N.M. No. 96656 ♂ from Bonito, Serra da Bocaina, State of Rio de Janeiro, near the São Paulo boundary, late February 1928, Dr. A. Lutz, B. Lutz, and J. Venancio, colls.). Head width (8 mm.) greater than head length (7.1 mm.); snout very short, truncate, the nostrils nearly terminal; canthus rostralis somewhat swollen but only a meager depression between canthi; tympanic area lateral, the tympanum concealed under skin; the supratympanic fold not or only indistinctly indicated; length of eye opening (2.4 mm.) about as long as the snout (2.5 mm.); the eye directed somewhat forward, and prominently elevated; distance between eye and nostril (1.8 mm.) nearly equal to distance between nostril and median notch on lip (1.82 mm.); interorbital interval (2.1 mm.) about equal to width of eyelid (2.2 mm.); distance between nostrils about equal to their distance from eye.

Choanae large, the distance between them 2.7 mm.; diameter of one choana in distance between, 3.5 times; a distinct deep transverse palatal groove crosses palate a short distance in front of choanae, almost reaching choanae on outer ends; the edges of the groove may be thickened and the skin in front seems loose; tongue broader than long, slightly emarginate behind, and free behind for approximately a fourth of its length; vocal sac indicated externally by longitudinal folding of the skin on chin and neck; vocal slits run somewhat diagonally from near jaw forward and across to tongue.

Arm with wrist reaching considerably beyond tip of snout; first finger shorter than second, but digits of nearly same width; fingers bearing broad terminal pads with terminal grooves, the discs distinctly wider than the digits, and delimited; the tips moderately rounded rather than sharply truncate; about one-fourth webbed between outer fingers; web absent between other fingers; a large, rather broad, inner metacarpal tubercle; a prominent rounded median palmar tubercle; subarticular tubercles distinct; supernumerary tubercles on palm and sole; heel reaches to nostril; when legs are folded at right angles to body, heels overlap 2.5 mm.; when laid along body, heel and elbow overlap; the presence or absence of an inner tarsal fold cannot be determined; inner metatarsal tubercle present, outer absent.

Skin everywhere smooth on dorsal surfaces; chin with surface of vocal sac longitudinally folded; breast smooth; venter covered with rather large granules; median part of ventral surface of thigh with a few granules, some distinctly larger than others; vent high, covered with a short, rather wide flap, notched mesially, flanked behind by two, irregular, large, flattened but relatively distinct anal pads.

Color: Flesh color, with lavender-purple pigment in small chromatophores, their distribution on dorsal surfaces of body nearly equal, not segregated into spots or a reticulum; chromatophores sparse on sides of head; venter and concealed parts of limbs flesh-color, probably transparent in life; tunic surrounding concealed parts of eyeball, cream-white, the iris white with purple streaking or clouding; anal flap pigmented. The species is probably green on exposed surfaces in life.

Measurements in mm.: Snout to vent, 22; width of head, 8; length of head, 7.1; length of eye, 2.4; interorbital width, 2.1; arm, 16; hand, 8; leg, 35.5; tibia, 11; foot and tarsus, 17.

Remarks: All the specimens of the topotypic series (U.S.N.M. nos. 96652-96661) are of the same species, all males except for a single small female (No. 96662). Tadpoles associated under the number 96663 seem to belong to more than a single species some of which may belong to this species. (See discussion of these elsewhere.)

The original description of this species is as follows: "*Hyla (Hylella) eurygnatha;* L. 17 mm.—Le dessus est vert, passant au jaunâtre au museau, aux doigts, aux orteils et sur une ligne marginale. Tête courte, élargie derrière les yeux, ce qui est dû à la largeur de la mandible. Iris or mat; lobule supérieur et inférieur au bord de la pupille. Pointillé noirâtre plus accentué après la mort. Membrane court entre les doigts, plus longue entre les orteils. Un seul exemplaire provenant de la Serra da Bocaina."

The drawing is of a specimen recently forwarded by Mr. Werner Bokermann (No. 7926) from Itatiaia, Brasil. The specimens recently preserved show more pigment, especially on eyelids, and there are some indistinct lighter spots, which may have been more evident in life. The fingers may be a trifle less than one-fourth webbed.

Cochranella uranoscopa L. Müller

Hyla (Hylella) uranoscopa L. Müller, Zool. Anz., Bd. 59, 1924, pp. 234-235 (type locality, "Humboldt [Flussgebeit des Rio Novo], Santa Catharina", S. E. Brasil; Bavarian States Herpetological Collection No. 81/1921, W. Ehrhardt, coll. Nov. 1919).

Diagnosis: Tympanum hidden; a large angular pollex-rudiment.

Description of the type: The frog appears very strongly depressed, at the same time proportionally slender; width of body is contained two and one-half times in the snout-vent length; head rather large (contained two and three-fourths times in the snout-vent length), as long as broad and very flat; head broadest in region of eye and narrows itself from eye to region back of tympanum, so that it appears to be set off from body by a slight necklike constriction. The limbs are rather long and slender; choanae moderately large; vomerine teeth lacking; the tongue oval, completely marginate, only free on edge; snout longer than eye, broadly rounded anteriorly; canthus rostralis not present and loreal region slopes gently out and down; eyes not lateral but are obliquely directed upward; nostrils directed upward; the interorbital space equals the length (diameter) of the eye; distance of nostrils from tip of snout equals two thirds its distance from eye; tympanum hidden under the skin; fingers slender, slightly flattened, with moderately large anteriorly truncate finger discs; first finger somewhat shorter than the second; on its basal part a moderately large angularly protruding flat spreading pollex-rudiment is in evidence; between third and fourth fingers one-third webbed; between the second and third somewhat less than one-third webbed; between the first and second fingers the web is vestigial.

Toes moderately long, likewise flattened, half webbed; subarticular tubercles on fingers and toes weakly developed; a distinct, elongate, strongly compressed metatarsal tubercle present; hind leg pressed against body, the tibiotarsal articulation reaches tip of snout; tibia somewhat longer than femur, measures one and two thirds the head length.

Skin of the dorsum finely granular; that of the ventral side strongly granular. A fold goes from back end of eye, over tympanum to insertion of upper arm.

Color: Color of the head and dorsum pale, characteristically transparent, bluish green which laterally becomes more yellowish; the limbs yellowish; entire upper side, with the exception of upper arm and parts of hind leg that are concealed when crouched, is covered with thickly distributed brownish-gray spots consisting of thickly distributed punctations; underside bright olive-yellow, transparent on the belly.

Measurements in mm: Head-body length, 25; head length, 9; head width, 9; length of hind leg, 46; length of tibia, 14; tibiotarsal articulation to tip of longest toe, 19.

(Data from type description).

Cochranella petropolitana sp. nov.

Type: U. S. National Museum No. 101135, Petropolis, Rio de Janeiro, Brazil; A. Lutz, Bertha Luth and Doris Cochran, colls., May, 1935.

Diagnosis: Head rather broad, somewhat spatulate, body depressed; tympanum large, very distinct, lateral, relatively close to jaw, directed outward; no specialization of fold, grooves or tubercles in anal region; the vent high, the anal flap short and wide; pigment where present scattered nearly equally on dorsal surfaces, with no tendency to segregate and form spots or reticulations; none, or only an ill-defined fold above tympanum; eye tunic dark.

Description of type: (The specimen is indifferently preserved and in the region of the tip of the snout and on hand and foot the characters are somewhat obscured.) Small frog, snout-to-vent length 23.5 mm.; head rather spatulate, widest part being opposite eye, narrowing a little near jaw angle; head depressed, the canthus not, or barely indicated, rounded, sloping obliquely to lip, with a shallow depression behind nostril in loreal region; area about nostrils slightly swollen, however no depression is indicated between swellings; tympanum distinct, not covered with skin or pigmented; its vertical diameter (1.1 mm.) a little greater than its length (1 mm.), separated from eye by a distance equaling the greatest diameter; length of eye (estimated 2.4 mm.) less than length of snout (estimated 3.5 mm.); tongue somewhat wider than long; vocal slits present in mouth, but no external evidence of vocal sac; no vomerine teeth; choanae large, length equal to half distance between them.

Arm with wrist extending considerably beyond tip of snout; first finger as long as second or (on right hand) a little longer than second; tips of fingers widened into truncate discs, distinctly wider than digit; inner fingers without web; two outer fingers about one-third webbed; inner metacarpal tubercle moderately distinct; median palmar tubercle subcircular, distinct.

Leg slender, tibiotarsal articulation extending two millimeters beyond tip of snout; when legs are flexed at right angles to body, heels overlap; when flexed on side of body, knee and elbow overlap; toes three-fourths to four-fifths webbed; the terminal discs truncate, smaller than those on fingers; inner metatarsal tubercle distinct, outer absent or obsolete.

Skin smooth on the dorsal and concealed surfaces; chin and breast smooth; venter longitudinally striate; no granules evident on ventral face of thighs; no distinct fold above tympanum.

Color: Probably green or olive in life, the venter transparent; in preservative flesh white with a thick scattering of lavender or purplish pigment, the chromatophores of nearly equal size; on head, pigment less dense on lips and loreal region; there is a narrow strip of chromatophores on surface of upper arm and upper surface of thigh, wider areas of chromatophores on forearm and tibia, the pigment extending onto outer finger and toe; a small area below vent pigmented; eyeball above, showing dark pigment through upper eyelid, the iris likewise being dark.

Measurements in mm. of type: Snout to vent, 23.5; greatest width of head, 8.6; width at jaw angle, 7.3; length of head, 7.6; arm, 16; hand, 8; leg, 41; tibia, 14; foot and tarsus 17.5.

Remarks: The specimen is not well preserved and the character of the subarticular tubercles, the eyelid and the length and shape of the snout in front of the nostrils cannot be determined satisfactorily. It is interesting that the specimen was taken at the same place as the type of *Cochranella lutzorum.* Both are rather similar in general appearance, but the following specific differences are in evidence:

1. Tympanum distinct, low, lateral, directed outward.	1. Tympanum partially concealed under skin, and directed upward.
2. No anal folds or tubercles.	2. A pair of vertical folds extend across the posterior face of thigh behind vent to ventral surface.
3. Pigment rather equally distributed on dorsum; pigment on upper arm.	3. Pigment forming a reticulum over dorsum, absent from upper arm.

Cochranella lutzorum sp. nov.

Type: U. S. National Museum No. 101134, Petropolis, Rio de Janeiro; colls., A. Lutz, Bertha Lutz, and Doris Cochran; May, 1935.

Diagnosis: A moderately large species of the genus with a broad spatulate head, the front of the snout sloping obliquely to lip in front of nostrils; tympanum covered with skin; the outline partly concealed; a pair of vertical folds behind vent; no pigment on upper arm.

Description of type: Area about nostrils swollen with a depression between continued on down to edge of lip and bordered by two distinct elongate elevations; nostrils separated from eye by a distance of 3 mm., from median edge of lip by 2.6 mm.; canthus rostralis absent; a longitudinal depression midway of the loreal region, the lower part sloping very obliquely to lip; tympanum covered with thin skin but its entire outline distinct, directed upward, separated from the eye by a distance equal to 1½ times diameter of tympanum; length of eye, 2.65 mm., a little more than 2½ times greatest diameter of tympanum, but much less than snout length (5 mm.); upper lip indistinctly notched; no trace of vomerine teeth; choanae moderately large, longer than wide, the distance between them (2.2 mm.) contains width of one (.5 mm.) a little more than four times; tongue large, much wider than long, not or but only a narrow fringe free behind; (vocal sacs present in males?).

Arms slender, the wrist reaching distinctly beyond mouth; the digits moderately slender, elongate, with widened truncate terminal discs; web lacking between first three fingers; about one-fourth webbed between the two outer fingers; a flattened protruding inner metacarpal tubercle; a prominent median rounded palmar tubercle; subarticular tubercles moderately distinct. Leg long, the heel extending 2 mm. beyond tip of snout; discs on toes smaller than those on fingers, truncate; the first toe with web reaching half its length; on outer side of second three-fourths webbed, third and fifth toes two-thirds webbed, the fourth toe with two and a half joints free; subarticular tubercles small but distinct; inner metatarsal tubercle small, slightly projecting; outer not distinctly indicated; the character of the tarsal fold cannot be determined but seemingly present; a small fold or ridge on heel.

Skin smooth on dorsal surfaces; chin and breast smooth; anterior part of venter finely striate longitudinally, the posterior part broken up into somewhat elongate granules; on under side of thigh large round granules indicated on posteroventral face; vent high, covered with a short pigmented flap; a pair of high vertical ridges curve across the thighs to ventral surface. Scapulae large, broad, elevated, their inner edges forming two irregular elevations which seemingly are discernible in life since the edge marks an elongate spot following the elevated portion.

Color: (In preservative.) Flesh white with lavender pigmentation unequally distributed; tip of snout and lips with sparse unequal pigmentation; top of head and dorsum with some segregation of chromatophores leaving small irregular pigmented areas; eye with whitish tunic; upper arm lacking pigment or at most a few chromatophores; forearm pigmented, the pigment continuing sparsely on outer finger to near tip; a narrow line of chromatophores on upper face of thigh, wider on tibia continuing sparsely on tarsus and two outer toes. Entire ventral surface flesh white (probably transparent in life).

Measurements in mm.: Snout to vent, 28; width of head, greatest, 10.3; width at jaw angle, 9.3; length of head, 8; diameter of tympanum, 1.05; length of eye, 2.6; length of snout, 5; arm, 18; hand, 8; leg, 46; tibia, 16; foot and tarsus, 21.

Remarks: The species is dedicated to Dr. Bertha Lutz and her illustrious father, Dr. A. Lutz.

Cochranella delicatissima sp. nov.

Type: U. S. National Museum No. 96481, Angra dos Reis, Rio de Janeiro; A. Lutz, coll.

Diagnosis: Snout short not spatulate the nostrils nearly terminal; flesh of body very white with a very fine scattering of lavender pigment; tympanum pigmented, visible, directed laterad; interorbital space wider than an eyelid; anal decoration probably absent, the pelvis extending a little behind level of thighs?; heel to beyond tip of snout; outer fingers about one-fourth webbed.

Description of type: (where characters are somewhat obscured the word "probably" is used.) Width of head, (7.8 mm.) greater than length (6.5 mm.); the canthus barely indicated; the tip of snout in lateral profile curving slightly to lip, the nostrils not quite terminal; loreal region slightly concave near eye, sloping obliquely to lip; tympanum distinct, pigmented, directed laterally outward and perhaps a trifle upward; its distance from eye double its greatest diameter; eye large, its length (3 mm.) distinctly greater than snout length (2.1 mm.); canthus rostralis barely indicated; the medial loreal region slightly concave near eye, sloping obliquely to lip; area about nostrils slightly swollen with a slight depression between, more or less evident down to lip; nostril as near to eye as to median point on upper lip; width of upper eyelid less than interorbital interval.

Choanae large, the greatest diameter of one, contained in distance between them about two times; groove for palatal glands absent or obsolete; openings of vocal slits elongate, diagonally placed; tongue wider than long, narrowed posteriorly, not or but slightly emarginate, free only on posterior edge; no trace of vomerine teeth.

Arm long, more than half of forearm extends beyond tip of snout; a small inner metacarpal tubercle; a rounded palmar tubercle; outer fingers one-fifth webbed; other fingers without or with only a trace of web; discs present (the tissues of the fingers have partially sloughed off so details of the discs and webs are not wholly clear); first finger shorter than second; heel to slightly beyond tip of snout;

probably no inner tarsal fold; small metatarsal tubercle, outer tubercle absent; toes probably three-fifths webbed.

Skin smooth on dorsal surfaces; venter with distinct fine granulations; probably no anal decoration but the sacrum extends slightly behind level of thighs on median line.

Color: Everywhere flesh white with a thin regular scattering of lavender in tiny chromatophores (in many places the skin has been rubbed and the color is seemingly absent); tunic about concealed parts of eye at least for the most part whitish. Iris light with some light lavender; pigment confined to dorsal surfaces but extending narrowly on limbs to outer fingers and toes.

Measurements in mm.: Snout to vent, 20.8; width of head, 7.8; length of head, 6.5; length of eye, 3; length of snout, 2.1; arm, 15.5; hand, 7.2; leg, 35.5; tibia, 11.4; foot and tarsus, 15.7.

Cochranella bokermanni sp. nov.

Type: Departamento de Zoologia, Secretaria de Agricultura, São Paulo, Brasil, No. 328, Itatiaia, Rio de Janeiro, May, 1906, Leuderwaldt, coll.

Diagnosis: A diminutive species, the head not spatulate, the dorsal skin glassy smooth; the chin smooth, the venter and under face of thigh granular, the granules large and irregular on thigh and posterior part of venter; a pair of slight swellings behind vent, widely separated; tympanum covered, its outline faintly visible; neck not constricted; heel reaching to between eye and nostril; web vestige between fingers two and three, a larger vestige between three and four. A slight fringe on outer edge of third; inner toes about one-half, or less webbed; outer toes three-fifths to three-fourths webbed; first finger much shorter than second.

Description of type: Head short the width (7 mm.) greater than length (6.1 mm.); canthus absent, the interorbital area rather flat and transparent showing the complete outline of the brain; snout somewhat oval rather than rounded, seen from above; nostrils nearly terminal, minute, equidistant from eye and the median point on upper lip; nostril not noticeably swollen and no depression occurs between; eyes large, directed somewhat forward, the length (2.45 mm.) greater than length of snout (2 mm.); tympanum covered with skin its outline partly visible, the loreal region sloping obliquely to lip, not or scarcely concave; snout extending about .75 mm. beyond mouth; width of an eyelid (1.8 mm.) less than interorbital interval (2.1 mm.); choanae moderate, the diameter of one (.7 mm.) in distance between them approximately 2.2 times. Eye with a brown tunic (the eye possibly red in life); palatal glands open into a nearly straight groove, nearer the choanae than front of palate; tongue rather thick, wider anteriorly than posteriorly, free for less than one fifth of its length, unemarginate behind; opening of Eustachian tubes equal to choana; (specimen a female lacking vocal slits).

Wrist reaching beyond snout tip; first finger shorter than second, with no trace of a web between them; between second and third fingers a distinct vestige and a larger vestige between two outer fingers (less than one-fifth webbed); tips of digits widened, sharply truncate, the subterminal "discs" subtriangular; subarticular tubercles single, moderately distinct; a small inner metacarpal tubercle, the palmar tubercle irregular, large; an indistinct fold on outer finger continued along the outer, under edge of arm.

Legs slender the heel reaching to nostril; inner toes less than half webbed, the outer nearly three-fourths webbed, subarticular tubercles indicated but there are no distinct supernumerary tubercles on sole or palm; a small, inner metatarsal tubercle and an indistinct outer tubercle; a distinct inner tarsal fold. Outer fold, if present, very indistinct.

Skin shining smooth above on head and dorsum; chin and breast smooth; venter with smaller granules anteriorly, larger more irregular ones posteriorly; under side of thigh with still larger irregular granules; presumably a pair of small pustular swellings behind vent. Anal flap short, wide, the vent opening at upper thigh level.

Color: (Faded in preservative). Whitish flesh above and whiter below; a small pigmented area visible on right side, the brownish lavender pigment scattered; eyelid appearing dark, taking color from the tunic of eyeball.

Measurements in mm.: Snout to vent, 20.4; width of head, 7; length of head, 6; length of eye, 2.45; length of snout, 2; arm, 18.4; hand, 7; leg, 32; tibia, 11; foot and tarsus, 15.

Remarks: The exposed brain is clearly visible, the posterior part being much widened, a little more than double that of the cerebral hemispheres and equal to the brain length. (The width is 3.5 mm. the greatest length 3.5 mm.)

The relationship of this species is probably closest to *Cochranella surda*, but seemingly differs in the greater width of an eyelid in relation to interorbital interval, in having the skin glassy smooth instead of being finely corrugated, and in having the first and second finger of nearly equal length, as well as other less obvious differences.

The species is dedicated to Mr. Werner Bokermann of the Museum of the Departamento do Zoologia who has given us the privilege of studying this form and *Cochranella vanzolinii.*

Cochranella divaricans sp. nov.

Type: U. S. National Museum No. 96562 ♂, Serra da Bocaina; A. Lutz coll.; Jan. 2-19, 1930.

Diagnosis: A small frog with a short head; lavender pigment in large spreading chromatophores that are contiguous or nearly so; eyeball with a dark tunic; the interorbital interval probably approximately equal to width of an eyelid; heel to front edge of eye; tympanum covered (outline partly visible); moderate, necklike constriction behind head; outer fingers one-fourth webbed; toes three-fifths to three-fourths webbed, the digital disks sharply truncate and angular, the pads subtriangular in shape.

Description of type: A small species, the type being 20 mm. in snout-vent length; width of head (7.2 mm.) greater than length of head (6.3 mm.); tympanum covered with pigmented skin but on one side its outline is dimly evident, showing it directed largely upward and slightly backward; the distance of tympanum from eye at least once and a half the diameter of the tympanum; eye large, directed partly forward, its length (2.5 mm.) greater than snout length (2 mm.); nostrils slightly injured (presumably by insects), probably swollen somewhat, although there is no evidence of a depression between them or on snout, and probably equidistant between median point on lip and eye; canthus rostralis barely indicated, rounded; loreal region not concave, but sloping rather abruptly to lip; eyelid probably nearly equal to interorbital distance; a necklike constriction behind head and partly including back part of head.

Choanae large, irregular, their greatest diameter contained in distance between them about two and one-third times; no trace of vomerine teeth; a pair of vocal slits somewhat diagonally placed; tongue (distorted) wider than long, free for at least one fourth of its length (membranes of the palatal region have sloughed so that the character of the palatal groove is not discernible, and the bony rim of the choanae is exposed).

Arm brought forward the wrist reaching a little beyond tip of snout; first finger shorter than second; digits with sharply truncate, angulate discs, considerably wider than the digits; the pads on the disc subtriangular in shape; web vestigial between first and second fingers; approximately one-fifth webbed between second and third, and one-fourth webbed between third and fourth; a well-developed inner metacarpal tubercle; without trace of a pollical spine; a rounded palmar tubercle.

Heel reaching to a point immediately in front of eye; leg slender when folded at right angles to body, the heels overlapping 2 mm.; webbing between the toes reaches three fifths to three fourths of the length of digits except on the fourth; discs at tip much wider than the digits, and only a little smaller than those on fingers; a small, flat, inner metatarsal tubercle (two indistinct tubercles on posterior median part of sole); no outer metatarsal tubercle.

Skin above smooth; venter seemingly smooth, definitely not striate but some granules may have been present in life; no distinct anal decoration, and no granules evident on the under side of the thigh. Subarticular tubercles not strongly marked.

Color: Above on body uniformly lavender, the pigment spread, rather than segregated in small dots, although on dorsal surfaces of limbs the pigment is in rather discrete dots; very little pigment on upper arm; venter and concealed surfaces of the limbs and body transparent flesh; under a lens one sees numerous minute lighter (probably white in life) areas scattered on dorsal surface of body and head; on limbs pigment extends to tips of outer digits.

Measurements in mm.: Snout to vent, 20; length of head, 6.3; width of head, 7.2; length of snout, 2; length of eye, 2.5; arm, 13; hand, 6.3; leg, 31; tibia, 10.5; foot and tarsus, 13.

Cochranella dubia sp. nov.

Type: U. S. National Museum No. 96722, Serra da Bocaina, boundary of Rio de Janerio and São Paulo, By A. Lutz; Dec., 1930-Feb., 1931.

Diagnosis: A spatulate-headed form with the interorbital area elevated, and sloping rather abruptly to base of snout; nostril a little closer to eye than median point on upper lip; tympanum distinct, directed upward; concealed part of eyeball with a white tunic; eye large, its length equals snout length; eyelid distinctly less than interorbital distance; probably no especial anal decoration, but the pelvic bones push back forming a decided posterior median protrusion behind level of thighs; heel reaches tip of snout or minutely beyond; discs on hand and feet nearly same size, relatively smaller than those of other spatulate-headed forms, their shape subtriangular rather than transversely oval; venter probably granular (?); purplish pigment in large chromatophores segregated into groups forming indefinite spots.

Description of type: Head somewhat spatulate, moderately wide, somewhat narrowed at jaw angles, the width (7.8 mm.) greater than length (7.3 mm.); canthus rostralis indistinct or absent, the snout sloping obliquely to lip, the loreal region not or but slightly concave; tympanum distinct, round, directed upward, its distance from eye greater than its diameter; eye very large, somewhat directed forward, its length (3 mm.) equal to length of snout (3 mm.); areas about nostrils swollen, with a slight depression between them; snout sloping forward obliquely in front of nostrils; width of an eyelid distinctly less than interorbital width, the area between the orbits and occiput elevated, sloping abruptly down to snout at anterior level of eyes; choanae moderate, their longitudinal diameter in distance between them, approximately two times; upper rim of choanae followed outward terminates in a lobulate projection of bone; a strongly defined transverse groove in palate for openings of palatal glands, much closer to choanae than to front of palate; tongue thick, subcircular, posteriorly emarginate, free for one fourth of its length and attached (seemingly) by a series of elongate lamellate, muscular fibers; large diagonal vocal slits; no trace of vomerine teeth.

Arm long, nearly half of forearm extends beyond tip of snout; digits with relatively narrow terminal discs the shape of pad subtriangular rather than transversely oval; first and second fingers equal, or second a trifle longer; digits slender, with a vestige of web between first two fingers, about one-fifth (or less) webbed between second and third; between outer fingers one-fourth webbed; inner metacarpal tubercle relatively small; palmar tubercle large, distinct, somewhat rounded; leg with heel reaching to or minutely beyond tip of snout; discs on toes small most of them not or scarcely wider than digit; probably an inner tarsal fold; inner metatarsal tubercle small, outer absent; foot about three-fourths webbed throughout; when limbs are folded at right angles the heels touch but do not overlap; knee and elbow overlap.

Skin of body is smooth; probably a short distinct skinfold above tympanum; suprascapulae not forming ridges; venter indistinctly granular but granules are not regular; indication of some granules under the femora; pelvis somewhat protuberant behind level of thighs.

Color: Deep purplish, on body and head, and dorsal surfaces of limbs, on a ground of flesh, the large chromatophores segregated into irregular groups sometimes suggesting reticulation; (probably no pigment on upper arm); below flesh; (a few brownish areas on venter and under side of limbs are probably due to discoloration).

Measurements in mm.: Snout to vent, 23.5; width of head, 7.8; length of head, 7.3; length of eye, 3; length of snout, 3; arm, 17; hand, 8; leg, 40; tibia, 13; foot and tarsus, 17.

Remarks: This species was taken in the Serra da Bocaina by Dr. A. Lutz together with the species described as *Cochranella albotunica* sp. nov.

Cochranella vanzolinii sp. nov.

(Fig. 3)

Type: Collection of the Departamento de Zoologia, Secretaria da Agricultura (Ipiranga, São Paulo, Brasil) No. 2952, from Boracea, São Paulo. Collected December 12-19, 1947 by P. Vanzolini and W. Bokermann.

Diagnosis: A diminutive species; pigment not equally distributed; head slightly spatulate; venter granular; tympanum distinct, directed only slightly upwards and covered by a cream-yellow spot size of tympanum; choanae small, diameter of one in distance between choanae, 4.5 times; upper arm very slender; forearm greatly thickened; fingers flattened, truncate at tips, the tips only slightly wider than digits, distinctly wider than toes.

Description of species: Snout-to-vent measurement, ♂, 20 mm.; width of head (7.7 mm.) less than its length (7 mm.); canthus rostralis present but rounded somewhat, the loreal region shallowly concave, sloping to upper edge of upper jaw, the remainder nearly vertical to tip; area about nostrils a little swollen with a slight depression between them, the nostrils not terminal but the snout sloping obliquely to lip; tympanum small, its diameter (.8 mm.) contained in length of eye (2.7 mm.) approximately 3.4 times; pupil of eye horizontal the upper edge with a tiny rounded median projection above giving the pupil a dumbbell shape when contracted; length of eye greater than length of snout (2.4 mm.); nostril almost equidistant between eye and median point on upper lip; eye directed somewhat forward; covering of the concealed parts of the eyeball white but eyelid itself heavily pigmented with dark purple; extent of upper eyelid not clearly defined but definitely less than the interorbital distance; choanae small, the greatest (diagonal) diameter of one choana in distance between them, 4.5 times; openings of the palatal glands form a sinuous groove close to anterior level of choanae; tongue broadest anteriorly, narrower posteriorly, unemarginate, free for less than a fourth of its length; vocal slits large; vocal sac evident on chin, displaying ample folds.

Upper arm very slender, about one third thickness of forearm; (the arm appears to be permanently flexed at elbow); fingers flattened, nearly truncate the subterminal discs somewhat triangular in shape; second finger distinctly longer than first; a web vestige between first and second, and second and third fingers; approximately two-fifths webbed between the third and fourth; subarticular tuber-

FIG. 3. *Cochranella vanzolinii* sp. nov. No. 2952. Type. Departamento de Zoologia, Secretaria da Agricultura, São Paulo, Brasil. Boracea, São Paulo. Actual length, snout to vent, 20 mm.

cles distinct and single; supernumerary tubercles present on digits and palm; a well-defined inner metacarpal tubercle; a well-defined single palmar tubercle; fringe on outer finger continued along arm as a distinct fold and bearing a number of elongate white tubercles; heel reaching to tip of snout; a distinct outer tarsal fold continuous with the fringe on outer toe and bearing occasional elongate white tubercles, terminating in a slight heel-fold; subarticular tubercles distinct; a small inner metatarsal tubercle; and a small but very indistinct outer tubercle; inner metatarsal fold indistinct. When legs are folded the heels overlap 2.5 mm.; no axillary web; toes nearly four-fifths webbed.

Skin generally smooth on dorsum; side of head and dorsolateral region with a few scattered low tubercles, whitish or cream in color; other similar small tubercles scattered on dorsal or exposed surfaces of limbs and in region below and about vent; the chin, breast, and venter closely granular, this extending to the pigmented area on sides; some granulation on under surface of thighs; skin on each side of vent seemingly swollen; a pair of strong, somewhat conical tubercles or granules on ventral surface of thigh below vent; anal flap short and broad, the vent opening near upper thigh level.

Color: In preservative, whitish with a pigmentation of lavender or purple in numerous chromatophores, unequally distributed leaving lighter reticulation and spottings most distinct dorsolaterally; concealed part of eye with a white tunic, the eyelid heavily pigmented with purple; tympanum almost entirely cream-yellow; border of nostril cream, this bordered by somewhat heavier pigment. Lip bordered by a series of fine elongate white or cream tubercles; limbs colored like back with all tubercles cream-white; ventral surface, sides, and concealed parts of limbs lacking pigment, possibly transparent or colorless in life, now dull, dirty, yellowish white.

Measurements in mm.: Snout to vent, 20; width of head, 7.7; length of head, 7; length of eye, 2.7; length of snout, 2.4; tympanum, .8; arm, 12; hand, 7; leg, 37; tibia, 12; foot and tarsus, 17.

Remarks: Due to the flexed condition of the limb at the elbow and knee joints it is impossible to straighten the limbs completely without injuring the specimen. In consequence the limb measurements are partially an estimation. The specimen however is in a perfect state of preservation. The relationship is thought to be closer to *Cochranella albotunica* and *Cochranella dubia* than to the other forms in southeastern Brasil. Neither of these species however have the cream-white tuberculation, the cream-colored spot covering tympanum, or the outer tarsal fold. Many other differences likewise are in evidence.

The species is named for Dr. P. Vanzolini of the Departamento de Zoologia, São Paulo, Brasil, one of the collectors.

This is one of the most distinctive forms of the genus.

Cochranella albotunica sp. nov.

Type: U. S. National Museum No. 96559, Serra da Bocaina, boundary of Rio de Janeiro and São Paulo, Brasil, A. Lutz, collector; Jan. 2-19, 1930.

Paratypes: U.S.N.M. No. 96557, same locality, data and collector; U.S.N.M. No. 96723, same locality and collector; Mar., 1927.

Diagnosis: Small frog, snout to vent 27 mm. Head broad, tympanum small, at least partly distinct, directed outward and somewhat upward; pigment segregated forming spots and reticulations; very prominent, somewhat protruding anal pads below and partly lateral to vent; suprascapulae very broad more or less distinct; head somewhat spatulate the snout sloping forward from nostrils, which are a little closer to eye than to median point of lip, nostrils large; canthus rostralis not or scarcely indicated; outer fingers one-fifth webbed; choanae large; no vomerine teeth; tongue one-fourth free; venter granular; heel to much beyond snout.

Description of type: Head rather spatulate, its width 8.4 mm. greater than length (7.3 mm.), narrowed in tympanic region; canthus rostralis not or but vaguely indicated, the loreal region not or but slightly concave, sloping very obliquely to lip; area about nostrils swollen, with a distinct depression between them; nostrils moderately large, the snout sloping obliquely to lip; tympanum small, directed almost upward, its greatest diameter about .9 mm.; length of eye, 2.8 mm. greater than its distance from nostril, but shorter than the length of snout (3.2 mm.); eyeball surrounded largely by a white tunic (seen easily on inside of mouth); greatest width of an eyelid (1.8 mm.) distinctly less than interorbital interval (2.15 mm.); (probably a distinct fold above and partly covering upper edge of tympanum); outline of suprascapulae more or less visible, their greatest (longitudinal) width 4.1 mm. Choanae large the greatest diameter of one in distance between the choanae about 2.2 times; no vomerine teeth; tongue a little wider than long, free behind for about one fourth of its length; vocal slits present, somewhat diagonal.

Arm rather long the wrist extending beyond tip of snout; first finger smaller and shorter than second; all fingers with terminal discs distinctly wider than digits, the tips slightly rounded and not or but little angular on sides; none or but a slight vestige of web between first two fingers; between second and third one-fourth, between third and fourth one-third webbed; a thick ridge follows outer side of fingers to disc; a rather large metacarpal tubercle; a rounded, prominent palmar tubercle.

Leg very long the heel extending 3 mm. beyond tip of snout; discs on toes smaller than those on fingers; webbing of foot as follows: between first and second, one-third webbed; between other toes, approximately three-fourths webbed; a small inner metatarsal tubercle, no outer tubercle visible; probably no inner tarsal fold; when legs are folded at right angles to body the heels do not overlap; when pressed on side of body, elbow and knee overlap.

Skin on dorsum generally smooth; venter with small granules; under surface of femur with some granulation; vent high followed by a pair of relatively large postanal pads or tubercles.

Color: (In preservative.) Everywhere transparent flesh. Dorsum with purplish or lavender pigment, the chromatophores segregated to form irregular small spots and reticulations; dorsal surface of limbs, with pigment extending onto outer finger and onto two outer toes; upper arm devoid of pigment.

Measurements in mm.

	96559	96557	96723*
Snout to vent	27	24	22**
Head width	8.4	9.1	
Head length	7.3	7.4	
Length of snout	3.2	3.3	
Length of eye	2.8	2.6	2.5
Arm	17	16	16.3
Hand	8.8	8.9	7.2
Leg	42	41	39
Tibia	14.2	15	13.3
Foot and tarsus	16.3	16.5	15

Remarks: The three specimens are indifferently preserved, and one, No. 96723, has the front part of the face missing. All show the same general distribution of the pigment, and all show the postanal pads well developed. The character of the granular belly, spatulate head, position of the nostril, and segregation of the chromatophores in groups forming "spots" and reticulations are characteristic of this form.

Cochranella parvula Boulenger

Hylella parvula Boulenger Proc. Zool. Soc. London, 1894, p. 646, pl. 40, fig. 3 (Lages and Theresopolis, Santa Catharina, Brasil.)

Diagnosis: A diminutive species (17 mm. snout-vent length); tympanum distinct belly granular; heel to a point a little beyond snout; upper eyelid very narrow, the interorbital space broad and convex; head as long as broad.

Description of type: (From Boulenger).

"Tongue circular, entire. Head as long as broad; snout short, rounded; no canthus rostralis; eye large and very prominent; upper eyelid very narrow; interorbital space broad and convex; tympanum distinct, hardly one third the diameter of the eye. Fingers dis-

* Tip of snout missing.
** Estimated.

tinctly webbed at the base, first slightly shorter than second; toes two-thirds webbed; disks moderate. Tibio-tarsal articulation reaching a little beyond the tip of the snout. Skin smooth above; belly and lower surface of thighs granulate. Grayish or pale brown above, speckled with white; lower parts white.

"From snout to vent 17 millimeters. Two specimens. One from Lages, Santa Catharina, collected by Hr. Michaelis; The other from Theresopolis, presented by Dr. Göldi.

"This species appears to be most nearly allied to *H. carnea,* Cope, but the tympanum is perfectly distinct and the coloration is entirely different."

Several pertinent characters are omitted from the description. However it does not seem to be synonymous with any of the forms described here as new.

DESCRIPTION OF TADPOLES

Associated with one lot of U.S.N.M. specimens (Nos. 96652-96662) is a series of four tadpoles bearing the number 96663 from the same locality. The tadpoles differ in size and there is no assurance that they belong to this species, or that all the tadpoles are conspecific. There is a very strong probability that they are *Cochranella* tadpoles. To differentiate the four tadpoles they are referred to as: A (37 mm.), B (30 mm.), C (24 mm.), and D (23 mm.).

The specimens are indifferently preserved, and that all the external tooth rows are present cannot be affirmed.

Specimen A: The largest specimen has a somewhat elongate oval body; the eyes dorsal and rather close together, their greatest diameter 1.3 mm.; their distance from the tip of the snout .35 mm.; distance between nostrils 2.1 mm.; the distance from eye to nostril (1.25 mm.) distinctly less than their distance to end of head (2.3 mm.). Spiracle sinistral its distance from anterior head level, 9.4 mm.; length of body from head to end of anal tube 13 mm.; from vent to tip of tail, 24; mouth located very close to front level of head on ventral surface (median point on upper horny beak .5 mm. from tip of snout); a large free frill surrounds lateral and posterior rim of mouth, 1.1 mm. wide mesially, its edge denticulate; just posterior to mouth the frill has certain fleshy ridges which may have borne horny teeth (the posteriormost has some minute fleshy denticulations); horny upper beak broadly curving, bearing on its edge a series of fine denticulations (approximately 38); lower beak much

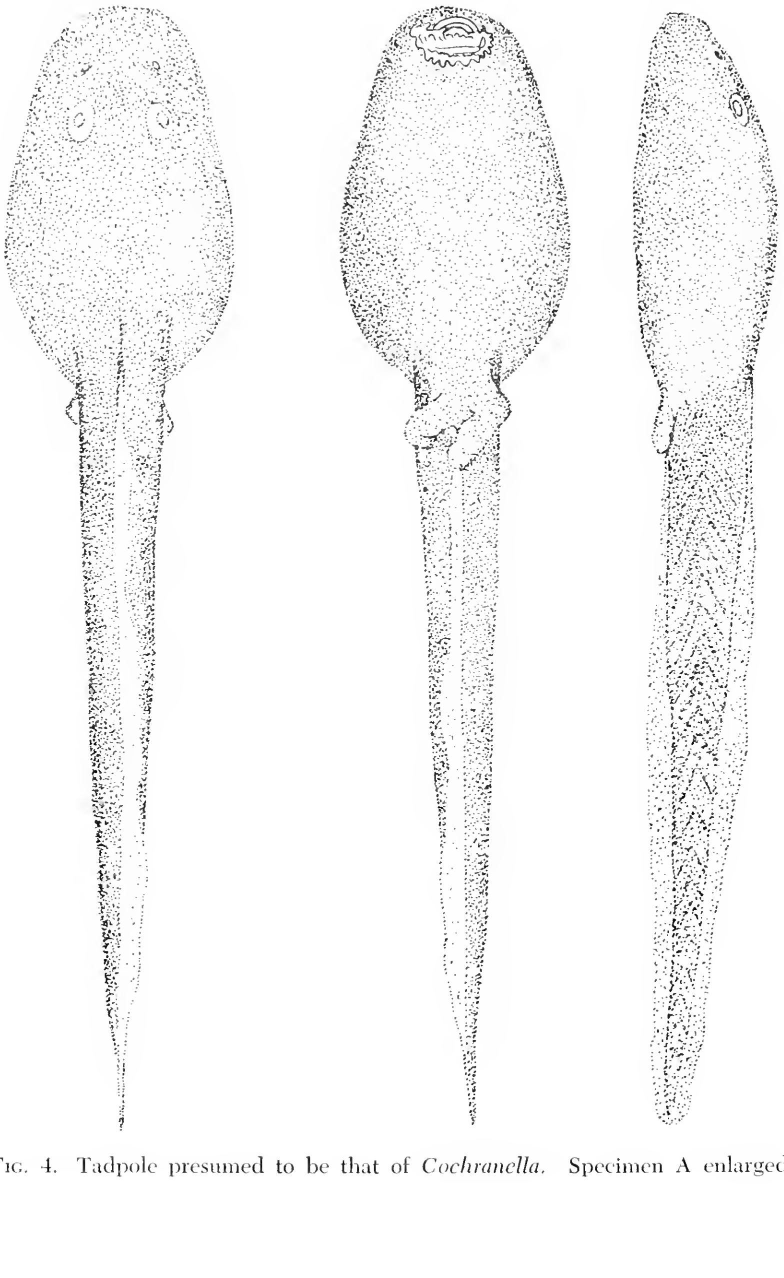


FIG. 4. Tadpole presumed to be that of *Cochranella.* Specimen A enlarged.

narrower with approximately the same number of denticulations but of smaller size, those near the outer ends a litttle larger. Hind limbs approximately 3 mm. long, the feet showing no development of the toes. Dorsal caudal fin begins at a point about 2 mm. in front of level of developing legs; anal opening definitely mesial; greatest width of the caudal expansion 4.2 mm., the musculature, continued to extreme tip, strongly attenuated.

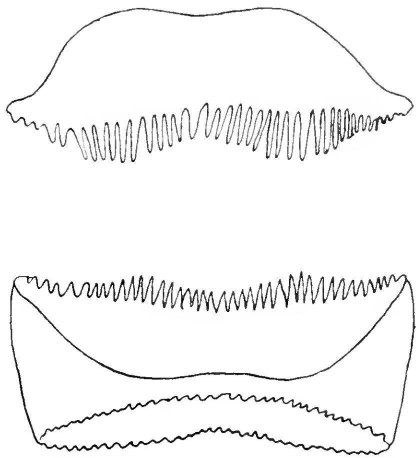


FIG. 5. Teeth of tadpole presumed to belong to *Cochranella*. Specimen A enlarged.

Specimen B: This specimen (30 mm. total length) is younger, presumably, since there is no external trace of developing hind legs; the body is somewhat elongate-spatulate, and the eyes are very small comparatively (about .35 mm. in greatest diameter), while the distance between them is approximately 1.1 mm.; eye to tip of snout, 3.05 mm.; eye to nostril, 1.55 mm.; spiracle sinistral, its distance from anterior head level, 7 mm.; snout to end of anal tube, 11 mm.; snout to base of tail, 10 mm.; vent to tip of tail, 19 mm.; greatest width of head, 6 mm.; body width at spiracle, 4.3 mm.; greatest elevation of fin, 2 mm.; greatest height of tail, 4 mm.; width between nostril, 1.9 mm.

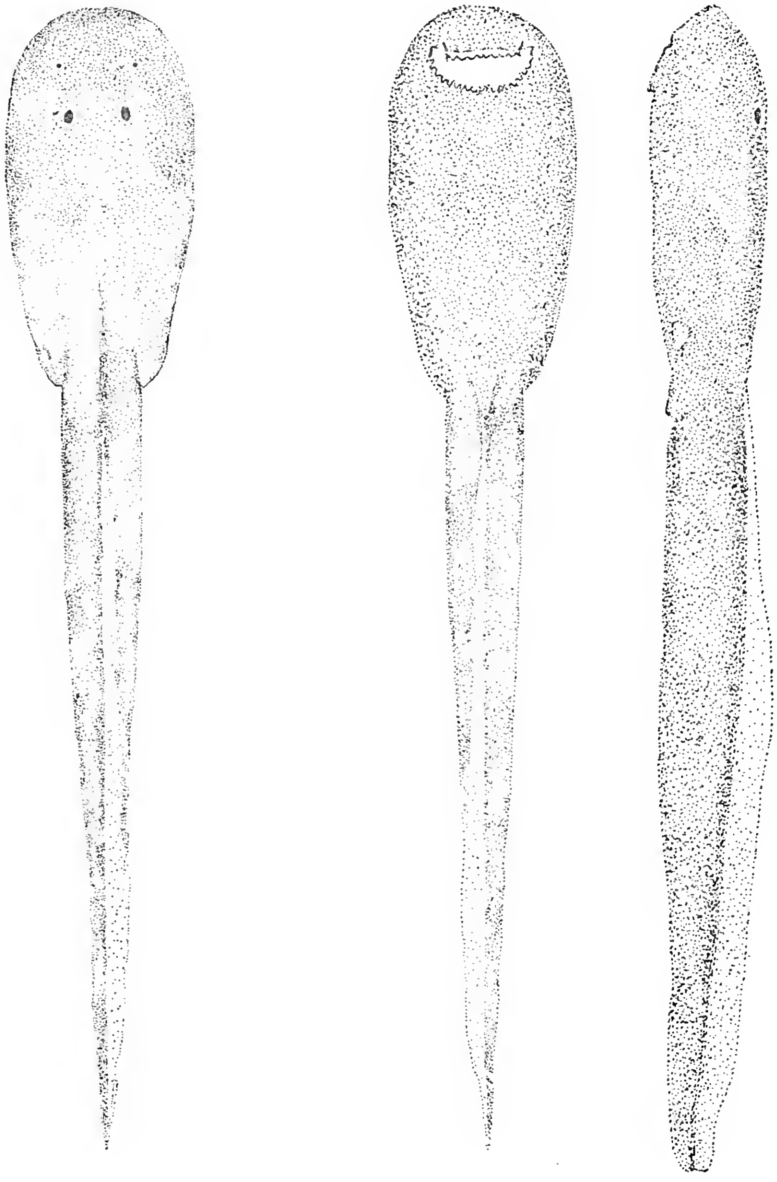


FIG. 6. Tadpole, presumed to be that of a species of *Cochranella.* Specimen B enlarged.

Mouth is surrounded on lateral and posterior parts with a free frill. Mouth ventral, 1 mm., back from the end of the head. The front upper part of the beak is slightly curved, the denticulations strongly marked, small at outer edges becoming gradually larger, then diminishing in size in the mesial region. The eight median teeth smaller, all of approximately the same size. There is a total

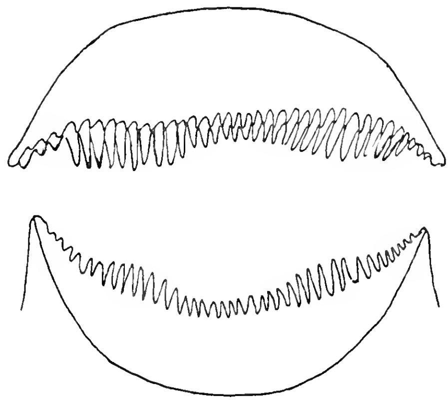


FIG. 7. Teeth of tadpole presumed to be a species of *Cochranella*. Enlarged.

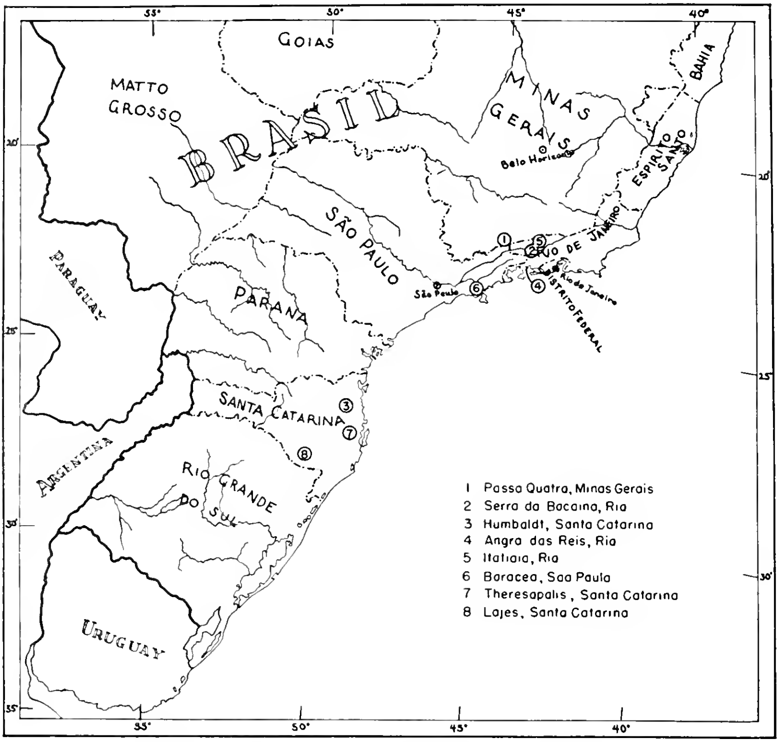
of 32 denticulations. The beak on lower jaw is deep within the mouth and likewise denticulate, but more strongly curved, the row consisting of about 30 denticulations suddenly increasing in size near the outer ends. Within the mouth and invisible when mouth is closed are two rows of very fine denticulations the more posterior nearly on a level but following the curve of the jaw, the more anterior is slightly arched but likewise following the curve of the mandible back of the beak.

The frill is denticulate on its edge, mesially, a millimeter wide but narrowing a little laterally; a row of small papillae border edge of lip and there are no fleshy ridges on the surface of the frill. At no point does the width of the tail and its fin exceed 4 mm. elevation.* No pigmentation whatever is visible.

Specimen C and D have lost much of the buccal frill but while one seems to agree with B in the character of the denticulation, the

* This specimen was accidentally destroyed before the characters of the ventral caudal fin were ascertained.

other suggests still a third form, as regards the denticulations on the beak. Here the teeth are fewer, large, and not reduced in the middle part of the series.



Map of southern Brasil showing type localities

24-6490

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THE UNIVERSITY OF KANSAS
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VOL. XXXV, PT. III] NOVEMBER 20, 1953 [No. 16

The Biology of a Leafcutter Bee (*Megachile brevis*) and Its Associates[1]

BY

CHARLES D. MICHENER[2]

ABSTRACT

This paper presents a detailed account of the habits of the commonest leafcutter bee in Kansas. It is shown that the bee increases greatly in abundance during the warmer part of each year, there being two to four generations per year. This species is very mobile, populations regularly dispersing from certain habitats and new assemblages concentrating at other places as their food sources (flowers) change during the year. Dispersal distances up to several miles are thought to be common. Places of concentration are of two kinds, (1) nesting habitats where the sexes are equally abundant and (2) nectar habitats which hold principally males although females may be found there.

The kinds of flowers used as pollen sources are systematically diverse. Most of them are blue, purple, or whitish in color. No flower constancy was detected in bees merely sucking nectar, but in those gathering pollen there is a strong tendency for only a single kind of pollen to be gathered on any one pollen collecting trip. Exceptions were noted, however.

Nesting sites are always in pre-existing hollows, but these may be almost anywhere. Most are in weed stalks but some are in the ground or even in very dense foliage. Cell structure is also highly variable, both petals and leaves being used in most cells. The processes of cell construction, provisioning, and egg laying are described in detail. Growth and development are also described. In summer the period from egg laying to adult emergence is about a month. The species overwinters as mature larvae.

The life history of the cuckoo bee, *Coelioxys octodentata,* the principal parasite of *Megachile brevis,* is described.

A section on the possible importance of this leafcutter as a pollinator of alfalfa is included and to a considerable extent serves as a summary.

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1. Acknowledgment is made to the General Research Funds of the University of Kansas for aid which made this study possible.

2. Contribution number 841 from the Department of Entomology, University of Kansas.

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INTRODUCTION

This work was undertaken in order to provide detailed information on the bionomics of one of our commonest North American leafcutter bees. Such information should contribute to the study of comparative behavior of bees, which ought to be pressed with the same vigor as that of comparative morphology, for it will doubtless improve our understanding of the relationships of various bee groups. Such information will also serve as a biological basis for efforts to increase the effectiveness of this bee as a pollinator of alfalfa and other crops. The work was begun primarily with this latter idea in mind for *Megachile brevis* is usually the commonest wild bee in Kansas alfalfa fields that is effective in tripping the flowers. However, since the relationships with the environment were found to be exceedingly complex and to vary from season to season, observations were made on all aspects of behavior that could be investigated with the hope that information of practical value in the effort to increase the abundance of these bees could be obtained.

The work was carried on over a period of three years, 1950 through 1952. Much of it was done in the vicinity of Lawrence, Kansas, but long series of observations at other points in the state were made, as indicated in the text.

The observations are not those of any one person; field information was gathered by several persons other than myself. Among these I wish to mention particularly Jimmy R. White, Alvaro Wille, Wallace E. La Berge, and Dr. Roland L. Fischer. Without their help the studies here reported would have required many more years.

Megachile brevis Say is a member of the subgenus *Litomegachile*. It is one of a group of very closely allied species. Mitchell (1936) separated the more distinctive species of *Litomegachile* but retained three forms as "varieties" of *brevis*. One of these "varieties," *nupta* Cresson, is presumably nothing but a rare color variant of *brevis* proper. If this is true, the name *nupta* ought to be placed in the synonymy of *brevis*.

Another of the "varieties" does not seem to intergrade with *brevis* and occupies a range from North Carolina and Mississippi to southern Florida. It is entirely sympatric with *brevis* and must therefore be regarded as a closely related but distinct species, *M. pseudobrevis* Mitchell.

The third "variety," *onobrychidis* Cockerell, has a wide range from Nebraska and Texas to the Pacific. Over this entire area it appears to intergrade completely with bees having characteristics of *brevis* proper. It is therefore probable that a western subspecies, *M. brevis onobrychidis* Cockerell, should be recognized, although some individuals of this subspecies are indistinguishable from *brevis* proper.

The bee upon which the series of observations described below is based is therefore properly called *Megachile brevis brevis* Say. The species ranges from the Atlantic to the Pacific and from southern Florida and northern Mexico to Quebec and British Columbia. It is thus one of our most widespread bees.

Although the details of the life history will be explained later, it seems necessary to give certain background information here. *Megachile brevis,* like other members of the family Megachilidae, is a non-social insect having no worker caste. Each female constructs cells made from pieces of leaves and petals, hence the name leafcutter bee. These cells are placed in any of a wide variety of situations such as in hollow weed stalks, in curled leaves, or in holes in the ground. They may be single or in series, placed end to end. Each is provisioned with a viscous mass of honey and pollen, sufficient to provide food for the entire larval development. An egg is then laid on top of the food mass and the cell is closed with a cap made from more pieces of petals and leaves. In summer the time required for growth and development from egg laying to emergence of the adult is about a month, but larvae reaching maturity after about the middle of August cease their development, passing the winter as mature larvae which pupate and emerge as adults in the spring. The males emerge at about the same time as the females and live about as long as the latter, a situation unusual among bees.

PART I. SEASONAL HISTORY AND HABITATS

SEASONAL FLUCTUATIONS IN ABUNDANCE

Megachile brevis can be seen on flowers throughout the warm season of the year, in Lawrence from May 10 to October 1, and doubtless earlier in very mild springs and later in warm fall seasons. In southern Florida there are collecting records as early as February 9 and as late as November 22; it is possible that the species is active throughout the year there.

Because of the mobility of populations of this bee, it is difficult to obtain satisfactory data on the fluctuations in abundance during the season. A particularly attractive patch of flowers may result in a concentration of bees at almost any time, yet for miles around there may be very few bees. When the attractive patch ceases to bloom, the bees disperse, with the result that there is an apparent (but almost certainly not a real) drop in population. Moreover, the observers were often intent on watching nests or known concentrations of bees with the result that serious attempts to estimate bee abundance over large areas were not made. Furthermore, such factors as temperature, wind, and sunlight so affected the activities of the bees that two days' observation rarely gave comparable results. In spite of these difficulties considerable information on population fluctuations was gathered. For comparative purposes, this was converted to average number of *Megachile brevis* seen per half hour in the field.

In the vicinity of Lawrence this bee is not especially common and in many places, particularly early in the season, not a single specimen would be seen. However, we soon learned the most satisfactory places to look and the data is largely based on observations made in these places, although as indicated above, this introduces irregularities due to the ability of the bees to concentrate in favorable areas.

In any event, near Lawrence, the first *M. brevis* were seen on May 15 in 1950 (a not entirely fresh female which must have been active for several days), May 22 in 1951, and May 26 in 1952. A very fresh male in the Snow Entomological Museum was collected near Lawrence on May 10, 1949. During May and the entire month of June, the bees were scarce. This was particularly so in the very cool, wet June of 1951. This was the wettest June on record, with a total rainfall of 11.65 inches, resulting in great floods. During this month there was no day recorded when the average number of *M. brevis* observed per half hour exceeded four. During the dry and relatively warm June of 1952, the bees were but little more abundant, probably because of the small number produced during 1951, but in the more normal but cool June of 1950, there were days when ten bees per half hour could be observed.

Both in 1950 and 1952, marked increases in abundance were noted soon after July 1. In the warm dry season of 1952, this was particularly noticeable and by the last week in July areas existed where one could hear the sound of *Megachile* flight at all times during the day and could see as many as 60 individuals (amount of duplication unknown) per half hour. In 1951, however, doubtless because of continued cool wet conditions and presumably poor reproduction during the extreme June weather, no marked increase in *Megachile* abundance was noted during July.

In August, 1950 and 1951, particularly the former, increases in *Megachile* populations were noted, so that averages of 40 bees observed per half hour were sometimes recorded in 1950, 20 in 1951. Although no more adults probably emerge after the first week in September,[1] this abundance was maintained through Sep-

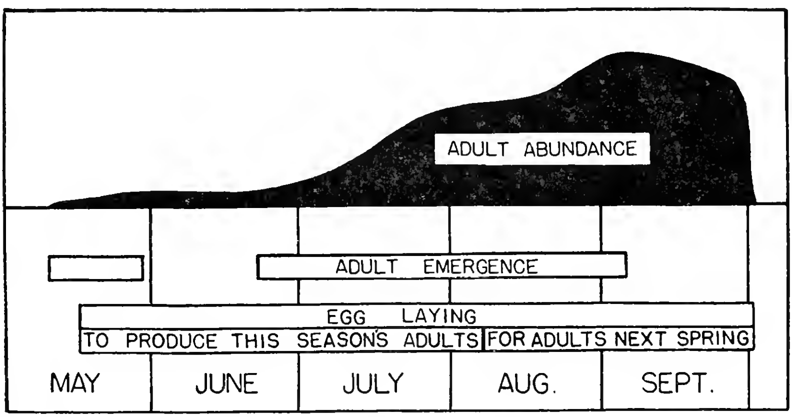

FIG. 1. Diagram showing estimated average seasonal fluctuation in adult abundance of *Megachile brevis*, together with probable seasons of adult emergence and of egg laying.

tember each year. In 1952, the records suggest a different picture, for by August 15, the bees seemed much scarcer than in late July and early August, and this situation prevailed through September. The year 1952, by contrast to 1951, was one of the dryest growing

1. A specimen emerged in the laboratory on September 5, 1952, and a very fresh specimen was seen in the field on September 11, 1950.

seasons on record and therefore by middle and late summer flowers were very scarce. There is no doubt that this scarcity resulted in an apparent reduction in the bee population by dispersing it as well as in a real reduction due to the scarcity of food supplies. Counts made in early September, 1952, in the most favorable locations and in good weather, showed only six to ten *Megachile* per half hour.

Based on the three years of experience which included one extraordinarily wet and cool summer (1951) and one hot and extraordinarily dry summer (1952), it seems certain that in an ordinarily warm summer with enough precipitation to grow a normal crop of flowers, *Megachile brevis* populations in the Lawrence area would increase during the summer in approximately the manner shown in figure 1. It seems possible that in the characteristically drier regions of western Kansas, where the predominant late summer and fall flowers are yellow composites rarely utilized by this bee, the fall increase in abundance might not occur, as was the case in 1952 in Lawrence.

NUMBER OF GENERATIONS PER YEAR

The number of generations per year doubtless fluctuates with the length of the active season. Even in a single locality it is apparently not a regular or constant matter. The only generation which is relatively easily understood is the first. All bees active in May and early June seemed rather fresh. Because of the scarcity of this generation it is impossible to say how long the adult emergence period is, but the impression gained from the apparent increase in abundance of bees on flowers during May is that the emergence may continue until about the end of May. Nest construction and egg laying doubtless begin within a few days after emergence of the adults and continue for nearly their entire lives, probably at least a month. In the climatically more or less normal spring and early summer of 1952, a perfectly fresh female believed to be of the second generation was seen on June 17, and an exceedingly badly worn female, doubtless a remnant of the first generation, on July 3. In summer the egg to adult period is about a month; in the cooler weather of spring it is somewhat longer. Thus second generation individuals would be appearing more or less continuously from about June 17 until the beginning of August.

Considering the earliest offspring of each generation (thus the maximum number of generations per year), we conclude that second generation individuals emerging as early as June 17 could probably have mature third generation progeny as early as July

20 or 25. (These would thus be emerging at the same time as the last second generation individuals.) These third generation individuals could have adult progeny of the fourth generation by the end of August or early September. Their progeny would hibernate and emerge in the spring as the first generation of the following year.

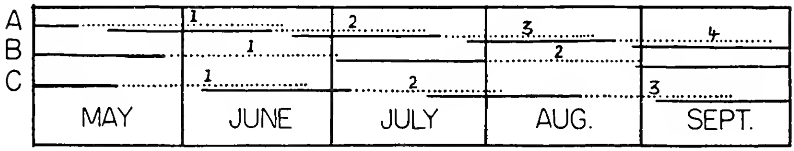

FIG. 2. Diagram showing the way in which generations become mixed, largely because of the long reproductive period of these bees. A represents a seasonal cycle of 4 generations, in which the earliest eggs of each generation give rise to the following generation. B represents a seasonal cycle of 2 generations in which the last eggs of each generation give rise to the following generation. C represents the presumably commonest situation of three generations. Solid lines represent immature stages; dotted lines adults. Generations of adults are numbered.

By contrast, considering the last offspring of each generation (thus the minimum number of generations per year) we conclude that second generation individuals emerging in late July would lay some of their last eggs well after the first week in August. Such eggs would not develop into adults until spring; thus there would be but two generations during the year. It is quite likely that some such second generation bees would survive until late August and thus be in flight at the same time as the earliest fourth generation individuals mentioned in the preceding paragraph. In short, it seems that in a year of ordinary temperatures near Lawrence, Kansas, there may be as few as two generations or as many as four; most probably go through three generations. After the first, the generations become completely mixed as shown in figure 2, because of the rather long periods (probably about a month) during which adults are active and laying eggs. One can therefore observe most adult activities, such as nest construction and provisioning, at all times from May until the first of October.

Studies of ages of population samples during 1952 support these statements. Age was judged by the amount of tattering of the wing margin; the condition of specimens was recorded as fresh, fair, or poor by comparison with drawings prepared in advance and carried in the field. Many of the bees were liberated after examination. About equal numbers of each sex fell in the various categories, indicating that wing wear of males is about equivalent to that of females. All specimens (15) collected in May and on June 1 and 2, were fresh. Five specimens collected on June 7, and five more on June 13, were fair. On June 17, nine specimens were fair, two poor, and one (presumably second generation) fresh. Increasing numbers of fresh specimens were observed later in June and on July 3, a small sample was classified as follows: one very poor (remnant of first generation), three fresh, three fair. As bees became more abundant it became possible to obtain larger samples for this purpose and during July and August 290 specimens were examined to determine the amount of wear of the wings. Of these 111 were classified as fresh, 166 as fair, and 14 as poor. During these months there was no particular time when one category was more abundant than at other times; the summer population was a complete mixture of age groups. The small number of bees in poor condition was due to the extremely tattered wings required for this classification; only a few bees achieved sufficient wear (and sufficient age?) to be so classified.

The data for the exceedingly cool and wet spring and early summer of 1951 indicated that weather conditions influenced the rate of development and hence the number of generations. Two freshly completed nests of three cells each were found, one on May 27, one on May 29. Each was kept and the time of emergence of adults was July 11 and 12. Unfortunately all six bees which emerged were the parasite, *Coelioxys*. However, later in the summer the developmental period of the *Coelioxys* is about the same as that of *Megachile;* therefore there is good reason to believe that the cool weather slowed the developmental period of both forms from about a month to about 45 days. This surmise is supported by the field observations which show that, while very few bees could be found, only tattered individuals (presumably first generation) were seen during the first week in July. Their number was even smaller than during June, so that it appeared that the first generation nearly died out before the appearance of the second generation. Several fresh individuals were seen in the field during the second week in July. In a year such as this it would seem that the maximum possible number of generations would be three and that two might be very common. The small number of generations, in addition to the reduced reproductive activity of individual bees due to frequent periods of cloudy weather, rain, and low temperatures, would account for the low populations observed during 1951.

OVERWINTERING

As can be seen from figure 1, a very large proportion of the normal year's production consists of the overwintering individuals, and relatively few of these individuals survive to emerge the following spring. The reasons for the high winter mortality are discussed elsewhere. Overwintering occurs as fully fed mature larvae or prepupae. The factors which cause the cessation of development at this stage are not obvious, for temperatures are still high, sometimes very high, in the third and fourth weeks of August. Yet larvae which reach maturity at that time remain in that stage. They do not pupate and soon emerge as adults, as would mature larvae earlier in the season even at much lower temperatures.

The data concerning the time at which diapausing begins are as follows: An egg laid August 5, 1952, produced an adult on September 5. An egg laid approximately August 7, 1952, produced an adult at an unknown date in early September. Larvae from these eggs must have been spinning cocoons about August 16 and 18, and proceeded with their development to become adults. Eggs laid about August 17, and on August 20, 1952, developed into individuals which went into winter as mature larvae.

Twelve eggs (in several nests) which were laid on various dates from August 7 to 13, 1950, did not produce adults that year but went into winter as mature larvae. Six other larvae which had reached maturity and were beginning cocoon spinning from August 16 to 21, 1950, also went into winter as mature larvae.

Nests are still being provisioned as late as October 1; therefore all of the eggs laid from about August 7, until October 1, go to make up the overwintering generation, or first generation of the following year. It is not known exactly when pupation of this generation occurs but it is in the spring with adults emerging during the last two thirds of May.

In nests kept in the laboratory at room temperature during the winter the emergence is spread out over a long period, from October to March. Under conditions of continued warmth the diapause is apparently broken very irregularly and at widely different times.

DISPERSAL AND FAVORED HABITATS

As has already been intimated, *Megachile brevis*, unlike many solitary bees, is a highly mobile species. Since it has a long season of adult activity with several generations per year, the places which are particularly favorable at one time of the year are entirely different from those that are favorable at other times. Not only do successive generations disperse from their regions of emergence and concentrate in the places that happen to be attractive at the moment, but it seems certain that a bee in the midst of its life and of its nest making activities may leave one area to go to another, perhaps several miles distant.

Strong indications exist of a constant shifting about of populations. Concentrations, largely of males, occur in areas of good nectar supplies even though nesting sites and pollen supplies are not available.

There are probably virtually no areas in eastern Kansas where *Megachile brevis* cannot occasionally be found. There appear to be no natural habitats which are favorable enough to attract large numbers of *Megachile* throughout the season of activity. The following sections on favorable areas where most of our studies were made are presented in order to indicate the characteristics of the places that are favorable at different seasons and in order to present the evidence for dispersal.

There are two types of favorable habitats which cause concentrations of the bees. One is called a *nesting habitat,* for it provides nesting sites and pollen sources as well as nectar. So far as is known, all plants utilized for pollen also provide nectar; at least the bees thrust their proboscides into the flowers as though sucking nectar at the same time that they collect pollen. The other is called a *nectar habitat.* It is a place where the principal flowers are highly attractive as nectar sources but are not used for pollen. Nesting sites may not be available in the vicinity. Male bees sometimes concentrate in such situations, and some female bees are found there.

Nesting Habitats

Although the first *Megachile brevis* emerge in the vicinity of Lawrence in the first third of May, there are no known areas of concentration until the last third of May. At that time (actual observations dated May 24 to June 5) *Amorpha fruticosa* comes into bloom in low moist areas where there is no shade and often the bees concentrate on it in considerable numbers for this season. *Area 1,* where many spring observations were made, is one mile east, one mile south of Lawrence. It is a swampy spot about two acres in area full of *Amorpha fruticosa.* A railroad embankment along one side of it is covered with small rose bushes which provide leaves for nest making and with dead stalks of various large weeds, such as *Helianthus* and *Ambrosia,* which provide favorable nesting sites.

The *Amorpha* is the only source, so far as known, for pollen and nectar at this place. In early June, when this species of *Amorpha* ceases to bloom freely, the *Megachile* disappear in spite of the presence of certain flowers sometimes used by *Megachile* (e. g. *Trifolium* [1]). At no subsequent time in the year, in spite of periodic observations throughout the summers of 1951 and 1952, were many *Megachile* seen in the region of Area 1, although very occasional individuals sucking nectar from *Teucrium* and *Verbena* were seen on a hill one fourth of a mile away during August.

In general, although it is occasionally a nectar source, sweet clover (*Melilotus*) is not a pollen source for *Megachile brevis*. On two occasions, however, among hundreds of patches of this plant examined, small patches of freshly blooming *Melilotus officinalis* have been found to be rather heavily used (considering the scarcity of the first generation) as pollen sources. One of these, *Area 2,* is four miles north of Garnett, Kansas, and bees were observed there on May 22, 28, and 29, 1951, each day abundant enough that about six could be seen per half hour of observation. This patch was on high dry land in a weedy roadside area where there were plenty of old *Helianthus* stalks for nesting sites. On June 10, only a single *Megachile* was seen there; presumably the others had left in favor of areas of *Psoralea floribunda* half a mile away or because the sweet clover became less attractive as it became older. The second area where bees were seen using *Melilotus officinalis* as a major pollen source was along the road through the sand hills four miles south of Garden City, Kansas, on June 12, 1952.

After the *Amorpha fruticosa* is no longer in full bloom the principal plant attractive to *Megachile brevis* as a pollen source is *Psoralea floribunda,* or in certain areas in southeastern Kansas (*e. g.,* Galena and three miles east of Baxter Springs), *Psoralea psoralioides eglandulosa.* The former in particular is a widespread and common prairie plant. It occurs often in small prairie patches remaining along roadsides or railroads, but is especially abundant in large prairie acreages. In eastern Kansas the prairies are limited to high ground, usually hill tops. Thus the bees of the first generation, when the *Amorpha fruticosa* is no longer in bloom, apparently must often move distances of several miles from low wet areas to prairies covered with *Psoralea floribunda.*

The most studied prairie of this sort, *Area 3,* located three miles southwest of Ottawa, Kansas, is several square miles in extent. A

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1. Except for the list in the section on kinds of flowers visited, generic names only are used in mentioning flowers unless two species of a genus are discussed in this paper.

few trees grow in the gullies but even there the herbaceous vegetation consists largely of prairie species. The *Psoralea floribunda* begins to bloom there at about the beginning of June and each year *Megachile* have been collected there between June 2 and 6. There are no earlier prairie flowers attractive to *Megachile* in this area. The *Psoralea* remains in bloom and serves as both a pollen and nectar source until near the end of June. In the latter part of that month *Amorpha canescens,* another prairie plant, is sometimes also used as a pollen and nectar source. As soon as the *Psoralea* is no longer in abundant bloom, however, the bees disappear from the prairie, even though *Amorpha canescens, Petalostemon,* and other seemingly suitable plants are in full bloom there. In Area 3, there are no suitable weed stalks for nesting, and the bees nest under bits of sod, under dried cow dung, or in fence posts. They use for nests leaves and petals of the small prairie rose as well as of various other prairie plants.

Area 4 is a floristically similar prairie of only a few acres extent located one and one half miles west and one half mile south of Lawrence. Any part of it is within a few hundred feet of such nesting sites as old *Ambrosia* and *Helianthus* stems. In this area, too, *Megachile* activity, although always slight, was limited to the season when *Psoralea floribunda* was in bloom, except for the one observation described in the following paragraph.

One of the first bits of evidence concerning migration came from the following series of observations: On August 3 and 7, Area 4 was carefully inspected for *Megachile* because of the excellent growth of seemingly suitable flowers such as *Petalostemon.* Not a specimen of *M. brevis* was seen. On these days, however, a few *M. brevis* were seen in a pasture one fourth mile away which was heavily grown up with *Vernonia*, from which the bees were gathering pollen as well as nectar and with *Symphoricarpos,* which was used only for nectar. On August 15, in the morning, this pasture was mowed and all the flowers in it cut. By noon that day several *M. brevis* of both sexes could be seen in Area 4, sucking nectar from the *Petalostemon* and from *Solidago* flowers. The next day, and subsequently, none could be found there. The inference was that the bees dispersed from the mowed pasture, some of them stopping for nectar in Area 4, but not staying since the flowers there were of rather unattractive sorts.

During the latter part of June and the first half of July the *Megachile brevis* seem very much dispersed with no areas of abundance on native vegetation. A very few remain in the prairies where they collect pollen of *Amorpha canescens;* others are attracted by the first flowers of *Vernonia.* Introduced alfalfa (*Medicago*) is the only plant which seems to attract rather large numbers of *Megachile brevis* at this season. They were studied in numerous areas on alfalfa, but the only place worthy of special comment is known as *Area 5.* This is a two-acre patch of alfalfa surrounded by brushy and weedy creek bottoms and roadside vegetation. It is located near Blue Mound, southeast of Lawrence, Kansas. It was in full bloom when first visited on July 14, 1950, and was nearly out of bloom by August 4. During this period *Megachile brevis* was abundant collecting pollen and nectar, particularly so about July 20, when the hum of several *Megachile* could be heard at all times and at one time an estimate of 80 bees seen per half hour of observation was made. In late July, as the flowering became poorer, the *Megachile* became much scarcer.

One of the principal sources of pollen in the latter part of July and throughout most of August is *Vernonia.* This plant comes up as a perennial weed in poorly cared-for pastures, particularly in low but not swampy lands. Patches of it are very common; a few *Megachile brevis* can be found in most of them, many in some. The *Vernonia* patch most fully studied is *Area 6,* a pasture of many acres 9 miles south and 3 miles east of Lawrence. It had grown up in brush and small trees, and then a few years ago it was cleared except for certain large trees. The resulting cut brush and trees were placed in large piles scattered over the pastures. Weeds coming up in these piles were out of reach of cattle and matured and died, leaving many old weed stalks for nesting sites, in addition to scattered weed stalks elsewhere in the pasture. Sumac (*Rhus*) bushes around the pasture served as an important pollen source in 1950, especially as the *Vernonia* went out of bloom in mid-August. In 1951, the *Vernonia* was just coming into bloom at the end of July and continued until the end of August but in the warmer summer of 1952 it was blooming by mid-July and nearly out of bloom by mid-August.

Area 7 is an abandoned pasture six miles southeast of De Soto, Kansas. Since the principal pollen source is *Vernonia,* the area is attractive to *Megachile* at the same season as Area 6. The situation differs from that of Area 6 principally in the great abundance of dead *Ambrosia* and *Helianthus* stalks throughout the area, forming suitable nesting places, and in the profusion of *Symphoricarpos* which provides nectar from late July into September. *Lythrum* in a low area also serves as a nectar source. Thus as long as the *Vernonia* is in bloom this is an important nesting habitat; indeed in 1952, the only season that this area was observed, *Megachile* was more abundant here than at any other place found in eastern Kansas, possibly because of the combination of a good pollen source and many nesting places.

On July 25, 1952, most of the *Megachile* observed in this area were working on *Vernonia* flowers. By August 8, many were visiting *Symphoricarpos* for nectar, as was observed on repeated visits thereafter. By August 20, the few stragglers among *Vernonia* plants were still being visited for pollen but most of the bees in the area were visiting *Symphorocarpos* for nectar. Although, as indicated above, the abundance of *Megachile* in this area in 1952 was doubtless due to *Vernonia* and the numerous nesting places, the availability of *Symphoricarpos* nectar may be the factor that kept the bees in the area almost until the last *Vernonia* was out of bloom. By August 10, the bees were nearly gone from a *Vernonia* patch about a mile away which lacked the *Symphoricarpos.*

Area 8 is a somewhat similar pasture two miles east and eight miles south of Lawrence. It lacks the numerous nesting sites of Area 7, and the *Vernonia* is rather sparse; as at Area 6 an important pollen source is bushes of *Rhus.* Because of the abundance of *Symphoricarpos*, and in some places of *Lythrum,* the area is also a nectar habitat. Observations began in this area on August 4, 1951, when both *Vernonia* and *Rhus* were being used as pollen sources. It seemed that *Rhus* was most visited in the mornings. As this was a high dry area, the *Vernonia* ceased bloom earlier than in Area 6, so that by mid-August most of the pollen collecting was from *Rhus,* which in turn ceased its blooming in late August. Thereafter the only *Megachile brevis* seen in the area were a few sucking nectar from various flowers which are not used for pollen.

After the *Vernonia* of the pasture areas and the *Rhus* of nearby fence rows and waste land stop blooming, there is a short season when there is no really suitable abundant pollen source for *Megachile brevis* in eastern Kansas. The bees apparently disperse (see records of dispersal from Area 8 in the section on studies of marked individuals below) and can be seen sucking nectar from a very wide variety of flowers.

In 1950, a pasture (*Area 9*) three miles northwest of Lawrence was the site of intense activity of *Megachile brevis.* On September

5, when the place was first visited the bees were collecting pollen from both *Gutierrezia* and *Trifolium*. This activity very likely started because of the shortage of more suitable flowers. At no other place were these flowers found to be used except as an occasional nectar source. Moreover, the same flowers growing in the same place were not seen visited for pollen by *Megachile brevis* in 1951 or 1952. In 1950, however, pollen gathering continued until the *Gutierrezia* ceased flowering about September 25.

The usual pollen source after the first week in September is various species of purple *Aster* which bloom along roadsides and in pastures. In *Area 10*, four miles northwest of Lawrence, *Aster* began to bloom about September 6, 1950, and continued until October 7, although no *Megachile* were seen after October 1, doubtless because of cool weather. They were collecting pollen on October 1, however.

NECTAR HABITATS

It seems likely that *Megachile brevis* will, on occasion, suck nectar from almost any flower from which this bee is physically equipped to obtain nectar. Moreover, as already stated, it will obtain nectar from probably all the kinds of flowers used as pollen sources. There are, however, certain kinds of flowers not or rarely visited for pollen but very attractive to these bees as nectar sources. Patches of such flowers seem to hold wandering bees, especially males, for varying lengths of time. It is the resulting concentrations of bees not active in nest making that characterize the nectar habitats.

Areas 7 and 8 described above became nectar habitats when the pollen sources in them failed. The bees obtained the nectar principally from *Symphoricarpos*, to a lesser extent from *Lythrum*, occasionally from *Pycnanthemum*, *Bidens*, and various other plants. In each of these areas there was a considerable period when both nesting bees and those which appeared to be only sucking nectar could be found.

A small seepage space in Area 6 is a nectar habitat, often full of male bees and of some females which show no evidence of nesting in the area. Here the nectar sources are numerous and attractive before, during, and after the pollen producing plants (*Vernonia*, *Rhus*) of this area are in bloom. The plants producing the nectar are *Lythrum*, *Lippia*, *Verbena*, *Lycopus*, *Trifolium*, *Pycnanthemum*, *Teucrium*, *Ludwigia*, and *Bidens*. One or another of this series of plants is in bloom from early July to early September, and at least a few *Megachile* can be found there throughout that season.

The only area studied which was strictly a nectar habitat was *Area 11*. This is a swampy meadow about 50 yards long and 25 yards wide. It is located nine miles south of Lawrence. It is surrounded by a corn field, a bit of prairie containing neither flowers nor nesting places likely to attract *Megachile brevis,* and a sowed grass pasture. Thus there are practically no nesting sites. The meadow was full of *Lythrum* in bloom through the entire month of August, 1951, and until mid-August in the dry summer of 1952. *Megachile brevis* was the commonest bee on these flowers.

The presence of an occasional nesting *Megachile* in this area is shown by the record of a female cutting leaves there. Such scattered nesting individuals can be found almost anywhere, irrespective of the areas of concentration discussed above.

Studies of Marked Individuals

The preceding sections show clearly that *Megachile brevis* is found in a wide variety of situations and that it concentrates in different places at different seasons. The conclusion is obvious that considerable dispersal occurs. To shed additional light on the matter, several marking studies were undertaken. Only two such studies produced significant data and even in these cases the data are meager. Both of these studies were made during August, 1951.

During the period August 4 to 20, inclusive, 148 *Megachile brevis* were marked in Area 8. Weather permitting, the area was visited and specimens marked every other day.

Marking was done by means of quick drying paints, spots of which were applied by means of a fine brush to bees captured in a net. All individuals marked on any one day were marked with the same color on the same part of the body. If a bee were recaptured on a subsequent day, it was marked with the color of that day, so that a bee might acquire several spots of color if it were recaptured several times. There was no evidence that the paint injured the bees. Sometimes it probably wore off, for bees were occasionally seen from which most of the paint had disappeared. However, there is no reason to believe that bees which had thus lost their identity played any large role in the results described below.

No doubt due to the change in this area from a nesting habitat in early August to a nectar habitat in the later part of the month, a considerable change in the *Megachile* population was noted. Thus from August 4 to 12 a total of 103 bees were marked, of which 67 (13.8 per day of marking) were females, 36 (7.2 per day of marking) males. From August 16 to 20, a total of 45 bees was marked, of which 13 (4.3 per day of marking) were females, 32 (10.7 per day of marking) males. Thus the number of males marked per day increased as the area became a nectar habitat, perhaps largely due to the decrease in abundance of females which allowed the marker more time for capturing and marking males. At the same time the number of females decreased very greatly. Each day of marking usually amounted to about three hours in the field, with variations due to weather conditions. The ages of the bees varied greatly throughout the month; there was no evidence of the bees in the nectar habitat averaging younger or older than those in the nesting habitat.

Recoveries of marked bees were remarkably few. Even early in the month when pollen collecting females were often marked, only two females were seen after marking; one first marked on August 6, was marked again on August 10 and 16, another first marked on August 4, was marked again August 8. Since nest making females spend most of their time either collecting pollen or pieces of leaves, it seems that had they remained in the vicinity they would have been seen again in greater numbers. The few nests located in and around Area 8 at this time consisted of only one or two cells. The impression which we acquired is that, with *Vernonia*, the principal pollen source, rather scarce, the female nesting bees remained only long enough to finish one or two cells and then moved on. It should be pointed out that while *Rhus* was an important pollen source, we have never seen this plant alone support a population of these bees; we have always seen it used merely to supplement *Vernonia* as the latter nears the end of its flowering season.

Two additional females were recovered from among individuals marked after the middle of the month. One was merely seen in Area 8 two days after marking. By good fortune, however, one which was marked in Area 8 on August 16 was seen again on August 30 near Area 1 at a distance of 5.5 miles from the point where it was marked. This lends strong support to the idea of the great mobility of these bees. On both occasions this female was merely sucking nectar, not gathering pollen, the first time from *Symphoricarpos*, the second time from *Teucrium*. As already explained, late August is a period of poor pollen supplies for *Megachile brevis* in this region, for *Vernonia* and other midsummer pollen sources are waning, but purple *Aster*, the main autumnal pollen source, is not yet in bloom. It is quite likely that many *Megachile* spend this time wandering about.

Among males eight individuals were recovered, twice as many as among females although there were 12 less males than females marked in total. If significant, this difference between the sexes indicates that the males moved about less than the females. This is quite likely true, for because of *Symphoricarpos* Area 8 was apparently an attractive nectar habitat. Females, being probably motivated by the need for pollen with which to provision nests, would not be expected to remain long in a nectar habitat.

One male (the only one recovered more than once) was marked on August 6, recovered August 16, 18, 20, and seen on August 22 and 28. All five times after August 6, this bee was found in or around a single clump of *Symphoricarpos* bushes, showing that this individual, probably unlike most, stayed in or returned to a very restricted locality for at least 22 days.

The other marking study was conducted at Area 11, the small isolated *Lythrum* patch with practically no nesting sites or pollen sources nearby. On August 17, 1951, in one and one half hours, 55 male and four female bees were marked (all in the same way). An hour later a 15 minute survey of the area revealed 19 marked males and 4 unmarked ones. Assuming that the ratio of marked to unmarked bees in the area was as the ratio of marked to unmarked ones seen in the 15 minute survey, it was calculated that there were 12 unmarked male bees in the area, or a total of 67 males. Their age distribution was wide, as usual at this season. Of the 55 males marked, 5 were fresh, 45 in good condition, and 5 in poor condition.

Table I shows the results of similar 15 minute surveys conducted on other dates. The consistent scarcity of females in this nectar habitat is evident, as is the rather rapid disappearance of marked individuals and appearance of unmarked ones. This seems to provide additional evidence of mobility in this species.

TABLE I.—Number of marked (M) and unmarked (U) *Megachile brevis* found in 15 minute surveys of Area 11 on various dates in August, 1951. Marking was done on August 17.

		Number marked	August 17	August 20	August 22	August 29	August 31
Male	M	55	19	8	5	1	2
	U		4	6	16	7	5
Female	M	4					
	U			1			2

PART II. RELATIONS WITH FLOWERS

KINDS OF FLOWERS VISITED

Megachile brevis is commonly regarded as a highly polylectic species. For example Mitchell (1936) writes, "There are apparently few flowers which it will not visit." This is probably quite true insofar as visiting flowers for nectar is concerned, although definite preferences are exhibited for certain nectar sources.

In its pollen collecting, *Megachile brevis* is clearly rather restricted, as shown in Table II. There is some systematic significance to the limitations of the list; for example whole families like the Rosaceae are unrepresented. Yet very diverse plants such as certain of the Leguminosae and certain of the Compositae are much used. It is interesting to note that the principal pollen sources are blue or purple flowers, although such flowers may be systematically in families as diverse as the Leguminosae and the Compositae. Certain less important pollen sources are white or greenish, and one rather minor source, *Gutierrezia,* is yellow. This is interesting in view of the large number of yellow composites of the region. Many of these, such as various species of *Helianthus,* are regularly visited by many bees, including various species of *Megachile,* but they are only rarely utilized by *Megachile brevis* even for nectar.

These observations show clearly that *Megachile brevis,* in its pollen collecting, is far more restricted than such forms as *Apis* and most species of *Halictus* and *Lasioglossum.* This leads to consideration of the meaning of the terms oligolectic and polylectic. These terms were used by Robertson and subsequent workers, oligolectic bees being those which visit few kinds of flowers and polylectic ones being those which visit many kinds. Mere visiting for nectar, however, is usually not of great biological significance, and most records of visits of bees to flowers are of far less value than if additional information as to whether or not pollen was gathered were also recorded. In most bees the males and nectar sucking females visit most readily the kinds of flowers from which pollen is also gathered by the species. However, they may visit almost any flowers which provide nectar. It is in their pollen gathering that many bees are specific.

The many highly oligolectic forms known to gather pollen from only a single genus (or even species) of flower, fall at one end of a spectrum, with highly polylectic forms (e. g. *Apis*) at the other end. *Megachile brevis* falls in the midst of this spectrum.

TABLE II.—Kinds of flowers visited in Eastern Kansas by *Megachile brevis*. (x marks under pollen and nectar sources indicate relative importance; from x—one or two records only, to xxxx—of major importance.) Presumably all pollen sources are also nectar sources but this is not indicated in the table. Localities of information not obtained in vicinity of Lawrence, Kansas, are indicated under "remarks."

Scientific name	Common name	Pollen source	Nectar source	Season	Color	Remarks
Alismataceae *Sagittaria*	Arrowhead		x	July	white	
Euphorbiaceae *Croton*	Croton		x	August	white	
Verbenaceae *Verbena micrantha*	Verbena		x	late July	white	
Verbena	Verbena		xx	July and August	purple	
Lippia lanceolata var. *recognita*	Fogfruit		x	July	whitish	
Labiatae *Lycopus americanus*	Water Horehound		xx	late July and August	whitish	
Pycnanthemum flexuosum	Mountain Mint		xxx	August	whitish	
Teucrium canadense	Wood Sage		x	August	purple	
Leguminosae *Astragalus*	Loco weed		x	June	whitish	
Amorpha fruticosa	False Indigo	xxx		May and early June	whitish	
Amorpha canescens	Lead Plant	x	xx	mid-June to mid-July	purple	
Petalostemon	Prairie Clover		x	July and August	white purple	
Medicago sativa	Alfalfa	xx		July and August	purple	
Melilotus alba	White Sweet Clover		x	July and August	white	
Melilotus officinalis	Yellow Sweet Clover	x		May and June	yellow	Locally used as an important pollen source
Psoralea floribunda	Wild Alfalfa	xxx		June	purple	
Psoralea psoralioides eglandulosa		xx		June	purple	Southeastern Kansas
Lespedeza violacea	Bush Clover	x		August	purple	
Strophostyles helvola	Wild Bean	x	xx	late Aug., early Sept.	red	
Tephrosia virginiana	Goat's Rue		x	June	red and yellow	

TABLE II—*Concluded*

Scientific name	Common name	Pollen source	Nectar source	Season	Color	Remarks
Trifolium repens	White Clover	xx	xxx	July to Sept.	white	In one locality, one season, important pollen source
Lythraceae *Lythrum alatum*	Winged Loosestrife		xxxx	July and August	purple	
Onagraceae *Ludwigia alternafolia*	False Loosestrife	x	xx	August	yellow	
Anacardiaceae *Rhus copallina*	Sumac	xx		August	whitish	Found used only near failing *Vernonia* patches
Umbelliferae *Zizia aurea*	Meadow Parsnip		x	late May early June	yellow	
Rubiaceae *Diodia teres*	Buttonweed		x	August	pinkish	
Caprifoliaceae *Symphoricarpos orbiculatus*	Buckbrush		xxxx	August	whitish	
Compositae *Coreopsis grandiflora*	Coreopsis		x	June	yellow	South-eastern Kansas
Bidens polylepis	Beggarticks		xx	late Aug., early Sept.	yellow	
Helianthus annuus	Sunflower		x	August	yellow	
Silphium perfoliatum	Cupplant		x	August	yellow	
Rudbeckia serotina	Black-eyed Susan		x	July	yellow	
Ratibita pinnata	Yellow Coneflower		x	July	yellow	
Helenium autumnale	Sneezeweed		x	August	yellow	
Gaillardia pulchella	Gaillardia		x	June	yellow-orange	Garden City Kansas
Gutierrezia dracunculoides	Broomweed	xx		Sept.	yellow	In one locality, one season, important pollen source
Aster	Aster	xxxx		Sept.	purple	
Solidago	Goldenrod		x	late Aug.	yellow	
Eupatorium perfoliatum	Boneset		x	August	whitish	
Vernonia interior	Ironweed	xxxx		late July and August	purple	

It should be clear that the terms oligolectic and polylectic are usually significant only in relation to pollen collecting, and that even in that reference they are only comparative terms.

Nectar Gathering

Bees of both sexes regularly insert their proboscides into flowers, evidently for nectar. This activity occurs throughout the lives of the adults. Individuals which had only been out of their nest for a few minutes were liberated in the midst of a patch of *Lythrum*. One of each sex alighted on *Lythrum* flowers after flying less than two feet from the point of liberation and inserted its proboscis in the ordinary and seemingly expert fashion. At the other extreme, very tattered and old individuals of both sexes are often seen sucking nectar.

Males alight on flowers almost solely in order to obtain nectar. Often in the midst of actions interpreted as searching for females they were seen to alight and suck from flowers.

Females probably suck nectar from every flower used as a pollen source. Rarely they stop only for nectar in the midst of pollen collecting. We have a record (August 9, 1950) of two females seen in Area 6 with a little *Vernonia* pollen on their scopas, but sucking nectar from *Ludwigia* flowers. Perhaps in the course of gathering pollen they wandered away from the *Vernonia* into the nectar habitat and sucked some nectar before going on to more *Vernonia*. More frequently, bees with full pollen loads are seen to stop at certain flowers and suck nectar only. This is most noticeable when nectar is gathered from kinds of flowers not used as pollen sources. Thus near Lawrence on August 19, 1950, two females with full loads of pollen from unknown but distant sources were seen to return to the vicinity of their nests. Before they went into their nests each stopped to suck from several flowers of *Diodia*. Such sucking may occur before the bees leave the vicinity of the pollen source, as shown by the following example: Near Galena, Kansas, on June 12, 1951, females were gathering pollen from *Psoralea psoralioides eglandulosa*. One with an apparently full pollen load was seen to leave the *Psoralea* and go to a *Coreopsis* head blooming among the *Psoralea*. There it sucked from several disk flowers, flew on to three more *Coreopsis* heads, to a *Psoralea* spike, to a *Coreopsis* head, to a *Psoralea*, to a *Coreopsis*, and then away. The impression was that having obtained a full pollen load, the bee sucked nectar from any convenient source, perhaps to fill its crop. That this is a common action is indicated by the frequency with which bees having full pollen loads were seen sucking nectar but not gathering pollen. Thus bees with full loads of *Rhus* pollen were several times seen sucking from flowers of *Teucrium* or *Vernonia.*

Female bees, while looking for a nesting site, will usually stop and suck from a flower of almost any kind if it is close to their line of flight, and if a patch of flowers is encountered, they may visit several of them before going on.

It is interesting to note that nectar gathering female bees visiting alfalfa trip most of the flowers from which they suck. On various occasions females were observed to trip from all to about 70 per cent of the flowers visited. In spite of the fact that they do less work than pollen collecting individuals, they usually visit fewer flowers per minute than those which are collecting pollen. Thus one female (August 5, 1950) was observed to suck from 10 flowers per minute (average of three minutes). She tripped 21 of the 30 flowers visited. Another sucked from an average of 12 flowers per minute (in over three minutes observed) and of 34 flowers which she was watched to visit, she tripped 24. Pollen collecting females regularly trip every flower.

Males, on the other hand, often trip few or none of the alfalfa flowers visited. It would be interesting to know if each learns independently how to suck the nectar without tripping the flowers, as appears to be true of honeybee workers.

FLOWER CONSTANCY IN NECTAR GATHERING

There is no evidence of the slightest tendency for bees of either sex to restrict themselves to particular kinds of flowers as nectar sources, even for short periods of time, if several equally favorable sources are available. The following records are selected from among many to exemplify this statement: On August 13, 1951, a female which appeared to be searching for a nesting place was watched as it chanced to approach the nectar habitat in Area 6. As it encountered the low growing flowers in this area, it started going from flower to flower sucking nectar and in three minutes was seen to suck from *Lythrum, Vernonia, Croton, Trifolium,* and *Sagittaria.* It then wandered away continuing its original activity. Another female was seen the next day in the same place under otherwise similar circumstances to visit *Trifolium, Croton, Ludwigia,* and *Lythrum.*

In the average area, however, there is one flower distinctly more attractive as a nectar source than the others. It may or may not be a pollen source, as well.

POLLEN GATHERING

The exact mechanics of pollen gathering by female *Megachile brevis* is difficult to determine because of the rapidity of the action and the minute quantities of pollen obtained from any one flower. The following observations were made near Cherryvale, Kansas, on June 13, 1951, where numerous bees were visiting flowers of *Psoralea floribunda*. Corroborative observations have been made repeatedly on this flower.

The female bee, on landing on the flower spike, puts her proboscis into an individual flower. This opens the flower, exposing the stamens and pistil. The front tarsi are rubbed on the anthers occasionally during the process. The bee moves rapidly over the spike, working several of the flowers in this manner, then goes on to other spikes. Occasionally, after the bee has visited several flowers, the front tarsi contact the middle legs. The details are not apparent because of the rapidity of the movement but presumably pollen gathered by the front legs is transferred to the middle legs. At other times the middle tarsi can be seen to brush the venter of the thorax, where pollen must sometimes be brushed off of the anthers, or the middle legs may even be bent up over the thorax to comb the mesoscutum. Presumably the pollen gathered from the body and front legs is transferred by the middle legs to the hind legs, but this was not observed; perhaps it occurs in flight.[1] After visiting 10 or 12 flowers the bee alights on a new spike of flowers and rubs the scopa (pollen collecting hairs of the abdomen) with one rear basitarsis, or often with one after the other. At the same time the abdomen is bent upward several times, almost spasmodically, then back to its normal position. This action opens up the spaces between the groups of scopal hairs on each sternum, and pollen seems to be introduced into the spaces from the rear. Because of the way in which pollen is placed on the scopa by the hind basitarsi, a bee which is starting to gather a load of pollen may be seen to have the pollen of the scopa arranged in the V-shaped pattern shown in figure 3, each arm of the V representing the zone rubbed by the rear basitarsus of that side of the body.

On alfalfa the pollen collecting is very similar to that on *Psoralea*. When the bee inserts her proboscis, the alfalfa flower is tripped, that is, the column of stamens and pistil rapidly move up from their

1. Leg movements which probably accomplished transfer of pollen from leg to leg were noted in flight between flowers of *Vernonia*. They were also noted among sluggish individuals gathering pollen from alfalfa. Sluggish individuals are better for such observations than highly active ones.

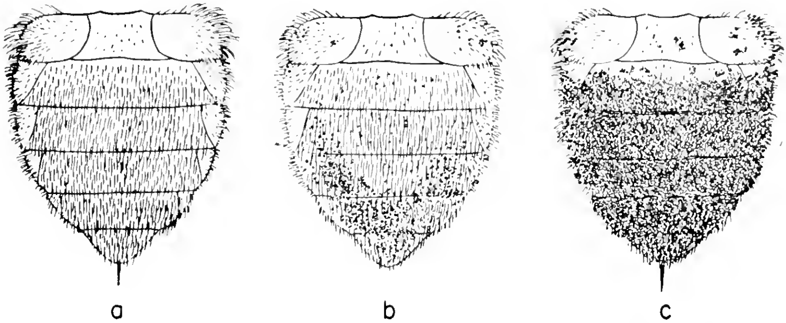

FIG. 3. Under surfaces of abdomens of females of *Megachile brevis*, showing the pollen collecting scopa. a, without pollen; b, with a little pollen; c, with a full pollen load.

original position in the keel of the flower to a position against the banner. In this process the bee's proboscis is often trapped between the column and the banner and the bee can be seen to pull loose, then reinsert the proboscis beside or behind the column. In this process also pollen is doubtless brushed off the stamens onto the under side of the thorax and head of the bee. Moreover, as the bee presses its head down into the flower, its face comes in contact with the stamens of the tripped flower. Thus pollen is probably scattered over the bee, especially over its head, more thoroughly by alfalfa than by *Psoralea*. Perhaps for this reason, bees were seen to brush their heads more when collecting from alfalfa than when collecting from *Psoralea*. After visiting several flowers a bee will cling to a flower with middle and rear legs only while brushing the front part of the body, especially the face, with the front legs. Other activity was as has been described for *Psoralea* pollen collecting.

On one occasion it was noted that when a female *Megachile* came to an alfalfa flower which had already been tripped, she immediately went on to other flowers.

The behavior of the bee is, of course, quite different on different flowers, particularly on those whose flowers occur in flat heads (Compositae) or in large masses (*Rhus*). On *Gutierrezia* a pollen collecting female tends to work with her head near the center of the flower, rotating her body around the flower head. On *Rhus* the female is noteworthy for being constantly on the move with a sort of wriggling motion over the large surface made up by the many small flowers. She appears to feed the pollen back from the front legs to the middle legs, thence to the hind legs and the scopa, rubbing the scopa with the hind legs and at the same time raising the abdomen, just as has been described for pollen collecting on *Psoralea* except that the bee is able to do all this without stopping her motion over the flowers. Sometimes while flying from one flower mass to another or while hovering the bee rubs the two hind legs together.

RAPIDITY OF POLLEN COLLECTING

Details on the duration of pollen collecting trips will be presented in the section on nesting activities. The present section concerns rates of flower visiting, that is, flowers visited per minute.

The data were gathered by watching individual pollen collecting bees over periods as long as possible and recording the number of flowers visited each half minute of observation. The figures were then converted to flowers visited per minute.

Most of the data were obtained by observing bees collecting pollen from alfalfa. There is some evidence that the rate of collecting is higher at higher temperatures, but due to the variability found at any one temperature, the evidence is not conclusive. The greatest amount of data collected in any one temperature range (82°-85° F.) was gathered during July 1950. A total of 121 half-minute counts gave a minimum rate of 9.4 flowers visited per minute, a maximum of 24, and an average of 15.7. Of the flowers visited, over 95 per cent were tripped and therefore presumably pollinated and utilized as pollen sources. The others were merely probed by the proboscis but for some reason not tripped. These results agree reasonably well with more extensive data on this subject gathered by Franklin (1951) in Kansas and Linsley and MacSwain (1947) in California.

Data from *Psoralea floribunda,* a plant often called wild alfalfa because its flowers are similar to those of alfalfa, taken in the same temperature range indicate a higher rate of visiting flowers, possibly because tripping, required for alfalfa, is unnecessary for *Psoralea.* A total of 87 half-minute counts gave a minimum rate of 12 flowers visited per minute, a maximum of 30, and an average of 22.0.

Information on other flowers is slight, but we have records of 16 to 18 *Gutierrezia* disk flowers probed per minute, 18 to 36 *Trifolium* flowers visited per minute, and 10 to 11 *Aster* disk flowers probed per minute.

The variation in rates of visiting single kinds of flowers indicated in the preceding paragraphs is not due entirely to irregularities in flower abundance in the fields studied. There is evidence that at the same time, place, and temperature different individuals work at different rates. Some appear sluggish, and repeatedly rest on leaves in the midst of their pollen collecting activities.

To verify this impression, data on individual bees in a single alfalfa field were gathered. The results are shown in table III. Similar data, obtained in a single patch of *Psoralea floribunda,* are presented in table IV.

TABLE III.—Rates of flower visiting by individual pollen gathering bees in a single alfalfa field.

Bee number	Flowers visited per minute			Minutes of observation
	Minimum	Maximum	Average	
1	19	20	19.3	3
2	12	18	15.7	4
3	16	17	16.3	3
4	9	15	11.3	5

TABLE IV.—Rates of flower visiting by individual pollen gathering bees in a single patch of *Psoralea.*

Bee number	Flowers visited per minute			Minutes of observation
	Minimum	Maximum	Average	
1	22	28	25.7	3
2	16	20	18.3	3.5
3	18	23	20.7	3
4	28	30	29	4

CONSTANCY IN POLLEN COLLECTING

Because of the small number of acceptable pollen sources usually available in any one area, individual pollen constancy is more difficult to judge than nectar constancy. However, one ordinarily observes pollen collecting females visiting flower after flower of the same species, and not deviating to visit other flowers, even for nectar, until a full load of pollen is gathered.

Exceptions to this general observation do occur when a bee stops using one flower and starts visiting another, but one never sees erratic visiting of various kinds of flowers as with nectar gathering. Evidence for changes in pollen sources are as follows:

Different kinds of pollen are sometimes found in a single cell. Changes may occur in the midst of a pollen collecting trip as shown by the following two observations: In September, 1950, in Area 10 *Gutierrezia* and *Trifolium* were intermixed, both serving as pollen sources. Most pollen collecting females seemed constant to one flower or the other so far as we could observe, but on September 10, a bee which had been collecting from *Gutierrezia* flowers was seen to start visiting *Trifolium.* From then on it gathered pollen from *Trifolium* constantly, as long as it could be watched (three or four minutes). On August 11, 1950, in Area 6 a female was watched collecting *Rhus* pollen. The posterior part of its scopa was covered with *Vernonia* pollen, showing that it had changed its flower during a pollen collecting trip.

Another observation made in Area 6 concerned a bee which was nesting in a hollow dead weed stalk. For several days it had been observed bringing in the pale pollen of *Vernonia,* and had constructed three cells with that pollen. This plant, however, was becoming gradually older, with fewer fresh flowers, although there were still a great many. In the midst of provisioning the fourth cell, the bee stopped using *Vernonia* pollen and began using *Rhus.*

Additional information on flower constancy (or lack of it) was obtained in recording the activities of certain individual bees near their nests. The color of the pollen brought in was usually uniform from trip to trip. However, the bee recorded as "d", figure 8, used yellow *Rhus* pollen throughout the period of observation except that after her second pollen collecting trip for the second cell recorded in figure 8, she came in with white (*Vernonia*?) pollen. Nest "i" (figure 9) was provisioned with *Vernonia* pollen on August 11. On August 12, *Rhus* pollen was used, except that after the eighth and twelfth pollen collecting trips on that day the pollen seemed white and was probably from *Vernonia.* On August 14, the same bee used bright yellow *Rhus* pollen except for the sixth and seventh trips, which resulted in collections of white (*Vernonia*?) pollen.

PART III. MISCELLANEOUS ACTIVITIES

RELATION OF ADULT ACTIVITY TO ENVIRONMENTAL FACTORS

Very little significant information on this subject has been gathered. Much better bee subjects for such investigations are those with more permanent nests, where activity can be watched over long periods. Activity appears to be dependent upon certain relationships of temperature, light intensity, wind, and possibly other factors. On a cool day, no wind and strong sunlight are necessary to produce activity. On a cloudy day, no wind and high temperature are necessary for activity. On a windy day, sunlight and high temperature are necessary. With regard to these various factors, different bees probably have quite different thresholds of activity, for even on a rather poor day one may find a few active bees.

Quantitative data concerning these matters is almost nonexistent for *Megachile brevis*. It has been seen active at temperatures (taken in the shade of the observer's body at the level of the flowers being visited, usually one to two feet above the ground) of 76° to 100° F. Flight below 80° F. was rarely observed in summer, but in September, when generally lower temperatures prevail, it was more common. On August 21, 1950 (a clear day) a female was seen to start her work when the temperature near the nest reached 80° F.; on another such occasion the temperature reached 83° F. before the bee flew.

On three different cloudy mornings it was noted that activity did not begin until the temperature reached 85° F. Twice this was not until 11:00 a. m. or later. There is a little evidence that once the bees start to work they continue at temperatures lower than those necessary to activate them.

The hours of activity during the day vary not only with weather but of course with the season. In early August in clear weather they have been seen active as early as 8:30 a. m. and as late as 5:20 p. m. On July 27, a bee returned to its nest at 6:07 p. m. It had left 17 minutes earlier. In general, morning activity does not involve many individuals until 9:00 a. m. or later even on an ideal day.

This species has been observed flying in winds strong enough to roll a bee over and over on the ground if it happened to attempt to land in a gust. This sort of behavior was rare near Lawrence, in eastern Kansas, but in western Kansas where high winds are almost continuous in certain seasons, it is common. Perhaps this is because the bees are forced into activity in spite of the wind.

FLIGHT

Megachile brevis is a bee that flies very rapidly with a distinct high pitched buzz audible on calm days for as much as ten or twelve feet. It is usually more easily found by means of this sound than by sight, although the sound is easily confused with that of certain bombyliid, nemistrinid, and tachinid flies as well as with that produced by certain of the other small species of *Megachile*. No difference was noted between the sound produced by males and females.

In full flight, as when females fly to and from their nests, the bees fly straight and at such a speed that the human eye can scarcely catch sight of a bee as it goes past. It is to be remembered, however, that the bee is dull colored and rather small, so that it is not easily seen. One bee was timed as making the 150 foot distance from her nest to the place where she was cutting leaves in 15 seconds. This is a rate of under 7 miles per hour. Considering that the bee quite obviously flies rather slowly as she starts her flight, gathering speed over a distance of 6 or more feet, and slows down over a similar distance at the end, the actual maximum speed is probably over 7 miles per hour but under 10. The bee is a noticeably faster flier than is *Apis*, which, however, has been reported to fly from 5.6 to 13 miles per hour by various authors.

Among flowers or elsewhere when the bees fly only short distances there is no difficulty in following their flight. Bees of either sex visiting flowers can be distinguished by sound from other bees because of the frequent brief interruptions of the flight while they rest on flowers. The characteristic buzz is therefore interrupted 9 to 36 times per minute, depending on the particular bee, kind of flower, etc.

Females searching for nesting sites can usually also be recognized by sound as they fly a sinuous or zigzag course close to the ground, investigating sticks and other possible nesting places. The flight is continuous except for irregular and often rather long interruptions while a bee crawls into a hole. In full flight to and from the nest, female bees fly two and one-half to three feet above the ground if there are no obstructions, but we have seen them fly over trees twenty feet high. They seem to do this in preference to flying through any considerable amount of shade.

MISCELLANEOUS NOTES ON BEHAVIOR

The following notes on various activities seem worth recording because they may be clues to consistent behavior patterns which may eventually be recognized:

One male was observed near Lebanon, Missouri, August 4, 1951, flying about plants of *Lespedeza violacea.* Frequently it lit on a leaf and rested for several minutes holding its forelegs up and forward.

Both sexes are often seen brushing various parts of the body with their legs. This often occurs when the bees are working flowers and probably serves to get scattered pollen off of parts of the body. We have frequently seen the eyes brushed.

In marking a male bee with quick drying enamel, paint was inadvertently got on the wings of the right side. It hardened, sticking them together. The bee could not fly. After some struggling it hooked the inner hind tibial spur between the two wings and pushed outward, straightening the leg. After repeating this several times the bee managed to peel the paint off of the wings and free them so that it could fly.

NOCTURNAL RESTING PLACES

As will be clearly shown later, females constructing nests rest in their nests at night. No positive field evidence is available on the night resting places of males or of females not constructing nests. We do know from numerous observations that they do not return to the nests in which they have developed and from which they have emerged to spend the night or for any other purpose.

In cages males and females crawl into curled leaves or similar protection to pass the night. It seems probable that they do likewise in the field.

MALE REACTIONS TO FEMALES

Curiously enough mating has never been observed in this bee. Probably it occurs very soon after emergence.

Males are often seen flying from flower to flower, not alighting but hovering for a moment over each flower, then going on to the next. The males may be very persistent in this activity or they may stop at intervals to suck nectar from certain of the flowers. We have considered this activity to be the search for females.

Males are occasionally seen to fly rapidly at females from a distance of a few inches and strike them. Females, so far as have been observed, repulse the males under such circumstances. Several times we have observed females which were collecting pollen disturbed by males pouncing upon them.

Slightly more elaborate approaches to females have also been observed. A male sometimes hovers for several seconds two to five inches above and behind a female on a flower, then somewhat slowly, or at other times rapidly, descends upon the female. In all cases observed, the female merely flew away. If she only flies to another flower an inch or so away, the male may repeat his approach.

LONGEVITY OF ADULTS

The oldest marked bee (a male) of which we have a record was last seen 22 days after the time of marking. However, there is considerable evidence that the bees actually live more nearly a month. The last eggs which will develop into fall adults are laid in early August; adults from these emerge in early September; such adults (both sexes) are active until the beginning of October (see figure 1) when they are probably killed by cold. There is some evidence that at least in cool weather longer adult life may occur. In the extraordinarily cool spring and summer of 1951, the second generation did not appear until the second week of July. Therefore, the disappearance of old and tattered first generation individuals could be observed without the complicating factor of second generation bees. Probably all first generation individuals had emerged by the last week of May, yet some still survived in the first week in July. All were females, suggesting that females survive longer than males.

Aging is shown in this species of bee in a number of ways. The wings become very much tattered in both sexes as the bees become older. This was the principal character used to judge age in the observations on age composition of populations reported under "Number of Generations Per Year." Figure 4 shows the amount of wear that occurs in wings.

The pubesence, quite ochraceous on the dorsum of the thorax in young males and slightly so in females, loses its reddish color, the pale hairs becoming grayish white with age. This fading must occur very quickly in females, for they are not often seen in the field with ochraceous pubescence. Males, however, seem to retain this color for at least a week after emergence. Very old individuals often seem blacker than less worn ones because some of the pale hairs are broken off. This is especially true of the dorsal abdominal hairs.

The mandibles of females (but not males) show much wear. Figure 5 illustrates this.

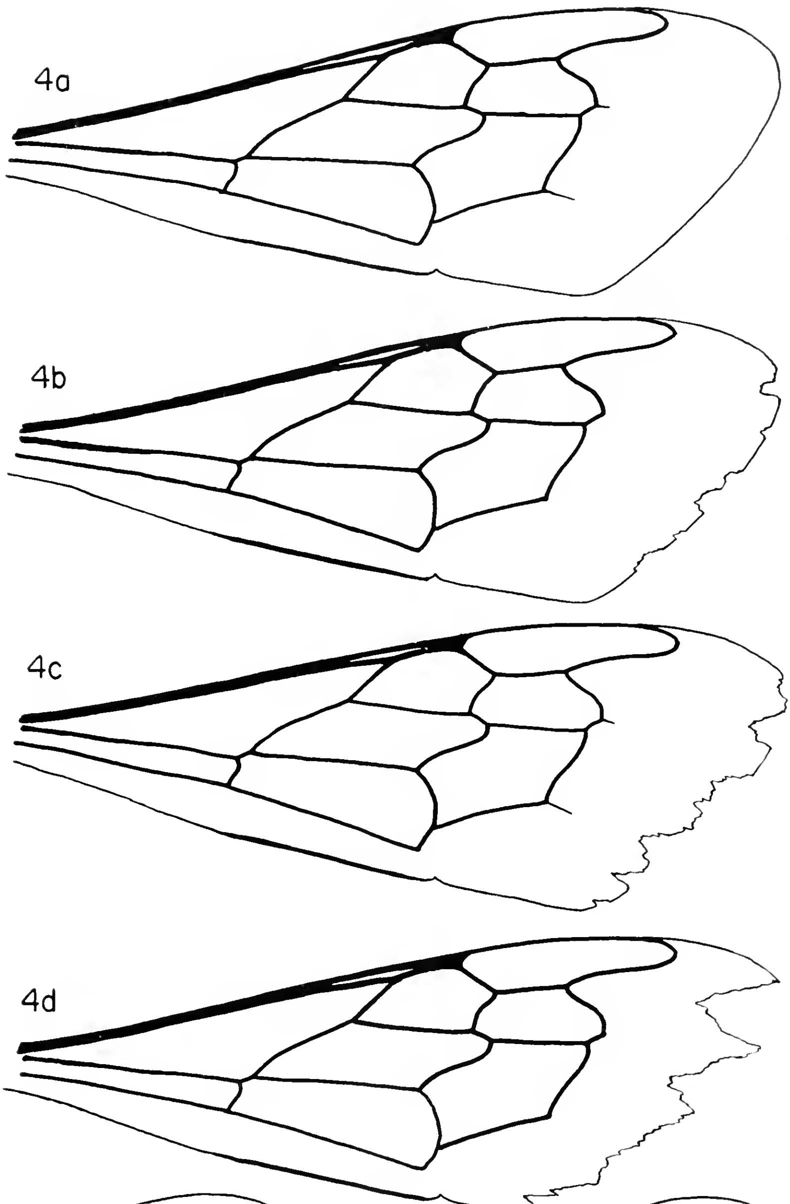

FIG. 4. Fore wings illustrating wear of outer margin. a, fresh; b, an example of the class called fair; c, an example of the class called poor; d, one of the most worn individuals studied.

FIG. 5. Mandibles of females illustrating wear. a, fresh; b, well worn.

PART IV. NESTING

Finding Nesting Sites

As mentioned in the section on "Flight," females searching for nesting sites are rather easily recognized. This behavior must occupy a considerable part of their time for they are often seen apparently searching. They fly in a wandering flight, often covering an area rather thoroughly, but at other times moving on in one general direction even though zigzagging considerably. In bare areas they usually fly one or two inches above the ground, in grassy places just over the grass tops, sometimes going down among the blades of grass. In weedy or brushy areas they commonly go down into the vegetation and are sometimes out of sight for minutes at a time as they fly or walk about. They rarely go into thoroughly shaded places, however. They alight and investigate all sorts of small cavities. Although they sometimes nest among green leaves, there seems to be a tendency for them to investigate darker objects, such as brown curled leaves, and especially sticks lying on the ground. The following quotations from our notes exemplify this behavior: "August 13, 1951 [Area 8]; 10:30 a. m. Saw one female which appeared to be looking for a nesting site. She was flying low over the grass, stopping here and there on leaves or [to suck] from flowers. Once she stopped for several minutes and crawled up and down and around a stick lying on the ground. Eventually she flew off." "August 14, 1951 [Area 6]; 10:00 a. m. One female (without pollen) watched for 15 minutes while she presumably searched for a nesting place. She flew about in the vegetation, especially where it was dense, occasionally stopping to walk about on some stems. When she found an old dead stick, she spent a long time crawling around it flying off a few inches and then returning to it. It had no hole in it and she finally left. As she flew about in her wandering, somewhat zigzag flight, she occasionally came upon a flower and would stop and suck from it."

The following observations provide the only concrete evidence available that the type of behavior described above is actually searching for a nesting place. "August 29, 1951 [Area 8]; 2:00 p. m. [A female was flying over the grass in the usual manner of one presumed to be searching for a nesting site. She happened to approach me.] I held out a rubber tube (inside diameter 9 mm.) just above the ground. She went into the tube, then flew a foot or so away, then re-entered, went in and out five times in five minutes, three times in the next five minutes, flying variable distances away, sometimes out of sight, between her visits. Ten minutes after she first entered the tube, she started bringing pieces of yellow petals for the nest. She brought many of them in rapid succession, but stopped and was not seen again after 4:00 p. m. [possibly because of the heat in the tube in the direct sunlight.]"

Another occasion when the "searching flight" was seen to lead to nest establishment was on August 11, 1950 (Area 6); 11:00 a. m. A female *Megachile brevis* was seen flying over the small rocks piled along the roadside. Once she left these rocks and went into the weedy pasture, searching along sticks, then returned to the rocks. At intervals she would crawl into spaces among the rocks. Finally she stayed in such a space for two minutes then left and flew all about the area (orientation flight?) well above the ground in a manner quite different from the searching flight. After this flight, she returned, then left again, flying about. This was repeated three times, one of the flights taking the bee 50 feet away. (Perhaps because of the uniform appearance of the roadside, these orientation flights were more extensive than usual.) The bee then left and after ten minutes (about 20 minutes from the time she first entered the nesting place) returned with a piece of a petal. She proceeded to construct a cell, as will be described later.

Rather different observations concerning nest establishment were made in an alfalfa field near Hutchinson, Kansas, July 26, 1950. Usual nesting sites, such as old weed stalks, were scarce in the area. A female was seen crawling in and out among the dense foliage of a deformed, fasciate plant of *Erigeron canadensis.* This bee left but soon returned to crawl around more among the leaves. After 50 minutes of this coming and going, the bee seemed to select a place, for she came back to the same spot among the leaves of the weed three times in about as many minutes, then started to bring leaves for the cell.

It is perhaps significant that among the three cases of nest establishment that we observed, the longest period required to start the work of cell construction was in the most abnormal nesting situation (among leaves of *Erigeron*).

NESTING SITES

Mitchell (1936) and Hicks (1926) both suggest that the wide variety of nesting sites reported for *M. brevis* by various workers (Reed, 1871; Packard, 1892; Rau, 1916, 1922; Hicks, 1926) may indicate that more than one species was identified as *brevis.* In view of the similarity of various species of *Megachile* this may have been the case, but the differences in the nesting sites do not necessarily indicate this. Even greater variability in nesting sites has been observed in Kansas populations of *Megachile brevis* than was previously recorded in the literature for this species. At the season of the year when the bees are largely in the prairie patches using *Psoralea floribunda* as a food source, their nesting sites will often necessarily be different from the old weed stalks favored when the populations are in other places. Perhaps the mobility of this bee, correlated with the fact of its several annual generations, forces it to retain catholic tastes in nesting sites. That we are not dealing in Kansas with two or more related species utilizing different sites is shown by the actions of females searching for nesting places.[1] They will sometimes search along sticks and weed stalks, then search bare ground, looking into holes, then crawl into curled leaves, as though all these sites were potential nesting places to a single bee.

The great variability in nest sites observed in *Megachile brevis* is not surprising in view of the literature concerning other species of this genus. For example, *Megachile centuncularis* Linnaeus of Europe has been recorded as nesting in the soil, in rotting wood (Baysson, 1902), beneath rocks (Bellevoye, 1884), in hollow stalks and bamboo (Hardouin, 1945), and in various other situations. Smith as early as 1855 recorded a great diversity of nesting sites for this species.

As Table V shows, the nesting sites most commonly chosen, in our experience, are hollow dead weed stalks, old cornstalks, and the like, lying on the ground. I believe that most of the nests in our area are in such places but probably not as preponderant a percentage as the table at first suggests. Nests are most easily found by splitting dead stalks; it is only by observing bees that one finds nests in the soil, under prairie grass, and in like situations. The second column (nests found by observing bees) probably gives the best comparative data on the various sorts of nesting sites.

In summary, it is evident that almost any sort of small cavity may be used for nesting by this bee. The bees apparently never excavate holes. When they nest in stalks, it is almost inevitably in pithy stalks hollowed out by various borers and subsequently broken to expose the hollow. There is some evidence that the bee may clean loose debris out of such a hollow or even enlarge the hollow. The diameter of the cavity holding the cells is sometimes slightly

1. Because of the superficial similarity of various *Megachile* species, specimens have been collected frequently in all areas of study and identification checked by means of the characters detailed by Mitchell (1936).

larger than the same hollow where bees have not entered it, and bits of freshly removed pith may be found beneath the entrance.

We have never found a nest in deep shade of woods or even under a large tree or in heavy shade produced by a luxuriant growth of tall weeds. Nests are most commonly found in old broken pieces of stalk lying about where the grass and weeds are short.

The pieces of stalk may be well hidden by short grass and weeds and shaded by them, or may be entirely exposed.

TABLE V.—Nesting sites of *Megachile brevis*, and numbers of cells in nests.

Site	Nests found by observing bees	Total nests found	Number of cells per nest		
			Minimum	Maximum	Average
Dead horseweed stalks, prostrate	5	22	1	8	3.7
erect		3	1	3	2
Dead pokeweed stalks, prostrate	1	2	2	2	2
Dead sunflower stalks, prostrate	2	14	1	7	3.4
erect	1	4	1	5	3
Dead cornstalks, prostrate	7	10	1	8	5
Dead thistle stalks, prostrate	6	30	1	11	4.2
erect	1	2	4	8	6
Base of dead ironweed stalk, prostrate		3	1	2	1.7
Dead curled boneset leaf	1	1	2	2	2
Termite hole in garage door	1	1	8	8	8
Among dense leaves of living fasciate muletail weed	4	7	1	2	1.1
Among small rocks on ground	1	1	1	1	1
Under dry cowchips		3	1	3	2
Under mat of prairie grass	2	2	1	1	1
In holes in ground	4	4	1	2	1.5

The plants listed in table V are as follows: Horseweed (or giant ragweed), *Ambrosia trifida;* pokeweed, *Phytolacca decandra;* sunflower, *Helianthus annuus, H. tuberosus;* corn, *Zea mays;* thistle, *Cirsium* sp.; ironweed, *Vernonia interior;* boneset, *Eupatorium perfoliatum;* muletail (or horseweed, fleabane), *Erigeron canadensis.*

NEST STRUCTURE

Nests typically consist of several cells placed end to end and snugly fitted into a tubular hollow. Sometimes only a single cell is located in a hollow. When there are several cells, of course, the first constructed is the one farthest from the entrance into the cavity while the last constructed is the one closest to the entrance. The position of the cells in a long hollow (such as a hollow stalk) varies greatly. Sometimes, even when the hollow was many centimeters long, cells were found only near the entrance, blocking the hollow and leaving most of it inaccessible and useless. At other times bees go deep into hollow stalks to construct cells. The last cell constructed may be flush with the open end of the hollow or may be deep in the hollow. Among 46 nests (in stalks) whose structure was recorded in detail, one had the last cell constructed 35 cm. from the entrance into the stalk, three had the last cell flush with entrance into the stalk, and the others were intermediate in this regard, the average distance from the entrance to the last cell constructed being 3.5 cm.

The cells are ordinarily tightly fitted together so that if a stalk containing a nest is carefully split, all the cells can be removed as a single unit. This is because the base of each cell fits inside of the apex of the preceding one. The elongate pieces of leaves and petals which form the cup of any cell extend well beyond the cap of that cell, leaving a hollow into which fit the elongate pieces which form the cup of the next cell. Often the cells of a series are so closely associated that it is necessary to break the series in order to determine how many cells are present.

Occasionally cell series constructed by two bees, or by one bee at different times, are found in the same stalk. This situation can be recognized by the old leaf and petal material of one series, compared to fresh material of the other. Sometimes in such cases there is an unoccupied space of one to several centimeters between the two series of cells.

As shown in table V, the nests are commonest in horizontal hollows (e. g. in prostrate stalks), so that the cells are usually horizontal. They are not infrequently vertical, however, with the caps upward, as in hollows of standing stalks exposed by breaking the stalk. One nest was found in which the bee entered a hole in the side of a standing stalk and turned upward, there constructing a series of vertical cells with the caps downward.

Most nests (except those few in which the last cell is flush with the entrance to the hollow) are closed at the entrance with a plug made of pieces of petals or leaves. These pieces are more or less round, like those used to cap cells, and are loosely or firmly fitted into the opening. The space between the last cell and the plug is usually empty although in one nest there was an additional plug of eight pieces of leaves just beyond the last cell and separated from it by a millimeter or two. The distance from the last cell to the usual entrance plug varies from 2 mm. to several centimeters. Entrance plugs (in 15 nests in which they were studied) ranged from a thick plug of 20 pieces of leaves and petals to a thin one consisting of only four pieces of rose petals and another thin one of four leaflets of *Lespedeza violacea.* The average number of pieces in the 15 plugs studies was 9.3. Most of them consisted of leaves or petals of the sort used as "fillers" in cell construction but five contained pieces of rose leaves in addition to leaves of *Lespedeza* or alfalfa, making much firmer plugs.

About one third of the cell series studied were provided with no entrance plug. Sometimes this was probably due to the death of the bee or to our collecting the nest for study before her work was completed, as indicated by an incomplete last cell. In other cases, however, the last cell was complete and it appears that sometimes *Megachile brevis* does not construct an entrance plug. In few cases was an entrance plug found where only a single cell had been constructed.

NUMBER OF CELLS CONSTRUCTED

The number of cells in any one nest depends in part on the size of the space available. A small cavity may provide room for only a few cells. The right hand column of table V illustrates this point; the average number of cells per nest is higher in stems, where the long cavities provide plenty of room, than in the miscellaneous small cavities listed in the lower part of the table. The small number of cells in nests in ironweed stalks is due to the very short basal region large enough to hold *Megachile* cells.

The number of cells constructed by any single female is unknown. A series as long as 11 cells has been found, but there is no reason to believe that this is a maximum. Few nesting places provide space for very many cells; as shown in table V many single cells were constructed, even in hollow stalks where there would have been space for several cells. Since the bees move freely from place to place, a bee may construct a few cells in one place and others several miles away. Packard (1868) reports a single *Megachile* (identified, probably incorrectly, as *centuncularis* Linnaeus) that constructed 30 cells. Perhaps females of *M. brevis* construct similarly large numbers, scattering them in various places.

Study of figures 8 and 9 shows that these bees can construct and provision 1 to 1.5 cells per day. If a bee lives for 30 days, it might presumably construct 30 cells, even allowing for some bad weather.

CELL STRUCTURE

The present section contains a summary of the data obtained by dissecting 100 cells of *Megachile brevis* from 48 nests. It is well known that cup portions of cells of many leaf cutter bees are made of elongated pieces of leaves which bend inward at one end (called the base of the cell) to close it. After provisioning the cell and laying an egg, the bee closes the other end by means of round pieces of leaves, which are called the cap.

Megachile brevis follows this general pattern, using elongate pieces of leaves and petals for the cup and circular pieces for the cap. The pieces for the cup are broadly overlapped, as shown in figures 6 and 7. The pieces which form the cap are all of about the same size and shape, slightly larger than the diameter of the hollow in the cup, so that when pressed into place their edges turn up slightly and the fit is snug (figure 6).

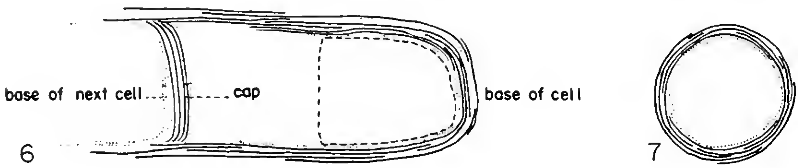

FIG. 6. Longitudinal section of cell (diagrammatic, to show make up of walls). Solid lines represent leaves; dotted lines, petals; broken line, mass of provisions.

FIG. 7. Cross-section of cell. Explanation as for figure 6.

In gathering the data on cells, the series were broken into the component cells. If round pieces adhered to the base of a cell, they were transferred to the preceding cell and considered part of the cap of that cell. This procedure is ordinarily justifiable, for the cap of one cell and the base of the next are in close contact (see figure 6). However, round pieces are sometimes found at the base of the first cell in a series. In such cases they must have been the first leaves cut and had nothing to do with any cap.

Great diversity is shown among various individuals of *Megachile brevis* as to the manner of cell construction. Part of this diversity is due to the size of the hollow in which the bee nests. The inside dimensions of the cells are quite constant, 4.2 to 5.2 mm. in diameter, 8.2-10.0 mm. in length. The dimensions of the hollows used are by no means as constant, ranging from just over 5 mm. in diameter to 10 mm. in diameter. A bee nesting in a small hollow needs to use only a few leaves and petals to construct a cell cup having the proper inside dimensions while a bee nesting in a large cavity must carry into it many leaves and petals to form the thick walls necessary to obtain the proper inside dimensions. For example, one bee nesting in a small hollow in a weed stalk used only eight pieces to construct a cup (nest 20, table VI) while another bee nesting in a space among leaves of a fasciate *Erigeron canadensis* used 41 pieces. (nest 23, table VI). This is the bee whose record is shown as nest f, figure 9. From this record it can be seen that she really brought to the cell about 58 pieces but some were dropped through the leaves to the ground and lost, a thing which never happens in ordinary nesting places. The outside length of a cell is also variable, depending in large part on how far the walls of the cup extend beyond the cap. Most cells are from 11.5 to 14 mm. long but rarely they reach 17 mm. in length.

Additional diversity in construction is due to individual variations. Two bees working at the same place constructing nests only 10 feet apart in cavities of similar size may use quite different materials. Moreover, the cells in any one series are usually fundamentally similar but often markedly different from those in other series. As will be explained later, the bees tend to gather their construction materials largely from small "cutting places." No doubt the somewhat chance selection of these places determines in large degree the characteristics of the cells.

Almost all individuals of *Megachile brevis* make use of two or more different materials in constructing the cups of their cells. If the cavity is appreciably larger than the inside diameter of the cell, filler petals or filler leaves are the first materials to be brought in. All petals used are thin and satisfactory as fillers. The leaves most commonly used are leaflets of *Lespedeza violacea* or *Medicago* (alfalfa). These are thin, easily cut leaves often placed rather loosely in the cavity. If petals are used they often are cut first so that they form the outside of the cup, with filler leaves inside of them, although they may be intermixed to a certain extent. Major irregularities in filler material sometimes occur. Thus the second cell in nest 3, table VI had 14 *Lespedeza* leaflets on the outside, followed by five pieces of *Cassia* petals on one side of the cell, followed by nine more *Lespedeza* leaflets. As shown by the first eleven nests in table VI, leaves are more commonly used than are petals as fillers. Yet there are nests in which petals are used extensively for fillers (nests 12, 13, and 14, table VI.) and others in which petals are used exclusively or nearly so (nests 15, 17, 22, 23, table VI). Occasionally nests are found in which the filler material is omitted entirely; see, for example, nests 18, 19, 20, and 21, table VI.

Inside of the filler materials are almost always placed a few firm leaves, usually cut from rose or sometimes from *Symphoricarpos*. These leaves are ordinarily the ones which provide much of the strength of the cell wall. In many species of *Megachile*, these are the only sort of leaf used in cell construction but in *M. brevis* they are usually very few in number. There are nests in which firm leaves constitute a large majority of the pieces used (e. g., first three cells of nest 13, and nests 18 to 22, table VI). On the other hand there are nests (25 to 30, table VI) in which firm leaves are altogether omitted. In nest 21, almost the whole of both cells was constructed of *Symphorocarpos* leaves. These leaves are a little thinner and more flexible than most rose leaves and presumably in this instance served both as firm leaves and filler leaves. This would explain the large number used. In nest 22, however, the 22 firm leaves recorded in table VI were all rose.

Lining petals are the last placed in the cell before pollen collecting begins. They are rather consistently present. Their number is often difficult to count in old nests, however (hence the many "+" signs in table VI), because they become soft and mushy, or later very delicate and brittle, and because at least those of the cap are often eaten by the bee larva. Lining petals are ordinarily from the same kind of flower as filler petals although they are occasionally mixed. Rarely, as in certain cells in nests 9, 10, 13, and 21, lining petals are absent and the pollen is placed in direct contact with firm leaves. Sometimes there is only a single lining petal in the cup, so that no complete lining exists (see nests 5, 9, and 21, table VI). Nest 30 is remarkable in that it contained no leaves, therefore no distinction between lining and filler petals existed. Rather than arbitrarily making a division, they are all recorded in table VI as lining petals. In three cells thin leaves, like those used for fillers, formed the lining or were among the lining petals. In table VI these leaves are listed in the column for lining petals but marked with an asterisk.

Like the materials used for the elongate pieces of the cup, those used for the round pieces of the cap are varied. Lining petals are quite consistently present, although occasionally absent (see nest 13). Filler leaves are also rather consistently present but sometimes absent. Firm leaves and filler petals are frequently absent.

In the cups, the materials are arranged in a fairly consistent man-

TABLE VI.—Materials used in the construction of cells.

Each horizontal row indicates a single cell, the figures representing the number of pieces of each material present. The first column at the left gives nest numbers, in order to show the way the cells were associated to form nests. The averages in the last row are based upon exact numbers and ignore "+" and "?" signs. A "+" indicates that the material was present but that the number of pieces was unknown. A "?" indicates that it could not be determined whether a material was present or not. In the "lining petals" column, a "*" marks figures representing thin leaves, such as those used for fillers. A blank space indicates absence of a type of material while a "—" indicates lack of information.

	Cup					Cap				
Nest No.	Lining petals	Firm leaves	Filler leaves	Filler petals	Total	Lining petals	Firm leaves	Filler leaves	Filler petals	Total
1	4	2	17		23	3		12		15
	5	3	11		19	2		4		6
	3	2	16		21	2		4		6
	5	3	19		27	3		3		6
	3	1	12		16	2	1	3		6
	3	2	11		16	2		3		5
	5+2*	2	15		24	2		3		5
2	+	11	13		—	1*	1	4		6
	+	8	9		—	?	2	1		—
	+	6	9		—	?	2	2		—
	+	8	5		—	1	4	3		8
3	5	4	19		28	3		3		6
	4	2	23	5	34	3		5	2	10
4	+	3	23		—	3	1	2		6
	4	5	23		32	2		2		4
	+	5	13		—	5	3	3		11
5	3	4	18	1	26	1		5		6
	+	3	14		—	2		1		3
	+	6	18		—	2	1	1		4
	+	4	15		—	2	2	1		5
	+	4	13		—	2	1	3		6

TABLE VI.—*Continued*

	Cup					Cap				
Nest No.	Lining petals	Firm leaves	Filler leaves	Filler petals	Total	Lining petals	Firm leaves	Filler leaves	Filler petals	Total
5	1	5	17		23	2	1	3		6
	?	8	21		—	2		3		5
	2	9	9		20	—	—	—	—	—
6	+	4	13	15	—	2	1	3	4	10
7	+	3	21	1	—	+	1	1		—
	+	1	23		—	+	2			—
	+	4	22	6	—	3	2	1		6
	+	4	24		—	2	1			3
	+	2	9		—	2	1	2		5
8	+	3	18		—	—	—	—	—	—
	+	4	22		—	—	—	—	—	—
	+	4	17		—	—	—	—	—	—
	+	5	16		—	—	—	—	—	—
9	2	4	22		28	—	—	—	—	—
	1	4	10	2	17	2	1	1		4
		4	19		23	1		6		7
10	?	5	5		—	?	4	4		—
	?	4	2	7	—	—	—	—	—	—
		2	8	3	13	—	—	—	—	—
11	3	3	23		29	1		3		4
12	+	5		10	—	4				4
	+	4	4	8	—	+	2			—
13		18	1		19	1	5			6
		15	5		20		2	2		4

TABLE VI.—*Continued*

	Cup					Cap				
Nest No.	Lining petals	Firm leaves	Filler leaves	Filler petals	Total	Lining petals	Firm leaves	Filler leaves	Filler petals	Total
		12	9	3	24	1	2	1		4
13	2	10	8	15	35	+		4		—
	5	6	7	10	28	—	—	—	—	—
14	+	4	1	2	—	—	—	—	—	—
15	4	11		8	23	—	—	—	—	—
	5	9		7	21	—	—	—	—	—
	+	5		5	—	—	—	—	—	—
16	+	4	1	7	—	—	—	—	—	—
	+	6	3	8	—	—	—	—	—	—
	5+1*	5			11	3		8		11
	4	4		5	13	3		3		6
17	3	5		3	11	1		3		4
	3	4		5	12	2		2		4
	2	4	1	3	10	2		5		7
18	5	7			12	2	5			7
19	4	14			18	3	5			8
20	+	7			—	2	2			4
	3	5			8	—	—	—	—	—
21	1	20			21		4			4
		25			25	—	—	—	—	—
22	5	22		12	39	—	—	—	—	—
23	2	10		29	41	—	—	—	—	—
24	3	3	10	2	18	—	—	—	—	—
	4	4	9	4	21	—	—	—	—	—

TABLE VI.—*Concluded*

	Cup					Cap				
Nest No.	Lining petals	Firm leaves	Filler leaves	Filler petals	Total	Lining petals	Firm leaves	Filler leaves	Filler petals	Total
24	3		12	3	18	—	—	—	—	—
25	2		25		27	5		3	5	13
26	+		5	5	—	6		2		8
27	+	1	6	4	—	4		2	1	7
28	4		11	7	22	4		1		5
29	2		2	17	21	—	—	—	—	—
	3		2	19	24	—	—	—	—	—
30	33				33	—	—	—	—	—
Average	2.8[1]	5.5	9.9	3.1	22.1	2.3	1.1	2.5	0.4	6.3

1. Nest 30 omitted from this calculation, since many of the 33 petals might best be called fillers.

ner. Thus the vertical columns of table VI are arranged from left to right in the order in which the materials are ordinarily found from the inside to the outside of the cell; however, considerable mixture often occurs so that a firm leaf may be inside a lining petal or filler leaves and petals may be somewhat intermixed. For the caps intermixture is much more the rule, the only generalization possible being that the lining petals are consistently on the inside.

The most complicated cells studied were the last three in nest 13, figure VI. All three of these cells contained four different kinds of materials, and their arrangement was far from standard. An example (the fourth cell) will be sufficient. From the inside out it contained the following: two lining petals (*Cassia*), seven firm leaves (Rose), six filler leaves (*Lespedeza*), two firm leaves (Rose), one firm leaf (*Symphorocarpos*), two filler leaves (*Lespedeza*), and 15 filler petals (*Cassia*).

The variability and complexity of the cells of *Megachile brevis* are not entirely unexpected in view of what is known of other species. Complex cell walls, consisting of layers of different materials, are well known in other species. For example several species put a layer of mud between outer and inner layers of leaves, others put a layer of masticated leaf material between outer and inner layers of leaves. Great variation in construction materials from individual to individual is also recorded for other species and Markowsky (1933) even records a nest of *M. centuncularis* Linnaeus made without the side walls of the cells but with only partitions between the cells made of pieces of leaves. That the construction of the cells of any one nest tends to be similar in *M. centuncularis,* as in *M. brevis,* is illustrated by Markowsky's anomalous nest mentioned above and by Grandi's (1934) figures of the numbers of leaf pieces used in five cells of a single nest.

Nests for the numerical analysis shown in table VI were selected at random from those available. They were collected at various seasons of the year. The arrangement of the nests from one to 30 is intended to place nests having similar characteristics together; the commonest types are at the beginning of the table, the unusual ones near the end. All of these nests were in stalks except for number 11 which was in a hollow under a mat of prairie grass, number 22 which was in a space among pebbles, and numbers 23 and 25 which were in spaces among the dense leaves of fasciate plants of *Erigeron canadensis.*

The sizes of the leaves used in different parts of cell cup construction vary. The alfalfa leaflets used in nest 25, table VI varied from 7 mm. to 14 mm. in length. In other cell cups (not included in table VI) *Lespedeza* leaflets from 7 to 11 mm. in length and *Trifolium* leaflets 5 to 11 mm. in length were used as filler material. The smallest pieces were near the bottom of the cell.

Leaf pieces cut most of the way around (as rose leaves) also vary in size. The long firm pieces of rose leaves varied in one cell from 4.5 mm. wide and 10 mm. long to 5 mm. wide and 14.5 mm. wide. In another the extremes in sizes were 5 x 11 and 6 x 13 mm. In another cell in which *Symphorocarpos* leaves were used, the smallest long pieces were 5 x 10 mm., the largest 9 x 15 mm. In this cell the *Symphorocarpos* served both as firm leaves and filler and the large pieces were consistently on the outside of the cell, sizes becoming progressively smaller toward the inside.

From the above information the impression is inevitable that as a bee cuts leaves or petals, it selects the texture and cuts the size appropriate to the needs of the moment in fashioning its cell. The same conclusion has been independently reached by other authors (e. g., Popovici-Baznosanu, 1907) working on other species of *Megachile.* This suggests that there are delayed reactions involved, the bee reacting while cutting the leaf to stimuli received while in its nest.

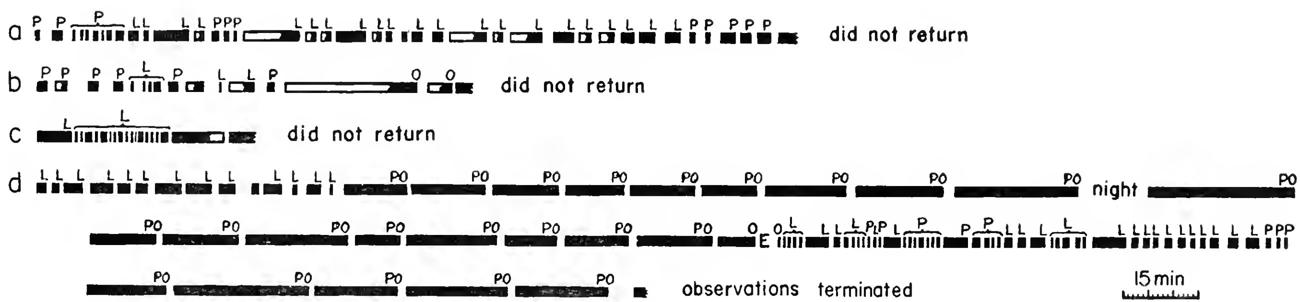

FIG. 8. Records of arrivals and departures of the bee from four nests (a, b, c, d). Records start at the left hand margin; continuations beyond the first horizontal line are indented. The time scale is indicated at the lower right. Information on the times of day, weather conditions, and kinds of pollen being collected are provided in the text, mostly in the section on duration of trips. The rectangles indicate time periods away from the nest; spaces between them indicate time periods when the bee was in the nest. Open rectangles or parts of rectangles indicate inaccurate timing. Above the end of most of the rectangles (or where the trips were short, above a bracketing line) is a symbol indicating what the bee brought back to the nest, thus: P = petal, L = leaf, PO = pollen (presumably also nectar), O = nothing visible. Absence of such a symbol indicates that the material (if any) brought back to the nest was not seen. "E" indicates the egg laying time.

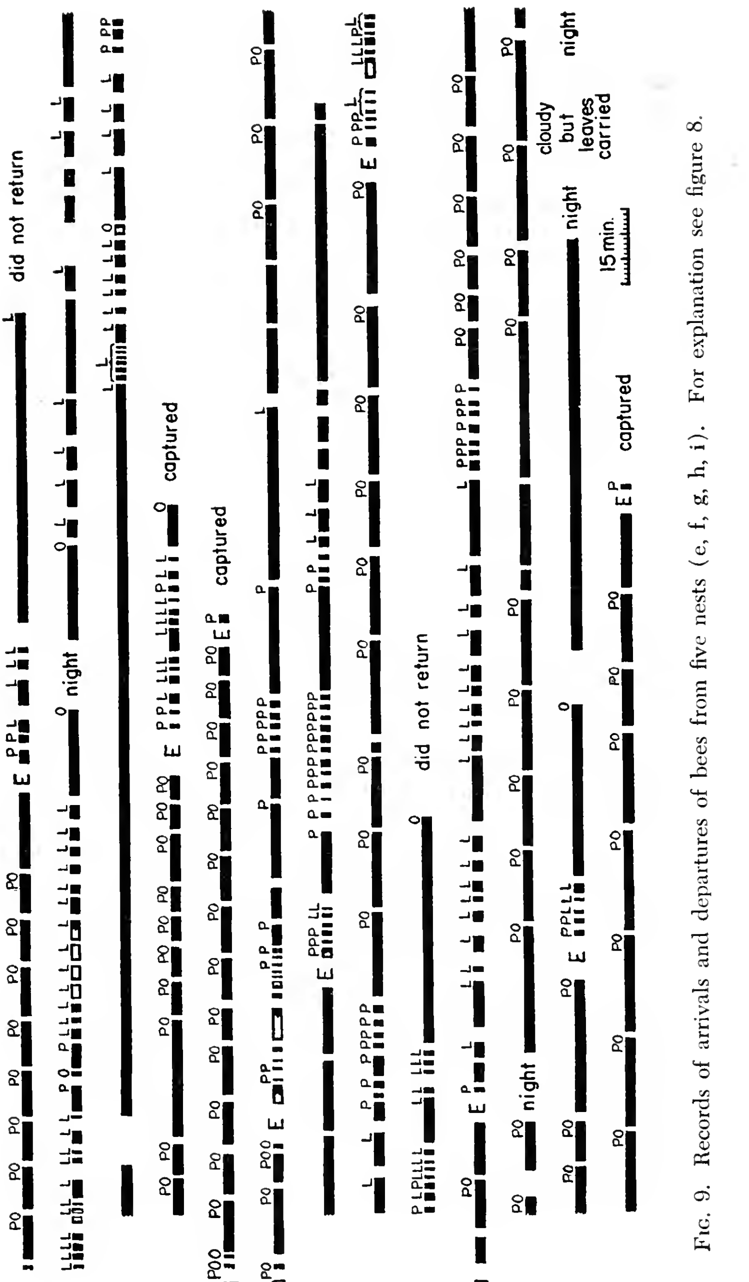

FIG. 9. Records of arrivals and departures of bees from five nests (e, f, g, h, i). For explanation see figure 8.

It is well known (see, for example, Malyshev, 1935) that senile bees sometimes behave in unusual ways. No evidence of this was obtained in the present study because no one bee could be followed through its entire adult life. However, some peculiar structures made by *Megachile brevis* were found. The most remarkable was in a nest of two cells, the lower cell of which was normally provisioned and contained a growing larva. The upper cell, that is the second one to be constructed, consisted of a normal cell cup which was filled, not with the usual provisions, but with 40 round pieces of leaves of *Symphorocarpos.*

Duration of Trips

Much of the information on the timing of the construction and provision activities of *Megachile brevis* is summarized in figures 8 and 9. In these figures is presented the information on the comings and goings of nine different bees (a to i) watched continuously for more or less extended periods.

Bee "a" started to construct a cell between some small roadside rocks at Area 6 on August 16, 1950, at 11:00 a. m. The record (figure 8) consists solely of the 39 trips in two hours and 25 minutes required for the bee to construct the cup (bottom and side walls of the cell) from pieces of petals and leaves. For some reason which is not known, the bee never provisioned the cell.

The bee lettered "b" was first seen at 10:55 a. m. on August 21, 1952, as it flew out of an old cornstalk lying on the ground near Area 6. It was observed for a little less than an hour and a half, after which it never returned. It was neither constructing nor closing a cell, but was constructing a plug at the entrance to a series of cells that it had previously built and provisioned. This is, therefore a record of this final activity which often follows cell construction.

The bee lettered "c" was first seen at 1:19 p. m. on June 19, 1951, as it left a cell situated in a small hollow just below the surface of the ground near Lawrence, Kansas. The bee was last seen thirty-eight minutes later when it left the nest, so far as we could tell, for the last time. The record is presented, in spite of its brevity, since it is the only information available on the closing of an underground cell. The space was completely occupied by the one cell and no more cells could have been constructed here.

The bee lettered "d" was first observed at 2:12 p. m. on June 30, 1951, as it left a nest in a curled leaf of *Eupatorium perfoliatum* in

Area 6. The bee brought in about 14 leaf pieces in the next hour, then started collecting pollen. It brought in its ninth pollen load and ceased work for the night at 5:39 p. m. The next morning it resumed activities at 8:43. Observations ceased six hours and twenty minutes later as the bee was provisioning a second cell. The unusually long period at the nest (5 minutes) just before the last departure observed was due to the fact that the curled leaf had wilted some in the hot sun and the bee had trouble getting into her nest.

Nest "e" (figure 9) was found in a fasciate *Erigeron canadensis* plant in an alfalfa field at Hutchinson, Kansas. The bee was seen to enter the nest at 11:45 a. m. on July 26, 1950. The bee was collecting alfalfa pollen at the time, and in due course laid an egg and closed the cell with petals and leaves. Observations were continued for a total of 3 hours and 10 minutes.

Nest "f" was established in the same fasciate *Erigeron* as nest "e". The record shows every visit in the construction, provisioning and sealing of a cell. The first leaf was brought at 4:16 p. m. and the cell was partly constructed when the last trip of the evening terminated at 6:07 p. m. Activity began next morning at 9:35 a. m. and observations continued until the bee was caught at 6:02 p. m. after having apparently completed closing the cell.

Nest "g," also in a fasciate *Erigeron* near Hutchinson, Kansas, was located at 12:23 p. m. on August 2, 1950, as the bee entered the nest. It was observed through a series of pollen collecting trips to the beginning of closing of the cell two hours and ten minutes later, at which time the bee was taken to verify its identity.

Nest "h" was found on August 9, 1950, at 9:38 a. m. as a bee entered a hole in a dead prostrate *Ambrosia* stem in Area 6. The bee was carrying pollen when first seen, but soon after brought in petals and leaves to close the cell and to construct the cup of the next cell, and by shortly after noon was carrying pollen for the next cell. At 2:39 p. m. it started on the first trip to get petals to close this cell, the second cell to be closed this day. Petals and leaves were brought in until the last trip of the afternoon which ended at 5:30 p. m. Next morning activity started at 8:53 a. m. with bringing of more petals and leaves. At 9:36 a. m. the first pollen collecting trip started, the last one for this cell terminating at 12:19 p. m. Petals and leaves for closing the cell were then brought, and more of both were used to close the hole in the stalk. The bee was last seen about the nest at 2:12 p. m.; two hours of watching after that time indicated that the bee had left permanently.

The bee lettered "i" was found on August 11, 1950, at 12:35 p. m. as it flew from its nest in a piece of *Ambrosia* stalk lying in the grass in Area 6. The first petal to cap the cell was brought in 35 minutes later, at 1:10 p. m. and by 3:30 p. m. the cup of the next cell in the series was complete. Pollen was carried into the cell until 5:03 p. m., the last trip of the day. Next morning it was cloudy and the bee did not leave the nest until 11:15 a. m. and provisioning of the cell started the previous afternoon was not complete until 3:29 p. m. The bee then brought in a few petals and leaves, after which it seemed to cease work; it had not returned to the nest for the evening when the observer left at 5:53 p. m. The next day, August 13, threatened rain all day. The bee was seen carrying leaves, although she had only a few suitable periods during the whole day. She must have completed the next cell cup in the series, however, for after she left the nest the next day for the first time, at 10:45, she returned with pollen. Provisioning was complete and the first petal to form the cap of the cell was brought in at 1:10 p. m. on August 14.

A study of figures 8 and 9 shows some interesting things about the timing of the trips to and from the nest. The trips at the time pieces of petals and leaves are being brought to the nest are very irregular in length, varying from 20 seconds to two hours and 26 minutes. Sometimes considerable series of very short trips are made, for example there is a series of ten trips in ten minutes shown in the record of nest c. Among the data shown in figures 8 and 9, plus other records, are 335 timed trips which ended by a piece of leaf or petal being brought to the nest. Of these, 93 were trips of less than a minute in duration, 203 were trips of one to five minutes in duration, 20 were trips of six to ten minutes, 8 were of seven to fifteen minutes, three were trips of 15 to 20 minutes, and seven were trips over 20 minutes in duration.

There is no evidence as to what the bees were doing on the very long trips; possibly they might merely suck nectar. It is apparent from figures 8 and 9 as well as from examination of nests, that leaves usually are gathered in series preceded or followed by series of petals; it is unusual that a petal is brought in after a leaf and followed by another leaf, or vice versa. There is no evidence that the bees take longer to obtain leaves than petals or that the first of a series takes longer to obtain than others. As is fully confirmed by the study of nest structure presented earlier, figures 8 and 9 show that the last additions to the cup (innermost layers) are ordinarily petals as are the first or innermost layers of the cap.

The length of time spent in the nest between such trips is short, ranging from as little as 10 seconds, in cases where it was later found the bee had been merely using leaves or petals to fill excess space in the nesting cavity, to 10 minutes. In the latter cases the bee apparently merely rested in the nest. In most cases where the bee was continually active two minutes was the maximum period spent in the cell between leaf or petal gathering trips.

The foraging trips, by contrast, are of relatively uniform duration for any one nest. Thus for nests e, f, and g the trips are rather short, four and one-half to ten minutes, except for one of 23.5 minutes. This suggests that pollen can be collected rather quickly from alfalfa. By contrast, pollen collecting from *Rhus* and *Vernonia* seemed to require a longer time per trip, as can be seen, for example, from nest "d," in which the shortest trip was 10.3 minutes, the longest 29 minutes.[1] For this nest the pollen source (*Rhus*) was not near the nest (it was at least one-fourth mile away and this may account for the long duration of the trips. The length of time spent in the nest between pollen collecting trips was one to two minutes in nearly every case.

After provisioning and before bringing in further petals and leaves, a pause in outside activity consistently occurs. This is the egg laying time. The bee is in the nest from 4.5 to 9 minutes (average of 13 observations, 6.6 minutes) at this time.

Study of figures 8 and 9 suggests that unless the bee is gathering pollen, the last trips in the late afternoon tend to be rather long and to result in nothing visible being brought back to the nest.

It is also evident that when a nest is completed, it is not always, if ever, summarily abandoned; the bee often returns once or twice, carrying nothing, and buzzes about the nest or alights there before going on. In one such instance (nest f) it was noted that the bee was acting as though looking for a new nesting site. This would suggest that after one nesting cavity is filled or abandoned, the bee goes on immediately searching for another.

Besides irregularities of action already noted, there are occasional trips for which there seems to be no explanation whatever. An example is seen near the beginning of the record of nest "g". After bringing in a load of pollen, the bee left, was gone for some 45 seconds, returned with nothing visible, then left on another pollen collecting trip. On another occasion a bee in the midst of con-

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1. Temperature does not seem to be well correlated with duration of pollen collecting flight.

structing the cup of a cell left the nest and rested on a leaf ten feet away for a full minute, then returned to the nest, and entered it, then left and soon brought back another leaf. The number of such irregular trips is very small, as is shown by the small number of "o" marks on figures 8 and 9.

PETAL AND LEAF CUTTING

Leafcutter bees are widely known to use rose leaves freely in constructing their cells. The broad range of leaves and petals used by *Megachile brevis* is something of a surprise, although other species are known to use both petals and leaves.[1] Table VII lists the various kinds of leaves and petals which we have seen cut by this species. Certain European authors (e. g. Hardouin, 1945) have overemphasized specificity in the kinds of leaves cut by species of *Megachile* such as *M. centuncularis* Linnaeus, a species similar to *M. brevis* in many ways. This emphasis is surprising in view of the lists of different kinds of leaves cut by various species provided in Friese's (1923) review and in much earlier papers referring to *M. centuncularis,* for example by Buysson (1902) and Ferton (1896).

As was shown in more detail in the section on nest structure, the various kinds of leaves do not fill the same needs. The petals used on the outside of the cell and the thin leaves such as those of the Leguminosae serve merely to fill up extra space. The firmer leaves, such as those of rose, give the cell its shape.

If one examines a region where *Megachile brevis* is nesting, scattered leaves or petals from which a piece has been removed by a bee will be seen. However, most of the cutting is found to be in small areas, for example a particular branch of a rose bush or a patch of *Oenothera* flowers a couple of feet square. There are no evident differences between such places which are favored for cutting and similar bushes or patches a few feet away.

The following notes made on June 14, 1951, in Area 3 illustrate this and other points: "Occasional rose petals cut by *Megachile* could be found scattered over the entire prairie. Most of the cutting, however, is concentrated in small areas two to four feet in diameter. In these places both petals and leaves are cut. The number of cuts in each little area is such that all may have been made by a single bee. One similar area where strawberry leaves

1. The author has examined a nest of *Megachile montivaga* Cresson made in a green weed stem near Eagle Rock, Los Angeles County, California. The cells in this nest were made of the pink petals of *Phlox* and leaves of poison oak, *Rhus diversiloba,* which had become red with fall coloring.

TABLE VII.—Kinds of leaves and petals utilized in nest construction.

(x indicates a single observation or a single nest, xx several observations or nests, xxx indicates repeated observation in many nests.)

Scientific name	Common name	Leaves	Petals	Remarks
Polygonaceae				
Polygonum opelusana	Smartweed	x		
Polemoniaceae				
Phlox (cultivated)	Phlox	x		
Solonaceae				
Petunia	Cultivated Petunia		x	
Rosaceae				
Fragaria virginiana	Wild Strawberry	x		
Fragaria	Strawberry	x		
Potentilla simplex	Cinquefoil	x		
Rosa suffulta	Prairie Rose	xxx	xx	Important source of leaf pieces.
Rosa	Cultivated Rose	xxx		Important source of leaf pieces.
Cassiaceae				
Cassia chamaecrista	Partridge Pea		xxx	Important source of petals
Fabaceae				
Medicago sativa	Alfalfa	xx		Whole or nearly whole leaflets used.
Lespedeza violacea	Bush Clover	xxx		Important source of whole or nearly whole leaflets.
Lespedeza virginica	Bush Clover	x		Nearly whole leaflets.
Trifolium repens	White Clover	x		Whole or nearly whole leaflets.
Lythraceae				
Lythrum alatum	Winged Loosestrife		x	
Crassulaceae				
Penthorum sedoides	Ditch Stonecrop	x		
Oenotheraceae				
Ludwigia alternafolium	False Loosestrife	x		Leaves bitten but piece not carried away.
Oenothera speciosa	White Evening Primrose		xx	
Aceraceae				
Acer sp.	Cultivated Maple	x		Leaves of young seedling.
Caprifoliaceae				
Symphoricarpos orbiculatus	Buckbrush	xx		
Compositae				
Zinnia sp.	Cultivated Zinnia		x	
Silphium perfoliatum	Cupplant		x	

(*Fragaria virginiana*) were being cut was found, and another where leaves of *Potentilla simplex* were being cut. Strawberries and roses were scattered over the whole prairie." Nevertheless bees observed cutting returned unhesitatingly to their little patches.

It seems likely that an advantage of this tendency to return to a single place for leaves and petals is that it makes possible rapid gathering of these materials without the need to search on each trip.

We have seen alfalfa leaflets cut only three feet from the nest, and have seen pieces of rose leaves and leaves of *Lespedeza virginica* cut 150 to 200 feet from the nest. In the latter cases rose and *Lespedeza* leaves could have been found within ten feet of the nest. The time spent in flights of such lengths is negligible compared to that that might be spent in searching.

Figures 8 and 9 show that petal and leaf collecting trips away from the nest vary greatly in length but that the periods of time at the nest are comparatively constant. Observations of individual bees made at cutting places show that the length of time spent in cutting is rather constant, but that there is great irregularity in the length of time away from the cutting place. This indicates that the bees may spend considerable time on some trips before getting to the cutting place, for after cutting a leaf they always fly directly toward the nest. This time is perhaps spent in sucking nectar or in searching for new leaf or petal sources.

The bees cut leaves and petals with remarkable speed. The cutting is done by means of the mandibles (figure 5). We noted the cutting of a round piece of rose leaf such as is used for capping cells in 3 or 4 seconds, and timed the cutting of the longer pieces used for cup walls at 13 to 30 seconds.

Sometimes a bee cuts the first leaf it alights on but very often it flies on to leaf after leaf, as though for some reason dissatisfied. We watched one bee alight on 38 leaflets of *Lespedeza violacea* before finally cutting one off. As shown in figure 10, the bees very commonly start to cut into a leaf, and may have a piece half cut off, before abandoning it and going on to another. This hesitancy is far more noticeable when bees are not working in a repeatedly visited cutting place, but occurs even in such cutting places.

The cutting process begins with the bee resting on the edge of the leaf (or petal) with the legs of one side clinging to the upper surface of the leaf, those of the other side clinging to the under surface. The bee cuts into the edge of the leaf with its jaws, cutting in a smoothly curved line irrespective of veins in the leaf (e. g. in small rose leaflets it cuts through the midvein, figure 10). As it cuts, the bee turns its body so that a piece of standard shape (long for the cup, round for the cap) is cut out. The middle part of the bee's body moves very little, merely rotating as the head and jaws describe an arc while the cutting goes on. As the cut is made the bee shifts its footing so that it is clinging to the piece being cut. At least in the case of an elongate piece, the piece is curled as it is cut by bending the edges away from the body of the bee. This is done as the bee shifts onto the under surface of the piece being removed,

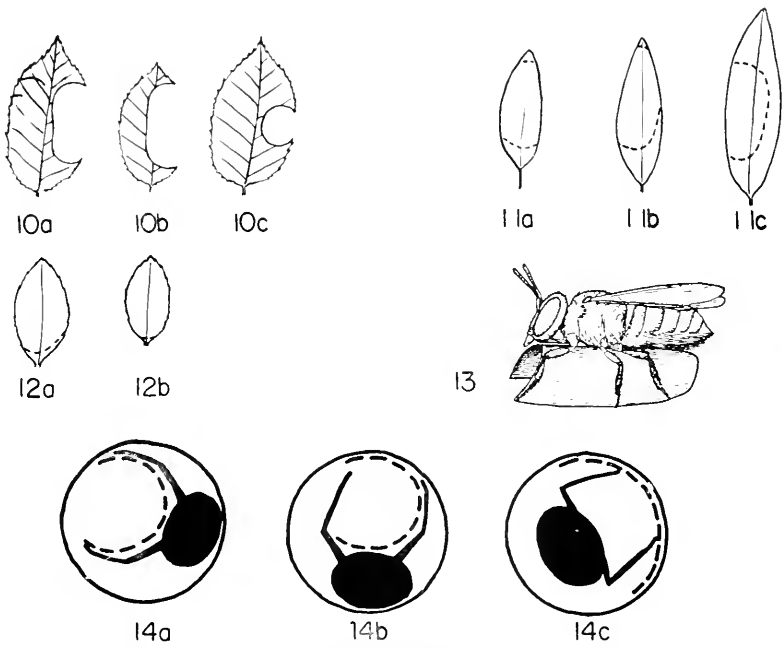


FIG. 10. Rose leaflets cut by *Megachile brevis*. a, leaflet with two incomplete cuts and one long piece removed; b, small leaflet with one long piece removed, showing that the bee cut across the midvein; c, leaflet with round piece removed.

FIG. 11. Leaflets of *Lespedeza virginica* showing the ways in which long pieces are obtained from leaflets of various sizes. a and b are common, c rare since leaflets are rarely so large.

FIG. 12. Leaflets of *Lespedeza violacea* showing ways in which they may be cut whole or nearly so for use as filler leaves.

FIG. 13. A female *Megachile brevis* showing the way in which she holds a piece of a leaf.

FIG. 14. Diagrams showing the way in which a bee places long leaf pieces to form the cell cup. The circles represent the hollow (or already partly constructed cup) seen from the open end. The leaf piece is represented by the broken lines. The bee, headed into the cell, is represented in black. The bee carries the leaf into the cell in the manner shown in a, moves sideways, as shown in b, until she gets past the edge of the leaf, as in c.

so that as the six tarsi hold the edges of the piece away from the bee's body, the center is bowed against the sternum. In every instance observed carefully (about 30 cuttings of leaves, three of petals) the piece was held in this fashion with the original under surface (of leaf) convex against the venter of the bee. As will be shown later, this results in the under surface of the leaf being outermost in the complete cell. Cutting continues around the arc characteristic of the type of piece being removed, and at the instant that the piece is severed the bee takes flight. The details of the cutting process must be rather constant among a large group of species of *Megachile;* see for example Ferton's (1893) notes on leaf cutting in *M. centuncularis* Linnaeus. Sizes and shapes of pieces removed will be discussed in more detail under nest structure.

When the bees are cutting small leaves, leaflets, or petals which, because of size, require a minimum of cutting, the cutting procedure is surprisingly little modified. Thus when a bee alights on a leaflet of *Lespedeza violacea,* she starts to curl it in the usual way as she works around the edge of the leaf with her jaws, not cutting it. When she reaches a point on the edge of the leaflet where the normal cutting arc enters the leaflet, she cuts into the leaflet and cuts it off (figure 12). This action suggests that cutting from larger leaves is the primitive behavior pattern, modified in *Megachile brevis* until more small leaflets and petals are used than pieces of larger ones. The pieces of larger ones are, of course, more accurately shaped and it is perhaps significant that the firmer leaves responsible in most cases for the shape and firmness of the cell are always cut from moderate-sized leaves (e. g., rose) and are not merely severed leaflets.

As shown in figure 11, the leaflets of *Lespedeza virginica* are of an intermediate size so that, while a piece may be cut out as with rose, more often the tip of a leaflet is cut off and dropped, then the jaws of the bee follow the leaf edge to a point near the base where they cut into the leaf and across it.

In one instance a bee was seen to cut off and carry away a small triangular piece of rose leaf left between two normal sized pieces removed previously. It is possibly significant that this was done on the last of at least ten trips of the bee to a particular cutting area.

Once the bee has cut off the leaf piece, it usually flies from one to ten feet and alights on a leaf or on the ground, remaining there as though resting for 45 to 80 seconds (average of 10 observations, 61 seconds). While resting the bee holds the leaf as previously described, curled under her body, the claws holding its margins (figure 13). Just before flying off toward the nest, the bee, in every instance observed, rubbed her abdomen against her closed wings several times. This brief period of inactivity following cutting is often omitted but only when bees are cutting either soft and easily cut petals or leaflets which required little more than severing. Eleven cuts of *Lespedeza virginica* leaflets by a single bee [1] were observed. Of these only two leaflets were large enough to require cutting around three sides; after these two the bee rested. The others were smaller leaflets requiring less cutting (see figure 11) and the bee did not rest but flew directly to the nest, 150 feet away.

Data on how far from the nest bees will go to obtain leaves and petals are very scanty. We have seen them cut within a few feet of the nest and we have seen pieces of petals brought from 300 feet away. In view of the diversity of leaves and petals that can be used, they are probably usually obtained rather near the nest.

NEST CONSTRUCTION

Ordinarily the cells of *Megachile brevis* are placed in hollows where the actual manner of building the cell cannot be observed. We have been fortunate in finding certain nests whose cells were incompletely enclosed, enabling us to observe certain things about the construction process. Three of these nests were in spaces among the leaves of fasciate plants of *Erigeron canadensis* but one was in a curled leaf of *Eupatorium perfoliatum*. In all cases the construction technique was the same. In making the cup of the cell, elongate pieces of leaves or petals are used. The bee brings in the piece of leaf or petal curled, with the edges held away from the body, as already described (figures 13 and 14). She carries the leaf into the cavity in this position, entering head first, then she releases it and works laterally around the cavity until she gets past one edge of the leaf, as shown in the diagrams (figure 14). Additional leaves and petals are added in the same manner so that the cell wall is constructed from the outside inwards. After the bee has placed a leaf or a petal in a partially constructed cell, she works in and out and around, the abdomen moving in small, quick (respiratory?) movements. The bee may move in and out only twice, or up to five times. While doing so, she is mouthing the leaves, particularly their edges, as can be seen occasionally when she backs almost out of the cell to mouth the outer portions of the leaves. At such times it can be seen that the apex of the proboscis

1. With an observer at the nest and another at the cutting place, there was no doubt about the bee being the same one each time she was observed cutting even though she was unmarked.

is applied to the leaves although the proboscis is scarcely unfolded. Probably this activity adds the invisible quantities of adhesive apparently used in cell construction. The leaves stick together only very feebly, yet they are not entirely loose when a nest is exposed. Some species of the genus evidently stick the leaves together much more firmly (see footnote 1 in Ferton, 1898) while others may use no adhesive material at all. When this activity is finished, the bee backs out of the cell and flies away.

After the cell is complete, provisioned, and an egg laid, the bee caps the cell, using round rather than elongate pieces of petals and leaves. The cap is placed well down within the mouth of the cup. When a bee is putting in this plug, she hangs on the edge of the cup with her rear legs, the body in the cell and braced against the inner walls with the other legs, then she pushes the round piece of petal or leaf into the opening with her head and mandibles. (This closing behavior was carefully noted only once, and may vary more than indicated here.)

Provisioning

The partially exposed cells described in the preceding section provided an opportunity for observations of provisioning activities. When a bee returns to her cell with the scopa (the long hairs on the under side of the abdomen) full of pollen, she quickly enters the cell head first and remains in this position for 20 to 45 seconds (average of 14 observations, 28 seconds). While in this position the apex of her abdomen, which is visible inside the cell, can be seen to tremble slightly. During this time the bee is no doubt placing nectar in the cell. After this the bee quickly backs out of the cell, turns around, and backs in. When she backs out the pollen can still be seen in the scopa. Occasionally as she backs in, the beginning of probable combing motions by the rear legs to remove pollen from the scopa can be seen. She remains in the cell in this position from 40 to 65 seconds (average of 12 observations, 50 seconds), her head visible within the opening of the cell. Just before leaving the cell, the bee moves from side to side a little and often brushes the head and eyes with the front legs; then she crawls out and quickly flies away. As she leaves it can be seen that the scopa is clean.

Unless the cell is vertical, the bee consistently enters the cell with her ventral surface down during the provisioning process, not rotating on her long axis within the cell as when the cup is being constructed.

Observations of the accumulating provisions in the cell, made while the bee was away, gathering more, show them to be firm (not sticky as in opened cells) and with the surface flat, at right angles to the long axis of the cell and smooth as though tamped down.

The distance from which *Megachile brevis* will gather pollen is unknown but we have observations of pollen gathering from a few feet to one quarter mile from the nest, and circumstances often suggest that they may go much farther than this.

EGG LAYING

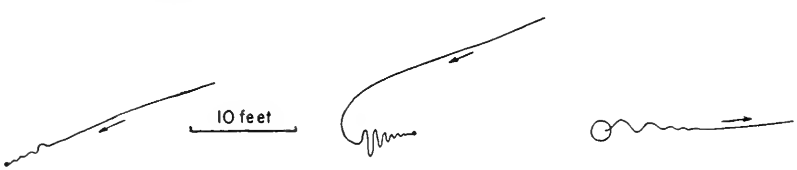
The behavior connected with egg laying was observed five times in cells which were sufficiently exposed that some details of the bee's activities could be seen. In each case the procedure was as described below. Minor variations in timing occur, of course, as can be judged by the variations in the length of the egg laying period shown in figures 8 and 9.

On returning from her last pollen gathering trip, the bee enters the cell head first presumably to regurgitate nectar, then backs out and backs into the cell and brushes the pollen from the scopa, just as after any other pollen collecting trip. She then comes out of the cell head first, quickly turns around at the entrance and re-enters, head first. She now works for about 50 seconds, moving about in the cell and often turning the body on a longitudinal axis so that she may be clinging to the roof of the cell (if it is horizontal) part of the time. During this period the apex of the abdomen (the only part visible) is sometimes bent downward in an unusual way. The bee then backs out of the cell, turns around, and backs in, remaining there about 45 seconds. It is during this period that the egg is laid on the surface of the mass of provisions. She then comes out head first, turns around, goes in head first again, once more working around the cell and curling the apex of the abdomen downward. This continues for about two minutes (in one case five minutes), after which the bee backs out and flies away, soon to reappear with a petal and start capping the cell.

In an ordinary nest in a weed stalk none of this activity is visible, for the hole in the stalk is large enough to allow the bee to turn around outside the cell but inside the stalk. It is interesting that in the megachilid genus *Hoplitis* (subgenus *Alcidamea*) precisely similar enterings and re-enterings occur at egg laying except that the diameter of the hole in which the cells are constructed is so small that the bee must come all the way out of the nest in order to turn around.

FLIGHT PATTERNS AROUND NESTS AND LEAF-GATHERING PLACES

The most noticeable feature of the arrival at and departure from a nest is its rapidity. When an observer first takes his place near a nest, the returning bee may be somewhat disturbed and may fly about the vicinity or about the observer for a short time before entering the nest, but when she becomes used to the observer and her activities are undisturbed, she ordinarily flies directly toward the nest, often with a little zigzag motion in the last few feet of the approach (figure 15). If the nest is among grass or weeds the bee may or may not have an invariable route through the obstructing vegetation; the flight through it is always slow, however, compared to flight in the open. One nest located under grass on an open prairie, where landmarks are presumably poor for the bees as they are for us, was always approached from one side, the bee swinging around and then zigzagging broadly in the last eight or ten feet of the approach (figure 15). The same bee regularly approached a leaf cutting place on the prairie directly, with no zigzagging whatever, perhaps because no great precision was required, the leaf cutting area being two or three feet in diameter. The most extensive searching flight which we observed in the approach to a nest occurred in the case of a bee which nested among small rocks along a roadside. Similar small rocks had been dumped for 100 yards along the road and the rocky surface looked much the same everywhere. The bee was rarely able to approach its nest directly and often, particularly if it had been away for over five minutes, flew up and down over the rocks, often going as much as 20 feet in the wrong direction before finally narrowing its field of search and then zigzagging toward the nest. Such behavior is very striking compared



15a 15b 16

FIG. 15. Patterns of arrival at nests. a, the common pattern, in which the bee scarcely slows down to zigzig before entering the nest; b, a pattern in which a bee regularly circled and zigzigged rather broadly on the way to the nest.

FIG. 16. Flight pattern of departure from a cutting place.

to the vast majority of nests studied, to which direct approaches were made by the bees, probably because brushy and weedy situations usually provide adequate landmarks. Similar difficulty in locating a nesting site was recorded by Rau (1916) for a female nesting in a railroad tie. The bee searched the wrong tie. Presumably all the ties along the track were much alike.

In leaving the nest in favorable weather the bee comes out, immediately takes wing and is gone, usually in an essentially straight course. Occasionally in cool weather, or at the first departure in the morning, the bee crawls out of the nest and rests for a few seconds to a minute or more before flying. It was noted that in leaving her nest on the open prairie, the bee mentioned above regularly spent about two seconds zigzagging or circling over the nest site. The same bee, leaving a leaf cutting place on the prairie usually zigzagged only slightly (figure 16).

Orientation flights around a newly discovered nesting site were observed three times, and about a newly discovered cutting place once. These flights did not follow any consistent pattern such as flights of increasing length from the site or flights in increasingly large circles around it but involved merely irregular flights over the site, and in the case of the nesting places, several returns from many yards away.

From the usual nest, the pollen source is more or less definitely in a particular direction, while sources of petals and leaves are in other directions. The bee, under such circumstances, often (although by no means always) uses particular routes as she leaves the nest and returns to it. The routes of departure may or may not be identical to the routes for returning. Our notes contain numerous references to the exact way which a bee, during any one phase (e. g., pollen gathering), follows a certain course, identified for us at least by bushes, weeds, and other fixed objects. When several observers could be got in the field, it was sometimes possible for them to take stations along the line of flight from the cutting place to the nest and see that the line of flight was followed quite exactly time after time for the whole distance (150 feet).

On the other hand, we have watched a nest (d, figure 8), in which the bee rarely took the same course in leaving on its pollen collecting trips. The bee flew in a generally westerly direction for pollen but left in directions as different as north northwest and southwest and sometimes returned from directions as different as 45 degrees from the direction taken on the outward journey. The pollen source (or sources) was at least one quarter of a mile away. The same bee, when collecting petals (mostly of *Lythrum*, one of *Cassia*?) and leaves, flew eastward, following approximately the same course each time. (There is no general rule that bees fly in the same direction for petals as for leaves; they may fly in opposite directions.)

The pollen collecting flight patterns of three bees nesting in alfalfa fields in the region of Hutchinson, Kansas, are interesting. One of the bees flew consistently northward from its nest, apparently gathering pollen from a particular part of the field, which, however, was not different so far as we could see from other parts of the field. The other two bees (one of which nested within 15 feet of the above bee and was observed on the same day) flew from their nests in many directions, apparently at random, for alfalfa pollen. These bees were able to return directly and quickly, without searching, from any direction and sometimes returned from a direction differing from the line of departure by as much as 90 degrees. All three bees flew in particular directions to gardens around nearby houses for petals and some of their leaves, but they obtained other leaves from the alfalfa plants around the nests.

CHANGES IN BEHAVIOR

Because of the mobility of *Megachile brevis* populations and the tendency of the females to construct cells in different places, we have no records of activities throughout the lives of individual bees; therefore we have no knowledge of changes which may occur in behavior during the life of a bee. However, in the brief period required for construction of single cells some observations on changes of activities are possible.

It has been noted that when the female bee concludes one phase of its activity and goes into the next, the change in behavior is abrupt and absolute. Thus when the bee finishes constructing the cell cup it promptly changes to pollen collecting behavior, and after the cell is provisioned and the egg laid, it promptly returns to leaf cutting behavior. A good example is provided by the data on nest "i" presented in figure 9. After each of the two egg layings indicated in this record, the bee, which had been flying in a generally westward direction for pollen, came out of the nest and without the slightest delay flew eastward for petals. In each case she was back to the nest with a petal within one minute. Doubtless because of previous experience in the area the bee was able to go quickly to a petal source. Examination of figures 8 and 9 shows that first trips after changes in phases of activity average no longer than later trips. This indicates that for these bees no extensive searching for materials (petals, leaves and pollen) was necessary. The bees must have "known" of the sources of the materials at the time they left the nest. This is suggestive of a delayed reaction to previous conditioning. There is some evidence to support the idea that much behavior of aculeate Hymenoptera results from delayed reactions which were first definitely recognized among invertebrate animals by Baerends' (1941) working on *Ammophila.*

There is some evidence, meager but nonetheless suggestive, that within any one phase of its activities, changes in sources of materials are made somewhat gradually. The details of a change from collecting *Vernonia* pollen to that of *Rhus* were observed on August 11, 1950, in Area 6. The bee had been gathering pale *Vernonia* pollen for several days and had provisioned three and one half cells with it. In the midst of provisioning the fourth cell, as she left on a pollen gathering trip, she was seen to fly toward some nearby *Vernonia* and when nearly there turn and fly on a different course toward some *Rhus* bushes 100 yards away. She returned with yellow *Rhus* pollen. On her next trip, she flew again toward the *Vernonia* but quickly veered toward the *Rhus.* Thereafter she flew directly toward the *Rhus* from the nest, completing the fourth cell and provisioning two more with its pollen.

Another instance of gradual change in behavior concerns leaf cutting operations of a bee observed in Area 3 on June 16, 1951. The bee had been gathering leaves of *Lespedeza virginica* at a very rapid rate, obtaining them from a small cutting place on the prairie. An observer was at the nest, another at the cutting place, 150 feet distant. The bee made 11 trips for leaves in rapid succession, being away from the cutting place for periods of time varying from one and one-half to three minutes. On the twelfth and thirteenth trips the bee was away from the cutting place for 7.5 and 6.5 minutes. Most of this time was spent in the nest but the two observers noted that her flight time from nest to cutting place nearly doubled on these two trips although when she arrived at the cutting place, she came from the direction of the nest. On the fourteenth and fifteenth trips, the bee left the nest in the direction of the cutting place, but did not alight there. The observer there (CDM) was virtually certain that on each trip she passed the cutting place and then headed in a southerly direction; at any rate an insect that looked and sounded like a female *Megachile brevis* arrived at the expected time (indicated by a shout from the observer at the nest) from the direction of the nest (northwest) and then headed southward. On each of these trips the bee returned to the nest with a piece of rose petal. There was no indication that she returned to the nest via the leaf cutting place. On the fifteenth trip the bee again left the nest, headed toward the leaf cutting place but was not detected there; on the sixteenth trip she left the nest headed in a more southerly direction, presumably toward the source of petals. From each of these trips she returned with a piece of rose petal.

PART V.—GROWTH AND DEVELOPMENT

TECHNIQUE OF STUDY

After the egg is laid in a cell and the cell is capped, the bee goes on to the construction and provisioning of other cells, giving no further attention to the egg or resultant larva. The developmental stages are ordinarily hidden from view. Two principal methods were used to study them. Cells, removed from the hollows in which they were constructed, were slit longitudinally on one side with a sharp blade. They could then be opened as desired for inspection of the contents. This method has serious disadvantages for the cells must be kept in a humid atmosphere to prevent desiccation of the pollen mass. Fungal growth therefore often occurs on the leaves, and later on the pollen. Moreover, the cap of the cell usually falls out. Since the larger larvae often press against the cap with their middle or posterior portions in order to force their heads down into the pollen, lack of the cap seems to cause slow feeding and sometimes larvae seem to have difficulty finding the food.

A better method consists of moving pollen mass and larva into a glass tube having an inside diameter of about 5 mm. The tube should be plugged at each end with absorbent cotton, the cotton plugs being about 10 mm. apart at their inner ends. Mold rarely grows in such containers. If they become too dry water may be added through the plugs.

Another good method consists of filling a Stender dish with paraffin, then making depressions 5 mm. in diameter and 10 mm. deep in the paraffin. Young larvae live very well in such containers, humidity being provided as needed. Visibility is very good as the lid of the Stender dish can be removed and the contents examined under a binocular. Older larvae do best in tubes, however.

Obviously all these methods involve considerable artificiality; this may account for some of the rather great variability noted in the duration of various stages. The records given below, however, omit cases where larvae were obviously away from their food for long periods or where other such avoidable abnormalities occurred.

All records of duration of stages were obtained at room temperature during August. Most larvae were observed but once each day, so that the margin of error in timing activities of short duration is great.

EGG

The egg is about three millimeters long or slightly less and 0.6 or 0.7 mm. thick (figure 18), soft and smooth on the outside, glistening white in color. It is laid on the top of the pollen mass, standing up from the surface of the pollen in a slanting position (figure 17). If the pollen mass becomes somewhat liquid, as often occurs, or if the nest is jarred in carrying it to the laboratory, the egg will slump down until it lies at full length on the pollen. This does not appear to influence development and hatching, and it may well be that the egg is often laid in this position.

It is exceedingly hard to tell when the egg hatches because the chorion or "shell" is so thin and soft and because it disappears completely after being shed. However, segmentation, muscular movements and gas filled tracheae can be seen before hatching. As soon as pollen is visible in the digestive tract, hatching must obviously have occurred. Three observations from laying time to approximate hatching time indicate that the egg stage lasts from 3 to 3.5 days.

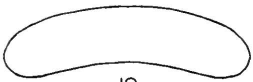
LARVA

The larva (figures 19 to 21) is a legless whitish grub. Dorsally it is feebly brownish, and the apices of the mandibles are dark brown. Details of certain anatomical features of the mature larva are shown in a previous paper (Michener, 1953).

During the entire feeding period of the larva, from shortly after it emerges from the egg until feeding ceases on maturity, small spots which are whiter than the rest of the grayish white body can be seen through the integument. They have been seen as little as twelve hours after hatching and may appear sooner, although they are absent at the time of hatching. They are not part of the cuticle, as they can be seen moving beneath the cuticle with the movement of the tissues inside the body. After the larva finishes feeding these spots disappear and the general color of the larva becomes more white, less grayish.

The number of larval stadia has not been definitely determined. The exuviae are very delicate and are probably usually eaten soon after ecdysis.

In the first day of its life the larva is straight and lies flat on top of the pollen mass. It has thick projecting folds along each side of the body which seem to help the small larva, 3 to 4 mm. in length, to float on the often quite liquid mass of food. At this stage the larva is unable to move about to any extent. Usually on the



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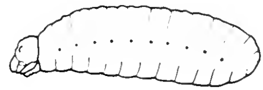

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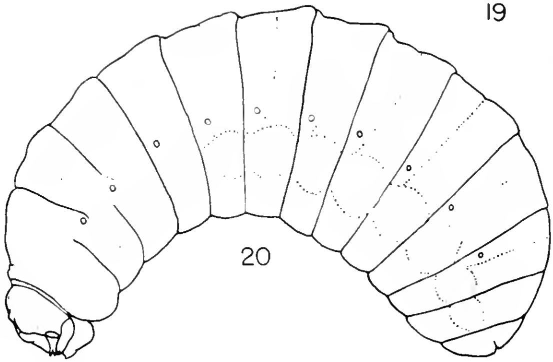

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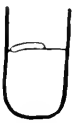

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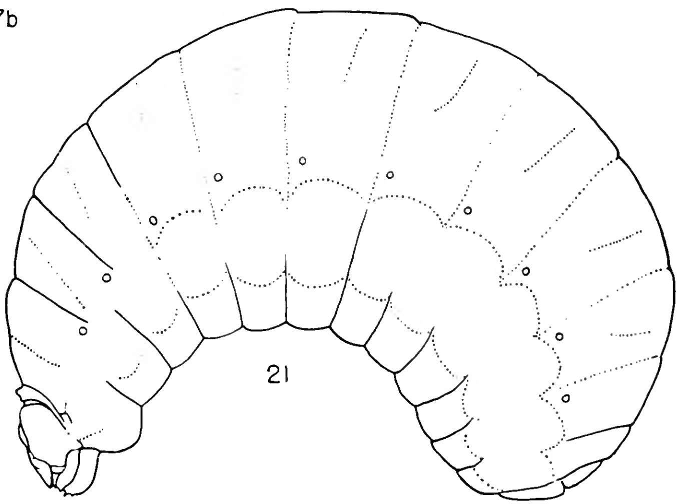

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FIG. 17. Diagrams of cell cups. a, with egg standing up from edge of mass of provisions; b, with egg as usually found, lying on provisions.

FIG. 18. Egg of *Megachile brevis*.

FIG. 19-21. Larvae of *Megachile brevis*, first stage, half-grown, and mature.

second day, after what is probably the first molt, the larva becomes more curved as it eats into the pollen at one side of the cell, and the lateral folds are far less prominent. At the beginning of this stage the larva when straightened out is about 5 mm. long. As it grows the larva becomes more strongly and permanently curved (so that it cannot be straightened for measurements of length) and eats the pollen down toward the base of the cell. Thus it has its head toward the base of the cell while it is eating.

When about half grown, the larva usually produces its first feces. We have a few records, however, of individual larvae which produced no fecal material until after the pollen supply was exhausted.

Feces are remarkably variable, not only in the time when the first ones appear but in their color, for they vary from white through testaceous to brown and black. Perhaps the color depends on the kind of pollen being eaten by the larva. They are cylindrical, often 1.0 or 1.5 mm. long, rather firm, the first ones produced usually being smaller than later ones. They are produced in considerable numbers, a dozen or twenty often appearing during the first twenty-four hours of defecation, a total of 40 or 50 or more being reached at the end of the period.

Since the larva lies in its cell feeding with the head toward the base of the cell, most of the feces are deposited near the cap. They are often crushed against the walls of the cell by the movements of the larva. Sometimes, perhaps regularly, scattered threads of whitish silk spun about on the cell walls by larvae serve to hold the feces against the walls and to prevent contamination of the food by fecal material.

Commonly about one day after the first feces are voided, the pollen mass is exhausted. In some cases this requires longer, even up to four days. The average of observations of this period on 15 larvae is 1.9 days, but it is probable that this average is too high for it is during this latter part of larval feeding that abnormal lengthening in the larval period due to laboratory conditions (e. g. pollen too moist, too dry, moldy, etc.) is probably greatest. Not infrequently in the laboratory, and in nature as well, larvae leave some of the pollen mass at the base of the cell uneaten. This unconsumed pollen consists of a pad one half to one millimeter thick in the base of the cell. It is not clear whether it is left because it has become unsuitable as food or because the larva has finished its development and needs no more food, but the latter seems probable.

After the larva has finished feeding on the pollen mass, it spends at least a day before it begins to spin its cocoon. Occasionally this period extends to three days, although the average of 14 records of this period is only 1.3 days. During this period the larva moves about considerably turning so that its head is away from the base of the cell and rasping the inner walls of the cell with its mandibles and eating some of the petals which usually form the linings of cells and which by this time have become soft and mushy. Evidently the larva may reverse its position in the cell more than once at this time for cells have been opened containing larvae which had finished all their provisions, turned so that their heads were toward the cap of the cell, part of which had been eaten, then turned back so that the head was toward the base of the cell. The larva eats especially from the cap of the cell, so that petals and even the inner leaves of the cap become mere rings, for the larva can get at the centers but not at the margins of the disc-shaped pieces used in the cap. So far as known this is the first report of bee larvae eating petals and leaves. One larva was observed eating petals from the wall of its cell a full day before it had finished eating pollen. Larvae reared in artificial containers without petals and leaves seem to develop quite normally, however, in spite of the lack of this food. Under artificial conditions, with larvae removed from their cells, the entire period from hatching until the beginning of cocoon spinning ranges from 5.1 to 13.3 days in summer. As already suggested, the maximum lengths of time almost certainly are abnormal.

Perhaps throughout the entire last half of the growth period the larva is capable of spinning, for slits in the sides of cells are often found closed by a few strands of whitish silk during this period.

Cocoon spinning requires from less than a day to three days, the average of 15 individuals whose cocoon spinning was timed being 1.4 days.

The silk is spun from the slitlike salivary opening and is applied by side-to-side movements of the head and forward parts of the body of the larva.

The spinning of the cocoon starts with the larva in a position with head away from the base of the cell. As will be explained later, the cocoon consists of various layers. Presumably the larva reverses its position in the cocoon in the process of laying down each layer. As a result spinning larvae may be found in almost any position within the cocoon. After the cocoon is complete, larvae consistently take up a position with the head away from the base of the cell. In describing cocoons, therefore, the end in the base of the cell is called posterior, the end toward the cap is called anterior. This orientation is maintained in the pupal stage so that the emerging adult has its head directed toward the entrance of the nest.

After the cocoon is complete, there is a period of a day during which the larva inside the cocoon is able to seal with new silk any slit made in the cocoon for observational purposes. In one instance out of ten observed a larva was able to do this on a second day.

After this the larva appears to be unable to produce silk; at least it does not mend slits in its cocoon. It remains able to move for several days, however. The total length of the larval period after completion of the cocoon and before pupation is three to eight days (average of seven, 5.2 days) in summer; individuals of the fall generation pass the winter in this stage.

Cocoon

The cocoons spun by the larvae are cylindrical with somewhat rounded ends. A randomly selected group of 15 varied from 4.3 x 8.5 mm. to 5.2 x 10.0 mm. The average width in this group was 4.75 mm., the average length, 9.06 mm. The cocoon of a partially starved larva was only 3.75 x 8 mm., but since cocoon diameter ordinarily depends on cell diameter, there probably was no relation between the starvation of this larva and the small diameter of its cocoon.

The outermost fibers of the cocoon are slender whitish or pale brown threads which form no continuous layer but attach any feces, bits of pollen, or other materials to the walls of the cell and which cause the cocoon to adhere to the inner wall of the cell except sometimes at its anterior end, where there may or may not be a small space between the anterior end of the cocoon and the cap of the cell. The outside diameter of the cocoon, therefore, is normally the same as the inside diameter of the cell.

Inside of these sparse fibers is the *outer cocoon.* In the *Coelioxys* described below it forms a complete layer, but in *Megachile brevis* the outer cocoon consists of a cap of coarse red threads covering the anterior end of the cocoon. Occasionally it is reduced to only a thread or two or is absent; more often it extends backward over the anterior end of the cocoon for a millimeter or two, and in one cocoon (out of 60 examined) the red fibers of the outer cocoon reached the middle of the cocoon. Thus the outer cocoon is always lacking from the posterior part of the cocoon.

The red fibers of the outer cocoon are coarser than those used in any other part of the cocoon. They vary greatly from cocoon to cocoon in thickness. In one the coarsest of the red fibers were .08 mm. in diameter, the finest .01 mm. in diameter with most of the fibers about .03 mm. in diameter. In another cocoon the coarsest were .04 mm., the finest .01 mm., with most of the fibers .02 mm. or less in diameter. Sometimes irregular thick places on the fibers occur so that in one cocoon whose thickest fibers were .045 mm. in diameter irregular bulges reached a thickness of .065 mm. The fibers of the outer cocoon are very stiff, lie criss-crossing one another at irregular angles, the various thicknesses indiscriminately mixed. The outer cocoon is hard, firm, and thick in contrast to the rather delicate and thin inner cocoon.

The *inner cocoon* is firmly in contact with the outer cocoon, and the two can be pulled apart only with difficulty. Posterior to the outer cocoon, the inner cocoon is continuous with the sparse pale threads which are attached to the walls of the cell. These threads and those of the inner cocoon seem identical; they are fine, .01 to .001 mm. in diameter, pale brown, criss-cross one another irregularly, with the various sizes intermixed. The inner cocoon is spun by the larva until it is opaque, but it still appears pale brown. A few hours later it changes to a dark brown. This presumably happens when a dark brown liquid (of unknown origin) is spread by the larva on the inner surface of the inner cocoon. This liquid impregnates the inner cocoon and quickly hardens, for in every cocoon opened this portion of the inner cocoon consisted of fibers imbedded in a hard but flexible, amorphous, translucent, dark brown material which obviously must have been applied to the fibers as a liquid. This is the outer layer of the inner cocoon.

The inner layer, which is difficult to separate from the outer, is highly variable. It is always thinner than the outer layer. It may consist merely of pale brown fibers like those of the outer layer applied to the inner surface of the outer layer and giving it a silvery appearance seen from the inside. These fibers may be impregnated and joined by the amorphous brown material characteristic of the outer layer, or this material may be present only in the anterior part of the inner layer. In over 50 percent of the cocoons the inner layer does not reach the posterior end of the cocoon, but fades out short of it. In six cocoons of the 60 studied, the inner layer of the inner cocoon was absent.

Rarely there are one or more small additional "layers" of inner cocoon, sometimes mere flakes, outside the outer layer or inside of it, at the anterior end of the cocoon. These layers are impregnated with the dark brown amorphous material. Regardless of the presence of such additional layers, there is virtually always a place (sometimes conspicuous and sometimes minute) in the center of the anterior end of the cocoon where the amorphous material does not completely close the spaces among the fibers of any of the layers of the inner cocoon. This allows for ventilation of the otherwise airtight cocoon. This place corresponds to the conspicuous nipple found on the anterior end of many megachilid cocoons.

It seems probable that the inner cocoon of *Megachile* and *Coelioxys* corresponds to the entire cocoon of *Osmia* and *Hoplitis,* that the reduction of the nipple in *Megachile* and *Coelioxys* is associated with the addition of the outer cocoon, and that the addition of the tough, hard outer cocoon, especially anteriorly, is advantageous in protecting against invaders.

Complexity of the cocoon in *Megachile* may be widespread, for Micheli (1937) describes the cocoon of *Megachile nigriventris* Schenck as consisting of no less than five layers.

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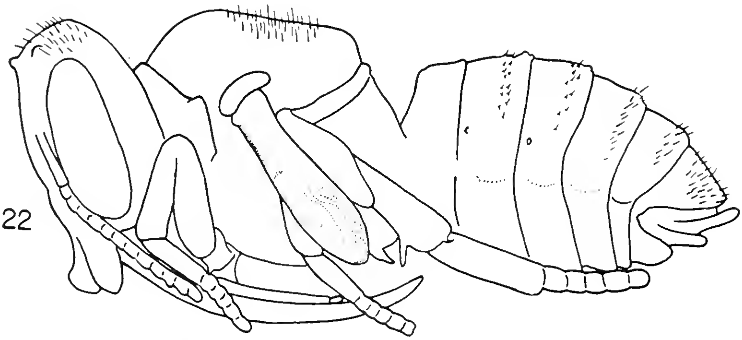

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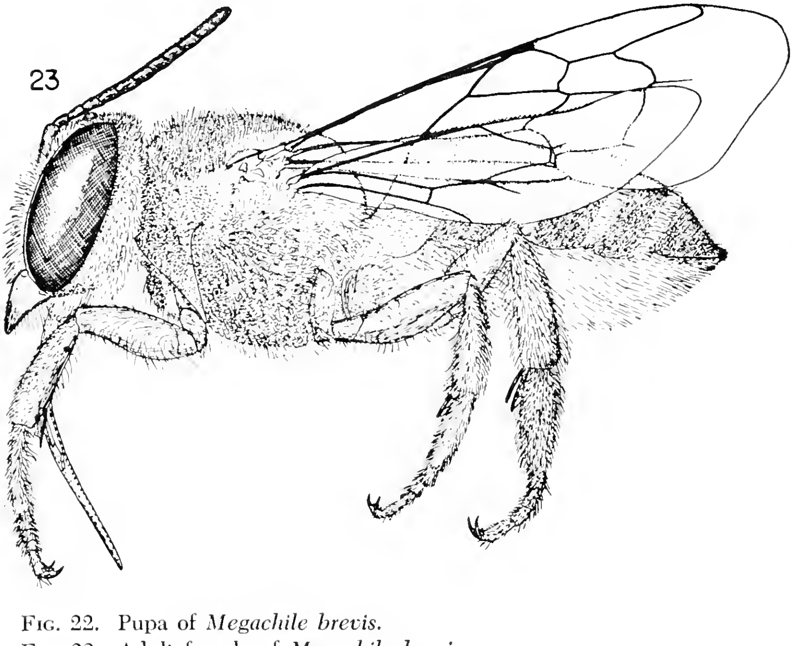

FIG. 22. Pupa of *Megachile brevis.*
FIG. 23. Adult female of *Megachile brevis.*

PUPA

The pupa lies in the cocoon with its head away from the base of the cell, that is toward the entrance of the nest. At first the pupa is entirely whitish in color but after one or two days the eyes become pink. They become gradually darker during the following several days. Then other parts of the body begin to darken, the antennae, tarsi, and tibial spurs being among the last. Finally the whole pupa becomes black. About a day before emergence of the adult, the pupa becomes soft and wrinkled in appearance.

The total pupal period ranges from 10 to 12 days (average of six, 11.2 days).

EMERGENCE

When the adult first emerges it is wet, and it may require half a day or more to dry off and expand its wings. This occurs within the cocoon. After this the apparently perfect adult remains in the cocoon from two to five days (average of 5 observations, 3.5 days), then chews its way out of the cocoon.

The adult then soon chews its way out of the cell. In so doing it commonly chews the cap and much of the cocoon into small bits. If cells are in a series, it is usual for the bees to emerge at about the same time, when the uppermost bee emerges. They leave behind them a tube of leaves and petals, the side walls of the cells, the lower or inner end of the tube being filled with the remains of cocoons and ends of cells, all broken into small pieces.

Because of the short series often available and especially because of the high rate of parasitism in long series, no significant data were gathered on whether females are usually reared in the older cells and males in the younger cells of a series.

Freshly emerged bees liberated in the field visited flowers immediately for nectar. One female stopped to suck from a *Lythrum* flower only one foot from the point where she escaped from the nest.

SUMMARY OF DEVELOPMENTAL STAGES

Making use of the data presented above, table VIII has been constructed to summarize the duration of the stages in the life history of this bee. Total figures from the time of egg laying until emergence of the adult from the cocoon are 23.9 days for the minimum column, 32.3 days for the average column and 45.8 days for the maximum column. Probably no bee achieves the minimum or maximum, as there is no reason to believe, for example, that a bee with one stage minimum in duration would have the others minimum also. The average period from egg laying to adult emergence from the cell in the case of eight undisturbed cells was 32.2 days (minimum 30, maximum 35). This indicates that the average figures independently obtained in the laboratory for the lengths of larval stages are not greatly different from those existing in nature.

TABLE VIII.—Estimates of duration (in days) of the stages in the life history of *Megachile brevis* under summer conditions.

	Minimum	Average	Maximum
egg	3	3.2	3.5
larva			
before starting cocoon	5.1	7.7	13.3
after starting cocoon	3.9	6.7	12
pupa	10	11.2	12
adult			
before emerging	2	3.5	5
after emerging		30±	

PART VI.—THE CUCKOO BEE, COELIOXYS

SEASONAL HISTORY AND HABITATS

Perhaps the most important natural enemy of *Megachile brevis* is a bee of an allied genus, *Coelioxys octodentata* Say. This species has previously been recorded as a parasite of *M. brevis* by Hicks (1926). *Coelioxys* is a social parasite; it does not make its own nests but our species lays its eggs in the cells of *Megachile,* where its young larvae kill the young *Megachile* larvae and then eat the provisions gathered by the *Megachile.*

Much less information is available on the seasonal history of this bee than on that of *Megachile brevis.* Its season of flight is probably about the same, at least individuals have been collected near Lawrence, Kansas, from May 25 to September 25. Like the *Megachile,* the *Coelioxys* is scarce early in the season, much more abundant later. The number of generations per year is probably the same as in the *Megachile,* for available information on the rate of development of immature stages indicates that the stages are of about the same length as in the *Megachile.* The wings of the adults become tattered with wear as in *Megachile.* Overwintering, like that of *Megachile,* is in the mature larval stage in cocoons. Larvae reaching this stage after about the first week in August remain in this condition through fall and winter, as in the *Megachile.*

The habitats of the *Coelioxys* are the same as those of the *Megachile.* The *Coelioxys* seems equally mobile, appearing wherever favorable flowers are to be found, in both the nesting habitats and the nectar habitats of the *Megachile. Coelioxys* are often seen sucking nectar from flowers, although of course they collect no pollen. Their choice of flowers is about the same as that of nectar sucking *Megachile brevis,* although perhaps they visit yellow Compositae more frequently.

FINDING MEGACHILE NESTS

Female *Coelioxys* are sometimes seen flying over the ground or through weedy places, stopping to fly along every dead weed stalk, especially those lying on the ground. We have never seen a *Coelioxys* discover a *Megachile* nest but presume that this is the searching behavior.

EGG LAYING

Several *Megachile* nests which had been discovered by *Coelioxys* females have been observed. The *Coelioxys* returned to these nests every few hours and could fly directly to the vicinity of the nest apparently as easily as the *Megachile*. The *Coelioxys* usually alights on a twig or grass blade and remains there perfectly quiet for minutes at a time. Once one was observed to remain in such a position for 72 minutes, after which it flew away without actually going to the nest. Sometimes after the *Megachile* leaves on a pollen collecting trip the *Coelioxys* leaves its resting place and hovers at the nest entrance for a few moments before flying away. The action has not been observed by us but it seems certain that if the proper amount of pollen has been accumulated, the *Coelioxys* enters at such a time and lays its egg in a cell which is being provisioned. On one occasion observations were such that it was certain that this egg laying by the *Coelioxys* must have occurred during a one minute period following the departure of the *Megachile* for her tenth load of pollen for that cell.

In view of the ability of the *Coelioxys* to return again and again to a *Megachile* nest, having once found it, it is not surprising that whole series of *Megachile* cells or large parts of series are parasitized, while other series escape entirely.

The egg of the *Coelioxys* is deposited at the base of the pollen mass with one end of the egg inserted into the leaf or petal pieces composing the base of the cell. No doubt the slender apex of the abdomen of the female *Coelioxys* is adapted for forcing its way through the pollen for egg laying. This seems to be the common manner of ovapositing in *Coelioxys* (see Ferton, 1896; Graenicher, 1927; and Iwata, 1939) but as Ferton shows, is by no means the only one.

LARVA

The first stage larva is highly specialized with a large, sclerotized head and huge, sharply pointed jaws (figure 24). Its body is curved, not straight like the first stage *Megachile*, and its size is larger than that of *Megachile*. On hatching, the larva works its way slowly upward through the soft pollen mass, constantly opening and closing its mandibles. On reaching the surface of the pollen it continues this activity and sooner or later kills the *Megachile* with its jaws, usually within a day after the *Megachile* has hatched and while it is still quite immobile. After killing the host larva, the *Coelioxys* continues to move about through the mass of provisions opening and closing its mandibles for as much as 24 hours.

Among first stage *Coelioxys* larvae there is considerable variation in the size of the mandibles. Possibly more than one species is involved although this is not evident from adults nor is there a clear division of the first stage larvae studied into two or more separate types.

There is considerable evidence that there are five larval stadia in *Coelioxys*. The development of the larva of both *Coelioxys* and *Megachile* will be discussed in a later paper.

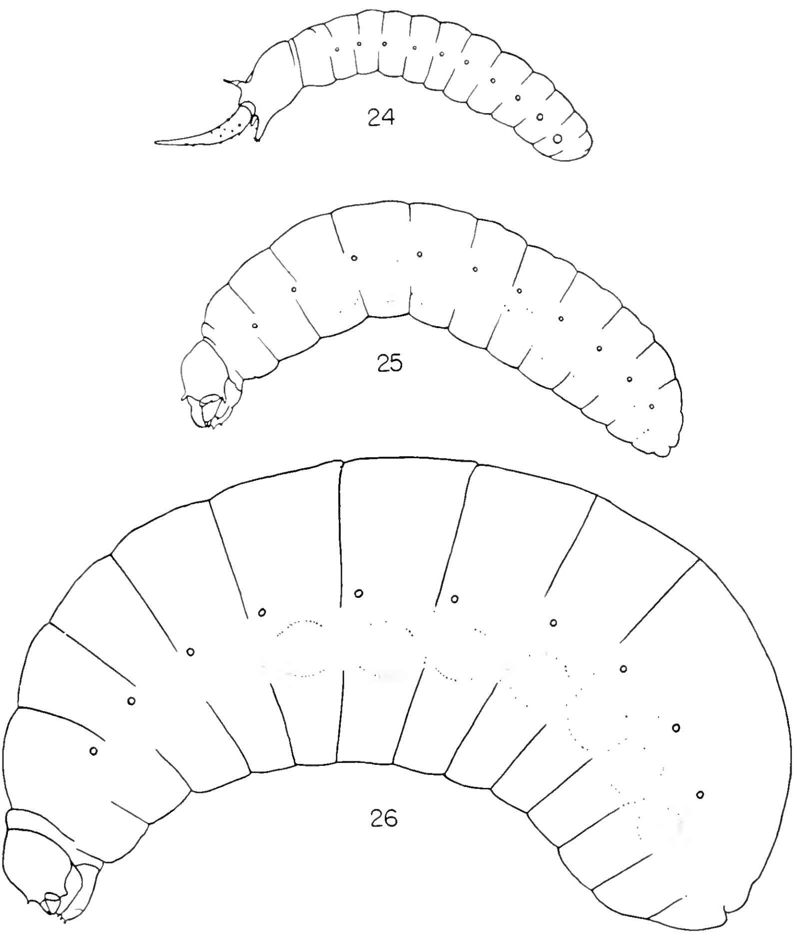

FIG. 24-26. Larvae of *Coelioxys octodentata*, first stage, half grown, and mature.

The presumed second stage larva has short but acute mandibles. One cell was opened in which the *Coelioxys* was in this stage but the *Megachile* had not been killed. This is an unusual situation, however.

Subsequent stages look much like those of *Megachile* (see Michener, 1953) and feed on the pollen from the surface toward the base, not burrowing into the pollen any more than *Megachile*. The easiest way to distinguish older larvae of *Coelioxys* from those of *Megachile* is the presence of several setae on the outer surface of each mandible (maximum of two such setae in *Megachile*) and of


27


28


29

FIG. 27. Nest of four cells of *Megachile brevis* in an *Ambrosia* stalk. Opening at top plugged with a few pieces of leaves (marked by arrow). There is also a plug of leaves immediately above uppermost cell.

FIG. 28. Similar nest of six cells with plug of leaves above uppermost cell, which is so close to end of hollow that no open space exists between last cell constructed and plug.

FIG. 29. Abnormal fasciate plant of *Erigeron canadensis*. A *Megachile* cell is hidden among the dense leaves near the top of this plant.

a genal projection just behind the mandibular base which is absent in *Megachile*. The duration of the larval stages averages less than that of *Megachile*, but the number of individuals is so small that this may not be significant. Defecation often starts well before the food is gone, as in the *Megachile*, and the positions taken by the larva after the presumed second stadium as well as the orientation of the pupa is as in *Megachile*.

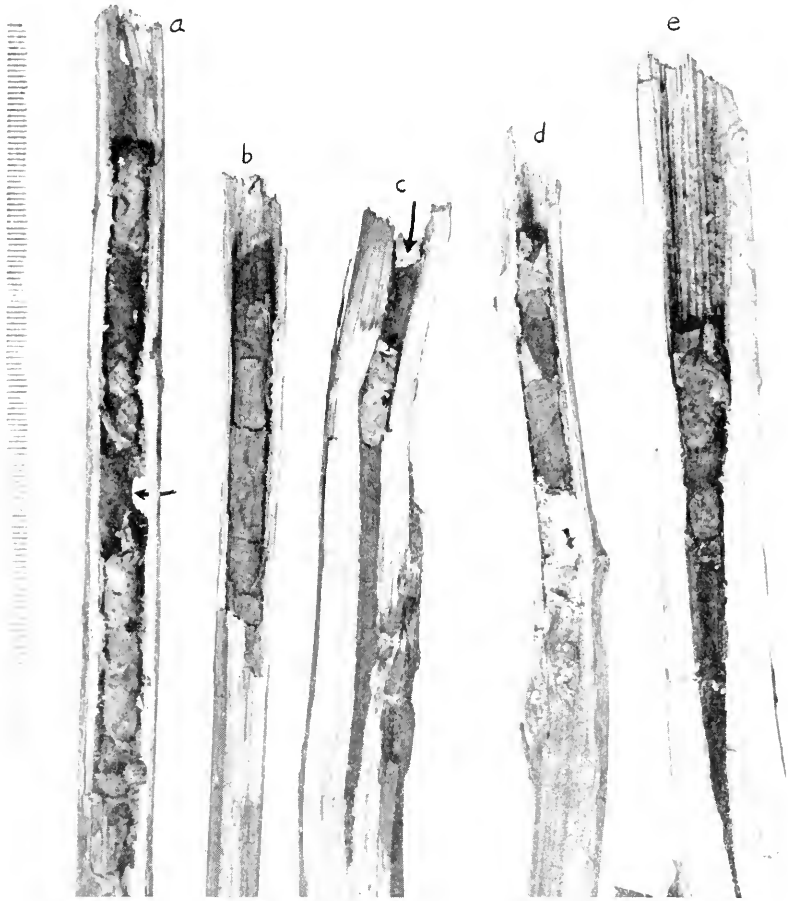

FIG. 30. Nests of *Megachile brevis* in various weed stalks. The scale at the left is in millimeters. a, entrance (arrow) at center, two series of three cells each, one above, the other below, entrance. No entrance plug. b, Series of five cells, no entrance plug. c, A single cell, with plug at entrance of hollow (shown by arrow). d, Series of four cells, no entrance plug. e, Series of 3 cells, no entrance plug. This series shows how hollows of varying diameters can be utilized by packing extra leaves or petals into large hollows. This nest is small in diameter at bottom, large above.

Cocoon

The cocoon differs markedly from that of *Megachile brevis* in that the outer cocoon of coarse red fibers is complete, covering the entire inner cocoon. Otherwise the cocoon is as in the *Megachile*, varying widely in the coarseness of fibers and in the extent, nature, and even presence of the inner layer of the inner cocoon.

Emergence

Emergence of adults occurs in the same manner as that described for *Megachile brevis.*

FIG. 31. Cell of *Megachile brevis* (marked by X) among leaves of the plant shown in figure 29.

PART VII.—NATURAL ENEMIES OF *MEGACHILE BREVIS*

SUMMER

Table IX presents data on the natural enemies of *Megachile brevis* as determined from 112 cells collected in July and August. These cells were left in the field at least until the larvae were half-grown, that is, long enough so that parasites would probably have made their attacks. Some destruction by ants and unknown predators was probably avoided by bringing the cells into the laboratory before emergence of the adults. Bees were considered to have survived if by the pupal stage no parasites were evident or if they went into winter as mature larvae with no evidence of parasites.

It is significant that not a single cell parasitized by *Coelioxys* was found in any situation other than dead stalks, and that the *Coelioxys* did not appear to search except in dead stalks, where they are often able to parasitize one cell after another in a series.

TABLE IX.—Natural enemies of *Megachile brevis*

(Based on 100 cells collected in July and August)

	Percentage of larvae destroyed
Coelioxys octodentata Say	29
Leucospis affinis Say (Leucospidae)	3
Aprostocetus sp. (Eulophidae) [1]	2
Merisus sp. (Pteromalidae) [1]	1
Unknown predators	5
Unknown causes (including apparent failure of bee to lay egg)	4

WINTER

We do not have sufficient data on the causes of winter mortality in *Megachile brevis.* The factors listed in table IX are probably all operative in winter as well as summer. *Coelioxys*, the principal natural enemy in summer, is just as important to the overwintering generation as to any other. There are, however, additional hazards to the overwintering brood.

Acrobat ants (*Crematogaster*) destroy many cells of the overwintering generation. The dealated queens in the fall burrow into weed stalks and often open and pass through *Megachile* cells and cocoons. Even if this treatment does not destroy the larvae, they dry out and die when exposed in this way. Colonies of the same ant are very common in dead weed stalks in the vicinity of Law-

1. Identified by Dr. B. D. Burks of the Division of Insect Detection and Identification, United States Bureau of Entomology and Plant Quarantine. Both of these species were also reared from cells parasitized by *Coelioxys octodentata.* It is possible although improbable that *Coelioxys* was the host in all cases.

rence and often destroy *Megachile* cells in the fall. Sometimes the leaf fragments are carried out so that no evidence of the nest remains.

Another major cause of winter mortality is trampling of nests by cattle and other animals, a fate much less likely during the brief period of a summer generation than during the winter months when protecting green vegetation is gone. Burning of prairie or pasture areas in spring or fall must also take a large toll of over-wintering larvae.

Finally it must be admitted that some larvae die in winter for unknown reasons possibly resulting from weather conditions.

PART VIII.—POSSIBLE IMPORTANCE OF THIS BEE AS A POLLINATOR

As explained in the introduction, the study here reported was designed, among other things, to serve as a biological basis for attempts to increase the effectiveness of a leafcutter bee, *Megachile brevis,* as a pollinator of alfalfa and other crops. By no means all of our findings are encouraging from this viewpoint and serious practical efforts along these lines have not yet been made. However, a summary of the principal facts of the life history that relate to the possible practical importance of this bee follows:

Individuals of *Megachile brevis* are effective alfalfa pollinators. Nearly every flower visited by a female while collecting pollen is tripped, therefore pollinated. Each female averages over 15 flowers per minute, and the average pollen collecting trip on alfalfa is about nine minutes long. Thus in each trip about 135 flowers are pollinated. If an average of 12 trips are required to provision a cell, 1,620 flowers would be pollinated per cell provisioned. Little is known of the number of cells a female bee provisions, but if she provisions 20, she might be responsible for pollination of 32,400 flowers. She may provision more cells; 30 is suggested as a possibility earlier in this paper in connection with other data. By comparison, the honeybee rarely trips alfalfa flowers if other pollen sources are available.

From a practical standpoint *Megachile brevis* is usually an ineffective alfalfa pollinator in Kansas and elsewhere because there are not enough of the bees in the fields. Probably the principal reason that the bees remain scarce is that there is not a continuous food supply. This bee passes through several generations per year. Thus it can build up its numbers during the summer months. However, a continuing food supply must be maintained for the various generations by a succession of suitable food plants if this build-up is to occur. A failure in the food supply causes the bees to disperse widely, as they are not bound to any permanent nesting site as are most solitary bees.

One might establish in the vicinity of an alfalfa field a succession of blooming plants providing pollen useful to the *Megachile,* such as false indigo (spring), wild alfalfa (early summer), iron weed (late summer), and wild purple asters (fall), with care being given to have at least some alfalfa in flower at all times when no one of the other plants is in bloom. Such a combination might attract and maintain a large population of this bee. The wild plants could be mowed at the time the bees are needed for alfalfa pollination. Unfortunately the plants in the above mentioned series have different soil preferences, but some farms have the various necessary conditions. These plants could grow as weeds in pastures adjacent to the alfalfa fields or in uncultivated borders or strips.

Where such a program is impossible, one may at least attract some *Megachile* in advance of the alfalfa seed crop by stands of uncut alfalfa which would bloom prior to the seed crop or by stands of wild alfalfa. Either could be cut as the seed crop comes into bloom.

Such highly attractive nectar sources as winged loosestrife and buckbrush may also be useful in holding a *Megachile* population in the desired area.

Nesting sites can be provided by the old stalks of large weeds or even by old cornstalks, broken in one or two places, and left lying on the ground where they will not be completely shaded by trees, bushes, or growing weeds. Such nesting places should be protected from trampling by stock and from burning.

Leaves and petals for nest construction can usually be obtained in almost any situation where the other requirements for survival are present. Some rosebushes will probably be helpful, since rose leaves are much used.

Unfortunately most of the usual farming activities are opposed to the survival and increase of this bee. Sowed pastures free of weeds, elimination of weedy fence rows and of patches of prairie, burning of pastures, trampling of ground by stock, and regular cutting for hay of entire fields so that no alfalfa flowers remain all contribute toward decreasing the abundance of the bee. On the other hand, weedy and brushy pasture areas, fence rows and roadside strips where flowers and weeds can grow unmolested and where the old stalks will neither be trampled nor burned in winter, and roadside alfalfa patches which are not or only irregularly cut, all favor the development of larger populations of this bee.

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