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NEW NEARCTIC *INVREIA* (HYMENOPTERA: CHALCIDIDAE)
FROM LEPIDOPTEROUS PESTS OF PEANUT

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Abstract.—*Invreia deceptor*, *I. usta*, and *I. threa*, new species, are described and keyed based on material reared from lepidopterous pupae collected in peanuts. All three new species are known from Texas and attack pupae of *Elasmopalpus lignosellus* (Zeller). *Invreia deceptor* and *I. threa* are also known from Oklahoma, where *deceptor* attacks *E. lignosellus* and *Stegasta bosqueella* (Chambers), but *threa* so far is known to parasitize only the latter host. *Invreia mirabilis* of Wall and Berberet, the only previously reported *Invreia* in the New World, is a misidentification of *deceptor*; *I. mirabilis* Bouček is a valid Old World species.

Invreia mirabilis Bouček, an Old World species, has thus far been the only member of the genus known from the New World. It was recently reported from Oklahoma by Wall and Berberet (1975) as a parasite of lepidopterous pests on peanuts. In studying the Wall and Berberet specimens as well as additional material from Texas, we find that *mirabilis* is a misidentification and that three undescribed species are represented. Because several workers are holding manuscripts pending the identification of these specimens, we take this opportunity to describe three new species of *Invreia*. *Invreia mirabilis* is a valid Old World species but is not known to occur in the Western Hemisphere.

The most recent revision of *Invreia* was by Nikol'skaya (1960) who treated 17 species worldwide. Since that time one species has been described by Steffan (1962; *festiva*) and another by Habu (1970; *ghanii*). Habu also cited taxonomic literature for the genus but overlooked a paper by Erdös (1957) describing the female of *I. mirabilis*. Additionally Steffan (1976) transferred the previously described species *elegantula* Masi from *Euchalcidia* to *Invreia*, making a total of 20 described species worldwide to date. We add

another three species in this paper, the only ones thus far known from the New World. Habu (1970) summarized distribution for *Invreia* as "Africa and Europe to Central Asia." The only host records for *Invreia* were pupae of *Myelois cincitipalpella* Christ (Pyralidae) for *I. rufitarsis* (Illiger) (Nikol'skaya, 1960) and pupae of *Chilo partellus* Swinhoe (Pyralidae) for *I. ghanii* (Habu, 1970). To these hosts were added the Nearctic records for pupae of *Elasmopalpus lignosellus* (Zeller) (Pyralidae) and *Stegasta bosqueella* (Chambers) (Gelechiidae) for *I. "mirabilis"* of Wall and Berberet (1975). These Nearctic records now refer to the *Invreia* species described below.

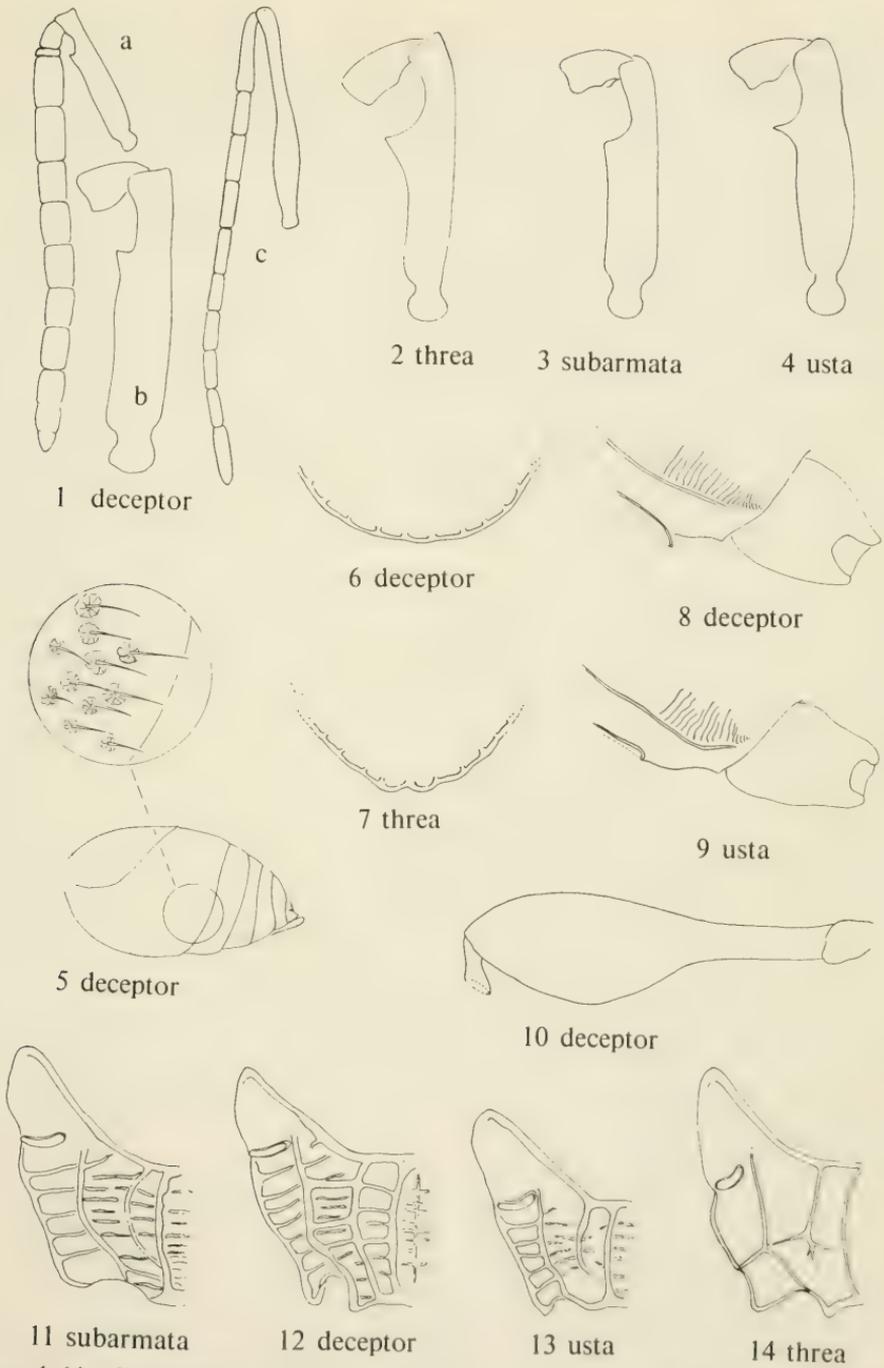
Invreia may be distinguished from other Chalcididae by the following characters: Hindtibia essentially truncate distally, two hindtibial spurs present (Haltichellinae); marginal vein slightly removed from anterior margin of wing, but parallel to it, postmarginal vein absent, stigmal vein rudimentary (Hybothoracini); scutellum posteriorly rounded, subtruncate, or slightly bilobed but without large projecting dents, propodeum not extended backwards on sides of abdomen, clypeus not developed as a projection, first tergum without lateral carinae at base.

In the descriptions all ratios were measured at 50× except ocellar ratios which were measured at 100×. All characters were measured in the flattest plane. Thoracic length was measured from the anterior extent of the pronotum to the posterior extent of the propodeum. Sculpture was described using fluorescent and incandescent light and largely follows the nomenclature of Eady (1968). Propodeal terms are adapted from Bouček (1951). Holotypes are in the U.S. National Museum of Natural History, Washington, D.C. (USNM).

Invreia deceptor Grissell and Schauff, NEW SPECIES

Figs. 1, 5, 6, 8, 10, 12, 15, 17,

Holotype female.—Length 3.8 mm. Ratio head:thorax:abdomen 25:90:80. Black except the following reddish brown: Basal ½ of scape, fore- and midlegs except coxae, hindtibia, tarsi, and base and apex of hindfemur. Face (Fig. 15) barely wider than high (53:50), eye essentially bare, eye height:interocular distance at vertex 25:27, lateral ocellus:ocellocular length:postocellar length 10:7:25, malar:intermalar distances 20:21; upper face with punctures ca. own diameter apart each with recurved seta, lower face laterad of scrobes rugulose and covered with appressed dense silvery pubescence; scrobe nearly reaching median ocellus, finely aciculate; flagellum (Fig. 1c) filiform, scape swollen in basal ½, ratio beginning with scape 38:15:7:8:8:8:7:7:7:11 (club counted as 1), pedicel 5.0× longer than wide (15:3). Thorax ratio pronotum:scutum:scutellum:propodeum 28:27:30:20; pronotum medially and anterior of scutum (Fig. 17) with setigerous punctures separated by ca. own diameter, seta length ca. 2× puncture diameter,



Figs. 1-14. *Invreia* spp. 1, Antenna, lateral (a, b = male; c = female). 2-4, Scape, male, inner. 5, Abdomen, lateral, insert shows sculturing. 6-7, Scutellum, posterior apex, dorsal. 8-9, Thorax, mesepisternum and hindcoxa, lateral. 10, Midfemur, lateral. 11-14, Propodeum, dorsal.

interspaces lightly transversely aciculate, slide lobe along notaular border with several punctures on otherwise aciculate background, setigerous punctures elsewhere on thorax (including pronotum laterally) variably spaced without apparent or regular ridges between, aciculation fading on posterior of scutum, nearly polished here and on scutellum; pronotum dorsolaterally with punctures nearly contiguous, laterally punctures mixed with reticulation continuing to ventral marginal strip which is reticulate; mesepisternum with forecoxal depression prolonged into toothlike flange ventrally (Fig. 8), posterior apex of scutellum rounded (Fig. 6); propodeum (Fig. 12) with complete, equally developed, submedian, accessory, sublateral, and lateral carinae, median carina present but much weaker than others, posterolateral margin angulate, produced about as far backward as petiolar foramen; midfemur (Fig. 10) distally swollen, rounded ventrally, nearly $3\times$ wider distally than proximally (11:4); forewing length:width 110:40, hyaline, submarginal:marginal:stigmatal veins 43:8:3. Abdomen elliptical in side view, tergum I reaching ca. $\frac{1}{2}$ length of abdomen (40:80), epipygidium and ovipositor barely visible from above; tergum I laterally polished, dorsally appearing mostly polished, faintly reticulate in median $\frac{1}{4}$ becoming polished laterally; tergum II laterally polished towards base parallel to lower margin of tergum I, otherwise covered with sparse regularly placed setae each surrounded at base by "petallike" arrangement of reticulation (Fig. 5; best seen at $25\times$ or higher), dorsally polished; complete terga II-VI with anterior polished, posterior reticulate with setal row, tergum VI inclined.

Allotype male.—Length 3.8 mm. Black except the following reddish brown: foretibia, distal $\frac{1}{2}$ of midfemur, tips of mid- and hindtibiae, all tarsi. Setae and structure as for female except: Scape (Fig. 1a, b) subapically incised with upward projecting denticle on lower margin, antennal ratio beginning with scape 24:5:2:9:9:8:8:8:7:7:14 (club counted as 1). Punctures on scutellum nearly contiguous. Reticulation on dorsum of tergum I as heavy as terga II-VI, terga II with areas between setae evenly reticulate (rather than with distant "petallike" reticulations at base as in female).

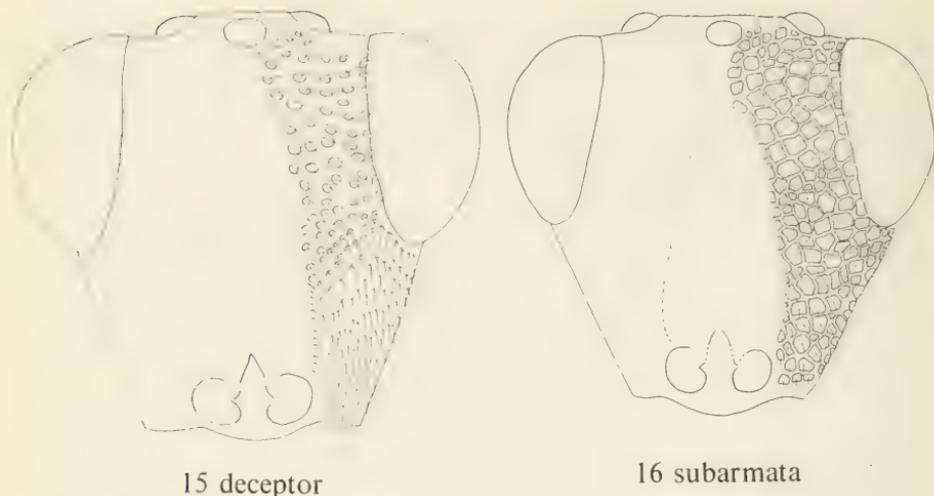
Holotype.—♂, Texas, Comanche County, 3 miles west DeLeon, 10-VII-1978. R. L. Sams; reared from *Elasmopalpus lignosellus* pupa in peanuts, USNM type no. 76269.

Allotype and paratypes.—Allotype ♂ and 9 ♀, 2 ♂ paratypes, same data as holotype (except collection dates range from 13-VII to 10-X-1978). 9 ♀, 14 ♂ paratypes, laboratory culture, parental stock from same locality, S. Johnson. Other paratypes as follows: 2 ♀, 2 ♂, Beattie, Texas, 18-VIII-1975, 6-25-IX-1976, S. Johnson, host data same as holotype. Specimens not paratypes, all from Oklahoma as follows: Reared from *E. lignosellus* pupae: 1 ♀, Acme, Grady Co., 22-VII-1974; 1 ♂, Colbert, Bryan Co., 1-VIII-1972; 1 ♀, Enos, Marshall Co., 13-VIII-1973; 1 ♀, Holdenville, Hughes Co., 19-VII-1974; 6 ♀, Madill, Marshall Co., various dates from 17-VIII to 3-X;

reared from *Stegasta bosqueella*: 60 ♀, 88 ♂, Marshall Co., R. Wall, 15-VIII to 29-IX-1975-76; 1 ♀, Madill, 10-VIII-1972. Paratypes will be deposited in the British Museum (Natural History) (London), the Canadian National Collection (Ottawa), the Florida State Collection of Arthropods (Gainesville), the Department of Entomology, Texas A. & M. University (College Station), and the USNM.

Variation.—Females (31) from *Elasmopalpus* vary in length from 2.9 to 3.8 mm; males (19) from 2.3 to 3.8 mm. Females (61) from *Stegasta* vary from 2.0 to 2.3 mm and males (88) from 2.3 to 2.7 mm. About one-fourth of the females from *Elasmopalpus* have the scape all dark; the rest are like the holotype. Almost all the females from *Stegasta* have the scape dark. Males are generally like the allotype, but a few small ones (ca. 2.5 mm) are entirely black except the tarsi. The denticle of the scape may not be as pronounced as in Fig. 1b. The median propodeal carina is present at least as a vague, broken line in all specimens, but the accessory carinae become irregular posteriorly in some specimens and fade before reaching the hindmargin of the propodeum.

Discussion.—In Nikol'skaya's key to world *Invreia* (1960), *deceptor* would be placed in rubric 26, keying out with *subarmata* (Förster). In direct comparisons with specimens, the females of both species agree in the elongate antenna with pedicel about 5× as long as wide and scape a little less than 3× the length of the pedicel. Both have the malar distance slightly shorter than the eye height, the marginal vein about 2.5× the length of the stigmal vein, the apparent sixth abdominal segment inclined (not vertical), the interspaces between scutal punctures aciculate, and the midfemora rounded ventrally with the greatest width in the distal third (Fig. 10) as opposed to angulate and/or with greatest width at the midpoint. Female *deceptor* may be distinguished from *subarmata* as follows: *Invreia deceptor* with lower face covered with dense, silvery pubescence on either side of scrobal basin and area beneath setae rugulose (Fig. 15) (*subarmata* with few setae on either side of scrobal basin, each placed in distinct puncture, Fig. 16); *deceptor* has anterior portion of scutum with punctures generally separated by puncture diameter or more (Fig. 17) (*subarmata* with punctures less than own diameter or nearly contiguous, Fig. 18); propodeum of *deceptor* with posterolateral margins developed as sharp angles (Fig. 12) (*subarmata* with margins nearly right angled, Fig. 11); and *deceptor* with fore- and midlegs (except coxae) concolorous reddish brown (*subarmata* has legs nearly black). Males of *deceptor* may be separated from those of *subarmata* by the characters just mentioned (except legs of *deceptor* are mostly black) as well as the following: In *deceptor* the antennal scape has an incision subapically with upward projecting denticle and the pedicel unmodified beneath (Fig. 1b), whereas in *subarmata* the incision is merely angulate basally and the pedicel has a protuberance (Fig. 3); *deceptor* has



Figs. 15-16. *Invreia* spp., face, female.

the wing hyaline beneath the marginal vein while *subarmata* has the wing weakly stained brown for about one-third the wing length from stigma to base.

Among Nearctic species, females of *deceptor* are morphologically like *threa* in having the mesepisternal depression with a projection, but otherwise share more characters with *usta* (e.g. smooth, punctate pronotum, smooth lateral area of tergum I). *Invreia deceptor* may be separated from both by characters given in the key. Males differ as discussed under *usta*.

Etymology.—From the Latin *deceptor* meaning "deceiver" in reference to its confusion with *mirabilis*.

Invreia usta Grissell and Schauff, NEW SPECIES

Figs. 4, 9, 13, 19

Holotype female.—Length 3.8 mm. Ratio head:thorax:abdomen 26:80:82. Black except the following orange brown: scape, pedicel, midcoxa, apex of hindcoxa, all legs beyond coxae (except hindfemur infuscate medially on outer side, ventrally with denticles nearly black, hindtibia ventrally with dark carinae), and tegula. Face slightly wider than high (54:48), eye essentially bare, eye height:interocular distance (at vertex) 25:29, lateral ocellus:ocellocular length:postocellar length 7:4:25, malar:intermalar distances 19:25; upper face with punctures ca. own diameter apart, each with recurved seta (as in Fig. 15); lower face laterad of scrobes rugose and covered with appressed dense silvery pubescence; scrobe nearly reaching median ocellus, finely aciculate; flagellum filiform, scape swollen in basal $\frac{1}{2}$, ratio (beginning with scape) 36:12:6:7:7:7:7:6:6:6:11 (club counted as 1), pedicel 4.0 \times longer

than wide (12:3). Thorax ratio, pronotum:scutum:scutellum:propodeum 25:23:31:18; pronotum medially and scutum anteriorly with setigerous punctures separated by ca. own diameter, seta length ca. $2\times$ puncture diameter, interspaces lightly longitudinally aciculate; pronotum laterally with punctures contiguous, laterally punctures mixed with reticulation continuing to ventral marginal strip which is reticulate; side lobes (Fig. 19) along notaular border with few punctures, scutum medially and anterior of scutellum with punctures separated by ca. $2\times$ own diameter, interspaces aciculate anteriorly becoming highly polished posteriorly, scutellum laterally with punctures contiguous, posterior apex of scutellum rounded (Fig. 6); mesepisternum with forecoxal depression not prolonged into a flange (Fig. 9); propodeum (Fig. 13) with complete, equally developed, submedian, sublateral, and lateral posterolateral carinae, accessory carinae fading posteriorly, no median carina, posterolateral margin angulate, produced ca. as far backward as petiolar foramen; hindfemur distally swollen, rounded ventrally, $2.5\times$ wider distally than proximally (10:4). Forewing length:width 124:50, hyaline, submarginal:marginal:stigmatal veins 48:8:3. Abdomen elliptical in side view, tergum I reaching less than $\frac{1}{2}$ length of abdomen (37:92); epipygidium and ovipositor barely visible from above; tergum I laterally polished with few setae at dorsolateral margins, dorsally almost uniformly "reticulate" (at $25\times$; actually microscopically punctulate at higher magnification) except posterior $\frac{1}{6}$ fading to faint reticulate-coriaceous sculpture; tergum II laterally with narrow anterior margin polished, otherwise reticulate and covered with regularly placed setae, some with "petallike" reticulation (as in Fig. 5), dorsally reticulate about like posterior of tergum I, medially without setae; entire terga III-VI polished anteriorly, reticulate with setal row posteriorly; tergum VI inclined.

Allotype male.—Length 2.9 mm. Black, reddish brown as follows: Flagellar segments beneath, fore- and midlegs past coxae (ventral forefemur and apical $\frac{1}{2}$ of midfemur infuscate), distal tip of hindcoxa, apical and distal tip of hindfemur, hindtibia, tarsi (hindtibia ventrally with dark carinae), tegula (dorsal edge black). Structurally as for female except: Malar:intermalar distances 15:25, scape (Fig. 4) subapically incised with forward projecting denticle on lower margin, pedicel with ventral protuberance, antennal ratio beginning with scape 20:5:2:9:7:7:6:6:6:13 (club counted as 1). Thorax ratio, pronotum:scutum:scutellum:propodeum 28:25:25:15, pronotum dorsolaterally with contiguous punctures, laterally shining to ventral marginal strip which is reticulate, thorax irregularly covered with setae $4-6\times$ length of own puncture diameter; anterior of scutellum with punctures irregularly separated by from ca. $1-4\times$ own diameter, posterolateral margin of propodeum an obtuse angle, not produced caudally as far as the petiolar foramen; abdomen without "petallike" reticulation.

Holotype.—, Texas, Comanche County, 3 miles west DeLeon, 14-VIII-

1978, R. L. Sams: reared from *Elasmopalpus lignosellus*, in peanuts (No. 81), USNM type no. 76488.

Allotype and paratypes.—Allotype ♂, 3 paratype ♀, same data as holotype except dates 17-VIII (allotype, no. 158), 20-VII (no. 28), 24-VIII (no. 39), 1-IX (no. 36). Paratypes in USNM, British Museum (Natural History), and Department of Entomology, Texas A. & M. University.

Variation.—In two female specimens the accessory carinae of the propodeum fade out posteriorly, but in the other two females and the male a transverse carina connects the accessory to the sublateral carinae. One female has the hindoxa and femur (except denticles) entirely orange brown.

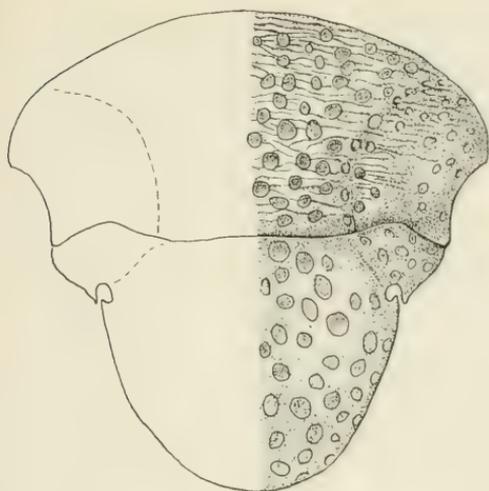
Discussion.—*Invreia usta* runs to rubrics 25 and 28 of Nikol'skaya's key (1960) but fits neither alternative. It has a polished thorax as in 28, but the marginal vein is only about $2.5\times$ the stigmal as in 25. Among females of the three New World species, *usta* has the reddish coloration of *threa* (legs, tegulae) but is distinguished from both *deceptor* and *threa* by the dorso-median area of the scutum and anterior of scutellum with punctures about two diameters apart and polished between as opposed to one diameter or less apart and reticulate to aciculate between (cf. Figs. 17, 19, 20). Males of *usta* may also be distinguished from *deceptor* and *threa* by the setae on the dorsum of the thorax being about four to six times the length of its puncture diameter, but setae only about two times or less as long in *deceptor* and *threa*. From *deceptor*, male *usta* may be distinguished by the strongly outward projecting denticle on the inner side of the scape (Fig. 4), whereas in *deceptor* the denticle projects upwards and is less developed (Fig. 1b); and in *usta* the lateral corners of the propodeum form an obtuse angle, whereas in *deceptor* they form an acute angle which projects caudally.

Etymology.—From the Latin *usta* meaning "burnt color" in reference to the legs of this species.

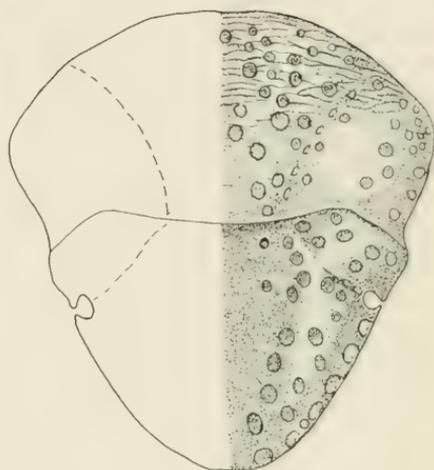
Invreia threa Grissell and Schauff, NEW SPECIES

Figs. 2, 7, 14, 20

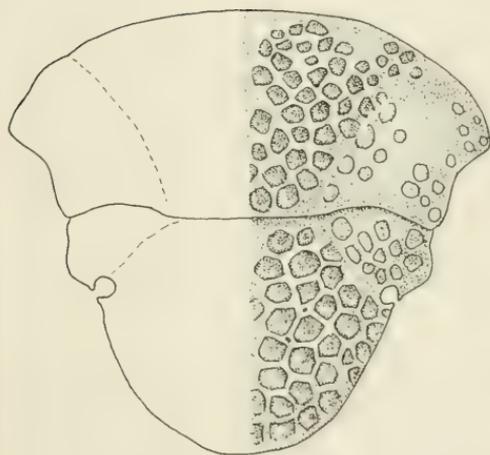
Holotype female.—Length 2.5 mm. Ratio head:thorax:abdomen 20:55:60. Black except the following reddish brown: Scape, midcoxa, all legs past coxae (except hindfemur ventrally with denticles nearly black, hindtibia ventrally with dark carinae), and tegula. Face barely wider than high (45:40), eyes essentially bare, eye height:interocular distance (at vertex) 20:20, lateral ocellus:occelocular length:postocellar length 7:5:20, malar:intermalar distances 18:16, face medially (scrobal basin) reticulate merging to strigose or rugose laterally, scrobe nearly reaching midocellus as faint, setaeless depression: upper face with evenly placed recurved to recumbent setae, area laterad of scrobe with recumbent to appressed dense silvery pubescence; flagellum filiform, scape swollen in basal $\frac{1}{2}$, ratio beginning with scape 30:19:5:6:7:7:5:5:5:5:10 (club counted as 1), pedicel $3.0\times$ longer than



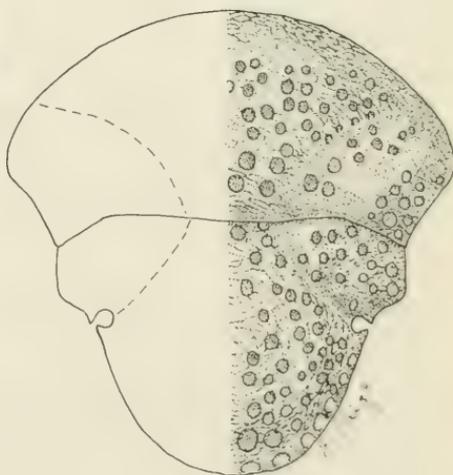
17 deceptor



19 usta



18 subarmata



20 threa

Figs. 17-20. *Inyreia* spp., thorax excluding pronotum, dorsal.

wide (9:3). Thorax ratio, pronotum:scutum:scutellum:propodeum 22:24:27:13; pronotum, scutum, and scutellum generally with setigerous punctures separated by ca. own diameter (Fig. 20), seta length scarcely $1\times$ puncture diameter, interspaces reticulate-aciculate, side lobes of scutum,

axillae, and anterior of scutellum with punctures ca. 2 or more diameters apart; pronotum dorsolaterally with punctures nearly contiguous, lateral lower $\frac{2}{3}$ evenly reticulate, without punctures; posteromedial margin of scutellum subtruncate; mesepisternum with forecoxal depression prolonged into toothlike flange ventrally (as in Fig. 8); propodeum distinctly reticulate between major carinae, with submedian, sublateral, and lateral carinae complete, accessory carina fading posteriorly, no median carina, areas between carinae without transverse carinae or where present carinae weak, posterolateral margin angulate, produced backward as far as petiolar foramen (Fig. 14); midfemur distally swollen, rounded ventrally, ca. $2.5\times$ wider distally than proximally (10:4); forewing length:width 90:35, hyaline, submarginal:marginal:stigmatal veins 35:5:2. Abdomen ovate-elliptic in side view, tergum I reaching ca. $\frac{1}{2}$ length of abdomen (33:65), epipygidium and ovipositor barely visible from above; terga uniformly reticulate; tergum I with few setae dorsolaterally, others with single setal row posteriorly, except tergum II bare medially, and tergum VI with several rows; tergum VI inclined.

Allotype male.—Length 1.7 mm. Black, reddish brown as follows: Flagellar segments beneath, forefemur distally, foretibia distally and beneath, foretarsi (distal segment darker), midfemur and midtibia distally, midtarsi (distal 2 segments darker), apical and distal tip of hindfemur, distal $\frac{1}{3}$ of hindtibia, hindtarsi (distal 2 segments darker), tegula posteriorly. Setae and structure as for female except: Face wider than high (40:30), lateral ocellus:ocellocular length:postocellar length 10:3:23, malar:intermalar distances 13:16, scape (Fig. 2) subapically incised with forward projecting denticle on lower margin, antennal ratio beginning with scape 16:5:1:6:5:5:5:5:5:11 (club counted as 1). Thorax ratio pronotum:scutum:scutellum:propodeum 13:16:18:8, anterior of scutum with punctures separated by ca. $1-3\times$ own diameter, side lobes of scutum with few punctures medially; posteromedial margin of scutellum not emarginate; forecoxal flange present, but difficult to see. Forewing length:width 75:30, submarginal:marginal:stigmatal veins 30:5:2. Abdomen with 1st tergum reaching past $\frac{1}{2}$ length (80:50) (posterior segments telescoped forward), tergum I with dorsal reticulation fading at lateral and posterior margins, tergum II with several rows of setae laterally.

Holotype.—♂, Oklahoma, Marshall County, 9-IX-1975, R. Berberet; No. 84, reared from *Stegasta bosqueella*, USNM type no. 76489.

Allotype and paratypes.—Allotype ♂, same data as holotype, except No. 111, 13-IX-1975; 55 ♀, 27 ♂ paratypes, same data, except 31-VII to 30-IX-1975-76; 1 ♂ paratype same data, except collected in Enos, 21-VIII-1974; 2 ♀ paratypes, Texas, Comanche County, 3 miles west DeLeon, 13-VII (No. 45) and 14-VIII (No. 187), reared from *Elasmopalpus lignosellus* pupa in peanuts. Paratypes in USNM, British Museum (Natural History), and the departments of entomology of Texas A. & M. University and Oklahoma State University.

Variation.—Differences among female specimens available for study are confined to the scutellum, the propodeum, and color. In one specimen there is a sharp angle formed at the intersection of the lateral carina and cross carina from the sublateral. A single specimen has a weak median propodeal carina which fades out dorsally. In all specimens the transverse carinae are variable in presence and/or intensity, not being as well developed as the primary longitudinal carinae. The areas between carinae are almost uniformly reticulate. In several specimens (from both *Elasmopalpus* and *Stegasta*) the apex of the scutellum is slightly bilobed (Fig. 7), in most it is as in Fig. 6, and in several it is nearly squared-off apically. The color of the hindfemur in females varies from all orange to black medially with orange apices. In some specimens from *Stegasta* the tegula is black for both sexes. Females from *Elasmopalpus* have the tegula orange. Females from *Stegasta* vary in length from 1.6 mm to 2.5 mm, males from 1.6 mm to 2.1 mm. Females from *Elasmopalpus* vary from 2.5 mm to 2.9 mm.

Discussion.—*Invreia threa* would be placed in rubric 27 of Nikol'skaya's key (1960). It agrees with *subtilis* Nikol'skaya in the generally small size (2.5 mm) and reddish coloration of antenna, tegula, and legs. According to the description, however, *subtilis* has the abdomen polished dorsally whereas *threa* is evenly reticulate dorsally. Additionally, *subtilis* has the posterolateral corners of the propodeum rounded and without dentation, whereas *threa* has the corners angulate and produced caudally.

From Nearctic *Invreia*, *threa* may be distinguished by characters given in the key and by the reticulate ventral half of the lateral aspect of the pronotum. In *deceptor* and *usta* this area has setigerous punctures extending nearly to the ventral edge.

Etymology.—A euphonious, arbitrary combination of letters.

KEY TO NEARCTIC SPECIES OF *INVREIA*

1. Males, scape on apicoventral margin produced as a denticle; pedicel scarcely longer than broad (Fig. 1a) 2
- Females, scape without denticle; pedicel 3–5× longer than broad (Fig. 1c) 4
2. Denticle of scape projecting upward (Fig. 1b)
..... *deceptor*, new species
- Denticle of scape projecting outward (Figs. 2, 4) 3
3. Pronotum laterally $\frac{2}{3}$ reticulate, no punctures; setae on dorsum of thorax subequal in length to own puncture diameter
..... *threa*, new species
- Pronotum laterally with mixture of reticulation and punctures; seta on dorsum of thorax 4–6× own puncture diameter .. *usta*, new species
4. Tergum I dorsally evenly reticulate (except narrow posterior polished band), lateral part of tergum either polished or reticulate; hind-

- femur entirely brownish or orange, or infused with black; tegula orange to black 5
- Tergum polished dorsally (faint reticulation may be visible medially) continuing to lateral part of tergum; tegula and hindfemur black ...
..... *deceptor*, new species
5. Tergum I as reticulate laterally as dorsally; scutellum reticulate-aciculate between punctures (Fig. 20) *threa*, new species
- Tergum I polished laterally; scutellum smooth between punctures (Fig. 19) *usta*, new species

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We thank J. W. Smith, Jr. (Department of Entomology, Texas A. & M. University, College Station) and R. C. Berberet (Department of Entomology, Oklahoma State University, Stillwater) for sending us the series of reared material which formed the basis for our study. Additionally, we thank John Noyes, British Museum (Natural History), London, for the loan and/or gift of several *Invreia* species, Yevgeny Sugonyayev (Zoological Institute, Academy of Sciences of the USSR, Leningrad) for translating Nikol'skaya's 1960 world key to *Invreia*, L. N. Kassianoff (Department of Entomology, Smithsonian Institution) for translating the species description of *I. subtilis*, and E. M. Paige for drawing Figures 17–20.

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**A REDESCRIPTION OF THE FEMALE OF *SIMULIUM SANGUINEUM*
KNAB AND DESCRIPTIONS OF THE MALE, PUPA, AND
LARVA (DIPTERA: SIMULIIDAE)¹**

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Abstract.—The female of *Simulium sanguineum* Knab is redescribed and the male, pupa, and larva are described for the first time from specimens from the type-locality in Colombia. Illustrations and biological information are provided. *Simulium sanguineum* is differentiated from the closely related species *S. amazonicum* Goeldi.

The original description of *Simulium sanguineum* Knab was based on female specimens collected biting man on the Atrato River, Boca de Arquía, Colombia (Knab, 1915). Since that time specimens identified as *S. sanguineum* have been reported from Panama, Venezuela, Guyana, and Brazil. Considerable confusion exists in the literature concerning the identification of specimens of this species as well as those of *S. amazonicum* Goeldi and other closely related species. Currently, the designations *S. amazonicum* and *S. sanguineum* groups are being used by *Simulium* taxonomists to include at least six described species and an unknown number of undescribed species some of which have been confused with *S. sanguineum*. Superficially, the females of these groups are very similar and difficult to distinguish. Resolving the taxonomic confusion regarding these groups has been hampered by the lack of associated immature stages or in some cases by the incorrect association of immature stages with adults of another species.

The purpose of this paper is to redescribe the female of *S. sanguineum* and to provide the first descriptions of the male, larva, and pupa. The descriptions are based on material collected at the type-locality, and the females were compared with the holotype of *S. sanguineum* from the British Museum (Natural History), London, provided through the courtesy of R.

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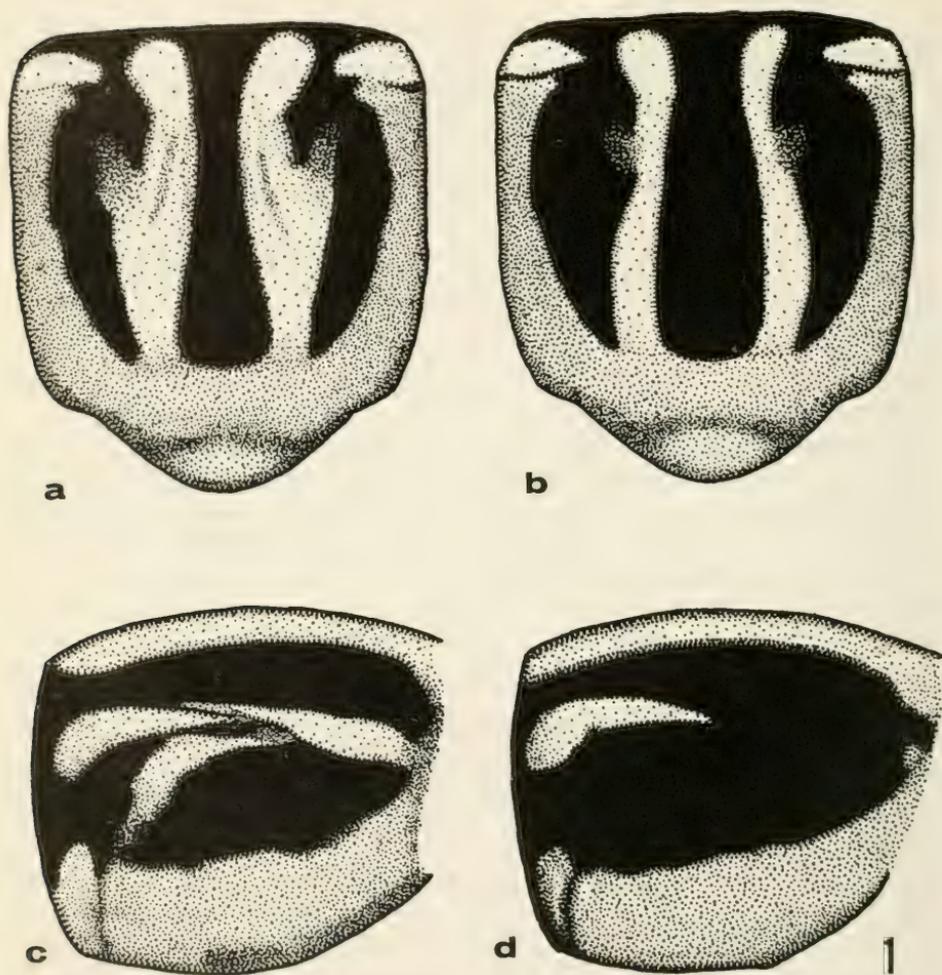


Fig. 1. *Simulium sanguineum*, female. a, Scutum, composite illustration with light sources from both sides. b, Scutum showing variation in pattern. c, Left lateral view of scutum with right submedian pruinose vitta at top, light sources anterior and posterior. d, Same position with posterior light source only.

Crosskey and A. J. Shelley. All colors are those of dry pinned specimens; measurements were made from slide mounted or alcohol preserved material. Figures 1a and b are composite drawings; with specimens in this position the lateral pruinosity is not normally observed to the extent that it has been illustrated. Figures 4a-c were drawn from cleared specimens in temporary gel mounts, and Figure 4d was made from a permanent slide mounted specimen.

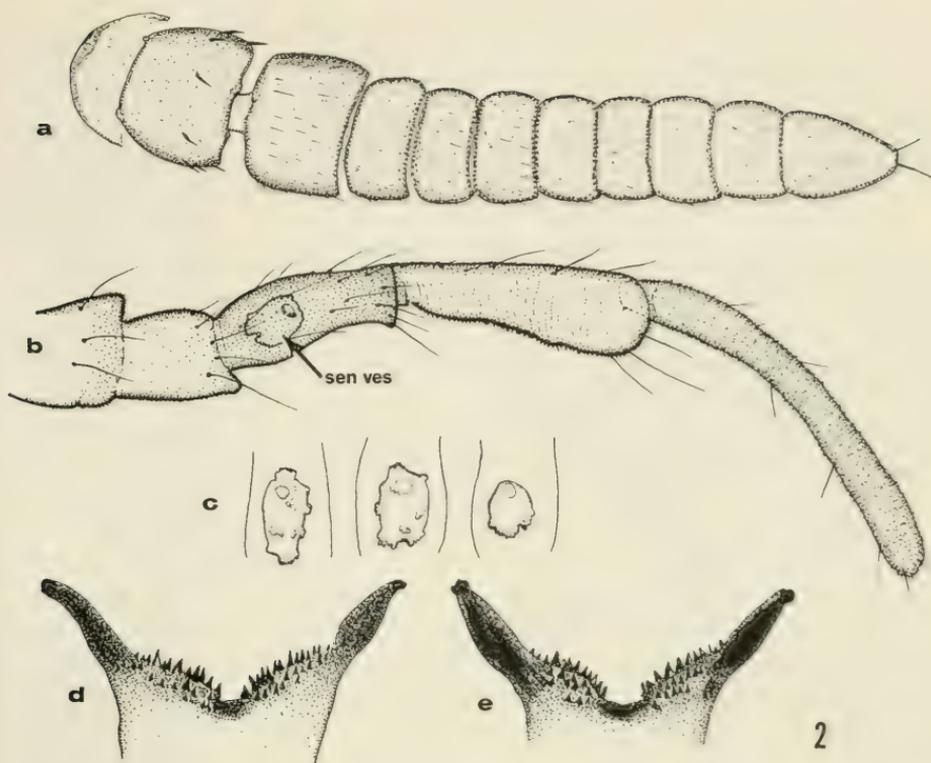


Fig. 2. *Simulium sanguineum*, female. a, Antenna. b, Palpus. c, Variation in form of sensory vesicle. d, Proximal margin of cibarial pump. e, Variation in margin of cibarial pump. Abbreviation: sen ves = sensory vesicle.

Simulium sanguineum Knab

Simulium sanguineum Knab, 1915: 279 (♀).

Female.—General body color black. Length: Body, 1.2–2.0 mm (dry pinned specimens), 1.6–2.1 mm (alcohol preserved specimens); wing, 1.3–1.5 mm.

Head black with a bluish-silver pruinosity. Frons pruinose, moderately broad, at vertex about 0.18 mm wide and approximately $1\frac{1}{3}\times$ as wide as at narrowest point. Ocular triangle greatly reduced, short but broad, at tallest point less than width of an ommatidium. Clypeus slightly wider than frons at narrowest point, concolorous with it except more densely pruinose, with sparse yellow to pale brownish setae. Antenna about 0.3 mm long, shape and proportions of segments as in Fig. 2a: scape, pedicel and base of 1st flagellomere yellow to brownish yellow, remaining flagellomeres dark brown to black. Proboscis yellowish brown to dark brown; mandible with about 6 or more serrations on outer lateral margin and 25–27 on inner margin. La-

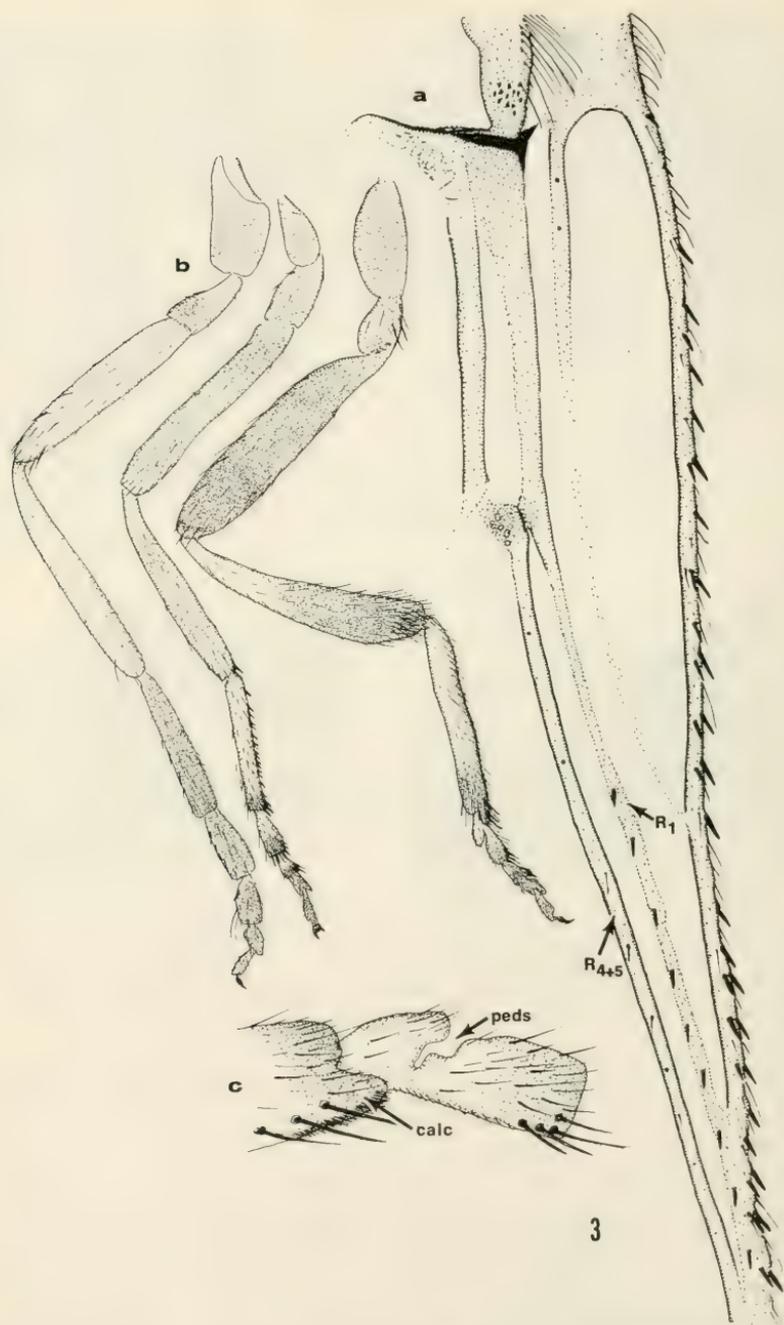


Fig. 3. *Simulium sanguineum*, female. a, Anterior wing venation showing detail. b, Legs. c, Portion of hindtarsus showing calcipala and pedisulcus. Abbreviations: calc = calcipala; peds = pedisulcus.

cinia with 16–20 (avg 18) retrorse teeth; palpus (Fig. 2b) dull dark brown to black, with brown setae; sensory vesicle of 3rd segment 0.5–0.6 as wide as segment; variation noted in size and shape of sensory vesicle illustrated in Fig. 2c. Proximal medial margin of cibarial pump with 38–60 minute teeth, narrow medial emargination and apices of dorsolateral arms simple, without teeth (Figs. 2d, e), width between distal portions of dorsolateral arms averaging 0.13 mm.

Thorax basically black; scutum with two submedian bluish-silver to golden-silver iridescent vittae on a velvety black background, with a wide band of similar colored pruinosity present along lateral and posterior margins, this pattern varying in shape and intensity according to direction and angle of incident light (Figs. 1a–d). Scutellum markedly triangular in shape, dark brown to velvety black with a light dusting of silvery pruinosity lateroventrally, and with long dark setae sometimes interspersed with some golden or bicolored setae. Postnotum black, densely silvery pruinose. Anepisternum and katapisternum with dense bluish-silver pruinosity. Wing about 0.7–0.9 mm wide; veins pale yellow, basicosta and stem vein with dark brown setae; costa and R_1 with spinules, R_1 with 5–9 (avg 7) and R_{4+5} with 8–14 (avg 10) spinules (counts of R_1 and R_{4+5} are made to point of fusion with costa). Stem of halter brown, knob creamy yellow. Shape and proportions of leg segments as in Fig. 3b; segments faintly to distinctly silvery pruinose; all coxae and trochanters dark brown to black, anterior trochanter sometimes dull yellow basally; anterior femur and tibia yellowish to brownish yellow, midfemur and hindfemur dark brown to black, midtibia with pale ring basally, hindtibia with basal $\frac{1}{3}$ to $\frac{1}{2}$ creamy white, remainder black; anterior tarsus slender, black, basitarsus of middle leg dirty yellow with small dark area distally, 2nd and 3rd tarsomeres pale basally and apical 2 tarsomeres dark brown to black; hindbasitarsus mostly creamy white with about apical $\frac{1}{6}$ black, 2nd and 3rd tarsomeres pale basally and apical 2 tarsomeres dark brown to black; legs generally with pale setae on yellow areas and dark setae on dark areas; all femora and tibiae with some flattened scales, more numerous on outer surfaces of midleg and hindleg; calcipala about as wide as long, pedisulcus deep (Fig. 3c); claw simple.

Abdomen black, with terga 1–5 dull velvety black, terga 6–9 subshining and with faint silvery pruinosity, terga 1 and 3–5 with a faint silvery pruinosity along posterior margins, tergum 2 more widely covered with distinct silvery pruinosity; fringe of tergum 1 of long brown setae, remaining terga with sparse brown setae. Sterna 2–7 not sclerotized, all sterna dull black with faint silvery pruinosity. Terminalia as in Fig. 4; hypogynial valves (ovipositor lobes) short, their hind margins slightly curved, medial margins slightly concave on about posterior $\frac{1}{2}$, and faintly sclerotized on about anterior $\frac{1}{2}$, with fine irregular rows of microtrichia on greater portion of ventral surface. Anal lobe, in lateral view, somewhat ovate, ventral margin

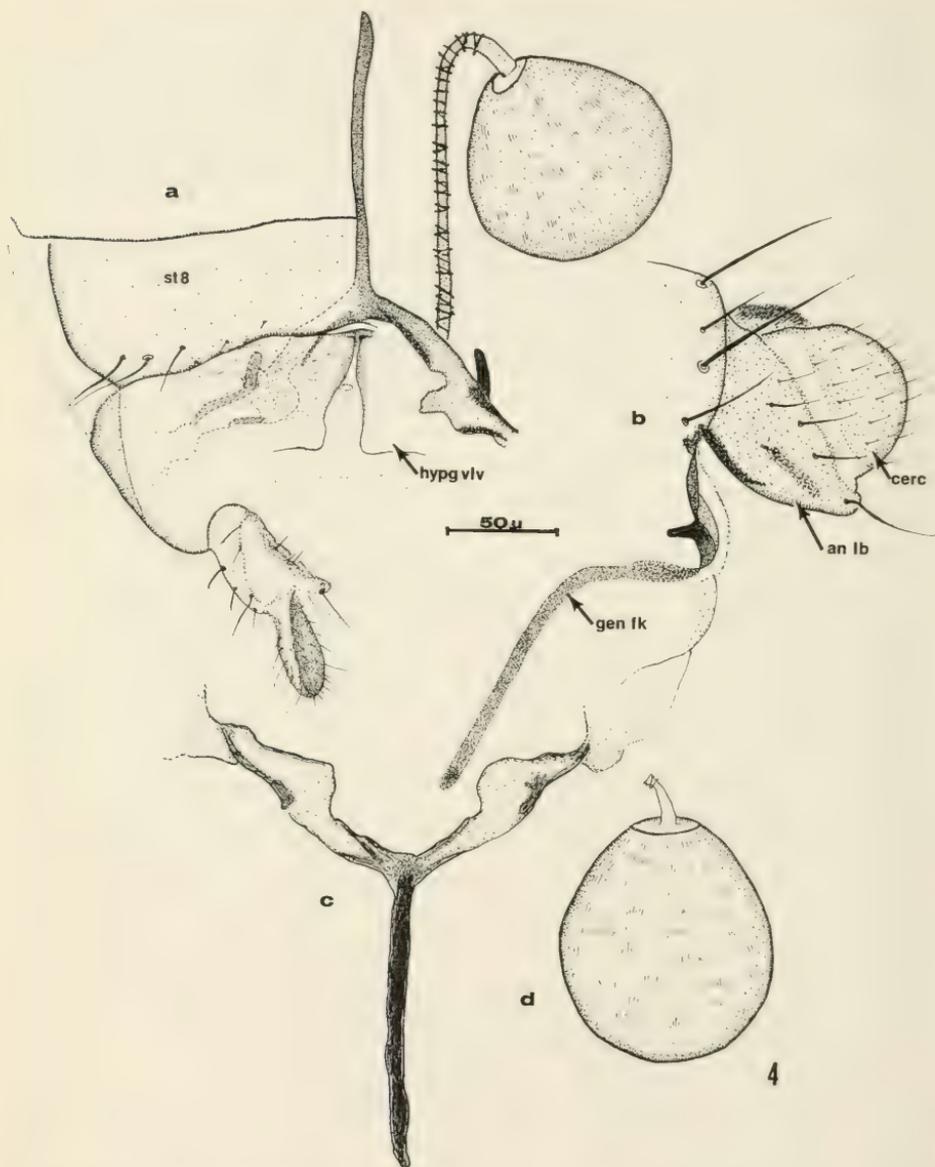


Fig. 4. *Simulium sanguineum*, female terminalia. a, Ventral view with portions of left side removed. b, Left lateral view including genital fork. c, Variation in genital fork. d, Variation in shape of spermatheca. Abbreviations: an lb = anal lobe; cerc = cercus; gen fk = genital fork; hypg vlv = hypogynial valve; st 8 = sternum 8.

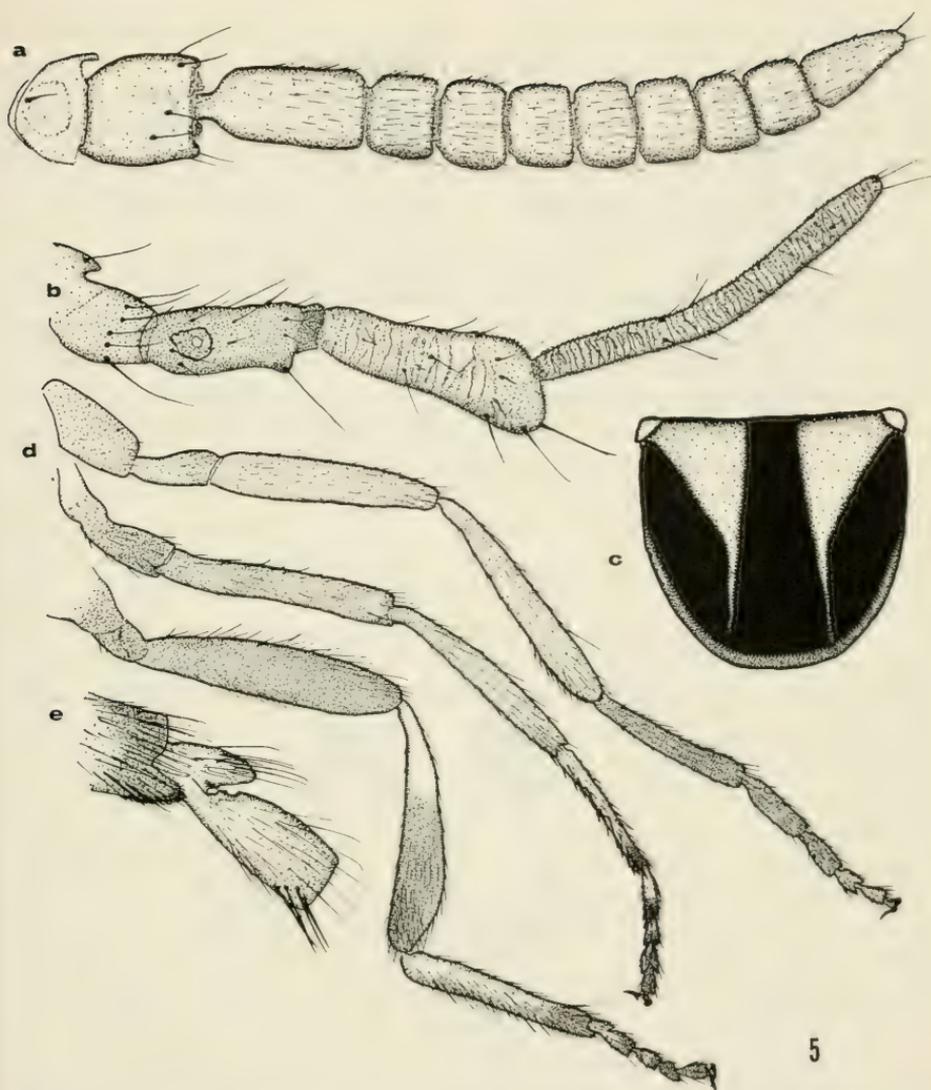


Fig. 5. *Simulium sanguineum*, male. a, Antenna. b, Palpus. c, Composite illustration of scutal pattern. d, Legs. e, Portion of hindtarsus showing calceipala and pedisulcus.

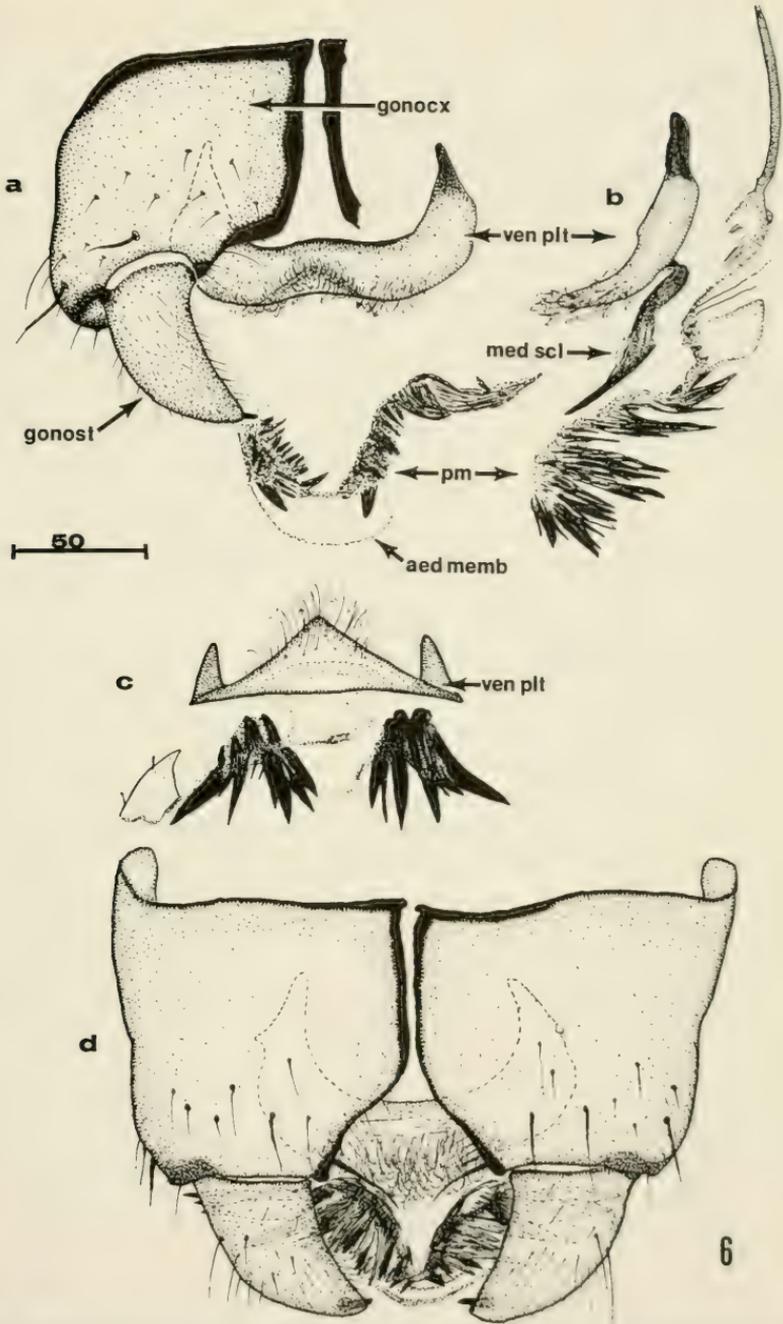
gently curving posteriorly but not produced beyond hindmargin of cercus. Cercus broadly rounded posteriorly. Genital fork with stem and base of arms heavily sclerotized, arms distally subrectangular to subtriangular, moderately sclerotized, each with a moderately long slender sclerotized anteriorly directed process. Spermatheca globular to slightly elongate, heavily sclerotized, with small differentiated circular area at junction with spermathecal duct.

Male.—General body color black. Length: Body, 1.3–1.6 mm (dry pinned specimens), 1.8–2.2 mm (alcohol preserved specimens); wing, 1.4–1.5 mm.

Head black; frons and clypeus with silvery pruinosity; clypeus with long pale yellowish to brownish hairs. Antenna (slide mounted) as in Fig. 5a; scape, pedicel, and base of 1st flagellomere dull yellow, remainder dark brown to dull black. Palpus dark brown to dull black, shape and proportion of segments as in Fig. 5b.

Scutum velvety black, with 2 triangular submedian silvery pruinose spots, inner margin of each spot extending posteriorly as a slender submedian concolorous vitta, these vittae somewhat variable in length but sometimes joining with broad pruinose band along hind margin of scutum that continues around lateral margins of scutum (Fig. 5c); anepisternum and katepisternum covered with dense silvery pruinosity. Scutellum dark brown with long hairs around margin, ventral portion with faint silvery pruinosity; postnotum covered with silvery pruinosity. Forecoxa of legs brownish with silver pruinosity, trochanter, femur, and tibia dirty yellow to brownish, tibia with whitish pruinosity, tarsi black; midcoxa and trochanter dark brown with faint silvery pruinosity, femur and tibia dirty yellow to dark brown, tibia paler on basal portion, basitarsus yellowish with dark apical ring, 2nd and 3rd tarsomeres pale basally, darker apically, remaining tarsomeres dark; hindcoxa and trochanter dark brown with faint silvery pruinosity, femur dark brown to black, tibia with basal $\frac{1}{3}$ to $\frac{1}{2}$ white, remainder black, hind-basitarsus white with black apical ring; 2nd and 3rd tarsomeres white basally, dark apically; remaining tarsomeres dark. Leg shape and proportions of segments as in Fig. 5d; calcipala and pedisulcus as in Fig. 5e. Wing essentially as in female, veins dull yellowish; R_1 with 5–8 spinules and R_{4+5} with 6–10 spinules. Stem of halter dark, knob yellowish.

Abdomen velvety black in general appearance with lateral silvery pruinosity on segments 1, 2, 6, 7, 8, and 9. Tergum 1 black, posterior margin fringed with long hairs; tergum 2 brownish black with silvery pruinosity; a faint anterior marginal pruinosity present on segments 3, 4, 5, and 6 and a faint posterior marginal pruinosity present on segment 5, and with faint trace of pruinosity on intersegmental membrane between segments 4 and 5 and segments 5 and 6; terga 6–8 with silvery pruinosity that is absent medially, thus forming a posteriorly expanded elongate black triangle. Male terminalia as in Fig. 6; gonocoxite subquadrate, with prominent setae on distal $\frac{1}{2}$; gonostylus approximately $\frac{3}{4}$ length of gonocoxite at longest point; basal width of gonostylus varying from $\frac{1}{2}$ to $\frac{3}{4}$ its length, tapering to apex, with a single apical spine. Ventral plate somewhat U-shaped in ventral view, and strongly depressed dorsoventrally, its greatest width occurring approximately midway between basal arms to decurved distal margin; basal extremities of arms strongly sclerotized. Paramere with numerous small and large spines.



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Fig. 6. *Simulium sanguineum*, male terminalia. a. Ventral view with portions of left side removed. b. Left lateral view of ventral plate and paramere. c. Terminal (end) view of same structures. d. Terminalia of separate specimen from permanent slide mount. Abbreviations: aed memb = aedeagal membrane; gonocx = gonocoxite; gonost = gonostylus; med scl = median sclerite of aedeagus; pm = paramere; ven plt = ventral plate of aedeagus.

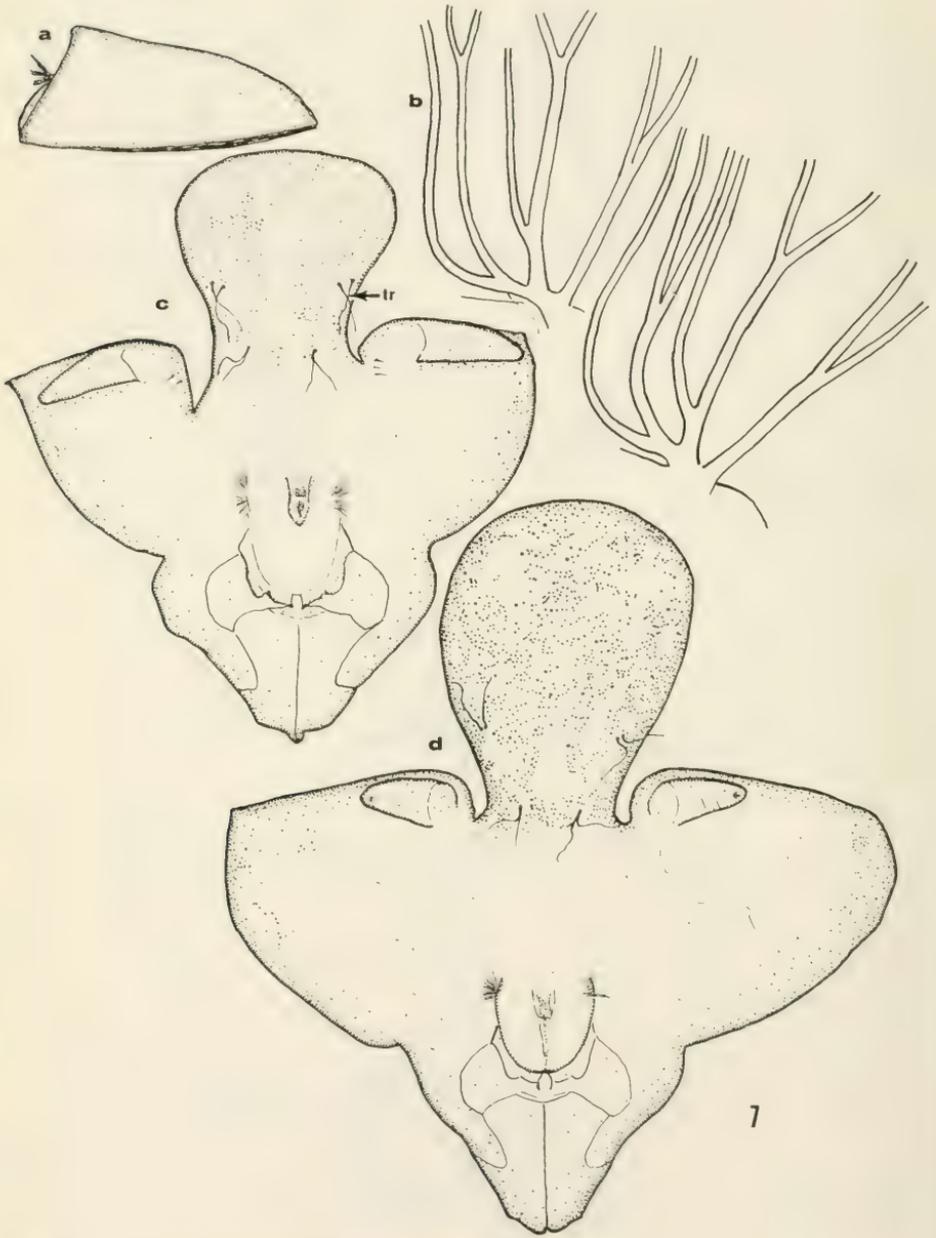


Fig. 7. *Simulium sanguineum*, pupa. a, Cocoon. b, Respiratory organ showing variation in level of branching. c, Head, female, d, Head, male. Abbreviation: tr = trichomes.

Pupa.—Cocoon slipper shaped (Fig. 7a); length, 1.7–2.5 mm; light brown in color, rim of anterior collar darker and with a short dorsomedial projection present in most specimens but this often broken off. Pupal length 1.6–2.2 mm; respiratory organ 1.4–1.8 mm in length with 8 filaments originating from 3 primary trunks, dorsal and medial trunks each giving rise at varying levels to 3 filaments and ventral branch to 2 filaments (Fig. 7b). Head (Figs. 7c, d) and portions of thorax with small rounded platelets in an irregular pattern: head with 2 + 2 single frontal and 1 + 1 usually bifid facial trichomes; thorax with 5 + 5 usually bifid or trifid dorsal trichomes (Fig. 8a). Abdominal setae and hooks as in Figs. 8b–d; posterior margins of terga 3 and 4 each with 4 + 4 anteriorly projecting hooks; terga 7–9 each with small posteriorly directed spines along anterior margin. Terminal caudal spines broad basally, tapering to an acute point. Sternum 4 with 1 pair, and sterna 5–7 with 2 pairs of usually bifid or trifid hooks.

Larva (Fig. 9a).—General body color dull creamy yellow with gray-green to dark brownish mottling, intensity varying from faint to dark. Length 3.8–4.5 mm; width of head capsule 0.39–0.43 mm; cephalic apotome pale, without distinct pattern. Antenna 0.10–0.34× longer than stalk of labral fan; proportional lengths of segments 1–3 approximately 1:1:1. Labral fan with 20–22 primary rays. Hypostomal cleft subtriangular (Fig. 9b), extensively produced anteriorly reducing hypostomal bridge to a narrow straplike process, distance across hypostomal bridge to hypostomal border less than width of anterior denticulate margin of hypostoma. Margin of postociput strongly sclerotized to approximate level of posterior tentorial pit. Hypostoma as in Fig. 9c; median tooth approximately same height as lateral teeth; sublateral teeth increasing slightly in height toward lateral tooth (Fig. 9d); 1 or 2 lateral serrations immediately posterior to lateral teeth; additional lateral marginal serrations on hypostoma varying from 2–5 (avg 3) on each side; hypostomal setae varying from 3–5 on each side; anterior region of hypostoma, posterior to teeth, not evenly sclerotized but with lighter median area. Mandible as in Fig. 9e; posterior to largest apical tooth there are 3 stout and 5–7 thinner comb teeth, and inner subapical margin with 1 large and usually 1 much smaller tooth followed by a row of setaelike teeth forming a subapical marginal brush. Apices of posterior bristles of external brush of bristles terminating at or near base of subapical marginal brush. Palpus approximately 2.6–3.4× as long as width at base. Posterior circlet composed of 52–55 rows of hooks with 8–12 hooks per row. Anal papillae with 3 compound lobes each having from 3–5 secondary lobules.

Remarks.—Topotypic females were compared with the holotype and found to be so similar as to be considered conspecific. Differences observed in the intensity of coloration were probably due to fading with age of the holotype. It was difficult to discern the extent of silvery pruinosity on some of the legs and the abdomen of the holotype and accurate comparisons could

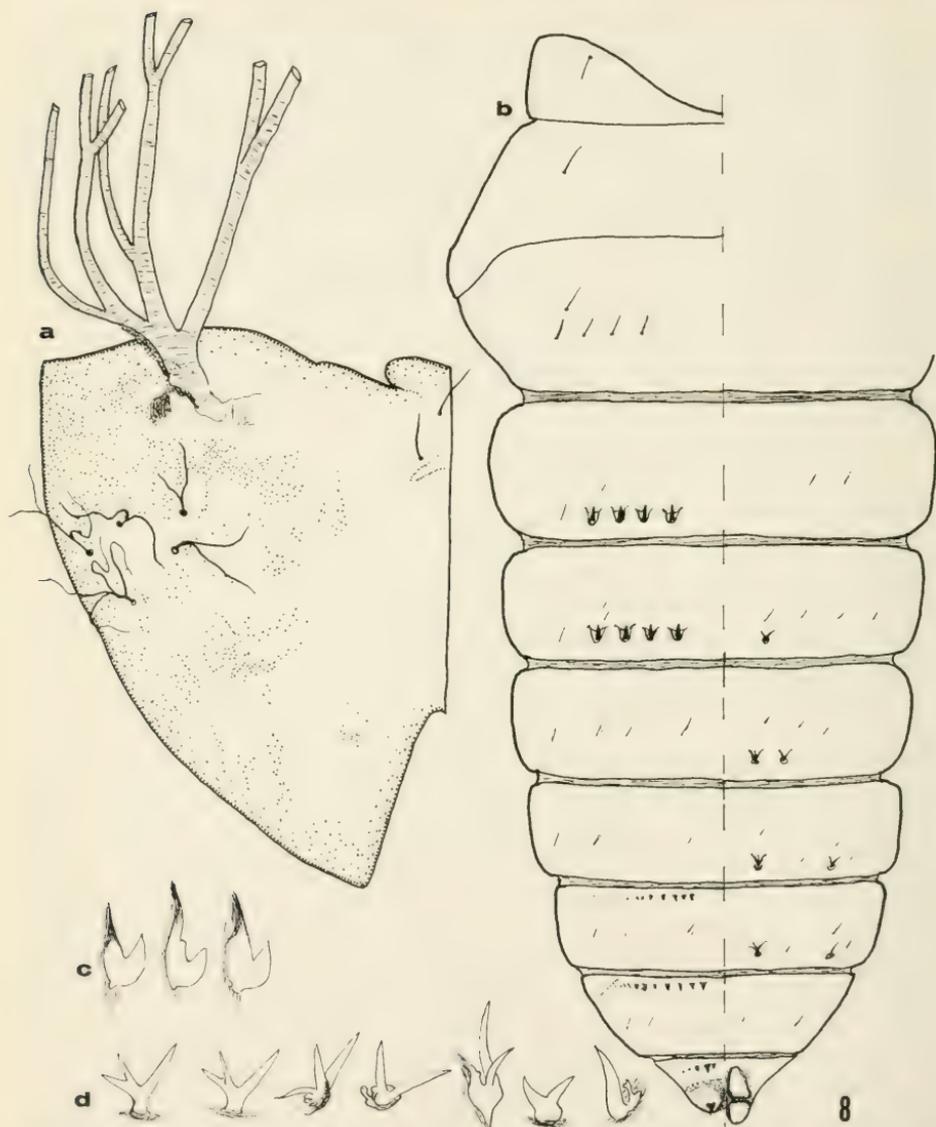
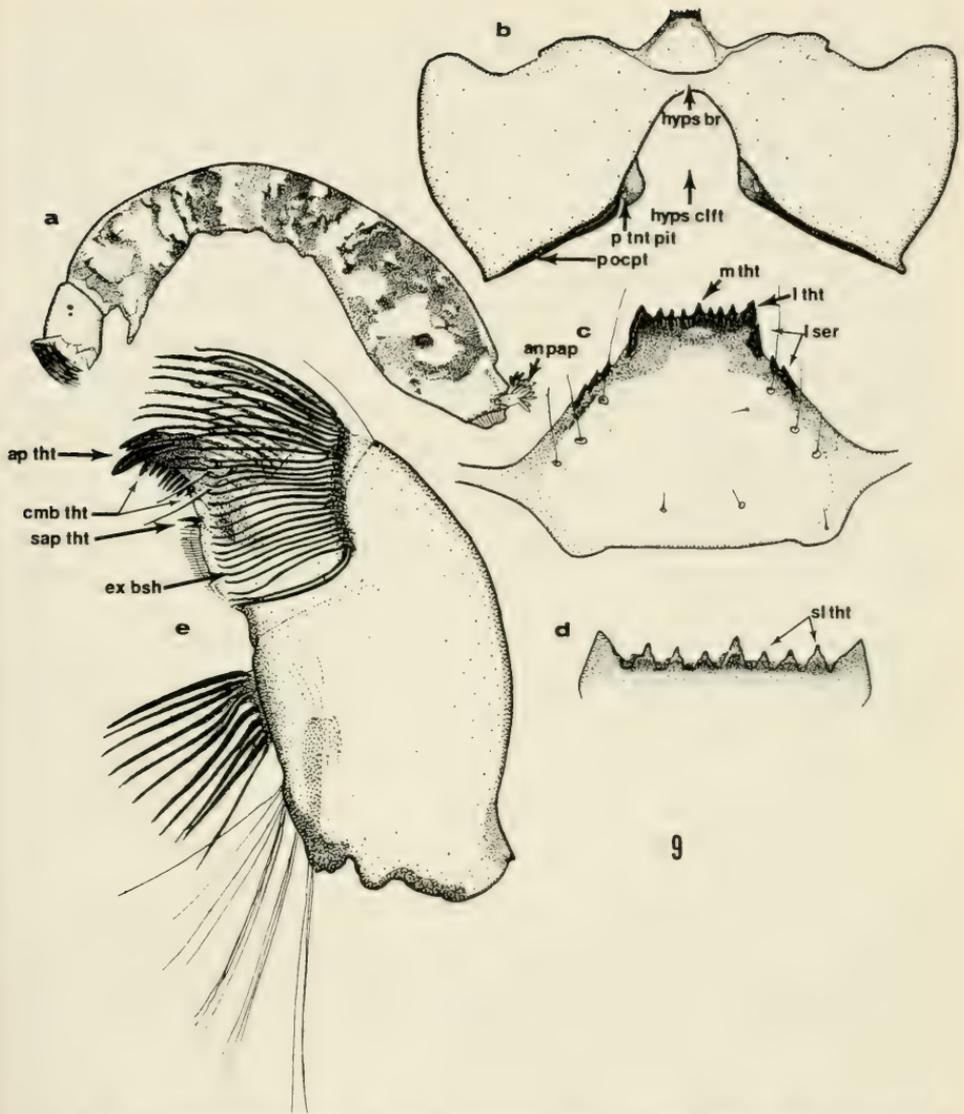


Fig. 8. *Simulium sanguineum*, pupa. a, Portion of thorax showing trichomes and respiratory organ. b, Abdomen, dorsal surface on left. c, Dorsal hooks. d, Variation in ventral hooks.

not be made. Knab apparently miscounted the abdominal segments in his description of *S. sanguineum* when he listed segments 5–8 as shining black.

Specimens examined.—COLOMBIA: Dept. of Chocó, Río Tagachí, 1–9 km from mouth of river, September 12, 1978, Tidwell, reared ♂ 41, reared



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Fig. 9. *Simulium sanguineum*, larva. a, Lateral view. b, Head capsule, undersurface. c, Hypostoma. d, Hypostomal teeth. e, Mandible. Abbreviations: an pap = anal papillae; ap tht = apical teeth; cmb tht = comb teeth; ex bsh = external brush; hyps br = hypostomal bridge; hyps cleft = hypostomal cleft; l tht = lateral tooth; l ser = lateral serrations; m tht = median tooth; p tnt pit = posterior tentorial pit; sap tht = subapical teeth; sl tht = sublateral teeth.

♀ 51, pupae 29, larvae 14; August 23, 1979, Tidwell, biting ♀ 10, pupae 4, larvae 10. Río Atrato near Boca Arquía, August 23, 1979, Tidwell, biting ♀ 31. Río Arquía, Pt. Palacio, September 9, 1977, Tidwell, biting ♀ 2; February 14, 1978, Tidwell, biting ♀ 5. Dept. of Cauca, approximately 11

km N. Santander de Quilichao, May 18, 1977, Tidwell, biting ♀ 21; June 14, 1977, Tidwell, biting ♂ 39; June 22, 1977, Tidwell, reared ♂ 4, reared ♀ 18, biting ♂ 31, pupae 5, larvae 7; July 4, 1977, Tidwell, reared ♂ 12, reared ♀ 23, pupae 3, larvae 7; January 9, 1978, Tidwell, pupae 9.

Biological notes.—The immature stages of *S. sanguineum* were found near the type-locality on submerged sticks and stems approximately 0.5 to 3.0 m in depth in the turbid waters of the Tagachí River within approximately 1–9 km of its confluence with the Atrato River. This area lies in a sparsely populated zone of tropical rain forest at less than 200 m elevation. At some sites the immature stages of *S. sanguineum* were collected along with those of *S. exiguum* Roubaud, but in general the latter were encountered more frequently in the relatively clear and faster flowing waters upstream where immatures of *S. sanguineum* were not found. These two species were the only *Simulium* species collected biting man in the region. Results of studies on the Arquía River to determine the vectors of *Mansonella ozzardi* (Manson), a human filarial parasite endemic in this region, shows that of the two man-biting species only *S. sanguineum* is a suitable intermediate host for this parasite (Tidwell et al., *in press*).

Specimens indistinguishable from topotypic *S. sanguineum* were collected approximately 330 km south of the type-locality on the eastern side of the Cordillera Occidental in the Department of Cauca. While the life stages from the two areas are similar morphologically, they were found in ecologically distinct habitats. The immature stages in Cauca were collected from small, clear, fast-flowing streams less than 4 m wide in an agricultural area at approximately 1000 m elevation. Streams of this type were not encountered at the type-locality.

Discussion.—The observed pruinose scutal pattern of *S. sanguineum* varies considerably with the position of the specimen and the angle and direction of incident light. Variation due to the latter is illustrated in Figs. 1c and d. When viewing specimens, care must be taken to standardize the positioning of the specimen and the placement of the light sources so that one can consistently make accurate comparisons of specimens of the same and closely related species. The pattern formed by the two submedian pruinose vittae as seen in dorsal view (Figs. 1a, b) may vary and this character should be used with caution when separating closely related species. The pruinose patterns seen in a standardized lateral view with the light source from the anterior and/or posterior aspects generally tend to be less variable and may be used to aid in a more accurate separation of some members of this group.

Characters for the separation of females of some species of the *S. amazonicum-sanguineum* groups have not yet been completely worked out and characters of the males and/or immature stages must be used for separating these species. Females indistinguishable from those of *S. sanguineum* but emerging from six filamented pupae have been reported from several South

American countries and such females have been incorrectly identified as *S. sanguineum*. Until further studies on the *S. sanguineum* group are completed, it seems advisable to limit the known distribution of *S. sanguineum* to Colombia, and possibly Panama. Vulcano (1967) lists Panama (Darién) in the distribution of *S. sanguineum*; since this region joins the northern border of the Chocó, Colombia, less than 200 km from the type-locality, it is possible that *S. sanguineum* is present in this area.

Simulium sanguineum females can best be distinguished from those of *S. amazonicum* by the absence of a broad, pronounced pruinose connection from the submedian silvery vittae to the lateral pruinosity in the region of the postpronotal lobe. This character is best observed using a light source from each side at approximately 45° angles and placing the specimen in an upright position with the head directed away from the observer. The specimen is then rotated approximately 1/8 turn to the right (right side turning down) or until the black area between the left lateral and submedian pruinose areas is centered in the field of view. A subanterior pruinose connection between the lateral and submedian pruinose areas, if present, can readily be seen in this position. A few *S. sanguineum* specimens may have a faint indication of a connection in this region but it is never broad and is always fading in intensity. A redescription of *S. amazonicum* by A. J. Shelley et al. is in preparation and will provide additional characters to help distinguish these two species from other members in this group.

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**A LIST OF THE COCCOIDEA SPECIES (HOMOPTERA)
OF PUERTO RICO**

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Abstract.—One hundred twenty-nine species of Coccoidea representing 72 genera and 10 families are recorded from Puerto Rico. Seven species are reported for the first time. Although mentioned in this paper, eight species apparently do not occur in Puerto Rico. Collection records based on examined material are presented for species that were misidentified and reported in the literature as another species. Unreported collection data also are given for other species.

In a publication on the food plants of the insects of Puerto Rico, Martorell (1976) listed 102 nominate Coccoidea species. Based on information compiled up to June 30, 1979, from examination of Puerto Rican material in the U.S. National Museum, research of literature, agricultural quarantine interception records, and recent collecting by various people, 129 species in 72 genera and 10 families are known to occur in Puerto Rico. *Aonidiella aurantii* (Maskell) and *Saissetia oleae* (Olivier) reported from Puerto Rico were not seen by the authors; however, these species are likely to be established on the island, and they have been included in this list. Two species denoted with a cross (+) are known only from agricultural quarantine interceptions. They are included because other species previously known only from quarantine interceptions were subsequently collected. Seven species denoted with two asterisks (**) are reported for the first time. Species previously reported in the literature that apparently do not occur in Puerto Rico are listed with comments and denoted with two crosses (++), or are treated as misidentifications of other included species.

Collection records based on examined material are presented for species that were misidentified and reported in the literature as another species. Unreported collection records are also given for other species.

The list is arranged alphabetically by family, genus, and species. References using the current accepted binomens are cited first followed by cita-

tions using synonyms. References published prior to Wolcott (1948) are not cited except when the species was not treated by him.

ACLERDIDAE

Aclerda sacchari Teague.—Wolcott, 1948; Martorell, 1976.

ASTEROLECANIIDAE

Asterolecanium bambusae (Boisduval).—Wolcott, 1948; Martorell, 1976.

Asterolecanium epidendri (Bouché).—Wolcott, 1948; Martorell and Medina Gaud, 1974; Martorell, 1976.

Asterolecanium ingae Russell.—Wolcott, 1948; Martorell, 1976.

Asterolecanium longum (Green) ++.—Wolcott, 1948; Martorell, 1976. Old records apparently based on misidentifications.

Asterolecanium miliare miliare (Boisduval).—Russell, 1941. Additional records: Near Arus, *Bambusa* sp., 17-VII-77, SN; Barcelona, *Bambusa* sp., 16-VII-77, SN; Corozal, *Bambusa vulgaris*, 4-II-71, S. Medina Gaud; Mayaguez, *Bambusa vulgaris*, 27-X-36, H. R. Plank.

Asterolecanium miliare robustum Green.—Wolcott, 1948; Martorell, 1976.

Asterolecanium pseudomiliare Green.—Wheeler et al., 1948. Additional records: Barcelona, *Bambusa* sp., 16-VII-77, SN; Mayaguez, bamboo, ltr. of 18-IV-16, R. H. Van Zwaluwenburg, 12-VIII-30, A. G. Harley; Puerto Rico, *Bambusa nana*, 16-III-24, N. L. and E. G. Britton.

Asterolecanium pustulans (Cockerell).—Wolcott, 1948; Martorell, 1976.

CEROCOCCIDAE

Cerococcus deklei Kosztarab and Vest.—Martorell, 1976.

COCCIDAE

Ceroplastes cerifer (Fabricius) ++.—Gimpel et al., 1974; *Ceroplastes ceriferus* (Anderson): Wolcott, 1948; Martorell, 1976. Records of this species are based on two old collections. The record from *Sauvagesia erecta* (Wolcott, 1948) is a misidentification of an undescribed *Ceroplastes*, and very likely, the record from *Bursera simaruba* is also a misidentification.

Ceroplastes cirripediformis Comstock.—Wolcott, 1948; Martorell, 1976; Gimpel et al., 1974.

Ceroplastes cistudiformis Townsend and Cockerell ++.—Wolcott, 1948; Martorell, 1976. Based on old records that probably are misidentifications.

Ceroplastes dugesii Lichtenstein **.—Records: Humacao (Palmas Del Mar), unknown host, 2-II-73, T. H. Flavell; Vega Alta, *Piper medium*, 26-I-17, R. T. Cotton.

Ceroplastes floridensis Comstock.—Wolcott, 1948; Gimpel et al., 1974; Martorell, 1976.

Ceroplastes rubens Maskell.—Medina Gaud and Garcia Tuduri, 1977. Ad-

- ditional records: Arecibo, *Aglaonema commutatum pseudobracteatum*, 8-VI-76, K. Stolley; Caribbean National Forest (Loquillo), *Dicranopteris flexuosa*, 22-VII-77, SN; Toa Baja, *Aglaonema* sp., *Ixora* sp., *Mangifera indica*, 13-III-75, H. O'Steen et al.; quarantine interception at San Juan, *Ixora coccinea*, 15-X-74, J. Thaw.
- Ceroplastes rusci* (Linnaeus).—Nakahara, 1978b; *Ceroplastes denudatus* Cockerell: Wolcott, 1948; Martorell, 1976.
- Coccus hesperidum* Linnaeus.—Wolcott, 1948; Martorell, 1976. Additional record: Isla Verde, *Brassaia actinophylla*, *Yucca* sp., 14-VII-77, SN.
- Coccus longulus* (Douglas).—Gill et al., 1977; *Coccus elongatus* (Signoret): Medina Gaud and Garcia Tuduri, 1977. Additional records: Hato Rey, *Spathiphyllum lanceifolium*, 13-III-73, S. Medina Gaud; Isla Verde, *Cajanus cajan*, 11-VII-77, C. E. Miller and SN; Rio Piedras, *Phaseolus puearia*, 8-III-54, H. Cibes; quarantine interception from Puerto Rico at New York, *Annona muricata*, 8-V-33, H. G. Taylor.
- Coccus moestus* De Lotto.—Gill et al., 1977, Medina Gaud and Garcia Tuduri, 1977.
- Coccus viridis* (Green).—Wolcott, 1948; Martorell, 1976.
- Cryptostigma secretus* (Morrison).—Wolcott, 1948; Martorell, 1976.
- Eucalymnatus tessellatus* (Signoret).—Wolcott, 1948; Martorell, 1976. Additional record: Isla Verde, *Ardisia* sp., 15-VII-77, SN.
- Inglisia vitrea* Cockerell.—Wolcott, 1948; Martorell, 1976.
- Kilifia acuminata* (Signoret).—*Coccus acuminatus* (Signoret): Wolcott, 1948; Martorell, 1976. Additional record: Quarantine interception from Puerto Rico at Miami, *Ixora* sp., 29-VI-65, L. A. McClain.
- Parasaissetia nigra* (Nietner).—*Saissetia nigra* (Nietner): Wolcott, 1948; Medina Gaud and Martorell, 1974; Martorell, 1976.
- Protospulvinaria longivalvata* Green.—Wolcott, 1948; Martorell, 1976. Additional records: Rio Piedras, *Mangifera indica*, 24-IV-75, J. Garcia Tuduri; Reserva Forestal Maricao, *Samyda spanulosa*, 21-VII-77, SN.
- Protospulvinaria mangiferae* (Green).—*Coccus mangiferae* (Green): Wolcott, 1948; Martorell, 1976.
- Protospulvinaria pyriformis* (Cockerell).—Martorell, 1976. Additional records: Reserva Forestal Maricao, unknown host, 21-VII-77, SN; quarantine interception at San Juan, *Psidium guajava*, 24-VIII-69, L. Crawford.
- Pulvinaria elongata* Newstead.—Martorell, 1976. *Pulvinaria iceryi* (Guérin-Ménéville): Wolcott, 1948.
- Pulvinaria psidii* Maskell.—Wolcott, 1948; Martorell, 1976.
- Pulvinaria urbicola* Cockerell.—Wolcott, 1948; Martorell, 1976. Additional records: Isla Verde, *Bidens pilosa*, 11-VII-77, C. E. Miller and SN; Bahia Montalva, *Melochia tomentosa*, 17-VII-77, SN.
- Saissetia coffeae* (Walker).—Martorell and Medina Gaud, 1974; Garcia Tu-

duri et al., 1974; Martorell, 1976: *Saissetia hemisphaerica* (Targioni): Wolcott, 1948.

Saissetia miranda (Cockerell and Parrott) **.—*Saissetia oleae* (Bernard): Wolcott, 1948; *Saissetia oleae* (Olivier): Martorell, 1976 (misidentifications in part). Records: Arecibo, *Terminalia* sp., 29-VI-17, H. Morrison*, *Erythrina berteriana*, 27-IX-40, G. N. Wolcott*; Fajardo, *Ficus* sp., 4-IX-32, G. N. Wolcott*; Isabela, *Gossypium* sp., 27-IX-35, L. C. Fife*; Isla Verde, *Cajanus cajan*, 11-VII-77, C. E. Miller and SN, *Erythrina* sp., *Yucca* sp., 14-VII-77, SN; Lajas, *Abutilon hirtum*, 12-XI-35, L. C. Fife*; Mayaguez, *Abelmoschus esculentus*, 15-XI-35, L. C. Fife*; Maricao (Maricao Insular Forest), *Cedrela odorata*, 15-XII-36, L. F. Martorell*; Mona Is., *Gossypium punctatum*, 5-IV-44, G. N. Wolcott*; Ponce, *Mangifera indica*, 10-III-17, H. Morrison*; *Spondias dulcis*, 10-VIII-32, R. G. Oakley*, *Tamarindus indica*, 28-VI-32, Bofill and Oakley*; Rio Piedras, *Swietenia mahogany*, 29-III-32, M. D. Leonard*; *Plumeria rubra*, ltr. of 8-II-49, L. F. Martorell*; San Juan, *Psidium guajava*, 27-V-30, A. S. Mills*, *Ixora coccinea*, 13-III-75, H. O'Steen et al.; Santurce, *Terminalia catappa*, 9-V-32, A. S. Mills*, *Zanthoxylum flavum*, 15-V-40, L. F. Martorell*; Vega Alta, *Montezuma speciosissima*, 9-VII-35, Faxon et al.*. Quarantine interceptions: At San Juan, *Kopsias* sp., 30-X-74, C. Havens; At New York, *Lippia* sp., 18-V-32, A. G. Lennox*, *Punica granatum*, 22-VII-35, Locke and Post*, *Sterculia apetala*, 20-XII-35, H. Fox*. Records marked * previously identified as *S. oleae*.

Saissetia neglecta De Lotto.—Medina Gaud and Garcia Tuduri, 1977: *Saissetia oleae* (Bernard): Wolcott, 1948; *Saissetia oleae* (Olivier): Martorell, 1976 (misidentifications in part). Additional records: Vicinity of Mayaguez, *Coccoloba pirifolia*, 4 to 10-III-06, J. F. Cowell*; Ponce, *Tamarindus indica*, 28-VI-32, Bofill and Oakley*; Santurce, *Citrus aurantifolia*, 1-VII-47, F. Sein*; unknown locality, *Dieffenbachia amoena*, 26-IV-78, F. McHenry, *Platyserium* sp., 25-IV-77, J. C. Denmark; Quarantine interceptions: At San Juan, *Annona muricata*, 3-IV-75, J. Thaw, *Citrus* sp., 21-VIII-73, A. Agostini, *Citrus paradisi*, 7-VII-25, C. E. Cooley*, *Psidium guajava*, 12-VIII-73, J. Judd; At New York, *Coffea* sp., 17-VII-39, McConnell*, *Manilkara zapota*, 17-II-36, Dodd and O'Brien*; At Philadelphia, *Mangifera indica*, 23-VII-30, W. W. Chapman*. Records marked * previously identified as *S. oleae*.

Saissetia oleae (Olivier).—Martorell, 1976: *Saissetia oleae* (Bernard): Wolcott, 1948; Martorell and Medina Gaud, 1974; Medina Gaud and Martorell, 1974. The senior author has examined the *S. oleae* material in the U.S. National Museum and found the identifiable Puerto Rican material was either *S. miranda* or *S. neglecta*. Although not seen from Puerto Rico, *S. oleae* probably occurs on the island.

Vinsonia stellifera (Westwood).—Wolcott, 1948; Martorell and Medina Gaud, 1974; Martorell, 1976.

CONCHASPIDIDAE

Conchaspis angraeci Cockerell.—Wolcott, 1948; Martorell, 1976. Additional records: Bahia Montalva, *Melochia tomentosa*, 17-VII-77, SN; Bokeron, *Coccoloba uvifera*, 18-VII-77, SN; Culebra Is., *Coccoloba uvifera*, 26-I-76, R. Gonzalez S.; Isla Verde, *Coccoloba uvifera*, 15-VII-77, SN; Vieques Is., *Hibiscus* sp., 22-VI-72, D. Miller. Quarantine interceptions: At San Juan, *Agave angustifolia marginata*, 1-IX-69, L. M. Crawford, *Agave angustifolia woodrawii*, 2-III-70, L. M. Crawford.

Conchaspis cordiae Mamet **.—*Conchaspis orchidarum* Mamet: Martorell, 1976 (misidentification). This record is based on a poor specimen deposited in the U.S. National Museum.

DIASPIDIDAE

Abgrallaspis cyanophylli (Signoret).—Records: Central Aquirre, *Guaiacum officinale*, ltr. 27-XI-25, H. L. Dozier; Ensenada, *Pithecellobium unguis-cacti*, 17-XII-35, H. L. Dozier; Isabela, *Persea americana*, 29-III-55, H. Goldstein; Isla Verde, *Jasminum* sp., 12-VII-77, SN; Mayaguez, *Cocos nucifera*, 3-XII-35, H. K. Plank; Ramey Field, *Jasminum* sp., 29-IV-48, various collectors; Rio Piedras, *Chlorophytum* sp., 25-XI-76, C. Mantaras. Quarantine interceptions: At New York, *Annona reticulata*, 5-V-26, Kennedy et al., *Annona* sp., 20-X-47, Johnston and Burnham. Refer to comments in Wolcott (1948) and Martorell (1976) concerning *Hemiberlesia palmae* (Cockerell) and *Aspidiotus cyanophylli*.

Aonidiella aurantii (Maskell).—Wolcott, 1948; Martorell, 1976. Although this species was not seen by the authors, it probably occurs on the island.

Aonidiella comperei McKenzie.—Wolcott, 1948; Martorell, 1976.

Aonidiella inornata McKenzie.—Nakahara and Miller, 1978a.

Aonidiella orientalis (Newstead).—Wolcott, 1948; Martorell, 1976.

Aonidomytilus albus (Cockerell) **.—Record: Vieques Is., *Carica papaya*, 31-VII-72, D. Miller.

Aspidaspis arctostaphyli (Cockerell and Robinson)++.—Martorell, 1976; *Aspidiotus arctostaphyli* Cockerell and Robinson: Wolcott, 1948. This species recorded from *Stenotaphrum secundatum* apparently is a misidentification.

Aspidiella hartii (Cockerell).—Martorell, 1976.

Aspidiella sacchari (Cockerell).—Martorell, 1976; *Targionia sacchari* (Cockerell): Wolcott, 1948.

Aspidiotus destructor Signoret.—Wolcott, 1948; Martorell, 1976.

Aspidiotus excisus Green.—Medina Gaud and Garcia Tuduri, 1977; *Temnaspidotus excisus* (Green): Dekle, 1966.

- Aspidiotus nerii* Bouché.—Martorell, 1976; *Aspidiotus hederæ* (Vallot): Wolcott, 1948.
- Aspidiotus spinosus* Comstock +.—Bureau of Entomology and Plant Quarantine, 1936. Additional record: Quarantine interception at Miami, *Cajanus cajan*, 5-II-58, C. Bennett.
- Aulacaspis rosæ* (Bouché).—Wolcott, 1948; Martorell, 1976.
- Aulacaspis tubercularis* Newstead.—Martorell, 1976. A common species on *Mangifera indica* on the island.
- Chrysomphalus aonidium* (Linnaeus).—Wolcott, 1948; Martorell, 1976.
- Chrysomphalus dictyospermi* (Morgan).—Wolcott, 1948; Martorell, 1976. Additional records: Near San Germán, *Persea americana*, 21-VII-77, SN; San Juan, *Ixora* sp., 13-III-75, H. O'Steen et al.: unknown location, *Draecena marginata*, 28-IV-78, Stolley et al.
- Clavaspis herculeana* (Doane and Hadden).—Martorell, 1976; *Aspidiotus herculeanus* Hadden: Wolcott, 1948. Additional records: Bahía Montalva, *Avicennia nitida*, 17-VII-77, SN; Isla Verde, *Erythrina* sp., 14-VII-77, SN.
- Crenulaspidotus portoricensis* (Lindinger).—Martorell, 1976; *Chrysomphalus (Melanaspis) portoricensis* Lindinger: Wolcott, 1948.
- Dactylaspis crotonis* (Ferris).—Martorell, 1976; *Lepidosaphes crotonis* Ferris: Wolcott, 1948.
- Diaspis boisduvalii* Signoret.—Wolcott, 1948; Martorell and Medina Gaud, 1974; Martorell, 1976.
- Diaspis bromeliae* (Kerner).—Wolcott, 1948; Martorell, 1976.
- Diaspis echinocacti* (Bouché).—Wolcott, 1948.
- Duplaspidotus fossor* (Newstead).—Nakahara, 1978a.
- Duplaspidotus tesseratus* (Grandpré and Charmoy).—*Pseudaonidia tesserata* (de Charmoy): Wolcott, 1948; Martorell, 1976.
- Fiorinia fioriniae* (Targioni-Tozzetti).—Medina Gaud and Garcia Tuduri, 1977. Additional record: Rio Piedras, *Artocarpus integrifolia*, 12-VII-77, SN.
- Furcaspis biformis* (Cockerell).—Wolcott, 1948; Martorell and Medina Gaud, 1974; Martorell, 1976.
- Genaparlatoria pseudaspidotus* (Lindinger).—Martorell and Medina Gaud, 1974; Martorell, 1976.
- Gymnaspis aechmeae* Newstead.—Medina Gaud and Garcia Tuduri, 1977.
- Haliaspis arecibo* Howell.—Howell, 1978; *Chionaspis distichlii* Ferris: Wolcott, 1948; Martorell, 1976 (misidentification).
- Haliaspis nakaharai* Howell.—Howell, 1978.
- Hemiberlesia lataniae* (Signoret).—Martorell, 1976; *Aspidiotus lataniae* Signoret: Wolcott, 1948. Additional records: Boqueron, *Melicoccus bijugatus*, *Nerium oleander*, 19-VII-77, SN; quarantine interception at San Juan, *Agave angustifolia woodrowii*, 20-III-75, L. M. Crawford.

- Hemiberlesia palmae* (Cockerell).—Martorell, 1976; *Aspidiotus palmae* Cockerell: Wolcott, 1948. Additional record: Unknown location, *Neoregelia carolinae*, 4-II-78, F. L. Ware.
- Hemiberlesia rapax* (Comstock).—Martorell, 1976; *Aspidiotus camelliae* (Signoret): Wolcott, 1948.
- Hemigymnaspis eugeniae* (Lindinger).—Martorell, 1976; *Melanaspis* (*Hemigymnaspis*) *eugeniae* Lindinger: Wolcott, 1948.
- Howardia biclavis* (Comstock).—Wolcott, 1948; Martorell, 1976. Additional records: Boqueron, *Ficus* sp., 19-VII-77, SN; Joyuda, *Alternanthera sessilis*, *Lantana camara*, 18-VII-77, SN; Near San Germán, *Bixa orellana*, *Persea americana*, 21-VII-77, SN; Reserva Forestal Maricao, *Clusia* sp., 21-VII-77, SN.
- Ischnaspis longirostris* (Signoret).—Wolcott, 1948; Martorell, 1976. Additional records: Yabucá, *Securidaca volubilis*, 7-V-75, S. Medina Gaud et al.; unknown location, *Vriesia polonia*, 22-X-75, F. L. Ware.
- Kuwanaspis linearis* (Green).—Nakahara, 1978a.
- Lepidosaphes beckii* (Newman).—Wolcott, 1948; Martorell, 1976.
- Lepidosaphes conchiformis* (Gmelin) ++.—*Lepidosaphes ficus* Signoret: Martorell, 1976. This record is based on one quarantine interception from Puerto Rico at California in fiscal year 1951. We have not been able to substantiate this record and because this species does not occur in the Caribbean Region, we do not consider this species established in Puerto Rico.
- Lepidosaphes gloverii* (Packard).—Wolcott, 1948; Martorell, 1976.
- Lepidosaphes rubrovittatus* Cockerell.—Nakahara and Miller, 1978b.
- Lepidosaphes tokionis* (Kuwana).—Martorell, 1976; *Lepidosaphes lasianthi* Green: Wolcott, 1948.
- Lepidosaphes vermiculus* Mamet.—Nakahara, 1978a.
- Lopholeucaspis cockerelli* (Grandpré and Charmoy).—*Leucaspis cockerelli* (de Charmoy): Wolcott, 1948; Martorell and Medina Gaud, 1973; Martorell, 1976. Additional records: Isla Verde, *Calophyllum* sp., 10-VII-77, SN; near Mameyes, *Citrus* sp., 16-VII-77, SN; Rio Piedras, *Dracaena fragrans*, 23-VII-77, SN; quarantine interception at San Juan, *Agave angustifolia marginata*, 1-IX-69, L. M. Crawford.
- Melanaspis bromeliae* (Leonardi).—*Targionia bromeliae*: Plant Quarantine and Control Administration, 1932. Additional records: Corozal, *Ananas* sp., 2-IV-36, Smith and Plank; quarantine interception at San Juan, *Ananas comosus*, 4-VIII-70, M. South and L. M. Crawford.
- Melanaspis coccolobae* Ferris **.—Records: Limestone hills, 7 mi. w. Ponce, *Coccoloba obtusifolia*, 26-XI-02, A. A. Heller; Loquillo Forest, *Coccoloba borinquensis*, 1-II-32, Barbour and Gerhart; Playa de Esperanza, *Coccoloba diversifolia*, 7-II-14, J. A. Shafer; Ponce to Penneles,

- Coccoloba laurifolia*, 22-II-06, Britton and Corwell; Vieques Is., *Coccoloba laurifolia*, 11-II-14, J. A. Shafer.
- Melanaspis nigropunctata* (Cockerell).—Martorell, 1976; *Chrysomphalus nigropunctatus* Cockerell: Wolcott, 1948.
- Melanaspis tenax* McKenzie +.—Girard, 1974.
- Morganella longispina* (Morgan).—Martorell, 1976. Additional records: Quarantine interception at Baltimore, *Citrus paradisi*, 29-VII-36, C. G. Latham; at New York, *Spondias dulcis*, 7-III-38, Bassen.
- Mycetaspis personata* (Comstock).—Martorell, 1976; *Chrysomphalus personatus* (Comstock): Wolcott, 1948.
- Octaspidiotus araucariae* Adachi and Fullaway.—Nakahara and Miller, 1978a.
- Odonaspis penicillata* Green.—Nakahara et al., 1978.
- Odonaspis ruthae* Kotinsky.—Miller, 1978.
- Odonaspis saccharicaulis* (Zehntner) **.—Records: Guanica Centrale Eusenada, *Panicum molle*, 9-III-12, T. H. Jones; quarantine interception at San Juan, *Saccharum officinarum*, 11-XII-74, J. Thaw.
- Parlatoria crotonis* Douglas.—Morrison, 1939. Additional records: Parguera, *Codiaeum variegatum*, 18-VII-77, SN; Rio Piedras, *Codiaeum variegatum*, 21-IV-76, J. Garcia Tuduri; quarantine interception at New York, *Codiaeum* sp., 1923.
- Parlatoria pergandii* Comstock.—Wolcott, 1948; Martorell, 1976.
- Parlatoria proteus* (Curtis).—Nakahara et al., 1978. Additional records: Quarantine interceptions at San Juan, *Aechmea* sp., 28-X-74, J. Thaw, *Mangifera indica*, 1-VI-76, C. E. Miller.
- Parlatoria ziziphi* (Lucas).—Records: In the U.S.D.A. Coccoidea reference file is a report that this species was found on a tangerine tree at Mayaguez in 1905. The species was intercepted at San Juan from Mayaguez on *Citrus* in 1975 and subsequent surveys found it established in a thirty-five mile area around Mayaguez on *Citrus*.
- Pinnaspis aspidistrae* (Signoret).—Wolcott, 1948; Martorell, 1976; *Pinnaspis caricis* Ferris: Martorell, 1976.
- Pinnaspis buxi* (Bouché).—Wolcott, 1948; Martorell, 1976. Additional records: Rio Piedras, *Monstera deliciosa*, 15-VIII-75, J. Garcia Tuduri; unknown location, *Vriesia polonia*, 22-X-75, F. L. Ware.
- Pinnaspis strachani* (Cooley).—Wolcott, 1948; Medina Gaud and Martorell, 1974; Martorell, 1976. Additional records: Isla Verde, *Erythrina* sp., 14-VII-77, SN; Parguera, *Rhizophora mangle*, 17-VII-77, *Bryophyllum pinata*, 18-VII-77, SN.
- Pseudaonidia trilobitiformis* (Green).—Medina Gaud and Garcia Tuduri, 1977. Additional records: Isla Verde, *Carissa grandiflora*, *Jasminum* sp., 14-VII-77, SN; Reserva Forestal Maricao, unknown shrub, 21-VII-77.

- SN; San Juan, *Rosa* sp., 11-VII-77, E. Feliu and SN; Toa Baja, *Ixora coccinea*, 13-III-77, H. O'Steen et al. Quarantine interceptions: At San Juan, *Kopsias* sp., 30-X-74, C. Havens; at New York, *Mangifera indica*, 23-XI-43, Owrey.
- Pseudaulacaspis major* (Cockerell).—Martorell, 1976; *Aulacaspis* (*Pseudaulacaspis*) *major* (Cockerell): Wolcott, 1948. Additional records: Boqueron, *Salix* sp., 21-VII-77, SN; Playa Aguila, unknown tree, 18-VII-77, SN.
- Pseudaulacaspis pentagona* (Targioni-Tozzetti).—Wolcott, 1948; Martorell, 1976.
- Pseudischnaspis howreyi* (Cockerell).—Wolcott, 1948; Martorell, 1976. Additional record: Reserva Forestal Maricao, *Coccoloba sentenisi*, 21-VII-77, SN.
- Pseudoparlatoria ostreata* Cockerell.—Wolcott, 1948; Martorell, 1976. Additional record: Parguera, *Bryophyllum pinnata*, 18-VII-77, SN.
- Pseudoparlatoria parlatorioides* (Comstock).—Wolcott, 1948; Martorell, 1976.
- Quadraspidiotus forbesi* (Johnson) ++.—*Aspidiotus forbesi* Johnson: Martorell, 1976. This record apparently is a misidentification.
- Radionaspis indica* (Marlatt).—*Leucaspis indica* Marlatt: Wolcott, 1948; Martorell, 1976.
- Selenaspis articulatus* (Morgan).—Wolcott, 1948; Martorell, 1976. Additional records: Parguera, *Cordyline terminalis*, 18-VII-77, SN; unknown location, *Dracaena marginata*, 17-III-78, M. Hornyak.
- Unaspis citri* (Comstock).—Wolcott, 1948; Martorell, 1976.

LECANODIASPIDIDAE

- Lecanodiaspis ingae* Howell and Kosztarab.—Howell and Kosztarab, 1972; *Lecanodiaspis* sp.: Wolcott, 1948; Martorell, 1976.

MARGARODIDAE

- Crypticerya rosae* (Riley and Howard).—Wolcott, 1948; Martorell, 1976.
- Icerya monserrattensis* Riley and Howard.—Wolcott, 1948; Martorell, 1976.
- Icerya purchasi* Maskell.—Wolcott, 1948; Medina Gaud and Martorell, 1974; Martorell, 1976.
- Margarodes formicarum* Guilding.—Wolcott, 1948; Medina Gaud and Martorell, 1974; Martorell, 1976.

ORTHEZIIDAE

- Orthezia insignis* Browne.—Wolcott, 1948; Medina Gaud and Martorell, 1974; Martorell, 1976.
- Orthezia praelonga* Douglas.—Wolcott, 1948; Martorell, 1976. Additional record: San Juan, *Vitex* sp., 11-VII-77, E. Feliu and SN.

PSEUDOCOCCIDAE

- Antonina graminis* (Maskell).—Martorell, 1976. Additional record: Isla Verde, *Tricholaena repens*, 11-VII-77, C. E. Miller and SN.
- Brevennia rehi* (Lindinger).—Nakahara et al., 1978.
- Chaetococcus bambusae* (Maskell).—Martorell, 1976; *Antonina* (*Chaetococcus*) *bambusae* (Maskell): Wolcott, 1948.
- Chnaurococcus radicola* (Morrison).—Martorell, 1976.
- Dysmicoccus boninsis* (Kuwana).—Martorell, 1976; *Pseudococcus boninsis* (Kuwana): Wolcott, 1948.
- Dysmicoccus brevipes* (Cockerell).—Martorell, 1976; *Pseudococcus brevipes* (Cockerell): Wolcott, 1948.
- Ferrisia virgata* (Cockerell).—Medina Gaud and Martorell, 1974; Martorell, 1976; *Pseudococcus* (*Ferrisia*) *virgatus* (Cockerell): Wolcott, 1948.
- Geococcus coffeae* Green.—Wolcott, 1948; Martorell, 1976.
- Nipaecoccus nipae* (Maskell).—Martorell, 1976; *Pseudococcus nipae* (Maskell): Wolcott, 1948.
- Planococcus citri* (Risso).—Martorell, 1976; *Pseudococcus citri* (Risso): Wolcott, 1948.
- Planococcus citricus* Ezzat and McConnell.—*Pseudococcus citricus* (Ezzat and McConnell): Martorell, 1976.
- Phenacoccus gossypii* Townsend and Cockerell.—Wolcott, 1948; Martorell, 1976.
- Pseudococcus comstocki* (Kuwana) ++.—Wolcott, 1948; Martorell, 1976. A questionable record.
- Pseudococcus elisae* Borchsenius **.—Records: Bayamon, *Bidens pilosa*, IV-36, Smith and Plank*; Isla Verde, *Mucuna* sp., 11-VII-77, C. E. Miller and SN; Mayaguez, *Lantana camara*, IV-53, N. L. H. Krauss*; Playa Aguila, *Melochia tomentosa*, 18-VII-77, SN; Playa Las Croabas, *Ipomoea pres-capre*, 16-VII-77, SN; Rio Piedras, *Ipomoea batatas*, 17-IV-48, Oakley and Mills*. Quarantine interceptions: At San Juan, *Punica granatum*, 3-XII-77, J. Thaw, *Sechium edule*, 25-VII-35, McCubbin et al.*; at New York, *Cajanus cajan*, 12-II-47, M. H. Sartor*, *Musa paradisiaca*, 29-IV-35, Fyke et al.*; at San Francisco, *Aglaonema* sp., 26-X-64, B. Davis*; at Washington, D.C., *Codiaeum* sp., 2-IV-67, H. F. Lowering*. Records marked * previously identified as *P. maritimus*.
- Pseudococcus longispinus* (Targioni-Tozzetti).—Martorell, 1976; *Pseudococcus adonidum* (Linnaeus): Wolcott, 1948; Martorell and Medina Gaud, 1974.
- Pseudococcus maritimus* (Ehrhorn) ++.—Wolcott, 1948; Martorell, 1976. This species apparently does not occur in Puerto Rico. Most of the previously identified material of *P. maritimus* are misidentifications of *P. elisae*.

- Puto barberi* (Cockerell).—Wolcott, 1948; *Ceroputo barberi* (Cockerell): Martorell, 1976.
- Rhizoecus americanus* (Hambleton).—Hambleton, 1976. Additional record: Unknown location, *Neoregelia carolinae*, 31-I-79, F. L. Ware.
- Saccharicoccus sacchari* (Cockerell).—Martorell, 1976; *Trionymus sacchari* (Cockerell): Wolcott, 1948.

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A NEW SPECIES OF *BOCHARTIA* OUDEMANS FROM TEXAS
(ACARI: ERYTHRAEIDAE: ERYTHRAEINAE)¹

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Abstract.—A new species, *Bochartia shirleyanneae* (Erythraeidae: Erythraeinae), was collected from southern Texas. This extends the distribution of the genus *Bochartia* Oudemans to include the United States.

Southcott (1961), in his studies on the systematics and biology of the Erythraeoidea, pointed out the relationship between Nearctic and Palaearctic Erythraeinae. Little comparison was possible at that time as no larval Erythraeinae had been described from either North or South America.

In a study of the microarthropod fauna of the Rob and Bessie Welder Wildlife Foundation in southern Texas, a single larval specimen representing the subfamily Erythraeinae was collected. This larva belongs to the genus *Bochartia* Oudemans following Southcott's (1961) definition of this genus.

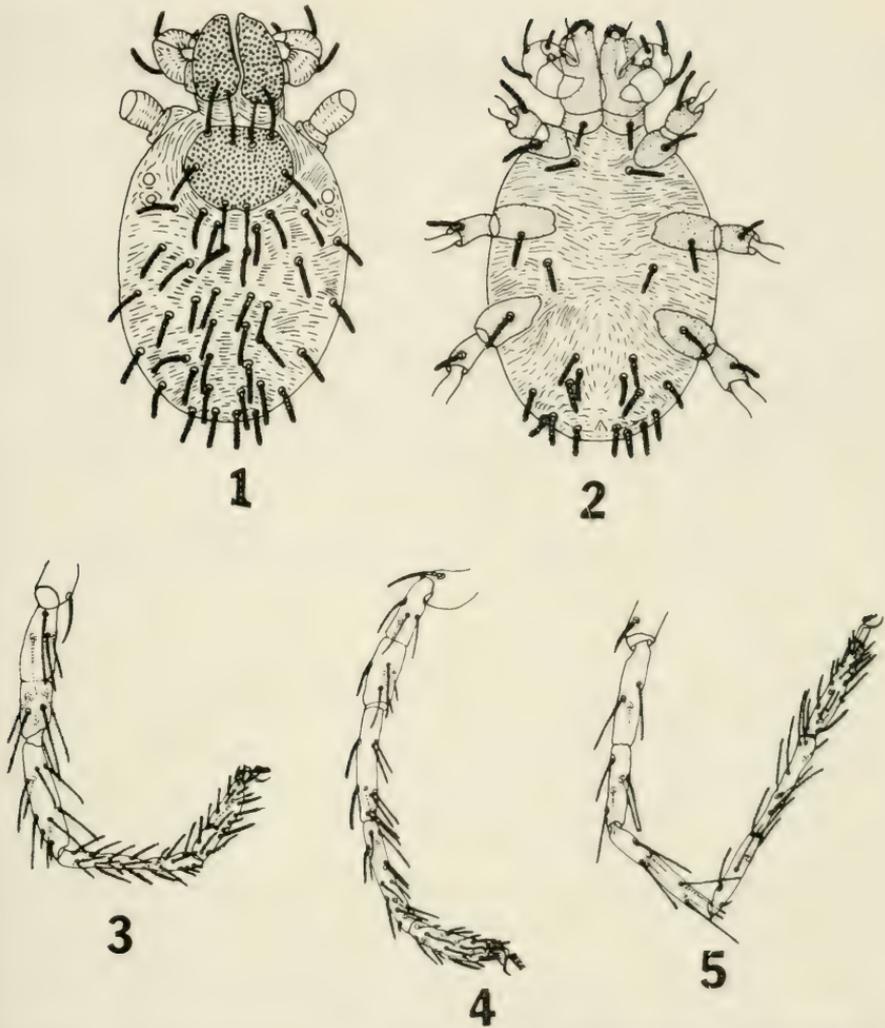
Bochartia was established by Oudemans (1910) for *B. kuyperi* Oudemans. Southcott (1961) utilized the following structures to separate *Bochartia* from *Forania* Southcott (1961) which contains the species *Forania mentonensis* (André): The presence of three pairs of scutalae in *Forania* against two in *Bochartia* and the coxal formula of 1, 3, 3 for *Forania* against 1, 1, 1 for *Bochartia*.

The larval specimen collected from southern Texas represents a new species and extends the distribution of the genus *Bochartia* to include the United States; to our knowledge the first record of an Erythraeinae larva from North America.

Bochartia shirleyanneae McDaniel and Bolen, NEW SPECIES
Figs. 1-5

Description.—Idiosoma globular, length to tip of mouthparts 420 μ , length of idiosoma 295 μ , width 225 μ (measured between legs 2 and 3). Dorsal

¹ South Dakota Agric. Exp. Stn. Jour. Ser. No. 1696.



Figs. 1-5. *Bochartia shirleyanneae*, holotype larva. 1, Dorsal view. 2, Ventral view. 3, First leg. 4, Second leg. 5, Third leg.

scutum punctate, oval, wider than long with posterior notch between posterior pair of sensillae, $94\ \mu$ long by $110\ \mu$ wide. Scutum with 2 pairs of scutalae: Anterior pair (AL) with bractate coarse daggerlike ciliation, $67\ \mu$ long, arising anteriorly to anterior sensillae, close to shield edge. Posterior scutalae (PL) similar to AL, also with bractate ciliations, $63\ \mu$ long, arising $17\ \mu$ from margin of scutal edge, anteriorly of posterior sensillae in middle of scutum. Anterior sensillae of scutum slender, tapering ciliated, $54\ \mu$ long; posterior sensillae similar to anterior sensillae in length and structure, $63\ \mu$ long, arising at posterior edge of scutum.

Eyes with 2 distinct lenses on each side, well separated, with idiosomal striations running between them; situated posterolateral to scutum. Anterior lens $15\ \mu$ wide, $20\ \mu$ long, posterior lens $13\ \mu$ wide, $11\ \mu$ long; lens separated by $11\ \mu$.

Dorsal idiosomalae arising in longitudinal rows with bractate ciliations, $37\text{--}55\ \mu$ long with a total number of 38. Dorsal body setae similar to scutalae on scutum in structure and size.

Ventral idiosomalae consist of 21 setae including a pair located at base of gnathosoma, a single pair between posterior margin of coxae I and another pair between coxae II and III. Behind coxae III are 15 setae, eight on right of small anal opening and seven on left of anus. All ventral setae resembling dorsal idiosomalae and of about same length.

Legs long, slender, typical for genus and subfamily. Coxal formula, 1, 1, 1, these similar in structure to ventral and dorsal idiosomalae. Tarsus I and II each with a single dorsal solenoidala; tarsal trichobothrium absent; tarsal claws 2; anterior claw a straight rod with a terminal ventrally directed hook, with a ventral brush of branching ciliations; middle empodium slender, sides ridged with ciliations. Posterior claw rodlike with ventral branching ciliations.

Gnathosoma punctate, with the movable chelicerae stout. Palpal tibial claw strong, with a dorsal accessory claw. Palpal tarsus with 1 solenoidala.

Holotype.—A single larval specimen collected on the Rob and Bessie Welder Wildlife Refuge, 10 miles north of Sinton, Texas, San Patricio County, February 2, 1978, by B. McDaniel and Eric G. Bolen. Slide mounted holotype will be deposited in the U.S. National Museum of Natural History, Washington, D.C. (USNM).

Remarks.—The only adults of the family Erythraeidae collected on the same date and site of *B. shirleyanneae* were members of the genus *Leptus* of the subfamily Leptinae. The possibility of *Bochartia* being a synonym of the genus *Erythraeus* Latreille (s.s.) is very real according to Southcott (1961); however, no attempt has been made to solve this situation as the collection of a single larval specimen without adults and without rearing data makes proof impossible at this time.

Habitat.—The holotype was collected within the transitional zone between the South Texas Plains and the Gulf Prairies and Marshes regionally known as the Coastal Bend (Thomas, 1975). The site supported a prairie community of bunchgrasses and annual forbs on deep Nueces and Falfurrias fine sands. Switchgrass (*Panicum virgatum*), seacoast bluestem (*Schizachyrium scoparium*), Pan American balsamscale (*Elyonurus tripsacoides*), big bluestem (*Andropogon gerardi*) and other tall and mid-grasses mixed with doveweed (*Croton* spp.), skunk daisy (*Ximenesia encelioides*), and wild buckwheat (*Eriogonum multiflorum*) characterize the vegetation. Overall, the vegetational composition approximates 75% grasses and 19% forbs with

the balance consisting of woody or succulent species. The community resembles the tallgrass prairie of the Nebraska Sandhills although it contains a greater percentage of tropical or subtropical vegetation (Drawe et al., 1978).

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THREE NEW ORIENTAL SPECIES OF *JENKINSHELEA* MACFIE
(DIPTERA: CERATOPOGONIDAE)

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Abstract.—Three new species of the predaceous midge genus *Jenkinshelea* Macfie are described and illustrated. One species, *J. niphanae* from Southeast Asia, is a typical member of the genus, whereas the other two species, *J. tokunagai* from Thailand and *J. setosiforceps* from Malaysia, are unusual in possessing wings with only a single radial cell. A key is given for the taxonomic separation of the five Oriental species of the genus.

This review of the Oriental species of the predaceous midge genus *Jenkinshelea* Macfie is prompted by receipt of a large collection of midges from Keizo Yasumatsu that he took in rice paddies in Thailand as a part of his studies on the ecology of insects harmful to rice in that country. Although predaceous midges are not of primary importance in biological control of rice pests, their habits as predators of small chironomid midges and possibly cecidomyiids and other small Diptera may give them some small place in rice paddy economics. A report on the major portion of Yasumatsu's collection will be published elsewhere as studies progress.

Jenkinshelea is a rather small genus with ten described species from the Nearctic, Oriental, Afrotropical, and Australasian regions. A review of the generic characters and systematics of the Nearctic species was given by Grogan and Wirth (1977), in which an explanation of our terminology may be found. In the Oriental and Australasian regions only two species have previously been described: *J. setosipennis* (Kieffer) (1913) from India, and *J. papuae* Tokunaga (1966) from New Guinea. We are taking this opportunity to describe three additional species from Southeast Asia. The types are deposited in the U.S. National Museum of Natural History, Washington, D.C. (USNM); paratypes, as available, will be deposited in the B. P. Bishop Museum, Honolulu, Hawaii, the British Museum (Natural History), London, and the Thailand Institute of Scientific and Technological Research, Bangkok.

Genus *Jenkinshelea* Macfie

Jenkinsia Kieffer, 1913: 161. Type-species, *Jenkinsia setosipennis* Kieffer (original designation). Preoccupied by *Jenkinsia* Jordan and Evermann, 1896.

Jenkinshelea Macfie, 1934: 177 (new name for *Jenkinsia* Kieffer). Type-species, *Jenkinsia setosipennis* Kieffer (automatic).

Diagnosis.—A genus of large, usually grayish pollinose Sphaeromiine predaceous midges. Anal angle of female wing greatly expanded; wing with 1 or 2 radial cells, female with distal cell greatly elongated with costa nearly reaching wing tip; in male radial cell extending to 0.75 of wing length. Legs slender, femora unarmed; 4th tarsomere cordiform; 5th tarsomere of female with stout ventral batonnets, inflated on foreleg; female claws of all legs rather short, equal, each with a small blunt external basal tooth.

KEY TO THE ORIENTAL AND NEW GUINEA SPECIES OF *JENKINSHELEA*

1. Wing with 2 radial cells 2
- Wing with 1 radial cell 3
2. Legs yellow; hindbasitarsus short, tarsal ratio about 2.2; 5th tarsomere of female with 1 batonnet on foreleg, 4 on midleg, and 6–8 on hindleg; wing hyaline, crossvein r-m darkened; antenna with bases of flagellomeres pale *setosipennis* (Kieffer)
- Legs yellow, narrow tip of hindtibia and all of tarsomeres 3–5 dark brown; hindbasitarsus elongate, tarsal ratio 3.5; 5th tarsomeres of female each with 4–8 batonnets; antenna uniformly dark brown *niphanae*, new species
3. Thorax and legs dark brown, proximal tarsomeres (and in *papuae* bases of fore- and midfemora) paler 4
- Thorax of female golden brown; legs yellow, only narrow apex of hindtibia and all of tarsomeres 3–5 dark brown; hindtarsal ratio of female 2.3 *tokunagai*, new species
4. Female only; bases of fore- and midfemora pale brown; hindtarsal ratio 2.9 (New Guinea) *papuae* Tokunaga
- Male only; femora and tibiae uniformly dark brown (Malaysia) *setosiforceps*, new species

Jenkinshelea niphanae Grogan and Wirth, NEW SPECIES

Fig. 1 a–f

Diagnosis.—A medium sized species of *Jenkinshelea* distinguished by the following combination of characters: Females with 1 large ovoid spermatheca; wing hyaline with 2 radial cells, anterior veins light brown, posterior veins pale; flagellum dark brown; 5th tarsomeres bearing 4–8 batonnets; legs yellow.

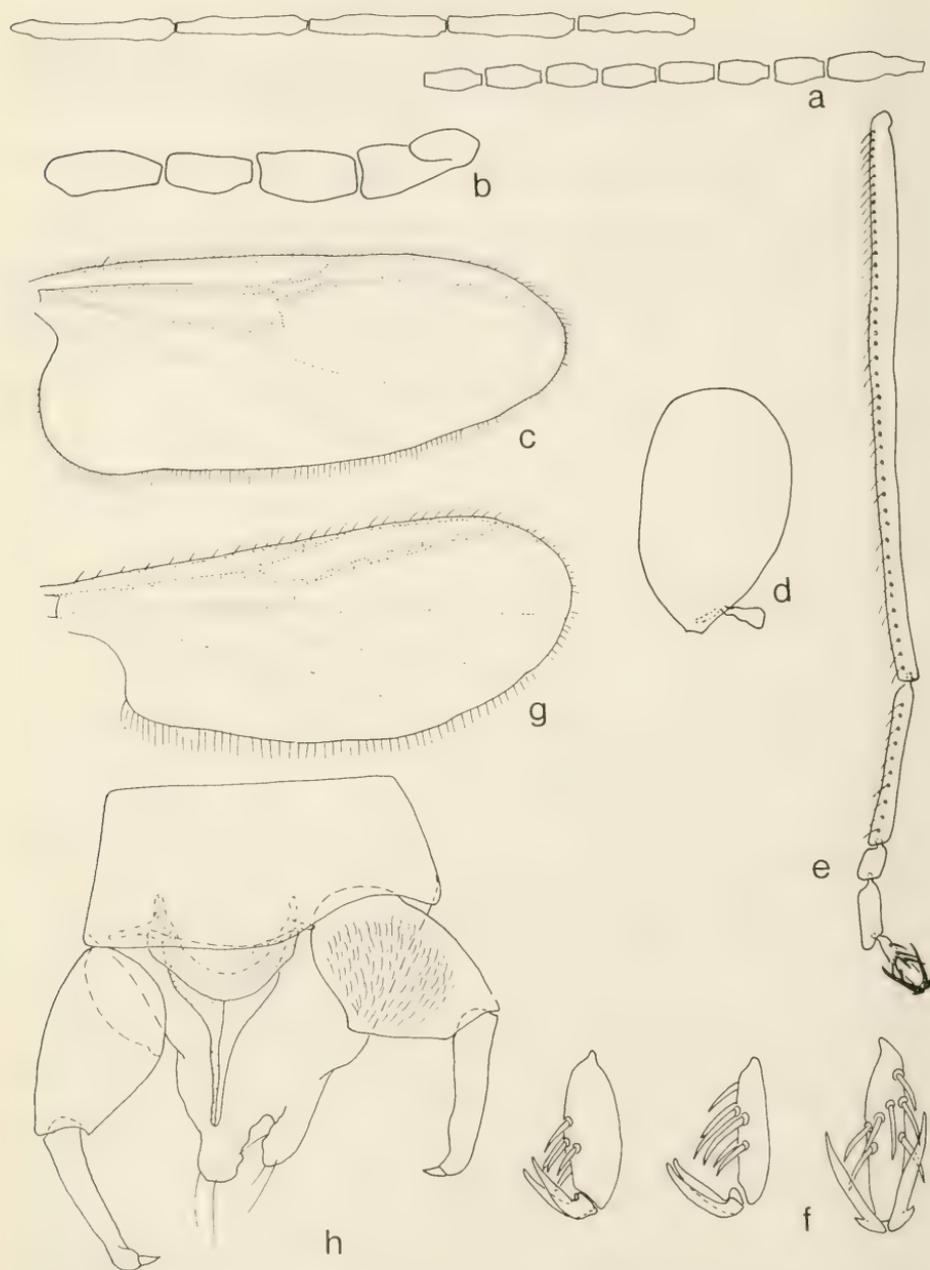


Fig. 1. *Jenkinshalea niphae*, female, a-f; *J. setosiforceps*, male, g-h. a, Antenna. b, Palpus. c, g, Wing. d, Spermatheca. e, Hindtarsus. f, Fifth tarsomeres and claws of (left to right) fore-, mid-, and hindlegs. h, Male genitalia.

Holotype female.—Wing length, 2.32 mm; breadth, 1.00 mm.

Head: Eyes bare, broadly separated (a distance of 0.05 mm). Vertex and frons dark reddish brown; clypeus and proboscis dark golden brown. Antennal pedicel reddish brown; flagellum (Fig. 1a) dark brown; proximal 8 flagellomeres subovoid, distal 5 flagellomeres more slender and elongated; flagellomeres with lengths in proportion of 20-12-11-12-12-12-14-14-28-32-33-33-45; antennal ratio 1.60. Palpus (Fig. 1b) light brown, 5th segment darker brown; lengths of segments in proportion of 7-9-10-9-13; 3rd segment with ventromesal patch of long slender capitate sensilla; palpal ratio 1.82. Mandible with 7 large coarse teeth.

Thorax: Light reddish brown. Mesonotum without anterior spine or pits; covered with fine pubescence and short sparse setae; scutellum with 4 bristles. Legs slender, yellow, unarmed; foretibia with dense apical patch of setae and dense comb with about 20 setae; midtibia with a single dark apical spine; hindtibia with heavy apical patch of setae and dense comb with 5 large setae and about 25 smaller setae; proximal 2 tarsomeres light yellow, distal 3 tarsomeres brown; basitarsus of midleg with 4-5 spines plus pair of apical spines; basitarsus of hindleg elongate, tarsal ratio 3.5; 1st and 2nd tarsomeres of hindleg (Fig. 1e) with dense palisade setae; 4th tarsomeres cordate, those of hindleg elongated (Fig. 1e); 5th tarsomeres (Fig. 1f) each with 4-8 ventral batonnets; claws equal with external basal tooth, hindclaws longer than fore- and midclaws. Wing (Fig. 1c) hyaline with broad anal angle and 2 radial cells as is typical for the genus; anterior veins light brown, posterior veins pale; costa extending to wing tip. Halter stem pale; knob white.

Abdomen: Reddish brown. One large ovoid spermatheca (Fig. 1d) measuring 0.150 mm by 0.090 mm, plus a small vestigial spermatheca.

Male.—Unknown.

Distribution.—China, Malaysia, Philippines, Thailand.

Types.—Holotype ♀, one ♀ paratype, Chiang Mai, Thailand, April-May 1958, V. Notonanda, light trap (type no. 76115, USNM). Other paratypes, 5 ♀ as follows: CHINA: Hainan Island, Ta Hian, 12 June 1935, 1 ♀. MALAYSIA: Sabah (N. Borneo), Tawau Residency, Kalabakan River, 30 mi W. of Tawau, 9-18 Nov. 1958, T. C. Maa, 1 ♀ (Bishop Museum). PHILIPPINES: Luzon, Pampanga Prov., Angeles, Clark Air Base, 15-22 Nov. 1957, I. Balatbat, light trap, 2 ♀. THAILAND: Chiang Mai, Amphoe Ban Pa Tong, Ban Thung Sieo, 19 Feb. 1979, K. Yasumatsu, in rice paddy, 1 ♀.

Discussion.—This species is named for Niphan Chanthawanich Ratana-worabhan of the Thailand Institute of Scientific and Technological Research, Bangkok, Thailand, in recognition of her numerous contributions to the study of ceratopogonid midges.

Jenkinshalea niphanae is distinguished from others in the genus by its single large functional spermatheca.

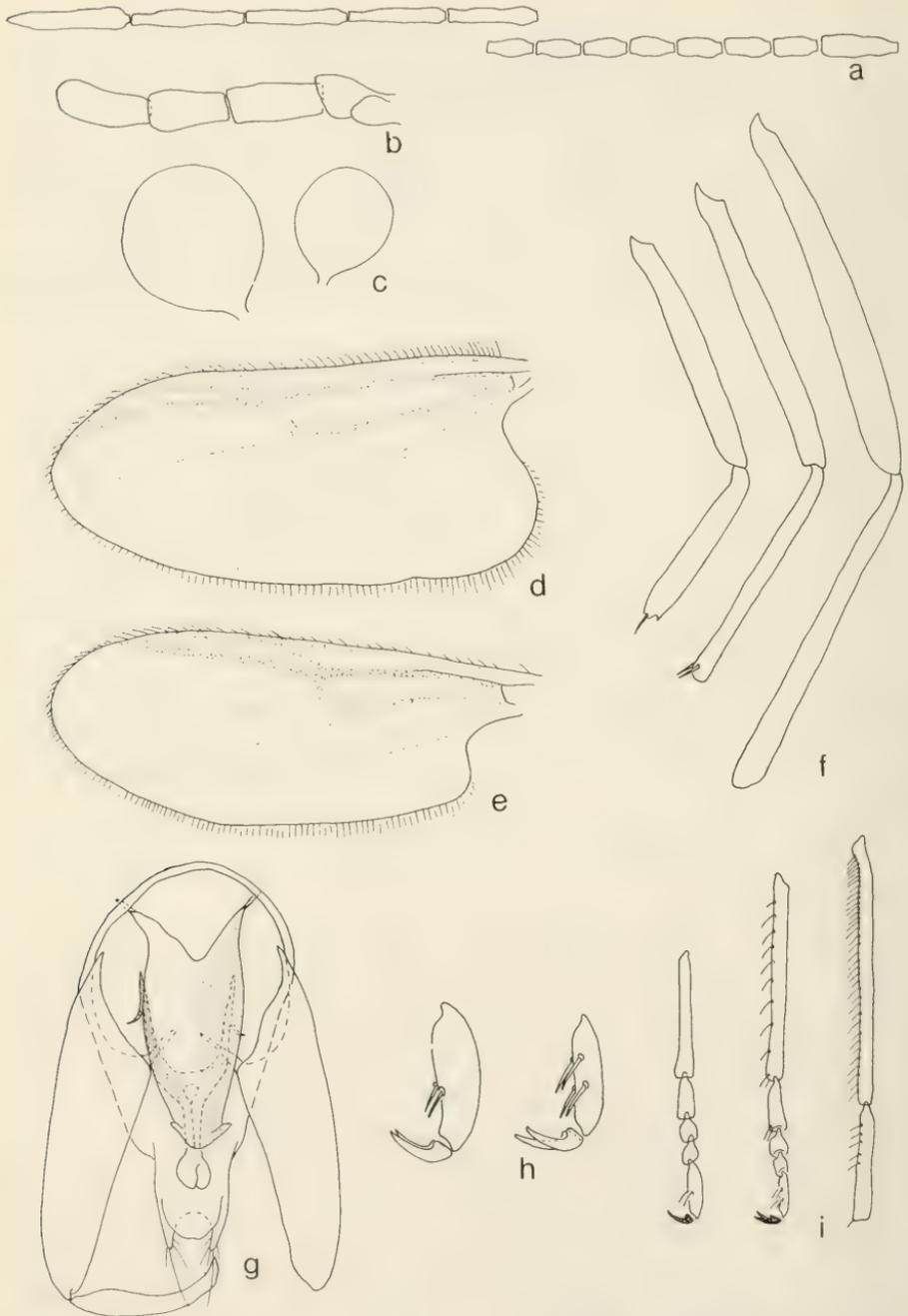


Fig. 2. *Jenkinshlea tokunagai*, female, a-d, f, h-i; male, e, g. a, Antenna. b, Palpus. c, Spermathecae. d-e, Wing. f, Femora and tibiae of (left to right) fore-, mid-, and hindlegs. g, Genitalia. h, Fifth tarsomeres and claws of foreleg (left) and midleg (right). i, Tarsi of (left to right) fore-, mid-, and hindlegs.

Jenkinshalea tokunagai Grogan and Wirth, NEW SPECIES
Fig. 2a-i

Diagnosis.—A small species of *Jenkinshalea* distinguished from other Oriental members of the genus except *J. setosiforceps* by the following combination of characters: Wing of both sexes with only a single radial cell; legs yellowish, only tarsomeres 3-5 and apex of hindtibia dark brown; males differ from those of *J. setosiforceps* in having a long slender aedeagus with long tapering basal arms.

Holotype female.—Wing length, 1.96 mm; breadth, 0.93 mm.

Head: Eyes bare, broadly separated (a distance of 0.07 mm). Vertex and frons dark golden brown; clypeus and proboscis lighter in color. Antennal pedicel reddish brown; flagellum (Fig. 2a) dark brown; proximal 8 flagellomeres subovoid, lighter brown on extreme basal portions, distal 5 flagellomeres more slender and elongated; flagellomeres with lengths in proportion of 21-13-13-12-13-12-13-13-25-27-27-31-34; antennal ratio 1.31. Palpus (Fig. 2b) light brown, 5th segment slightly darker; lengths of segments in proportion of 6-8-10-9-11; 3rd segment with 2 subapical ventromesal capitate sensilla; palpal ratio 2.2. Mandible with 7 large coarse teeth.

Thorax: Golden brown. Mesonotum without anterior spine or pits; covered with rather coarse pubescence and a few short setae; scutellum with 6 bristles. Legs (Fig. 2f) yellow, slender, unarmed; foretibia with dense apical patch of setae and dense comb; midtibia with 2 subapical spines; hindbitia with a moderately dense apical patch of setae and dense comb with 5 large setae and about 30 smaller setae; proximal 2 tarsomeres yellow, distal 3 tarsomeres of fore- and midlegs brown, distal 3 tarsomeres of hindleg lost; basitarsus of midleg (Fig. 2i) with 9 spines plus a pair of heavy apical spines; 1st and 2nd tarsomeres of hindleg (Fig. 2i) with dense palisade setae; tarsal ratio of hindleg 2.3; 4th tarsomeres of fore- and midlegs and presumably of hindleg cordate; 5th tarsomeres (Fig. 2h) of foreleg with only 1 pair of batonnets, of midleg with 4 batonnets; claws equal with basal external tooth. Wing (Fig. 2d) hyaline with broad anal angle but with only a single long radial cell which is quite atypical for the genus; anterior and posterior veins pale; costa extending to 0.98 of distance to wing tip. Halter pale brown.

Abdomen: Light golden brown. Two well-developed spermathecae (Fig. 2c) that are ovoid and unequal, the larger measuring 0.070 by 0.050 mm.

Allotype male.—Wing length, 1.07 mm; breadth, 0.62 mm. Smaller than holotype female, with generally similar coloring and features and with the usual sexual differences as follows:

Flagellum with sparse brown plume. Thorax darker brown. Fifth tarsomeres without batonnets; claws small and equal with bifid tips. Wing (Fig. 2e) with narrower anal angle; costa extending 0.83 of wing length.

Genitalia as in Fig. 2g. Ninth sternum very short with greatly curved base:

9th tergum tapering gradually distally, then becoming constricted at the base of the cerci that are long and slender and extend almost to tip of basimere. Basimere nearly straight, about $4\times$ longer than broad; telomere slightly less than $\frac{1}{2}$ length of basimere, curved and tapering slightly distally to broad, curved, pointed tip. Aedeagus heavily sclerotized, $1.5\times$ longer than broad, basal arch $\frac{1}{4}$ of total length; basal arms long and slender with pointed tips; distal portion narrowing then expanding to a hastate tip. Claspettes fused; basal arm heavily sclerotized and recurved 180° ; distal portion divided with short blunt tips bent ventrad and more lightly sclerotized than remainder.

Distribution.—Thailand.

Types.—Holotype ♀, allotype ♂, Chiang Mai, Thailand, April–May 1958, V. Notananda, light trap (type no. 76116, USNM). Paratypes, 12 ♂, Thailand, Chiang Mai, Amphoe San Pa Tong, Ban Thung Sieo, 19 Feb. 1979, K. Yasumatsu, in rice paddy.

Discussion.—This species is named for Masaaki Tokunaga in recognition of his many contributions to our knowledge of the ceratopogonid midges of the Orient and Pacific.

Jenkinshalea papuae Tokunaga, known only from a female from New Guinea, also has the wing with one radial cell and has two large functional spermathecae, but the New Guinea species has dark brown femora and tibiae and the hindtarsal ratio is 2.9. *Jenkinshalea setosiforceps*, known only from the male from Malaysia, has one radial cell, but is a dark brown species with dark brown femora and tibiae, and the male genitalia are unusually short and broad, with densely setose basistyle and transversely arcuate aedeagus.

Jenkinshalea setosiforceps Grogan and Wirth, NEW SPECIES

Fig. 1 g–h

Diagnosis.—A small species of *Jenkinshalea* distinguished from all other members of the genus except *J. tokunagai* by the following combination of characters: Wing with only a single radial cell; males differ from those of *J. tokunagai* by their genitalia with dense setae on the mesal surface of the basimere and their short, half-moon shaped aedeagus.

Female.—Unknown.

Holotype male.—Wing length, 1.02 mm; breadth, 0.43 mm.

Head: Eyes bare, broadly separated (a distance of 0.07 mm). Entire head including palpus brown. Antennal pedicel dark brown; flagellum light brown; plume dark brown, sparse. Palpus shriveled, segments not measurable.

Thorax: Medium brown. Mesonotum without anterior spine or pits, covered with rather long pubescence and a few larger setae; scutellum with 4 bristles. Legs brown; 4th tarsomeres cordate; 5th tarsomeres without ventral batonnets; claws small, simple, equal sized. Wing (Fig. 1g) hyaline with

moderately narrow angle but only a single long radial cell; anterior veins light brown, posterior veins pale; costa extending to 0.95 of wing length. Halter brown.

Abdomen: Brown. Genitalia as in Fig. 1h. Ninth sternum about twice as broad as long with straight base; 9th tergum tapering rather abruptly before becoming constricted at the cerci which extend beyond basimeres. Basimere straight, about $1.5\times$ longer than broad, mesal surface with dense strong setae; telomere nearly the length of basimere, nearly straight, tapering only slightly distally, tip curved and pointed. Aedeagus heavily sclerotized and reduced, half-moon shaped without basal arms or distal extensions. Claspettes fused; basal arm heavily sclerotized with subbasal lateral extensions; distal portion divided with long slender tips.

Distribution.—Malaysia.

Type.—Holotype ♂, Malaysia, Kuala Kengrong, Girik, Perak, 14 April 1958, R. Traub, light trap (type no. 76117, USNM).

Discussion.—The male genitalia of this species are quite unusual for the genus in being short and squat and having dense coarse setae on the mesal surface of the basimeres, from which the species derives its name.

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TWO NEW SPECIES OF *ACANTHOSCELIDES* (COLEOPTERA:
BRUCHIDAE) ASSOCIATED WITH *PHASEOLUS* (LEGUMINOSAE)
FROM ARGENTINA, WITH THE DESCRIPTION OF A NEW
SPECIES-GROUP, AND A NEW SYNONYM

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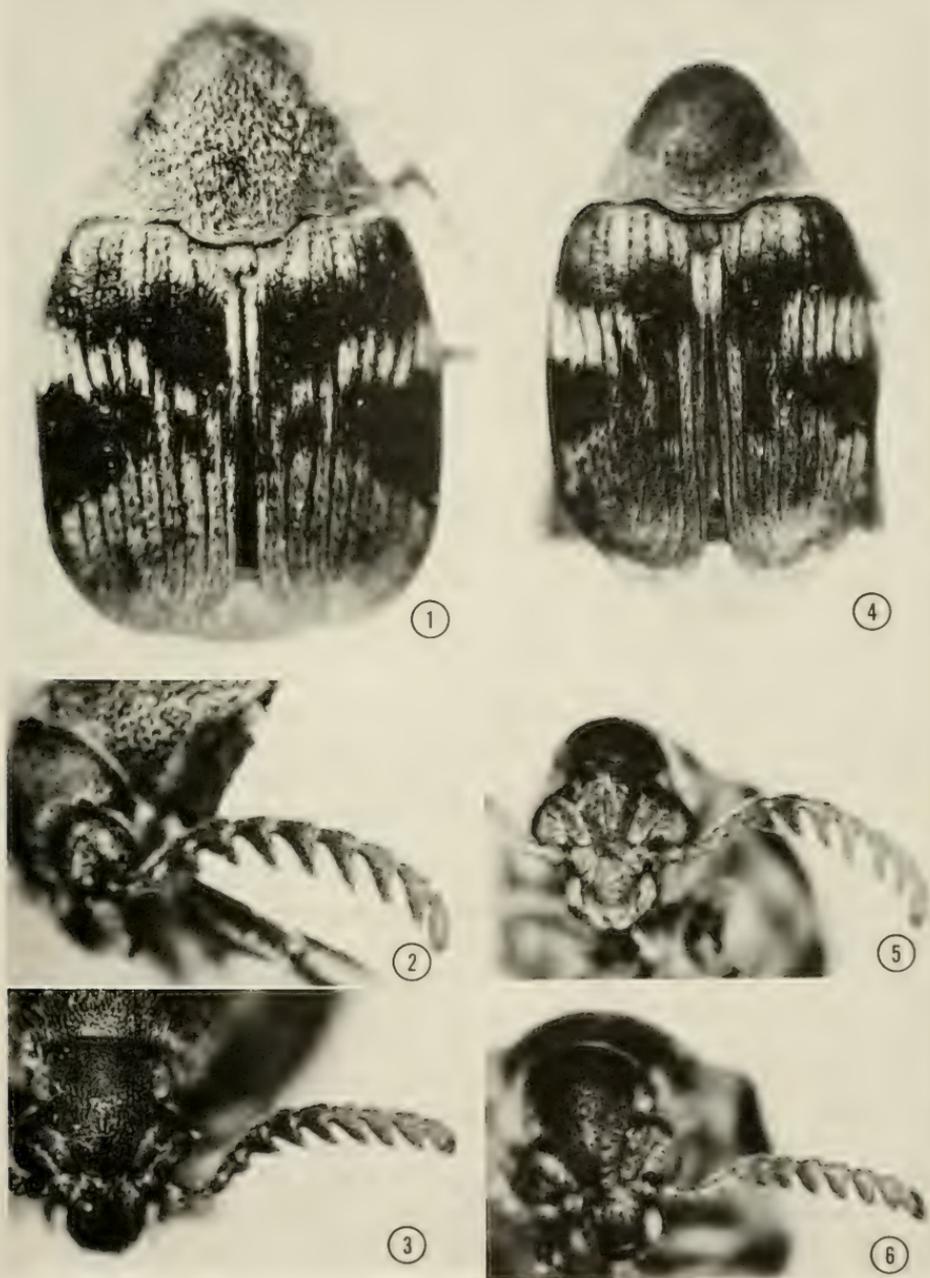
Abstract.—Two new species, *Acanthoscelides comptus* and *A. caracallae* are described and critical characters of external morphology and of male genitalia are illustrated. Since these species are associated with *Phaseolus*, the genus to which many of the common bean varieties belong, they are of potential importance to bean growers. A new species-group, the *suaveolus* group, is characterized, a key to the species now included in the group is provided, and a new synonym *Acanthoscelides clandestinus* (Motschulsky, 1874) (= *Bruchus multisignatus* Sharp, 1885) is proposed.

Arturo L. Terán and Susana Muruaga de L'Argentier, Fundación Miguel Lillo, Tucumán, Argentina, have recorded biological data for two new species of Bruchidae from the Tucumán area. To provide names for these species, the following descriptions are provided. Because both species attack seeds of species of *Phaseolus*, they are of potential importance to commercial bean crops.

Acanthoscelides comptus Kingsolver, NEW SPECIES
Figs. 4-6, 11-13

Measurements.—Body length, 2.3-2.7 mm, width, 1.9-2.1 mm; pronotal length, 0.9-1.0 mm, width, 1.1-1.2 mm.

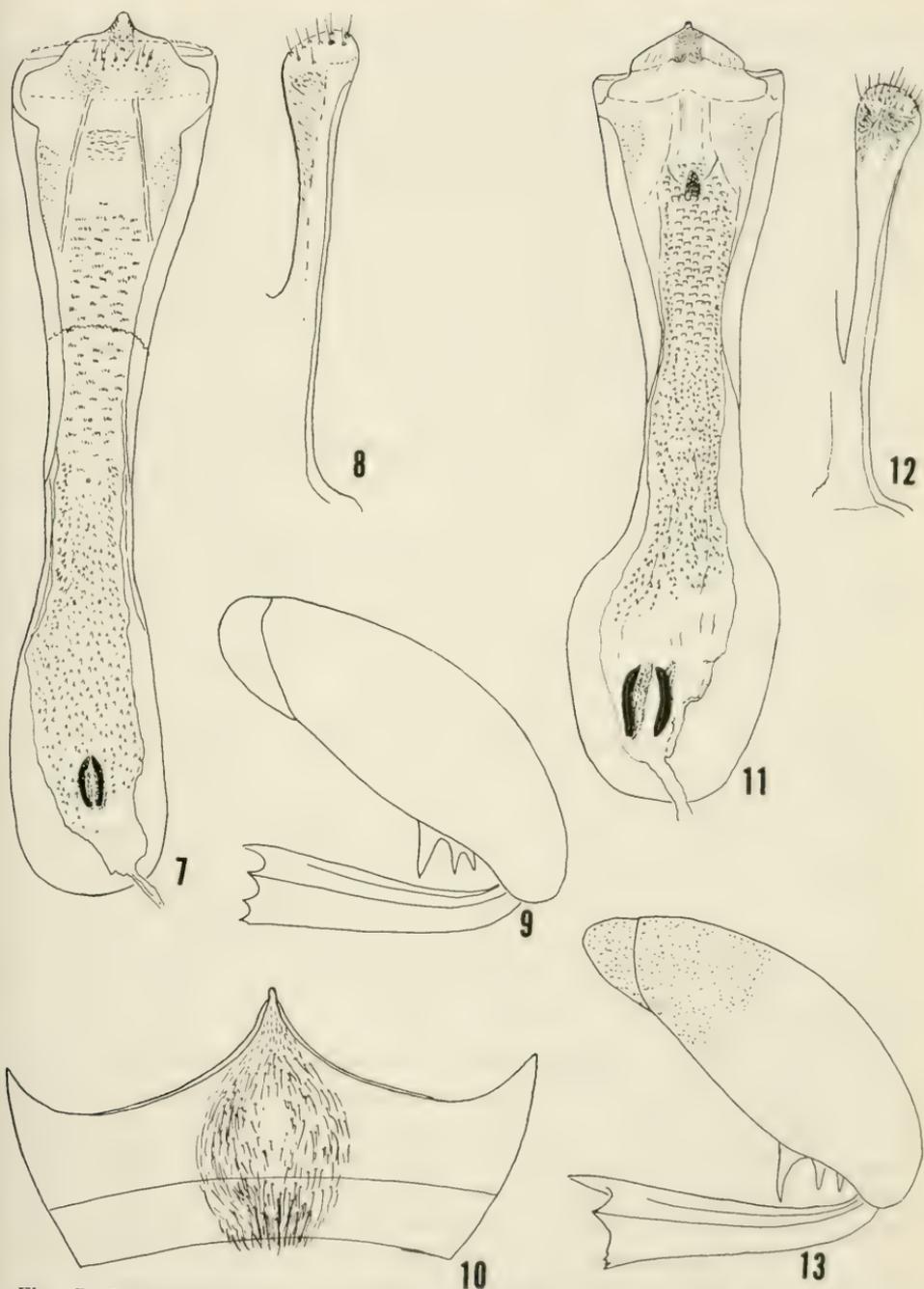
Color.—Integument black except pro- and mesolegs, distal $\frac{3}{4}$ of metafe-mur, metatibia, metatarsus, and at least proximal 4 segments and sometimes entire antenna dark red to reddish yellow, head behind eye usually with a reddish spot. Vestiture of silvery-gray, white, and dark brown slender hairs in pattern as in Fig. 4; with median, subcircular pronotal spot of dark brown hairs and with flanks of pronotum and transverse basal band gray; elytra with basal, elongate spots on intervals 2, 3, 4, and 5, elongate postscutellar



Figs. 1-3. *Acanthoscelides caracallae*. 1. Habitus, dorsal aspect. 2. ♂ antenna. 3. ♀ antenna. Figs. 4-6. *A. comptus*. 4. Habitus, dorsal aspect. 5. ♂ antenna. 6. ♀ antenna.

spot, posthumeral band, and scutellum white; apical $\frac{2}{5}$ of elytra and pygidium gray; body beneath evenly clothed with gray hairs except for white spot on posterior end of metepisternum and distal end of metacoxa.

Structure.—Body ovate (Fig. 4), widest at posthumeral band of elytra. Head subtriangular, eyes strongly protuberant laterally, interocular distance narrower in δ than in η ; ocular sinus about $\frac{1}{2}$ length of eye; postocular fringe narrow, sparse; supraocular sulcus not well defined, marked by row of umbilicate, setiferous punctures; vertex finely, densely punctate, intervals finely granulose, frons less densely punctate, intervals granulose, frontal carina fine, distinct; clypeus punctation as on frons, intervals granulose, labrum bare, polished; antenna of δ strongly serrate from 3rd segment (Fig. 5), segments 6–10 wider than long, 11 elongate-elliptical, in length reaching metacoxa, in η serrate from 4th segment (Fig. 6), segments 5–10 wider than long, 11 elongate-elliptical, reaching middle of metepisternum. Pronotum campaniform, lateral margins perceptibly arcuate, basal margin bisinuate, disk strongly convex with shallow depression near each posterior angle; surface finely, densely, somewhat irregularly punctate, punctures nearly concealed by vestiture; lateral carina distinct anteriorly joining cervical sulcus dorsad of procoxal cavity; cervical boss bisetiferous; prosternum T-shaped, short before coxae, apex acute, procoxae connate. Scutellum subquadrate, emarginate and bidentate apically. Elytra together slightly longer than wide (Fig. 4), lateral margins subparallel in middle $\frac{1}{3}$, evenly convex except 2nd and 3rd intervals slightly depressed behind scutellum, sutural interval prominent behind scutellum; striae regular in course, 1st stria arising behind scutellum, 2–6 arising basally, without basal denticles, all striae ending free apically except 5th and 6th usually conjoined; strial punctures deep, set in ovate or obovate foveolae in basal $\frac{1}{3}$, each puncture setiferous; 3rd, 5th, 7th, and 9th intervals perceptibly wider than 2nd, 4th, 6th, and 8th; intervals imbricate, not punctate; mesosternum lingulate; post-mesocoxal sulci meeting medially at acute angle, slightly expanded behind coxae; metasternum finely punctate, metepisternum sparsely foveolate. Abdomen with 1st sternum slightly longer than remaining sterna together in η , $2\times$ as long as remaining sterna in δ , sterna strongly telescoped in δ , 5th sternum broadly emarginate in both sexes; pygidium subtriangular, lateral margins arcuate, disk moderately convex, surface finely, shallowly foveolate, foveolae generally discrete and separated by a diameter. Male genitalia with median lobe about $4\times$ as long as wide (Fig. 11), apex and cucullus expanded, middle of lobe narrowed, ventral valve short, broad, subtriangular, lateral margin shallowly emarginate near base, internal sac lined with fine, truncated denticles in basal $\frac{1}{2}$, denticles more acute in apical $\frac{1}{2}$, a pair of short, boat-shaped sclerites near apex of sac surrounding a mass of fine spicules; lateral lobes long (Fig. 12), slender, spatulate apically, separated by deep cleft. Pro- and mesolegs not modified; metacoxal face reniform,



Figs. 7-10. *Acanthoscelides comptus*. 7, ♂ genitalia, median lobe. 8, ♂ genitalia, right lateral lobe, ventral aspect. 9, Metaleg. 10, 1st and 2nd abdominal sterna of ♂. Figs. 11-13. *A. comptus*. 11, ♀ genitalia, median lobe. 12, ♀ genitalia, right lateral lobe, ventral aspect. 13, Metaleg.

densely punctulate except for narrow, bare strip near anterior margin; meta-femur (Fig. 13) not strongly incrassate, dorsal margin moderately arcuate, ventral margin nearly straight except for slight sinuation near apex; pecten with 1 long, slender denticle followed by 2 minute denticles, these often separated from long denticle by broad gap; metatibia (Fig. 13) slightly arcuate basally, slightly broadened apically, lateral, lateroventral, ventral, and dorsomedial carinae distinct and complete; mucro short, about $\frac{1}{2}$ as long as width of tibial apex, lateral denticle short, acute; corona with 3 denticles.

Types.—Holotype ♂, Argentina. Tucumán, Ticucho, V-1977, A. L. Terán coll., ex. *Phaseolus* aff. *peduncularis* H.B.K. Allotype ♀ and 75 paratypes, same data. Holotype and paratypes deposited in the collection of the Fundación Miguel Lillo, Tucumán, Argentina. Allotype and paratypes deposited in the U.S. National Museum of Natural History, Washington, D.C. Paratypes also deposited in the C. D. Johnson Collection, Flagstaff, Arizona.

Remarks.—The specific name is taken from the Latin adjective *comp-tus*—ornamented, adorned.

The principal distinguishing characters of the species are pro- and mesolegs yellowish red; metalegs partly red; dark pronotal disk with basal gray band; apices of elytra gray; and first abdominal segment not modified.

Acanthoscelides caracallae Kingsolver, NEW SPECIES

Figs. 1-3, 7-10

Measurements.—Body length, 2.5-2.9 mm, width, 1.7-1.8 mm; pronotal length, 0.7-0.8 mm, width, 1.2-1.3 mm.

Color.—Integument black throughout except 1st and 2nd antennal segments occasionally brownish red; pro- and mesolegs occasionally piceous or faintly dark red; lateral spot behind eye red. Vestiture composed of slender, silvery-gray and dark brown hairs arranged in pattern shown in Fig. 1: posthumeral band and elongate postscutellar stripe more densely clothed so as to appear pure white; body beneath evenly clothed with silvery-gray hair except pure white spot on posterior portion of metepisternum extending onto metacoxal face.

Structure.—Body ovate (Fig. 1), widest immediately behind humeri. Head subtriangular, eyes strongly convex and protuberant laterally; ocular sinus deep, about $\frac{3}{4}$ length of eye; supraocular sulcus narrow, deep, bottom closely set with setiferous, umbilicate punctures; postocular fringe narrow; frons convex, frontal carina distinct; frons and vertex densely foveolate, each foveola umbilicate and setose, intervals narrow, ridgelike, those on frons tending to be longitudinally imbricate; clypeus with foveolae irregular, somewhat larger than those on frons; labrum bare, polished; antenna of ♂ strongly serrate (Fig. 2), extending to 1st abdominal segment, moderately serrate in ♀ (Fig. 3) but reaching only to humerus. Pronotum campaniform, lateral margins slightly arcuate, basal margin bisinuate, apical margin strong-

ly arcuate; disk strongly convex with slight depression opposite base of each 3rd elytral interval and on basal lobe; surface densely, evenly microfoveolate, intervals micropunctate; in lateral aspect, dorsal profile strongly convex, lateral carina traceable as an arcuate, obtuse ridge from posterolateral angle $\frac{1}{2}$ distance to anterior margin then as a fine sulcus connected to ventral end of cervical sulcus; cervical boss bisetiferous; pleural region concave; prosternum T-shaped, short before coxae, apex acute, not separating apices of procoxae. Scutellum quadrate, slightly longer than wide, apex emarginate, bidentate. Elytra together as long as wide (Fig. 1), widest at basal $\frac{1}{3}$, lateral margins subparallel, apices evenly rounded, disk subdepressed medially between 6th striae; striae regular in course, stria 1 arising behind scutellar depression, 2 from a small basal puncture, 3, 4, 5, and 6 subbasal in origin, lacking basal denticles, all striae free apically; striae shallow, distinct, composed of confluent rectangular or polygonal foveolae each bearing a fine seta at its anterior border; intervals finely imbricate and densely setose; mesosternum triangular, truncate apically and with a tuft of short hairs; postmesocoxal sulci meeting medially at right angle, laterally arcuate parallel to coxal cavity margin; metepisternum sparsely foveolate; metasternum finely punctate. Abdomen with 1st sternum $1.5\times$ as long as remaining sterna together, δ with 1st sternum depressed medially (Fig. 10), depression finely but distinctly punctate, posterior margin of depression with fringe of long setae, 2nd and 3rd sterna also with some long setae, 5th sternum broadly emarginate to receive apex of reflexed pygidial apex; ♀ with 1st sternum not modified, 5th sternum less deeply emarginate than in δ , δ pygidium subtriangular, lateral margins arcuate, apex slightly more narrowed in ♀ , disk in both sexes microfoveolate, evenly convex. Male genitalia with median lobe (Fig. 7) about $4\times$ as long as wide, expanded apically; ventral valve short, broad, lateral margins strongly arcuate; internal sac without armature in basal $\frac{1}{2}$ but with short transverse rows of minute setae, apical $\frac{1}{2}$ with fine, acute denticles and spicules, apex with pair of boat-shaped sclerites fringed with fine spicules; lateral lobes (Fig. 8) long, expanded apically, separated by cleft about $\frac{1}{2}$ their length. Pro- and mesolegs not modified; metacoxal face reniform, concave medially, densely, irregularly punctulate; metafemur (Fig. 9) with dorsal profile evenly arcuate, ventral profile sinuate; pecten with 1 long and 1 or 2 shorter denticles; metatibia (Fig. 9) arcuate basally, slightly expanded and distinctly sinuate in apical $\frac{1}{2}$; lateral, ventral, and dorsomedial carinae distinct and complete, lateroventral carina obsolete in apical $\frac{1}{4}$; mucro short, acute, scarcely longer than lateral denticle, subequal in length to coronal denticles.

Types.—Holotype δ , Argentina, Tucumán, Dpt. Trancas, San Pedro de Colalao, 21-IX-1952, A. L. Terán coll., ex semillas de *Phaseolus caracalla*. Allotype ♀ and 53 paratypes, same data. Other paratypes, ARGENTINA: same data as type except IX-1953 (16); same data as type except IV-1953

(10); same data as type except IX-1960 (4); same data as type except 26-V-1964 (emerged 11-XI-1964 to 18-XI-1964), plant no. 24 (7); same data as type except 3-III-1965, plant no. 41 (2). PARAGUAY: Intercepted USDA APHIS, Los Angeles, 13-V-1980, *Vigna* sp. seed (2).

Holotype and paratypes are deposited in the collection of the Fundación Miguel Lillo, Tucumán, Argentina. Allotype and paratypes deposited in the U.S. National Museum of Natural History, Washington, D.C. Paratypes deposited also in the C. D. Johnson collection, Flagstaff, Arizona.

Remarks.—The specific name is taken from that of the host plant, *Phaseolus caracalla* L.

This species is distinctive in this group by its nearly uniformly black coloration, and by the modified first abdominal segment of the male.

Discussion

These two species belong to a group of species of *Acanthoscelides* that includes also *A. suaveolus* (Sharp, 1885) described from Nicaragua and Panama, *A. clandestinus* (Motschulsky, 1874) (= *Bruchus multisignatus* Sharp, 1885, NEW SYNONYMY), and several undescribed species in Central and South America. Characteristics of this group that I am designating the *suaveolus* group are the contrasting pattern of white or gray transverse bars on a black or piceous background on the elytra, and an elongate postscutellar white mark. Male genitalia are not strongly differentiated in the species studied, but color patterns on pronotum, elytra, legs, and antennae appear to be constant for each species. The following key will separate the described species:

1. Metalegs entirely black; antennae black except segments 1 and 2 partly reddish; prolegs partly piceous; ♂ abdomen with median depression and caudal fringe of long setae
 *Acanthoscelides caracallae* Kingsolver, new species
- Metalegs with some red or reddish-yellow infusion; antennae red or piceous; prolegs reddish; ♂ abdomen not modified 2
2. Pronotum immaculate ashy gray; eyes not sexually dimorphic
 *A. suaveolus* (Sharp)
- Pronotum with median dark markings; eyes sexually dimorphic or not 3
3. Pronotum and elytra with only brown, gray, and white setae; median area of pronotum uniformly dark except for basal band, without lines or spots; eyes not sexually dimorphic
 *A. comptus*, Kingsolver, new species
- Pronotum and elytra with yellowish setae in addition to black, gray, and white, especially on pronotum and elytral base; pronotum with

median line and lateral spots; ♂ eyes larger than ♀ eyes
..... *A. clandestinus* (Motschulsky)

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2-NONANOL IN THE EXOCRINE SECRETION OF THE NEARCTIC
CADDISFLY, *RHYACOPHILA FUSCULA* (WALKER)
(RHYACOPHILIDAE: TRICHOPTERA)

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Abstract.—Abdominal secretions of *Rhyacophila fuscula* (Walker) contain 2-nonanol as the major component. The possible defensive function of the secretion in the biology of the insect and the evolutionary significance of similar abdominal glands in Lepidoptera and Trichoptera are discussed.

In recent years the exocrine chemistry of eusocial insects has been studied extensively in order to determine the controls of their behavioral patterns. The chemistry of a number of economically important non-social insects has also been studied because of the potential application of this information for monitoring and manipulating pest populations (Koehler et al., 1977). Little attention, however, has been directed toward the exocrine chemistry of solitary species. One such taxon is the Trichoptera or caddisflies. They are a small order of insects with about 1300 North American species for which the systematics is relatively well established.

Rhyacophila fuscula (Walker), a common species in the eastern United States, emerges throughout the summer and early autumn. It can be collected in sufficient quantities for chemical analysis by black-lighting. We have observed that this medium-sized caddisfly emits a sweet odor when handled. Herein we report the identification of 2-nonanol from exudates released from a pair of abdominal exocrine glands on the fifth segment. The function of the abdominal gland is discussed as well as its phylogenetic significance.

MATERIALS AND METHODS

Collection of animals.—Adults of *Rhyacophila fuscula* were collected during September 1979 at Catocin Mountain Park, Thurmont, Maryland. Adult caddisflies landing on a large white sheet hung behind a black-light were removed and placed in individual glass shell vials. The caddisflies were chilled in an ice chest and transported to the laboratory where they were stored for a maximum of 24 hours prior to extraction.

Exocrine source and collection of secretion.—Female specimens were cleared in KOH and examined both internally and externally for an exocrine glandular apparatus.

Whole body extracts of females were prepared by dipping the specimen in methylene chloride. In addition, the paired exocrine glands on the fifth abdominal segment were dissected from female specimens held under ice water. These excised glands were extracted in methylene chloride for later chemical analysis.

Chemical analyses.—An extract made from 30 whole specimens was analyzed on a computerized Finnigan 3200 gas chromatograph-mass spectrometer (GC-MS) equipped with a 1 m × 1 mm (I.D.) glass column utilizing 3% OV-17 and 10% SP-1000 as stationary phases. The column was programmed at 10°C/min from 60°–200°C (or 300° for OV-17). The major component was identified by comparison of mass spectra and retention times with those of previously published spectra and standard compounds. An extract of eight abdominal glands was analyzed by gas chromatography and the retention time compared to those of standard compounds.

RESULTS AND DISCUSSION

Gas chromatograph analyses of both excised glands and whole body extracts of *R. fuscula* showed the presence of one component which constituted over 95% of the observed volatiles. The component has a base peak at m/z 45 with additional peaks at m/z 129, 126, 111, 98, 97, 83, 69, and 55. The molecular ion at m/z 144 was not visible, but the base peak and the M-15 peak at 129 plus the M-18 peak at 126 indicated that this component was 2-nonanol. Comparison with an authentic sample established its structure. The specific stereochemistry of the 2-nonanol is unknown.

2-Nonanol has previously been identified in the head extracts of two species of stingless bees in Mexico, *Trigona mexicana* Guérin and *T. pectoralis* Dalla Torre. 2-Nonanol along with a series of alcohols and ketones functions to release alarm behavior in these bees (Luby et al., 1973). It has also been found in the mandibular glands of bumblebees (Cederberg, 1977). Interestingly, 1-nonanol has been identified in the mandibular gland secretions of the formicine ants, *Lasius niger* (L.) (Bergström and Löfqvist, 1970) and *Oecophylla longinoda* (F.) (Bradshaw et al., 1975) where it functions in signaling alarm.

The chemistry of exocrine secretions of trichoptera has been reported only in one other species, *Pycnopsyche scabripennis* (Rambur) (Limnephilidae). Secretions in this species are dominated by indole along with traces of skatole and cresol (Duffield et al., 1977).

Most caddisflies have paired glandular openings on the fifth abdominal segment (Betten, 1934; Ross, 1956). The presence of an exocrine gland in

this segment appears to be a basic caddisfly characteristic which has subsequently been modified in different taxa (Ross, 1956). The structure and position of the gland are variable within the segment. Both males and females of *Pycnopsyche scabripennis* have paired glands 1.8 mm in length opening dorsolaterally on the fifth abdominal sternum. There is a peglike cuticular modification near the opening of the gland (Duffield et al., 1977). A large dorsal exocrine gland has been described in the males of the South American caddisfly *Barypenthus* sp. (Odontoceridae) which opens between the fifth and sixth abdominal terga (Barth 1963a, 1963b). This may represent a fusion of the paired fifth abdominal glands or may represent an entirely different gland. The function of the gland is unknown. A number of other species have what appear to be openings of exocrine glands on other abdominal segments (Flint, personal communication). At present there are no comprehensive studies of the distribution and morphology of abdominal exocrine glands present in Trichoptera.

Based on morphology, it is believed that Trichoptera and Lepidoptera are closely related (Carpenter, 1953; Ross, 1955). This is substantiated by the presence of abdominal exocrine glands on the fifth sternum in both primitive families of Microlepidoptera, Micropterygidae and Eriocranidae (Davis, 1975) and the primitive family of caddisflies, Rhyacophilidae. Thus, the presence of exocrine glands in the fifth segment represents a plesiomorphic character shared by both caddisflies and some primitive Lepidoptera.

The function of these abdominal glands may also be similar in both orders. Kristensen (1972) has suggested they may serve a defensive purpose in the Microlepidoptera. In Trichoptera they may be used to repel small invaders such as ants while the caddisflies rest in the vegetation during daylight hours (Duffield et al., 1977). Since 1-nonanol functions as an alarm releaser/defensive product in *Lasius* and *Oecophylla*, 2-nonanol may function similarly for caddisflies.

The natural product chemistry of the Trichoptera must be regarded as an unexplored field. At this juncture it is impossible to discuss the distribution of 2-nonanol in Trichoptera. Future studies may well demonstrate the usefulness of comparative chemical and morphological data on the fifth abdominal glands in the systematics of Trichoptera. This information may be used both as systematic characters and to test phylogenetic affinities proposed in the literature.

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TWO NEW SPECIES OF *DICHELACERA* (*NOTHOCANTHOCERA*)
FAIRCHILD WITH A KEY TO THE SPECIES OF THE
SUBGENUS (DIPTERA: TABANIDAE)^{1,2}

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Abstract.—Two new species of the subgenus *Nothocanthocera* are described and figured: *Dichelacera* (*N.*) **adusta** from Brazil, Minas Gerais, and *D.* (*N.*) **flavicosta** from Venezuela, Bolivar. A key to the females of all 12 species is presented, and figures of all species showing a wing pattern are included. Additional criteria for characterizing *Nothocanthocera* are given. *Dichelacera* (*N.*) *leucotibialis* (Barretto) is a new synonym of *D.* (*N.*) *diaphorina* (Barretto).

The subgenus *Nothocanthocera* of the genus *Dichelacera* is a widely distributed Neotropical group, most members of which are found east of the Andes, with one isolated species, *costaricana* (Fairchild), from Central America. The subgenus was erected by Fairchild (1969) to accommodate 11 Neotropical species, most of which were previously placed in the genus *Acanthocera*. Fairchild felt these species were more closely allied to *Dichelacera* than *Acanthocera* yet subgenerically distinct from the other *Dichelacera* species (Fairchild, 1939; Barretto, 1947).

Nothocanthocera have a bare and somewhat inflated frontoclypeus, a dorsal antennal tooth which does not reach the end of the basal plate, contrastingly pale tibial bases, and a pollinose subcallus. They are usually wasp-like in appearance with the first two abdominal segments slightly constricted, often with golden-yellow hair patches on the pleura, sides of the mesonotum, scutellum, and along the posterior borders of some abdominal segments. In addition, they generally have a dark infuscation along the entire anterior half of the wing.

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Nothocanthocera differs from other *Dichelacera* subgenera by lacking a strong diagonal wing band (indistinctly present only in *D. (N.) tenuicornis* (Lutz)), by having only a partially sclerotized labella, and by their wasplike appearance. *Nothocanthocera* does have in common with other *Dichelacera*, *s.l.*, a first antennal segment which is usually much shorter than the basal plate and annuli which are sometimes slightly longer, but more commonly shorter, than the basal plate.

Acanthocera species, which also resemble wasps, seem to be closely related to *Nothocanthocera*. They are separable on antennal characters. *Acanthocera* has annuli which are much wider, when viewed from above, than the first two antennal segments or the basal plate, while the annuli of *Nothocanthocera* are not wider than the other antennal parts. In addition, the annuli are 1.5–2.5 times longer than the basal plate, those of *Nothocanthocera* 1.1 or less. Usually *Acanthocera* has the first antennal segment at least as long as the basal plate; the first segment is usually much shorter in *Nothocanthocera*.

Three species presented in the key, *nigricorpus* (Lutz), *cnephosa* (Barretto), and *steleiothorax* (Barretto), are known to me only from their original descriptions, the last described from a male. Wing photos of the above two Barretto species are reproduced here from his treatment (Barretto, 1947).

Dichelacera (N.) leucotibialis (Barretto) was described from a male for which there was no associated female. The wing pattern of *leucotibialis* (Barretto, 1947, fig. 16) is identical to that of *diaphorina* (Barretto) (Fig. 7; Barretto, 1947, fig. 13); in addition I find no appreciable non-sexual differences between the description of *leucotibialis* and the specimen of *diaphorina* before me. I therefore place *leucotibialis* as a synonym of *diaphorina* (NEW SYNONYMY). Both names were published simultaneously, but *diaphorina* is preferable since it was described from a female.

KEY TO FEMALES OF *DICHELACERA (NOTHOCANTHOCERA)* SPECIES

1. Wing nearly evenly infuscated yellow or brown, without contrasting pattern 2
- Wing with contrasting yellow or brown and hyaline areas 3
- 2(1). Hindtibia mostly black, whitish and white haired at base only. Palp, sides of posterior mesonotum, and 2nd abdominal segment with a few reddish hairs intermixed with the black. Lateral posterior margins of abdominal segments pale with fine, shiny, white hairs. About 15 mm long. Wing infuscated yellow (Brazil: Santa Catarina, São Paulo, Rio de Janeiro) ... *nigricorpus* (Lutz)
- Hindtibia mostly pale yellow and yellow haired, apical ¼ dark. Palp brown haired. Posterior ⅔ of mesonotum and scutellum

- mostly golden-yellow haired. Abdomen wholly brown haired. About 10 mm long. Wing evenly brown infuscated (Guyana) *melanoptera* (Hine)
- 3(1). Wing darkly infuscated except for hyaline triangular patches occupying $\frac{1}{2}$ – $\frac{3}{4}$ of basal cells and narrow posterior hyaline border beginning in 2nd submarginal cell and extending at least to axillary cell (Figs. 3, 4) 4
- Wing not as above, variable but usually hyaline with at least a broad yellow or dark anterior margin (Figs. 5–12) 5
- 4(3). Dorsal antennal tooth subequal to 2nd antennal segment. Terminal annulus about as long as wide. Basal cells hyaline except for their apices, lightly infuscated median area in 1st basal cell and small infuscated area at base of 2nd. About 10 mm long. Frontal index about 2.3 (Fig. 3) (Venezuela, Colombia) *trigonifera* (Schiner)
- Dorsal antennal tooth 1.5–2.0× longer than 2nd antennal segment. Terminal annulus longer than wide. Hyaline areas of basal cells restricted to $\frac{1}{4}$ of 1st basal cell and contiguous anterior $\frac{1}{3}$ of 2nd. 12–15 mm long. Frontal index 2.8–3.4 (Fig. 4) (Colombia: Chocó) *albomarginata* (Kröber)
- 5(3). Wing tricolored, the following cells yellow: Costal, subcostal, marginal, basal $\frac{1}{2}$ of 1st submarginal, 1st basal, and basal $\frac{1}{2}$ of anal. Vein R_5 to fork and vein R_1 broadly margined dark brown. Apical $\frac{1}{2}$ of anal cell infuscated brown except for a hyaline center. Remainder of wing hyaline or lightly brown tinted (Figs. 2A–C, 5) (Venezuela: Bolívar) *flavicosta*, new species
- Wing not as above, bicolored, usually with broad dark anterior margin and broad hyaline or lightly infuscated posterior margin 6
- 6(5). Wing with oblique lightly infuscated mark extending from near apex of anal cell, across bases of the 5th and 4th posterior cells and through discal cell where it joins dark anterior margin of wing in 1st posterior cell. Posterior $\frac{1}{2}$ of scutellum and hindborders of abdominal terga 2–4 golden-yellow haired. Remaining terga dark brown haired (Fig. 6) (Brazil: São Paulo, Minas Gerais, Santa Catarina) *tenuicornis* (Lutz)
- Wing without an oblique infuscated mark. Scutellum and abdomen often marked as above but posterior border of tergum 4 not golden-yellow haired 7
- 7(6). Discal cell infuscated (Fig. 11) (Brazil: Paraná) *steleiothorax* (Barretto)
- Discal cell with at least a hyaline center 8

- 8(7). Wholly brown and brown haired, without golden-yellow hairs (Figs. 1A–C, 8) (Brazil: Minas Gerais) *adusta*, new species
 – Yellow hairs present in at least 1 of the following locations: On longitudinal sutures, scutellum, on notopleural lobe, below wing base, and on posterior margins of abdominal segments 2 and 3 9
- 9(8). Anterior wing infuscation does not include base of 1st posterior cell. Remainder of wing, except anal cell, hyaline. Thorax blackish with pale pollinose and yellow pilose scutellum, notopleural lobe, and paired anterior dorsal stripes. Abdomen shiny black, only 1st segment pale pilose. Halter creamy white (Fig. 9) (Honduras; Costa Rica) *costaricana* (Fairchild)
 – Wing similar to above but with base of 1st posterior cell infuscated, and area along posterior margin from 2nd submarginal to 5th posterior cell lightly infuscated. Abdomen with at least 2nd segment with a fringe of pale pilosity laterally. Halter brown 10
- 10(9). Notopleural lobe with tuft of yellow hair (Fig. 10) (Brazil: São Paulo) *apicalis* (Fairchild)
 – Notopleural lobe brown haired 11
- 11(10). Wing with 1st posterior cell nearly wholly darkened except for thin line along posterior margin. Dorsal antennal tooth recurved, nearly reaching 1st annulus. Space between tooth and basal plate about $\frac{3}{4}$ width of basal plate (Fig. 12) (Brazil: Rio de Janeiro) *cnephosa* (Barretto)
 – Wing with basal $\frac{1}{2}$ of 1st posterior cell darkened, contrasting with paler apical $\frac{1}{2}$. Dorsal antennal tooth more or less straight. basal plate $\frac{1}{3}$ again as long as tooth. Space between tooth and basal plate equal to about $\frac{1}{2}$ width of basal plate (Fig. 7) (Brazil: São Paulo, Rio de Janeiro) *diaphorina* (Barretto)

Dichelacera (*Nothocanthocera*) *flavicosta* Wilkerson, NEW SPECIES

Figs. 2A–C, 5

Medium-sized, dark-brown species with bare shiny frontoclypeus, long, slender, dorsal antennal tooth, and basally swollen subshiny palp. Wing tricolored, broadly yellow along costal margin, broadly dark brown along vein R_5 to fork, along vein R_1 , and apical $\frac{1}{2}$ of anal cell, remainder hyaline.

Female.—Length, 14 mm; of wing, 14 mm. Head characters as figured. Frontal index 2.9. Frons reddish black in ground color, dark yellowish-gray pollinose. Frons, thorax, and upper abdomen slightly greased. Basal callus protuberant, shiny reddish black. Median callus subshiny reddish black, borne on central elevated area leading from just above callus to below the

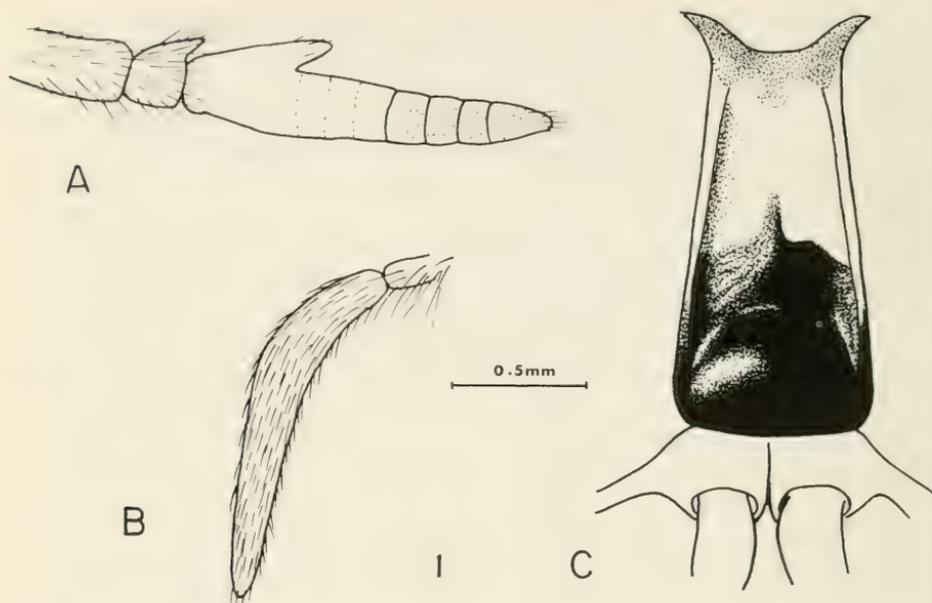


Fig. 1. *Dichelacera (Nothocanthocera) adusta*, holotype. A, Antenna. B, Palp. C, Frons.

barely visible ocellar vestiges. Subcallus and gena reddish black in ground color, yellowish-gray pollinose. Beard and hairs of upper gena sparse and dark brown. Frontoclypeus protuberant, mostly shiny dark reddish brown but yellowish-gray pollinose below level of tentorial pits. Antennal segments 1 and 2 dark brown and black haired with sparse grayish pollinosity. Segment 3 black with base, dorsal tooth, and small rings at each annulus yellowish. Third segment sparsely grayish pollinose and black haired. Palpus subshiny dark reddish brown and black haired, covered with sparse grayish pollinosity. Labella with dorsolateral shiny sclerotized stripes.

Mesonotum reddish brown with sparse grayish pollinosity and sparse black hairs. Scutellum dark reddish in ground color, mostly black haired with a few yellowish hairs intermixed. Pleura and coxae dark brown in ground color, pale grayish pollinose and dark brown haired. Legs dark reddish brown and black haired except for basal $\frac{3}{4}$, $\frac{2}{3}$, and $\frac{1}{2}$ of fore-, mid-, and hindtibiae, respectively, which are yellowish white and yellowish-white haired. Wing as figured, costal, subcostal, marginal, basal $\frac{1}{2}$ of 1st submarginal, 1st basal, and basal $\frac{1}{2}$ of anal cells yellow, veins R_1 and R_5 broadly brown margined, apical $\frac{1}{2}$ of anal cell brown, remainder of wing hyaline. Basicosta bare. Halter pale yellowish brown.

Abdomen above dark brown in ground color and black haired except for posterior borders of terga 1 and 2 which are yellowish brown and sparsely

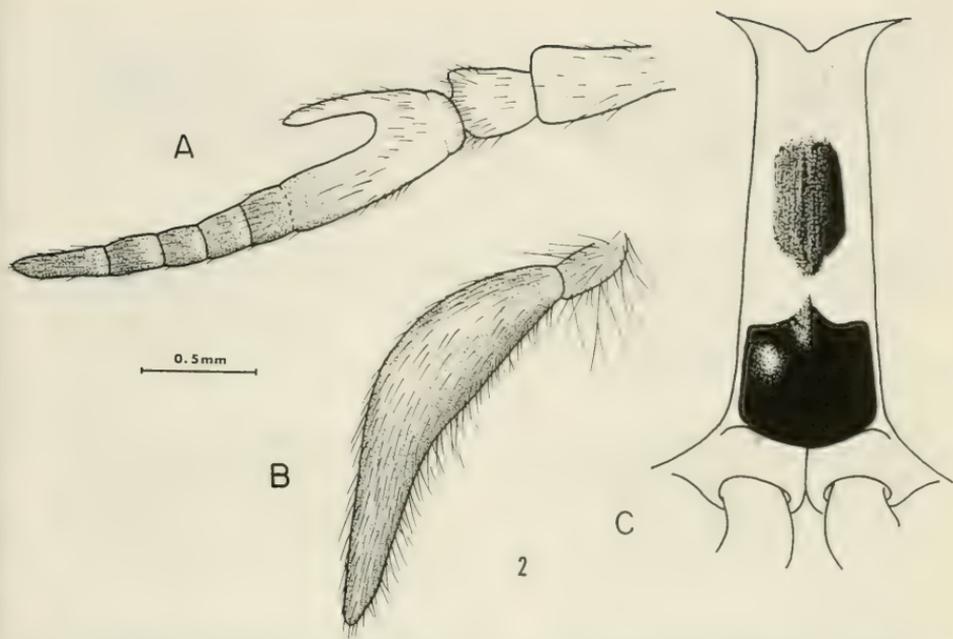


Fig. 2. *Dichelacera (Nothocanthocera) flavicosta*, holotype. A, Antenna. B, Palp. C, Frons.

yellow haired. Pale margin of segment 2 much narrower than that of segment 1. Segments 1 and 2 constricted, slightly narrower than following segments. Tergum 1 appears slightly paler than other terga due to sparse grayish-yellow pollinosity and lateral pale yellow hairs. Abdomen below as above but only sternum 2 with yellowish and yellow haired posterior border.

Male.—Not known.

Type material.—Holotype, ♀, Venezuela, Bolivar, Sta. Elena, 10–11-IX-1977, leg. Lindemann. In Zoologische Staatsammlung, Munich, West Germany.

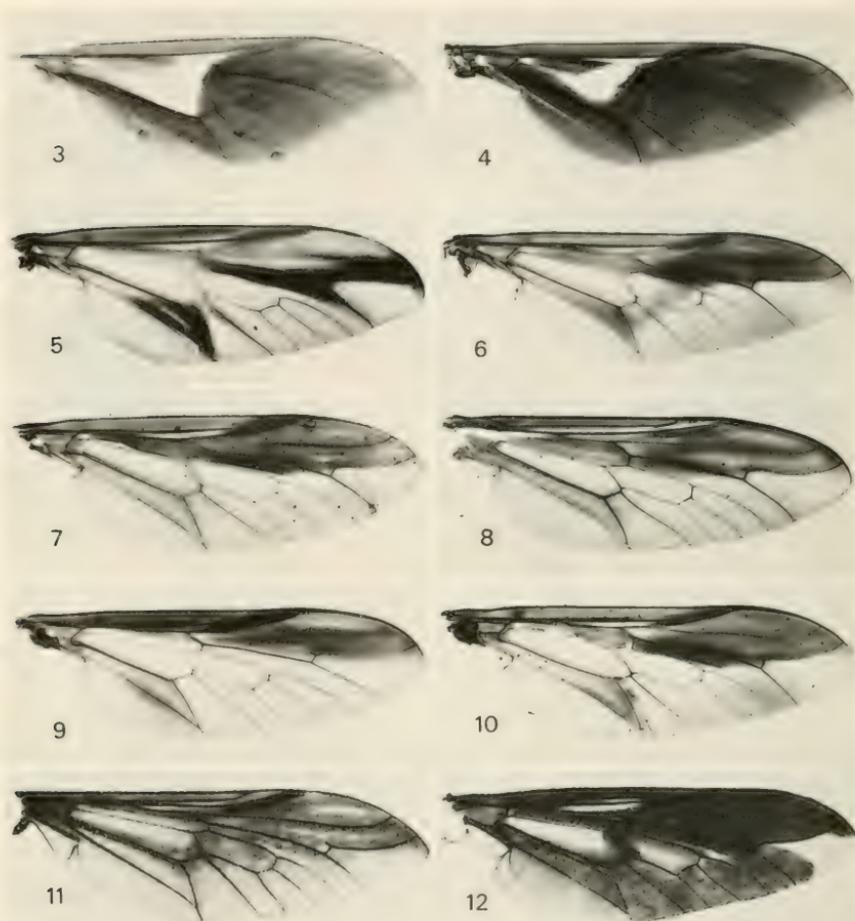
Discussion.—This species, as the name suggests, may be separated from the other members of this group by the broad yellow coloration along the costal margin of the wing.

Dichelacera (Nothocanthocera) adusta Wilkerson, NEW SPECIES

Figs. 1A–C, 8

Small to medium sized, all brown and brown haired species with short dorsal antennal tooth, shiny frontoclypeus, and slender palp.

Female.—Length, 9 mm; of wing, 9.5 mm. Head structures as figured. Frontal index 2.2. Frons pale yellowish brown pollinose. Callus shiny yellowish brown, basal $\frac{1}{2}$ protuberant, upper $\frac{1}{2}$ sunken in, borne on median



Figs. 3-12. Wings. 3, *Dichelacera (Nothocanthocera) trigonifera*. 4, *D. (N.) albomarginata*. 5, *D. (N.) flavicosta*. 6, *D. (N.) tenuicornis*. 7, *D. (N.) diaphorina*. 8, *D. (N.) adusta*. 9, *D. (N.) costaricana*. 10, *D. (N.) apicalis*. 11, *D. (N.) steleiothorax*. 12, *D. (N.) cnephosa*.

concave portion of frons. Three barely visible vestiges of ocelli present near vertex, area around and above these subshiny yellowish brown. Subcallus and most of gena pale yellowish brown pollinose. Frontoclypeus and median thin stripe below each eye on genae shiny yellowish brown. Beard of sparse brown hairs. Antennal segments 1 and 2 pale yellowish brown and dark brown haired. Segment 3 orange yellow basally, darkening to brown on annuli. Palp brown in ground color, pale yellowish-gray pollinose and brown haired. Labella nearly $\frac{1}{2}$ total proboscis length, wholly fleshy except for small lateral shiny areas.

Mesonotum reddish brown in ground color, covered with pale yellowish-brown pollinosity and brown hairs. Scutellum darker than mesonotum with coppery-yellow pollinosity and dense brown hairs. Pleura and coxae as mesonotum. Femora and apices of tibiae paler reddish brown and brown haired. Basal halves of tibiae yellowish white with a few whitish hairs intermixed with brown. Tarsi dusky. Wing as figured, broadly infuscated brown anteriorly, but paler in anal cell and through posterior cells, remainder hyaline. Basicosta bare, halter reddish brown. Abdomen above and below wholly reddish brown and brown haired.

Male.—Not known.

Type material.—Holotype, ♀, Brazil, Minas Gerais, Cipo, 20-XI-1938, A. Vianna Martins coll. Holotype to be deposited in Museu de Zoologia da Universidade de São Paulo.

The holotype is damaged, lacking the left antennal flagellum, the left forefemur, foretibia, and foretarsus, the right midtarsus, half of one hindtibia, and both hindtarsi. In addition, the thorax is somewhat compressed dorso-laterally, and the insect has been stabilized on the pin with glue.

Paratype, same data as holotype, in the Florida State Collection of Arthropods. This specimen is somewhat larger, 11.5 mm long, and darker than the holotype. It is also damaged, the body being mostly denuded, it lacks the mid- and hindlegs of the left side, and the wings are both dirty and torn. The mid- and hindtibiae of this specimen are mostly pale, their apical fourths darkened.

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**MORPHOLOGY OF THE MALE INTERNAL REPRODUCTIVE SYSTEM
IN ARMY ANTS: PHYLOGENETIC IMPLICATIONS
(HYMENOPTERA: FORMICIDAE)**

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Abstract.—The morphology of the male internal reproductive system is described for representative species of New and Old World army ants. Functional testes in these species are present only in the pupa. The testes atrophy to such extent prior to or at the time of eclosion that little evidence of their existence in the adult can be found. Spermatogenesis and the storage of newly formed sperm cells in the seminal vesicles thus occur during pupal development before emergence. The internal genital structures are most derived and uniquely developed in New World species and least so in Old World species. The extraordinary differences in male internal genitalic morphology between New and Old World forms constitute further evidence of the polyphyletic origin of army ants.

The internal reproductive system of male ants includes a pair of testes, their vasa deferentia, and a pair of accessory glands. The vasa deferentia, ducts that connect the testes to the accessory glands, are expanded in some species to form seminal vesicles. The accessory glands empty through a pair of ducts that converge to form a common ejaculatory duct (Matsuda, 1976). This duct proceeds caudally where it enters the sclerotized genital capsule. Relatively few studies of these soft internal structures have been undertaken. Descriptions of this system in ants were published by Adlerz (1886), Janet (1902), Mukerjee (1926), Marcus (1953), Forbes (1954, 1958), Forbes and Do-Van-Quy (1965), Beck (1972), and Hung and Vinson (1975). Of these, only the studies of Mukerjee, Forbes (1958), Forbes and Do-Van-Quy, and Hung and Vinson deal specifically with or include army ants.

The "true" army ants were formerly placed in the single subfamily Dorylinae but are now regarded as two subfamilies. The New World genera (*Cheliomyrmex*, *Eciton*, *Labidus*, *Neivamyrmex*, and *Nomamyrmex*) are currently assembled in the subfamily Ecitoninae, while the Old World genera (*Aenictus* and *Dorylus*) comprise the Dorylinae (Snelling, in press). This reflects the generally held view that the doryline ants as previously consti-

tuted are polyphyletic. Although Wheeler (1928) supposed that the dorylines shared a common ancestor, both Brown (1954) and Borgmeier (in Seevers, 1965) later hypothesized that the group was diphyletic. In studies of morphological, behavioral, and geographic characteristics, Gotwald (1969, 1977, 1979) and Gotwald and Kupiec (1975) speculated that the dorylines are triphyletic. They proposed that the New World dorylines constituted one lineage, the Old World genus *Dorylus* with its six subgenera (*Alaopone*, *Anomma*, *Dichthadia*, *Dorylus*, *Rhogmus*, and *Typhlopone*) a second, and the Old World genus *Aenictus* a third.

Most of the morphological and behavioral evidence upon which the polyphyletic hypothesis of doryline origins is based was gathered from the worker caste. The queens and males seem obvious candidates for similar evidence-gathering investigations. This is especially true for the males which possess a well-developed, conspicuous but retractile genital capsule. The sclerotized components of this capsule are commonly figured in taxonomic treatments of the army ants (see Borgmeier, 1955), but a comparative examination of the soft, internal reproductive structures of the males does not exist. Indeed, only one species of *Eciton* (Forbes, 1954), two of *Neivamyrmex* (Forbes and Do-Van-Quy, 1965; Hung and Vinson, 1975), and one of *Dorylus* (Mukerjee, 1926) have ever been described in the literature.¹

The purpose of this paper is to describe the gross morphology and certain histological aspects of the male internal reproductive system in both Old and New World army ant species and to interpret the phylogenetic implications of this morphology. Special emphasis was placed on the subgenera of *Dorylus*, since one of us (WHG) is currently revising the Old World genera.

METHODS AND TERMINOLOGY

Most specimens dissected were preserved in alcohol or Bouin's fluid although a few critical forms were available only as dried specimens. These were relaxed in 70% ethanol and then dissected. In a majority of the alcohol- or Bouin's-preserved specimens, the internal structures retained their elasticity to a remarkable degree. After being removed from the gaster, the reproductive structures were described and drawn. Specimens of all five New World genera and of both Old World genera, including all six subgenera of *Dorylus*, were dissected. Additionally, the male of one ponerine species was examined. Male pupae of the genera *Neivamyrmex* and *Dorylus* were also dissected.

The internal genitalia of two adult males of *Dorylus* (*Rhogmus*) were sectioned and stained with Delafield's hematoxylin-eosin. Also sectioned were the testes of a male pupa of *Dorylus* (*Anomma*). These sections were

¹ See Ford and Forbes, 1980, J. N.Y. Entomol. Soc. 83: 133-142 for an additional account of *Dorylus* male reproductive anatomy.

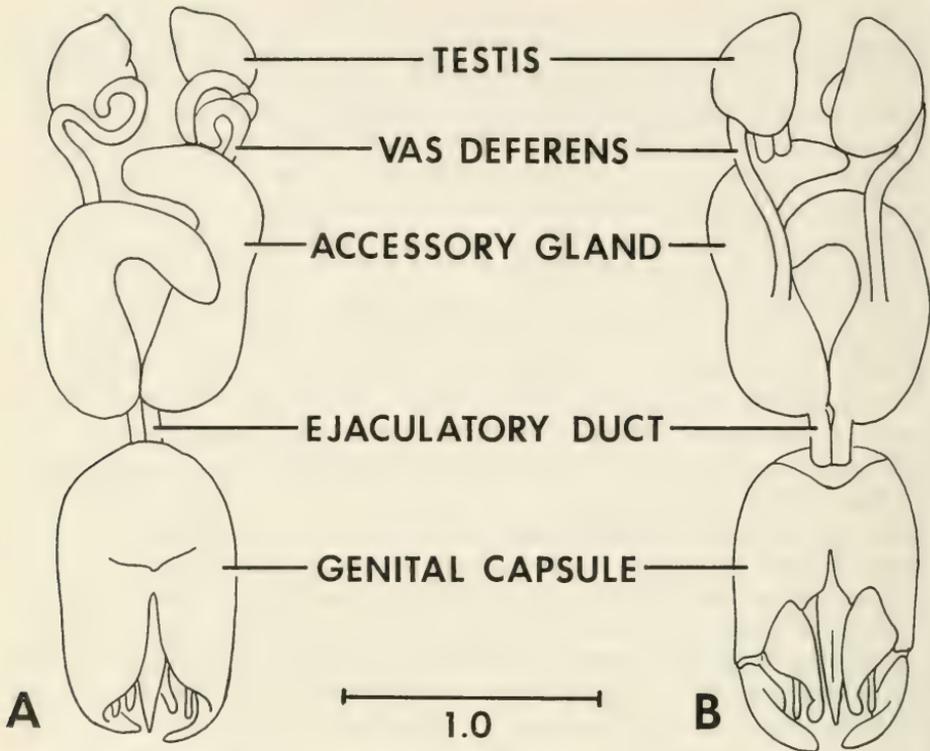


Fig. 1. Male reproductive system of *Plectroctena lygaria*. A, Dorsal view. B, Ventral view. Scale in mm.

stained with gallocyanin blue-phloxine. Serial sections of an entire adult male of *Labidus* were provided by Julian F. Watkins II.

Terms used for the male internal reproductive structures are essentially those of Snodgrass (1935) and Matsuda (1976). When functional, the testes are composed of a variable number of follicles in which spermatogenesis occurs. The vasa deferentia are the narrow tubes that transport the sperm cells from the testes to the middle or base of the accessory glands and/or ejaculatory duct. If the vasa deferentia are swollen and bulbous and function to store the spermatozoa, they are called the seminal vesicles. The accessory glands are usually dorsal to the vasa deferentia and probably contribute to the formation of seminal fluid. The ducts into which the accessory glands empty are here assumed to be the anterior, bifurcated ends of the ejaculatory duct. However, when these ducts unite to form the ejaculatory duct, their lumina usually remain separate and distinct. For this reason Forbes (1958) referred to the ejaculatory duct as the "bound accessory gland ducts." The term genital capsule is used to collectively denote the sclerotized external genitalia.

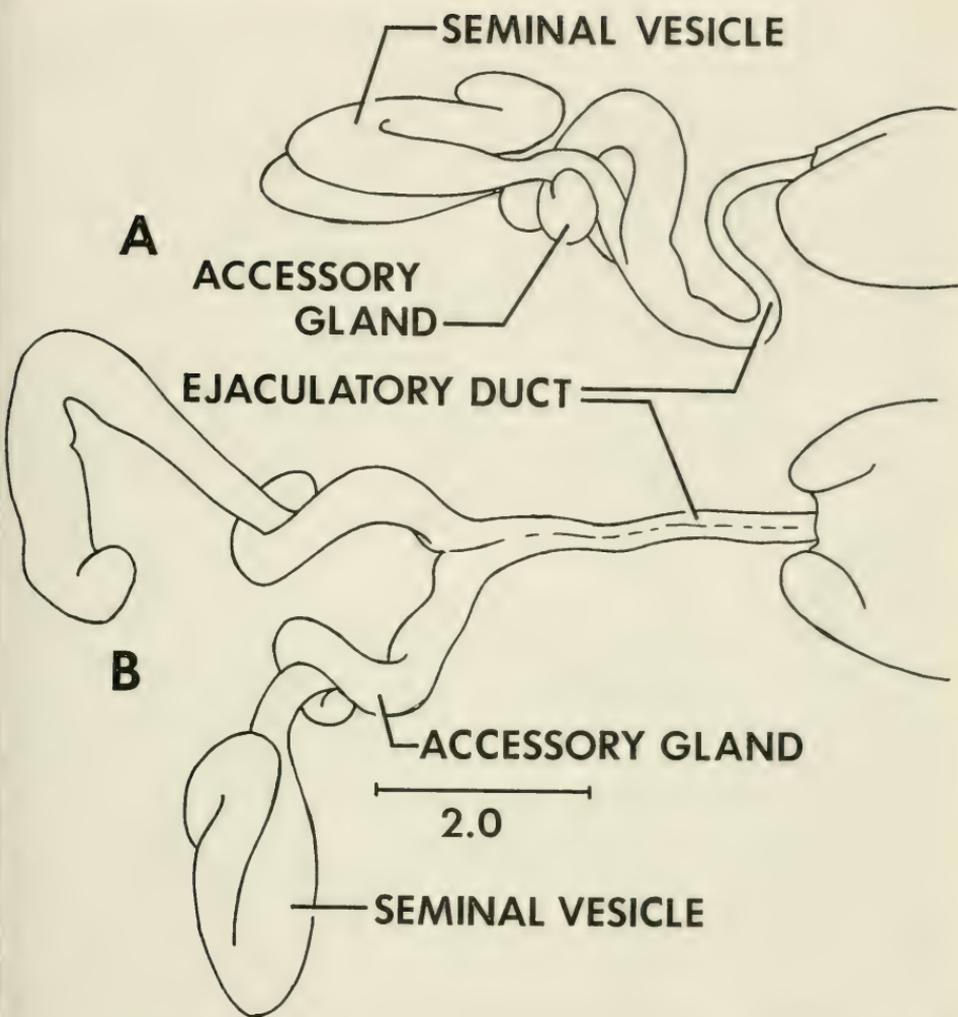


Fig. 2. Male reproductive system of *Cheliomyrmex morosus*. A, Lateral view. B, Dorsal view. Scale in mm.

RESULTS

SUBFAMILY PONERINAE

Plectroctena lygaria Bolton, Gotwald, and Leroux (1 specimen from the Laboratoire d'Ecologie Tropicale, Lamto, Ivory Coast) (Fig. 1).

Because the ponerines are among the most primitive or generalized of ants, a male of one ponerine, *P. lygaria*, was dissected to serve as a morphological "reference point." Each testis in this species is a conspicuous globular structure composed of sperm-producing follicles. Leading from

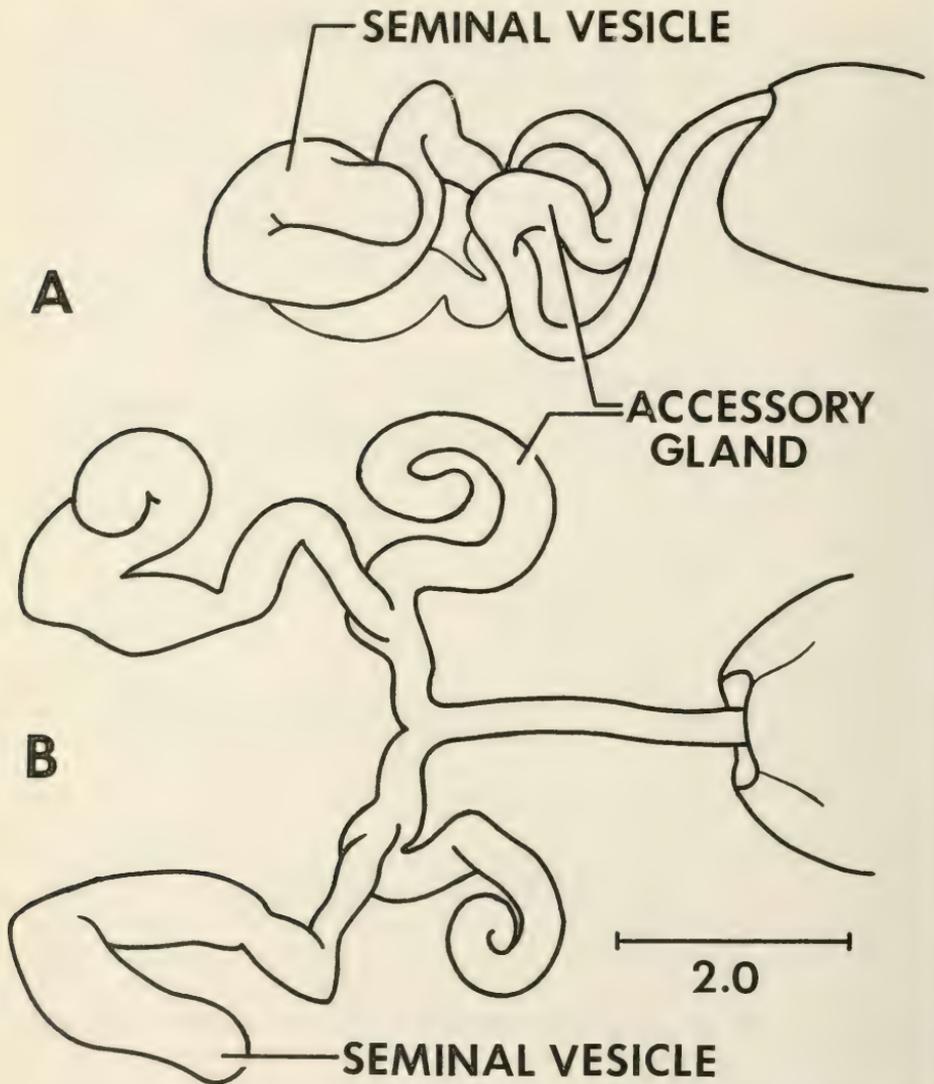


Fig. 3. Male reproductive system of *Labidus praedator*. A, Lateral view. B, Dorsal view, structures displaced for purpose of display. Scale in mm.

each testis is a narrow, distally convoluted vas deferens. This duct does not expand to form a seminal vesicle but instead continues without changing in diameter, attaching to the middle region of the ventral surface of the accessory gland. The two accessory glands are elongated, apically pointed bodies that are directed anteriorly. Although the ducts from the accessory glands



Figs. 4, 5. *Labidus coecus*, male. 4, Accessory gland, cross section: two sections can be seen (marked AG) (200 \times). 5, Ejaculatory duct, cross section (400 \times).

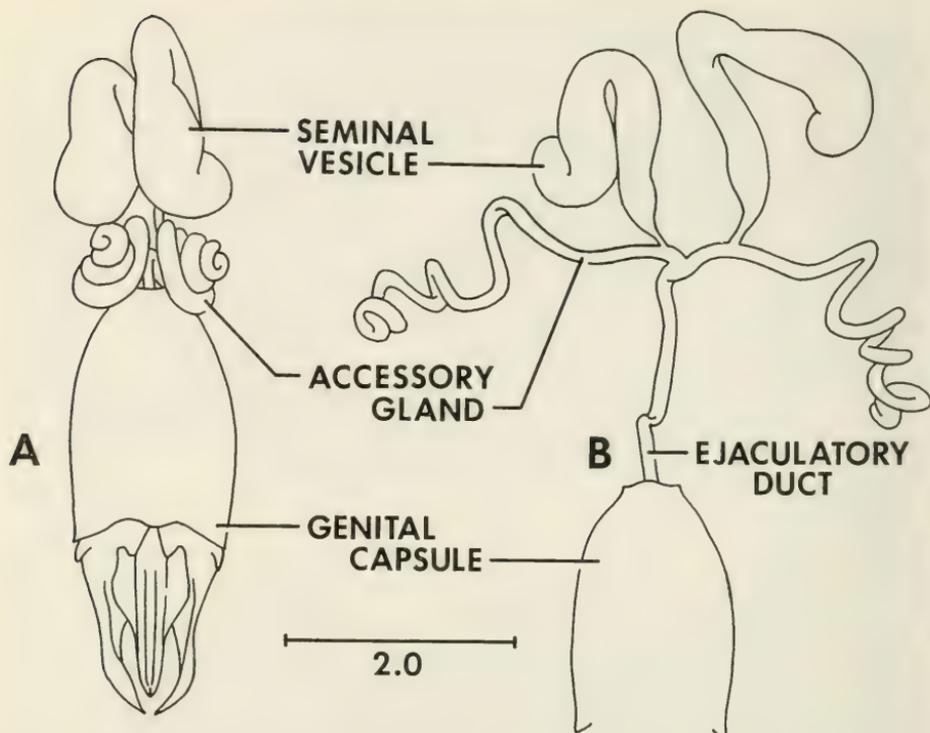


Fig. 6. Male reproductive system of *Neivamyrmex* sp. A, *In situ* dorsal view. B, Structures displaced for purpose of display, dorsal view. Scale in mm.

join to form a common ejaculatory duct, predictably their lumina are individually retained, even as the ejaculatory duct enters the genital capsule.

SUBFAMILY ECITONINAE

Cheliomyrmex morosus (F. Smith) (1 specimen from Palenque, Mexico) (Fig. 2).

Testes are not evident. The seminal vesicles are elongated, sperm-filled sacs. Each is folded upon itself twice. The accessory glands are elongated structures, each of which is coiled once about the proximal end of its corresponding seminal vesicle. The ejaculatory duct forms a ventrally directed loop before entering the genital capsule.

Labidus praedator (F. Smith) (1 specimen from Tamazunchale, Mexico) (Fig. 3).

Testes are not evident. The seminal vesicles are elongated, folded sacs similar to those of *Cheliomyrmex*. Each opens into the proximal end of its corresponding accessory gland. The accessory glands are proportionately

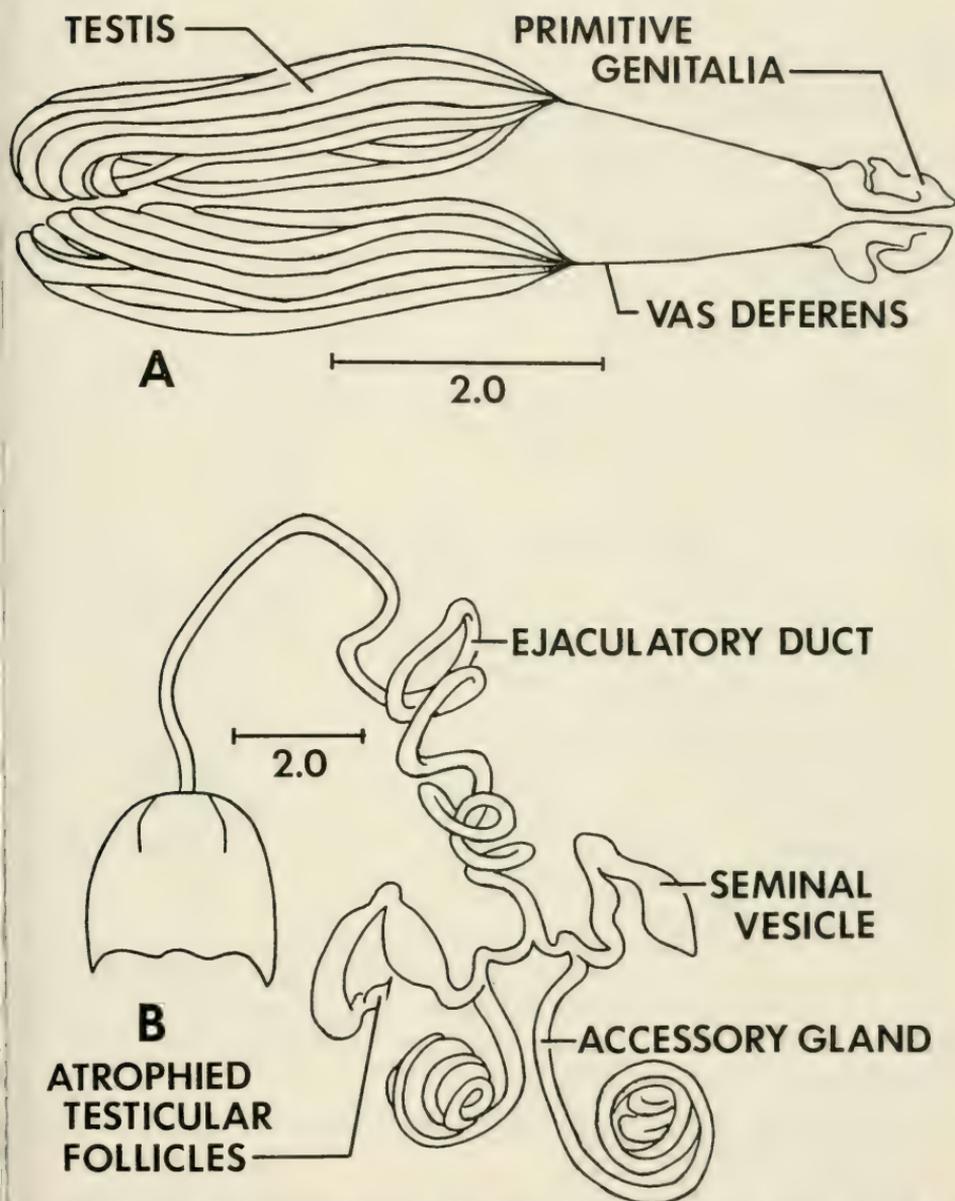


Fig. 7. Male reproductive system. A. *Neivamyrmex texanus* pupa, dorsal view. B. *Neivamyrmex esenbecki wilsoni*, structures displaced for purpose of display, dorsal view. Scales in mm.

longer than those of *Cheliomyrmex*. Although they are coiled, they do not wrap about the seminal vesicles. The ejaculatory duct loops ventrally before entering the genital capsule.

Serial sections of *Labidus coecus* (Latreille) reveal the presence of

"clumps" of sperm cells in the seminal vesicles. Each clump appears as a discrete unit of closely packed spermatozoa. The seminal vesicles are thin-walled sacs. The accessory glands are lined with a columnar epithelium that is unevenly distributed about the lumen of each gland. The epithelium is placed at opposite sides of the lumen, giving a bilateral organization to each gland (Fig. 4). Sperm cells were not present in the lumina of the accessory glands. Two lumina are present in the thick-walled ejaculatory duct and each is lined with an epithelium that stains the same color as the accessory gland epithelium. This epithelium is thickest on the median septum that separates the lumina (Fig. 5).

Neivamyrmex sp. (2 specimens from Pima County, Arizona) (Fig. 6). *Neivamyrmex nigrescens* (Cresson) (1 pupal specimen from Bell County, Texas) (Fig. 7A). *Neivamyrmex texanus* Watkins (1 pupal specimen from Waco, Texas).

Testes in the adult are not present. The seminal vesicles are large bulbous structures, each of which is bent back upon itself and enclosed in a membrane. Attached to the apex of each vesicle is a series of thin, tubule-like structures that may be the testes in atrophied form. Microscopically, these "tubules" reveal little except that they are not muscle fibers. A portion of the seminal vesicle, after being macerated, was examined under the compound microscope. This spongy tissue within each vesicle is composed of a compact mass of spermatozoa. The accessory glands are tightly coiled tubes lying on either side of the midsagittal plane next to the anterior end of the genital capsule. The seminal vesicles join the proximal ends of the accessory glands just before these glands unite to form the ejaculatory duct. This duct, containing two lumina, forms a ventrally directed loop that caudally enters the genital capsule.

Testes were prominent in both pupae dissected. The *N. nigrescens* pupa was still larviform with testes that extended the length of abdominal segments 4-6. Each pupal testis is composed of many elongated or tubular follicles (Fig. 7A), and each is connected, albeit tenuously, to the primitive genitalia by a rudimentary vas deferens.

Nomamyrmex esenbecki wilsoni (Santschi) (1 specimen from Rio Corona, Tamaulipas, Mexico (Fig. 7B).

A small group of atrophied testicular follicles attached to the distal end of one seminal vesicle. No other evidence of testes could be found. The seminal vesicles are flattened structures that fold back upon themselves once. They are similar to those of *Neivamyrmex* but not as bulbous. The accessory glands are tightly coiled, elongated tubes and are joined at their bases by the seminal vesicles. The ejaculatory duct is uniquely developed into a long tube that wraps around the ventriculus of the alimentary canal before looping ventrally and posteriorly. It then enters the genital capsule.

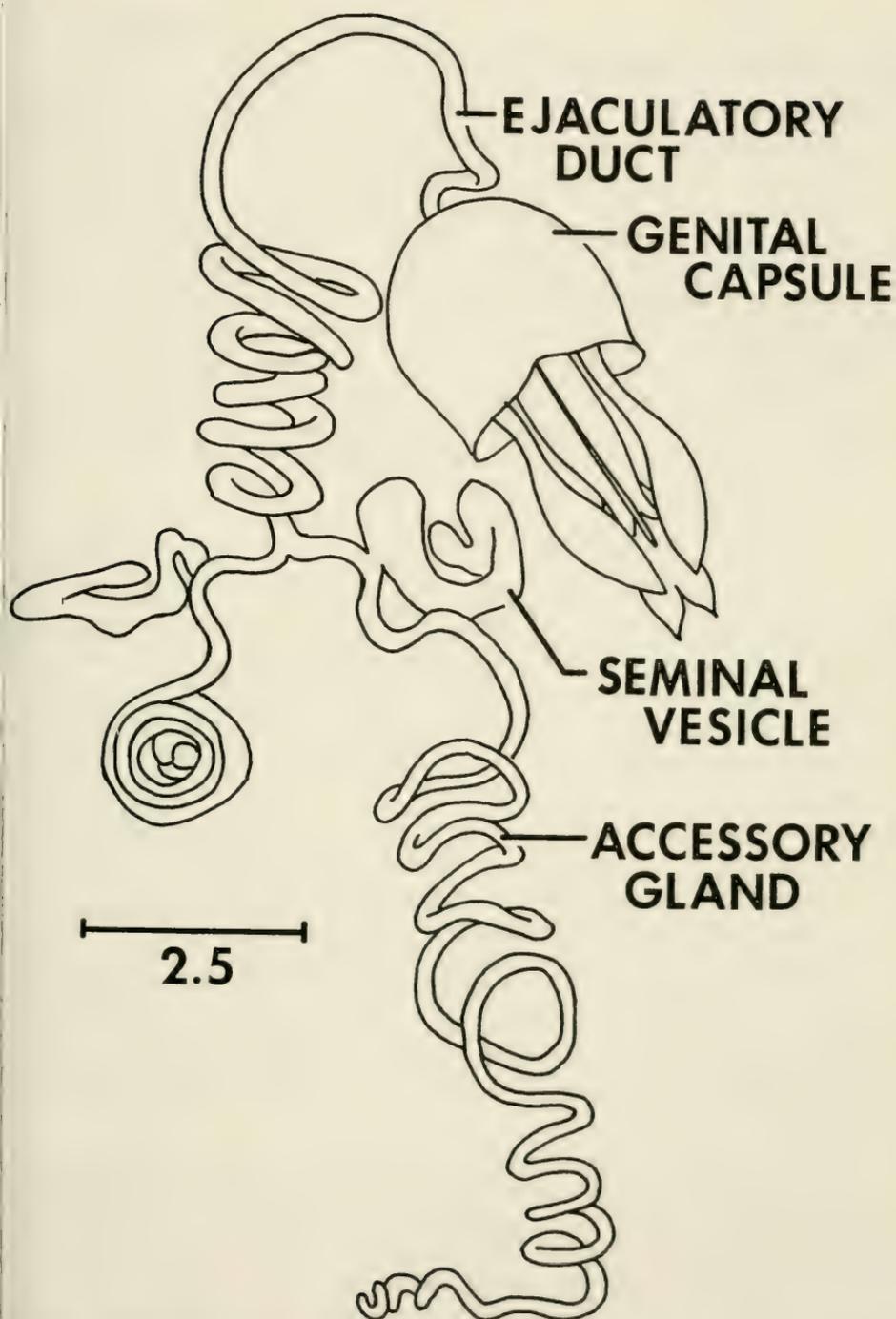


Fig. 8. Male reproductive system of *Ecton hamatum*, dorsal view, left accessory gland uncoiled. Scale in mm.

Eciton hamatum (Fabricius) (3 specimens from Barro Colorado Island, Panama Canal Zone) (Fig. 8).

Testes are absent. The seminal vesicles are flattened dorsoventrally and each is enclosed in a membranous capsule. Each joins its corresponding accessory gland near the proximal end of the gland. The accessory glands are long, coiled tubes. These glands lie on either side of the midsagittal plane juxtaposed to the anterior end of the genital capsule. The ducts from the accessory glands join to form a long ejaculatory duct that coils around the ventriculus of the alimentary canal. The lumina of the two ducts remain distinct throughout the length of this tube. The ejaculatory duct encircles the ventriculus in an anterior direction. At one point, it folds back upon itself, continuing around the ventriculus in the opposite direction but still proceeding anteriorly. Following the last coil, the duct loops back ventrally, i.e., beneath the ventriculus toward the posterior end of the gaster where it enters the genital capsule.

SUBFAMILY DORYLINAE

Aenictus sp. (2 specimens from Lamto, Ivory Coast) (Fig. 9A, B).

Although the seminal vesicles are encapsulated by a single membrane (Fig. 9A), testes are not evident within the membrane capsule. The seminal vesicles are elongated, convoluted structures (Fig. 9B). The accessory glands are short and closely applied to the anterior end of the genital capsule. These glands empty into a short ejaculatory duct that directly enters the genital capsule.

Dorylus (Alaopone) sp. (3 specimens from Kade, Ghana) (Fig. 9C). *Dorylus (Anomma)* sp. (3 specimens from Lamto, Ivory Coast) (Figs. 10A, 13, 14). *Dorylus (Anomma) nigricans* complex (3 pupal specimens from Rwantonde and Musasu, Rwanda) (Figs. 11, 12). *Dorylus (Dichthadia) laevigatus* (F. Smith) (2 specimens, 1 from Sandakan, Borneo, 1 with undecipherable locality label). *Dorylus (Dorylus)* sp. (2 specimens from Kibos near Lake Victoria, Kenya) (Fig. 15 A, B). *Dorylus (Dorylus)* sp. (2 pupal specimens from Rwantonde and Rubona, Rwanda) (Fig. 15C-E). *Dorylus (Typhlopone)* spp. (2 specimens from Kibos, Kenya; 1 from Kade, Ghana) (Fig. 16).

The morphology of the male internal reproductive system of *Dorylus* is relatively uniform throughout the subgenera. Only *Dichthadia* remains to be thoroughly examined. The two dried pinned specimens available for dissection did not, when treated, soften sufficiently, and the internal genitalic structures remained withered and rather amorphous.

Testes are not present in the adult male. In the pupae of *Dorylus (sensu stricto)* and *Anomma* they are massive structures, equal to or larger than

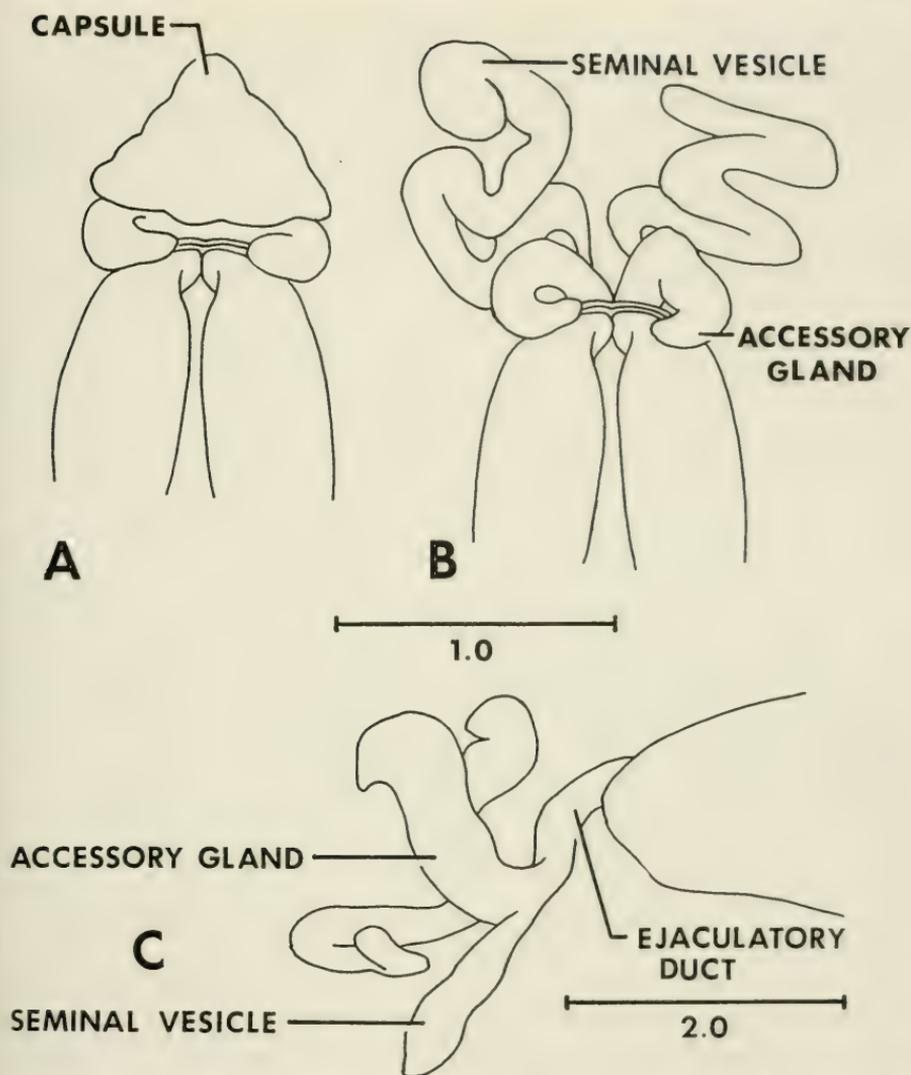


Fig. 9. Male reproductive system. A. *Aenictus* sp., *in situ*, dorsal view. B. *Aenictus* sp., capsule removed, dorsal view. C. Subgenus *Alaopone* sp., lateral view. Scales in mm.

the genital capsule of each individual specimen from which they were dissected. Each testis consists of many follicles, all of which converge upon and empty into the narrow distal end of the seminal vesicle (Fig. 15). Histologically, each follicle is predictably composed of spermatocysts consisting of small clusters of spermatogenic cells. Each spermatocyst is surrounded by a capsule of somatic cells (Figs. 11, 12). Pupae of the other four

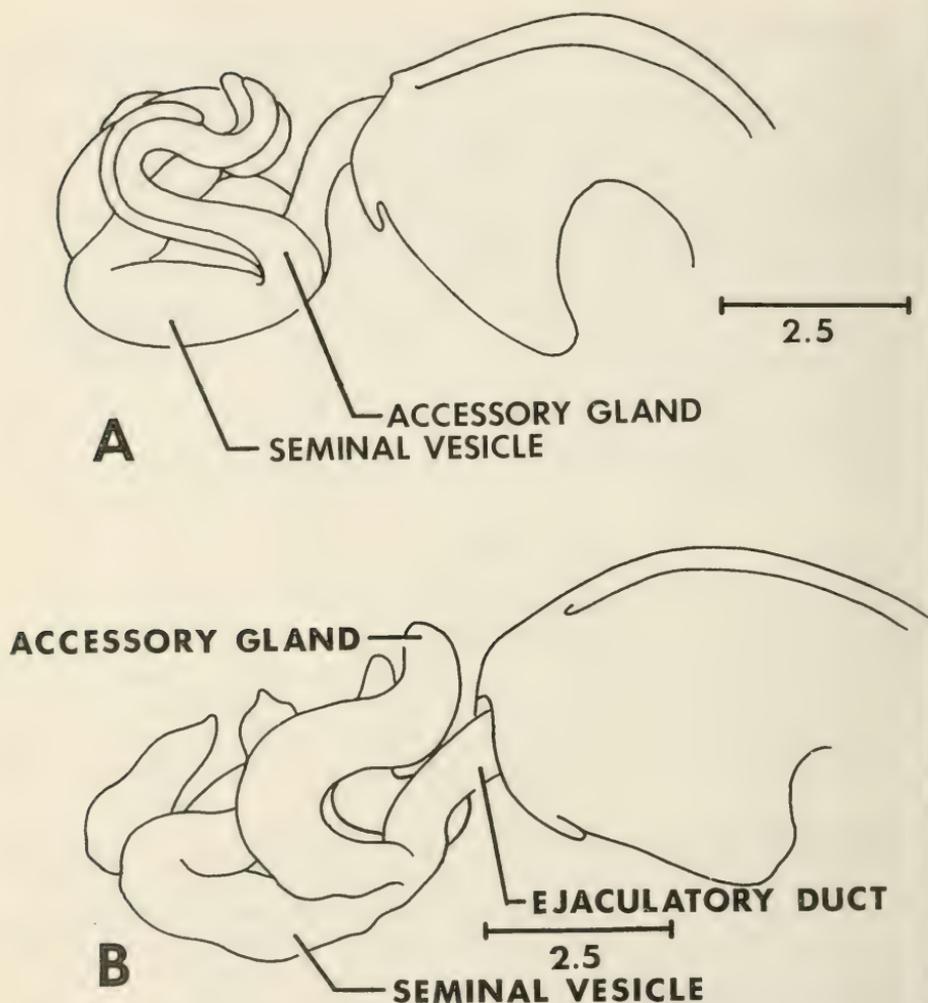
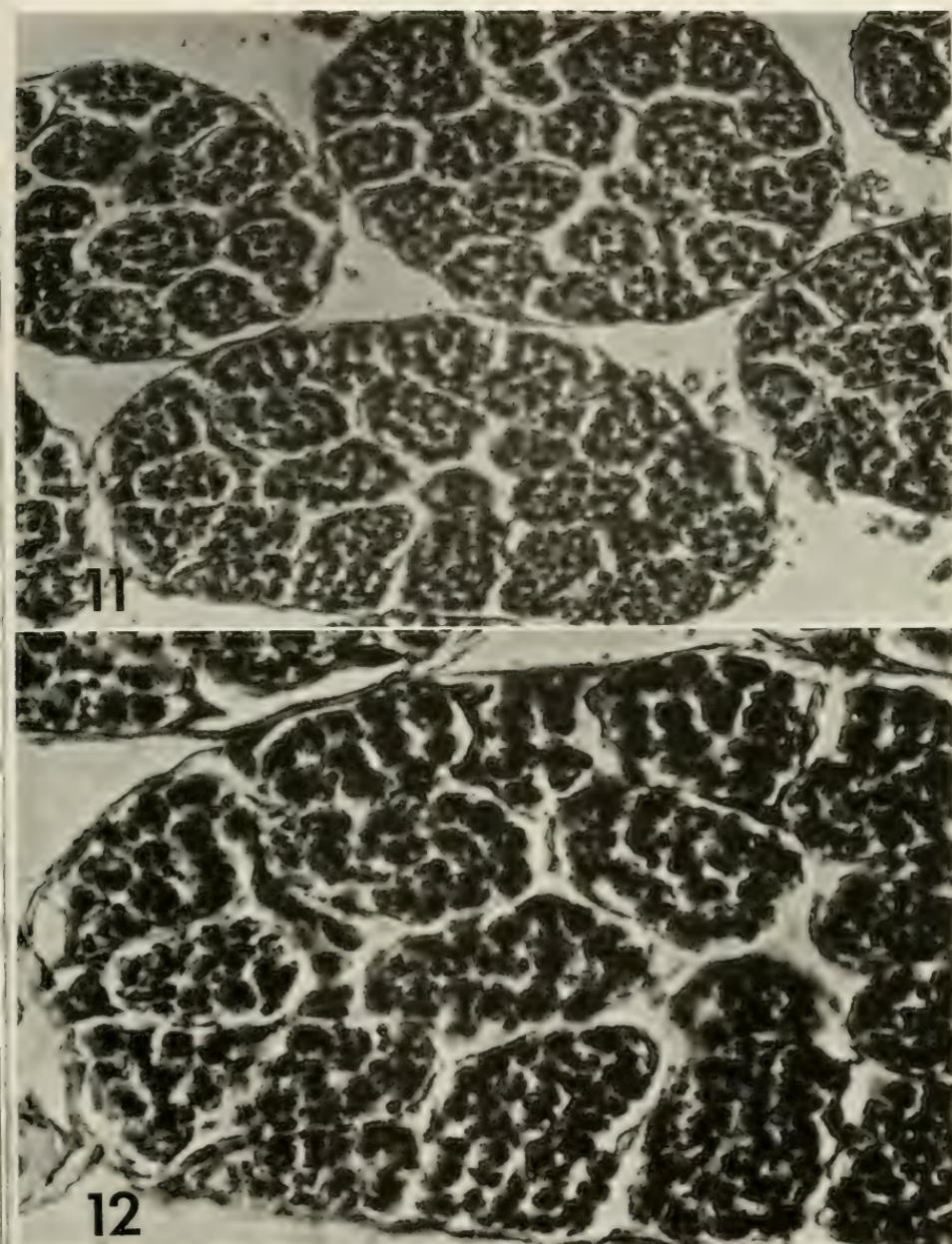


Fig. 10. Male reproductive system. A, Subgenus *Anomma* sp., outer covering of left accessory gland removed, lateral view. B, Subgenus *Rhogmus* sp., lateral view. Scales in mm.

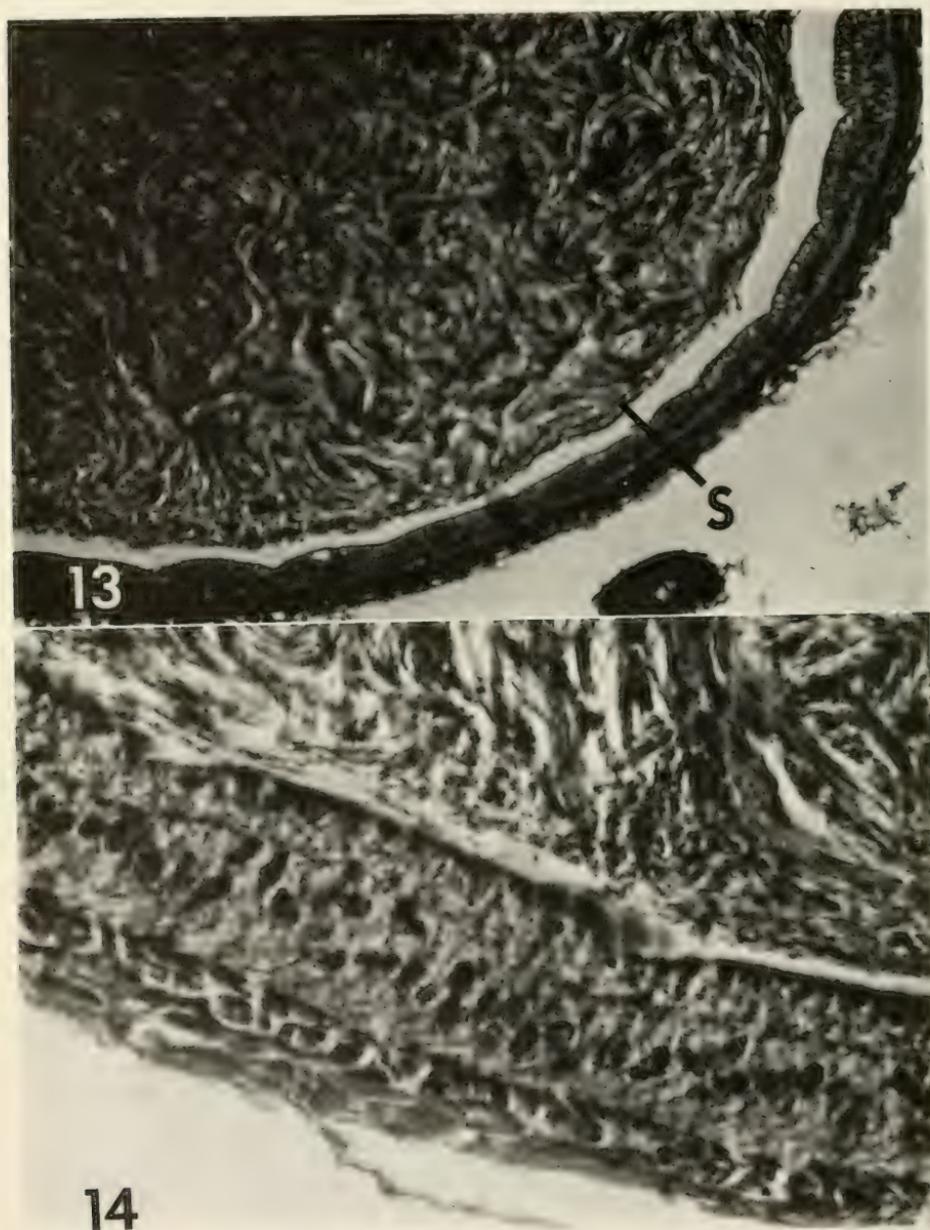
subgenera were not available for dissection, but there is no reason at the moment to assume that they differ significantly from *Dorylus* and *Anomma*.

The vasa deferentia are enlarged to form saclike seminal vesicles. These are elbowed, with their apices directed dorsally or posteriorly (Figs. 9, 10, 15, 16). They lay ventral to the accessory glands, which they superficially resemble, and they join the accessory glands ventrally at the proximal end of the glands. The wall of the seminal vesicle, at least in *Anomma* and *Rhogmus*, consists of a thin outer layer of muscle (?) and connective tissue and an inner layer, lining the lumen, of columnar epithelium (Figs. 13, 14).



Figs. 11, 12. Testis of pupa of *Dorylus (Anomma) nigricans*, cross section. 11, Several follicles (200 \times). 12, Single follicle with clearly defined spermatocysts (400 \times).

In *Rhogmus*, the lining is of uneven thickness in some places and in other locations is produced into a series of ridges. The lumen of the vesicle is filled with tightly packed spermatozoa.



Figs. 13, 14. Seminal vesicle of subgenus *Anomma* sp. male, cross section. 13, Portion of vesicle showing spermatozoa (S) in lumen (100 \times). 14, Detail of vesicle wall (400 \times).

The accessory glands appear saclike and usually curve or bend back upon themselves so that the distal half of each gland is directed dorsally or posteriorly (Figs. 10, 15, 16). *Alaopone* is the only exception to this general

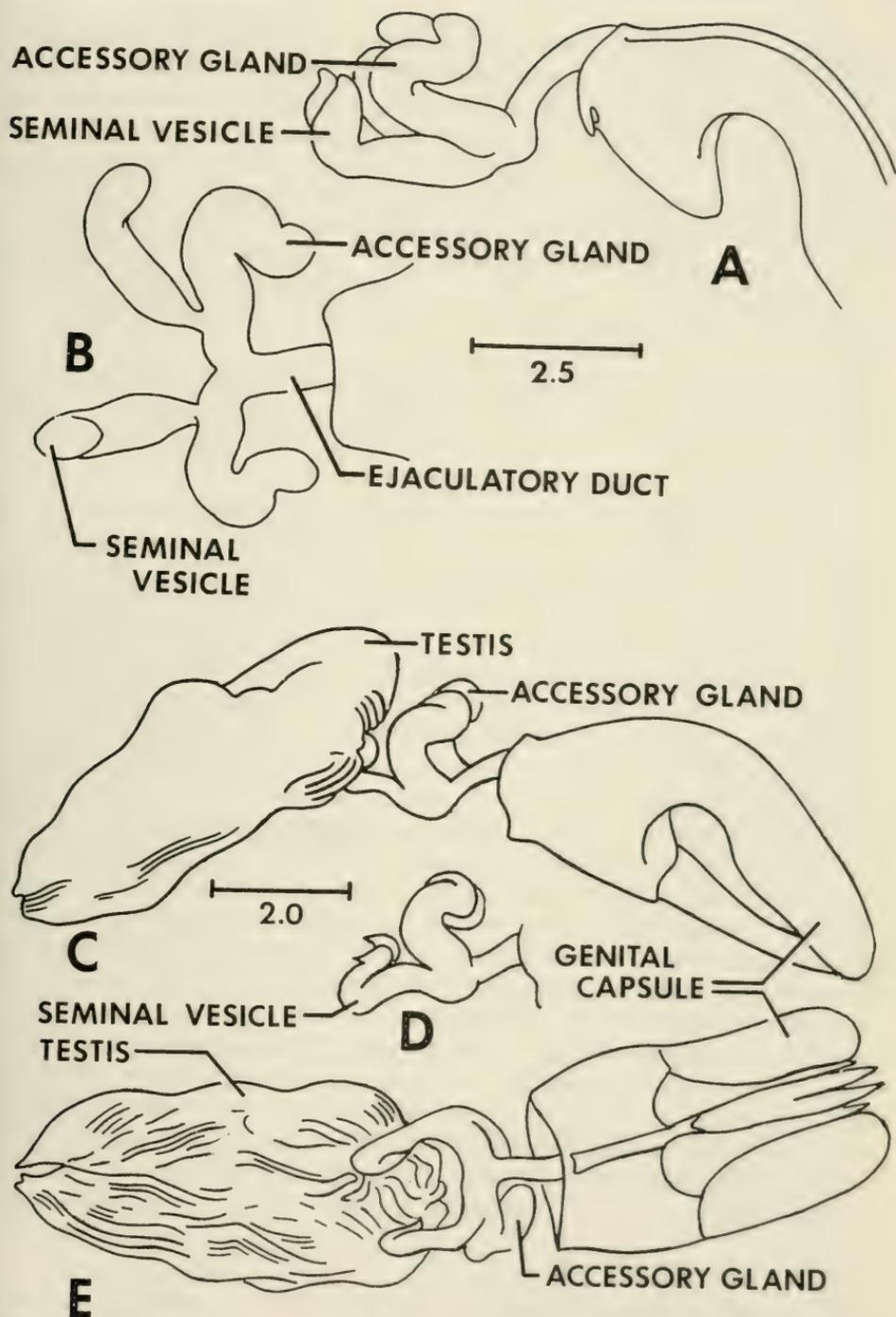


Fig. 15. Male reproductive system of subgenus *Dorylus* spp. A. Adult structures, lateral view. B. Adult structures, dorsal view. C. Pupal structures, lateral view. D. Internal pupal structures with testes removed, lateral view. E. Pupal structures, ventral view. Scales in mm.

morphology (see Fig. 9C). Removal of the outer wall reveals an internal, linear, hardened structure of unclear definition. Microscopically, in *Anomma* and *Rhogmus*, the wall of the gland is composed of two layers, an outer, probably muscular, layer and an inner layer of columnar epithelium. The outer layer is further subdivided into an outer coat of longitudinally arranged fibers and an inner coat of circularly arranged fibers. A lumen is present but its cross sectional shape is irregular because the lining is thrown into a series of ridges. These may represent the linear structures detected in gross dissection. The lumina of the glands sectioned were empty, except for the presence of some spermatozoa in limited areas in the *Rhogmus* specimen.

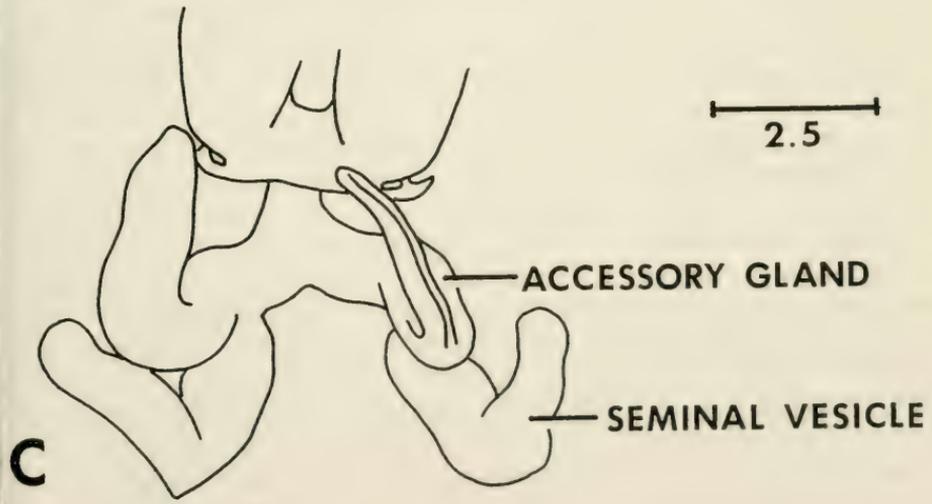
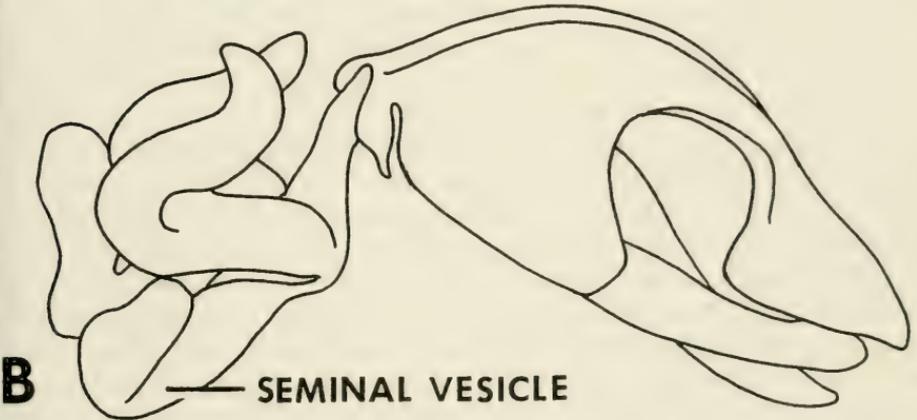
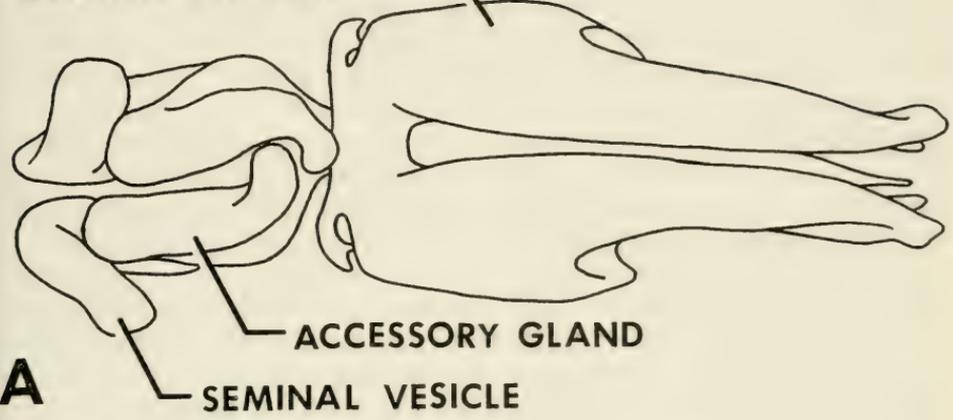
The ejaculatory duct is organized bilaterally with two lumina present. The epithelial lining is enlarged on the median wall in each lumen.

DISCUSSION

It is not uncommon among male holometabolous insects for the testes to reach their greatest development in the pupa. In the honey bee, for example, spermatogenesis is already completed by the fifth or sixth day of the pupal period (Snodgrass, 1956). After emergence, the testes of the drone shrink and eventually, in about 12 days, they are reduced by more than two-thirds their maximum pupal length. Shrinking or atrophy of the testes following pupal eclosion is not quantitatively uniform throughout the ants, although information in the literature on this phenomenon is largely nonexistent. For instance, in *Myrmica rubra* Linnaeus, the testes are well developed and conspicuous (Janet, 1902) and quite evident as well in the ponerines *Rhytidoponera metallica* F. Smith (Hagopian, 1963) and *Plectroctena lygaria*. However, Hung and Vinson (1975) noted, in dissections of male pupae and adults of different ages from several ant subfamilies, that as the males mature, the spermatozoa descend into the vasa deferentia and the testes become progressively smaller. Marcus (1953) avoided altogether figuring the testes in several ant species without explanation. From our observations, we must conclude that the disappearance of the testes in the adult male army ant is a universal phenomenon in both the Ecitoninae and Dorylinae. Only in the dissected specimens of *Neivamyrmex* and *Nomamyrmex* was there any evidence of atrophied testicular follicles. While the crudeness of gross dissection technique might obscure the observation of such follicles, we submit that this is unlikely since we specifically searched for the structures. Certainly we found nothing like the prominent testes described pre-

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Fig. 16. Male reproductive system of *Dorylus (Typhlopone)* sp. A, Dorsal view. B, Lateral view. C, Internal structures displaced for purpose of display, outer covering of left accessory gland removed, dorsal view. Scale in mm.

GENITAL CAPSULE



viously for *E. hamatum* (Forbes, 1958) and *N. harrisi* (Forbes and Do-Van-Quy, 1965). Even so, the testes described and figured for those two species appear much smaller than we would estimate their size to be in the pupa. The *N. harrisi* specimens were collected on their "nuptial" flight and might have been rather newly emerged.

While the vasa deferentia of many ant species—and other Hymenoptera, for that matter (see Matsuda, 1976)—are slender tubes (Fig. 1), those of army ants are characteristically expanded to form seminal vesicles. Some confusion regarding these expansive tubes exists in the literature. For example, the term "seminal vesicle" has been incorrectly applied to the accessory glands in several instances (Forbes, 1954; Hagopian, 1963; Hung and Vinson, 1975). Usually the seminal vesicle of army ants is of rather uniform diameter throughout its length. This was not true of one specimen of *Typhlopone* that we dissected, nor was it so for the specimens of *D. (Typhlopone) labiatus* examined by Mukerjee (1926). In these specimens each seminal vesicle included two prominent swellings separated by a constriction. These dilatations proved not to be discrete structures but rather areas containing compact masses of spermatozoa. There can be no doubt that the expanded vasa deferentia serve in the storage of gametes, since closely packed spermatozoa have been found there in *D. (T.) labiatus* (Mukerjee, 1926) and *Neivamyrmex* (Forbes and Do-Van-Quy, 1965) in previous research and in all genera and subgenera in the present study.

The army ant males are noteworthy in two respects when compared to other ants: (1) their testes rapidly degenerate once they become imagos; and (2) their vasa deferentia are expanded to form seminal vesicles. The genera *Eciton*, *Nomamyrmex*, and *Neivamyrmex* possess uniquely formed accessory glands, and *Eciton* and *Nomamyrmex* have a distinctly produced ejaculatory duct. In fact, thus far, similarly developed genitalia have not been found elsewhere amongst the ants. The internal male genitalia of the New World army ants are conspicuously different from those of the Old World species.

Within the New World species, *Eciton* and *Nomamyrmex* are most derived, with their long coiled accessory glands and ejaculatory duct. *Neivamyrmex* lacks the coiled ejaculatory duct and has instead one that forms a ventrally directed loop. Certainly *Cheliomyrmex* and *Labidus* are least derived. Their accessory glands, while partially coiled, are short and more closely approximate in size those of other ants. This condition in the males is consistent with the primitive nature of these two genera, especially *Cheliomyrmex* in which the workers possess a uninodal waist (the waist is binodal in the workers of all other New World ecitonines). In the Old World species, most especially in *Dorylus*, the internal male genitalia are uniformly developed. Even *Aenictus*, a genus hypothesized to have arisen independently in tropical Laurasia in the early Tertiary (Gotwald, 1977, 1979), con-

forms closely to the general pattern, except in the containment of its seminal vesicles in a single membranous capsule.

PHYLOGENETIC CONCLUSIONS

1. The male internal reproductive system of army ants is most derived in New World genera, especially in *Eciton*, *Nomamyrmex*, and *Neivamyrmex*, and least so in the Old World genera.

2. Morphology of the system within the New World species confirms the primitive nature of *Cheliomyrmex* and the generally derived state of *Eciton* and *Neivamyrmex*.

3. The system is uniform in the six subgenera of *Dorylus*, emphasizing the probable shared ancestry for these species.

4. Although the morphologies of the male system clearly reveal a dichotomy in development, supporting a diphyletic hypothesis of doryline origins (New vs. Old World species), they do not demonstrate a conspicuous difference between *Dorylus* and *Aenictus*.

ACKNOWLEDGMENTS

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AN UNUSUAL EXAMPLE OF TERATOGENESIS IN THE FLEA
THRASSIS FOTUS FROM COLORADO
(SIPHONAPTERA: CERATOPHYLLIDAE)

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Abstract.—A female *Thrassis fotus* (Jordan), collected from a deer mouse, *Peromyscus maniculatus* (Wagner), in Weld Co., Colorado, displayed teratogenic defects of the mesothorax and middle legs. Fusion and loss of segments of the two middle legs resulted in only one reduced middle leg, being neither right nor left, which arises midventrally. A photograph of this flea is presented, and the abnormalities are described and figured. Other abnormalities reported for Siphonaptera are reviewed.

The first review of teratogenic deformities in fleas (Smit, 1949a) reported the doubling of the receptaculum seminis (spermatheca), asymmetry of genital ctenidia, and shortening of spines and bristles. In subsequent papers Smit (1949b, 1952, 1953) reported another case of spermathecal duplication and abnormalities of the genitalia causing castration in male fleas. Brinck-Lindroth and Smit (1973) reviewed abnormalities associated with parasitic nematode infestations and presented more examples of male castration as well as female castration and intersexuality. Poinar and Nelson (1973) also reviewed examples of castration in New and Old World fleas. In fact, most reported cases of abnormalities in fleas deal with genitalia and structures that display secondary sexual dimorphism (e.g. the head): very few reports are concerned with deformities of the legs. Claassens (1967) described minor abnormalities in the legs of a male *Ceratophyllus gallinae* (Schrank) from Ireland which showed slight alterations in the marginal outlines of all coxae, one femur, tibia, and tarsomere. Sanjean and Travis (1955) reported an eight-legged *Orchopeas howardi howardi* (Baker) from New York which had a small distorted fourth pair of legs attached posteriorly to the metathoracic segment.

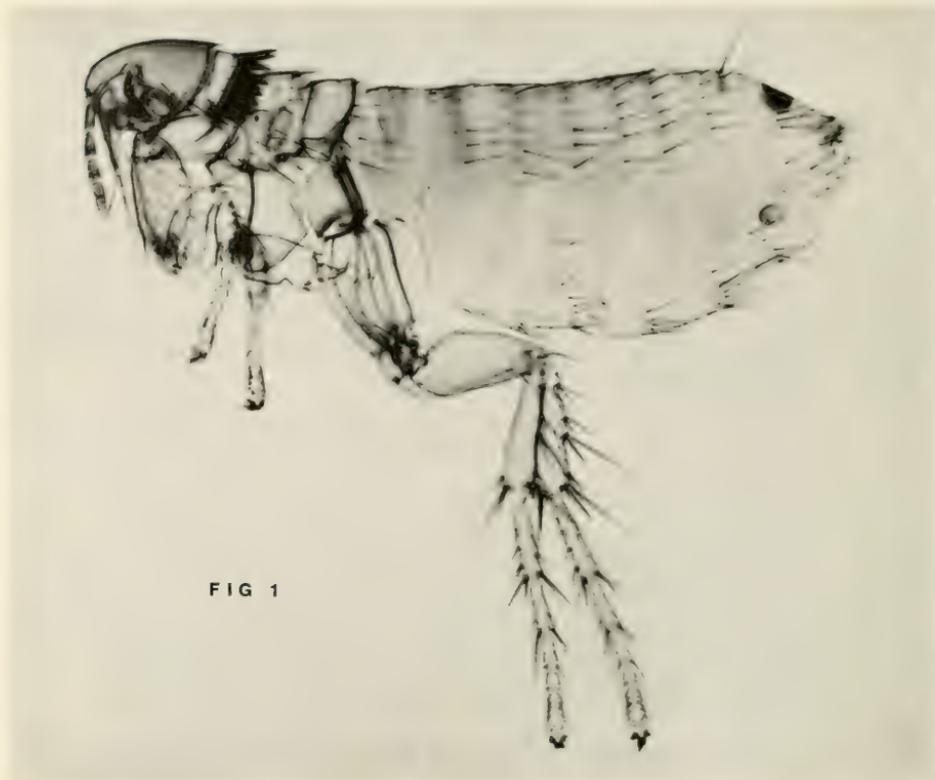


Fig. 1. *Thrassis fotus*, female, showing the single reduced middle leg. Body length, 2.0 mm.

As part of a study of small mammal populations on the shortgrass prairie, a female *Thrassis fotus* (Jordan) was collected which displayed teratogenic defects of the mesothorax and middle legs. This report describes this unusual flea.

MATERIALS AND METHODS

The flea was collected in the western division of the Pawnee National Grasslands, Weld Co., northeastern Colorado (40°45'N, 104°30'W). The site is shortgrass prairie at an elevation of 1500 m with an average annual precipitation of 300 mm. The prairie deer mouse, *Peromyscus maniculatus* (Wagner), and the thirteen-lined ground squirrel, *Spermophilus tridecemlineatus* (Mitchill), comprise approximately 90% of the individuals of the rodent community. The abnormal *T. fotus* was collected on 15 October 1974 from a *P. maniculatus* which had died while confined overnight inside a

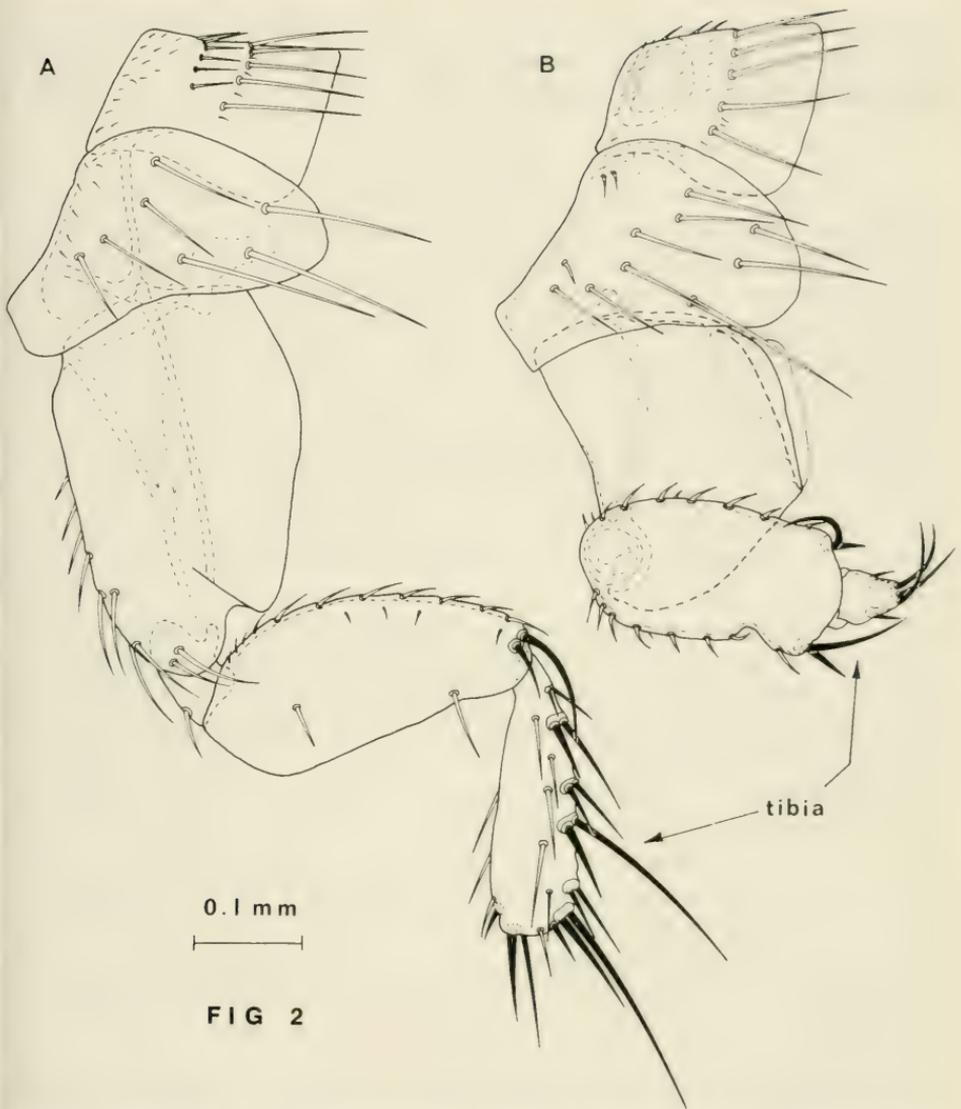


Fig. 2. Left lateral view of mesothorax and middle leg of *Thrassis fatus*. A. Normal, tarsus not illustrated. B. Teratogenic, tarsus absent (see text).

Sherman live trap. The flea was stored in 70% ethanol and later rehydrated, bleached in 10% KOH, and mounted for identification. The abnormalities were not noticed until after the flea had been bleached and mounted. Other fleas collected from *P. maniculatus* during the same period (14–16 October) were *Monopsyllus wagneri* (Baker) (25 ♂, 20 ♀), *Epitedia wenmanni wenmanni* (Rothschild) (1 ♀), and *Orchopeas* sp. (1 ♀). A normal female *T.*

fotus was also collected from the northern grasshopper mouse, *Onychomys leucogaster* (Wied-Neuwied), and this specimen is used for comparative purposes in the following description.

RESULTS

Fig. 1 is a photograph of the entire flea, and Fig. 2B shows the abnormal mesothorax and middle leg. For comparison, the normal morphology of a typical *T. fotus* collected from the same locality is illustrated (Fig. 2A).

Abnormalities in the mesothorax are: (1) The lack, on the left side, of a pleural rod except for dorsal and ventral thickenings (the rod is normally developed on the right side); and (2) presence of an internally sclerotized ring delineating a membranous area on the wall of the right anterior region of the mesonotum (apparently part of a distorted anterior phragma) and some of the large setae on this side bunched together and out of alignment.

Fusion and loss of segments of the two middle legs have resulted in only one reduced middle leg. This leg is neither right nor left but arises midventrally and is composed of a coxa, trochanter, femur, and tibia. The tarsus is absent.

The coxa is apparently the result of fusion between the right and left mesocoxae. Evidence to support this includes: (1) The coxa with one anterior and ventral margin but two dorsal and posterior margins; (2) two folds of less sclerotized cuticle, probably representing remnants of the medial walls, located between and joined to the two posterior margins; (3) presence of two pleural-coxal articulations but no sternal-coxal articulations since most of the medial walls have been lost in the fusion; (4) both lateral walls with a single unbranched outer internal ridge, the forked vertical thickening characteristic of the inner internal rod of the medial walls being absent; (5) absence of patches of small setae normally located anteriorly on the medial walls and no setae present along the anterior margin; and (6) absence of the partial oblique sutures of the lateral walls. In lateral view the coxa is shorter and rounder than normal.

The position of the trochanteral-coxal articulation has shifted slightly above and anterior to the normal position, and asymmetry in this articulation has caused the trochanter to project out to the left. This orientation and the position of the mounted specimen make observation of this segment very difficult.

The femur is near normal size, misshapen, and lies to the left of the coxa. The absence of lateral setae, the presence of both dorsal and ventral marginal setae, the presence of two pairs of preapical spiniform setae, and the presence of the short wavy cuticular striations characteristic of the medial walls, all suggest that this femur consists of two dorsal-medial halves. This could have resulted either through fusion of the left and right femora or through duplication of the dorsal-medial portion of one femur.

The leg's terminal segment is a very reduced tibia, and, like the femur, it has an identical setal pattern along both margins, suggesting that fusion or duplication has also occurred in this segment. In all other respects this particular specimen is quite normal.

DISCUSSION

Thrassis fatus occurs primarily on the thirteen-lined ground squirrel, *S. tridecemlineatus*, but has been found on other rodents, particularly *S. spilosoma* Bennett and *O. leucogaster* while records from *Peromyscus* spp. are rare (Stark, 1970). The abnormal *T. fatus* was the only individual of this collection found on the "wrong" host (*P. maniculatus*) although both *S. tridecemlineatus* and *O. leucogaster* were present at the site. This flea was most likely a straggler from one of these two species, but its physical deformity may have resulted in a lack of selectivity in its host choice. Alternatively, since this flea was probably raised in the nest of its preferred host, the impairment likely reduced its ability to maintain an association with its primary host. The fact that this five-legged flea was collected alive from an atypical host suggests that its survival was not precluded by the absence of functional middle legs. While the mesothorax and mesocoxae of fleas are involved with the jump, the major force is provided through the back legs (Rothschild et al., 1973, 1975). The role of the middle legs during the jump remains unclear, but these legs may be used to help the flea stabilize itself just prior to jumping, and they may assist, along with the back legs, in grasping on to a host at the end of a jump (Rothschild et al., 1975). However the question remains as to whether the scarcity of reported leg abnormalities in fleas is due to their low frequency of occurrence, their possible cause of high mortality in newly emerged adult fleas, or failure of observers to report such defects.

The specimen is deposited in the Siphonaptera Collection, British Museum (Natural History), London.

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A NEW SPECIES OF *PHORBELLIA* ROBINEAU-DESVOIDY
SEPARATED FROM A PREVIOUSLY DESCRIBED
NORTH AMERICAN SPECIES
(DIPTERA: SCIOMYZIDAE)

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Abstract.—A new species, *Pherbellia suspecta*, is separated from the recently described Nearctic *P. subtilis* Orth and Steyskal. Both are members of the *P. ventralis* group. A collection locality map indicates the North American distribution of this group, which includes *P. obscura* Ringdahl, an Holarctic species. Terminalia illustrations are included for the above as well as for *P. ventralis* (Fallén), a Palaearctic species.

The new species, *Pherbellia suspecta*, described here was recognized too late to be included in a recent paper by Orth et al. (1980) on the *P. ventralis* group. Examination of material from the Biosystematics Research Institute, Agriculture Canada, now confirms an additional North American species in the subgenus *Chetocera* belonging to the *P. ventralis* group. Members of this group are typified by the European species *P. ventralis* (Fallén). In North America the group now consists of the Holarctic species, *P. obscura* Ringdahl, and two Nearctic species, *P. subtilis* and *P. suspecta*. Distribution of *P. suspecta* is mid-Canadian to northeastern United States. This new species was at first thought to be a variant of *P. subtilis*. However, now that additional material has been seen, we recognize it as a distinct species. At Banff National Park, Alberta, Canada, *P. suspecta* is sympatric with *P. subtilis* and *P. obscura*. Throughout the geographic distribution of the above three species, we have seen no intergrades that might suggest that this new species is a variant of the two previously recognized species.

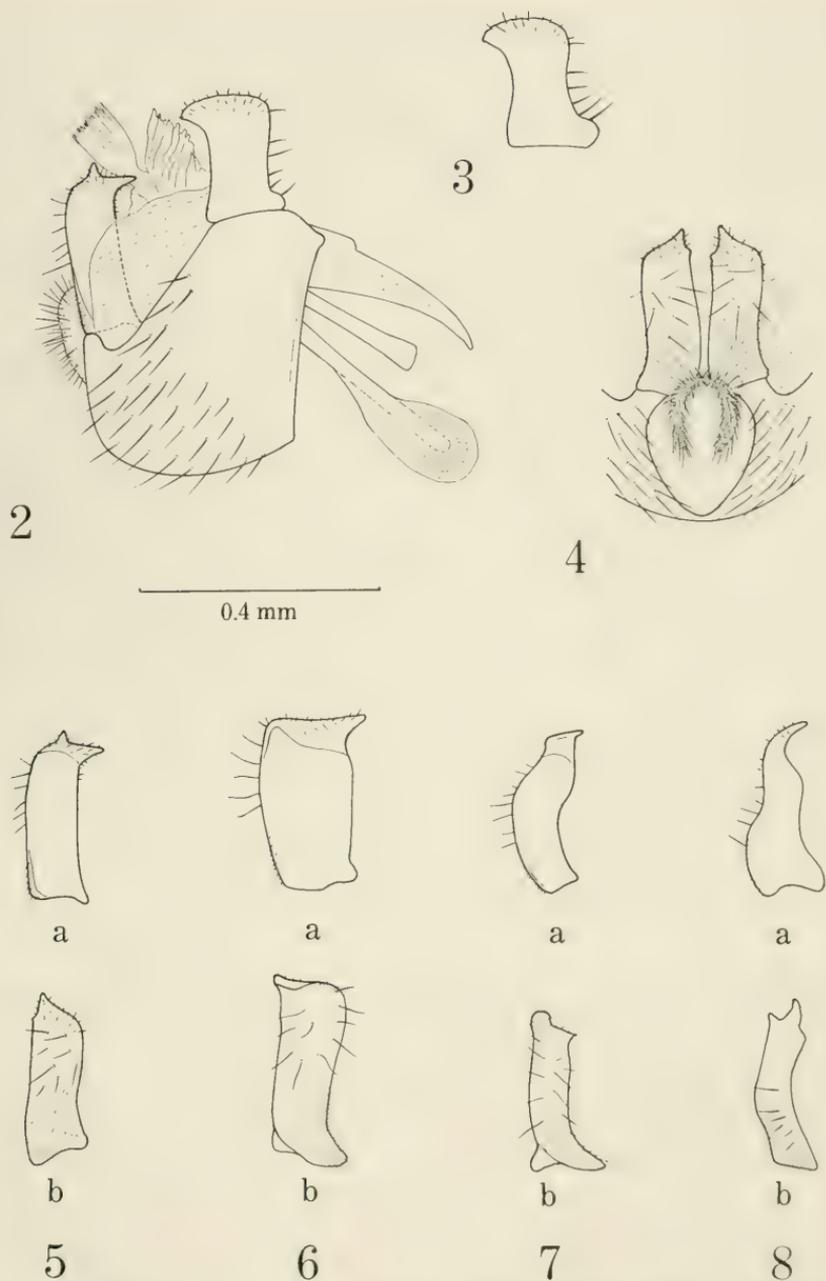


Fig. 1. *Pherbellia suspecta*, holotype male. Abdominal segments excised and retained in genitalia capsule on pin beneath specimen.

Pherbellia suspecta Orth and Steyskal, NEW SPECIES

Figs. 1-5

Holotype male.—Height of head $\frac{2}{3}$ width. Medifacies yellowish pruinose, parafacies and cheeks pruinose yellowish to whitish, respectively. Frons dull yellowish, slightly narrowed anteriorly. Midfrontal stripe extending less than $\frac{1}{2}$ distance from anterior ocellus to anterior margin of frons. Ocellar triangle and orbital plates with greyish pruinosity. Orbital plates strongly tapered anteriorly, extending slightly beyond midfrontal stripe. Orbitoantennal spot lacking, narrow strip of grey pruinosity along upper orbital margin. Two pairs of fronto-orbital bristles, anterior pair slightly shorter; ocellars, postocellars and inner and outer verticals well developed. Occiput greyish pruinose. Short black setae on lower $\frac{2}{3}$ of cheeks and parafacies, on anterior $\frac{1}{2}$ of frons, between ocellar and postocellar bristles, along outer parts of orbital plates, and in midcervical patch. Lateral occipital margins with stronger setae and bristles. Antennae testaceous, segment 3 elongate oval, dorsal margin straight. Arista brownish black, without hairs. Palpi yellowish, labium and labella brownish.



Figs. 2-4. *Pherbellia suspecta*. Hull, Quebec, Canada. Inverted views. 2. Postabdomen, sinistral view. 3. Anterior surstylus, viewed in broadest aspect. 4. Posterior view of postabdomen. Figs. 5-8. Posterior surstyli, inverted: a, lateral view; b, posterior view. 5. *P. suspecta*. Hull, Quebec, Canada. 6. *P. subtilis*. Willits, Mendocino Co., California, USA. 7. *P. obscura*. Kvikkjokk, Norrbotten, Sweden. 8. *P. ventralis*. Tzavrou, Corfu, Greece.

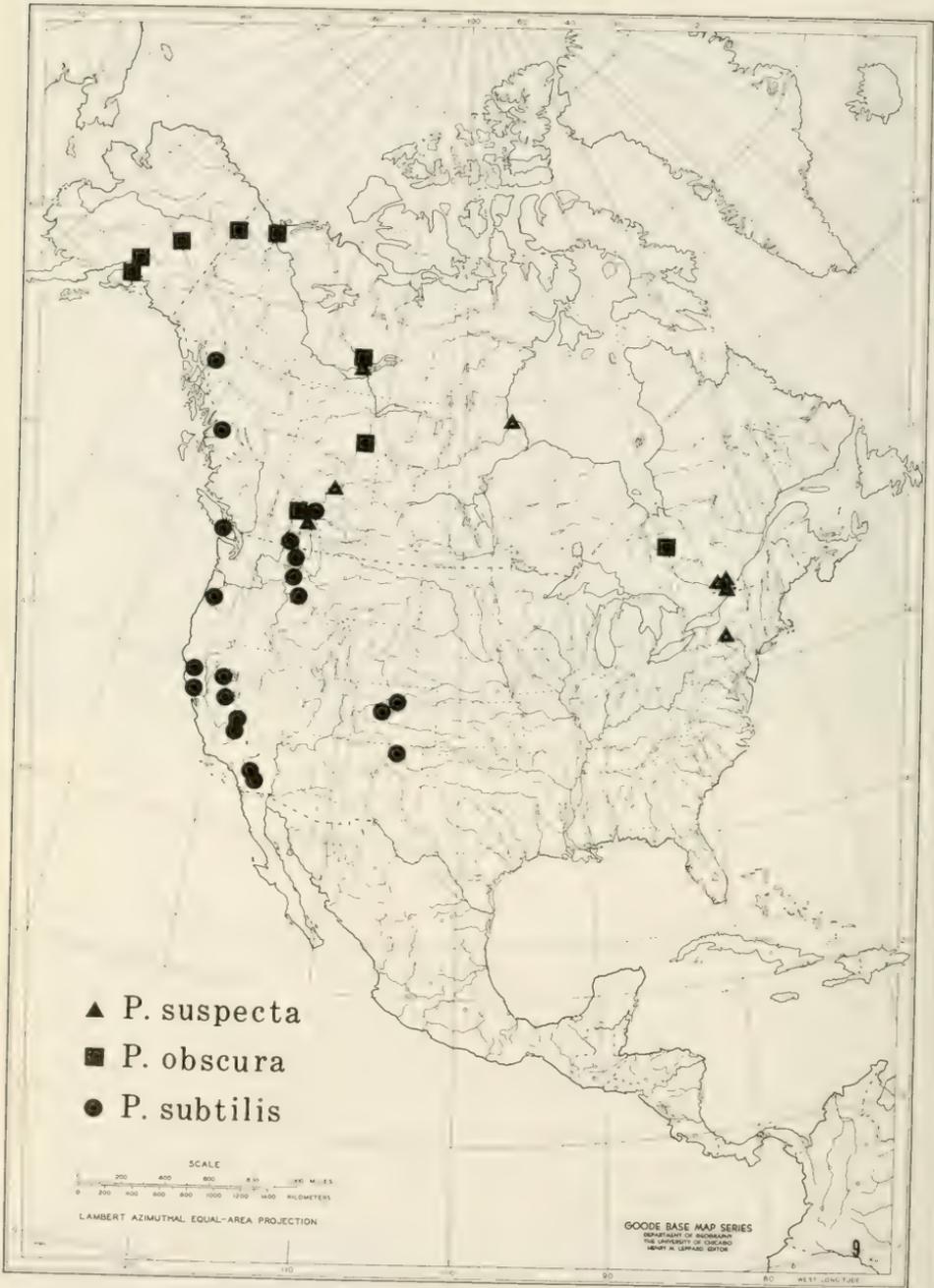


Fig. 9. Collecting sites for *Pherbellia suspecta*, *P. obscura*, and *P. subtilis*.

Thorax grey pruinose dorsally with brownish longitudinal stripes. Mesopleuron with broad, diagonal brown stripe extending below middle but not to lower posterior corner. Remainder of thoracic surfaces light greyish pruinose. Mesopleuron bare. Pteropleuron with a cluster of 6 sinistral and 8 dextral bristles of nearly equal size; no vellar bristles. Sternopleuron with fine short hairs over most of the surface and well-developed bristles ventrally. Prosternum bare.

Coxae testaceous with silvery pruinosity. Forefemur and foretibia brownish black. Tarsal segments brownish. Mid- and hindlegs entirely brownish yellow, slightly infumated.

Wing length 3.7 mm. Membrane greyish yellow hyaline; costal margin and wing veins testaceous; crossveins very slightly infuscated. No stump veins; anterior crossvein oblique, 1st vein ending well beyond level of anterior crossvein; anal vein reaching margin. Haltere, squama, and squamal ciliae yellowish white.

Abdominal segments brownish, slightly infumated dorsally, andrium testaceous; postabdomen as in Figs. 2-5.

Allotype female.—Similar to holotype except in abdominal morphology. Wing length 3.6 mm.

Holotype.—♂, Canada, Quebec, Hull, 12 May 1947, G. E. Shewell.

Allotype.—♀, same data as holotype.

Paratypes.—Same data as holotype (13 ♂, 2 ♀).

Other specimens.—In addition to the above, we have seen material from the following localities: *Alberta*: Banff National Park. *Northwest Territories*: Yellowknife. *Ontario*: Ottawa. *Quebec*: Old Chelsea; Beach Grove.

The following material previously determined (Orth et al., 1980) as *P. subtilis* must now also be ascribed to *P. suspecta*. *Alberta*: 40 mi W of Edmonton (Wabamun Lake). *Manitoba*: Churchill. *New York*: Tompkins Co., Ringwood, Dryden.

Deposition of material.—Holotype, allotype, and paratypes are all the property of the Biosystematics Research Institute, Agriculture Canada, Ottawa, Ontario.

Variation.—This species shows moderate variation in color. Grey areas may be in part replaced by tan or brown. Bristles in the cluster on the pteropleuron vary in number from 5 to 10. Wing length varies from 3.0 to 3.8 mm in males, 3.0 to 4.0 mm in females.

Discussion.—Species within the *P. ventralis* group closely resemble each other in external morphology. Size and color are too variable for positive identification. Examination of dissected male postabdomens in the laboratory remains the best means for separating the various species. The posterior surstylus has excellent characters for separation (Figs. 5-8). Distribution of the three North American species (Fig. 9) shows partial geographic isolation as well as areas of overlap for each species. *Pherbellia suspecta*

is known from Yellowknife, N.W.T.; south to Banff, Alberta; east to Ottawa, Ontario; and south to Dryden, New York. *Pherbellia obscura* is known from Anchorage, Alaska; northeast to Aklavik, N.W.T.; south to Yellowknife, N.W.T. and Banff, Alberta. A single male specimen was recorded at Low Bush, Ontario, a disjunct locality 1600 miles (2550 km) east of any site where *P. obscura* had been previously collected. *Pherbellia subtilis* is known from Lisadale Lake, British Columbia; southeast to Banff, Alberta; southwest to Lake Hemet, California; and east to Cimarron Canyon, New Mexico.

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REVISION OF THE GENUS *FRENCHIA* WITH
DESCRIPTION OF A NEW SPECIES
(HOMOPTERA: COCCOIDEA: ASTEROLECANIIDAE)

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Abstract.—The genus *Frenchia* is redescribed, and its taxonomic status is discussed. The immature and adult female stages of a new species, *F. banksiae*, are described and illustrated. Also, redescriptions and illustrations are provided for *F. casuarinae* Maskell and *F. semioculta* Maskell. Numerical data on the external morphological structures of each stage are given, and keys are provided for determination of the three species in each stage. Plant galls and other malformations produced by each species are illustrated and described, and the economic importance of each species is discussed. Species of *Frenchia* occur only in the Australian Region, and are considered to form a distinct branch of the family Asterolecaniidae.

The genus *Frenchia* was erected by Maskell (1892) to include the species *F. casuarinae*, a gall-forming coccoid from Australia. Later, Maskell (1895) included a second species, *F. semioculta*, in the genus. Froggatt (1898, 1921, 1933) provided additional data on gall formation, hosts, and distribution for both species. Morrison and Morrison (1922, 1927) redescribed both species but stated that they were unable to see several morphological characters of the various instars because of the poor quality of the slide-mounted material. It is for this reason and for the interesting new species recently recognized in a shipment from Australia, that we are revising this genus.

Morphological descriptions and illustrations have been prepared for all available stages of the three *Frenchia* species to show relationships. Keys to the adult females and first- and second-instar females are presented to assist with species determination. Measurements are given in microns; averages are followed by ranges in paranthesis. Abbreviations for the names of institutions from which material was obtained or is deposited are: Australian National Insect Collection, Canberra, Australia (ANIC); British Mu-

seum (Natural History), London, England (BM); Department of Scientific and Industrial Research, Auckland, New Zealand (DSIR); U. S. National Museum of Natural History, Beltsville, Maryland (USNM); University of Tennessee, Knoxville, Tennessee (UT); Virginia Polytechnic Institute and State University, Blacksburg, Virginia (VPI); and Waite Agricultural Research Institute, Adelaide, S. Australia (WARI). For type-material designations and material studied lists, the first digit indicates the number of specimens, the second digit in parenthesis is the number of slides.

Frenchia Maskell, 1892

Type-species.—*Frenchia casuarinae* Maskell, 1892, by original designation and monotypy.

Type-locality.—Australia.

Diagnosis.—Probably all 3 species bisexual; however, male descriptions lacking because of rarity of specimens. Males of different stages seen in *F. banksiae*, n. sp. and in *F. semiocculta*. Galls produced by males known in *F. semiocculta*. Adult females occur within galls, or in pitlike malformations.

Adult female body variable in form; pyriform, or ovoid with acutely tapered abdomen. Dorsum with numerous quinquelocular pores, except in *F. semiocculta*; often with few 8-shaped or simple disc pores on abdomen, large 8-shaped pores few or absent, many scattered tubular ducts, these without terminal filament (usually absent on posterior abdominal segments), anal region rounded or acute at apex, distinct anal lobes and apical setae absent. Venter with unsegmented antennae, legs absent, bilocular pores on cephalothorax, usually with quinquelocular pore band in submarginal area or at least in spiracular furrows, anal ring indistinct without setae, or distinct with setae, tacklike setae scattered on both body surfaces.

Second-instar female body pyriform or elliptical, tapering toward caudal end. Quinquelocular pores numerous on dorsal and ventral submarginal area, or restricted to a marginal row on venter, or absent, except in spiracular furrows. Dorsum without tubular ducts, setae rare, large 8-shaped pores and simple disc pores absent or present. Venter with short unsegmented antennae, scattered bilocular pores and often with few trilocular pores in spiracular furrows, quinquelocular pores in marginal row or band and in spiracular furrows, anal ring poorly developed.

First-instar body elliptical. Dorsum with large 8-shaped pores and simple disc pores in segmental or longitudinal rows, setae rare, most tacklike. Venter with 6-segmented antennae, elliptical eyes, 5-segmented legs, a campaniform sensillum at base of each tarsus, apparently none on trochanter, slender pairs of tarsal and claw digitules, at least 1 trilocular pore associated with each spiracle, few bilocular pores on derm. anal ring without or with setae, anal lobes with prominent apical setae.

Notes.—*Frenchia* originally was included by Maskell (1892) in the family Brachyscelidae because of formation of plant galls. This family name was changed to Apiomorphidae because *Brachyscelis* Schrader was preoccupied in the Coleoptera in 1834, and was replaced by *Apiomorpha* Rübsaamen, 1894. Other workers realized that besides the gall-forming habits, the type-species of the genus morphologically had very little in common with *Apiomorpha*, but much more with Asterolecaniidae.

Morrison and Morrison (1922) placed *Frenchia* in a group of genera containing *Asterolecanium*. Russell (1941) assigned *Frenchia* to the subfamily Asterolecaniinae and noted that it belonged to a group of genera most closely related to *Amorphococcus*, *Asterolecanium*, and *Polea*.

Borchsenius (1960) placed *Frenchia* in the tribe Polliniini in association with the genera *Callococcus* Ferris, *Mycococcus* Ferris, and *Pollinia* Targioni-Tozzetti. Koteja (1974a), based on characters of the mouthparts, disagreed with the latter assignment. It appears from Koteja's and our studies that *Frenchia* occupies a distinct status among the asterolecaniids and is probably not closely related to any of the recently studied genera in this family; therefore, it probably needs to be transferred into a new subfamily. Studies on the poorly known genera of Asterolecaniidae to be undertaken by the first author in the near future should assist with the proper phylogenetic placement of the genus *Frenchia*. Taxonomic information on the adult males in these genera also would be helpful.

KEY TO ADULT FEMALES OF *FRENCHIA*

1. Anal region not sclerotized; large 8-shaped pores absent on dorsum of cephalothorax; anal ring without setae 2
- Anal region heavily sclerotized; large 8-shaped pores present on dorsum of cephalothorax; anal ring with setae .. *banksiae*, new species
2. Abdominal region more than twice as long as cephalothorax; quinquelocular pores present on dorsum *casuarinae* Maskell
- Abdominal region less than twice as long as cephalothorax; quinquelocular pores absent on dorsum *semiocculta* Maskell

KEY TO SECOND-INSTAR FEMALES OF *FRENCHIA*

1. Anal ring absent or incomplete; dorsal 8-shaped pores absent; antennae with 2 or 3 setae 2
- Anal ring well developed; dorsal 8-shaped pores present; antennae with 4 setae *banksiae*, new species
2. Quinquelocular pores present on dorsum and in submarginal band on venter; anal ring absent *casuarinae* Maskell
- Quinquelocular pores absent on dorsum and restricted to spiracular furrows on venter; anal ring present, but incomplete
..... *semiocculta* Maskell

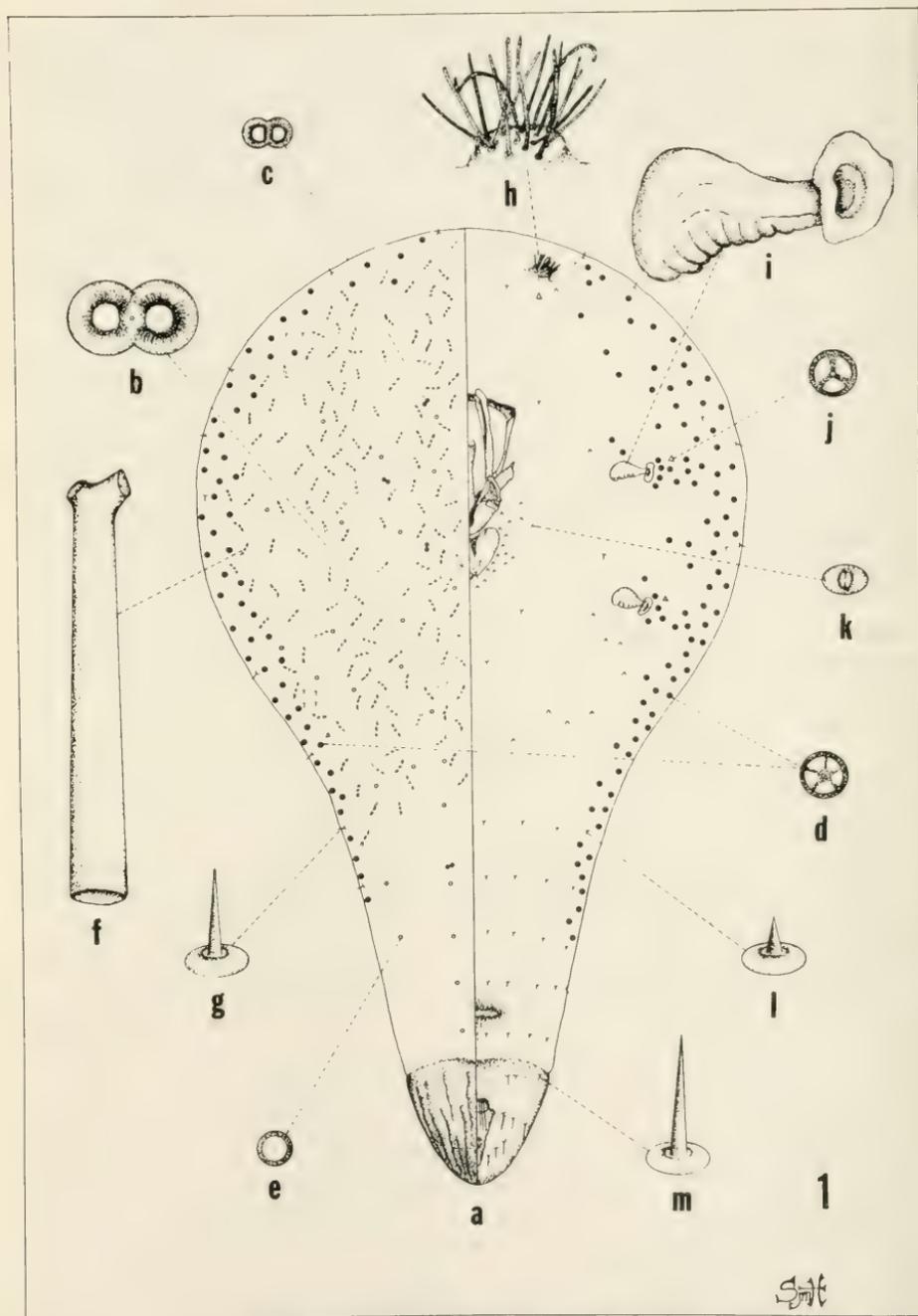


Fig. 1. *F. banksiae*, adult female. a, Dorsoventral view. b, Large 8-shaped pore. c, Small 8-shaped pore. d, Quinquelocular pore. e, Simple disc pore. f, Tubular duct. g, Tacklike seta. h, Antenna. i, Spiracle. j, Trilocular pore. k, Bilocular pore. l, Tacklike seta. m, Needlelike seta.

KEY TO FIRST-INSTAR FEMALES OF *FRENCHIA*

1. Large 8-shaped pores in 6 long (extending almost entire body length) and 2 short (extending less than halfway on body) longitudinal rows; 1 trilocular pore associated with each spiracle; labium with 4 or less pairs of setae 2
- Large 8-shaped pores in 4 long (extending almost entire body length) and 2 short (extending less than halfway on body) longitudinal rows; 2 trilocular pores associated with posterior spiracle; labium with 5 pairs of setae *semioculta* Maskell
2. Large 8-shaped pores not forming 2 intermedial longitudinal rows; anal ring without setae; 2 pairs of setae between antennal base and clypeolabral shield; bilocular pores on submarginal area of anterior abdominal segments and near clypeolabral shield *casuarinae* Maskell
- Large 8-shaped pores forming 2 intermedial longitudinal rows; anal ring with setae; 3 or more pairs of setae between antennal base and clypeolabral shield; bilocular pores only near clypeolabral shield *banksiae*, new species

Frenchia banksiae Lambdin and Kosztařab, NEW SPECIES

Adult Female

Figs. 1a–m

Type-material.—From leaf galls of *Banksia serrata* L., 5(3), Nr. Bairnsdale, Victoria, Australia, 11 Aug. 1976, P. Gullan Coll. (WARI); 3(3) Malacoota, Victoria, Australia, 20 Feb. 1976, P. Gullan Coll. (WARI No. 5/76) (2 at WARI and holotype deposited at ANIC); 2(1), 20 mi. W. of Bairnsdale, Victoria, Australia, 31 Jan. 1972, J. W. Beardsley Coll. (WARI); on *Banksia* sp., 10(5), Sydney, New South Wales, Australia, G. Compere Coll. No. 248 (USNM); 3(1), G. Compere Coll. No. 178 (USNM); 3(1), New South Wales, Australia, G. Compere Coll. No. 691 (USNM); 6(2), Australia, 10 Mar. 1977, coll. at San Francisco. (Quarantine No. 8200), P. T. Meyerson Coll. (USNM). Material deposited as follows: Holotype 1(1) and paratypes 5(3), (ANIC); other paratypes 1(1), (BM); 16(7), (USNM); 1(3), (UT); 1(3), (VPI); 3(2), (WARI).

Body (Fig. 1a).—Pyriform, 1190 (1080–1320) long, 711 (604–900) wide; derm membranous.

Dorsum.—Large 8-shaped pores on margin. An occasional pair of 8-shaped pores (Fig. 1b) on 1st or 2nd abdominal segment; each 8 (8–9) long, 5 wide. Four pairs of small 8-shaped pores (Fig. 1c) on cephalothorax and anterior abdominal segments; each 4 (3–5) long, 3 (2–4) wide. Quinquelocular pores (Fig. 1d) in marginal-submarginal band 1–8 pores wide from anterior cephalothoracic region to 4th or 5th abdominal segment; each 4 (3–5) in diameter. Simple disc pores (Fig. 1e) in transverse segmental rows on

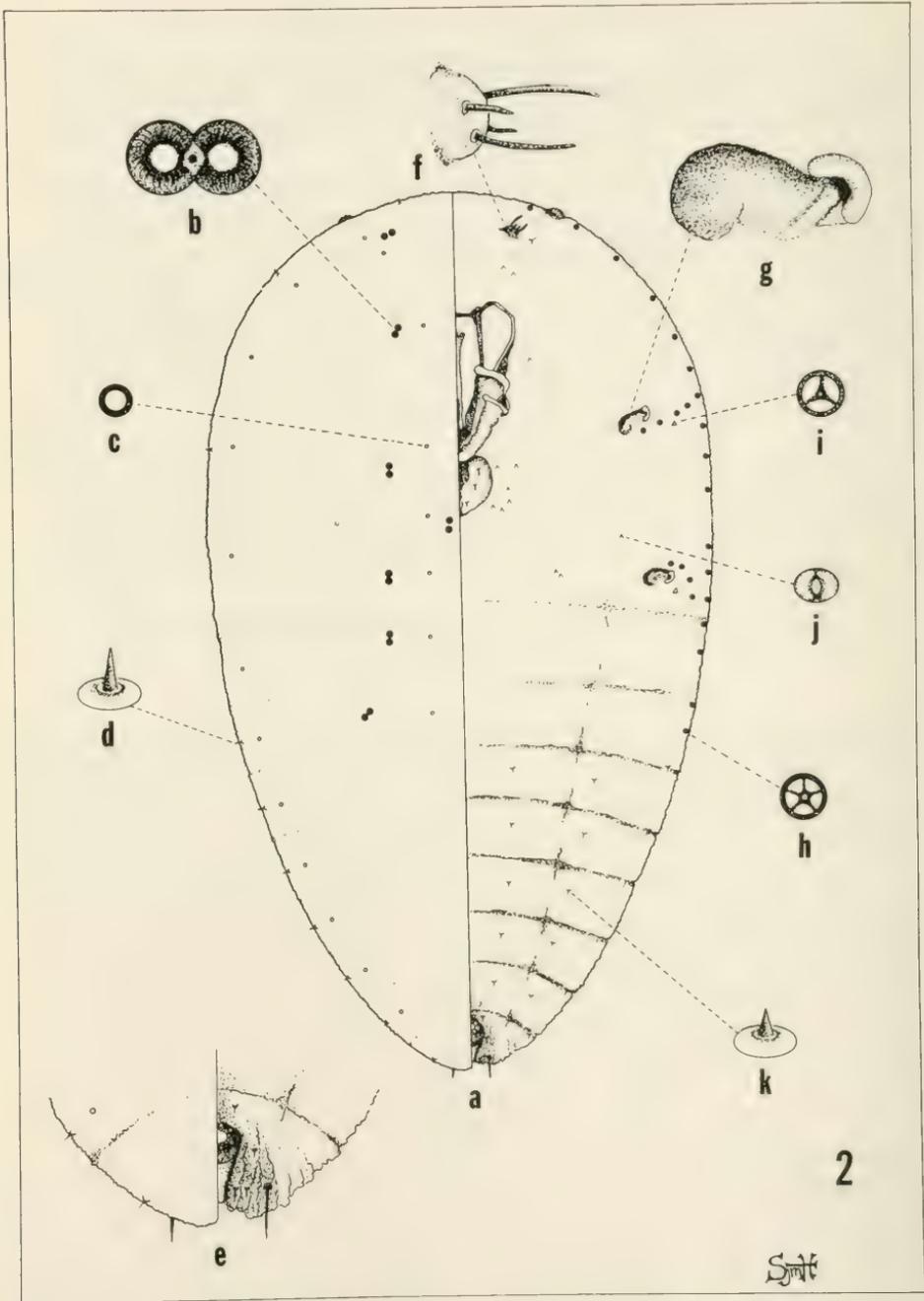


Fig. 2. *F. banksiae*, second-instar female. a, Dorsoventral view. b, Large 8-shaped pore. c, Simple disc pore. d, Tacklike seta. e, Anal region. f, Antenna. g, Spiracle. h, Quinquelocular pore. i, Trilocular pore. j, Bilocular pore. k, Tacklike seta.

cephalothorax and anterior abdominal segments, each 3 (2–4) in diameter. Tubular ducts without terminal filament (Fig. 1f) on cephalothorax and anterior abdominal segments; each 34 (31–37) long, 2 (1–2) wide. Tacklike setae (Fig. 1g) on body margin; each 5 (4–7) long. Anal region well developed, heavily sclerotized, rounded at apex and lacking setae.

Venter.—Antennae (Fig. 1h) unsegmented, 22 (16–29) long, 23 (19–25) wide; with 18 (11–23) setae, some bifid. Clypeolabral shield 157 (135–174) long, 114 (103–121) wide. Labium unsegmented, 53 (50–63) long, 69 (64–76) wide; with 2 pairs of slender setae 10 (7–13) long. Legs absent. Spiracles (Fig. 1i) on submargin; 59 (54–62) long, 24 (18–34) wide, atrial opening 8 (6–10) in diameter. Associated quinquelocular pores (Fig. 1d) near spiracles and in marginal band that extends from antennae to about mid-abdomen, shape and size as those on dorsum. Few trilocular pores (Fig. 1j) also associated with spiracles. Cluster of 18 (14–22) bilocular pores (Fig. 1k) near mouthparts on each side, 1 near base of antenna and a few on each anterior abdominal segment; each 3 (2–4) long, 3 (2–5) wide. Tacklike (Fig. 1l) to needlelike setae (Fig. 1m) in medial and submarginal regions of cephalothorax and in 5 transverse rows on abdomen; each 5 (4–8) long. Anal ring positioned anterior to heavily sclerotized anal tube; 16 (12–20) long, 15 (11–18) wide. Anal ring with 6 setae, each 40 (36–42) long. Anal area setae in oblique rows in sclerotized region; anterior row with outer seta 8 (7–10) long, medial pair 9 (7–11) long; medial row lateral of anal ring with outer seta 21 (18–24) long, medial pair 12 (11–16) long; posterior row with outer seta 24 (22–27) long, medial seta 8 (6–11) long, inner seta about 19 long.

Note.—Females present in galls formed on leaves of *Banksia* (Figs. 9, 10).

Second-Instar Female

Figs. 2a–k

Paratypes studied.—On *Banksia serrata*, 21(8), Mallacoota, Victoria, Australia, 20 Feb. 1976, P. Gullan Coll. (WARI); 3(1), 20 mi. W. of Bairnsdale, Victoria, Australia, 31 Jan. 1972, J. W. Beardsley Coll. Material deposited as follows: 3(1), (ANIC); 2(1), (BM); 3(1), (USNM); 7(1), (UT); 2(1), (VPI); 8(3), (WARI).

Body (Fig. 2a).—Ovoid, 594 (501–666) long, 345 (248–465) wide; derm membranous.

Dorsum.—Six (3–8) submedial pairs of large 8-shaped pores (Fig. 2b) in irregular longitudinal row on cephalothoracic and anterior abdominal segments; 1 pair in median area of cephalothorax; each 8 (7–8) long, 6 (4–6) wide. Simple disc pores (Fig. 2c) in submarginal row, 1 pair per segment, extending from cephalothorax to 8th abdominal segment, and in 2 irregular submedial rows on cephalothorax and a few on anterior abdominal segments; each 2 in diameter. Usually 1 pair of tacklike marginal setae (Fig. 2d) per segment, each 3 (2–4) long. Anal lobes (Fig. 2e) slightly pronounced.

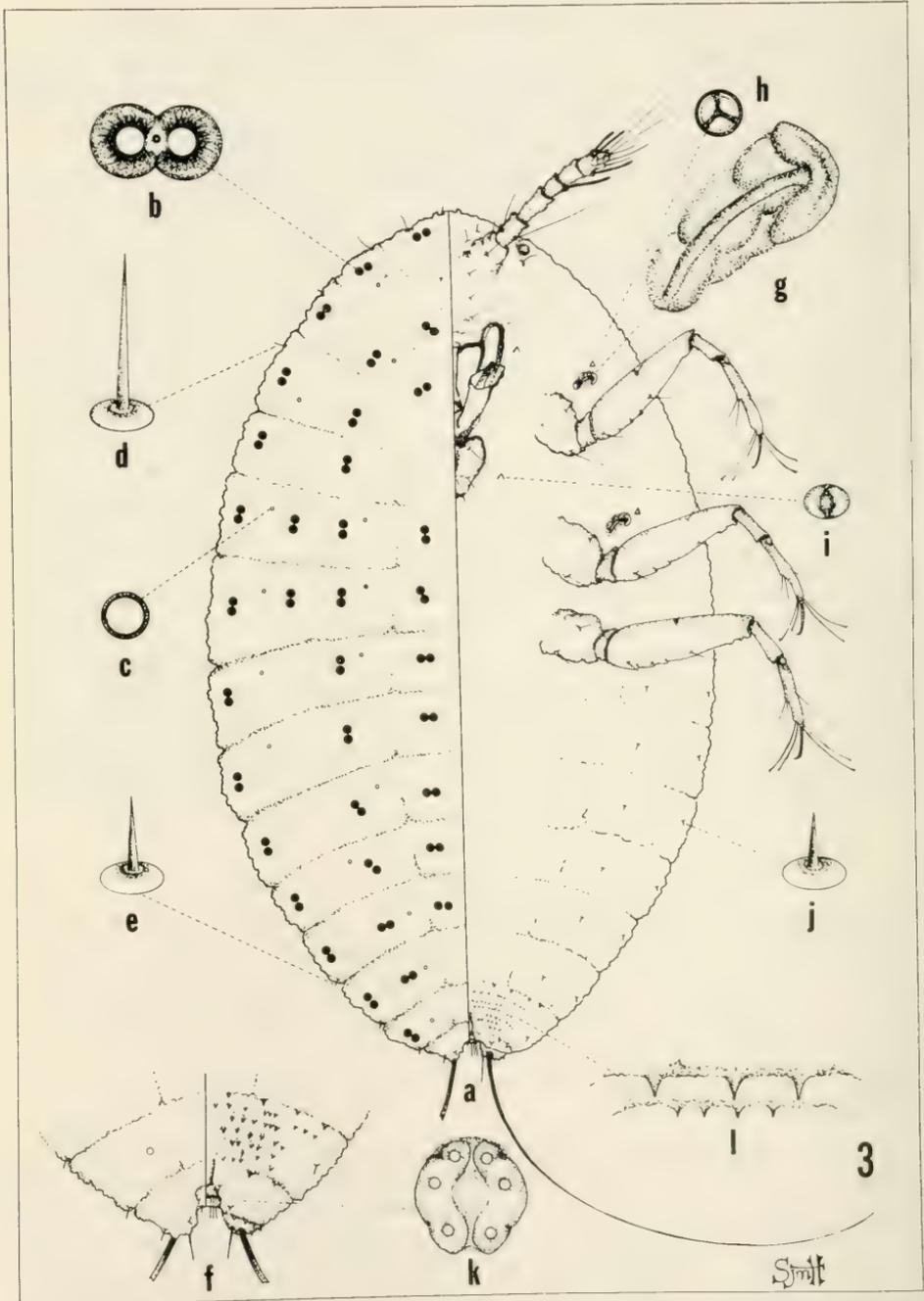


Fig. 3. *F. banksiae*, first-instar female. a, Dorsoventral view. b, Large 8-shaped pore. c, Simple disc pore. d, Needlelike seta. e, Tacklike seta. f, Anal lobes. g, Spiracle. h, Trilocular pore. i, Bilocular pore. j, Tacklike seta. k, Anal ring. l, Macrospines and microspines.

Venter.—Antennae (Fig. 2f) unsegmented, 9 (7–12) long, 13 (12–16) wide; with 4 fleshy setae, each 11 (7–14), 7 (6–10), 4 (4–5) and 2 (1–2) long. Clypeolabral shield 114 (106–122) long, 86 (74–118) wide. Labium 44 (32–61) long, 57 (50–60) wide; with 3 pairs of setae, each 4 (2–6) long. Legs absent. Spiracles (Fig. 2g) 32 (24–37) long, 11 (8–13) wide, atrial opening 3 (2–5) in diameter. Quinquelocular pores (Fig. 2h) associated with spiracles and forming 2 marginal rows, 17 (12–19) per row, extending from eyes to anterior abdominal segments, each 4 (3–4) in diameter; occasionally a few aberrant trilocular (Fig. 2i) or multilocular pores present in spiracular furrows. Most bilocular pores (Fig. 2j) near mouthparts, 8 (7–10) pores on each side, each ca. 2 in diameter. Anal ring (Fig. 2e) 13 (13–14) long, 13 (12–14) wide; with 6 setae, each 18 (11–23) long. Tacklike abdominal setae (Fig. 2k) in 5 or 6 transverse rows, each 3 (1–4) long. Each $\frac{1}{2}$ of anal area (Fig. 2e) with 1 seta anterior to anal ring, 5 (4–7) long, 1 laterad of anal ring and 2 mesad of apical seta, each 6 (5–8) long, apical seta 14 (11–16) long.

First-Instar Female

Figs. 3a–l

Paratypes studied.—On *Banksia serrata*, 5(2), Mallacoota, Victoria, Australia, 20 Feb. 1976, P. Gullan Coll. (WARI); 1(1), 20 mi. W. of Bairnsdale, Victoria, Australia, 31 Jan. 1972, J. W. Beardsley Coll. No. 4-76 (WARI); on *Banksia* sp., 40(5), Sydney, Australia, G. Compere Coll. No. 248 (USNM); 1(1), G. Compere Coll. No. 178 (USNM). Material deposited as follows: 4(1), (ANIC); 41(6), (USNM); 2(2), (WARI).

Body (Fig. 3a).—Ovoid, 243 (180–345) long, 120 (69–150) wide; derm membranous.

Dorsum.—Large 8-shaped pores (Fig. 3b) on each $\frac{1}{2}$ of body in 4 longitudinal rows (3 complete and 1 incomplete); marginal row with 13 (10–14) pores; submarginal row with 2 (1–3) pores on posterior cephalothoracic region; submedial row with 10 (8–12) pores; medial row with 9 (8–10) pores on each side; each pore 13 (10–16) long, 8 (6–11) wide. Simple disc pores (Fig. 3c) apparently associated with 8-shaped pores, usually arranged in an incomplete submarginal and a submedial row; each 1 (1–2) in diameter. Anterior cephalothoracic segments with 5 marginal setae on each side (Fig. 3d); each 10 (8–11), 14 (13–14), 11 (7–17), 10 (5–17), 3 (2–4) and 6 (2–12) long, respectively from anterior to posterior; posterior 3 abdominal segments each with 2 tacklike setae (Fig. 3e) 2 (1–4) long. Anal lobes (Fig. 3f) slightly pronounced; each lobe with an apical seta 118 (84–151) long; outer margin with a tacklike seta 2 (1–4) long; inner margin with a needlelike seta 11 (8–13) long and a tacklike seta 3 (2–4) long.

Venter.—Antennae 6-segmented, 68 (59–80) long, width at base 17 (14–18). Scape 12 (11–16) long. Segments II to VI: 14 (12–18), 12 (7–16), 8 (6–10), 7 (6–8), and 15 (12–19) long, respectively. Segments: I with 2 hairlike

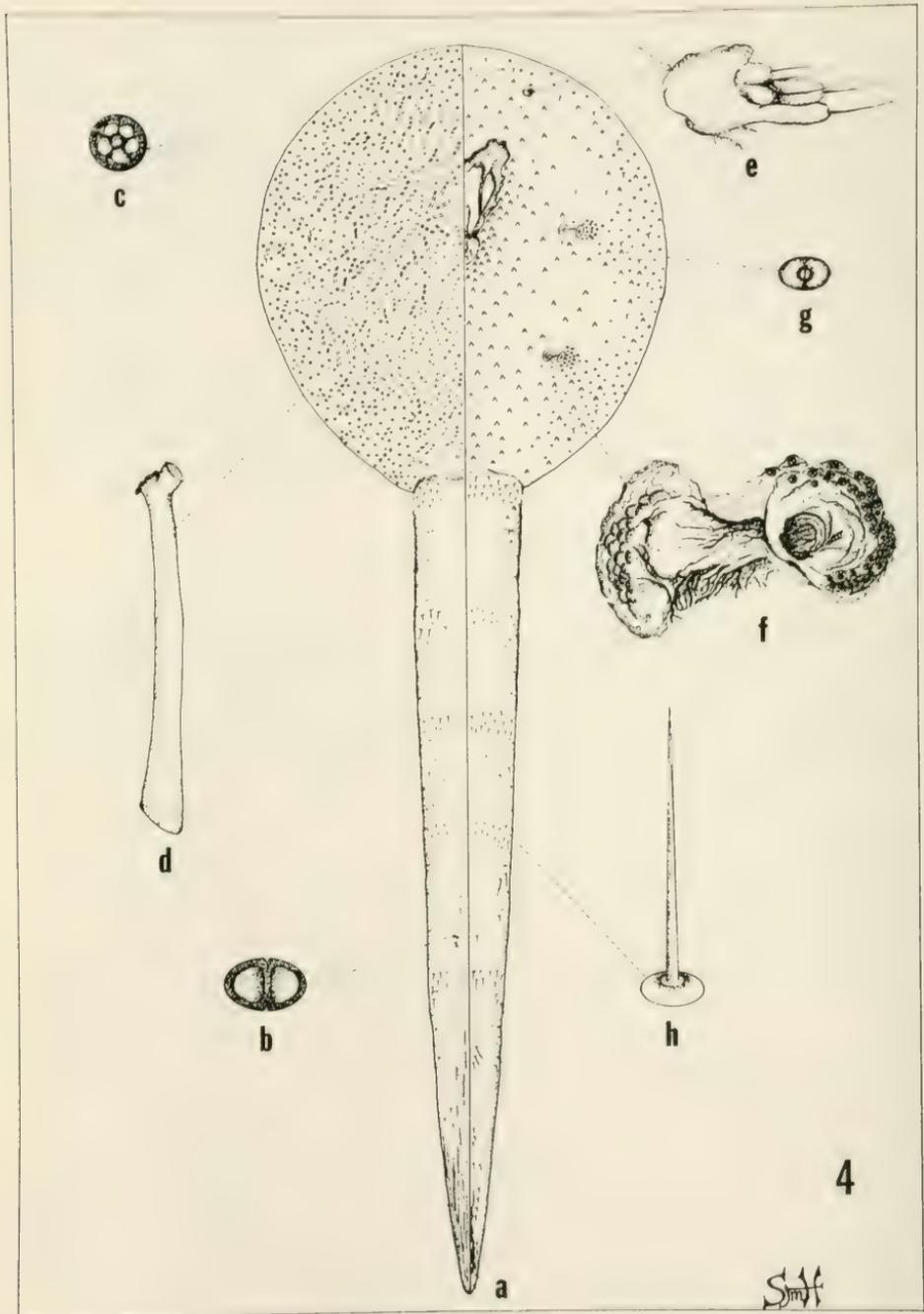


Fig. 4. *F. casuarinae*, adult female. a, Dorsal view. b, 8-shaped pore. c, Quinquelocular pore. d, Tubular duct. e, Antenna. f, Spiracle. g, Bilocular pore. h, Abdominal seta.

setae, II with a sensory pore, 2 long hairlike setae, III without setae, IV with 1 fleshy seta, V without setae and terminal segment with 3 fleshy, 3 needlelike, and 2 hairlike setae. Simple eyes elliptical, between antennal base and body margin. Clypeolabral shield 72 (52–114) long, 56 (42–72) wide. Labium heart-shaped, 35 (30–47) long, 34 (29–38) wide; with 3 pairs of hairlike setae 11 (5–17) long, and a sclerotized apical projection 2 (1–2) long. Legs well-developed, 5-segmented, tarsal digitules 35 (29–38) long, claw digitules 21 (16–24) long. Claw without denticle. Size of leg segments as follows:

Part of Leg	Lengths		
	Prothoracic	Mesothoracic	Metathoracic
Coxa	25 (18–30)	30 (24–38)	34 (26–38)
Trochanter	11 (11–12)	10 (8–12)	11 (7–13)
Femur	51 (42–64)	55 (40–67)	58 (43–65)
Tibia	19 (14–24)	20 (13–25)	21 (13–26)
Tarsus	41 (31–43)	53 (42–67)	53 (43–60)
Claw	11 (7–14)	21 (14–28)	20 (17–23)
Entire Leg	156 (132–179)	182 (142–227)	196 (151–222)

Spiracles (Fig. 3g) 12 (8–17) long, 7 (5–10) wide, peritreme 3 (1–4) in diameter; each with an associated trilocular pore (Fig. 3h) anterolateral to each spiracle, each 3 (2–4) in diameter. Two pairs of bilocular pores (Fig. 3i) associated with mouthparts, each 2 (1–2) in diameter. Setae sparse, 5 pairs of hairlike setae in a submedial longitudinal row extending from anterior of antennal scape to clypeolabral shield, each 6 (6–7), 10 (7–11), 7 (6–7), 14 (13–14), and 32 (28–38) long, from anterior to posterior; a pair of setae associated with simple eye, anterior about 16.8 long, posterior 7 (5–8) long; abdomen with tacklike segmental setae (Fig. 3j) in submarginal and marginal regions, each 1 (1–2) long. Anal ring (Fig. 3k) 10 (10–11) long, 9 (8–11) wide; with 3 pairs of fleshy setae, each 8 (6–11) long. Few macro- and microspines (Fig. 3l) on derm of posterior abdominal segments.

Note.—No adult males observed in the available material, but second- and third-instar (pupae) males have been found along the midrib of leaves in the Bairnsdale, 11 Aug. 1976, sample, 13(3), and in the Mallacoota material, 2(1), of 20 Feb. 1976, both from Victoria.

Frenchia casuarinae Maskell, 1892

Adult Female

Figs. 4a–h

Type-material.—From the syntype series we have designated and marked as LECTOTYPE an adult female on one slide, and as paralectotypes the re-

maining incomplete specimens (on 3 slides). All labeled: on *Casuarina* sp., Australia, 1891, W. M. Maskell Coll. Material deposited as indicated: Lectotype 1(1), and paralectotypes, specimen fragments (3), (DSIR); 2(1), (USNM No. 7308); 1(1), Australia (Maskell Coll. No. 125).

Additional material.—On *Casuarina equisetifolia* L., 2(2), Canberra, A.C.T., Australia, 25 Aug. 1972, M. Koszarab Coll. (VPI-No. Au-18a,b); *C. "quadrivalvis,"* 5(2), Hobart, Tasmania, Rec'd 15 Nov. 1909 (USNM); on *Casuarina* sp., 2(1), Kanmantoo, S. Australia, 5 Aug. 1954, M.V. Carter Coll. (WARI No. 153/54); 2(2), Aldinga Beach, S. Australia, 5 Feb. 1966, H. M. Brookes Coll. (WARI No. 5/66); 2(1), Hobart, Tasmania, A. M. Lea Coll. (BM).

Body of adult female (Fig. 4a).—Cephalothoracic region subcircular, most of abdomen acutely elongate; 6090 (4360-8410) long, 2163 (1850-2400) wide. Live females reddish yellow changing to red and dark brown with age, and covered with fine white waxy powder. Because of their tubular abdomen, resemble upturned slender-stalked mushrooms.

Dorsum.—Large 8-shaped pores absent. Occasionally 1 or 2 small 8-shaped pores (Fig. 4b) irregularly spaced on abdomen, each 7 (5-8) long, 4 (4-7) wide. Quinquelocular pores (Fig. 4c) most numerous on marginal and submarginal areas of cephalothorax, each 6 (6-7) in diameter. Tubular ducts without terminal filaments (Fig. 4d) irregularly spaced on cephalothorax, each 38 (29-43) long, 3 (2-4) wide. Setae on cephalothorax rare, abdomen with transverse segmental bands of needlelike to hairlike setae that extend onto venter. Abdomen tapered, apex slightly rounded and without pores, ducts, or setae.

Venter.—Antennae (Fig. 4e) unsegmented, 23 (15-31) long; with 5 (3-8) setae. Clypeolabral shield 630 (615-642) long, 485 (481-510) wide. Labium appears unsegmented, 121 (96-141) long, 133 (120-153) wide; with 2 pairs of setae, median pair hairlike about 27 long, apical pair about 4 long. Spiracles (Fig. 4f) 217 (186-255) long, 126 (108-135) wide, atrial opening 41 (36-48) in diameter. Quinquelocular pores (Fig. 4c) associated with spiracles and in marginal-submarginal band on cephalothorax, size same as for those on dorsum. Bilocular pores (Fig. 4g) most abundant around mouthparts, irregularly spaced throughout medial and submedial cephalothoracic region and on anterior of abdomen; each pore 4 (2-5) in diameter. Anal ring apparently absent. Anal opening elongate, heavily sclerotized. Slender setae on cephalothoracic submargin 6 (5-6) long, those near antennae 12 (9-15) long. Abdomen with setae (Fig. 4h) in segmental bands. Number of setae per segment decreases anterior to posterior from 44 to 4; size of setae on abdominal segments varies from 8 to 132 with an additional pair on apical tip of abdomen 4 (4-5) long.

Note.—Individual female galls on smaller twigs, 5-6 mm in diameter, averaged 15 mm long and 8-10 mm wide; on branches 10-12 mm diameter

(Fig. 11), these multiple galls usually occurred with 2–3 inhabitants per gall, and galls were globular with medial region 18–25 mm in diameter. When fully developed the wooden tubes were first yellow, but later became reddish brown to almost black with age and were 4–5 mm in diameter in the middle. The apical end, 6–9 mm long, extended out from the gall. Total length was 9–14 mm, and 6–8 mm thick at base (Fig. 13) when fully developed. The inside wall of the tube, especially close to the female, was covered with white waxy powder.

Careful extraction of the wooden tube (Fig. 13) revealed the gall cavity (Fig. 12) to be broad and closed at the base, while the nipple-shaped upper end had a central small slitlike aperture, allowing nymphs to escape. The woody closure or platform at the bottom of the tube, to which the adult female is attached from inside, was detached with a scalpel. Dead adult females found inside were brown, but covered with a fine white waxy powder. The enlarged placoid cephalothorax of each female was attached to a platform at the bottom of the tube, while the tapered abdomen extended into the inner cavity of the tube, giving a thumblike appearance. Apparently the wooden tube, lined with waxy powder, provided protection for the newly hatched nymphs from desiccation, parasites, and predators. A few nymphs were occasionally found entrapped in this cavity, especially when the aperture did not properly develop. After the galls dried, some of the wooden tubes split open (Fig. 13).

Second-Instar Female

Figs. 5a–h

Type-material.—On *Casuarina* sp., 2(1), Australia, 1891, W. M. Maskell Coll. (USNM No. 7308); 5(1) McLaren Flat, S. Australia, 7 Jul. 1965, H. M. Brookes Coll. (WARI No. 24/65).

Additional material.—On *C. "quadrivalvis,"* 4(1), Hobart, Tasmania, Rec'd. 15 Nov. 1919 (USNM).

Body (Fig. 5a).—Pyriform, 1218 (1150–1330) long, 1014 (840–1066) wide; derm membranous. Live specimens reddish yellow.

Dorsum.—Large 8-shaped pores and simple disc pores absent. Quinquelocular pores (Fig. 5b) numerous on cephalothoracic and anterior abdominal segments, on abdomen appearing to be arranged in 3 partial segmental bands, each pore 5 (5–6) in diameter. Setae sparse, with 6 (5–7) hairlike setae (Fig. 5c) on margin of posterior abdominal segments, each 35 (28–40) long, and a needlelike pair at apex (Fig. 5d) of abdomen, each 6 (4–8) long.

Venter.—Antennae (Fig. 5e) unsegmented, 11 (10–12) wide at base, with 2 hairlike setae. Maskell (1892), noted 5-segmented antennae, probably by confusing this with first-instars before molting. Clypeolabral shield 225 (207–243) long, 140 (130–153) wide. Labium unsegmented, 73 (66–78) long, 104

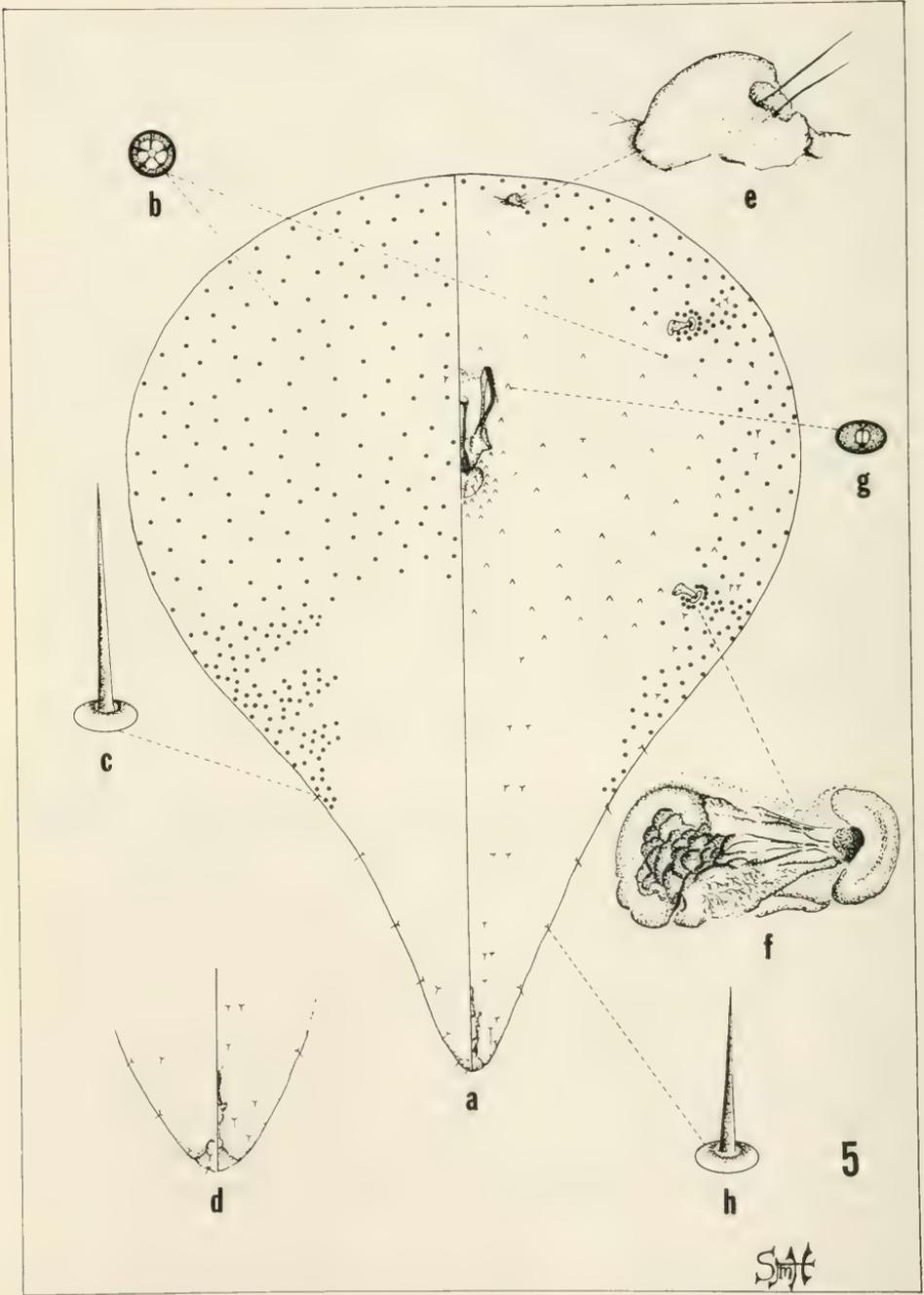


Fig. 5. *F. casuarinae*, second-instar female. a. Dorsal view. b. Quinquelocular pore. c. Hairlike seta. d. Anal region. e. Antenna. f. Spiracle. g. Bilocular pore. h. Abdominal seta.

(93–120) wide; with 2 pairs of setae, each 10 (8–11) long. Legs absent. Spiracles (Fig. 5f) ornate, 85 (74–99) long, 86 (78–97) wide, atrial opening 34 (27–38) in diameter. Quinquelocular pores (Fig. 5b) on margin and submargin of cephalothorax and anterior abdominal segments, size same as those on dorsum. Bilocular pores (Fig. 5g) most numerous around mouthparts, extending laterad to spiracular area, each 3 (2–5) in diameter. Needle-like setae (Fig. 5h) in 7 or 8 transverse rows on abdomen; marginal setae 22 (18–29) long, medial and submedial setae 6 (2–11) long.

Note.—Maskell's (1892) second-instar description refers to a first-instar about to molt.

First-Instar Female

Figs. 6a–i

Paralectotypes.—On *Casuarina* sp., 9(4), Australia, 1891, W. M. Maskell Coll. (DSIR).

Additional material.—On *C. "quadrivalvis,"* 21(1), Hobart, Tasmania, Rec'd 15 Nov. 1909 (USNM); on *Casuarina* sp., 9(1), McLaren Flat, S. Australia, 7 Jul. 1965, H. M. Brookes Coll. (WARI No., 24/65); 9(1) same lot (UT).

Body (Fig. 6a).—Ovoid, 443 (369–609) long, 238 (141–555) wide; derm membranous. Yellow when alive.

Dorsum.—Large 8-shaped pores (Fig. 6b) on each $\frac{1}{2}$ of body in 3 complete longitudinal rows and with 0–4 pores between marginal and submarginal rows on cephalothorax; marginal row with 14 (13–14) pores, submarginal row with 12 pores (found some specimens, possibly males, with 4–5 pores) and submedial row with 11 (10–12) pores; each pore 14 (12–16) long, 8 (8–10) wide. Simple disc pores (Fig. 6c) appearing to be associated with 8-shaped pores, on each half of body in an interrupted submarginal row of 8 (7–9) pores, and a submedial row of 7 (5–10) pores, each 1 in diameter. Simple eyes on margin, 13 (11–14) in diameter. Setae rare, few on margin, most tacklike (Fig. 6d). Anal lobes prominent, each with an apical seta 121 (108–138) long, laterad a pair of tacklike associated setae, each 1 (1–2) long.

Venter.—Antennae 6-segmented, 85 (79–90) long, width at base 19 (13–23). Scape 14 (12–17) long. Segments II to VI: 17 (14–19), 17 (16–19), 11 (10–14), 7 (6–10), 19 (17–23) long, respectively. Segments: I with 1–3 slender setae, II with 2 hairlike setae and a sensory pore, III without setae, IV with a fleshy seta, V without setae, VI with 1 or 2 needlelike, 2 hairlike, and 2 fleshy setae. Maskell (1892) illustrated it with 7-segmented antennae. He probably noted a false division on segment III. Clypeolabral shield 74 (65–91) long, 60 (52–73) wide; Koteja and Liniowska (1976), who compared this structure in the genera of *Asterolecaniidae*, found it to be rather elongate, pentagonal, with anterior tentorial arms well developed in this species. Labium unsegmented, 41 (36–54) long, 36 (30–48) wide; with 4 pairs of setae.

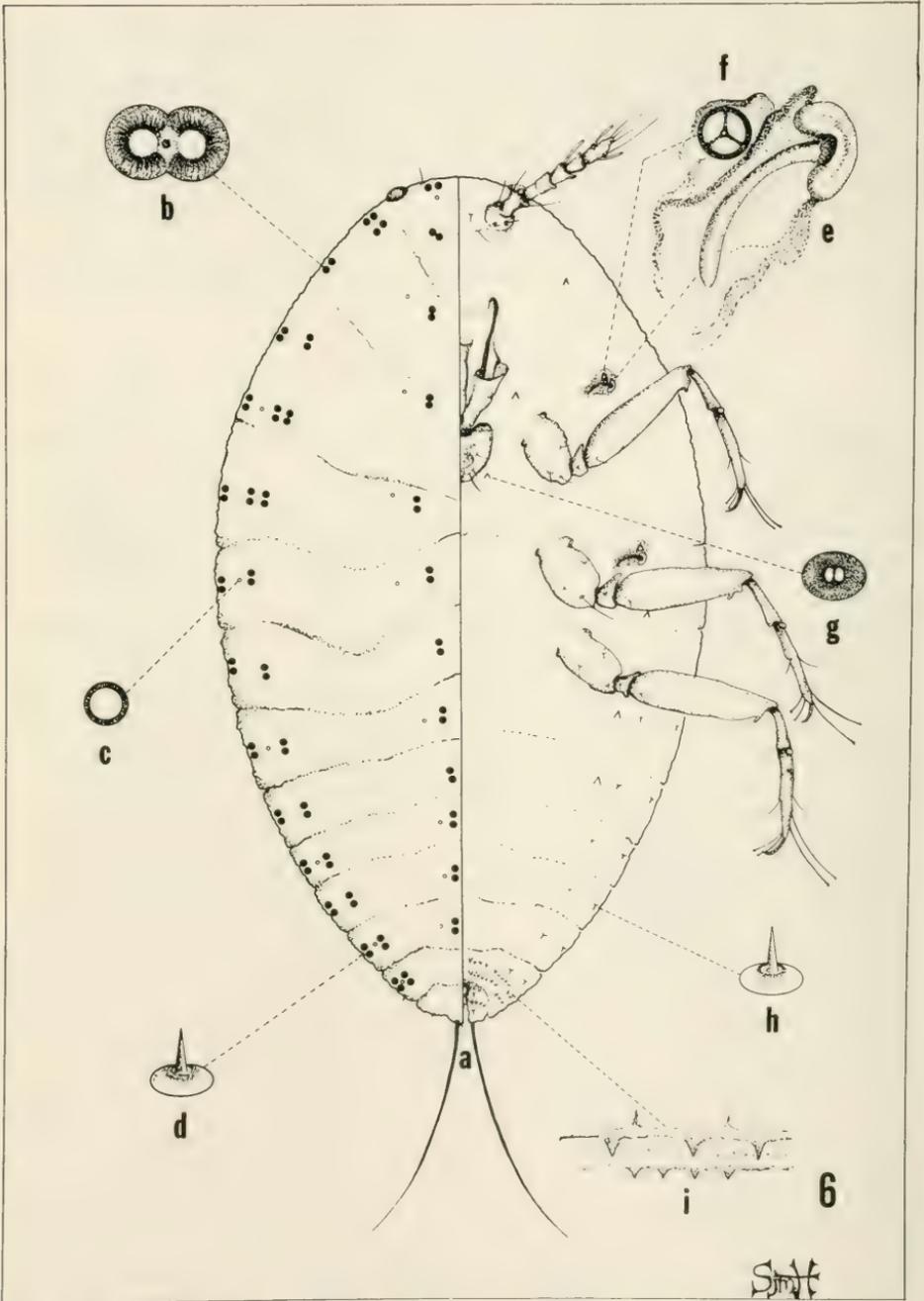


Fig. 6. *F. casuarinae*, first-instar female. a, Dorsoventral view. b, Large 8-shaped pore. c, Simple disc pore. d, Tacklike seta. e, Spiracle. f, Trilocular pore. g, Bilocular pore. h, Tacklike seta. i, Macrospines.

each 11 (6–17) long. Legs well developed, 5-segmented, tarsus with sensillum, tarsal digitules 36 (29–41) long, claw digitules 24 (19–28) long. Claw without denticle. Size of legs as follows:

Part of Leg	Lengths		
	Prothoracic	Mesothoracic	Metathoracic
Coxa	27 (18–36)	31 (20–37)	37 (35–40)
Trochanter	12 (7–14)	10 (8–13)	12 (7–17)
Femur	51 (42–57)	57 (40–67)	63 (53–71)
Tibia	23 (14–35)	23 (20–28)	23 (19–26)
Tarsus	42 (34–44)	52 (43–58)	57 (48–61)
Claw	15 (11–20)	21 (16–23)	22 (20–24)
Entire Leg	171 (151–190)	195 (161–215)	215 (182–231)

Spiracles (Fig. 6e) 14 (11–17) long, 7 (6–8) wide, atrial opening 2 (1–2) in diameter; each with an associated trilocular pore (Fig. 6f) near anterior and posterior spiracle, each 4 (3–5) in diameter. Bilocular pores (Fig. 6g) located in submargin of cephalothorax and anterior 2 abdominal segments and 2 pairs associated with mouthparts, each about 4 long. With 2 pairs of slender setae between antennae and clypeolabral shield; anterior pair 3 (1–4) long, posterior pair 6 (5–7) long; tacklike setae (Fig. 6h) on margin and submargin of abdomen, each 2 (1–2) long. Anal ring absent. Few microspines (Fig. 6i) on posterior abdominal segments.

Note.—Koteja (1974b) found campaniform sensillum on the tarsus of nymphs of this species.

Frenchia semioculta Maskell, 1895

Adult Female

Figs. 7a–h

Type-material.—From the syntypes an adult female has been designated and marked as LECTOTYPE on 1 slide and 2 adult females on 2 slides as paralectotypes (DSIR). All labeled: *Frenchia semioculta*, Australia, 1894, W. M. Maskell Coll. From Maskell's (1895) original description and Froggatt's (1933) article we are assuming that it was collected from *Casuarina suberosa* Otto and Dietrich, at Thornleigh near Sydney.

Body (Fig. 7a).—Subcircular with tubular abdominal region, 2078 (915–3240) long, 1860 (900–2820) wide. According to Maskell (1895) the live females are yellowish or with a tinge of red, mated females become dull-red and increase in size, dorsum somewhat convex and venter slightly concave.

Dorsum.—Large 8-shaped pores, quinquelocular pores and simple disc pores absent. Tubular ducts (Fig. 7b) numerous, without terminal filament.

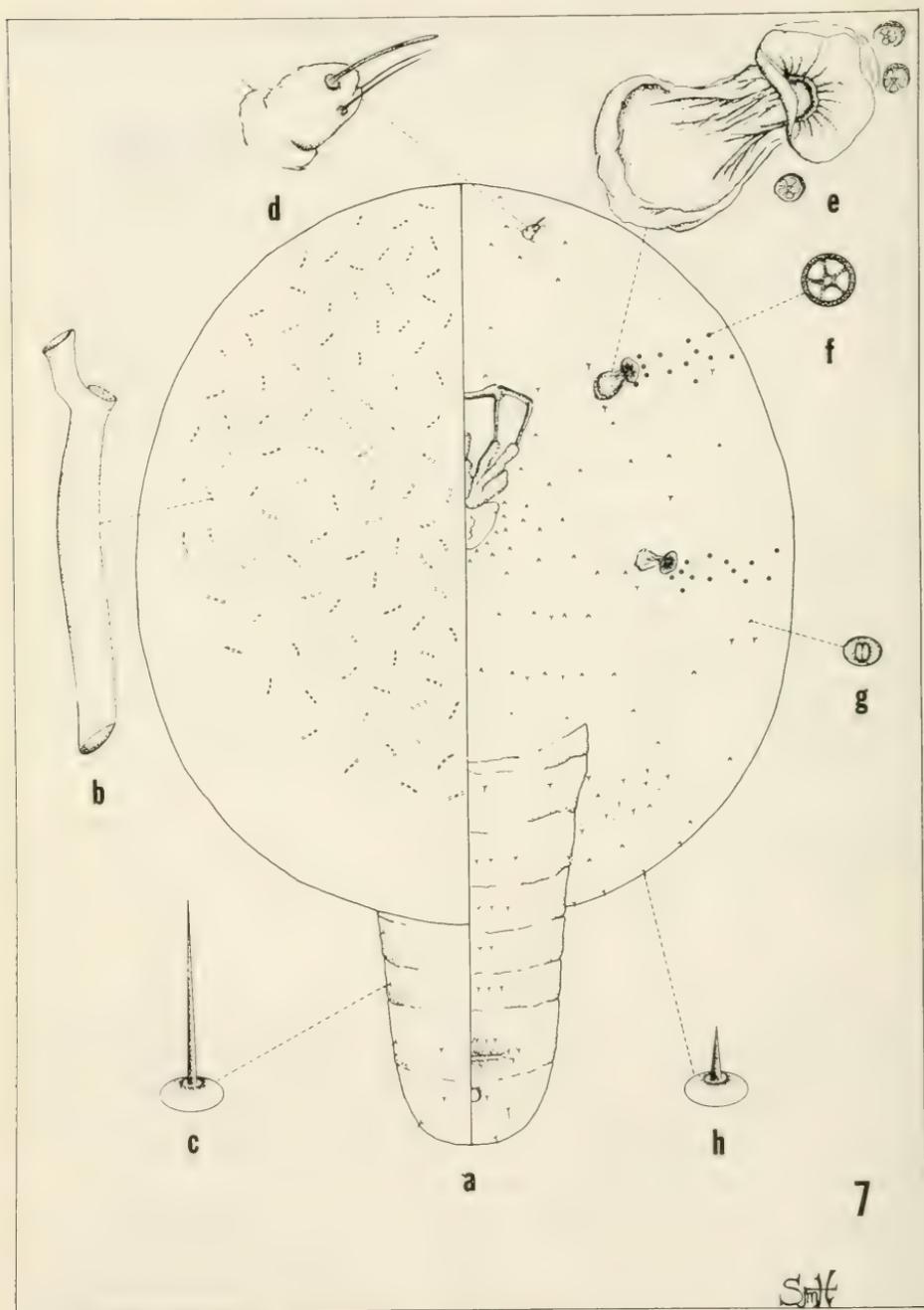


Fig. 7. *F. semioeculta*, adult female. a. Dorsoventral view. b. Tubular duct. c. Needlelike seta. d. Antenna. e. Spiracle. f. Quinquelocular pore. g. Bilocular pore. h. Tacklike seta.

each 34 (30–44) long, 3 (2–5) wide. Setae rare, minute segmental setae (Fig. 7c) located on posterior abdominal segments, each 6 (4–8) long.

Venter.—Antennae (Fig. 7d) unsegmented, with 1 fleshy and 2 slender setae, each antenna 21 (11–36) long, 19 (6–36) wide. Clypeolabral shield 161 (111–255) long, 130 (68–240) wide. Labium unsegmented, 52 (44–63) long, 66 (54–84) wide, apparently without setae. Legs absent. Spiracles (Fig. 7e), anterior pair larger than posterior pair; anterior 107 (94–114) long, 56 (48–64) wide, atrial opening 17 (16–19) in diameter; posterior 83 (76–91) long, 37 (31–46) wide, atrial opening 6 (5–7) in diameter. Associated quinquelocular pores (Fig. 7f) extend from spiracles to margin, 15 (8–26) per spiracular furrow, each pore 6 (5–7) in diameter. Bilocular pores (Fig. 7g) most numerous around mouthparts, each 3 (2–4) long, 2 (1–2) wide. Setae (Fig. 7h) on cephalothorax between spiracles and in segmental rows on abdomen, each 6 (4–8) long, prevulvar setal pair about 12 long. Anal ring with setae absent. Anal opening about 6 in diameter.

Note.—Maskell (1895) reported that the adult female lives under the bark and produces a slight swelling on the bark (Fig. 14). A minute pustule with an orifice was present in the middle of the swelling. Occasionally the tip of the female's abdomen was found to protrude through this orifice, probably releasing sex pheromones for the attraction of males. Froggatt (1933) also reported this species from *Casuarina lehmanniana* Baker at Euston, New South Wales.

Second-Instar Female

We were unable to locate the specimens Morrison and Morrison (1927) used to describe this instar. Their brief description of the second-instar is summarized here.

Body pear shaped, 620 long, 520 wide, with derm entirely membranous. Dorsum apparently without pores, 3 pairs of tacklike setae in the submarginal band of abdomen. Venter with unsegmented platelike antennae, each bearing 2 small setae; clypeolabral shield and labium well developed; legs absent; spiracles slender with associated quinquelocular pores, apparently 5 or 6 pores each at anterior and 2 each at posterior spiracles (no other type of pores observed by the Morrissions); few small setae on derm, most on abdomen, and a pair of large apical setae; anal ring close to caudal end of body, simple and incomplete.

First-Instar Female

Figs. 8a–i

Type-material.—On *Casuarina* sp., 32(4), Australia, 1894, W.M. Maskell Coll. (DSIR); 10(1) same lot (VPI); 8(1) same lot (UT).

Body (Fig. 8a).—Ovoid, 346 (331–366) long, 221 (216–225) wide; derm membranous.

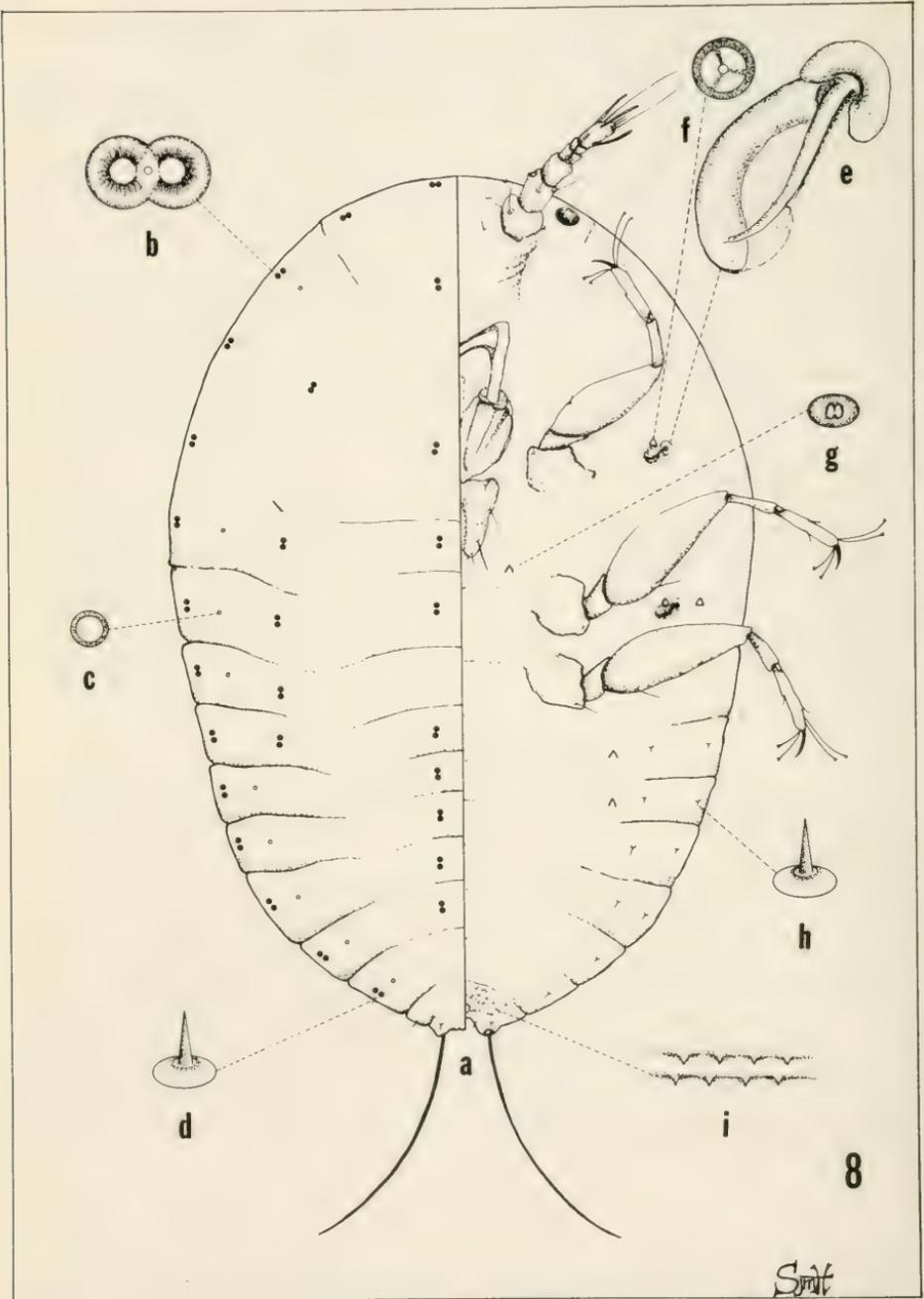


Fig. 8. *F. semioculta*, first-instar female. a, Dorsoventral view. b, Large 8-shaped pore. c, Simple disc pore. d, Tacklike seta. e, Spiracle. f, Trilocular pore. g, Bilocular pore. h, Tacklike seta. i, Microspines.

Dorsum.—Large 8-shaped pores (Fig. 8b) on each half of body in 3 longitudinal rows (4 complete and 2 incomplete); marginal row with 14 pores, submarginal row with 5 pores, and submedial row with 9 (9–11) pores; pore distribution as illustrated; each pore 8 (6–10) long, 5 (4–5) wide. Simple disc pores (Fig. 8c) in submarginal row consisting of about 9 pores, each 2 in diameter. Setae rare, few tacklike (Fig. 8d) on posterior abdominal segments, each 2 long. Anal lobes prominent, each with an apical seta 82 (75–87) long, and a tacklike seta.

Venter.—Antennae 6-segmented, width of base 20 (17–24). Scape 13 (12–17) long. Segments II to VI: 16 (14–17), 10 (8–12), 6 (6–7), 6 (5–7), 16 (14–18) long. Segments: I with 1 hairlike seta, II with 2 hairlike setae and a sensory pore, III without setae, IV with a fleshy seta, V without setae, VI with 2 needlelike, 2 hairlike and 3 fleshy setae. Simple eyes elliptical, laterad of antennal base. Clypeolabral shield 61 (58–72) long, 49 (46–53) wide. Labium unsegmented, 40 (37–42) long, 33 (31–35) wide; with 5 pairs of setae, each 9 (2–17) long. Legs well developed, 5-segmented, with sensory pore on tarsus, tarsal digitules 31 (29–32) long, claw digitule 19 (16–23) long, claw without denticle. Size of leg segments as follows:

Part of Leg	Lengths		
	Prothoracic	Mesothoracic	Metathoracic
Coxa	32 (25–38)	35 (34–36)	28 (25–31)
Trochanter	11 (8–17)	9 (7–10)	12 (7–13)
Femur	44 (42–50)	48 (46–54)	48 (40–55)
Tibia	13 (8–14)	16 (14–18)	15 (12–17)
Tarsus	32 (24–36)	40 (38–41)	42 (40–46)
Claw	14 (12–16)	13 (12–13)	13 (10–16)
Entire Leg	146 (120–172)	161 (151–172)	156 (133–178)

Spiracles (Fig. 8e) on submargin, each 14 (12–16) long, 8 (4–8) wide, atrial opening 2 (1–4) in diameter; with 1 (rarely 2) trilocular pores (Fig. 8f) associated with anterior spiracle and 2 with posterior spiracle, each 4 (4–5) in diameter. One pair of bilocular pores (Fig. 8g) near labium and 2 pairs on abdomen, each 2 (2–3) in diameter.

Small tacklike setae (Fig. 8h) in segmental rows on abdomen, and 1 submedial pair between antennal bases, each 4 (4–5) long; 2 slender setae on each anal lobe, 2 long; apical anal lobe setae, each 51 (46–56) long; anal ring and setae absent; microspines (Fig. 8i) present on terminal abdominal segments.

Note.—Two of the syntype slides included one male and its test. Both in too poor condition for study.

On dry twigs of the type material, the male galls were reddish dark-brown.

broad conical, diameter about 2 mm at base, 1 mm at top, about 1 ½ mm high with a wide thick-rimmed opening on top (Fig. 15). Galls produced by males resembled those of *Apiomorpha* males, while the swelling produced by females resembled those made by females of *Asterolecanium*.

ECONOMIC IMPORTANCE OF *FRENCHIA*

The known hosts of *Frenchia* species are in the genus *Banksia*, which belongs to the family Proteaceae, and the genus *Casuarina* (Beefwood, Australian Pine), which belongs to the Casuarinaceae. Both genera are restricted to the Australian Region.

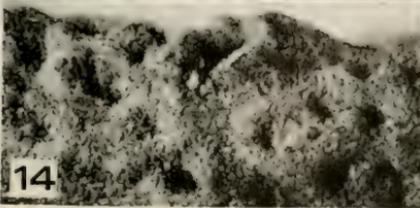
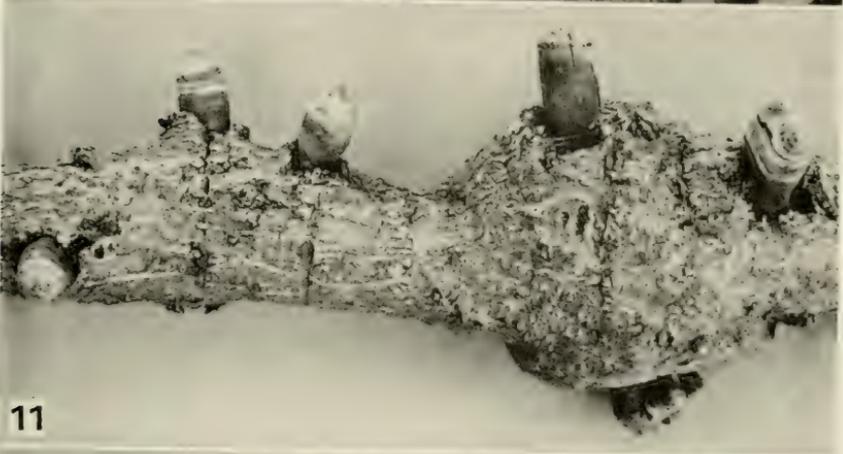
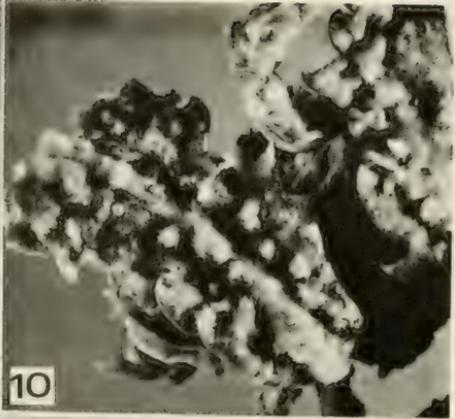
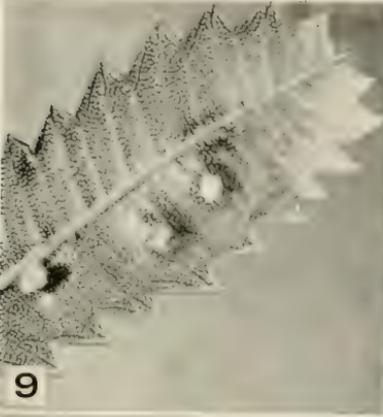
The woody gall formations of *Frenchia casuarinae* on *Casuarina* trees (Fig. 11) subject the limbs to breakage, especially during high winds, in addition to making them less desirable for use by farmers or industry. The galls of *F. banksiae* on *Banksia serrata* produce severe deformations and discolorations on leaves (Figs. 9, 10), and may occasionally cause premature leaf drop. *F. semiocculta* adult females occupy a pit in a swelling on the bark of twigs on *C. lehmanniana* and *C. suberosa* (Fig. 14). Males produce a more distinctive conical gall (Fig. 15). Further information on the tree hosts of *Frenchia* spp. is given by Uphof (1968) as follows: *Banksia serrata* L.—“Wattung-Urree,” or Redwood Banksia. The wood of this Australian tree is used for furniture, window frames, and boat and ship building; *Casuarina equisetifolia* L.—Swamp or Bull Oak, Horsetail Beefwood, is a tree widely distributed in Australia. Its wood is used for fencing, gates, and shingles; *C. stricta* Ait. (= *quadri-valvis*).—Shingle or River Oak, Coast Beefwood. In Australia, the wood is used for furniture, shingles, axe-handles, etc.; *C. suberosa* Otto and Dietr.—Swamp or River Black Oak, Erect Beefwood, is a common tree in Australia, especially New South Wales, Queensland and Tasmania. The bark sometimes is used for tanning.

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Figs. 9–15. Galls and damage of *Frenchia* spp. 9. Galls on leaf of *Banksia serrata* L. produced by *F. banksiae*. 10. Heavy infestation of *F. banksiae* causing severe deformations of leaves. 11. Galls on branch of *Casuarina equisetifolia* L. produced by *F. casuarinae*. 12. Cross-section of gall cavity of *F. casuarinae* after the removal of the wooden tube and adult female. 13. Old, split wooden tube, removed from gall cavity of *C. equisetifolia*. The removed adult female occupied the base of wooden tube. 14. Bark swelling with pits produced by females of *F. semiocculta* Maskell on *Casuarina* sp. 15. Conical galls with large openings on top produced by males of *F. semiocculta* on *Casuarina* sp. twig.



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A NEW SPECIES OF NORTH AMERICAN CECIDOMYIIDAE
(DIPTERA) FROM *SPARTINA ALTERNIFLORA*
(POACEAE)

RAYMOND J. GAGNÉ

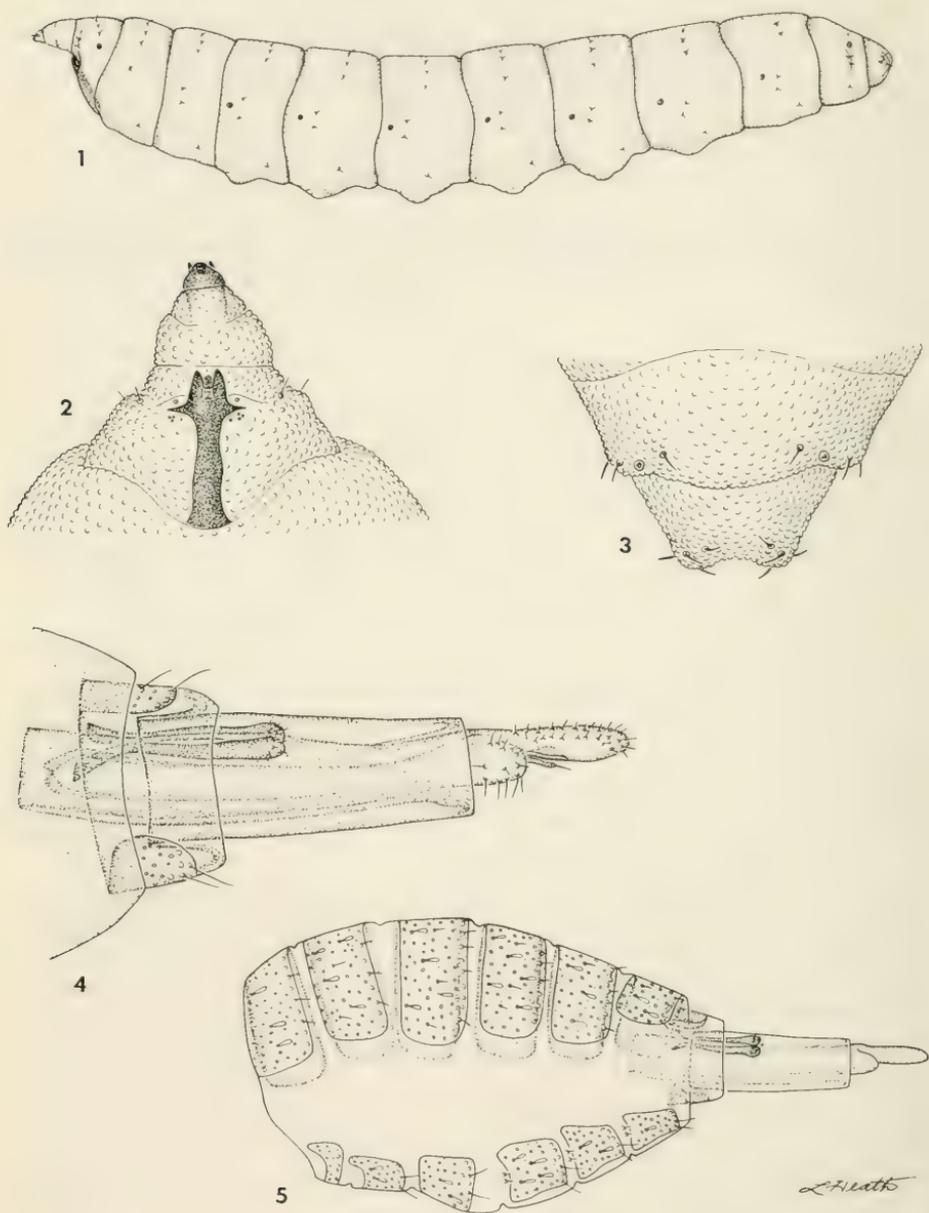
Systematic Entomology Laboratory, IIBIII, Agric. Res., Sci. and Educ. Admin., USDA, % U.S. National Museum of Natural History, Washington, D.C. 20560.

Abstract.—A new species of cecidomyiid fly, *Calamomyia alterniflorae* Gagné, is described and illustrated. Its larvae live in the culms of smooth cordgrass, *Spartina alterniflora* Loisel., the dominant vascular plant in coastal intertidal marshes in eastern North America. The new species is compared with the other described species of *Calamomyia*, and the scant information available about that genus is reviewed.

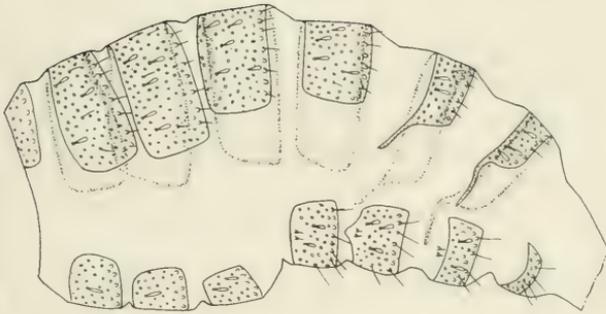
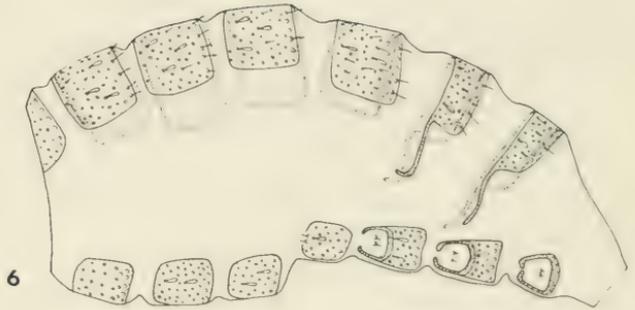
A new species of *Calamomyia* from smooth cordgrass, *Spartina alterniflora* Loisel., is described here to make a name available for a study in progress by Nolan H. Newton, a graduate student in the Department of Entomology, North Carolina State University at Raleigh. Mr. Newton is currently preparing a paper on the biology of this gall midge and other insects associated with smooth cordgrass.

Calamomyia Gagné is a genus of phytophagous cecidomyiids that until now contained 17 species (Gagné, 1969), all from North America and all described by Felt in separate papers between 1908 and 1936. Only six species were reared from hosts, one from an unidentified grass, the others from grasses in the genera *Danthonia*, *Echinochloa*, *Eragrostis*, *Panicum*, and *Phragmites*. These came from culms showing no exterior sign of damage except occasional discoloration due to an associated fungus. One other species was collected in the act of ovipositing on another species of *Panicum*. The remaining ten species of *Calamomyia*, each known from a single male or female specimen, were caught in flight but are presumably also associated with grasses.

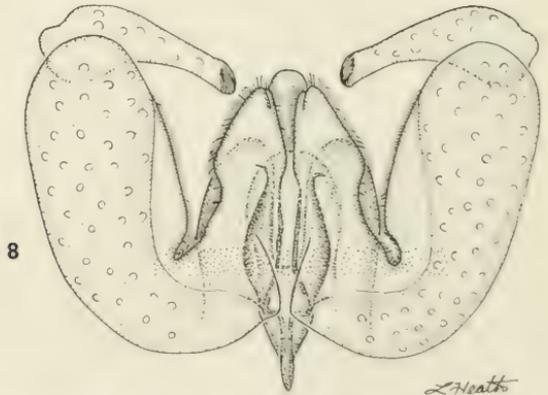
No one yet has undertaken a proper study of *Calamomyia*, but the genus is probably very rich in species. The known hosts, including the new one recorded here, are distributed among five tribes of Poaceae. The recorded, combined distribution is from the Atlantic coast to North Dakota and Mis-



Figs. 1-5. *Calamomyia alterniflorae*. 1, Larva (lateral view). 2, Anterior segments of larva (ventral). 3, Posterior segments of larva (dorsal). 4, Female postabdomen (lateral). 5, Female abdomen (lateral).



7



8

Fig. 6. *Calamomyia agrostis*, male abdominal segments 1-8 (lateral view). Figs. 7-8. *C. alterniflorae*. 7, Same as above. 8, Male terminalia (ventral).

souri, but I have seen specimens of undescribed species from California. Cecidomyiids of the genus are very common. In late summer in the Washington, D.C. area, full-grown larvae can be found readily, singly or gregariously, in the culms of almost any species of native grass. These cecidomyiids are inconspicuous enough to preclude notice except when close

attention is paid to the fauna associated with a particular grass, such as Nolan Newton is doing for smooth cordgrass.

Calamomyia alterniflorae Gagné, NEW SPECIES

Adult.—Scale color pattern: Frons white, head brown behind except white laterally; scutum mostly brown with 2 dorsocentral and 2 lateral white stripes; pleurites white; wing brown along costal margin except white at junction with R5; legs brown dorsally, lighter basally on basal tarsomeres but not distinctly banded, white ventrally; abdominal tergum 1 mostly white, with narrow, brown, central and lateral stripes; remaining terga mostly brown, terga 2–4 each with 2 large, white, triangular patches, 5–6 with few white scales apically, tergum 7 with white scales and setae along apical margin; sides and venter of abdomen white. Antenna with 13–15 flagellomeres in male, 15–16 in female. Palpus 4-segmented. Wing length, 1.4–1.5 mm in males, 1.5–1.6 mm in females; R5 (from arculus) slightly shorter than $\frac{1}{2}$ wing length. Male abdomen (Figs. 7–8): pleurites 6 and 7 with sclerotized band extending ventrally from associated terga; sterna 6–8 rectangular, not pincer shaped basally; sterna 7–8 short. Female abdomen (Figs. 4–5) with divided tergum 8.

Larva (Figs. 1–3).—Spatula tridentate anteriorly. Terminal segment with 8 setae.

Types.—Holotype ♂, ex culms *Spartina alterniflora* collected 19-VIII-1976, Carteret Co., North Carolina, N. H. Newton, USNM type no. 76640. Paratypes (all in USNM): 13 ♂, 7 ♀, with same data as holotype except 1 ♂ and 1 ♀ collected 7-VII-1975; 7 larvae, same locality, 28-VII-1976, and 2 larvae, Bar Harbor, Maine, 3-VIII-1973, W. W. Woodhouse. Additional material is deposited in the Department of Entomology Collection, North Carolina State University, Raleigh.

Remarks.—*Calamomyia alterniflorae* differs from all other described males of *Calamomyia* spp. in that the anterior margins of abdominal sterna 6–8 are not pincer shaped. The difference is seen in Figs. 6 and 7, which show representative male abdomens of *C. agrostis* (Felt), generally similar to previously described *Calamomyia* spp., and of *C. alterniflorae*. The larva of *C. alterniflorae* has four pairs of setae on the terminal segment rather than the three pairs found in the two species for which larvae are known, namely, *C. echinochloa* (Felt) and *C. inustorum* (Felt).

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THE IDENTITY OF *MAMESTRA PASSA* AND *MORRISONIA*
PERACUTA OF MORRISON (LEPIDOPTERA:
NOCTUIDAE: HADENINAE)

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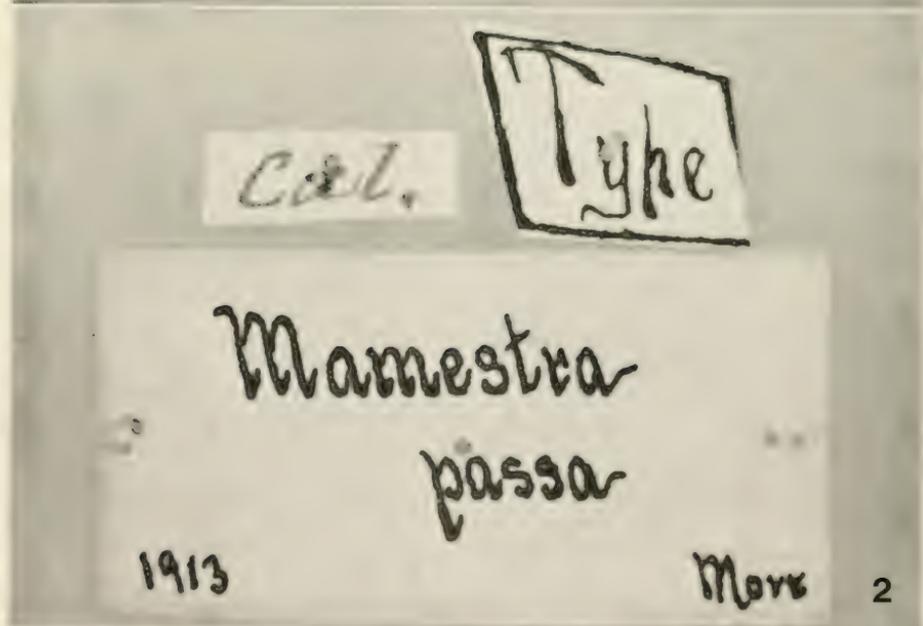
Abstract.—*Mamestra passa* Morrison,³1874, is shown to be a synonym of *Graphania mutans* (Walker, 1857) from New Zealand, and the synonymy of *Morrisonia peracuta* Morrison, 1874, with *Persectania aversa* (Walker, 1856), stated as probable by Common in 1954, is made positive by the designation of a lectotype for *Morrisonia peracuta*.

Morrison's description of *Mamestra passa* (1874b) is excellent, and I came to the conclusion inasmuch as the type-locality was California that, if the moth described was North American, it was a western species of *Xylomyges* (*recte Egira*). However, extensive collecting in California by various collectors, especially William Bauer and John Buckett, failed to produce any moth that fitted Morrison's description.

The species was carried in North American lists under *Mamestra* Ochseneheimer through Dyar's 1902 [1903] List. In 1905 Hampson, without examining the type, placed the species in *Polia* Ochseneheimer, and it has been carried since then in that genus near *P. latex* Guenée where Smith placed it in 1890 when he revised the genus *Mamestra*.

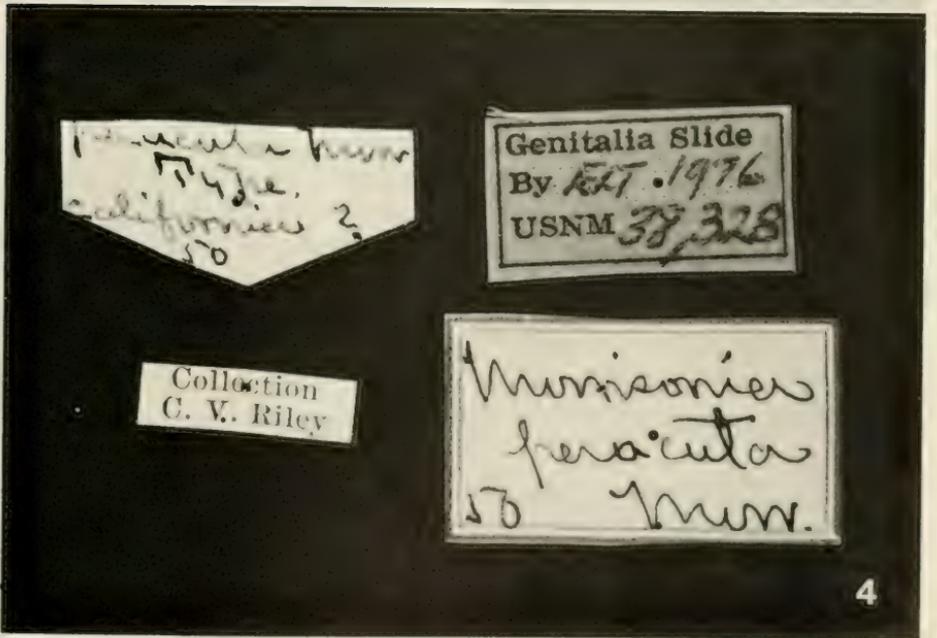
Through the kindness of Frederick W. Stehr, Roland L. Fisher, and Dean L. Haynes of the Department of Entomology of Michigan State University the type of *passa* was brought to Cornell where I was able to study and photograph it. The moth seemed familiar, but it was obviously not a North American species. For a time the possible country of origin was a puzzle; then I remembered that there were a number of *Xylomyges*-like moths in New Zealand, and with that a fact the answer was evident. The type of *Mamestra passa* is a specimen of the very common, widespread, and variable New Zealand species *Graphania mutans* (Walker, 1857). The type of *passa* matches very well two of the contrastingly marked females in a series of *mutans* sent to me a long time ago by W. George Howes of Dunedin, New Zealand.

Hadena mutans Walker was placed in *Morrisonia* by Hampson (1905) in



Figs. 1, 2. *Mamestra passa*. 1, Type, female. 2, Pin labels for type.

Maoria, a new genus, by Warren (1912), and by most modern workers, but *Maoria* Warren is preoccupied by *Maoria* Laporte, 1868, in the Coleoptera and by *Maoria* Pilsbry, 1892, in the mollusks. However, *mutans* is conge-



Figs. 3, 4. *Morrisonia peracuta*. 1, Lectotype, female. 2, Pin labels for lectotype.

neric with *Graphania disjungens* (Walker, 1858), the type of *Graphania* Hampson, 1905, and *mutans* has been placed in that genus by Dugdale, 1971.

Polia passa (Morrison) should be removed from North American lists and placed as a synonym of *Graphania mutans* (Walker), NEW SYNONYMY. The type of *passa*, like that of *Morrisonia peracuta* Morrison, was not from the locality stated, but from New Zealand. Morrison did not state how the specimens of these species came into his possession so there is no way to fix the responsibility for the error.

Edward L. Todd has suggested that a lectotype be designated for *Morrisonia peracuta* Morrison, 1874a, and thus render positive the synonymy considered as probable by Common, 1954. All four specimens that Morrison referred to in his description of *peracuta* can apparently be accounted for; one is in the British Museum (Natural History) from the Grote Collection from the Collection of the Buffalo Society of Natural Sciences, two are in the U.S. National Museum from the C. V. Riley Collection from Morrison's Collection, and one is in the Collection of the Department of Entomology of Michigan State University from the Tepper Collection from Morrison's Collection. One of the specimens in the U.S. National Museum bears the peculiar five-sided type label of Morrison; this specimen is designated the LECTOTYPE and has so been labelled. The moth and the pin labels are illustrated. This specimen is conspecific with *Leucania avera* Walker, 1856, and thus *Morrisonia peracuta* is a junior synonym of *Persectania avera* (Walker).

ACKNOWLEDGMENTS

I thank George L. Godfrey, Illinois Natural History Survey, Urbana, and Edward L. Todd, Systematic Entomology Laboratory, USDA, Washington, D.C. for reading and commenting on an earlier version of this paper; I also thank Edward Todd for furnishing the photographs of *Morrisonia peracuta* and the pin labels.

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STATUS OF FIVE SPECIES OF MALLOPHAGA DESCRIBED
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Abstract.—*Strigiphilus lophotrix* Carriker, 1966 is a new synonym of *S. transversifrons* (Carriker, 1903); *Sturnidoecus incomptus* Ansari, 1955 is a new synonym of *S. caligineus* (Carriker, 1903); and *Formicaphagus gulariae* Carriker, 1957 is a new synonym of *F. rhamphasti* (Carriker, 1903).

In his first major paper on Mallophaga, Carriker (1903) described 45 new species and subspecies from birds that he (1910) and C. F. Underwood collected in Costa Rica in 1902. Carriker (1967), in a paper published posthumously, provided his last opinion of the taxonomic status of all the forms which he described as new. Recently, I had an opportunity to examine the types of several species described by him, and this is a report of my findings.

The names of birds given below are from Peters (1940, 1948, 1951).

Strigiphilus transversifrons (Carriker)

Docophorus transversifrons Carriker, 1903: 127, pl. 1, fig. 1. Host: *Micrastur guerrila* (error) = *Lophotrix cristata stricklandi* Selater and Salvin.

Strigiphilus lophotrix Carriker, 1966: 89, figs. 24-25. NEW SYNONYMY.
Host: *Lophotrix cristata wedeli* Grisom.

Philopterus transversifrons (Carriker). Carriker, 1967: 79. Host: *Micrastur ruficollis interstes* Bangs (error) = *Lophotrix cristata stricklandi* Selater and Salvin.

Holotype male and allotype female are both on USNM type slide 68262, and both belong to the genus *Strigiphilus*, a genus found only on owls. Carriker (1910) stated that he and Underwood collected only four species of owls in June 1902 in the vicinity of Pozo Azul, Costa Rica. They were *Strix virgata* (Cassin), *Rhinoptynx clamator* (Vieillot), *Pulsatrix perspicillata* (Latham), and *Lophotrix stricklandi* Selater and Salvin. Later, Carriker (1954, 1966) described four new species of *Strigiphilus*, one for the form found on each of these owls. Fortunately the type for each of these four new species of Mallophaga is also in the USNM. The type of *Doco-*

phorus transversifrons is identical with that of the *Strigiphilus lophostrix* Carriker, 1966 (USNM type slide 68815).

Sturnidoecus caligineus (Carriker)

Nirmus caligineus Carriker, 1903: 144, pl. 3, fig. 2. Host: *Merula grayi* = *Turdus grayi casius* (Bonaparte).

Sturnidoecus incomptus Ansari, 1955: 72, t.f. 18a-f. NEW SYNONYMY. Host: *Turdus grayi incomptus* (Bangs).

Penenirmus caligineus (Carriker). Carriker, 1967: 105. Host: *Turdus grayi casius* (Bonaparte).

Holotype female and allotype male of *Nirmus caligineus* are both on USNM type slide 68273 and they agree with the holotype male and allotype female of *Sturnidoecus incomptus* Ansari, 1955 on USNM type slide 76393.

Formicaphagus rhamphasti (Carriker)

Nirmus rhamphasti Carriker, 1903: 135, pl. 2, fig. 1. Host: "Rhamphastos tocard" (error) = *Grallaria perspicillata lizanoi* Cherrie.

Formicaphagus grallariae Carriker, 1957: 426, figs. 3b, 5f, 6f. NEW SYNONYMY. Host: *Grallaria perspicillata intermedia* Ridgway.

Sturnidoecus ramphasti (Carriker) Carriker, 1967: 10. Host: *Ramphastos swainsoni* Gould (error) = *Grallaria perspicillata lizanoi* Cherrie.

Holotype male of *Nirmus rhamphasti* on USNM type slide 68267 agrees with the allotype male of *Formicaphagus grallariae* on USNM type slide 68682, which also has the holotype female. *Formicaphagus* is a genus of Mallophaga found only on the antbirds (Formicariidae). Carriker and Underwood collected twelve species of antbirds in the vicinity of Pozo Azul, Costa Rica. I have not seen Mallophaga from each of the hosts they collected, but fortunately Carriker described *F. grallariae* which agrees with the specimen he earlier described as *N. rhamphasti*. Carriker (1957) erected the genus *Formicaphagus* for a distinctive group of Mallophaga found only on antbirds. When he compiled his list of described forms (1967), he noted the host originally given for *N. rhamphasti* was incorrect and stated, "It resembles very much the genus *Sturnidoecus*." Apparently he was not convinced he was correct in placing it in *Sturnidoecus*. I suspect the incorrect host data caused him to overlook the species when he erected *Formicaphagus*. Had he re-examined the type of *N. rhamphasti*, I am sure he would have properly placed the form because of the distinctive male genitalia.

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NEW SPECIES AND RECORDS OF *CULICOIDES* REARED FROM
ARBOREAL HABITATS IN PANAMA, WITH A SYNOPSIS OF
THE *DEBILIPALPIS* GROUP
(DIPTERA: CERATOPOGONIDAE)

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Abstract.—A study was made of the breeding sites of *Culicoides* in Panama with special attention to plants of the family Bromeliaceae as larval habitats. Collections were made between May and August 1976 at a field station on an island in the reservoir formed behind the newly constructed Bayano River dam. *Culicoides* adults were successfully reared from larvae and pupae collected in bromeliads of the genera *Aechmea* and *Vriesea*, tree holes, rotting palm stumps, and moist trapped leaf humus on tree trunks at or near ground level. Although 82 bromeliads in five genera were sampled, *Culicoides* was reared only from *Aechmea* and *Vriesea*, whose large water tanks proved a better habitat during rainless weather. Five species of *Culicoides* were reared from these habitats, including three new species, *C. annuliductus*, *C. bayano*, and *C. filiductus*. The pupae of the three new species are described and illustrated. A key is presented for the identification of 27 Neotropical species of the *debilipalpis* group to which these species belong.

Bloodsucking midges of the genus *Culicoides* Latreille are important pests of man and domestic animals and are known to feed on many wild vertebrate species. The role of *Culicoides* midges as disease vectors is just now beginning to be appreciated through their implication in the transmission of several viruses of the bluetongue group to cattle, sheep, and various wild bovine and antelope species and their transmission of filarial worms of the genera *Acanthocheilonema*, *Dipetalonema*, *Macacanema*, *Mansonella*, and *Onchocerca*, and haematozoa of the genera *Haemoproteus*, *Hepaticystis*,

and *Leucocytozoon*. Pinheiro et al. (1976) isolated the virus of Oropouche fever, a human pathogen in Brazil, from *Culicoides* pools containing 95% *C. paraensis* (Goeldi). Several viruses, still being studied as potential human pathogens, have recently been isolated by Gorgas Memorial Laboratory workers from *Culicoides* collected in the Bayano region of Panama. For these reasons it was highly desirable to undertake a detailed study of possible breeding sites of the *Culicoides* species in the Bayano River area, both for an understanding of the possible significance of these species in disease transmission, and to aid in devising eventual control measures should such be required.

The larval biology of Neotropical *Culicoides*, while receiving considerable study, remains for the most part unknown. Earlier observations of larval habitats in Panama include those of Carpenter (1951), Woke (1954), Breeland (1960), and Wirth et al. (1968). Wirth and Blanton (1959) described known breeding sites for only 15 of the 88 reported Panamanian species of *Culicoides*, some of which have a biology closely associated with the local flora, in which the immature stages are found in plants, plant products, or the rainwater associated with them. *Culicoides* were reported from crab holes, salt marshes, tree holes, rotting calabash, bromeliads, mangrove swamps, and inflorescences of *Heliconia*. Williams (1964) made a significant contribution to Neotropical *Culicoides* breeding biology, reporting larval habitats for 24 species in Trinidad. New habitats for *Culicoides* from that study included "decaying cocoa pods, discarded animal bedding of macerated coconut fibers, mouths of rivers which enter the sea across open sandy beaches where salt and fresh water mix to flood large sandy areas at each high tide; the decaying flowers of Cachibou (*Calathea lutea*), and the rotting flowers of Scotch Attorney (*Clusea rosea*)." Williams (1964) and Aitken et al. (1975) reported *C. nigrigenus* Wirth and Blanton from the bromeliad *Guzmania* sp. in Trinidad. Clastrier (1971) reared *C. quasiparaensis* Clastrier from moss growing on a palm trunk and from moist material accumulated in the axils of palm fronds in French Guiana. Fish and Soria (1978) collected an undescribed species of *Culicoides* in Bahia, Brazil, from water held in the flower bracts of *Calathea* sp. (Marantaceae).

During May–August 1976 an investigation of *Culicoides* breeding places was undertaken at the field station of the Gorgas Memorial Laboratory on Majé Island in the Bayano River impoundment about 120 km east of Panama City, Republic of Panama. This period ordinarily forms a part of the wet season, but it was unusually dry in 1976 with very little rain, and consequently suitable larval habitats were difficult to find.

Bromeliads were collected by hand with care to preserve water-filled "tanks" formed by the leaf bases. Plants collected from sites higher than 5 m were tied closed and lowered by rope. Biological data recorded included site description, height from ground, accessibility of light, tank size, water

content, and presence of debris or animal life. Plant specimens were dissected in white enamel pans while washing each leaf with collected rain-water. Tank contents were examined carefully for *Culicoides* larvae and pupae, which, if found, were placed individually in small cotton-stoppered test tubes with ca. 5 ml of water and debris from the bromeliad; the tubes were checked daily for pupation and emergence of adults. The remaining sample was transferred from the pan to 500 ml paper cartons which were covered with fine nylon mesh. These were also examined daily. All emerging arthropods were collected and stored individually in vials of 70% alcohol for later identification. Having two rearing methods allowed for individual association of larval skin and pupal case with a specific adult specimen while also permitting emergence of larger numbers of adults from the less-disturbed, nutrient-containing original sample.

Other habitats sampled were tree holes, water-containing bamboo internodes placed previously by Gorgas workers for mosquito larva collection, moist soil and leaf debris areas, rotting palm stumps, stream sources, *Heliconia* (Musaceae) inflorescences, palm crowns, inflorescences of *Costus* (Costaceae), leaf axils of *Xanthosoma* (Araceae), and a water-holding palm frond. These were chosen as potential habitats for *Culicoides* immatures on the basis of water and moisture content or by previous reports as known habitats. These sites were sampled by collecting substrate into 500 ml carton containers using a white enamel dipper, a basin, or suction tube. In most cases, habitats were not depleted or destroyed on sampling to permit sequential collections as the wet season progressed.

RESULTS

A total of 169 collection sites were sampled, including 82 bromeliads, 23 tree holes, 21 bamboo internodes, 18 moist soil and leaf debris areas, 9 rotting palm stumps, 7 stream sources, 3 *Heliconia* inflorescences, 3 palm crowns, 1 *Costus* inflorescence, 1 leaf axil of *Xanthosoma*, and 1 water-holding palm frond. The 23 tree hole sites were sampled 53 times during the collection period and the 9 rotting palm stumps 12 times, bringing the total number of habitat samples to 202. The bromeliads comprised *Aechmea pubescens* Baker, *Billbergia macrolepis* L. B. Smith, *Guzmania erythrolepis* Brongniart ex Planchon, *G. lingulata* var. *flammea* (L. B. Smith) L. B. Smith, *Tillandsia anceps* Loddiges, *T. elongata* (Baker) L. B. Smith, *T. fasciculata* var. *fasciculata* Swartz, *T. monadelpha* (E. Morren) Baker, and *Vriesea heliconioides* var. *heliconioides* (Humboldt, Bonpland, and Kunth). From these collections 363 *Culicoides* larvae and 41 live pupae were isolated to produce 256 adults. *Culicoides* larvae were found in tree holes, *Aechmea* and *Vriesea* bromeliads, leaf humus, rotting palm stumps, streams, bamboo internodes, and *Heliconia* inflorescences, but adults were successfully reared from only the first four.

Table 1. Numbers of various collections from bromeliads. Te = *Tillandsia elongata*; Tf = *T. fasciculata*; Ta = *T. anceps*; Tm = *T. monadelpha*; Ap = *Aechmea pubescens*; Vh = *Vriesea heliconioides*; Gl = *Guzmania lingulata*; Ge = *G. erythrolepis*; Bm = *Billbergia macrolepis*; u = unidentified bromeliads.

	Bromeliad species									
	Te	Tf	Ta	Tm	Ap	Vh	Gl	Ge	Bm	u
Total collections	6	4	1	4	19	39	1	3	1	4
Collections with free standing water	6	4	1	4	11	36	1	3	1	4
Height above ground in meters; avg./range	2.4/ 1-4	2.4/ 1.5-3	6	ground	4.6/ 0-9	3.6/ 5-7	3	2.4/ 2-3	1	3.0/ 2-5
<i>Culicoides</i> adults reared					9	5				
Plants with <i>Culicoides bayano</i>					2	3				
Plants with <i>Culicoides paraensis</i>					1					
Ceratopogonidae adults other than <i>Culicoides</i>					7	24				
Culicidae adults	1	2			34	39				
Psychodidae adults					3	25				
Tipulidae adults					1	42		4		

Of the nine species of bromeliads collected, *Culicoides* were reared only from *Aechmea pubescens* and *Vriesea heliconioides*. These two species were the most abundant bromeliads in the area, and their tank structure was such that they consistently contained plenty of free water; they probably provided year round breeding opportunities. The other bromeliads were neither as abundant nor as wet, and the lack of *Culicoides* rearings from them could be explained on either basis. During the progression of the wet season bromeliads and other plants were found to contain more water. The tree holes were excellent *Culicoides* habitats because, regardless of architecture of individual holes or their height above ground, they were more permanent and not so profoundly depleted by lack of rain, exposure to the sun, or proximity to the forest canopy.

It should be stressed that the breeding strategies of the *Culicoides* comprising this study on the Pacific side of Panama are adapted to an area with a definite wet and dry season cycle. In the wetter tropical rain forests of the Atlantic side the *Culicoides* species would be expected to adapt their strategies to more constant rainfall and occasional excesses possibly detrimental to their optimum survival.

The study demonstrates the taxonomic importance of including data on rearing methods in the collection of *Culicoides*. Eighty-one percent of the specimens reared represented three previously undescribed species belonging to a difficult taxonomic group where the association of sexes by reared material was critical to understanding the species. The described methods of individual isolation and rearing proved to be quite effective and minimally time-consuming.

Culicoides adults were identified by one of us (WWW) as belonging to five different species, all taxonomically related within the *debilipalpis* group (see Wirth and Blanton, 1959, 1974): *C. debilipalpis* Lutz, *C. paraensis* (Goeldi), and the three new species herein described. Whereas the five species could easily be distinguished in the adult stage, the pupae were practically indistinguishable and larval identification was impossible.

Linley and Kettle (1964) gave excellent descriptions and figures of the larva and pupa of *C. hoffmani* Fox, which to date is the only member of the *debilipalpis* group whose immature stages have been studied. We recommend a close study of their paper before and while using the pupal descriptions of our new species. Our descriptions of the adults follow closely the format and use the characters explained and illustrated in the papers by Blanton and Wirth (1979) and Wirth and Blanton (1959, 1974).

The holotypes of the new species are deposited in the U.S. National Museum of Natural History, Washington, D.C. Paratypes as available will be deposited in the British Museum (Natural History), London; Gorgas Memorial Laboratory, Panama, R.P.; Museu de Zoologia da Universidade de São Paulo, Brazil; and Museum National d'Histoire Naturelle, Paris.

The classification of the Neotropical species of the *debilipalpis* group is difficult and progress has been slow in revising, redescribing, and illustrating the previously named species. Aitken et al. (1975, Trinidad), and Wirth and Blanton (1959, Panama; 1973, Amazon; 1974, West Indies) have published fairly satisfactory keys of the *Culicoides* of particular regions, but no inclusive key has been published for the identification of all members of this very difficult group. While not quite complete, and although it still has some weak couplets and species that need more study, the following key is presented in the hope that future identifications will be easier.

KEY TO SPECIES OF THE *CULICOIDES DEBILIPALPIS* GROUP

1. Second radial cell included in a very dark spot; cell R5 with 3 or 4 small pale spots, the 2 poststigmatic pale spots sometimes fused; subapical pale spot in cell R5 usually transverse, not attaining wing margin; cell M2 with only 1 pale spot distal to level of mediocubital fork; 2 functional spermathecae present; antennal sensory pattern 3, 8-10 (sometimes also on some of segments 4-7) (*debilipalpis* Group) 2

- Without the above combination of characters other groups of *Culicoides*
- 2. Cell M1 with 3 pale spots 3
- Cell M1 with 1 or 2 pale spots 6
- 3. Pale spot present in cell M2 lying adjacent to anterior side of mid-portion of mediocubital stem (Fig. 3c); smaller spermatheca with long threadlike duct (Fig. 3d); sclerotized ring of duct short and cylindrical; eyes narrowly separated; wing with marginal pale spots large and distinct *filiductus*, new species
- No pale spot in cell M2 lying adjacent to midportion of mediocubital stem; smaller spermatheca with duct broader, not threadlike; sclerotized ring, eye separation, and wing spots various 4
- 4. Smaller spermatheca with duct more slender and tapering than that on the large one; sclerotized ring elongate and tapering; eyes broadly separated; wing with marginal spots smaller and usually not meeting wing margin; male parameres slender in midportion with elongate ventral lobe *paraensis* (Goeldi)
- Smaller spermatheca with duct as stout as that on large one, not tapering; sclerotized ring short and cylindrical; eyes usually narrowly separated; male parameres without elongate ventral lobe 5
- 5. Antennal sensory pattern 3,7-10; male paramere with definite, broad, ventral swelling *neoparaensis* Tavares and Sousa
- Antennal sensory pattern 3,8-10; male paramere uniformly slender in midportion, without ventral swelling *quasiparaensis* Clastrier
- 6. Cell M1 with 1 pale spot near tip of cell *trilineatus* Fox (in part)
- Cell M1 with 2 pale spots 7
- 7. Anal cell with 2 pale spots in distal portion; crossvein r-m with pale spot small and lying entirely on distal side of vein *mirsae* Ortiz
- Anal cell with 1 pale spot in distal portion; crossvein r-m with pale spot centered on the vein 8
- 8. Mesonotum with prominent pattern of punctiform brown dots; 3 small round equidistant pale spots in a triangle in cell R5; (halter knob dark at base; eyes bare; antennal segments in continuous series) *ginesi* Ortiz
- Mesonotum with prominent pattern of large pale patches or without prominent pattern 9
- 9. Palpus pale yellow; small species, wing 0.65 mm long; antennal segment 11 shorter than 10; (male genitalia with stem of paramere gradually tapering to fine tip, no ventral lobe or distal fringing spines) *gabaldoni* Ortiz

- Palpus not pale yellow; larger species, wing 0.7–1.4 mm long; antennal segment 11 subequal to or longer than 10 10
- 10. Second radial cell unusually broad; (pale spot at end of costa well separated from spot behind 2nd radial cell, farther from it than from the distal pale spot in cell R5, which is narrow and transverse; distal pale spot in anal cell elongated, extending caudad nearly to wing margin; eyes bare; halter brown; larger species, wing 1.00 mm long; aedeagus with slender distal process bearing deep distal fork *glabrior* Macfie
 - Second radial cell not unusually broad 11
- 11. Pale spot absent in front of mediocubital fork 12
 - Pale spot present in front of mediocubital fork, though sometimes faint 25
- 12. Pale spot absent behind medial fork; (palpal pit opening by smaller pore) *horticola* Lutz
 - Pale spot present behind medial fork 13
- 13. Posterior poststigmatic pale spot located slightly distad of anterior one; (palpal pit broad and shallow; male aedeagus with broad truncate tip; parameres with stem slightly sinuate with lateral fringing spines, no ventral lobe) *imitator* Ortiz
 - Posterior poststigmatic pale spots oblique with posterior one located proximad of the other 14
- 14. Pale spot present in cell M2 lying adjacent to midportion of mediocubital stem; 3rd palpal segment long and slender with sensory pit deeper than diameter of pore opening; femora dark to tips; male apicolateral processes short, mesal notch between them on tergum 9; parameres sinuate and slender without ventral lobe; aedeagus short with simple tip *todatangae* Wirth and Blanton
 - No pale spot present in cell M2 lying adjacent to midportion of mediocubital stem 15
- 15. Distal pale spot in cell M1 extending to wing margin 16
 - Distal pale spot in cell M1 lying far from wing margin 17
- 16. Poststigmatic pale spots in cell R5 fused into a single pale spot; antennal sensory pattern 3,7–10 *eldridgei* Wirth and Barreto
 - Poststigmatic pale spots in cell R5 separate; antennal sensory pattern 3,8–10 *limonensis* Ortiz and Leon
- 17. Larger species, wing 1.08 mm long; 3rd palpal segment slender with broad shallow pit; aedeagus conspicuously cleft distad with 2 sharp laterally directed teeth on each side; parameres with simple twisted tips without fringing spines *crucifer* Clastrier

- Smaller species, wing less than 1.00 mm long; 3rd palpal segment and male aedeagus and parameres various 18
- 18. Wing densely hairy, with macrotrichia extending in at least 2 rows to base of cell M2 19
 - Wing moderately hairy, with macrotrichia only on distal ½ or less, a few in anal cell, hairs extending to base of cell M2 only in *C. bayano* 21
- 19. Wing length 0.80 mm; 3rd palpal segment long and slender, with pore opening smaller than pit diameter; eyes broadly separated, hairy; spermathecae brownish, ducts not annulate, sclerotized ring longer; aedeagus Y-shaped, with slender simple tip and slender, nearly straight basal arms; parameres with nearly straight stem and long ventral lobe; ventral root of basistyle moderately long and slender *debilipalpis* Lutz
 - Wing length 0.93–0.97 mm; eyes narrowly separated, bare; palpus, spermathecae and male genitalia various 20
- 20. Third palpal segment short and broad (PR 1.9) with moderately shallow pit, pore opening as large as pit diameter; proboscis short, P/H ratio 0.60; spermathecae nearly colorless, bases of ducts with fine annulations; male basistyle with ventral root long and slender, toes nearly meeting mesad; distomedian process of aedeagus short and stout with broad truncate tip; parameres sinuate without distinct ventral lobe *annuliductus*, new species
 - Third palpal segment moderately long and slender (PR 2.6), with moderately deep sensory pit, pore opening as large as pit diameter; proboscis long, P/H ratio 0.83; spermathecae brownish, bases of ducts not annulate; male basistyle with ventral root short and stout, the toe blunt-pointed; aedeagus with long slender distomedian process, apex deeply divided into 2 sharp appressed points; parameres curved gently in midportion and tapering to slender, filamentous tip *trilineatus* Fox (in part)
- 21. Antennal sensory pattern 3,7–10; 3rd palpal segment with small deep pit *germanus* Macfie
 - Antennal sensory pattern 3,8–10; 3rd palpal segment various 22
- 22. Eyes narrowly separated; 3rd palpal segment with moderately broad shallow pit; male aedeagus as in *debilipalpis* (couplet 19); parameres slender and sinuate without ventral lobe *denisae* Clastrier
 - Eyes moderately to broadly separated; 3rd palpal segment various; male aedeagus short, tip broad with distinct median lobe and sharp lateral points 23
- 23. Female eyes broadly separated; male paramere with distinct ventral lobe *eadsii* Wirth and Blanton

- Female eyes moderately separated; male paramere without ventral lobe 24
- 24. Female wing without macrotrichia in base of cell M2; 4th palpal segment usually as broad as long; male aedeagus unusually broad at tip, the lateral points prominent; heel of ventral root much shorter than toe *hoffmani* Fox
 - Female wing with macrotrichia extending in 2 rows to base of cell M2; 4th palpal segment longer than broad; male aedeagus only slightly broadened at tip, the lateral points inconspicuous; heel and toe of ventral root blunt and long *bayano*, new species
- 25. Pale spot present in cell M2 lying adjacent to anterior side of midportion of mediocubital stem; 3rd palpal segment with sensory pit deeper than diameter of pore opening; eyes broadly separated *insinuatus* Ortiz and Leon
 - No pale spot present in cell M2 lying adjacent to midportion of mediocubital stem 26
- 26. Third palpal segment with small deep pit; smaller species, wing 0.72 mm long; halter infuscated; aedeagus with short tapering, distally rounded, distal processes; paramere sinuate without ventral lobe, with distal fringing spines; palpal pit with pore opening smaller than pit diameter *spurius* Wirth and Blanton
 - Third palpal segment with broad shallow pit 27
- 27. All femora with subapical pale bands; (3rd palpal segment with broad elliptical pit *equatoriensis* Barbosa
 - Femora dark to tip 28
- 28. Antennal sensory pattern 3,8-10; 3rd palpal segment with shallow pit with same size pore; wing length 0.86 mm *darlingtonae* Wirth and Blanton
 - Antennal sensory pattern 3,(5),6-10; 3rd palpal segment with pit deeper, opening by a smaller pore; wing length 0.91 mm *youngi* Wirth and Barreto

Culicoides debilipalpis Lutz

Culicoides debilipalpis Lutz, 1913: 60 (♀; Brazil; fig. wing); Wirth and Blanton, 1959: 442 (redescribed; figs.; Panama); Blanton and Wirth, 1979:78 (redescribed; figs.; Florida; review of biology and distribution).

Distribution.—A common species in the southeastern U.S. from Maryland and Kentucky to Florida and Louisiana; absent in Texas, Mexico, and the West Indies; present in Central and South America south to Argentina. It is replaced in Texas and Mexico by *C. eadsi* Wirth and Blanton and in the West Indies by *C. hoffmani* Fox.

Biology.—Williams (1964) reared this species from rotting cacao pods

and bamboo stumps in Trinidad; Messersmith (1964) reared it from wet tree cavity debris in Virginia; and Smith (1965) reared it from wet tree holes and stump holes in Florida.

New records.—PANAMA: Panama Prov., Bayano Field Sta., June 1976, G. C. Vitale, 1 ♂, 5 ♀ reared from a collection of very wet soil trapped on a split fallen tree trunk at 10 cm above ground level; 1 ♀ reared from a tree hole at 1.5 m.

Culicoides annuliductus Wirth, NEW SPECIES

Fig. 1

Female.—Wing length, 0.97 mm; breadth, 0.47 mm.

Head: Eyes (Fig. 1e) narrowly separated, bare. Antenna (Fig. 1a) with lengths of flagellar segments in proportion of 28-26-30-30-30-30-30-32-32-32-48, antennal ratio 0.77; sensory pattern 3,8-10, segments 8-10 each with 4 sensilla coeloconica. Palpus (Fig. 1b) with 3rd segment rather short and swollen, with moderately shallow sensory pit with opening same diameter as pit; palpal ratio 1.9. Proboscis short, P/H ratio 0.60; mandible with 14-15 teeth.

Thorax: Brown; mesonotum with moderately prominent dark brown sublateral patches. Legs (Fig. 1i) brownish, knee spots blackish; narrow pale rings subapically on fore- and midfemora and basally on all tibiae, broad apex of hindtibiae pale; tibial comb with 4 spines, the 2nd from the spur longest. Wing (Fig. 1c) deeply infuscated with distinct small round pale spots as figured; 2nd radial cell dark to tip; 2 poststigmatic pale spots in cell R5 well separated, the posterior one very slightly proximad of the other; distal pale spot in cell R5 transversely oval to slightly irregular in shape; cell M1 with 2 pale spots, the distal one lying far from wing margin; cell M2 with small oval pale spot behind medial fork and a larger round one near wing margin; cell M4 with round pale spot in midportion not meeting wing margin; anal cell with one pale spot in distal portion; macrotrichia numerous and coarse, extending to base of cell M2 in more or less a double row; costal ratio 0.59. Halter with dark brown knob.

Abdomen: Brown. Genital sclerotization as in Fig. 1d. Spermathecae (Fig. 1f) 2, poorly sclerotized and yellowish brown; sclerotized ring and rudimentary $\frac{1}{3}$ as in figure, the ring short and tapering; functional spermathecae ovoid, the slender necks bearing distinct microscopic annulations; slightly unequal, measuring 0.058 by 0.039 mm and 0.051 by 0.035 mm including the necks.

Male.—Similar to female with usual sexual differences; antenna with well developed brownish plume, segments 3-12 more or less fused; segments 3, 10-12 with sensilla coeloconica; last 4 segments with lengths in proportion of 5-13-10-11. Genitalia (Fig. 1h): 9th sternum with broad shallow caudo-median excavation, ventral membrane not spiculate; 9th tergum long and

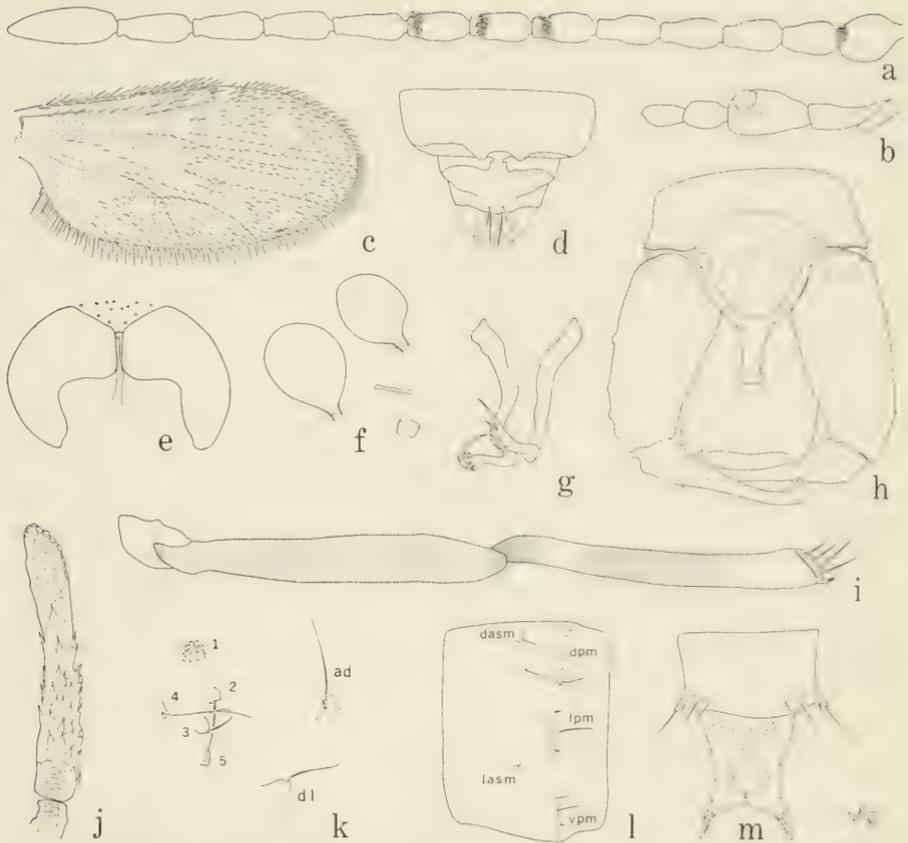


Fig. 1. *Culicoides annuliductus*. a-f, i, female; g-h, male; j-m, pupa. a, Antenna. b, Palpus. c, Wing. d, Genital sclerotization. e, Eye separation. f, Spermathecae. g, Parameres. h, Genitalia, parameres removed. i, Hindfemur and tibia. j, Respiratory horn. k, Thoracic tubercles 1 to 5 (left), and anterodorsal (top right) and dorsolateral (bottom right) tubercles of head. l, Lateral view of 4th abdominal segment. m, Dorsal view of last 2 abdominal segments.

tapering with moderately long, triangular, apicolateral processes. Basistyle with foot-shaped ventral root, anterior "toes" unusually long and slender, nearly meeting each other on midline; dististyle slender and slightly curved, with bent, hooked tip. Aedeagus with basal arch extending to $\frac{1}{2}$ of total length, basal arms slender and curved; distomedian process short and stout with broad truncate tip. Parameres (Fig. 1g) separate; each with knobbed base, stem slightly bent near base, slender and slightly sinuate in midportion, without ventral lobe; distal portion not greatly elongated, with slender pointed tip and 3-4 lateral fringing spines.

Pupa.—Length 2.0 mm. Color of exuviae pale yellowish. Nearly identical

with pupa of *C. hoffmani* described by Linley and Kettle (1964). Respiratory horn (Fig. 1j) with 10 distal and 2 lateral spiracular openings; surface with coarse sharp scalelike spines on proximal $\frac{1}{2}$. Operculum lost on available specimens. Anterodorsal and dorsolateral tubercles of head as in Fig. 1k; thoracic tubercles as figured, no. 1 in form of a cluster of minute granules, 2, 3, and 4 with rather elongate setae, 5 unarmed. Head and thorax without distinct integumental spinules; abdomen without integumental spinules except dorsally on last segment as figured (Fig. 1m); segmental tubercles of abdomen as in Fig. 1l, lateral postero-marginals longer than in *C. hoffmani*. Apical processes of last segment with well-developed spinules and not as divergent as in *hoffmani* (Fig. 1m).

Distribution.—Known only from the type-series from Panama.

Types.—Holotype ♀, allotype ♂, Bayano Field Station, Panama Prov., Panama, June 1976, G. C. Vitale, reared from tree holes (type no. 76105, USNM). Paratypes, 36 ♀, 43 ♂, same data, all reared from tree holes. Of these, 67 were found in two tree holes from 1–2.5 m above ground level while the remaining 14 were found in three tree holes at heights of 8–9 m.

Discussion.—The species takes its name from the annulate ducts of the spermathecae. It is closely related to *C. debilipalpis* Lutz, from which it can readily be separated by the characters given in the key. This species has been reared only from tree holes, at various heights from 1–9 m above ground level.

Culicoides bayano Wirth, NEW SPECIES

Fig. 2

Female.—Wing length, 0.85 mm; breadth, 0.40 mm.

Head: Eyes (Fig. 2e) narrowly separated, with short interfacetal hairs. Antenna (Fig. 2a) with lengths of flagellar segments in proportion of 26-23-26-27-27-28-29-30-30-32-32-32-50, antennal ratio 0.82; sensilla coeloconica on segments 3,8–10, double on 10, with long ringing setulae. Palpus (Fig. 2b) with lengths of segments in proportion of 10-27-40-17-15; 3rd segment moderately swollen, palpal ratio 2.0, with moderately large and deep sensory pit opening by same size pore. Proboscis moderately long, P/H ratio 0.82; mandible with 15 teeth.

Thorax: Dark brown; mesonotal pattern not determined in slide-mounted specimens. Legs (Fig. 2h) brown, knee spots blackish; narrow pale rings subapically on fore- and midfemora, basally on all tibiae, broad apex of hindtibia pale; tibial comb with 4 spines, the 2 nearest the spur longest, subequal. Wing (Fig. 2c) dark grayish, with distinct pattern as figured: 2nd radial cell dark to tip; pale spot over r-m crossvein extending broadly to costal margin; poststigmatic pale spots in cell R5 two, more or less fused in a transverse double spot, distal pale spot in cell R5 rounded, slightly transverse; 2 oval pale spots in cell M1, distal one lying far from wing margin;

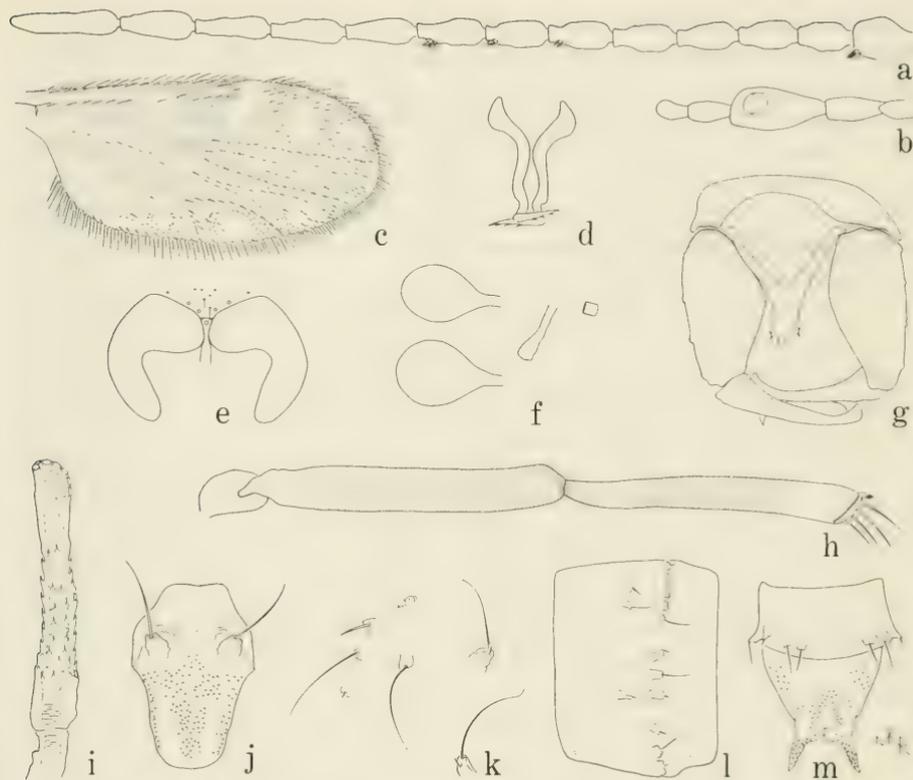


Fig. 2. *Culicoides bayano*. a–e, f, h, female; d, g, male; i–m, pupa. a, Antenna. b, Palpus. c, Wing. d, Parameres. e, Eye separation. f, Spermathecae. g, Genitalia, parameres removed. h, Hindfemur and tibia. i, Respiratory horn. j, Operculum. k, Tubercles of thoracic and head regions, as in Fig. 1k. l, Lateral view of 4th abdominal segment. m, Dorsal view of last 2 abdominal segments.

cell M2 with elongate pale spot behind medial fork and a rounded pale spot lying at wing margin in apex of cell; cell M4 with large rounded pale spot at wing margin; anal cell with 1 pale spot in distal portion. Macrotrichia sparse and inconspicuous, confined to distal $\frac{1}{2}$ of wing with a sparse double row extending to base of cell M2; costal ratio 0.58. Halter knob dark brown.

Abdomen: Brown. Spermathecae (Fig. 2f) 2, dark brown, ovoid with long slender necks; rudimentary spermatheca and sclerotized ring present, latter as broad as long with parallel sides; functional spermathecae slightly unequal, measuring 0.058 by 0.036 mm and 0.052 by 0.030 mm including necks.

Male.—Similar to female with usual sexual differences; antenna with sparse brownish plume, segments 4–12 more or less fused; segments 3, 10–

12 with sensilla coeloconica; last 4 segments with lengths in proportion of 17-55-41-50. Genitalia (Fig. 2g) short, nearly as broad as long. Ninth sternum with broad, shallow, caudomedian excavation, ventral membrane bare; 9th tergum short and tapering with large triangular apicolateral processes. Basistyle with ventral root foot shaped, with "heel" and "toe" both blunt and stout and of approximately equal lengths; dististyle slender and nearly straight with hooked tip. Aedeagus with basal arch extending to $\frac{1}{2}$ of total length, basal arms stout and nearly straight; distomedian process moderately broad and stout, with apex well sclerotized and bearing a small rounded median process and 2 inconspicuous sharp lateral points, the latter each with a sharp, ventrally directed spine arising at base. Parameres (Fig. 2d) separate; each with basal knob slender and sinuate in midportion without ventral lobe; apex abruptly bent ventromesally and tapering to distal point with lateral fringe of 3-4 fine spines.

Pupa.—Length 1.9 mm. Color of exuviae yellowish brown, respiratory horns brownish. Very similar to that of *C. hoffmani*. Respiratory horn (Fig. 2i) with 7 distal and 2 lateral spiracular openings, surface with coarse scale-like spines on proximal 0.7. Operculum (Fig. 2j) similar to that of *hoffmani*, more fine, blunt spinules than in *hoffmani*; anteromarginal tubercles large, with long spine. Anterodorsal and ventrolateral tubercles (Fig. 2k, right) similar to those of *hoffmani*; dorsal tubercles of thorax similar to those of *annuliductus*, but tubercle 5 bearing a short seta as usual in the group. Integument of cephalothorax with abundant pale microtubercles and that of abdomen with numerous sharp micro-spines (similar to the "small scales" described by Linley and Kettle, 1964, in *C. hoffmani*). Segmental tubercles of abdomen as in Fig. 2l, nearly identical with those of *hoffmani* and *annuliductus*. Last segment (Fig. 2m) with apical processes short and directed caudad, slightly diverging, and bearing abundant spinules.

Distribution.—Panama.

Types.—Holotype ♀, allotype ♂, Bayano Field Station, Panama Prov., Panama, June 1976, G. C. Vitale, reared from *Aechmea pubescens* (type no. 76106, USNM). Paratypes, 20 ♂, 39 ♀, same data, except as follows: 27 from 6 tree holes, 19 from 3 rotting palm stumps, 6 from collections of leaf humus and moist soil trapped on a fallen tree trunk 1 m above ground level, and 13 from the bromeliads *Aechmea pubescens* and *Vriesea heliconioides*. Of the 65 reared adults, 50 came from sites 1-2.5 m above ground, 13 from bromeliads 3-5 m above ground, and 2 from tree holes more than 8 m above ground.

Other specimens examined.—PANAMA: Coco Solito, Canal Zone, 8 Dec. 1958, S. Breeland, in emergence cage 305, 2 ♂, 3 ♀; Mojinga Swamp, C.Z., 13 Oct. 1952, F. S. Blanton, light trap, 1 ♂; Fort Clayton, C.Z., 18 June 1952, F. S. Blanton, light trap, 1 ♂; Taboga Island, Panama Prov., 10 Dec. 1953, F. S. Blanton, light trap, 1 ♂.

Biology.—The Coco Solito specimens reared by Breeland were identified by Wirth as *C. hoffmani* and reported under this name by Breeland (1960) as follows: "Five specimens (2 males, 3 females) recovered from a single location in black muck mangrove habitat (type 1) with from 1 to 2 inches of standing water. Cage operated in position for a period of 6 cage weeks, Oct. 21, 1958 - December 5, 1958 near Rainbow City. *C. hoffmani* was recovered in this location to the exclusion of other species, although a subsequent study revealed no special habitat characteristics, except for standing water."

Discussion.—The species takes its name from the type-locality, the field station on the Bayano River in Panama Province, Panama. This species is very closely related to *C. hoffmani* but can be distinguished by the characters given in the key. The best characters are in the male genitalia, especially the shape of the ventral root of the basistyle and the distal processes of the aedeagus.

Culicoides paraensis (Goeldi)

Haematomyidium paraense Goeldi, 1905: 137 (♀; Brazil; fig. ♀, wing).

Culicoides paraensis (Goeldi); Lutz, 1913: 55 (combination; redescribed; figs.); Ortiz, 1951: 574 (redescribed; figs.; Venezuela); Wirth and Blanton, 1959: 440 (redescribed; figs.; Panama); Wirth and Blanton, 1974: 71 (redescribed; figs.; West Indies); Blanton and Wirth, 1979: 131 (redescribed; figs.; Florida; review of biology and distribution).

Distribution.—Common in North, Central, and South America and West Indies, in U.S. from Pennsylvania to Florida and Louisiana, Mexico and south to Argentina and Bolivia.

Biology.—Snow et al. (1957) and Smith (1965) found this species breeding in tree hole debris in Florida and Tennessee, Breeland (1960) reared it from tree hole debris in Panama, and Williams (1964) reared it from rotting cacao pods and a rotting calabash in Trinidad. Childers and Wingo (1968) reared it from sap flows from cottonwood trees in Missouri.

New records.—PANAMA: Bayano Field Station, Panama Prov., June 1976, G. C. Vitale, 3 ♂, 6 ♀ from 2 tree holes at 1.5 and 4 m above ground level; 1 ♀ from *Aechmea pubescens* at 5 m above the ground.

Culicoides fliiductus Wirth, NEW SPECIES

Fig. 3

Female.—Wing length, 0.87 mm; breadth, 0.43 mm.

Head: Eyes (Fig. 3e) narrowly separated, hairy. Antenna (Fig. 3a) with lengths of flagellar segments in proportion of 35-23-26-30-28-28-28-28-28-28-28-30-45, antennal ratio 0.72; sensilla coeloconica present on segments 3, 8-10, 2 per segment, with long ringing setulae. Palpus (Fig. 3b) with lengths

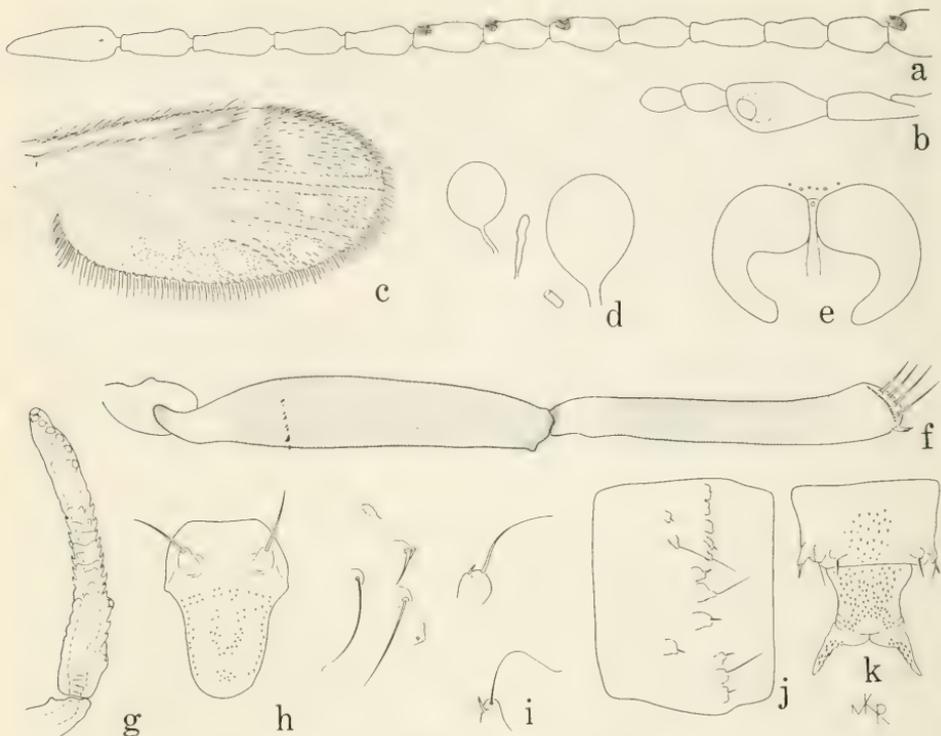


Fig. 3. *Culicoides fliductus*. a-f, female; g-k, pupa. a, Antenna. b, Palpus. c, Wing. d, Spermathecae. e, Eye separation. f, Hindfemur and tibia. g, Respiratory horn. h, Operculum: tubercles of thoracic and head regions, as in Fig. 1k. j, Lateral view of 4th abdominal segment. k, Dorsal view of last 2 abdominal segments.

of segments in proportion of 10-25-45-13-15; 3rd segment broad, palpal ratio 2.8, with large deep pit opening by a smaller pore. Proboscis short, P/H ratio 0.73; mandible with 15 teeth.

Thorax: Dark brown; mesonotal pattern not determined in slide-mounted specimens. Legs (Fig. 3f) brown, knee spots blackish; subapical pale rings on fore- and midfemora faint to absent, hindfemur entirely dark; tibiae with narrow basal pale rings, hindtibia with broad apex pale; tibial comb with 4 spines, 2nd from the spur longest. Wing (Fig. 3c) dark grayish with prominent, coarse macrotrichia; pattern as figured, 2nd radial cell dark to tip; pale spot over r-m crossvein continued in full width to costal margin; 2 well-separated small round poststigmatic pale spots in cell R5, the posterior one located slightly proximad; cell R5 with 2 pale spots in distal portion as in *C. paraensis*, the proximal one transversely V-shaped, the distal one quite small and round; cell M1 with 3 pale spots, the distal one located at wing margin; cell M2 with a distinct pale spot lying just ahead of

midportion of cubital stem, and an elongate pale spot lying behind medial fork and another lying ahead of mediocubital fork, and a large rounded pale spot at wing margin; cell M4 with round pale spot in midportion; anal cell with a round pale spot in distal portion. Macrotrichia sparse and confined to distal $\frac{1}{2}$ of wing; costal ratio 0.60. Halter knob dark brown.

Abdomen: Brown. Spermathecae (Fig. 3d) 2 plus vestigial 3rd and a slender tubelike sclerotized ring; functional spermathecae very unequal in size and shape; the larger ovoid with a long slender neck, measuring 0.063 by 0.044 mm including the neck; the smaller nearly spherical with a long threadlike neck 0.022 mm long, the main portion measuring 0.032 by 0.029 mm.

Male.—Unknown. Despite careful study no reared specimens could be attributed to this species and distinguished from *C. paraensis*, which was also present in the tree hole collections.

Pupa.—Length 1.8 mm. Color uniformly yellowish brown, respiratory horns darker towards tips. Nearly indistinguishable from pupae of *C. hoffmani*, *C. annuliductus*, and *C. bayano*. Respiratory horn (Fig. 3g) with 7 distal and 2 lateral spiracular openings. Operculum (Fig. 3h), tubercles of head and thorax (Fig. 3i), abdominal tubercles (Fig. 3j), and last 2 segments (Fig. 3k) as figured. Integument with abundant pale micro-tubercles and micro-spines resembling those of *C. hoffmani*, much better developed than those of *annuliductus* and *bayano*.

Distribution.—Panama.

Types.—Holotype ♀, Bayano Field Station, Panama Prov., Panama, June 1976, G. C. Vitale, reared from tree hole 1.5 m above ground (type no. 76107, USNM). Paratypes, 61 ♀, same data, of which 60 emerged from five tree holes while one emerged from a rotting palm stump. All specimens were from breeding sites less than 2.5 m above ground except one from a tree hole 8 m above the forest floor.

Other specimens examined.—PANAMA: Barro Colorado Island, C.Z., July 1967, W. W. Wirth, light trap, 6 ♀.

Discussion.—The species is named for the threadlike sclerotization of the neck of the subspherical small spermatheca. *Culicoides fliductus* belongs to a group of four Neotropical species including *C. paraensis* (Goeldi), *C. quasiparaensis* Clastrier, and *C. neoparaensis* Tavares and Sousa. These species have a wing pattern nearly identical with that of *C. debilipalpis* Lutz and related species, except for the presence of two extra pale spots located in the extreme apices of cells R5 and M1. The separation of these four species is detailed in the key.

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TRAPPING EXPERIMENTS WITH THE GERMAN COCKROACH,
BLATTELLA GERMANICA (L.) (DICTYOPTERA:
BLATTELLIDAE), SHOWING DIFFERENTIAL EFFECTS
FROM THE TYPE OF TRAP AND THE
ENVIRONMENTAL RESOURCES

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Abstract.—Trapping experiments with the German cockroach, *Blattella germanica* (L.), tested (1) the comparative attractiveness of food vs. water in areas of a laboratory with differences in the availability of these resources and (2) the comparative catch from roatel vs. mason jar-type traps. Cockroaches tended to enter the trap offering the resource which was scarcest within the immediate area of the harborage. The two types of trap showed similar results for all age classes except small nymphs. The roatel caught about four times as many small nymphs as the jar type.

In the course of some twenty years of rearing cockroaches, we have noted certain places in the Cockroach Stock Center laboratory where it is not uncommon to find German cockroaches, *Blattella germanica* (L.). The nature of our rearing and research programs prohibits the use of insecticides to control such infestations. Therefore, traps are used regularly to reduce density and prevent the spread of cockroaches. This situation was utilized recently to investigate suspected differences in the effectiveness of traps, both with respect to baiting with food vs. water and the type of trap. The results of the two experiments reported here have implications for the use of traps to sample populations for purposes of density estimation, analyses of age structure, or other population parameters.

Two infested areas were used as trapping sites. These were at opposite ends of the laboratory, separated by ca. 10 m. Visual observation (sightings) indicated the larger infestation was around the sink, where water was available continuously but food was scarce. The other site was in an area where maintenance activities are conducted routinely (feeding, watering, changing rearing jars, etc.). Here access to water was, at best, sporadic, but bits of dog food are present in difficult to clean places which almost certainly pro-

Table 1. Comparison of the attractiveness of food vs. water to German cockroaches in two environmentally different sites.

Trapping Site	Bait	Collection Period	Number of Cockroaches		
			Adults	Nymphs	Total
Site 1	Dog food	1st wk	14 (8 ♀)	80	94
		2nd wk	10 (4 ♀)	98	108
		2 wks	24 (12 ♀)	178	202
	Water	1st wk	0	0	0
		2nd wk	0	1	1
		2 wks	0	1	1
Site 2	Dog food	1st wk	3 (2 ♀)	14	17
		2nd wk	0	6	6
		2 wks	3 (♀)	20	23
	Water	1st wk	2	70	72
		2nd wk	0	18	18
		2 wks	2	88	90

vided some opportunity for feeding. The trapping site at the sink is referred to herein as "site 1" and that in the maintenance area as "site 2."

The traps were either roatel traps (Cornell Chemical Co.) or a homemade mason jar type (1.5 l). In the former, access was by several one-way entrances at floor level. In the latter, paper towels, held in place around the outside of the jar with rubber bands, made it possible for the cockroaches to climb the jar. Once inside, escape was prevented by a thin layer of vaseline[®] around the upper inside jar rim. Bait consisted of water (vial stoppered with sponge), dog food pellets, or both.

The first experiment tested the comparative attractiveness of food vs. water to cockroaches within the two areas. One roatel trap baited with dog food and a second with water were placed at site 1 and site 2. The traps were replaced by clean, freshly baited traps on Monday, Wednesday, and Friday during two successive weeks. The trapped cockroaches were counted and categorized as to adults vs. nymphs. The results are summarized in Table 1. In the sink area (site 1), food was attractive; water was not. At site 2, cockroaches were attracted to both traps, but water proved to be the greater lure. The only dead cockroaches among those trapped at either site were in the food-baited traps at site 2. Apparently these cockroaches were physiologically in critical need of water. A comparison of total numbers caught at each site verified visual observations in that the heavier infestation was clearly in the sink area (site 1), not unlike the situation in apartments or single homes. The second weekly catch at site 1 equalled that of the first, indicating trapping had had little effect on population density. However, at

Table 2. Collections of German cockroaches from roatel vs. jar-type traps. Nymphs grouped as large (L), medium (M), and small (Sm).

Type of Trap	Collection Period	Number of Cockroaches				Total
		Adults	Nymphs			
			L	M	Sm	
Roatel	2 wks	29	33	36	127	235
	2 wks	34	16	24	55	129
Jar	2 wks	30	44	45	29	148
	2 wks	25	36	37	15	113

site 2, the catch within both types of trap during the second week was markedly less than that of the first week.

The second experiment utilized the heavier infestation at site 1 to compare catch from the roatel to that of the jar-type trap. One of each was baited with food and water. The traps were placed side-by-side at site 1. Collecting procedures were similar to the first experiment except that the nymphal cockroaches were grouped as "large" (primarily 5th-6th stage), "medium" (mainly 3rd-4th stage), and "small" (primarily 1st-2nd stage). This experiment was replicated once. The results are summarized in Table 2. Catches were similar for all age groups except small nymphs. With the latter, about four times as many were caught in the roatel as in the jar trap. Possibly due to the combined effects of double trapping and the continuance of trapping over a longer period, a tendency towards reduced catch finally appeared during the second two weeks of trapping. Apparently trapping was beginning to have an effect on density of the site 1 infestation. The similarity between the number of "medium" and "large" nymphs from all collections is of interest. Apparently there was little mortality among middle or late stage nymphs. The larger numbers of small nymphs, as revealed by roatel traps, probably indicate high mortality among very young nymphs. It also shows how easily heavy infestations of small nymphs could be missed in survey trapping.

To a large extent, the experimental results demonstrate environmental effects that might be predicted by anyone familiar with the German cockroach. Due to the more limited resources, especially with respect to water, the infestation at site 2 was smaller than that at site 1. Scarcity of food, water, or both has been shown previously to affect oothecal formation and nymphal survival (Mueller, 1978). The present experiment showed that cockroaches are attracted to whichever trap offers the resource that is scarcest within their immediate environment. Thus, within kitchens, it is hardly surprising that Ebeling et al. (1966) found removal of food from feeding stations was followed by increased catch in food-baited traps. Another implication from the present results concerns water. It could be a

useful addition to food in traps in bedrooms or other situations where water is not readily available. It is noteworthy that jar and roatel traps gave closely similar results for all age groups except small nymphs. Apparently small nymphs were either less willing or able to scale the vertical distance necessary to reach the top of the jar than were those of later stages.

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DESCRIPTION OF A NEW SPECIES OF *TRICHOGRAMMA*
(HYMENOPTERA: TRICHOGRAMMATIDAE) FROM NEW YORK

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Abstract.—*Trichogramma julianoi*, a new species from New York, is described and illustrated. Its distribution and host range are given, and comparisons are made with closely related species.

The following description of a new species of *Trichogramma* is provided at the request of Steven A. Juliano, Department of Biology, Pennsylvania State University, University Park. The species was one of several *Trichogramma* included in his graduate research at Cornell University, Ithaca, New York, during 1978-79. The description is based on dry and alcohol-preserved specimens which are mounted in Hoyers solution on glass slides.

Trichogramma julianoi Platner and Oatman, NEW SPECIES

Fig. 1

Adult body fuscous with front and middle legs, trochanter, tibia, and tarsus of back leg, and frontovertex of head lighter in color. Female slightly lighter in color than male.

Holotype male.—Antenna with flagellum 0.16 as wide as long (0.030×0.184 mm) and 1.13 as long as hindtibia (0.163 mm); flagellar setae 45 in number with longest seta (0.101 mm) 3.39 as long as maximum width of flagellum (0.030 mm). Forewing with 28 setae between 4th and 5th vein tracts; longest seta (0.041 mm) on postapical margin 0.16 as long as maximum width of wing (0.265 mm). Genital capsule 0.35 as wide as long (0.041×0.120 mm); DEG (0.117 mm long), CS (0.115 mm long), and MVP (0.106 mm long) 0.98, 0.96, and 0.89 length of genital capsule, respectively. Aedeagus (0.122 mm long) 0.75 length of hindtibia and 1.02 length of genital capsule.

Male.—Antenna (Fig. 1C) with flagellum relatively long and curved at basal $\frac{1}{2}$, 0.17 ± 0.01 (0.15-0.22) (N = 15) as wide as long, and 1.12 ± 0.01 (0.96-1.19) (N = 15) as long as hindtibia; flagellar setae relatively long, ta-

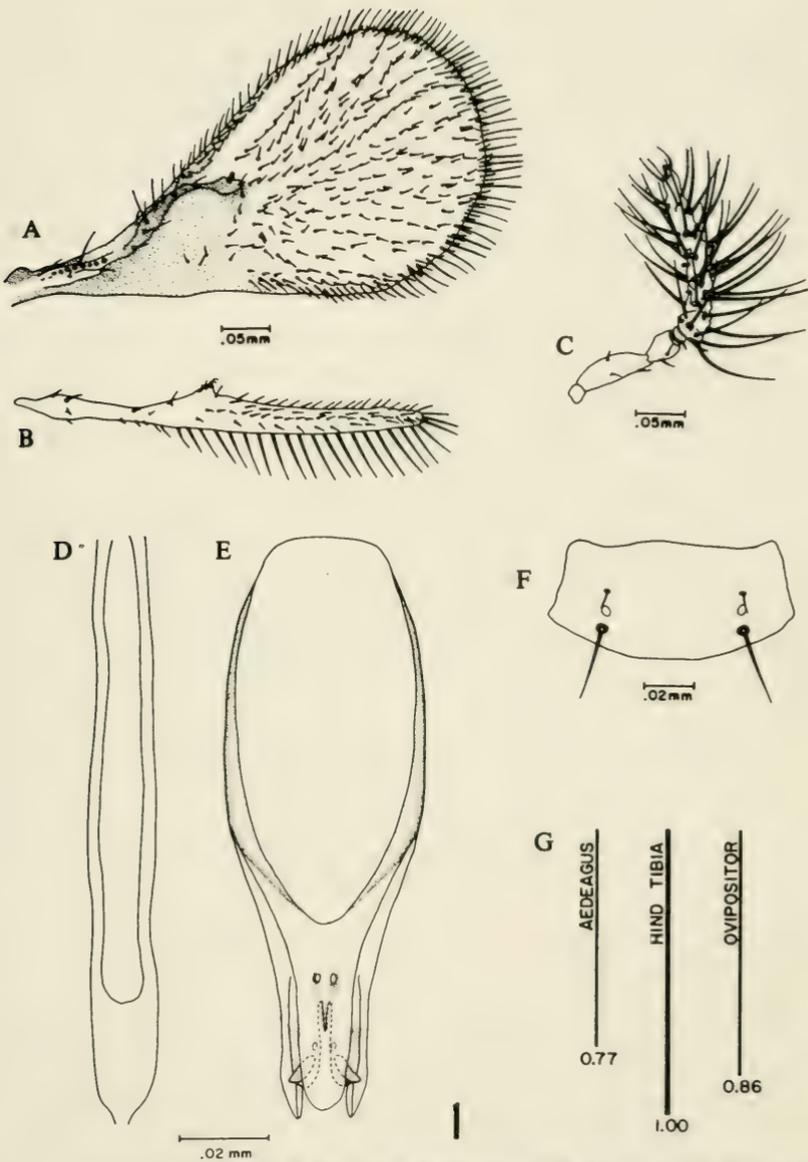


Fig. 1. *Trichogramma julianoi*. A, Forewing. B, Hindwing. C, Male antenna. D, Aedeagus. E, Male genital capsule. F, Mesoscutellum. G, Ratio of aedeagus and ovipositor to hindtibia of male and female, respectively.

pering gradually from base, 42.6 ± 1.63 (30–49) (N = 14) in number, length of longest seta 3.40 ± 0.08 (2.93–4.00) (N = 15) as long as maximum width of flagellum.

Forewing (Fig. 1A) with vein tracts relatively well defined, setae between tracts moderate in number, area between 4th and 5th tracts (i.e., the 2 tracts posterior to RS_2) with 20.5 ± 1.70 (9–36) ($N = 15$) setae; longest seta on postapical margin 0.18 ± 0.01 (0.16–0.22) ($N = 15$) as long as maximum width of wing.

Hindwing (Fig. 1B) with anterior and posterior vein tracts equally as prominent as middle tract, component setae equal in size, anterior tract extending just short of wing tip with posterior tract extending to wing tip.

Mesoscutellum (Fig. 1F) with anterior pair of setae fine, short, ca. $\frac{1}{5}$ length of posterior setae.

Genital capsule (Fig. 1E) 0.33 ± 0.01 (0.29–0.36) ($N = 15$) as wide as long; dorsal expansion of gonobase (DEG) moderately narrowed with blunt tip apically, sides only slightly concave without basal constriction, entire structure heavily sclerotized; DEG extending slightly beyond chelate structure (CS) and extending 0.98 ± 0.01 (0.93–1.00) ($N = 15$) length of genital capsule; CS extending 0.95 ± 0.003 (0.93–0.98) ($N = 15$) length of genital capsule; median ventral projection (MVP) narrow and sharply pointed, well below CS and DEG, extending only 0.86 ± 0.004 (0.84–0.89) ($N = 15$) length of genital capsule. Aedeagus (Fig. 1D) 0.77 ± 0.01 (0.73–0.84) ($N = 15$) length of hindtibia (Fig. 1G) and 1.03 ± 0.01 (0.98–1.07) ($N = 15$) length of genital capsule; apodemes comprising ca. $\frac{1}{5}$ length of aedeagus.

Female.—Ovipositor 0.86 ± 0.02 (0.79–0.95) ($N = 9$) length of hindtibia (Fig. 1G).

Type information.—Holotype ♂ reared from a *Sepedon fuscipennis* Loew egg (Diptera: Sciomyzidae) collected 29 May 1978 by Steven A. Juliano from Ithaca, Tompkins County, New York. Allotype ♀, same data as holotype. The holotype and allotype are deposited in the collection of the U.S. National Museum of Natural History, Washington, D.C. (USNM type no. 76665).

Geographical distribution.—Presently known only from the area in and near Ithaca, New York.

Material examined.—*New York*: Ithaca (type-locality, see above); Lansing, ex. *Sepedon fuscipennis* eggs on vegetation, 20 August 1978; Oxbow Swamp, Newfield, ex. *S. fuscipennis* eggs on vegetation, 10 August 1978. Paratypes are not designated because there is no way of knowing whether or not the specimens are siblings from the same female. We prefer to designate paratypes only when we have such material.

Remarks.—This species is readily separated from other known species of *Trichogramma* by the apodemes of the aedeagus which are longer than those in any other known species of *Trichogramma*. *Trichogramma aurosum* Sugonyaev and Sorokina, a Russian species, is closest in this respect (Sugonyaev and Sorokina, 1976). However, *T. aurosum* differs from *T.*

julianoi by having shorter setae on the male antenna, being slightly less than twice the width of the flagellum, and by the notched base of the DEG.

The male genital capsule in *Trichogramma julianoi* is most comparable to *Trichogramma achaeae* Nagaraja and Nagarkatti, except for the obsolescence of the MVP in the latter species (Nagaraja and Nagarkatti, 1969).

The hindwing of *Trichogramma julianoi* has three complete vein tracts which are present in several species of *Trichogramma*, including *Trichogramma japonicum* Ashmead and *Trichogramma brevicapillum* Pinto and Platner (Nagarkatti and Nagaraja, 1971; Pinto et al., 1978).

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**SPATIAL PATTERN AND MOVEMENT OF GERMAN COCKROACHES
IN URBAN, LOW-INCOME APARTMENTS
(DICTYOPTERA: BLATTELLIDAE)**

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Abstract.—The spatial pattern and movement of the German cockroach, *Blattella germanica* (L.), were studied in urban apartment buildings in Roanoke, Virginia. Each building (8 m × 32 m) contained six apartments adjacent to each other in a row. The spatial pattern was studied by trapping cockroaches in each apartment for eight weeks. Traps were made from one-qt. Mason jars baited with boiled raisins and a vial of water. A mark-recapture method, using genetic mutant black-body male German cockroaches, was used to study movement of cockroaches within apartment buildings.

German cockroaches were distributed throughout the three apartment buildings, but in each building a large number of cockroaches were "focused" at one or two apartments. Poor sanitary conditions in these apartments probably provided abundant food, water, and harborage for cockroaches. The movement study results indicate that laboratory reared, male German cockroaches can move between adjacent apartments. The large number of cockroaches captured in the apartments adjacent to focus apartments indicates the possibility of movement of field cockroaches between adjacent apartments.

The German cockroach, *Blattella germanica* (L.), is one of the most important household insect pests in the continental United States (Mampe, 1972). In an urban environment, especially in apartment buildings and row houses, this cockroach can occur in large numbers and achieve serious pest status. Wright (1965) reported the German cockroach as the most prevalent cockroach in urban, low-income apartments in North Carolina. A survey taken in 1970, in six New Haven, Connecticut public housing projects, showed that 60% of the apartments were infested with German cockroaches (Moore, 1971). Reiersen and Rust (1977) and Ogata et al. (1975) reported the dominance of the German cockroach in apartments and other urban buildings. Cornwell (1968) noted that this species was the pest in 70% of the

reported cockroach infestations in Boston city apartments and Gupta et al. (1973) and Wright (1979) found a relationship between household sanitation and German cockroach populations. Investigations of German cockroach habitats and population density include those by Wright and McDaniel (1973), Artyukhina (1972), Ogata (1976), Komiyama and Ogata (1977), Robinson et al. (1980), and Wood (1980).

The prevalence and importance of *B. germanica* in urban environments indicate the need for more field research on its biology and habits. The objectives of this research were to examine the spatial pattern of German cockroaches in three urban apartment buildings.

MATERIALS AND METHODS

Study Area.—The work was conducted in three Roanoke Redevelopment and Housing Authority apartment buildings in Roanoke, Roanoke Co., Virginia from September to November 1977. Each building contained six apartments adjacent to one another in a row. The buildings are 8 m × 32 m, constructed of concrete block, and have a brick veneer outside. There is a basement under one end apartment (apartment 6); the remaining apartments have a shallow crawl space beneath a suspended concrete slab. Each apartment contains approximately 65 m² of floor space, divided between two floors; a living room, kitchen, and pantry are on the first level, with two bedrooms and a bathroom on the second level. All the apartments in the three buildings were occupied during the study time. The buildings were labeled A, B, and C for identification.

Sampling Method.—Existing cockroach populations were sampled by using traps made from one-qt. Mason jars. Traps were modified from those used by Reiersen and Rust (1977). A tablespoon of boiled raisins and a sponge-wicked vial (4 dram) of water were placed in the jar. A thin film of petroleum jelly was spread on the inside lip of the jar, and a paper towel secured around the outside.

The traps were collected weekly, and replaced with fresh traps. Traps were returned to the laboratory where the nymph and adult cockroaches were separated and counted. First- and second-instar nymphs were not included in the data because of the possibility of ootheca of captured females hatching during the week. The traps were placed in the buildings for eight weeks. During the trapping period the regular chemical pest control program was suspended, and residents were asked to refrain from using insecticides.

Trapping Sites.—Three traps were placed in each apartment: one under the kitchen sink (=kitchen site); one in the pantry (=pantry site); and one under the bathroom sink (=bathroom site). The kitchen site was an enclosed cabinet (0.61 m × 1.3 m) which usually contained cleaning substances, packaged food, and sometimes garbage containers. The stove was adjacent to the kitchen sink cabinet. The pantry site was a small (2 m × 1.8 m) room

Table 1. Comparison of the sanitation rating and the number of German cockroaches captured in apartments for 8 weeks.

Bldg/Apt	Sanitation Rating	Total No. Captured	% of Total Captured	Mean Captured/Wk	S.D.	Range
A/1	G	158	7.8	19.7	10.6	6-38
A/2	B	779	38.7	97.3	35.5	41-142
A/3	B	854	42.4	106.7	85.4	14-292
A/4	G	209	10.4	26.1	12.5	6-43
A/5	G	5	0.2	0.6	0.7	0-2
A/6	G	7	0.3	0.8	1.1	0-2
B/1	B	652	54.4	81.5	20.1	43-105
B/2	G	151	12.6	18.8	15.0	0-35
B/3	G	97	8.1	12.1	6.0	9-21
B/4	G	19	1.6	2.3	2.9	0-7
B/5	B	259	21.6	32.3	11.1	17-52
B/6	G	20	1.7	2.5	1.4	0-4
C/1	G	3	0.2	0.3	0.5	0-1
C/2	G	13	4.7	9.1	7.6	0-22
C/3	G	112	7.3	14.0	15.3	0-49
C/4	G	24	1.5	3.0	3.5	0-8
C/5	G	283	18.3	35.3	23.2	19-72
C/6	B	1048	67.9	131.0	31.1	98-176

lined with wooden shelves and with a door that opened into the kitchen. The pantry usually contained packaged food, non-food items, and sometimes garbage containers. In the bathroom (1.5 m × 2 m), the trap was in the open (not in a cabinet). In apartment 2 (bldg. A) the trap for the bathroom was placed on the top shelf of the small closet adjacent to the bathroom.

The general construction, room furnishings, relative humidity, and temperature in the 18 apartments were nearly equal and constant. The sanitation level in the apartments was variable.

Sanitation Rating.—The sanitation level in the apartments was rated either Good or Bad. A Bad sanitation rating was given to apartments with accumulated newspapers, laundry, garbage, open food containers, unwashed dishes, excessive food scraps, and human excreta (including soiled diapers). A Good sanitation rating was given to apartments with average housekeeping, i.e. with no excessive amounts of food scraps, clutter, or garbage.

Movement Studies.—A mark-recapture method was used to study movement of cockroaches within apartment buildings. Black-body (BB) German cockroaches, characterized by dark body pigmentation (Ross and Cochran, 1966), were used as the marked cockroaches. These genetic mutants were selected because they are easily distinguished without the aid of a microscope.

During the first week of the study, 200 nymphal and virgin adult BB German cockroaches were released in the basement under the end apartment (apartment 6) in each of the three buildings. The traps in the apartments were checked weekly for the presence of BB cockroaches.

RESULTS AND DISCUSSION

Spatial Pattern.—German cockroaches were distributed throughout the three apartment buildings. Table 1 shows that German cockroaches were captured in all the apartments during the study period. In some apartments (A/5, A/6, C/1) the total number of cockroaches captured was small, less than ten. However, there were one or two apartments in each building in which the total number of cockroaches was very large. In apartments A/2, A/3, B/1, and C/6 the mean number of cockroaches captured per week was significantly greater ($P < 0.001$) (Least Squares Means) than in any other apartment.

Ebeling et al. (1967) showed the importance of proximity of food and water to German cockroach survival in the laboratory. Wright (1979) showed a direct relationship between the number of German cockroaches (visually counted) and the sanitation level of a single family dwelling: in houses with poor sanitation, the numbers of cockroaches counted were high. In this study, a sanitation rating of Bad was given to apartments A/2, A/3, B/1, and C/6. These apartments apparently provided food, water, and harborage in sufficient quantities to support the large number of cockroaches "focused" at these locations.

Table 1 shows that all apartments adjacent to "focus apartments" had a sanitation rating of Good, but the mean numbers of cockroaches captured per week were large. In all the apartments adjacent to focus apartments the mean numbers of cockroaches captured per week were significantly greater ($P < 0.001$) (Least Squares Means) than the means for apartments not adjacent to focus apartments. This study shows that apartments with a sanitation rating of Good, but adjacent to a focus apartment, can have a large number of cockroaches. Although food, water, and harborage were not abundant in the adjacent apartment, cockroaches from the large population in the focus apartment may include the adjacent apartment in their foraging and harborage-seeking activity. Movement to adjacent apartments is possible through cracks in the walls and along water and heating pipes.

Movement.—In building A, 11 BB cockroaches were recaptured during the four weeks following the release of 200 in the basement of apartment six: first week, 1 BB in apt. 6; second week, 1 BB in apt. 5; third week, 4 BB in apt. 6, 1 BB in apt. 5, 2 BB in apt. 4; fourth week, 2 BB in apt. 5. No other BB cockroaches were captured in this building. In building B, 1 BB cockroach was recaptured in apt. 5 during the first week following release. In building C, 1 BB cockroach was recaptured in apt. 5 during the third

week following release. No other BB cockroaches were captured in bldgs. B and C during the remaining weeks of the study. The results from the movements studies indicate that laboratory reared, virgin, male German cockroaches can move between adjacent apartments. It is not unreasonable to assume that cockroaches in field populations have this same capability. The large numbers of cockroaches captured in the apartments adjacent to focus apartments suggest the possibility of movement of field cockroaches between adjacent apartments.

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NOTE

Updated Distribution of *Aleuropteryx juniperi* (Neuroptera:
Coniopterygidae), a Predator of Scale Insects
on Ornamental Juniper

Aleuropteryx juniperi Ohm (1968. Entomol. Nachr. 15: 14), an Old World coniopterygid, was described from juniper as a species distinct from the common pine inhabitant, *A. loewii* Klapalek. Ward (1970. Entomol. Mon. Mag. 106: 74-78) reported this neuropteran from England in association with juniper scale, *Carulaspis juniperi* (Bouché), and suggested that it may have been introduced to Britain with scale-infested nursery stock. Henry (1974. Coop. Econ. Insect Rep. 24(33): 659) gave the first records from North America, based on collections from seven counties in south central and southeastern Pennsylvania. Later that year, Fairfax, Virginia was added to the North American distribution (anonymous. 1974. Coop. Econ. Insect Rep. 24(35): 703). Henry (1976. Proc. Entomol. Soc. Wash. 78: 195-201) provided the first detailed information on life history and established that larvae and adults of this coniopterygid or dustywing are predaceous on *C. juniperi* and the related pest of ornamental junipers, *C. minima* (Targioni-Tozzetti), the so-called minute cypress scale.

The following records, based on my collections from scale-infested Hetz and Pfitzer junipers in landscape plantings, extend the known distribution of *A. juniperi* in the eastern U.S. MARYLAND: Allegany Co., Cumberland, Aug. 1, 1980; Prince Georges Co., New Carrollton and near Greenbelt, July 26-27, 1980. NEW JERSEY: Atlantic Co., Smithville; Cumberland Co., Vineland; and Salem Co., Penns Grove, June 14-15, 1980. NEW YORK: Tompkins Co., Ithaca and Cornell Univ. campus, July 18-19, 1980. WEST VIRGINIA: Hampshire Co., Romney, May 31, 1980; Mineral Co., Keyser, June 10, 1979; Monongalia Co., Morgantown, West Virginia Univ. campus, Aug. 3, 1980.

Aleuropteryx juniperi continues to be the most effective natural enemy of minute cypress scale in Pennsylvania (Stimmel. 1979. Proc. Entomol. Soc. Wash. 81: 222-229). Movement of juniper nursery stock appears to have aided in dispersal; further collecting in the eastern states should show that this beneficial insect is even more widely distributed.

I am grateful to Thomas J. Henry, Systematic Entomology Laboratory, USDA, Washington, D.C., for introducing me to the Coniopterygidae, an interesting but neglected family.

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NOTE

On The Identity of *Dysmesus* Chamberlin:
A New Generic Synonymy
(Chilopoda: Geophilomorpha: Geophilidae)

There are in the Geophilomorpha a number of putative taxa, both species and genera, that owe their inception and continued existence to chance defects of dissection or to the anomalies occasioned by the caprices of various mounting techniques and media, or to all three. *Dysmesus* is such a genus. It was proposed in 1944 (Field Mus. Nat. Hist. Zool. Ser. 28(4): 193) by R. V. Chamberlin, who referred to it just one new species, *orites*, which had been collected in the Great Smoky Mountains National Park, Tennessee. Therefore, *orites* is the type-species of *Dysmesus* by original designation and monotypy.

I have examined the holo- and allotypic slides of *orites* and find them referable to the holarctic *Brachygeophilus* Broelemann, 1909 (= *Dysmesus* Chamberlin, NEW SYNONYMY). Owing to the very unsatisfactory condition of both specimens I cannot at the moment be certain that they are not really referable to *B. truncorum* (Bergsøe and Meinert), type-species of *Brachygeophilus*. Provisionally I assume the two species to be different, for the burden of the evidence known to me favors that assumption. Accordingly, I recognize three species of *Brachygeophilus* known to occur in the eastern United States: *truncorum* (Bergsøe and Meinert), *rupestris* Crabill, and *orites* (Chamberlin) (NEW COMBINATION).

In fact in his original description Chamberlin compared *Dysmesus* to *Brachygeophilus* but attributed to his new genus a feature of major importance that is nearly unique among all members of the order and that would be absolutely unique in the Geophilidae (*sensu* Chamberlin, *nec* Attems): "coxosternum of the second maxillae preserving a distinct median suture."

The first and second maxillae are preserved only on the holotypic slide where they are badly fragmented and badly mounted in Canada balsam. Torn down the midline, the second maxillary coxosternum only appears to be medially sutured. This chance deception must have been further reinforced by the presence of torn tissues partly *in situ* and by the unsatisfactory refractive index of very old and very tired Canada balsam.

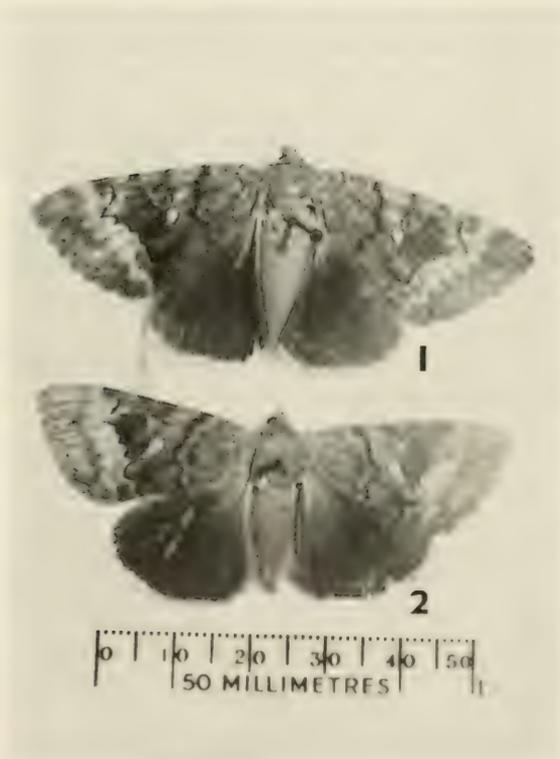
R. E. Crabill, Jr., *Department of Entomology, National Museum of Natural History, Smithsonian Institution, Washington, D.C. 20560.*

NOTE

The Identity of *Noctua marginata* Fabricius, 1775, with a
Note on *Schinia marginata* (Haworth, 1809)
(Lepidoptera: Noctuidae: Catocalinae and Heliiothinae)

In the *Systema Entomologica* of 1775, Fabricius described two different moths to which he gave the name *Noctua marginata*, one on p. 597 and the other on p. 610. The type-localities given for the two species are "America" and "Europa," respectively. In the *Entomologia Systematica*, vol. 3, pt. 2, p. 29, of 1794, he renamed the first species, that on p. 597 of the *Systema Entomologica*, *Noctua marginella*.

The species with the type-locality given as Europe has long been recognized as a synonym of *Pyrrhia umbra* (Hufnagel, 1766). The species with



Figs. 1-2. *Noctua marginata*. 1, Lectotype. 2, Paralectotype.

the type-locality given as America seems to have never been considered by American lepidopterists.

Fabricius stated in the description of the American species that it was in the collection of Dr. Hunter. Inasmuch as the Hunterian collection was known to be in the Museum of the Department of Zoology of the University of Glasgow in Scotland, I wrote to Dr. R. A. Crowson and asked if he might be able to furnish a photograph of the type or types of *Noctua marginata*, 1775 (= *Noctua marginella*, 1794). Dr. Crowson very kindly responded to my request and sent the photograph that is reproduced here. Fabricius had given no indication of the size of the species, and so large a species as the photograph showed was unexpected, but there was no question that this was the species that Fabricius had before him because the specimens did not violate the description in any way. The identity of the specimens was obvious; they were *Catocala epione* (Drury, 1770 [1773]). Thus, *Noctua marginata* Fabricius, 1775 (p. 597), with its replacement name, *Noctua marginella* Fabricius, 1794, is a synonym of *Phal[aena] Noct[ua] epione* Drury, 1770 [1773], NEW SYNONYMY.

Dr. Crowson suggested that I select a LECTOTYPE; I have selected the upper specimen in the photograph (Fig. 1), and I have sent Dr. Crowson a label reading, LECTOTYPE/*Noctua marginata*/Fabricius/Selected by/J. G. Franclemont 1979. The two specimens can be readily separated by the relative positions of their wings. Both specimens appear to be females.

It seems advisable at this time to refer to the species that stands in North American lists as *Schinia marginata* (Haworth); this species was described in 1809 on p. 574 of *Lepidoptera Britannica* as *Crambus marginatus*. This name is a primary homonym of *Crambus marginatus* Fabricius, 1798, *Supplementum Entomologicae Systematicae*, p. 472, which is an emendation of *Tinea marginella* [Denis and Schiffermüller], 1775. Thus, Guenée's 1852 name, *Anthoecia rivulosa*, must be used, and the species will be known, as it has on occasion in the past, as *Schinia rivulosa* (Guenée).

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BOOK REVIEW

Insect Hemocytes Development, Forms, Functions and Techniques. 1979.
A. P. Gupta, ed. Cambridge University Press, N.Y., x + 614 pages. Cost:
\$79.50.

This book is a collection of 22 articles devoted to different aspects of insect hematology. Some contain very misleading information or factual errors. Wigglesworth's chapter contains a remarkable number of serious errors which require correction. Hemocytes do not arise at the end of embryonic development but before the body muscles, fat body and heart are formed in the young embryo. There is no evidence whatsoever that myoblasts circulate. The hemocytes which Wigglesworth calls "oenocytoids" do not have an excentric nucleus, do not resemble oenocytes, and vary in number from 11 to 68% (average of 38), and are thus comparable to the granular hemocytes of other insects. Plasmatocytes of the Lepidoptera do not normally possess lipid. Those hemocytes which have abundant lipid are termed *adipohemocytes*: they are not adipocytes. No one has demonstrated that hemocytes synthesize a macromolecular factor or that hemocytes are of any importance in the transport of hormones. Hoffmann and his associates indicate that both the phagocytic organs and sessile masses of hemocytes resemble hemopoietic tissue of higher animals, but they do not point out that among vertebrates blood-cell-forming tissues may be found within or associated with bone marrow, kidney, and/or spleen, and that insects have no such organs. Arnold and Hinks do not point out that Romanowsky stains often do not adequately differentiate various hemocytes of many insects. Gupta does not tell the reader that hanging drops are totally unsuited to phase contrast examinations of hemocytes, and Shapiro does not mention that inulin is a major method for determining hemolymph volumes.

Mori's chapter shows that the hemocytes of the hemipteran *Gerris* first appear about nine hours after the onset of blastokinesis. Brief chapters on the multiplication of hemocytes and cellular and humoral responses of these cells to toxic substances is given by Feir. In Gupta's chapter on hemocyte types, he states that podocytes have not been recognized as a type with the electron microscope; however, Zachary and Hoffmann (1975) and Brehélin et al. (1978) show them to be highly distinctive forms. Akai and Sato's chapter in this volume shows a podocyte which the authors label as being a reticular cell. Grégoire and Goffinet bring up to date our knowledge on the cytological aspects of hemocytes and coagulation of the hemoplasma. Although they state that all hemocytes contain thromboplastic substances, this should *not* be interpreted to mean that all types are involved in normally inducing coagulation.

Arnold critically discusses the single cell and multiple cell origin of hemocytes, and concludes that the one-cell theory is not supported. Sohi has a chapter on hemocytes in tissue culture. Although he states that differences in cell size and shape and the presence of granules and vacuoles are not reliable parameters for classifying hemocytes, each one is essential to classifying the basic types, as is pointed out by Jones in his chapter on pathways and pitfalls in the study of hemocytes.

Ashhurst's chapter on hemocytes and connective tissues concludes that the former do not normally form the latter. Ratcliffe and Rowley's chapter on the role of hemocytes in defense against biological agents is the outstanding review in this volume. Crossley also gives a particularly valuable review on the biochemistry of the hemolymph and the histochemistry of hemocytes. Although he implies that plasma phenoloxidases arise from the hemocytes, no one has critically demonstrated it. He correctly points out that although hemocytes may produce dopa and/or dopamine, this does not mean that they normally transfer them to the cuticle.

Baerwald gives a chapter on techniques for light, transmission and scanning electron microscopical examination of hemocytes. Ashhurst has a chapter on histochemical methods for hemocytes. Both will be indispensable to future students of these cells.

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PROC. ENTOMOL. SOC. WASH.
83(1), 1981, pp. 178-180

BOOK REVIEW

The Semiaquatic and Aquatic Hemiptera of California. 1979. Arnold S. Menke, ed. Bull. Calif. Insect Surv., Vol. 21, 166 pp. Cost: \$16.00 (paperback).

Carrying on the fine tradition of R. L. Usinger's *Aquatic Insects of California* (1956. Univ. Calif. Press, Berkeley and Los Angeles, Calif., 508 pp.), editor A. S. Menke and authors H. C. Chapman, D. R. Lauck, J. T. Polhemus, and F. S. Truxal have provided us with an updated and greatly expanded treatment of the California aquatic and semiaquatic fauna.

In a well-developed introduction, Menke begins by mentioning the 14 families to be discussed and two obscure families that may eventually be found in the coastal state. The California fauna, composed of 113 species, is compared to both the total world fauna of more than 3,100 species and

the entire 415 Nearctic species. Excellent general discussions are provided on biogeography, biology, economic importance, morphology, and collecting methods. Added tidbits of information such as discussions on parasites and commensals and alary polymorphism provide us with stimulating food for thought.

The treatment of systematics in the aquatic fauna brings together the most recent findings in higher classification with the editor admitting that this ordering of higher taxa is not yet complete. Nevertheless, the literature is presented openly to allow the reader to develop his own opinion on such nasty interpretations as where to split and what to include in the Leptopodomorpha, viz. Saldidae. Perhaps the most controversial proposal discussed is Cobben's (1978. *Evolutionary Trends in Heteroptera*. Part II. *Mouthparts*, H. Veenman and Zonen B. V., Wageningen, 407 pp.) suggestion that the Gerromorpha are the sister group to all other Hemiptera. Readers intrigued with the idea may find further discussions in Cobben (1979. *Ann. Entomol. Soc. Am.* 72: 711-715) and Sweet (1979. *Ann. Entomol. Soc. Am.* 72: 575-579, 1980. *Ann. Entomol. Soc. Am.* 73: 163).

Each family is reviewed, with the Corixidae and Saldidae containing nearly four pages of discussion and the Belostomatidae, Gerridae, and Veliidae each having at least three. Anyone interested in general biology, food habits, habitats, morphology, and certain other specializations like egg development and oviposition will find these sections especially stimulating. Even though the introductions are intentionally kept general, select references direct the curious investigator to additional information. That certain belostomatids display lunar periodicity, that at least some *Ranatra* and *Nepa* species lack functional intermediate respiratory spiracles, or that gelastocorids may be found far from aquatic habitats are examples of phenomena presented to the reader.

This bulletin is furnished with numerous workable keys to all the taxa, beginning with family and descending to subfamily, genus, and all species to be expected in California (generic keys will apply to most of North America). Researchers with even a casual knowledge of insects can appreciate the keys to the aquatics based on habits and habitats or on eggs and egg-laying habits. Although based largely on keys first provided by Usinger (1956) and Hungerford (1920. *The Biology and Ecology of Aquatic and Semi-aquatic Hemiptera*. *Kans. Univ. Sci. Bull.*, Vol. II, 34 pp.), this bulletin presents keys that have been updated and expanded. Only minor inconsistencies exist in format, but these involve punctuation or parentheses and do not affect the use of the keys.

Excellent figures supplement the keys, with virtually every genus represented by a full dorsal habitus (taken almost exclusively from Usinger, 1956). Perhaps a few original drawings would have enhanced this publication and made it a bit more complete. Numerous line drawings contribute greatly

to the reader's understanding of more difficult morphological structures required to deal with certain taxa.

Perhaps the weakest aspect of this study is the lack of definitive diagnoses to species. In most cases, the keys give information adequate to establish identities with confidence, but in several cases another literature source might have to be consulted. For example, *Pentacora saratogae* Cobben is separated from *P. signoretii* (Guérin-Méneville) by *P. saratogae*'s larger size and its second antennal segment usually being subequal to segments three and four combined. Although these characters may separate the two taxa the majority of the time, such exact measurements can cause confusion without additional supporting data.

The Semiaquatic and Aquatic Hemiptera of California is the most comprehensive treatment of aquatics compiled thus far for the Nearctic fauna, which makes it a must for any serious student of the Hemiptera-Heteroptera. Unfortunately, the volume seems somewhat expensive in relation to its size (166 pp.) and the quality of paper offered, but the cost should not deter interested workers from purchasing this useful treatise.

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MEETING ANNOUNCEMENT

The joint meeting of the IV Congreso Latinoamericano de Entomología, VI Congreso Venezolano de Entomología, II Congreso de la Sociedad Panamericana de Acridiología, and the I Simposio de Lepidopterología Neotropical will be held in Maracay, State of Aragua, Venezuela, July 5-10, 1981.

An extensive program is being planned which will include several paper sessions alternated with symposia and conferences. In addition to these activities, there will be educational, artistic, and commercial exhibits related to insects.

The Organizing Committee invites all persons interested in entomology to participate in and contribute to this scientific event.

Further information may be requested from:

Secretario General
IV Congreso Latinoamericano de Entomología
Instituto de Zoología Agrícola
Apartado 4579
Maracay 2101-A, Estado Aragua, Venezuela

BOOK REVIEW

The Insects and Arachnids of Canada. Part I. Collecting, Preparing, and Preserving Insects, Mites, and Spiders. Compiled by J. E. H. Martin. Agriculture Canada, Publication 1643. 182 pp. 1977. Paper cover. Available by mail from Printing and Publishing Supply and Services Canada, Hull, Quebec, Canada K1A 089 or through your bookseller. Cost: Canada, \$3.50; other countries, \$4.20.

The 133 page book by Bryan P. Beirne et al., published in 1955 and reprinted at least in 1962 and 1963, has done yeoman service for two and a half decades. It has now been worthily succeeded by this volume of 182 pages. The increased size is testimony to the growth of the complexity of the subject during that time. The new book also has grown in artistic merit, thoroughness, and clarity of exposition. The very numerous illustrations are admirable. There are 2½ pages of references and a good index. The price of the 1955 book was \$2.00 (hard-bound); the price of the new one must, under present conditions, be considered extremely low. It is well worth the price to anybody who is interested in any aspect of the subjects it treats.

Not all entomologists will agree on the best way to do many of the procedures described in this book. Little mention is made of methods of preparing dry mounts from specimens preserved in fluid, although Sabrosky's method (1966, Bull. Entomol. Soc. Am. 12: 349) is mentioned in the list of references; it yields excellent specimens with a minimum of trouble and is much used by USDA entomologists at least. KOH is still recommended for maceration of specimens for preservation in microvials or on slides, although I pointed out many years ago (Steyskal, 1954, Ann. Entomol. Soc. Am. 47: 513-514, and in Gurney et al., 1964, *ibid* 57: 240-242) that NaOH will do all that the other reagent will do more easily and safely. I cannot agree that "Double mounts made with card points and minuten pins are not recommended for small Diptera" (p. 156), but believe that, properly done, a minuten-mounted small fly (or any of many other small insects) is the best-prepared specimen for serious study. I strongly object to gluing small flies to the side of a regular pin. The late Fr. Thomaz Borgmeier, the great student of Phoridae, claimed that the only good way to prepare a fly of that family is to put it on a minuten from below, between the coxae. No mention, either, is made of the usefulness of euparal in making microscope slides of insects and their parts.

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ANNOUNCEMENT:

NEOTROPICAL LEPIDOPTERA PROJECT

The Neotropical Lepidoptera Project is a research project for Latin America that will utilize habitat inventory work and museum research to describe and catalog the moths and butterflies (Lepidoptera) of the entire Neotropical faunal region, from Mexico and the West Indies south to Patagonia. The results of field and museum research over a 20-year period will be published in a series of volumes entitled *Atlas of Neotropical Lepidoptera*. The *Atlas* will feature a synoptic text of all known species (some new taxa will be described) and will include illustrations of adults and critical morphological characters so each species can be identified.

The *Atlas* is designed primarily as an identification guide, or encyclopedia of our current knowledge of Neotropical Lepidoptera. All described species will be noted, their valid names indicated, and all other information known about them summarized. Illustrations will be black and white photographs of wing maculation and morphological characters (line drawings in some cases), with color diagnoses in the text.

It is estimated that the *Atlas* will require 125 volumes to encompass all 83 known Neotropical families, including introductory volumes, a six part checklist, 83 fascicles of text and illustrations, and final index and bibliographic volumes. An initial checklist to all described species is currently being produced by 43 collaborators from 11 countries. This checklist will be revised after the 20-year sequence of text publication. The checklist is the initial phase of the project so the known fauna can be reorganized, in many cases involving extensive rearrangements and new combinations, and to determine how many names actually exist.

The well known natural history publisher Dr. W. Junk BV, The Hague, will cover all publication costs for the series (contact Dr. W. Junk BV, P.O. Box 13173, The Hague, Netherlands, for further information). The Editor and project Director is Dr. John B. Heppner, Smithsonian Institution, Washington, D.C.

Partial funding for the field inventory and museum research aspects of the project is being sought from a number of organizations and from Latin American governments in a cooperative venture. The Neotropical Lepidoptera Project, as the first in a possible series for a "Fauna Insecta of Latin America," is the type of cooperative project very necessary now if we are to make any significant progress in the study of Neotropical habitats within the remaining few years prior to the anticipated alteration of too many of these habitats from their natural state.

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PROCEEDINGS OF THE ENTOMOLOGICAL SOCIETY OF WASHINGTON

INFORMATION FOR CONTRIBUTORS

Publication in the Proceedings is generally reserved for members. Manuscripts should not exceed 15 printed pages including illustrations (approximately 25 typewritten pages). Papers, after acceptance, are published in approximately the order they were received; notes are published as space is available. Manuscripts will be reviewed before acceptance. Final decision for rejection of a manuscript is made by the Publications Committee.

Typing.—Submit two copies of a manuscript, the original and one xerox or carbon copy. Type manuscripts on bond paper with double-spacing and ample margins. Original copies on paper larger than 8½ × 11" are not acceptable. Number pages consecutively beginning with the title page. Do not use all capitals for any purpose. Underscore only where italic is intended in the body of the text. Begin each of the following entries on a separate page: Title page, abstract, text of article, literature cited, footnotes, tables, figure legends.

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THE GENUS *CHIONANTHOBIUS* PIERCE (COLEOPTERA:
CURCULIONIDAE): DESCRIPTIONS OF A NEW SPECIES ON
FORESTIERA (OLEACEAE) AND OF THE LARVA
AND PUPA OF *C. SCHWARZI* PIERCE

WAYNE E. CLARK AND DONALD M. ANDERSON

(WEC) Department of Zoology-Entomology and Alabama Agricultural Experiment Station, Auburn University, Auburn, Alabama 36849; (DMA) Systematic Entomology Laboratory, IIBIII, Agric. Res., Sci. and Educ. Admin., USDA, % U.S. National Museum of Natural History, Washington, D.C. 20560.

Abstract.—The heretofore monotypic genus *Chionanthobius* Pierce, and adults, larvae, and pupae of the type-species, *C. schwarzi* Pierce, are re-described, and adults of a new species, *C. autumnalis* Clark, collected in Brazos County, Texas, on *Forestiera ligustrina* (Michx.) Poir. (Oleaceae), are described. Information on the life history of *C. schwarzi*, whose larvae develop in seeds of *Chionanthus virginicus* L. and *Osmanthus americanus* (L.) (both Oleaceae), is summarized from literature and collection data. Larvae of *C. autumnalis* are thought to develop in seeds of *F. ligustrina*.

The tribe Lignyodini was delimited and characterized, and its relationship to other taxa of Tychiinae was discussed by Clark et al. (1977). Since then, the senior author has continued revisionary studies on the lignyodines (*Chionanthobius* Pierce, *Hamaba* Casey, *Lignyodes* Dejean, *Neotylopterus* Hustache, *Plocetes* LeConte, and *Rosella* Whitehead). The discovery of a new species of *Chionanthobius* in Texas prompted the investigations reported here.

The heretofore monotypic genus *Chionanthobius*, along with the adult stage of the type-species, *C. schwarzi* Pierce, are re-described and illustrated. The new species is described and illustrated and compared to *C. schwarzi*. Larvae and pupae of *C. schwarzi* from the collections of the U.S. National Museum of Natural History, Washington, D.C. (USNM) are also described and illustrated for the first time. A manuscript description and illustrations prepared by William H. Anderson form the basis for the description of the larva of *C. schwarzi*.

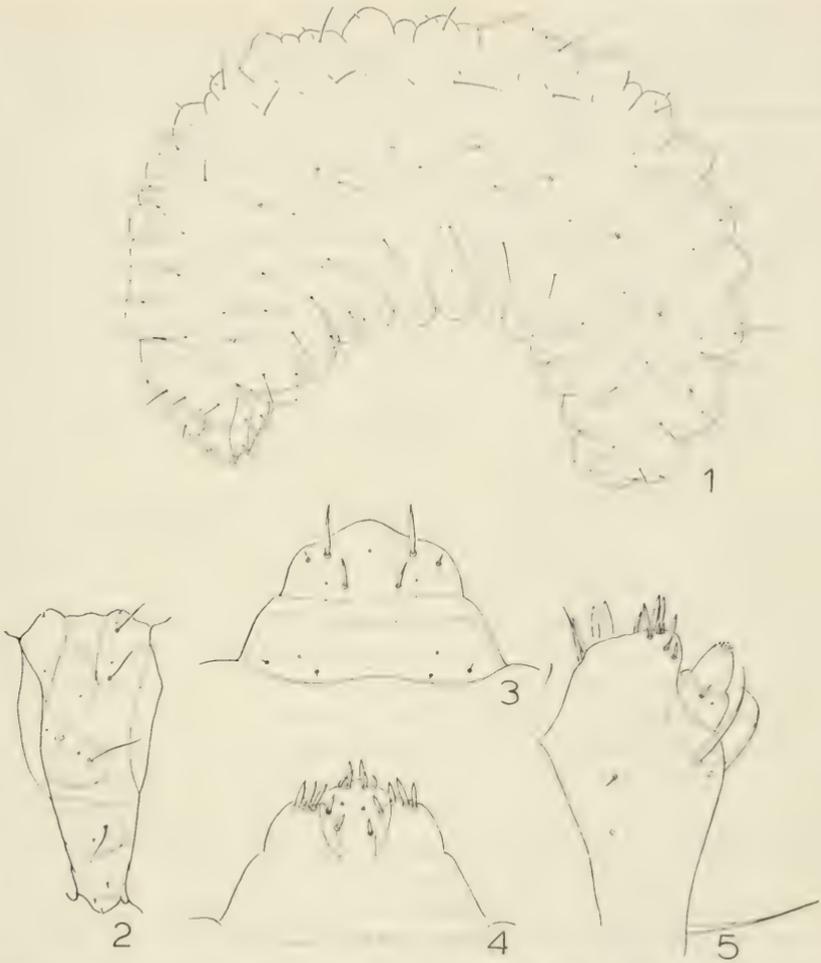
Chionanthobius Pierce

Chionanthobius Pierce, 1912: 168. Type-species, by original designation and by monotypy, *Chionanthobius schwarzi* Pierce. Blatchley and Leng, 1916: 243-244; Kissinger, 1962: 9, 1964: 53, 54; Clark et al., 1977: Figs. 4, 11, 17, 24, 52.

Description of adult.—*Head*: Densely punctate; vertex with elongate, narrow, fulvoferruginous scales, gena and venter with broader, white scales; frons narrower than rostrum at base, eyes separated by distance less than 20% of eye width. *Antenna*: Funiculus with 7 articles. *Pronotum*: Densely punctate on disc; scales recumbent, their apices directed toward midline. *Elytra*: humeri slightly prominent, sides broadly, evenly curved in apical $\frac{1}{2}$; apices of interspaces 4-6 raised to form posterior tubercles; interspaces uniformly, moderately deeply punctate; striae shallow, discretely punctate; interspaces with narrow, elongate, apically subtruncate scales. *Pygidium*: In male, moderately large, broadly exposed, the exposed portion convex, vertical; in female, much smaller, much less broadly exposed, the exposed portion flat, oblique. *Abdomen*: Sides of sterna 1-3 with dense, broad, white to pale fulvous scales, broad scales replaced toward midline by progressively narrower scales; sterna 4 and 5 with fine, setalike fulvoferruginous scales only; sternum 5 with small lateromedian tufts of suberect setae. *Legs*: Vestiture of tibiae recumbent, fine, setalike.

The description of the adult is a composite of features shared by *C. schwarzi* and a new species described below.

Description of mature larva (Figs. 1-5).—Terminology used to describe setae and other structures is that proposed by Anderson (1947). *Body*: Cream white, robust, moderately curved, thickest through middle abdominal segments (Fig. 1). *Length*: 5.70-7.20 mm ($n = 10$). Dorsum of pronotum slightly sclerotized, lightly pigmented. Asperities inconspicuous. *Head*: Light orange brown, lightly mottled with pale areas dorsally; free, as broad as long, broadest at middle, truncate posteriorly. *Width*: 0.92-1.06 mm ($n = 18$). Anterior ocelli present, posterior ocelli absent. Antenna consisting of 1 membranous article which bears a subconical sensory appendage and 6 minute projections, of which 1 is short and blunt. Epicranial suture approximately $\frac{1}{2}$ as long as head. Frontal sutures distinct, nearly straight posteriorly, incomplete anteriorly. Endocarina distinct, approximately $\frac{2}{3}$ as long as frons. Four pairs of frontal setae present, of which 2, 3, and 5 are minute, 4 long. Two pairs of frontal sensilla present. Dorsal epicranial setae 1 and 4 minute, 2 slightly longer, 3 and 5 long, subequal. Four minute posterior epicranial setae present. Lateral epicranial seta 1 very short, 2 moderately long. Ventral epicranial setae very short, subequal. Clypeus (Fig. 3) distinctly transverse, with 2 minute setae and 1 sensillum on each side near base. Labrum (Fig. 3) with anterior margin produced near middle. Labral



Figs. 1-5. *Chionanthobius schwarzi*, larva. 1, Full-grown larva, lateral view. 2, 1st abdominal segment, lateral view. 3, Clypeus and labrum. 4, Epipharynx. 5, Right maxilla, ventral view.

setae 1 and 2 short to moderately long, subequal, and much longer than 3. Paired lateral and median sensilla present on labrum, median sensilla distinctly anterior. Labral rods short, moderately stout, slightly convergent posteriorly. Epipharynx (Fig. 4) with 3 anterolateral, 6 anteromedian, and 4 median setae. Median setae subequal in length, as long as anteromedian setae. Epipharyngeal sensory pores in 2 clusters of 3, between or slightly in front of anterior pair of median setae. Epipharynx without asperities. Mandible with 2 apical teeth and 2 minute setae, of which 1 is positioned

directly behind 2. Seta on basal article of maxillary palpus very short. Maxillary mala (Fig. 5) with 7 dorsal and 5 ventral setae. Labial palpi with 2 articles. Setae of ligula minute. Premental sclerite with distinct anterior and posterior median extensions. Postmental setae 1 and 3 short, subequal, 2nd $3\times$ as long as 1st; posterior pair separated by only slightly greater distance than anterior pairs. *Thorax*: Pronotum with 10 or 11 dorsal setae, of which 4 are moderately long, the others short to minute. Pleurum of all segments with 2 setae, 1 long, the other short. Epipleurum of meso- and metathorax with 1 long seta. Spiracle bicameral. Spiracular area of mesothorax with 1 minute and 1 very short seta. Postdorsum of meso- and metathorax with 4 setae of which 1 and 3 are very short, 2 and 4 long, subequal. Alar areas with 1 short seta. Pedal lobes with 7 setae of which 1 is long, the remainder short, the ventral most of them subequal to sternal setae. Sternal setae short, subequal to eusternal setae of abdomen. *Abdomen*: Segments I–VIII (Figs. 1, 2) with lateral spiracles which are bicameral, with air tubes subequal to or slightly shorter than diameter of peritreme. Segments I–VII with 3 dorsal folds. Dorsal fold I developed laterally on most segments. Prodorsal setae present on segments I–VII, absent on VIII and IX. Five postdorsal setae present on segments I–VII, 1, 2, and 4 very short, 3 and 5 long; segment VIII with 3 setae, 2 minute, 1 long; segment IX with 2 setae, 1 minute, 1 long. Pleura with 1 short and 1 long seta. Pedal areas with 1 very short seta. Eusterna with 2 very short setae. Anus terminal, surrounded by 4 lobes, each lateral lobe bearing 3 minute setae.

The description of the larva is based on examination of 18 specimens of *C. schwarzi* (USNM) from Plummers Island, Maryland (August 26, 1907, seeds *Chionanthus virginicus* L., J. A. Hyslop, and from the same locality and host, August, 1912, E. A. Schwarz and H. S. Barber), and from Greensboro, Florida (January 10, 1942, *Osmanthus americanus* (L.) seed).

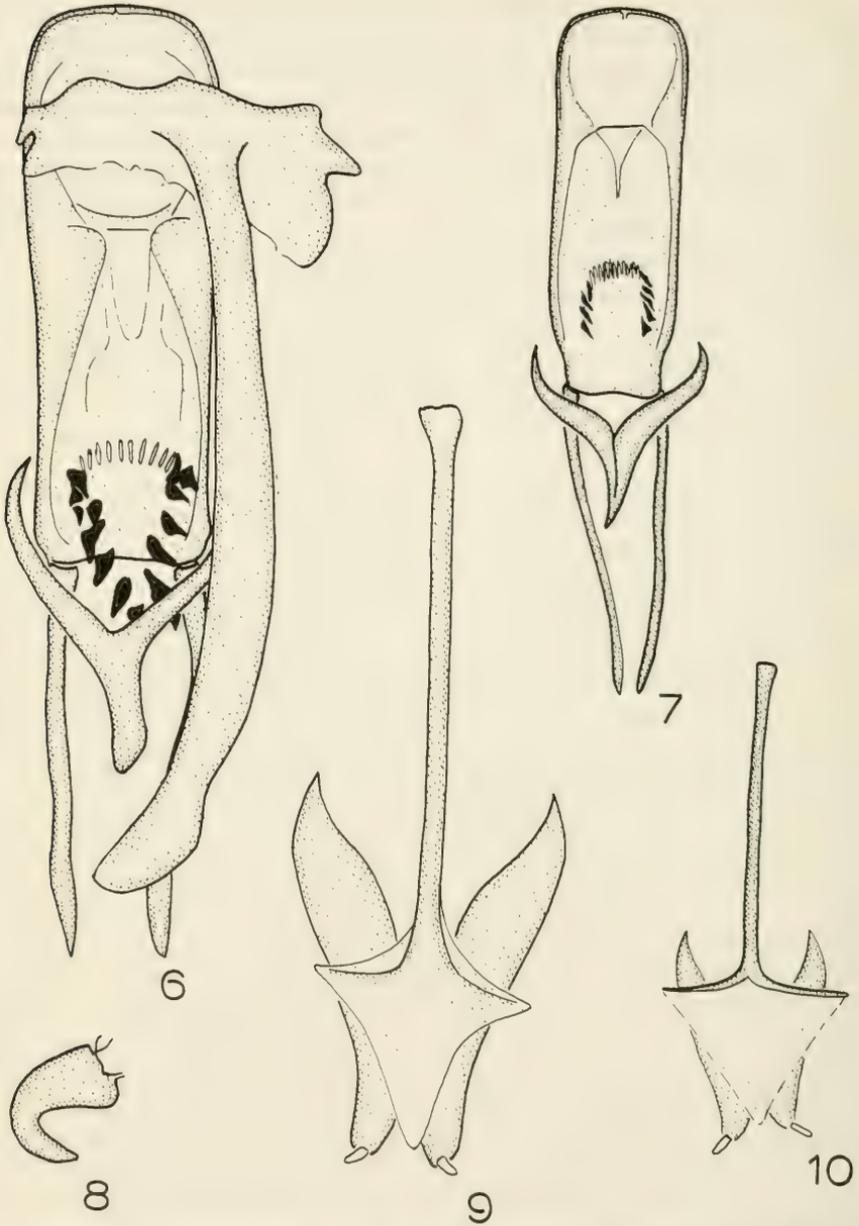
Description of pupa.—Terminology used to describe setae and other structures is that proposed by Burke (1968). *Body*: stout, clothed with dark, attenuate setae, all borne on summits of subconical, large-to-small-sized tubercles. Length (of 2 pupae), 5.2–5.3 mm. *Head and rostrum*: One pair of moderately long frontal setae borne on small tubercles present, with a pair of small, rounded tubercles without setae between them. One pair of supraorbital setae present, subequal in length to frontal setae. One pair of interocular setae present, subequal in length to frontal and supraorbital setae, but borne on longer tubercles and separated by a slightly greater distance than the frontal setae. Basirostral setae absent. One pair of moderately long distorostral setae present, borne on short tubercles. Rostrum elongate, extending posteriorly to apices of tibiae of folded mesothoracic legs. Prothorax rounded at sides, slightly broader than long, with moderately long setae. One pair of anteromedian setae, 1 pair of median setae, and 1 pair of posteromedian setae present, borne on medium-sized tubercles. Four pairs

of posterolateral setae present, all borne on large tubercles, the 4th pair dorsal to the 3rd pair. *Mesothorax*: With 1 pair of anteronotal setae, and 1 pair of mesonotal setae, all moderately long and borne on moderately large tubercles. *Metathorax*: With no anteronotal setae; 2 pairs of moderately long metanotal setae present, borne on moderately large tubercles. *Abdomen*: Segments 1-7 with 2 pairs of moderately long discotergal setae, segment 8 with 1 pair of discotergal setae, all borne on moderately large tubercles. No anterotergal setae present on any segments. Segments 1-7 with 2 pairs of laterotergal setae, of which seta 1 is very tiny, 2 is longer than 1, but shorter than discotergal setae. Ninth segment bearing a pair of widely separated, long, curved, attenuate posterior processes, each with a terminal seta, and 1 lateroventral seta on a moderately long tubercle. Sterna devoid of setae, except for 1 pair of laterosternal setae on segment 8. *Femora*: Each bearing 1 apical seta and 1 preapical seta on moderately large tubercles.

Two pupae of *C. schwarzi* (USNM), both in alcohol, from Plummers Island, Maryland (June 7, 1913, Schwarz, Barber, and Pierce, "from Soil"), identified by association with larvae of *C. schwarzi*, were examined.

Remarks.—The combination of characters presented by Clark et al. (1977) to distinguish *Chionanthobius* from the other lignyodine genera was: Rostrum long, finely sculptured, strongly sexually dimorphic; scrobe longitudinal; subapical elytral tubercles prominent; sternum 5 shorter than sterna 3 and 4 combined; and scales on elytra uniformly recumbent. Only the last of these now appears to be unique to *Chionanthobius*. This is apparent after detailed examination of numerous species of Lignyodini in the course of ongoing revisionary studies. Kissinger (1964: 53) separated *Chionanthobius* from *Lignyodes* (his *Thysanocnemis*) by stating of the latter that the "suture between sterna 4 and 5 [is] not as apparent as [the] suture between sterna 3 and 4." This does not distinguish *Chionanthobius* from all other Lignyodini. The species of *Chionanthobius* are distinguished from known species of *Neotylopterus*, *Plocetes*, and *Rosella*, and from many, but not all species of *Lignyodes*, by having the median lobe of the male genitalia symmetrical rather than twisted (cf. Figs. 6 and 7 with Figs. in Clark et al., 1977, and Clark, 1980). Further evaluation of the characters of *Chionanthobius* and the other lignyodines will be made as revisionary studies proceed.

Among Lignyodini, only *Neotylopterus pallidus* (LeConte) was until now known from published descriptions of the larva and pupa (Clark, 1978). The larva of *C. schwarzi* is distinguished from that of *N. pallidus* in possessing four rather than three frontal setae (setae 2, 3, 4, and 5 are present), and in relative lengths of the five postdorsal setae on abdominal segments I-VII (Fig. 2), seta two being short in *Chionanthobius*, long in *Neotylopterus*, seta three being long in *Chionanthobius*, short in *Neotylopterus*. The pupa of *C. schwarzi* is similar to that of *N. pallidus*, but differs in having no



Figs. 6-10. *Chionanthobius* spp., male and female genitalia. 6, Median lobe, tegmen, and spiculum gastrale of male *C. schwarzi*. 7, Median lobe and tegmen of *C. autumnalis*. 8, Spermatheca of *C. schwarzi*. 9, Spiculum ventrale and ovipositor of female *C. schwarzi*. 10, Spiculum ventrale and ovipositor of *C. autumnalis*.

basirostral setae, unbranched preapical setae on the femora, two small tubercles between the frontal setae of the head, and laterosternal setae on the eighth abdominal segment.

Chionanthobius schwarzi Pierce

Figs. 6, 8, 9, 11

Chionanthobius schwarzi Pierce, 1912: 168. Holotype ♂: Plummers Island, Maryland (USNM, examined). Blatchley and Leng, 1916: 244; Greene, 1916: 143–144; Clark et al., 1977, Figs. 4, 11, 17, 24, 52.

Male holotype.—*Length*: 5.60 mm. *Width*: 2.88 mm. *Head*: Eyes separated by distance 19% of eye width. *Rostrum*: In profile, dorsal margin strongly curved in distal $\frac{1}{3}$, nearly straight proximally; in dorsal view, narrow at base, gradually widened from there to tip; dorsal and ventral margins of scrobe carinate; dorsolateral carinae distinct, bounded by moderately deep, rugosely punctate sulci which are distinct between antennal insertions and tip; dorsum with short, shallow sulcus over antennal insertions; glabrous except for small slender scales in basal $\frac{1}{4}$. *Prothorax*: Sides feebly convergent from base to apical $\frac{1}{3}$, strongly rounded from there to shallow subapical constriction; scales dense, short, narrow, striate, fulvoferruginous. *Elytra*: Interspaces broad, flat, odd interspaces slightly more prominent than even ones; white scales forming incomplete anteromedian transverse band and irregular but more nearly complete posteromedian band which is interrupted by fulvoferruginous scales on interspace 2; fuscous scales forming broad, nearly complete median band which is interrupted on interspaces 2 and 6 by fulvoferruginous scales; interspaces 2 and 3 each with small subbasal patch of pale fuscous scales; fulvoferruginous scales also covering apical $\frac{1}{4}$ of all but sutural interspaces, the latter with elongate subapical patch of fuscous scales and apical patch of white scales; striae scales not, or only slightly wider than scales on interspaces, mostly the color of scales on adjacent interspaces. *Legs*: Femora stout, each with small but distinct ventral tooth; with vestiture of fine, pale fulvous to ferruginous, acuminate, setalike, recumbent scales; metatibia mucronate, pro- and mesotibiae each with long, slender, curved apical uncus. *Genitalia*: As in Fig. 6, not of holotype.

Female exemplar.—*Length*: 5.52 mm. *Width*: 3.04 mm. Otherwise as described for male, except for longer, more slender, less deeply carinate and punctate rostrum (see Clark et al., 1977, Fig. 17), and smaller, less broadly exposed pygidium. *Genitalia*: As in Figs. 8, 9.

Variation.—The range of variation in size observed in the 101 adult specimens in the USNM collection is as follows: Length of males, 4.28–5.48 mm, width of males, 2.58–3.12 mm; length of females, 4.16–5.68 mm, width of females, 2.20–3.12 mm. There is also variation in distribution of variously

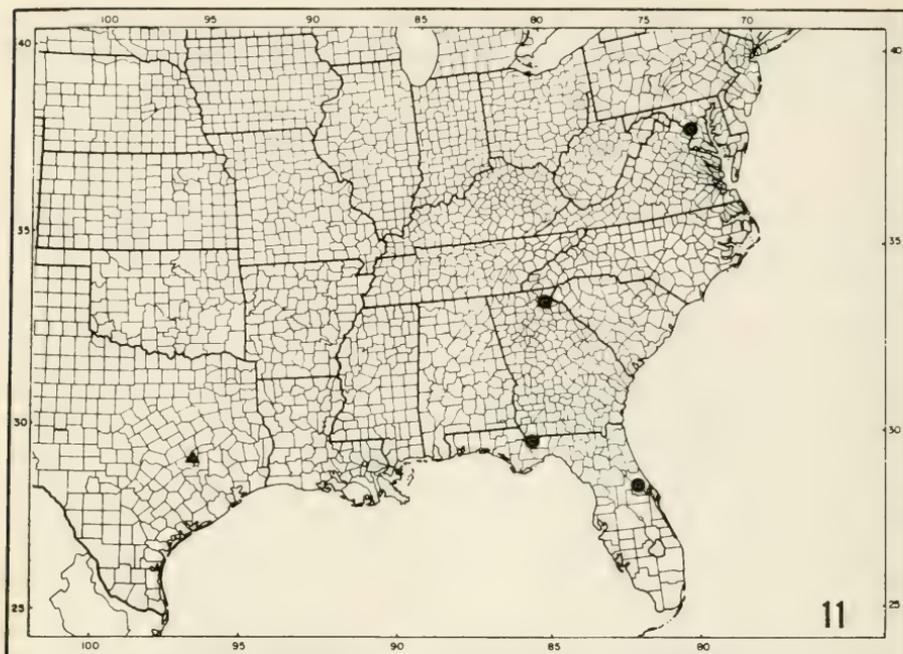
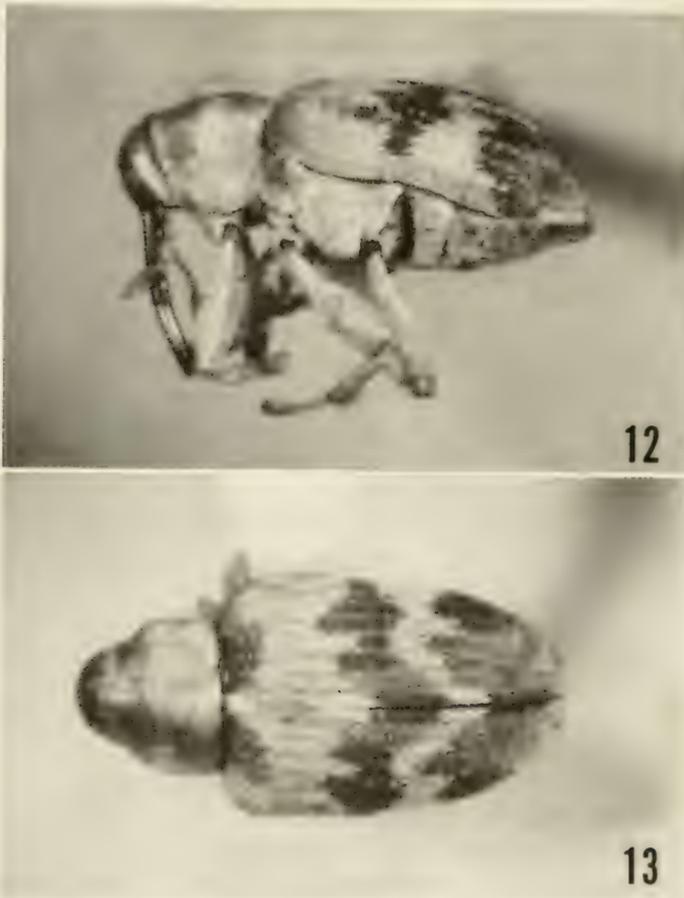


Fig. 11. Map of the southeastern United States showing distribution of *Chionanthobius schwarzi* (circles) and *C. autumnalis* (triangle).

colored scales on the elytra. The transverse bands of white scales are interrupted in some specimens on interspaces other than the second, and white scales are more or less sparsely intermixed with fulvoferruginous scales on the bands in some. Variation in distribution of fuscous scales is roughly the same, fulvoferruginous scales being intermixed more or less densely on the transverse bands in some. A distinct posteromedian vitta of fuscous scales on the sutural interspaces is a constant feature, however. The midline of the pronotum is feebly carinate in large individuals.

Distribution (Fig. 11).—All but 7 of the adult specimens examined are from the type-locality, Plummers Island, Maryland. Four of the other specimens are from Great Falls, 2 from Cropley, Maryland, and 1 from Demorest, Georgia. Greene (1916) reported the species from Enterprise, Florida, but no specimens are on hand to verify this record. Some of the larvae described above were collected at Greensboro, Florida, the others are from the type-locality.

Life history.—Label data on the adult specimens examined indicate that the weevils were active between mid-June and mid-August between 1905–1933 in Maryland. The Georgia adult was collected on 15 May 1939, the Florida specimens reportedly on 10 July 1915 (Greene, 1916). Larvae were



Figs. 12-13. *Chionanthobius autumnalis*, female allotype. 12, Lateral view. 13, Dorsal view.

taken during August of 1907 and 1912 in Maryland, on January 20, 1942, in Florida. Mating occurs as early as July 3-12, as indicated by two pairs of specimens in the collection taken on those dates, mounted one pair to each of two pins, each with the label "in copula."

In reference to *C. schwarzi*, Pierce (1912: 168) stated that "according to Mr. Schwarz, the weevils breed in the berries of the fringe tree (*Chionanthus virginica* [sic]) and the larvae develop in the seeds of the same tree." A vial containing weevil larvae attached to a pin in the unit tray containing the pinned adult specimens is accompanied by the label "*Chionanthobius schwarzi* larvae dead in sand beneath berries from which they issued.—Plummers Isl. Md note no. 122c Preserved Sept. 29, 1912—Schwarz &

Barber." From this it is evident that larvae of *C. schwarzi*, like those of *Neotylopterus pallidus*, emerge from the seeds and enter the ground to complete their development (see Clark, 1978).

Some of the larvae examined were taken from seeds of *Osmanthus americanus* (L.) (Oleaceae).

Chionanthobius autumnalis Clark, NEW SPECIES

Figs. 7, 10, 11-13

Type-material.—*Holotype*: ♂, labelled "Texas, Brazos Co. College Station 31 Oct. '72 W. E. Clark" "taken on *Forestiera ligustrina*" (USNM type no. 76746). *Allotype*: ♀, with same label data as the holotype (USNM). *Paratypes*: With same label data as the holotype (7 ♂, 23 ♀); same, except 3 Oct. '72 (3 ♂, 6 ♀); same, except 10 Oct. '72 (2 ♂); same, except 7-XI-72 (3 ♂, 18 ♀); same, except 14-XI-72 (5 ♀); same, except 2-XII-72 (2 ♂, 12 ♀); total paratypes, 81, (in Auburn University, C. W. O'Brien, Texas A&M University, and USNM collections).

Male holotype.—*Length*: 3.28 mm. *Width*: 1.64 mm. *Head*: Eyes separated by distance 17% of eye width. *Rostrum*: Slender; in profile, dorsal margin nearly evenly curved from base to apex; in dorsal view, narrow at base, widened slightly from base to antennal insertions, slightly, abruptly expanded at insertions, and expanded again slightly at tip; scrobal margins not carinate; dorsolateral carinae obsolete, sulci represented by rows of elongate, irregular punctures, these very shallow distad of antennal insertions; dorsum with moderately long, deep median sulcus over antennal insertions; vestiture consists of a few slender scales on dorsolateral portion near extreme base, and sparse, short, fine setae which arise from punctures in sulci in basal ½. *Prothorax*: Sides subparallel in basal ¼, strongly rounded anteriorly to distinct subapical constriction; with dense, elongate, fulvoferruginous scales, and broad, white scales in dorsomedian vitta and dorsal lateromedian fasciae. *Elytra*: Interspaces moderately broad, mostly flattened; odd interspaces not more prominent than even ones, except where median portions of sutural, 3rd, and 5th interspaces are feebly raised; white scales form irregular but complete anteromedian and posteromedian transverse bands; fuscous scales form an irregular transverse band between white bands, and an incomplete band posterior to posteromedian white band; median fuscous band interrupted by elongate patch of fulvoferruginous scales on interspace 2; fulvoferruginous scales predominant basally and on apical ¼, except for subapical sutural vitta of fuscous scales; feebly raised white scales sparse on interspaces 5-6; strial scales distinctly wider than scales on interspaces, mostly fulvoferruginous, forming more or less distinct vittae. *Legs*: femora stout, unarmed; with vestiture of narrow, white to fulvous, acuminate, recumbent scales; metatibia with long, slender, straight, acute,

Table 1. Characters distinguishing *Chionanthobius autumnalis* from *C. schwarzi*.

<i>C. autumnalis</i>	<i>C. schwarzi</i>
Pronotum with dorsomedian vitta and dorsal lateromedian, and in some specimens dorsal posterolateral fascia of white scales.	Pronotum with fulvoferruginous scales only.
White scales on elytra dense, anteromedian transverse fascia extending across entire width in most specimens, posterior band complete.	White scales on elytra less dense, anteromedian transverse band not distinct across entire width in most specimens, posteromedian band broken on interspace 2, greatly narrowed or interrupted on interspace 4.
Strial scales distinctly broader than scales on interspaces, fulvous, contrasting with white or fuscous scales on adjacent interspaces.	Strial scales not or very slightly broader than scales on interspaces, their color matching that of scales on adjacent interspaces.
Interspaces 2 and 3 without subbasal patch of fuscous scales.	Interspaces 2 and 3 each bearing small subbasal patch of fuscous scales.
Dorsal and ventral scrobal margins ecarinate; dorsolateral portion of rostrum at most shallowly punctate in male and in female above antennal insertions.	Dorsal and ventral scrobal margins distinctly carinate, especially in males; dorsolateral portions of rostrum of males deeply rugose above antennal insertion.
Femora not toothed beneath.	Femora toothed beneath.

apical mucro; pro- and mesotibiae each with moderately long, slender, acute, apical uncus. *Genitalia*: As in Fig. 7; paratype.

Female allotype (Figs. 12, 13).—*Length*: 3.76 mm. *Width*: 1.82 mm. Otherwise as described for male, except for longer, more slender, less deeply carinate and punctate rostrum, and smaller, less broadly exposed pygidium. *Genitalia*: As in Fig. 10, paratype.

Variation.—The range in size observed in the 81 specimens of the type-series is as follows: Length of males, 2.76–3.56 mm, width of males, 1.34–1.70 mm; length of females, 2.72–4.00 mm, width of females, 1.32–2.04 mm. Although there is slight variation in the width of the transverse bands of white and fuscous scales on the elytra, there is no notable tendency for the fulvoferruginous scales to be intermixed among the scales on these bands as in *C. schwarzi*.

Distribution (Fig. 11).—Known only from the type-locality.

Life history.—Adults of *C. autumnalis* were collected over a period extending from 3 October to 2 December 1972. All were on the pistillate individuals of a dioecious shrub, *Forestiera ligustrina* (Michx.) Poir. (Oleaceae). On each of the collection dates, they were present along with adults

of *Neotylopterus ligustricolus* Clark (see Clark, 1980). Both species were present in roughly equivalent numbers on each date. Adults of the latter species were reared from larvae which emerged from fruit collected from the plants, but *C. autumnalis* individuals were not among the numerous specimens reared. The two weevil species closely resemble each other, and the fact that both were present was not recognized at the time the adults and larvae were being collected. It cannot now be ascertained, therefore, whether the observations made on adult feeding, mating, and oviposition were of both species, or of *N. ligustricolus* alone.

Remarks.—In addition to the characters listed in Table 1, *C. autumnalis* differs from *C. schwarzi* in its obviously smaller size, generally stouter, less setalike scales, especially those on the venter and legs, and in the more convex elytra and generally stouter body form. There are only minor differences in the male and female external genitalia of the two species (cf. Figs. 6–10).

ACKNOWLEDGMENTS

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NEW SYRPHIDAE FROM ISRAEL (DIPTERA)

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Abstract.—The following three new species of Syrphidae from Israel are described: *Paragus hermonensis* Kaplan (also from Italy); *Cheilosia sulcifrons* Kaplan (also from Turkey); and *Brachyopa quadrimaculosa* Thompson. *Cheilosia sareptana* Becker is redescribed and its lectotype designated. Keys to the Israeli species of *Paragus* and *Cheilosia* are given.

More than 100 species of Syrphidae have been collected in Israel during a survey carried out since 1971. About a fifth of these species were found, or are suspected, to be undescribed. Most of the undescribed species belong to the genus *Merodon* Meigen, which contains approximately 20% of the Israeli species of Syrphidae. *Merodon* will be dealt with in a coming paper. This paper deals with the other genera that contain undescribed species, namely *Paragus*, *Cheilosia*, and *Brachyopa*. The new species are described and placed in the most recent keys to the Palaearctic species of their respective taxa. Keys to the Israeli species of *Paragus* and *Cheilosia* are also given.

The new species are described to make their names available for the forthcoming Syrphidae part of the *Fauna Palaestina* series. This publication will include detailed information about the flower fly fauna, its contents and relationships, as well as keys to and descriptions of its components.

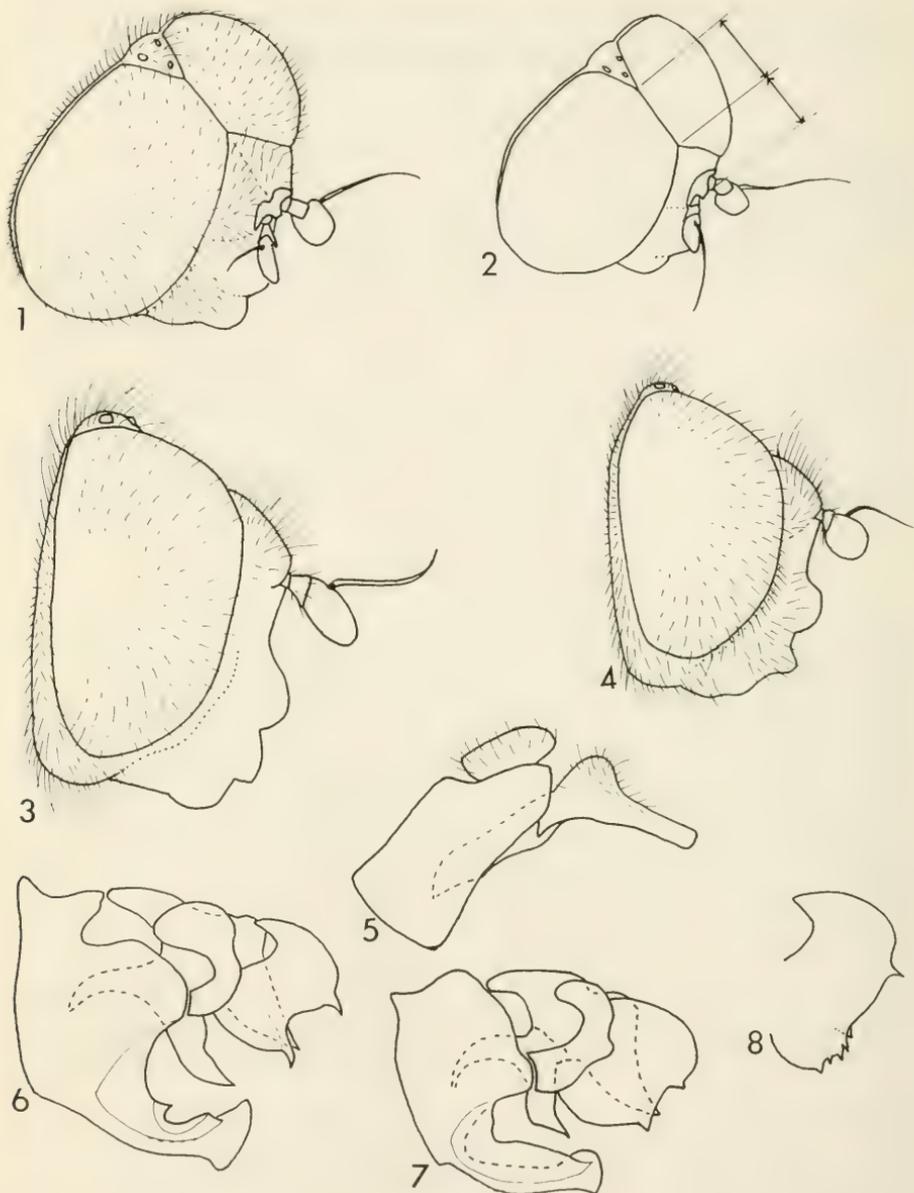
Genus *Paragus* Latreille

Seven species of *Paragus* have been found in Israel. These species belong to three species groups: *tibialis* group of the subgenus *Pandasyophthalmus*—*tibialis* Fallén and *haemorrhous* Meigen; *serratus* group of the subgenus *Paragus*—*azurea* Stuckenberg; and *bicolor* group of the subgenus *Paragus*—*bicolor* Fabricius, *compeditus* Wiedemann, *hermonensis* Kaplan, and *quadrifasciatus* Meigen. Stuckenberg has revised the afrotropical species

of *Paragus* (1954b) and all the species of the *serratus* species group (1954a). Goeldlin (1976) has revised the European species of *Paragus*.

KEY TO THE SPECIES OF *PARAGUS* FOUND IN ISRAEL

1. Eye with unicolorous pile; spurious vein long, extending beyond discal crossvein 2
 - Eye with bicolorous pile, with alternating vittae of pale and dark hairs; spurious vein shorter, not extending beyond discal crossvein .. 3
2. Male: Sterna 3 and 4 subequal (Speight 1978: 104, Fig. 2b); surstyle and paramere subequal in length (Goeldlin 1976: 87, Fig. 4) *haemorrhous* Meigen
 - Male: Sternum 4 only about $\frac{2}{3}$ as long as 3rd (Speight 1978: 104, Fig. 2d); surstyle about $\frac{1}{2}$ as long as paramere (Goeldlin 1976: 87, Fig. 3) *tibialis* (Fallén)
(Females of these species are indistinguishable)
3. Scutellum with dentate margin *azureus* Stuckenberg
 - Scutellum simple, without dentate margin 4
4. Mesonotum shiny, with submedial pollinose vitta broadly interrupted and appearing as 2 maculae. Male: Surstyle with basoventral prong; lingula greatly enlarged, not distinctly differentiated from 9th sternum; aedeagus with basolateral lobe simple (Goeldlin 1976: 93, Fig. 6). Female: 7th tergum with dorsoapical tubercle (Goeldlin 1976: 101, Fig. 24) *quadrifasciatus* Meigen
 - Mesonotum shiny or dull, with submedial pollinose vitta continuous. Male: Surstyle without basoventral prong; lingula smaller, distinctly differentiated from 9th sternum, aedeagus with basolateral lobe complex. Female: 7th tergum simple, without any tubercles 5
5. Mesonotum shiny. Male: Lingula in profile emarginate apically, aedeagus with basolateral lobe without teeth (Goeldlin 1976: 93, Fig. 14). Female: Face entirely yellow (Goeldlin 1976: 101, Fig. 27) *compeditus* Wiedemann
 - Mesonotum dull. Male: Lingula not emarginate in profile, aedeagus with more complex basolateral lobe. Female: Face with black medial vitta 6
6. Abdomen extensively black; abdominal margin almost entirely black, rarely narrowly reddish on basal $\frac{1}{3}$ of 3rd tergum. Male: Aedeagal apodeme with large apicolateral prong; aedeagus not produced anterodorsally (Fig. 7) *hermonensis* Kaplan, new species
 - Abdomen extensively red; abdominal margin beyond 2nd tergum red. Male: Aedeagal apodeme without an apicolateral prong; aedeagus produced anterodorsally (Goeldlin 1976: 87, Fig. 6) *bicolor* (Fabricius)



Figs. 1-8. 1-2, Head, dorso-oblique view. 3-4, Head, lateral view. 5-8, Male genitalia. 5, 9th tergum and associated structures, lateral view. 6-7, 9th sternum and associated structures, lateral view. 8, Superior lobe, lateral view. 1, 4, *Cheilosia sulcifrons*. 2, *C. barbata*. 3, *C. sareptana*. 5, 7, 8, *Paragus hermonensis*. 6, *P. majoranae*.

Paragus hermonensis Kaplan, NEW SPECIES

Figs. 5, 7, 8, 19

Size.—Body, male, 6.2 mm, female 5.4 mm; wing, male 4.4 mm, female 4.1 mm.

Male.—*Head*: Face yellow except slightly brownish on tubercle and oral margin, with white pile; cheek black, with white pollen and pile; frontal triangle small, yellow, with white pile except for a few black hairs around frontal lunule; vertical triangle $3.5\times$ as long as frontal triangle, bluish black, with white pollen anteriorly, shiny posteriorly, with yellowish pile except for a few black hairs intermixed on ocellar triangle; occiput bluish black, with white pollen and pile on ventral $\frac{2}{3}$, shiny and with yellowish pile on dorsal $\frac{1}{3}$; eye contiguity about $\frac{1}{3}$ as long as frontal triangle. *Antenna*: Basal 2 segments black, with sparse white pollen and black pile; 3rd segment dark brown, $3\frac{1}{3}$ times as long as wide; arista dark brownish orange, shorter than 3rd antennal segment.

Thorax: Bluish black; mesonotum shiny except for white pollinose submedial vitta which extends from anterior margin to slightly beyond transverse suture, with yellowish pile; pleura with sparse white pollen and white pile; scutellum black basally, yellow on apical $\frac{1}{3}$; squama white with yellowish margin and fringe; halter brown on stem, yellow on capitulum. Wing (Fig. 19): Hyaline, microtrichose as figured; stigma brown. Legs: Mainly orangish yellow; coxae and trochanters black, with white pile; fore- and midfemora black on basal $\frac{1}{3}$; hindfemur black on basal $\frac{2}{3}$, with yellowish pile; hindtibia with brownish subapical annulus, with white and yellowish pile; hindbasitarsomere brownish orange dorsally.

Abdomen: Dorsum black with reddish-orange fasciae on 2nd through 4th terga, with black pile except white on fasciae, basolateral $\frac{2}{3}$ of 2nd, basolateral $\frac{1}{3}$ of 3rd and 4th terga and genitalia; fasciae on 2nd tergum isolated from lateral margin, on 3rd and 4th terga broadly continuous with lateral margin, on 4th tergum interrupted medially, with white pollen and pile; sterna brownish black, with sparse gray pollen and white pile. Male genitalia (Figs. 5, 7): Cercus simple; surstyle simple; 9th tergum simple; 9th sternum simple; lingula elongate, simple apically, with flared lateral margin, with lateral margin not emarginate; aedeagal apodeme with small apicolateral prong; aedeagus with basolateral lobe with shallow apical emargination bordered by small teeth.

Female.—Similar to male except for normal sexual dimorphism and: Face with broad brownish-black medial vitta that is about $\frac{1}{3}$ as wide as face; frons shiny black except with very narrow white pollinose vitta along eye margin.

Variation.—Body size ranges from 4.4 mm to 6.2 mm: 3rd antennal segment color ranges from entirely dark brown to having basoventral $\frac{1}{4}$ orange;

the genus is uncommon and restricted to the northern and mountainous part of the country. The last comprehensive key to the Palaearctic species of *Cheilosia* is that in Sack (1928: 39), which was based on Becker's monograph (1894). Sack included 144 species in his key. About 126 species have been described since Sack's work, and his key did not include 13 previously described species.

KEY TO THE SPECIES OF *CHEILOSIA* FOUND IN ISRAEL

1. Eye bare; face bare 2
 - Eye pilose 4
2. Antennal pits confluent, not separated by frontal lunule; arista pubescent, with hairs at least as long as aristal width; facial tubercle very broad, reaching lateral facial margin 3
 - Antennal pits isolated, separated by ventral extension of frontal lunule; arista appearing bare, with hairs much shorter than aristal width; facial tubercle narrow, isolated from lateral facial margin ..
..... *latifacies* Loew
3. Third antennal segment dark, reddish brown to brownish black. Male: Thorax with extensive black pile; black pile on mesopleuron, pteropleuron and broadly submedially on mesonotum. Female: Face orange ventrolaterally; 3rd antennal segment circular, about as long as wide *scutellata* (Fallén)
 - Third antennal segment pale, bright orange. Male: Thorax almost entirely with pale pile, with only a few black hairs intermixed on lateral margin of mesonotum. Female: Face black; 3rd antennal segment more elongate, about $1\frac{1}{2}\times$ as long as wide .. *soror* (Zetterstedt)
4. Face bare 5
 - Face pilose (Fig. 4) *sulcifrons* Kaplan, new species
5. Fore- and midbasitarsomeres and hindtarsus brownish black. Male: frontal triangle with black pile unidentified species?
 - Fore- and midbasitarsomeres and 2nd through 4th tarsomeres of hindtarsus orange. Male: Frontal triangle with at least some pale hairs, frequently with pile all yellow *sareptana* Becker

Cheilosia sulcifrons Kaplan, NEW SPECIES

Figs. 1, 4, 10, 12, 13, 15

Size.—Body, male 7.5 to 9 mm, female 8.5 mm; wing, male 7 to 8 mm, female 7 mm.

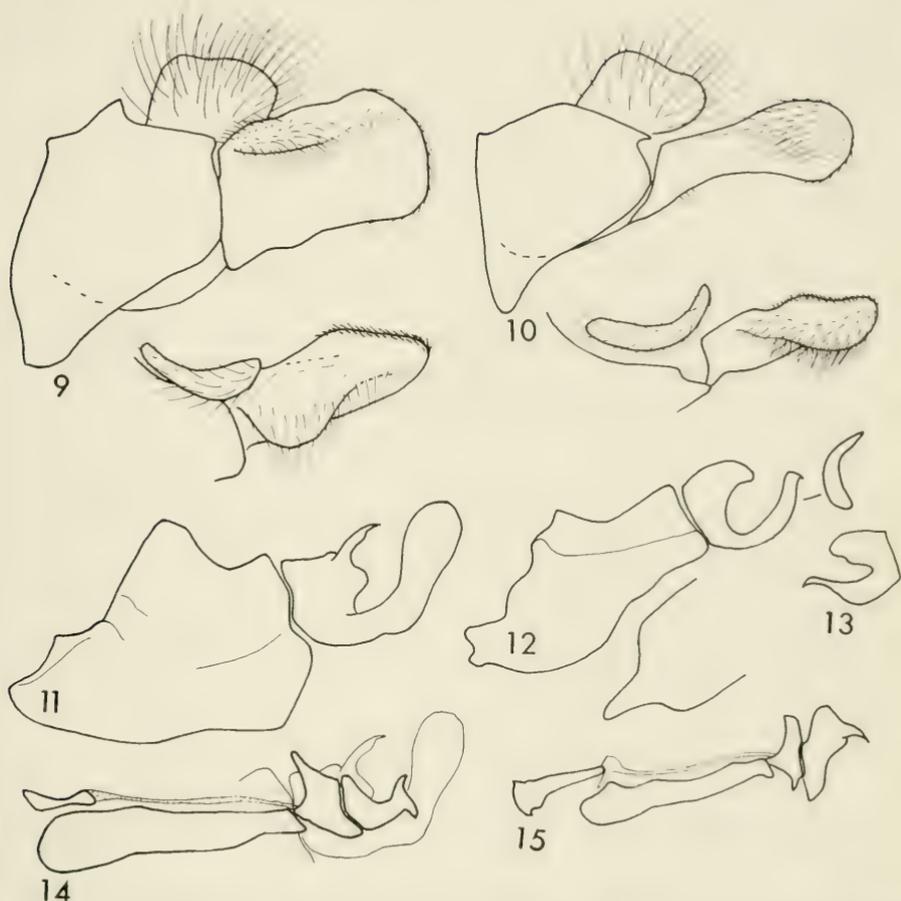
Male.—*Head* (Fig. 4): Face black, with white pile and pollen except bare and slightly shiny tubercle; facial tubercle low, abrupt dorsally, strongly concave ventrally; cheek black, with white pile; frontal triangle black, shiny except with sparse white pollen laterally, with long erect black pile, mod-

erately swollen, with longitudinal medial sulcus; frontal lunule brown; antennal pits separate; vertical triangle black, with intermixed yellow and black pile; occiput black, with white pile and pollen, with row of long black hairs and with pollen sparse on dorsal $\frac{1}{3}$; eye contiguity as long as frontal triangle; eye with dense white pile. *Antenna*: Basal 2 segments dark brownish black, with black pile; 3rd segment oval, orange except dorso-apical margin brown; arista black, about $1\frac{2}{3}$ times as long as antenna, thick on basal $\frac{1}{4}$, elsewhere thin, with very short aristal hairs, their length less than $\frac{1}{4}$ aristal width.

Thorax: Black, shiny, with bronze tinge, with long intermixed yellow and black pile; mesonotum with sparse pollen, subshiny; scutellum with long black marginal hairs, these hairs not thick nor bristlelike; pleura with sparse pollen; sternopleuron continuously pilose; metathoracic spiracle with golden fringe; squama white, with yellowish margin and fringe; halter brown, with yellow stem. *Wing*: Slightly brownish, densely microtrichose; stigma yellowish brown. *Legs*: Mainly black and with white pile; femora orange brown on apex, with sparse white pollen on dark areas; front femur with black pile posteriorly; hind femur with some black spinose hairs ventrally; front tibia orange brown on basal $\frac{1}{3}$ and apex, with black pile posteriorly; middle tibia orange brown on basal $\frac{1}{2}$ and apex, with black pile anterodorsally; hind tibia orange brown on basal $\frac{1}{3}$ and apex, with black pile anterodorsally.

Abdomen: Dorsum black, shiny laterally and apically, with gray pollen sublaterally on 2nd and 3rd terga and dull black pollen medially on 2nd and 3rd terga; dorsal pile yellowish except with some intermixed black hairs apically on 4th tergum and genitalia, long, erect, except shorter mesally; sterna brownish black, with dense gray pollen and sparse long yellow pile. *Male genitalia* (Figs. 10, 12, 13, 15): Cercus quadrate, pilose; surstyle elongate, broader apically, without a distinct lateral carina, but swollen dorso-apically; 9th sternum with lingular area simple, triangular; superior lobes slightly asymmetric, with dorso-apical prong short and blunt, with ventro-apical prong elongate and acute; ejaculatory apodeme elongate and flared anteriorly, triangular; aedeagus two-segmented, with basal portion short and elongate dorsoventrally, with apical portion also elongate dorsoventrally and with apical hook.

Female.—Similar to male except for normal sexual dimorphism and: pile shorter, more extensively pale; frons at antennal base 3.2 times as wide as 3rd antennal segment, with shallow longitudinal sulcus laterally and a very shallow medial sulcus, with a transverse sulcus dorsad to antennal bases, with pile mostly yellowish, with a few intermixed black hairs; 3rd antennal segment almost entirely orange, only dorsal edge brownish, larger and more quadrate; halter yellow; abdomen more extensively shiny, with medial black pollinose areas reduced and gray pollinose areas enlarged.



Figs. 9-15. Male genitalia of *Cheilosia* species. 9-10, 9th tergum and associated structures, lateral view, with dorsal view of cercus and surstyle. 11-12, 9th sternum and associated structures, lateral view, with outline of lingular area and posterior view of apex of right superior lobe in Fig. 12. 13, Left superior lobe, lateral view. 14-15, Aedeagus and associated structures, lateral view. 9, 11, 14, *C. sareptana*. 10, 12, 13, 15, *C. sulcifrons*.

Types.—Holotype ♂, Israel, Merom Golan, 15 March 1975, M. Kaplan. Allotype ♀, 2 ♂ and 1 ♀ paratypes with same data as holotype; one other ♀ paratype from type-locality but collected 18 March 1973 by M. Kaplan. 2 ♂ paratypes, Israel, Mt. Hermon, 1650 m, 22 July 1973, A. Freidberg; 1 ♀ paratype same locality but 1600 m, 6 May 1975, M. Kaplan. 5 ♂, 1 ♀ paratypes, Turkey, 16 km west of Gaziantep, at Buyukaraptat village, along Adana-Gaziantep Highway E 24, 17 May 1967, P. H. Dunn, swept from *Cardaria draba* (Linnaeus). Holotype, allotype and some paratypes depos-

ited in the Entomological Collection, Department of Zoology, Tel Aviv University; other paratypes deposited in British Museum (Natural History), London; Canadian National Collection, Ottawa, and U.S. National Museum, Washington, D.C.

Remarks.—*Cheilosia sulcifrons* belongs to group B and keys to *frontalis* Loew and *barbata* Loew in Sack (1928: 44). These species can be distinguished by the following couplets:

1. Arista pubescent, with hairs as long as or longer than arista width; sternopleuron with pile continuous. Male: Frontal triangle small, shorter than eye contiguity, not swollen (Fig. 2); eye pile yellowish brown; mesonotum subshiny; squamal fringe orange. . . *barbata* Loew
- Arista appearing bare, with hairs much shorter than arista width. Male: Frontal triangle large, longer than eye contiguity, swollen (Fig. 1) 2
2. Sternopleuron with pile broadly separated. Male: Eye pile brown; mesonotum dull, with dense pollen *frontalis* Loew
- Sternopleuron with pile continuous. Male: Eye pile white; mesonotum subshiny, with sparse pollen . . . *sulfifrons* Kaplan, new species

The specific epithet, *sulfifrons*, is a noun formed from the Latin noun, *sulcus*, meaning "groove," and the Latin noun, *frons*, meaning forehead, and refers to the longitudinal groove on the frons of the males.

Cheilosia sareptana Becker

Figs. 3, 9, 11, 14

Chilosia sareptana Becker, 1894: 418. Type-locality: USSR, "Sarepta." Lectotype ♀ in Zool. Mus. Humboldt-Univ., Berlin.

Size.—Body, male 8.8 to 11.3 mm, female 8.5 to 10.7 mm; wing, male 7.7 to 9.2 mm, female 6.6 to 8.5 mm.

Male.—*Head* (Fig. 3): Black; face bare, with gray pollen; facial tubercle large, so that facial profile is gently sloping dorsally, strongly concave ventrally; facial stripe broad, with short white pile; cheek with sparse gray pollen, with yellow pile; frontal triangle large, swollen, about 1.3× as long as eye contiguity, with sparse gray pollen except dense laterally, with pile black and intermixed with a few yellowish hairs, with medial sulcus; frontal lunule dark brown; antennal pits separate; vertical triangle with gray pollen and yellow pile, $\frac{5}{8}$ as long as frontal triangle; occiput with white pollen and yellow pile; eye contiguity longer than vertical triangle; eye with dense white pile. Antenna: 1st segment brownish black, with orange pile; 2nd segment brown, with orange pile; 3rd segment orange except slightly brownish dorsoapically, elongate, about 2× as long as wide; arista black, $\frac{7}{8}$ as long as

antenna, bare, with arisal hairs microscopic and much shorter than arisal width.

Thorax: Black, with pile long, dense, almost entirely yellow except for a few black hairs on mesonotum near wing base and on sternopleuron; mesonotum shiny, with bronze tinge, finely punctate, with very sparse pollen laterally; pleura with dense pollen; sternopleuron with pile widely separated; metathoracic spiracle with golden-brown fringe; squama white with yellow margin and fringe; halter orange. Wing: Slightly yellowish brown, densely microtrichose; stigma orange; veins brown except more yellowish basally. Legs: Coxae and trochanters black, with white pollen and yellow pile; femora black except orange apex, with orange pile except for some intermixed black hairs, especially posteriorly on forefemur; tibiae orange, with orange pile; fore- and midtarsi orange except black apical tarsomere, with orange pile except black on apical tarsomere; hindtarsus orange on 2nd through 4th tarsomeres, with basomere broadly brownish black medially, with apical tarsomere black, with black pile.

Abdomen: Elongate, with parallel margins, narrower than thorax; dorsum black, shiny laterally and on 4th tergum, with silvery pollen basomedially and black pollen apicomediaally, with dense erect long orange pile; sterna brownish black, with sparse gray pollen, with pile erect and long yellow on basal sterna and laterally on apical sterna, with pile appressed and short, black medially on apical sterna. Male genitalia (Figs. 9, 11, 14): Cercus quadrate, pilose; surstyle rectangular, with a strong dorsobasal carina laterally; 9th sternum with lingular area simple, rectangular; superior lobes symmetric, with a small acute dorso-apical prong, with a large lobate ventro-apical prong; ejaculatory apodeme simple, short, rod-shaped; aedeagus 2-segmented, with basal portion trapezoidal, with apical portion strongly V-shaped in dorsal view, elongate, curved, with dorso- and ventro-apical teeth.

Female.—Similar to male except for normal sexual dimorphism and: Pile shorter; with less black hairs; facial tubercle more distinct, more strongly concave ventrally; frons at antennal base $3.5\times$ as wide as 3rd antennal segment, shiny except gray pollinose basolaterally, with short orange pile; 3rd antennal segment shorter and broader.

Specimens examined.—ISRAEL: Merom Golan, 18 March 1973, M. Kaplan, 20 ♂, 6 ♀; 15 ♂, 4 ♀ from same locality but collected by A. Friedberg, F. and M. Kaplan on 15 March 1975; Qusbiye, 16 March 1975, F. Kaplan, 2 ♂; Tanur, 15 March 1975, F. Kaplan, 2 ♀; Jerusalem, 28 February 1956, 1 ♀. Material deposited in the Entomological Collection, Department of Zoology, Tel Aviv University; British Museum (Natural History), London; Canadian National Collection, Ottawa; and U.S. National Museum, Washington, D.C.

Remarks.—*Cheilosia sareptana* belongs to group C and keys to *schineri* Egger in Sack (1928: 47). These species are separated by the following couplet:

1. Fore- and midtarsi with basal 4 tarsomeres orange, only apical tarsomere black; arista, frontal lunule and basal 2 antennal segments brown; facial tubercle large, distinct, strongly concave ventrally (Fig. 3) *sareptana* Becker
- Fore- and midtarsi with basal 3 tarsomeres orange, with apical 2 tarsomeres black; arista, frontal lunule and basal 2 antennal segments orange; facial tubercle small, indistinct, not strongly concave ventrally (Sack 1929: 99, Fig. 148) *schineri* Egger

Cheilosia sareptana Becker was described from and is apparently known from just 2 females collected by Christoph from "Sarepta" and in the Loew Collection. In the Zoologisches Museum of the Museum für Naturkunde der Humboldt-Universität zu Berlin, there is a single female labeled "Sarepta / Christoph," (black circle), "Coll. / H. Loew," "Typus" (red), and "Cheilosia sareptana B" (handwritten, but neither in Loew's nor Becker's hand), which is designated *Lectotype* and has been so labeled. The only difference between the lectotype and our Israeli material is that the pile on the head and thorax of the lectotype is pale yellowish white instead of bright golden yellow. This difference is undoubtedly the result of bleaching due to the age of the type. As the male of *sareptana* was previously unknown, we have redescribed the species.

Genus *Brachyopa* Meigen

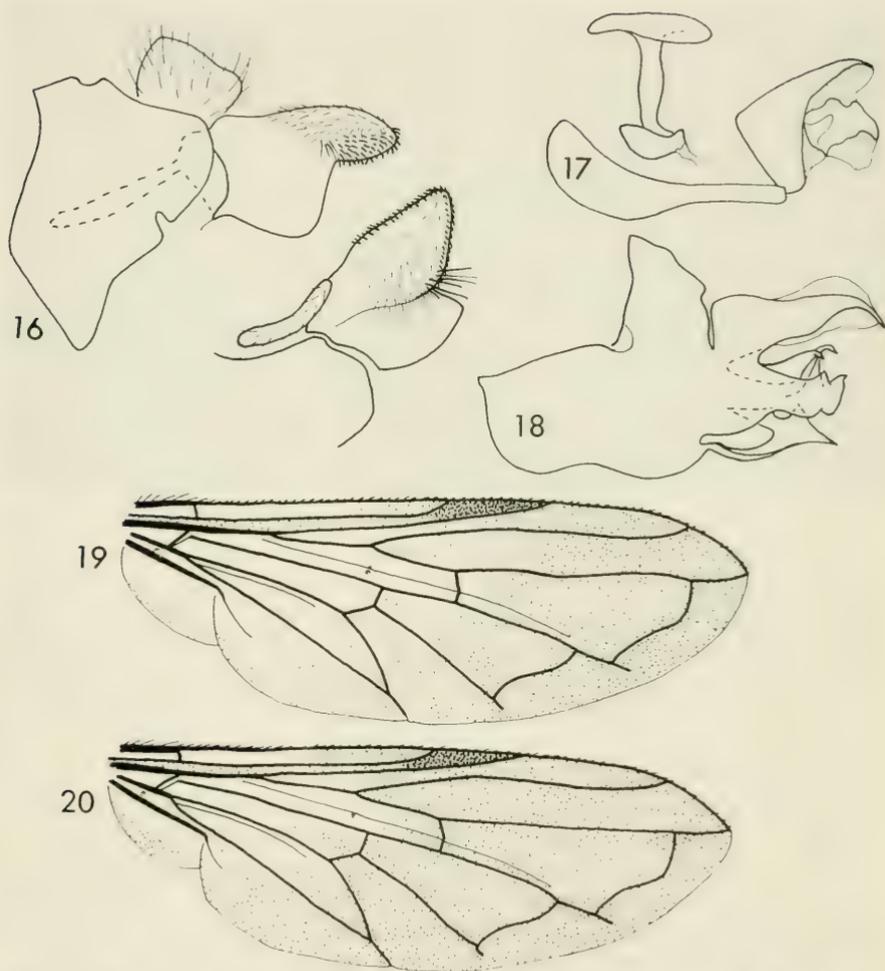
Brachyopa Meigen is a small genus of North Temperate flower flies, whose larvae breed in sap wound in trees. Thompson (1980) provided a key to the Palaearctic species as well as a review of their nomenclature. The species described below is the only one known from Israel and represents southern most limit of the genus in the Palaearctic Region.

Brachyopa quadrimaculosa Thompson, NEW SPECIES

Figs. 16–18, 21, 22

Size.—Body, male 6.9 mm, female 5.2 mm; wing, male 6.5 mm, female 5.0 mm.

Male.—*Head* (Fig. 22): Face orange, slightly brownish laterally, with dense grayish-white pollen; cheek orange, with dense white pollen, with white pile; frontal triangle orange medially, brownish black laterally, shiny on anterior ½, with dense grayish-white pollen posteriorly; vertical triangle black, with dense grayish-white pollen, with white pile; occiput black, with dense grayish-white pollen, with white pile except for a few black cilia on dorsal ¼; eye contiguity short, about as long as ocellar triangle. Antenna



Figs. 16-20. 16-18, Male genitalia of *Brachyopa quadrimaculosa*. 19-20, Wing, dorsal view. 16, 9th tergum and associated structures, lateral view, with dorsal view of cercus and surstyle. 17, Aedeagus and associated structures, lateral view. 18, 9th sternum and associated structures, lateral view. 19, *Paragus hermonensis*. 20, *P. majoranae*.

orange, with black pile; 3rd segment oval, about $\frac{3}{4}$ as wide as long, with a very small sensory pit; arista appearing bare, with hairs very short, less than $\frac{1}{4}$ as long as aristal width.

Thorax (Fig. 21): Black, generally with dense gray pollen; humerus and propleuron with white pile; mesonotum with two large and one minute shiny maculae, with minute macula slightly mesad and posteriad to humerus, with one of large macula anterior to transverse suture and mesad to notopleuron

and other macula at end of transverse suture, with black appressed pile except for a few scattered and intermixed white hairs on margins; pleura with white pile; mesopleuron with 2 apicoposterior black bristles; sternopleuron with dorsal and ventral pile patches broadly separated; postalar callus with 2 strong black bristles; scutellum brownish black and with gray pollen on basal $\frac{1}{2}$, orange and shiny apically, with erect white pile, with 3–4 strong marginal bristles on each side; squama and plumula white; halter orange. Wing: Hyaline, microtrichose; stigma yellowish. Legs: Orange except brownish tarsi, with sparse grayish-white pollen, with pale pile except with a few black bristlelike hairs apicoposteriorly on fore- and midfemora; hindfemur with black spinose hairs ventrally along almost its whole length.

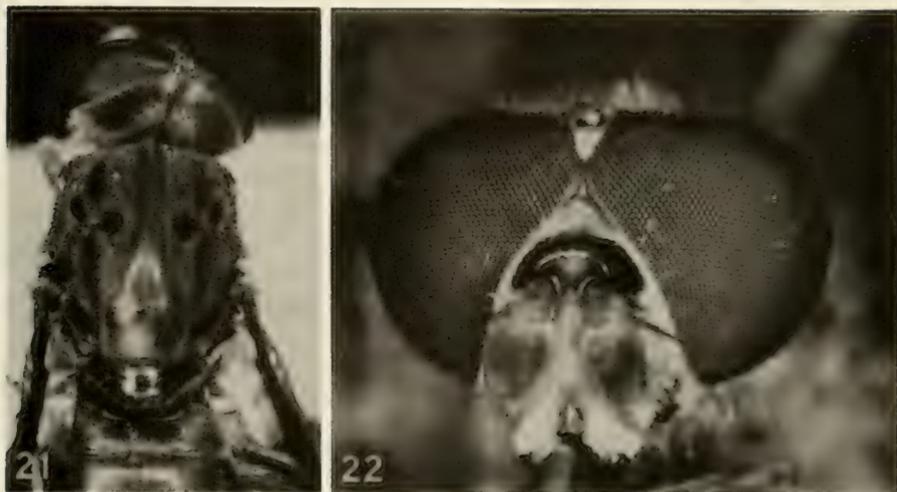
Abdomen: Orange except gray 1st segment and dark brownish-orange genitalia, with white pile; terga shiny except gray pollinose 1st tergum; sterna with dense grayish-white pollen; genitalia shiny except gray pollinose 9th tergum. Male genitalia (Figs. 16–18): Cercus quadrate, pilose; surstyle quadrate with a pilose dorso-apical lobe, with dorso-apical lobe acute in dorsal view and not recurved apically, with dorso-apical lobe with strong short setae ventrally and medially; 9th sternum with well-developed lingula; lingula rectangular, with an acute anterior directed dorsal lobe; superior lobe complex; dorsal lobe of superior lobe elongate, acute apically, semi-sclerotized dorsally and ventro-apically; ventral lobe of superior lobe elongate, with 2 dorso-apical teeth and 2 ventro-apical lobes; superior lobe with 2 mesial processes between dorsal and ventral lobes, with one produced dorsally as an anterior-posteriorly flattened lobe, and other process as an elongate and apically and acutely bifid lobe, which extends over the 1st mesial lobe; ejaculatory apodeme umbrella-shaped; aedeagus 2-segmented, with large basal hood and lateral process arising apically under hood.

Female.—Similar to male except for normal sexual dimorphism and: Face shiny on ventral $\frac{1}{2}$; front black on dorsal $\frac{2}{3}$, with dense gray pollen and white pile on dorsal $\frac{2}{3}$, orange medially and black laterally as well as shiny on ventral $\frac{1}{3}$; 3rd antennal segment larger, without sensory pit.

Types.—Holotype ♂, Israel, Monfort, 4 March 1976, A. Freidberg. Allotype ♀, 11 ♂, 2 ♀ paratypes with same data as holotype but collected by A. Freidberg and M. Kaplan. Holotype, allotype and most paratypes deposited in the Entomological Collection, Tel Aviv University; other paratypes deposited in British Museum (Natural History), London, Canadian National Collection, Ottawa, and U.S. National Museum, Washington, D.C.

Remarks.—*Brachyopa quadrimaculosa* is readily distinguished from all other known congeners by its shiny maculae on the mesonotum. The specific epithet is an adjective from the Latin adjective, *quadrate*, meaning "four-fold," and the Latin adjective, *maculosus*, meaning "spotted," and refers to the marks on the mesonotum.

In Thompson's (1980) key to Palaearctic *Brachyopa*, *quadrimaculosa* will



Figs. 21–22. *Brachyopa quadrimaculosa*. 21, Thorax, dorsal view. 22, Head, frontal view.

run to couplet 8 (*insensilis* Collin and *bicolor* (Fallén)) and agrees in part with each alternative. The key is modified to include *quadrimaculosa* by deleting the last character ("propleuron (proepimeron) bare") in the first alternative of couplet 7 and changing the number from "8" to "8a"; and adding the following new couplet:

- 8a. Mesonotum uniformly covered with gray pollen; propleuron (proepimeron) bare; scutellum almost entirely orange, only rarely with base narrowly grayish, with appressed black pile; frontal triangle and front with ventral $\frac{1}{3}$ entirely orange 8
- Mesonotum with gray pollen except for 4 large shiny maculae (Fig. 21); propleuron pilose; frontal triangle and front with ventral $\frac{1}{3}$ black on lateral $\frac{1}{3}$, orange medially; 3rd antennal segment with a very small sensory pit in male and no pit in female (Fig. 22) *quadrimaculosa* Thompson, new species

Brachyopa quadrimaculosa was collected from inflorescences of *Smyr-nium olusatrum* Linnaeus (Umbelliferae) at the margin of the maquis, a type of dense growth of small trees and shrubs in the Mediterranean area.

ACKNOWLEDGMENTS

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DESCRIPTIONS OF TWO NEW SPECIES OF NEOTROPICAL
LEPTOGLOSSUS GUÉRIN (HEMIPTERA: COREIDAE)¹

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Abstract.—Two new species of *Leptoglossus* Guérin, *L. nigropearlei* and *L. usingeri*, are described from the Pearl Islands, Panama, and Temescal-tepec, Mexico, respectively. Both species belong to the *stigma* group.

Two undescribed species of *Leptoglossus* Guérin were discovered among unidentified specimens in the collections of the California Academy of Sciences and the U.S. National Museum of Natural History (USNM). Allen's (1969) revision of *Leptoglossus* treated 38 species and Brailovsky (1976) described one additional species from Mexico. The only other recently related work in the genus was the discussion of the genitalia and comparative morphology of *L. gonagra* (Fabricius) and *L. stigma* (Herbst) by Jurberg et al. (1971).

Measurements are those of the holotype with parentheses used to indicate values for paratypes. Line increments for figures equal 1 mm.

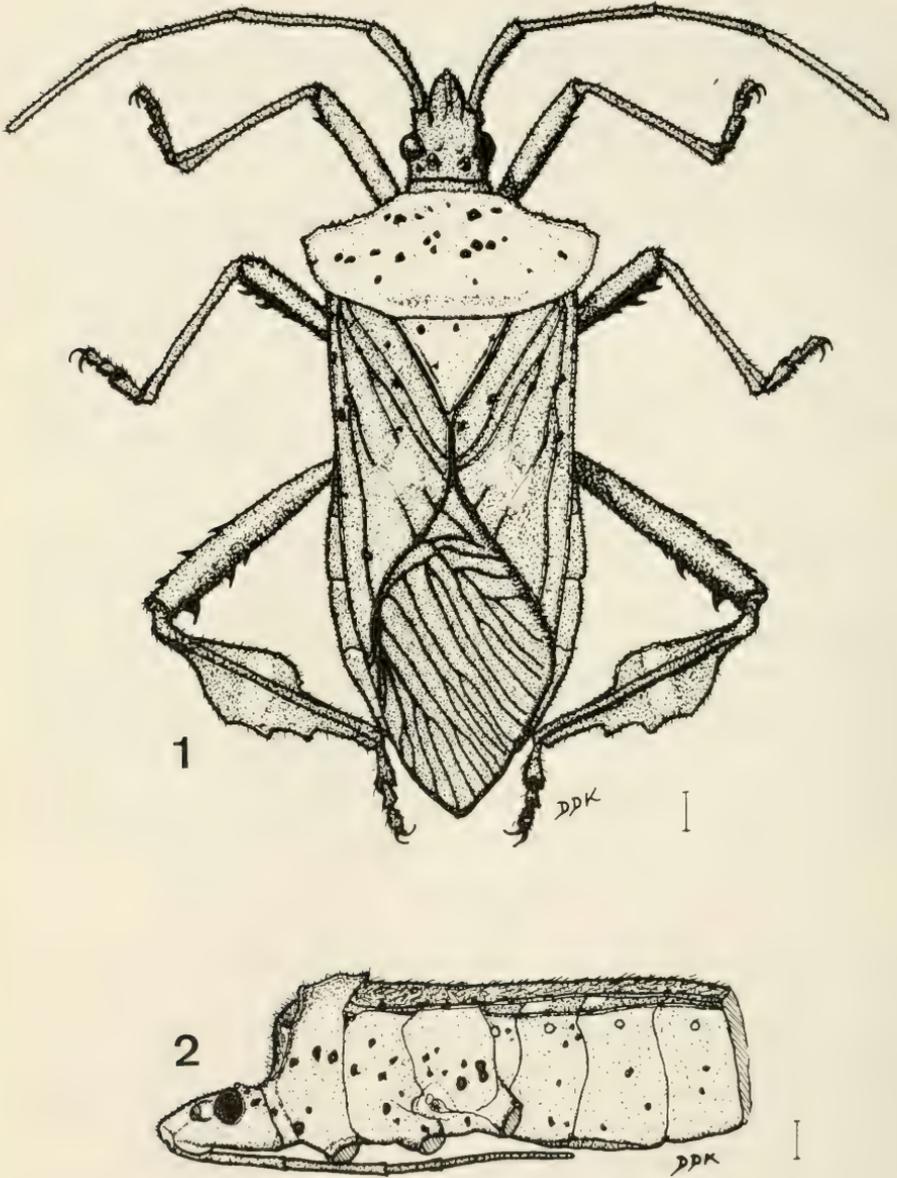
Leptoglossus nigropearlei Yonke, NEW SPECIES

Figs. 1-7

Description.—Body elongate oval, length to wing tip 20.48 mm (19.36–21.44 mm), humeral width 8.16 mm (7.20–8.32 mm), thickened dorsoventrally; dorsum light reddish brown, except pronotum with light yellowish brown in areas especially at humeral angles; entire venter light yellowish brown. Numerous small black dots randomly positioned on body, especially numerous on pronotum, thoracic pleura, and abdominal venter.

Head: Elongate, length 2.88 mm, with tylus and jugae projecting well beyond antennal sockets; tylus slightly raised above and extending beyond jugae; outer ocular width 2.88 mm, inner ocular width 1.36 mm, anteoocular length 1.60 mm, inner ocellar width 0.72 mm; uniformly reddish brown on

¹ Contribution from the Missouri Agricultural Experiment Station, Journal Series No. 8619.



Figs. 1-2. *Leptoglossus nigropearlei*. 1, Allotype ♀, dorsal habitus. 2, Lateral view.

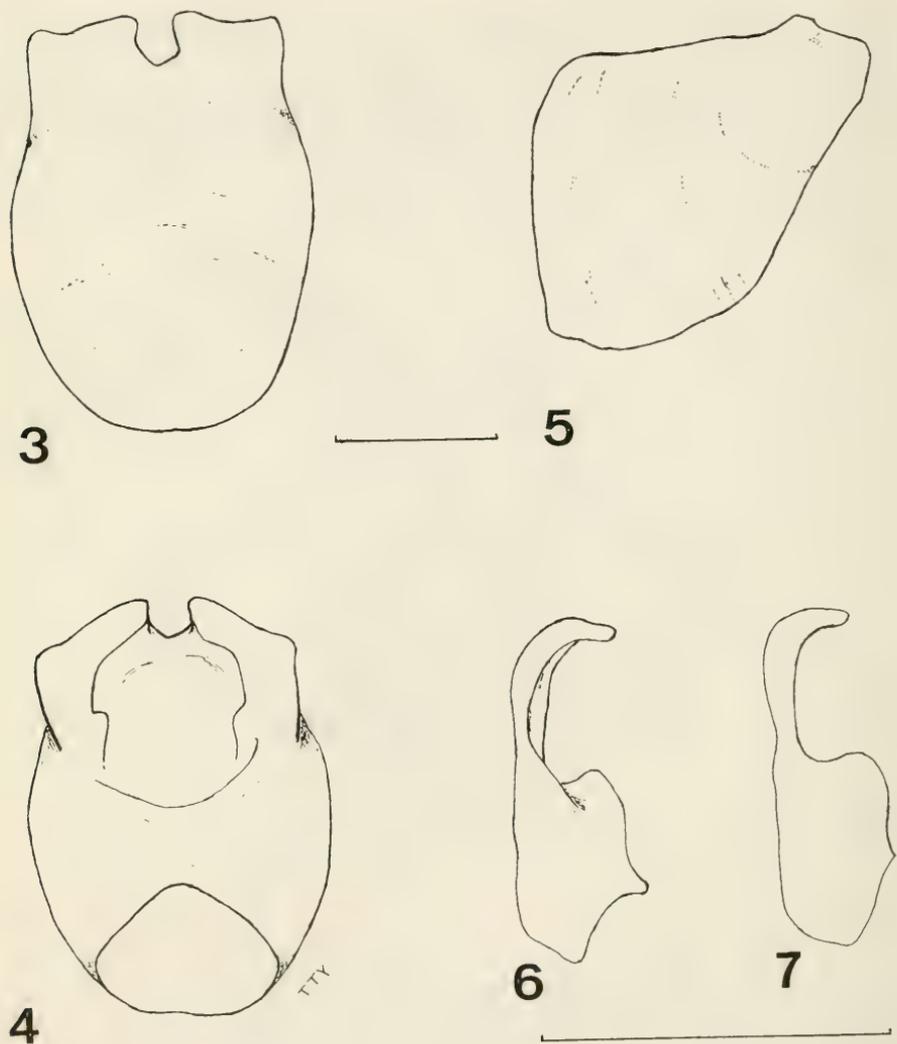
dorsum, yellowish brown on venter, except for black rim on median areas of ocellar tubercles and 2 black dots (size ca. $2\times$ ocellar diameter) behind each compound eye; bucculae short, about $\frac{1}{4}$ length of head; labium yellowish brown except for thin black rim along labial groove and apex of IV black, extending to anterior edge of 3rd abdominal sternite, segment I-2.56 mm, shorter than head, II-2.96 mm, III-1.36 mm, IV-3.36 mm; antennal segments cylindrical, yellowish brown, slightly darker at apex of II and III, segment I-2.72 mm, II-3.84 mm, III-2.72 mm, IV-4.32 mm.

Thorax: Pronotum strongly deflexed toward anterior edge, length 4.32 mm, distinct anterior pronotal collar 2.00 mm wide; anterior lateral margin with few small tubercles on cephalic $\frac{1}{2}$, larger tubercles (serrate) to humeral angle; posterior lateral margin tuberculate, entire along posterior margin, humeral angles nearly 90° ; scutellar length 2.72 mm, basal width 3.04 mm; surface densely pitted, anterior $\frac{1}{2}$ covered with erect golden setae and flattened whitish setae; pronotal color reddish brown on anterior and posterior areas, yellowish brown on disc and to humeral angles, numerous, small ($1-3\times$ diam. ocellus) black dots over pronotum; scutellum, corium and clavus reddish brown with few black dots; irregular fascia on corium; membrane brown; entire pleura yellowish brown except for numerous black dots; legs generally reddish brown, spines black at tips; profemur slender with $3-4$ spines at apex; mesofemur slender with 5 spines larger approaching apex; metafemur incrassate elongate with rows of spines small on dorsal aspect, 2 ventral rows with large spines; metatibia elongate 8.32 mm (7.20-9.12 mm), leaflike, shallowly scalloped along outer margin, small black dots on dilations; inner and outer dilations each with small yellowish area; outer dilation extending to ca. 73% (63-81%) and inner dilation to ca. 62% (51-64%) of tibial length; greatest width of dilation 2.08 mm (1.92-2.32 mm).

Abdomen: Greatest width 7.12 mm (6.72-8.32 mm); connexivum light yellowish brown for anterior $\frac{1}{4}$, dark reddish brown for posterior $\frac{3}{4}$ of each segment; dorsum light orange except for black dots on tergum 2, large black patches on lateral aspect of terga 4 and 5, and smaller diffuse black areas on terga 6 and 7; sterna light yellowish brown with many black dots especially laterad; shallow midventral "rostral" groove extending from 2 to anterior $\frac{1}{2}$ of sternum 5.

Genitalia: 8th sternum with small black dots, U-shaped and wider at base, narrower near tergum; tergum 8 transversely narrow; genital capsule as in Figs. 3-5, lateral posterior margins nearly at right angles, median notch deeper than wide; claspers with broad rectangular base and slight lateral basal lobe, straight shank except for shallow median groove, hook evenly rounded (Figs. 6, 7).

Types.—Holotype, ♂, Panama, Pearl Is., San Jose, 24-VIII-1944, J. P. E. Morrison (USNM type no. 76474). Allotype, ♀, same data except 23-



Figs. 3-7. *Leptoglossus nigropearlei*. 3-5, Genital capsule. 3, Posterior view. 4, Dorsal view. 5, Lateral view. 6-7, Right paramere. 6, Ventral view. 7, Dorsal view.

VIII-1944. Paratypes, all "collected at light," 1 ♀, same data as for holotype, others with same data as for holotype except dates as follows: 1 ♂, 1 ♀, 9-VIII-1944; 1 ♀, 24-V-1944; 1 ♀, 18-VIII-1944; 1 ♀, 23-VIII-1944. The allotype and 4 paratypes have been deposited in the USNM. One ♂ and 1 ♀ paratypes have been retained in the collection of the author.

Remarks.—Males and females are similar in nearly all respects including coloration, general structure, and shape of the humeral angle. The hindfe-

mur of the male is incrassate while that of the female is more slender. Depending upon the position of the head, the labium may extend to the posterior edge of the third sternum or onto the fourth.

Based on both external features and structures of the genitalia, this species would appear to belong to the *stigma* group of Allen (1969) and be most closely related to another Panamanian species, *L. pallidivenosus* Allen. Using Allen's (1969) key, *nigropearlei* runs to couplet 11 which includes both *brevirostris* Barber and *pallidivenosus*. *Leptoglossus brevisrostris* is a distinctly smaller species, ca. 16 mm in length, and possesses a shorter labium (as specified in the key). It can be separated from *pallidivenosus* on the basis of its yellowish brown rather than dark reddish brown coloration; its humeral angles being ca. 90° rather than acute; and the outer dilation of its hindtibia being shallowly scalloped as compared to the deeper scallops of *pallidivenosus*.

Etymology.—The species name takes its origin from both the morphological feature of the small pearl-like black dots common and distinct over the body, and from the type-locality, the Pearl Islands.

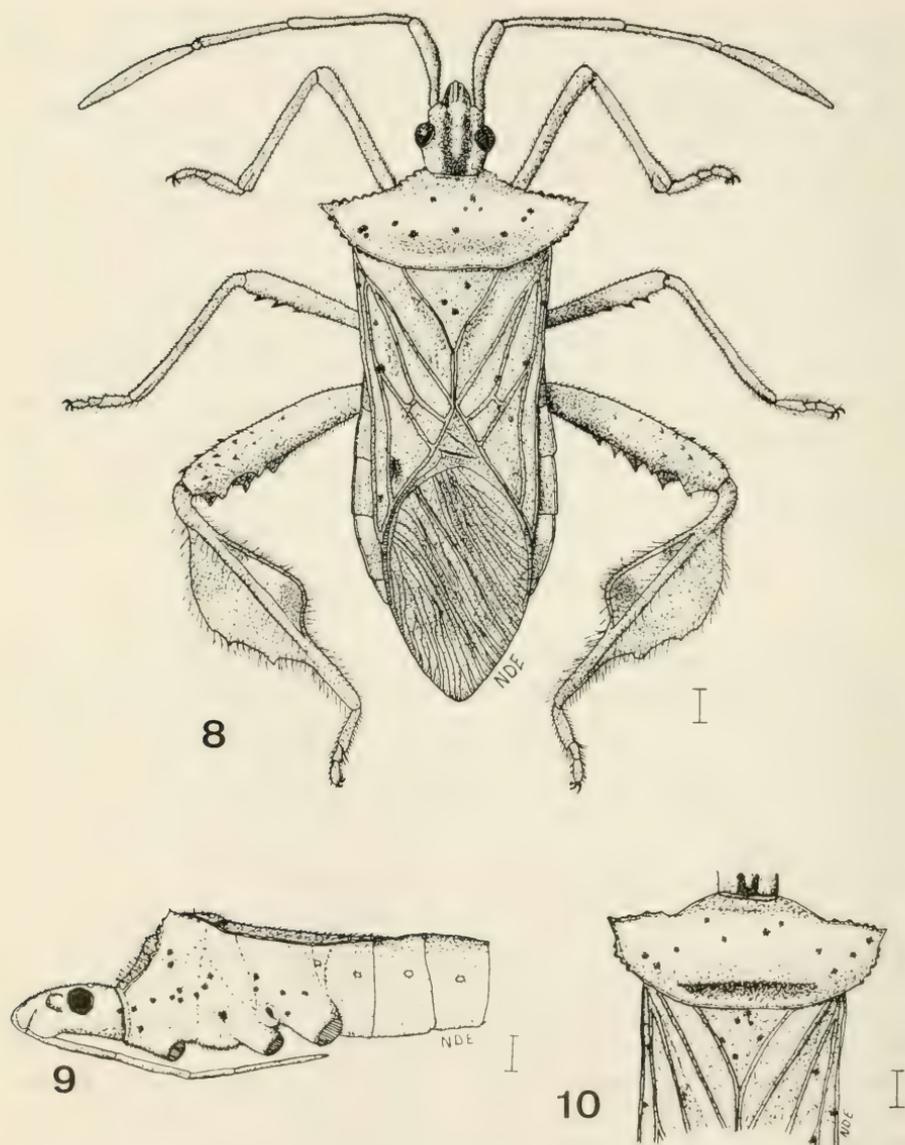
Leptoglossus usingeri Yonke, NEW SPECIES

Figs. 8–15

Description.—Body elongate oval, length 17.6 mm, to wing tip 19.04 mm (16.48–20.16 mm); humeral width 7.84 mm (7.04–8.32 mm); humeral angle extending laterad and acute on ♂ (Fig. 8), less acute and projecting anteriorlaterad on ♀ (Fig. 10); color on dorsum dark reddish brown except pronotum with large transverse yellowish-orange area extending onto disc, head with 2 wide black bands from posterior edge, over ocelli and extending onto jugae; small black dots randomly positioned on body, especially common on pronotum, thoracic pleura, and abdominal venter.

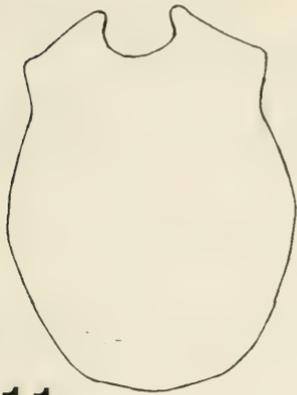
Head: Elongate, length 2.88 mm, with tylus and jugae well beyond antennal sockets, tylus slightly exceeding jugae, outer ocular width 2.40 mm, inner ocular width 1.24 mm, antocular length 1.48 mm, inner ocellar width 0.72 mm; color dark reddish brown with 2 large, longitudinal, black bands joining posteriorly to margin of head, extending anteriorly over ocelli well onto the jugae, small black area just behind compound eye and few small black dots on posterior aspect of head; bucculae short, extending to below antennal socket; labium dark reddish brown to black, especially segment 3 and distal ½ of 4, reaching onto 3rd abdominal sternum, segment I–2.32 mm and shorter than head, II–2.48 mm, III–1.12 mm, IV–2.72 mm; antennal segments I–III reddish brown, dark at apex of each, IV dark reddish brown, segment I–2.72 mm, II–3.84 mm, III–2.72 mm, IV–4.32 mm.

Thorax: Pronotum strongly deflexed toward anterior edge, length 3.68 mm; distinct anterior pronotal collar, 1.76 mm wide; entire anterior lateral and posterior lateral margins with small black tubercles (serrated), posterior

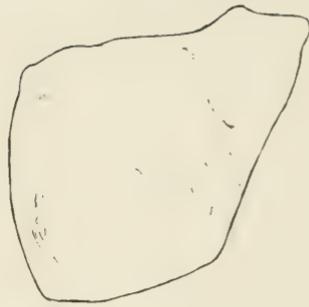


Figs. 8-10. *Leptoglossus usingeri*. 8, Holotype ♂, dorsal habitus. 9, Lateral view. 10, Paratype ♀, partial dorsal habitus.

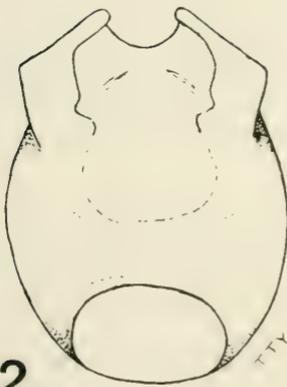
margin entire; humeral angles of ♂ acute, projecting laterad; transverse ridge just cephalad of posterior margin; scutellar length 2.56 mm, basal width 2.56 mm; pronotal color reddish brown on anterior $\frac{1}{3}$ and posterior $\frac{1}{3}$, diffuse transverse yellowish-orange area on median $\frac{1}{3}$ to humeral angles;



11



13



12



14



15



Figs. 11-15. *Leptoglossus usingeri*. 11-13, Genital capsule. 11, Posterior view. 12, Dorsal view. 13, Lateral view. 14-15, Right paramere. 14, Ventral view. 15, Dorsal view.

small black dots on pronotum, scutellum, corium and clavus; fascia on corium very light to indistinct; membrane brown; pleura reddish brown with numerous small black dots; legs generally reddish brown, coxae mostly black; pro- and mesofemora slender each with 3-4 spines nearing apex; metafemur incrassate elongate with rows of black spines, small on dorsal aspect, large in 2 ventral rows; metatibia elongate 8.4 mm, leaflike with 3 shallow scallops along outer margin, inner dilation with small orangish area;

outer dilation extended to ca. 76% (δ 66–76, η 76–80%) and inner dilation to about 67% (δ 57–67, η 67–70%) of tibial length; greatest width of dilation 2.72 mm (δ 2.08–2.40, η 2.88–3.20 mm).

Abdomen: Greatest width 6.08 mm; connexivum alternating with anterior $\frac{1}{3}$ yellowish orange and posterior $\frac{2}{3}$ dark reddish brown on each segment; dorsum generally orange except for small dark area on lateral margins of terga 4 and 5; venter reddish brown except for few small black dots; shallow midventral rostral groove extending from 2 to anterior $\frac{1}{2}$ of sternum 5.

Genitalia: 8th sternum U-shaped, wider at base and narrower near tergum, tergum 8 transversely narrow; genital capsule as in Figs. 11–13, lateral posterior margins nearly at right angles, median notch wider than deep; claspers with broad rectangular base, straight shank except for shallow median groove, hook evenly rounded (Figs. 14, 15).

Types.—Holotype, δ , allotype η , paratypes 1 δ , 2 η , Temescaltepec, Mex., Mex., VII–II–33, H. E. Hinton, R. L. Usinger, collectors. The holotype, allotype and 1 paratype have been deposited in the collection of the California Academy of Sciences, and 1 δ and 1 η paratypes have been retained in the collection of the author.

Remarks.—Males and females are similar in most respects, but differ with the humeral angles of the male being acute and distinctly terminating in a spine (Fig. 8) while the angle in the female is ca. 90° and ends in a less pronounced spine; also the hindtibial dilations of the male are less broad than those of the female.

The fascia on the corium is not readily visible on these specimens, but upon close examination it is apparent that a light irregular fascia is present on three of the five types. The yellowish-orange transverse humeral band of the pronotum is somewhat mottled on the disc of one male, but distinct on the other specimens.

This species belongs to the *stigma* group of Allen (1969). Using Allen's key, *usingeri* runs through couplet 9 to couplet 12 due to the indistinct fascial markings on the corium. An examination of the types of the species treated in this section of the key demonstrates that *usingeri* is not conspecific. In addition, it is not sympatric with any of these six species.

If some specimens of *usingeri* prove to be more distinct in the fascial markings of the corium, they will key to *pallidivenosus* as does *L. nigropearlei*. *Leptoglossus usingeri* is easily separated from *nigropearlei* by its darker coloration, acute humeral angles of the male, and distinct longitudinal black ocellar bands on the head; and from *pallidivenosus* by the contrasting light and dark areas on the pronotum, the shallow scalloping of the hindtibia, and the genital capsule with a median notch shallower than wide.

Both *L. nigropearlei* and *L. usingeri* can be easily separated from *L. jacquelineae* Brailovsky since the latter species has the pronotal disc with

two large diffuse spots, the anterior lateral margin of the pronotum entire, and the outer dilation of the hindtibia extending to only 55% of the tibial length and being deeply scalloped.

Etymology.—The species name is selected in honor and memory of the distinguished hemipterist, Dr. Robert L. Usinger, one of the collectors of the type-series.

ACKNOWLEDGMENTS

Thanks are extended to Dennis D. Kopp, Nancy D. Epsky, and Thaddeus T. Yonke for the illustrations that they prepared. I express my appreciation to the American Philosophical Society (Penrose Fund, Grant no. 5447) and the Graduate School Research Council (NSF Grant no. 1365) University of Missouri—Columbia for their support of trips to various museums in the United States and Europe.

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A NEW SPECIES OF *ENDAPHIS* (DIPTERA: CECIDOMYIIDAE)
ENDOPARASITIC IN APHIDS IN BRITISH COLUMBIA

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Abstract.—*Endaphis gregaria*, new species, is described, illustrated, and compared to its nearest relatives. Its larvae are gregarious endoparasites of aphids on red alder in British Columbia. Although endoparasitic cecidomyiids are widely distributed, *E. gregaria* is the first species recorded from North America.

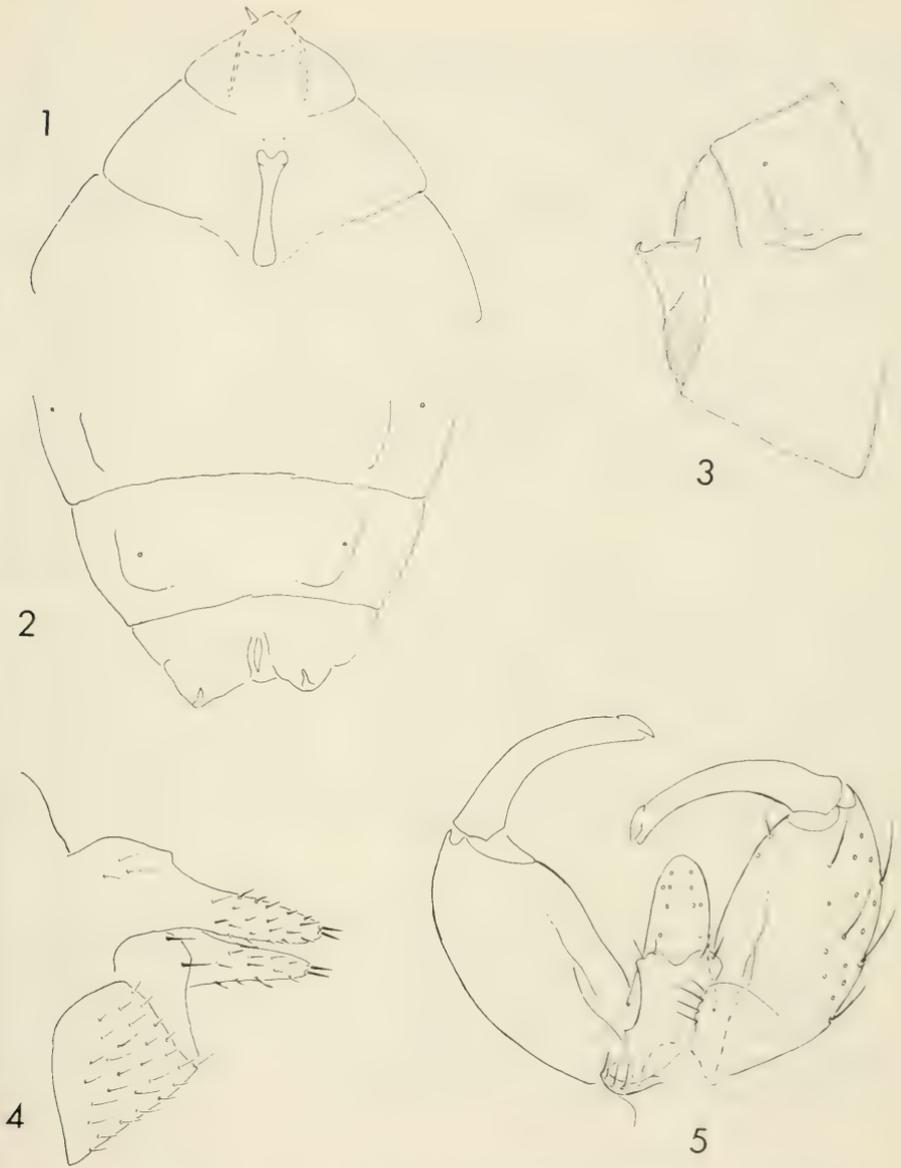
A new species of *Endaphis* is described to provide a name for the first endoparasitic cecidomyiid of aphids recorded from North America. Mackauer and Foottit (1979) reported on the bionomics of this species (as *Endaphis* sp.) on *Euceraphis gillettei* (Davidson) (Homoptera: Aphididae) on red alder, *Alnus rubra* Bong., in British Columbia.

The genus *Endaphis* is otherwise known from one European species, *Endaphis perfida* Kieffer, but the genus is similar in many respects to *Endopsylla*, *Pseudendaphis*, and *Occuloxenium*, which together include five species that are endoparasitic in aphids, tingids, or psyllids in Europe, Ghana, and Trinidad. *Endaphis* species are separated from those of the other three genera by the bifilar flagellomeres of the male antennae and the more simplified larvae with diminutive spiracles, reduced papillae, and cone-shaped caudal extensions. Mackauer and Foottit (1979) summarized the scant biological information available on the related species.

I am grateful to M. Mackauer, Simon Fraser University, Burnaby, B.C., for submitting the specimens to me for description and to K. M. Harris, Commonwealth Institute of Entomology, London, for reviewing the manuscript.

Endaphis gregaria Gagné, NEW SPECIES

Adult.—Eyes 7-8 facets long across vertex; eye facets circular, slightly less close together on lateral parts of eyes than elsewhere. Occipital peak very short, but the 2 associated large setal bases evident. Flagellomeres of



Figs. 1-5. *Endaphis gragaria*. 1-3, Larva. 1, Anterior segments (ventral view). 2, Posterior segments (dorsal). 3, Same (lateral). 4, Female posterior segments (ventrolateral). 5, Male terminalia (dorsal).

♂ antenna binodal, bifilar; circumfilar loops short, not reaching base of next distal node. Flagellomeres of ♀ antenna with neck about $\frac{1}{3}$ length node. Palpus 4-segmented. Wing length: ♂, 1.4 mm; ♀, 1.5 mm. Anepimeron bare; anepisternum with 7–8 setae; mesoscutum uniformly covered with scales, setae of dorsocentral rows sparse, in single file. Claws simple, sharply curved beyond midlength, as long as empodia. Abdominal terga short, about as long as distance between them; sterna about $2\frac{1}{2}\times$ as wide as long; male terminalia as in Fig. 5; female terminalia as in Fig. 4.

Larva (Figs. 1–3).—Head wide with long caudolateral apodemes and long, pointed antenna. Spatula clove-shaped. Papillae evident (at $600\times$) only on venter of thorax. Integument smooth except for spinules covering venter of terminal segment. Anus dorsal. Terminal segment with 2 short, cone-shaped, caudal extensions, each with dorsally recurved point.

Types.—Holotype ♂, reared from *Euceraphis gillettei* on *Alnus rubra*, Burnaby, British Columbia, 27 July 1973, M. Mackauer, in U.S. National Museum, Washington, D.C. Paratypes, 2 ♂, 3 ♀, 3 larvae, same essential data as holotype; 4 larvae, from same host, Shannon Falls, B.C., 26 August, 1973; 1 ♂ and 1 ♀ paratype will be deposited in the Canadian National Collection, Ottawa, the remainder in the U.S. National Museum.

Discussion.—*Endaphis gregaria* differs from the European *E. perfida* in the shape of the terminalia which, in *gregaria*, have a divided sternum 10 and a much larger aedeagus than that drawn in Harris (1966) for *perfida*. The larva of *gregaria* differs from that of *perfida* as shown in Mamaev and Krivosheina (1965) in that abdominal papillae are not apparent in *gregaria*. The specific name, *gregaria*, was chosen because several larvae may occur within the hemocoel of an individual aphid.

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A BIBLIOGRAPHY OF THE MALAISE TRAP

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Abstract.—The flight trap designed by Malaise in 1937 was slow to attract attention but it has now become a major tool in general collecting and surveillance of insects. Its principles of operation are discussed, with mention of a few similar devices. All published notes that have come to the author's attention are listed chronologically.

The Swedish entomologist René Malaise published in 1937 the description of a new kind of trap that had performed well in general collecting for several years. It was many years before other entomologists began to use this kind of trap, but all who did became enthusiastic about its general efficiency in capturing all kinds of flying insects at all times of the day, even night-flying insects that are not attracted to light. Modifications in the design have been made, and the trap has been adapted to the use of carbon dioxide gas as an attractant. It is now considered to be one of the major advances in collecting methods in this century.

The Malaise trap is essentially an interceptive device in which screens of non-opaque fine-meshed fabric netting serve as baffles to impede the flight of insects. The tendency of flying insects to go over or around objects in their path is then used to direct them upward into a closed chamber. The chamber is generally a killing bottle, but may contain a killing and preserving fluid. The original Malaise design and those now in use do not include an attractant, but modifications for use of a lure, notably carbon dioxide gas, have been made.

A few citations to devices that are not strictly Malaise traps have also been included. The window box trap designed by C. F. Hodge and described by Bishopp (1916) operates on much the same principle as the Malaise trap. The traps designed by Burgess (1935) consist of opaque baffles and use an attractant to lure insects into an open-sided 'lean-to.' A bright area near the top of the structure is provided with a glass jar into which the insects are attracted when they attempt to escape upwards from the semi-enclosure.

The interceptive trap described by Leech (1955) is very similar to the Malaise trap but does not include a killing chamber; the operator must collect the intercepted insects by other means. The traps based upon the eeltrap principle, called a Reuse in German, are not included here, although the killing chamber used with the Malaise trap is often constructed on this principle, that of a funnel set in the mouth of a jar. The McPhail trap (Steyskal, 1977) and many emergence traps and cone traps set over a lure also use this principle.

Malaise's design was apparently independent of any previous design. He says, "During my extensive travels I have repeatedly found that insects happened to enter my tent, and that they always accumulated at the ceiling-corners in vain attempts to escape at that place without paying any attention to the open tent-door. On one occasion one of the upper tent-corners happened to have a small hole torn in the fabric, and through this hole all the insects pressed their way and escaped. Later on the idea occurred to me, that, if insects could enter a tent and not find their way out, and always persistently tried to reach the ceiling, a trap, made as invisible as possible and put up at a place where insects are wont to patrol back and forth, might catch them better than any tent and perhaps better than a man with a net, as a trap could catch all the time, by night as well as by day . . ." Thus, the whole idea was original.

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**REDESCRIPTION AND LECTOTYPE DESIGNATION OF THE
TESSELLATED SCALE, *EUCALYMNATUS TESSELLATUS*
(SIGNORET) (HOMOPTERA: COCCIDAE)¹**

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Abstract.—A lectotype is designated for the tessellated scale, *Eucalymnatus tessellatus* (Signoret). The three immature instars and the adult female are described and illustrated, and a key for the separation of all instars is presented.

The tessellated scale, *Eucalymnatus tessellatus* (Signoret, 1873), is primarily a leaf-infesting soft scale and a greenhouse pest. In Florida, infestations of the tessellated scale are often of economic importance in commercial nurseries whenever pest management practices are neglected (Dekle, 1973). It occurs most commonly on palms but has been found on a wide range of host plants (Riddick, 1955). Borchsenius (1957) suggested that *E. tessellatus* probably originated in South America and was disseminated by man to all parts of the world on its cultivated hosts.

Much confusion has resulted from attempts to identify immature or young adult female specimens of *E. tessellatus*. The immature stages were previously undescribed and easily confused with members of the genus *Coccus*. Some authors (Kirkaldy, 1902; Steinweden, 1929) went so far as to include the tessellated scale in the genus *Coccus* because of the similarity of the younger stages.

Because of its economic importance and uncertain relationship with the genus *Coccus*, a morphological study of *E. tessellatus* was initiated. Here presented are a redescription and illustration of the adult female and descriptions and illustrations of three immature instars of *E. tessellatus*. Males are unknown.

¹ Part of a thesis submitted by the first author to the Graduate School of Auburn University in partial fulfillment of the M.S. degree requirements.

Terminology employed in the descriptions is mainly after Williams and Kosztarab (1972). Measurements (based on ten specimens) are given in microns and presented in the text as an average followed by the range in parentheses. In the material studied, detailed collection data are given for the type-series of the species. Additional records include only the locality, host plant, and depository of the material studied. The study is based on material from the National Museum of Natural History Coccoidea Collection, Beltsville, Maryland (USNM), the Auburn University Coccoidea Collection, Auburn University, Alabama (AU), and Naturhistorisches Museum, Vienna, Austria (NMVA).

Eucalymnatus tessellatus (Signoret)

Lecanium tessellatum Signoret, 1873: 401; Douglas, 1886: 77; 1887: 25; Cockerell, 1893: 51; 1894a: 19; 1894b: 73; 1894c: 312; Newstead, 1894: 234; Cockerell and Parrott, 1899: 229; King, 1899: 254; 1901: 312; Green, 1904a: 205; 1907: 197.

Lecanium perforatum Newstead, 1894: 233; 1897: 75; Cockerell, 1895: 257; King, 1901: 312; Thro, 1903: 212; Tullgreen, 1906: 91; Green, 1907: 197; Costa Lima, 1923: 35.

Lecanium tessellatum var. *swainsonae* Cockerell, 1897a: 109; 1897b: 90; Cockerell and Parrott, 1899: 229.

Lecanium tessellatum var. *perforatum* Cockerell, 1897b: 90; Quaintance, 1897: 91; Cockerell and Parrott, 1899: 229; Green, 1904a: 207.

Lecanium (Eucalymnatus) tessellatum Signoret, Cockerell and Parrott, 1901: 57; Green, 1904b: 206; Newstead, 1917: 130.

Eucalymnatus tessellatus (Signoret), Cockerell, 1902: 452; Fernald, 1903: 166; Sanders, 1909: 435; Dietz and Morrison, 1916: 243; Bodkin, 1917: 108; Lawson, 1917: 186; Costa Lima, 1923: 35; Hall, 1923: 55; Hollinger, 1923: 41; Merrill and Chaffin, 1923: 260; Trimble, 1925: 6; 1928: 44; Balou, 1926: 23; Essig, 1926: 300; 1958: 300; Leonard, 1926: 196; Takahashi, 1928: 343; 1929: 56; 1939: 262; Lizer y Trelles, 1937: 352; Lindinger, 1935: 138; 1943: 147; Mamet, 1943: 152; 1949: 26; 1952: 171; Wolcott, 1948: 170; Zimmerman, 1948: 318; Borchsenius, 1950: 146; 1957: 306; Ebeling, 1950: 679; Schmutterer, 1952: 551; Bodenheimer, 1953: 94; Merrill, 1953: 94; Riddick, 1955: 3; Simmonds, 1957: 8; Metcalf, Flint, and Metcalf, 1962: 869; De Lotto, 1965: 193; Beardsley, 1966: 487; Ezzat and Hussein, 1967: 397; Avidov and Harpaz, 1969: 164; Nur, 1971: 305; Dekle, 1973: 1; 1974: 1; Koteja, 1974: 249; Kozarzhenskaya and Reitzel, 1975: 5; Gill, Nakahara, and Williams, 1977: 11.

Coccus tessellatum (Signoret), Kirkaldy, 1902: 106; Steinweden, 1929: 202.

Lecanium subtessellatum Green, 1904a: 206; 1907: 197; Costa Lima, 1923: 35.

Eucalymnatus perforatus (Newstead), Fernald, 1903: 166; Essig, 1913: 113; Bodkin, 1917: 108.

Eucalymnatus tessellatus swainsonae (Cockerell), Fernald, 1903: 167; Costa Lima, 1923: 35.

Lecanium (Eucalymnatus) perforatum Newstead, Pettit and McDaniel, 1920: 18.

Lecanium tessellatum obsoletum Green, 1922: 1024.

Lecanium tessellatum obsoletum Green, Ramakrishna Aiyar, 1926: 454.

Lecanium tessellatum Signoret, Ramakrishna Aiyar, 1926: 454.

Eucalymnatus tessellatus (Signoret), Balachowsky, 1927: 185; 1938: 257.

Type material.—Through the courtesy of Dr. A. Kaltenback of the Naturhistorisches Museum, Vienna, Austria, the authors have received for study dry material of three fully-grown adult females and several immature soft scale insects labelled “*tessellatum*, det. Signoret. auf *Caryota ursus*. Im Pflanzenhause gefunden.” The collection data of this material (cf. “Cette espèce nous a été communiquée par M. le professeur Planchon, de Montpellier, qui l’a récoltée dans les serres, sur le *Caryota ursus*” in the original description of *Lecanium tessellatum* Signoret, 1873: 401); the inscription “det. Signoret,” as well as the fact that Signoret described only one species of scale insect with the specific name *tessellatum*, indicate that these specimens are syntypes of *Lecanium tessellatum* Signoret, 1873.

We have selected an adult female (slide number AL-13-77c) from a series of five slides prepared from this dry material of Signoret’s and here designate it as LECTOTYPE. The four specimens on the remaining four slides are designated as paralectotypes. Stages of the paralectotypes are: adult female (1); first-instar (2); and second-instar female (1). The lectotype and three paralectotype slides have been deposited in the Naturhistorisches Museum, Vienna, Austria. One paralectotype slide has been deposited in the National Museum of Natural History Coccoidea Collection, Beltsville, Maryland.

KEY TO THE STAGES OF *EUCALYMNATUS TESSELLATUS*

- 1. Anal plates with 1 apical seta about 1/2 length of body; submarginal tubercles absent first-instar (Fig. 2)
- Anal plates with apical setae less than length of anal plates; submarginal tubercles present 2
- 2. Anal ring with 6 anal ring hairs; 1 submarginal tubercle on each side of body between spiracular furrows second-instar female (Fig. 3)
- Anal ring with 8 anal ring hairs; 4 to 11 submarginal tubercles scattered over entire margin 3
- 3. Large discoidal pores present anterior to anal plates; numerous dorsal setae present; ventral multilocular pores present in vulvar area adult female (Fig. 1)

- Large discoidal pores absent anterior to anal plates; dorsal setae absent; ventral anal multilocular pores absent
 third-instar female (Fig. 4)

ADULT FEMALE

Fig. 1

Material studied.—Lectotype (NMVA), 1 paralectotype (USNM), 25 (AU), 4 (USNM): *Caryota urens*, Caracas, Venezuela; *Cocos nucifera*, Hilo, Hawaii; *Ficus aurea*, St. Petersburg, Florida; *Jasminum* sp., Ancon, Canal Zone; *Persea* sp., Lake Placid, Florida; *Sabal* sp., New Orleans, Louisiana; Everglades National Park, Florida; *Zingiber* sp., Cypress Gardens, Florida.

General appearance.—At maturity, derm heavily sclerotized and divided into platelike regions. Color dark brown to nearly black. Body shape ovoid to deltoid, slightly convex. Body (Fig. 1A) usually widest posteriorly. Slide mounted specimens 1691–3589 long, 922–3044 wide.

Dorsal surface.—Derm divided into platelike areas, sclerotized, with small clear areas occurring over entire dorsum, but most numerous marginally. Large irregular patterns in derm in 2 submedian rows posteriorly. Marginal setae (Fig. 1B) 17 (12–21) long, blunt to slightly fringed, usually bent posteriorly, distributed as follows: 37 to 57 between anterior spiracular setae, 11 to 18 on each side between anterior and posterior spiracular setae, 79 to 98 on posterior of body. Body setae (Fig. 1C) 8 (7–10) long, thick throughout length, usually bent, blunt apices, usually in or near clear areas between plates of derm, numerous. Three spiracular setae (Fig. 1D) in each spiracular furrow; median seta 49 (41–58) long, 6 (4–12) wide, thick throughout length, lateral setae 19 (12–26) long, 5 (4–9) wide, all setae with acute to rounded apices. Submarginal tubercles (Fig. 1E) cylindrical with inner filament, 8 to 11 present submarginally around entire body, 10 (7–11) in diameter. Bilocular pores (Fig. 1F) 1.4 (1.0–2.0) in diameter in clear areas in derm, numerous. Simple disc pores (Fig. 1G) 1.4 (1.0–2.0) in diameter scattered over dorsum, much less numerous than bilocular pores. Five to 10 larger disc pores 2.9 (2.4–3.7) in diameter anterior to anal plates. No ducts detected. Eyes submarginal on dorsum just above level of antennal scape.

Anal plates (Fig. 1H₁, 1H₂): Each plate triangular with acute angles; 165 (147–176) long, 75 (65–87) wide; cephalolateral margin 111 (99–124) long, caudolateral margin 113 (100–139) long. Each plate with 4 apical setae and 3 to 5 subapical setae. Anal fold with 2 pairs of fringe setae, lateral pair longer. Anal ring (Fig. 1I) notched laterally, 35 (27–43) long, 58 (49–65) wide; with 8 hairs and 2 irregular rows of pores.

Ventral surface.—Derm membranous. Ventral submarginal setae (Fig. 1J)

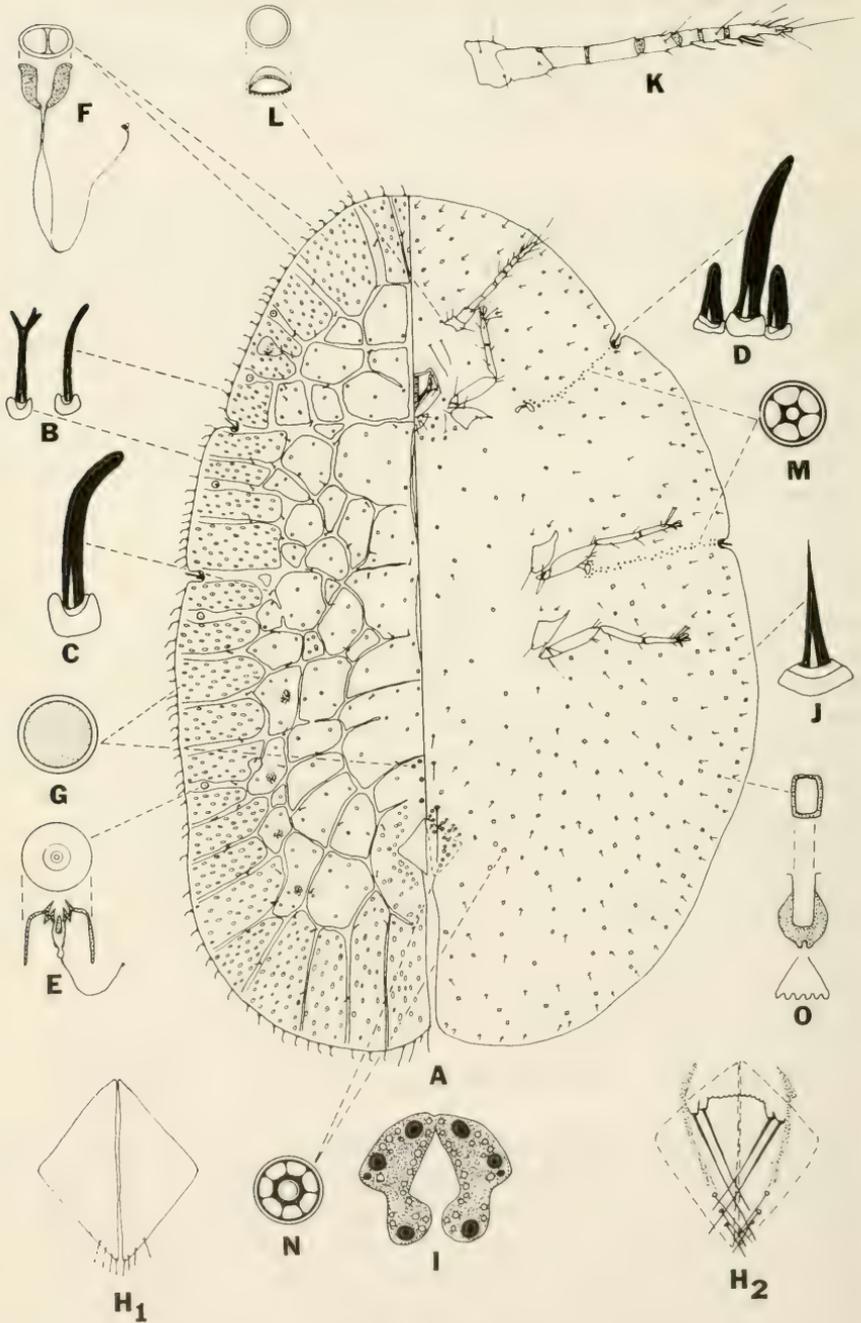


Fig. 1. *Eucalymnatus tessellatus*, adult female. See text for explanation of A-O.

7 (5–9) long, bristlelike, scattered around entire submargin. Body setae 7 (5–7) long, similar to submarginal setae, scattered over venter; 2 pairs of bristlelike interantennal setae, median pair longer; 1 to 3 setae near base of each coxa. One pair of large prevulvar setae; 2 smaller pairs of prevulvar setae anterior to large pair. Antennae (Fig. 1K) well developed, 7- or 8-segmented; total length 322 (258–363). Legs well developed, 494 (430–564) long, with tibiotarsal sclerotization and free articulation; claws without denticle; 2 knobbed claw digitules; 2 slender, knobbed tarsal digitules, extending past apex of claw. Spiracular furrows with pore band 1 or 2 pores wide; each anterior pore band with 20 to 30 pores; each posterior pore band with 25 to 42 pores. Simple conical pore (Fig. 1L) anterior to each antennal scape. Quinquelocular pores (Fig. 1M) in spiracular furrows and a few in anal area. Multilocular pores (Fig. 1N) with 6 to 10 loculi in vulvar area and a few in spiracular furrows. Microducts (Fig. 1O) scattered over entire venter. Tubular ducts not detected.

FIRST-INSTAR

Fig. 2

Material studied.—2 paralectotypes, 27 (AU), 6 (USNM): *Caryota urens*, Caracas, Venezuela; *Ficus aurea*, St. Petersburg, Florida; *Jasminum* sp., Ancon, Canal Zone; *Zingiber* sp., Cypress Gardens, Florida.

General appearance.—Body (Fig. 2A) flat, elongate-oval, reddish brown, widest in middle area of body. Slide mounted specimens 353–402 long, 204–241 wide.

Dorsal surface.—Derm membranous. Marginal setae (Fig. 2B) 15 (12–17) long, pointed, usually bent posteriorly, distributed as follows: 12 between anterior spiracular setae, 2 on each side between anterior and posterior spiracular setae, 16 on posterior of body. No body setae detected. Three spiracular setae (Fig. 2C) in each spiracular furrow: median seta 12 (10–14) long, thick throughout length, lateral setae 4 (4–5) long, all setae with acute to blunt apices. Submarginal tubercles absent. Bilocular pores (Fig. 2D) in 6 longitudinal rows. Apex of head with 2 (membranous) trilocular pores (Fig. 2E). Simple disc pores (Fig. 2F) in 2 submarginal rows and 1 near each trilocular pore. No ducts detected. Eyes present on margin just above level of antennal scape.

Anal plates (Fig. 2G): Each plate elongate-triangular with rounded angles; 50 (47–56) long, 22 (15–25) wide; cephalolateral margin 30 (26–35) long, caudolateral margin 32 (27–36) long. Each plate with 4 apical setae, 3 on apex of plate, 1 in small notch on median edge of plate; median seta on apex 144 (114–161) long. Each plate with 1 subapical seta. Anal fold with 1 pair of fringe setae. Anal ring (Fig. 2H) quadrate with large lateral notch, 6 hairs and 2 rows of pores.

Ventral surface.—Ventral submarginal setae (Fig. 2I) in a row of 7 setae

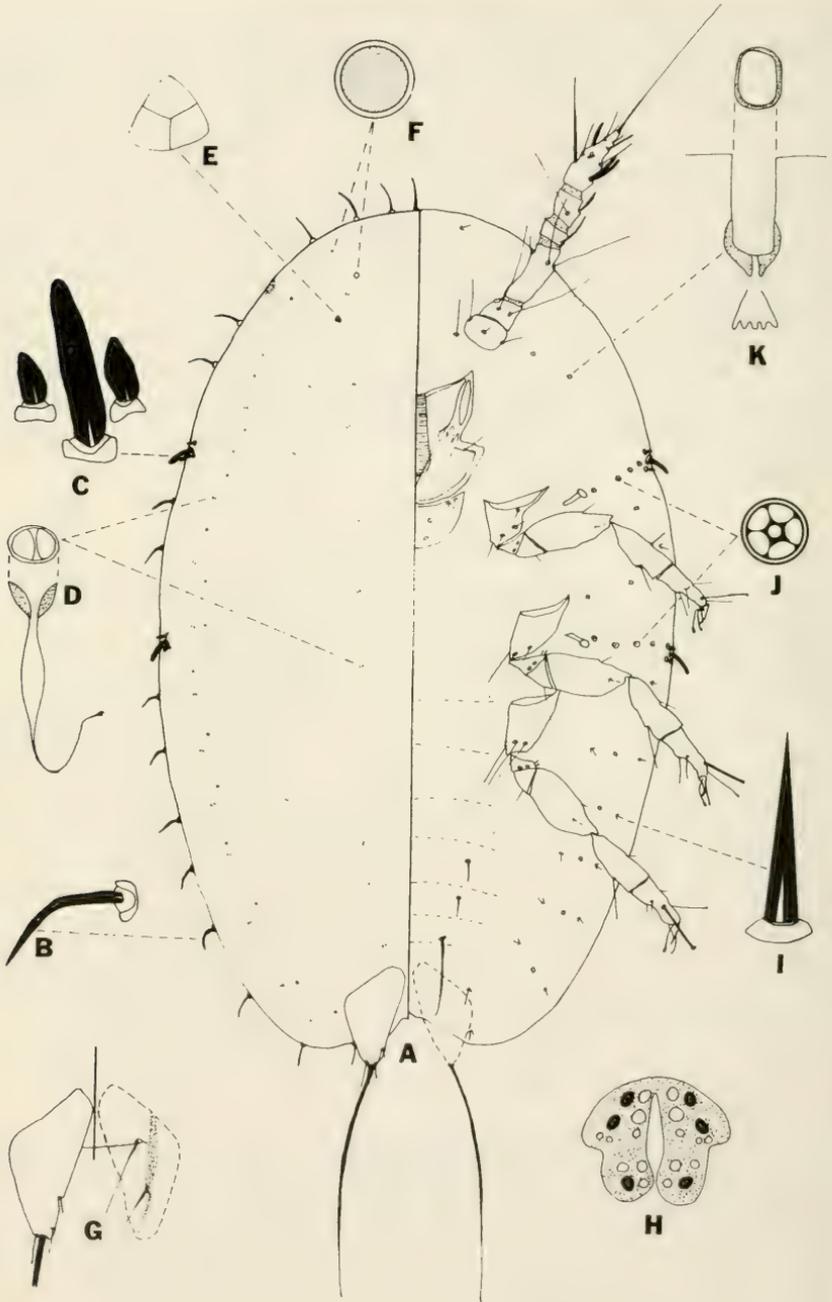


Fig. 2. *Eucalymnatus tessellatus*, first-instar. See text for explanation of A-K.

on each side of abdomen, 1 between spiracular furrows on each side of body, and 1 pair at apex of head; short, bristlelike. Body setae similar to submarginals, in a submedian row on each side of abdomen. Two or 3 large interantennal setae. Three pairs of large, posterior, submedian setae, posterior pair longest. Antennae well developed, 6-segmented, 108 (103–114) long. Legs well developed, 157 (137–172) long, without tibiotarsal sclerotization or free articulation; claws without denticle; 2 knobbed claw digitules; 2 slender, knobbed tarsal digitules, except prothoracic tarsi with 1 digitule setiform. Spiracular furrows with quinquelocular pores (Fig. 2J); each anterior pore band with 3 or 4 pores; each posterior pore band with 4 pores. Multilocular pores with 6 to 9 loculi occasionally in spiracular furrows. Microducts (Fig. 2K) between submarginal and body setae on abdomen, 2 to 4 between spiracular furrows, and 2 lateral to each antennal scape. Tubular ducts not detected.

SECOND-INSTAR FEMALE

Fig. 3

Material studied.—1 paralectotype, 10 (AU), 4 (USNM): *Ficus aurea*, St. Petersburg, Florida; *Jasminum* sp., Ancon, Canal Zone; *Sabal* sp., New Orleans, Louisiana; *Zingiber* sp., Cypress Gardens, Florida.

General appearance.—Body (Fig. 3A) flat, oval, adhering so closely to the leaf surface as to be nearly transparent, light golden in color. Slide mounted specimens 773–1200 long, 426–742 wide.

Dorsal surface.—Derm membranous. Marginal setae (Fig. 3B) 16 (15–16) long, blunt to slightly fringed, usually bent posteriorly, distributed as follows: 16 to 20 between anterior spiracular setae, 3 to 5 on each side between anterior and posterior spiracular setae, 28 to 33 on posterior of body; a few near anal cleft much longer and hairlike, 28 (16–37) long. No body setae detected. Three spiracular setae (Fig. 3C) in each spiracular furrow; median seta 18 (16–27) long, thick, straight, with slightly rounded apex; lateral setae 10 (9–12) long with rounded to acute apices. Submarginal tubercles (Fig. 3D) cylindrical with inner filament, usually 2, 1 on each side of body between spiracular furrows. Bilocular pores (Fig. 3E) with inner filament and simple disc pores (Fig. 3F) scattered over dorsum. No ducts detected. Eyes submarginal on dorsum just above level of antennal scape.

Anal plates (Fig. 3G₁, 3G₂): Each plate triangular with lateral angles pointed; cephalolateral and caudolateral margins slightly concave, often notched on median margin; 72 (65–74) long, 34 (28–40) wide; cephalolateral margin 50 (43–53) long, caudolateral margin 50 (40–53) long. Each plate with 4 apical setae and 1 subapical seta. Anal fold with 2 pairs of fringe setae, lateral pair longer. Anal ring (Fig. 3H) laterally notched, with 6 hairs and 2 rows of pores.

Ventral surface.—Ventral submarginal setae (Fig. 3I) bristlelike, in 2 lon-

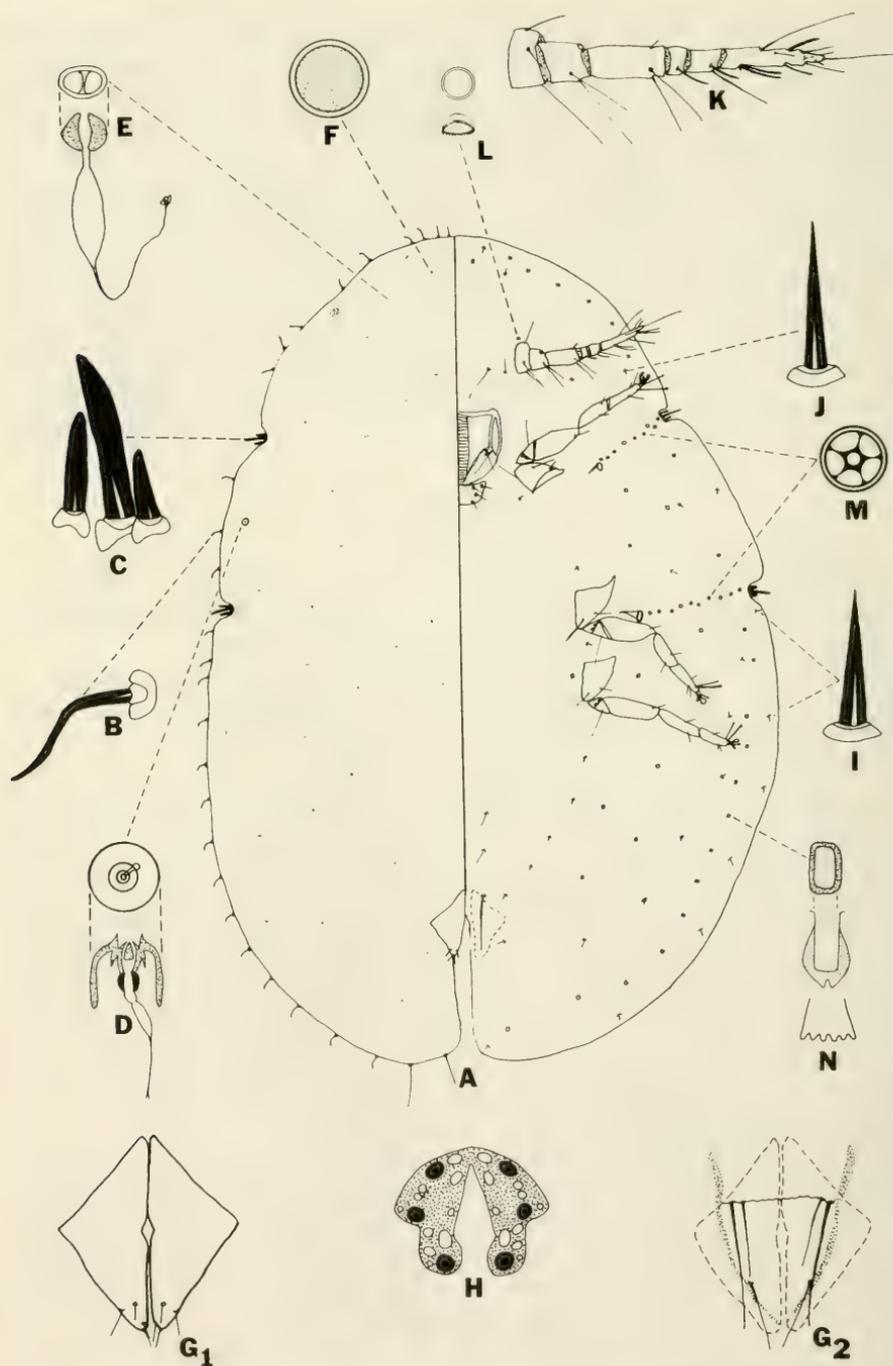


Fig. 3. *Eucalymnatus tessellatus*, second-instar female. See text for explanation of A-N.

itudinal rows on abdomen, each row with 7 setae, 1 to 3 between spiracular furrows. Body setae (Fig. 3J) in 4 rows on abdomen and 1 seta near each coxa, shorter than submarginals, bristlelike; 2 pairs of bristlelike interantennal setae, median pair longer. Three pairs of posterior, submedian setae, posterior pair longest. Antennae (Fig. 3K) well developed, 6-segmented, 146 (136–158) long. Legs well developed, 211 (198–248) long, without tibiotarsal sclerotization or free articulation; claw without denticle; 2 knobbed claw digitules; 2 slender, knobbed tarsal digitules. Spiracular furrows with pore bands 1 or 2 pores wide; each anterior pore band with 7 to 10 pores; each posterior pore band with 8 to 12 pores. Simple conical pore (Fig. 3L) anterior to each antennal scape. Quinquelocular pores (Fig. 3M) in spiracular furrows. Multilocular pores with 6 to 9 loculi occasionally in spiracular furrows. Microducts (Fig. 3N) scattered over venter and in submarginal row around body. Tubular ducts not detected.

THIRD-INSTAR FEMALE

Fig. 4

Material studied.—20 (AU), 5 (USNM); *Caryota urens*, Caracas, Venezuela; *Jasminum* sp., Ancon, Canal Zone; *Sabal* sp., New Orleans, Louisiana; Mobile, Alabama.

General appearance.—Body (Fig. 4A) asymmetrical, flat, ovate, adhering so closely to the leaf surface as to be nearly transparent, light golden in color. Slide mounted specimens 1299–2166 long, 804–1361 wide.

Dorsal surface.—Derm membranous. Marginal setae (Fig. 4B) 15 (12–18) long, pointed, bifid, or slightly fimbriate, usually bent posteriorly, distributed as follows: 30 to 35 between anterior spiracular setae, 7 to 11 on each side between anterior and posterior spiracular setae, 49 to 68 on posterior of body; a few near anal cleft much longer and hairlike, 28 (25–37) long. No body setae detected. Three spiracular setae (Fig. 4C) in each spiracular furrow; median seta 26 (19–31) long, thick throughout length, acute apex, often somewhat hooked in appearance; lateral setae 13 (6–16) long with rounded apices. Submarginal tubercles (Fig. 4D) cylindrical with inner filament, 4 to 7 around entire body. Bilocular pores (Fig. 4E) with inner filament and simple disc pores (Fig. 4F) scattered over dorsum. No ducts detected. Eyes submarginal on dorsum just above level of antennal scape.

Anal plates (Fig. 4G₁, 4G₂): Each plate triangular with lateral angles pointed; cephalolateral and caudolateral margins slightly concave; 110 (99–114) long, 52 (43–61) wide; cephalolateral margin 73 (62–93) long, caudolateral margin 78 (74–80) long. Each plate with 4 apical setae and 2 subapical setae. Anal fold with 2 pairs of fringe setae, lateral pair longer. Anal ring (Fig. 4H) laterally notched, with 8 hairs and 2 rows of pores.

Ventral surface.—Ventral submarginal setae (Fig. 4I) bristlelike, scattered around entire submargin. Body setae (Fig. 4J) scattered over body and 1 or

2 near each coxa, shorter than submarginals, bristlelike; 2 pairs of bristlelike interantennal setae, median pair longer. Three pairs of posterior, submedian setae, posterior pair longest. Antennae (Fig. 4K) well developed, 7-segmented, 218 (186–260) long. Legs well developed, 311 (275–343) long, without tibiotarsal sclerotization or free articulation; claws without denticle; 2 knobbed claw digitules; 2 slender, knobbed tarsal digitules. Spiracular furrows with pore bands 1 or 2 pores wide; each anterior band with 10 to 17 pores; each posterior pore band with 11 to 21 pores. Simple conical pore (Fig. 4L) anterior to base of each antennal scape. Quinquelocular pores (Fig. 4M) in spiracular furrows. Multilocular pores with 6 to 9 loculi occasionally in spiracular furrows. Microducts (Fig. 4N) numerous over venter except for median area between legs. Tubular ducts not detected.

DISCUSSION

Steinweden (1929) and Ferris (*in* Zimmerman, 1948) felt that *Eucalymnatus tessellatus* belongs in the genus *Coccus*, stating that the only character separating *E. tessellatus* from members of the genus *Coccus* is the hardened and tessellated derm. However, compared to *Coccus hesperidum* Linnaeus, the type-species of the genus *Coccus*, *E. tessellatus* exhibits many differences: Lack of dorsal and ventral tubular ducts, blunt to slightly fringed rather than pointed to slightly fringed marginal setae, blunt rather than pointed dorsal body setae, 8- rather than 7-segmented antennae, and a laterally notched rather than ovate anal ring. There are similarities between the two species: Possession of submarginal tubercles, two pairs of fringe setae, and eight anal ring hairs.

A final decision as to the placement of *Eucalymnatus tessellatus* cannot be made until the genus *Coccus* is revised, the immatures of *Coccus* are studied, and other species placed in the genus *Eucalymnatus* are studied.

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**ETHOLOGY OF *EUDIOCTRIA TIBIALIS* BANKS (DIPTERA:
ASILIDAE) IN MARYLAND: SEASONAL DISTRIBUTION,
ABUNDANCE, DIURNAL MOVEMENTS, AND BEHAVIORS**

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Abstract.—The asilid fly, *Eudioctria tibialis* Banks, is a short-lived late spring-early summer species in Maryland. The population of adults emerges in early June, reaching maximum abundance within 10 to 12 days, and decreases in late June-early July, with some flies extending into July. Adults live for about two to three weeks. Males and females exhibit similar daily and seasonal patterns, although the proportions of each sex involved in any activity pattern differs significantly in time and space. Flies usually remain on the forest canopy near clearings, moving into them and out again throughout the day. Flies are initially attracted to clearings by prey aggregations, whereas the rapid increase of males during the afternoon is associated with reproduction. Diurnal movements and subsequent activities are discussed.

Eudioctria was originally proposed as a subgenus of *Dioctria* in the tribe Dioctrinii (Wilcox and Martin, 1941). Recently it was elevated to the generic level and placed in a new tribe Echthodopini (Adisoemarto and Wood, 1975). The genus presently contains 14 species, of which four (*albius* Walker, *brevis* Banks, *tibialis* Banks, and *propinqua* Bromley) occur primarily in the mid- and northeastern Atlantic states and along the Appalachian Mountains. Only *tibialis* and *brevis* have been reported from Maryland (Scarborough, 1974; McAtee and Banks, 1920). Both species are similar in size, color, and genitalia. *Eudioctria tibialis* can be recognized by a bare mesopleuron and largely bare mesonotum, with some pollinosity present posterior to the postpronotum. A morphological description of the species and a key to the genus *Eudioctria* are given by Adisoemarto and Wood (1975). The present study, which will appear in three parts, is the first to report the ethology of a species of the genus *Eudioctria*.

METHODS AND STUDY AREA

This study encompassed 200 days spent in the field from 1 June to 1 August during the summers of 1972 through 1976. General methods and

rationale for their use in this study and a detailed description of the study site and its location were published previously (Scarborough and Norden, 1977; Scarborough 1978a, b).

The study was conducted in several clearings along a 500 m east-west foot path which bisected the forest at the Loch Raven Watershed in Baltimore Co., Maryland. Clearings varied in size (43.0–110 m²) with the largest located at the mid-point of the path's length. Most of the work was conducted in the larger clearing because of its size, location, and proportionally greater number of flies. Observations were usually taken under sunlit conditions from 0900 to 2100 hrs when temperatures varied between 15° and 37°C. Temperatures were taken one meter above ground level in the largest clearing.

Seasonal distribution and abundance was determined by using a mark-recapture technique. During the 1974 season, all flies observed during a 90 minute period between 1330 and 1500 hrs were captured with a hand net or vial and placed within a retaining cage. At the end of the sample period, flies were taken to the largest clearing, marked on their thoraces or wing bases with Testor's PLA enamel and released. Previously marked flies were released without remarking. The following information was recorded: Number and sex of flies, color of enamel on recaptures, and distance of recapture from the release point. The latter two recordings were used to determine approximate life span of flies and dispersion from the release point. Data concerning seasonal distribution were plotted as a mean of two sample days. During the succeeding summers, this technique was used only during the early and late (ca. 15 days) segments of the fly seasons to determine more accurately emergence patterns and maximum length of the season.

Diurnal activities were determined by taking observations during 15 minute periods between 15 and 30 June, 1975 and 1976. Each census consisted of slowly walking through the largest clearing, recording all flies and their activities. Observations of individual activities were taken during the first three years of the study. Multiple marking techniques were used in some instances to examine movement of flies into and out of clearings.

RESULTS AND DISCUSSION

SEASONAL DISTRIBUTION AND ABUNDANCE

Eudioctria tibialis is a short lived, late spring-early summer species in Maryland (Fig. 1). The population emerged rapidly, with individuals becoming abundant shortly after the first fly was observed (Fig. 2). The population persisted at peak densities through late June but decreased rapidly thereafter, with some individuals remaining through early July. Censuses in succeeding years indicated that the population had similar seasonal ranges and abundances although variations occurred, corresponding with unseasonable



Fig. 1. Male *Eudiectria tibialis* perching in a typical foraging position. The wings are infusate, with the blackish tinge limited to the distal half (males) or distributed uniformly on the wing surface (females).

cool or wet periods. The first fly was found after June 15, 1975, following a cool May, and the season was extended until July 30, 1976, following a wet late June (U.S. Climatological Data, 1974, 1975, 1976).

The fly population emerged within the first 10 to 12 days of the fly season (Fig. 2). The number of recaptures was comparatively small during the first eight days of the season. It increased gradually and peaked at the time corresponding to the end of the maximum fly density, and then, decreased rapidly in late June. The low number of marked flies captured early in the season was undoubtedly due to a rapid emergence of the population, diluting the number of marked flies. The number of marked flies captured increased in late June, suggesting the emergence of new flies had decreased.

Some flies were captured 15 or more days after marking, and one on the 20th day (Fig. 3). This indicates that adult flies may live for about two or three weeks. The population on June 28 was at the end of maximum fly density, and by June 30, the population had decreased significantly in total numbers of marked and unmarked flies (Fig. 2). Seventeen days earlier, the

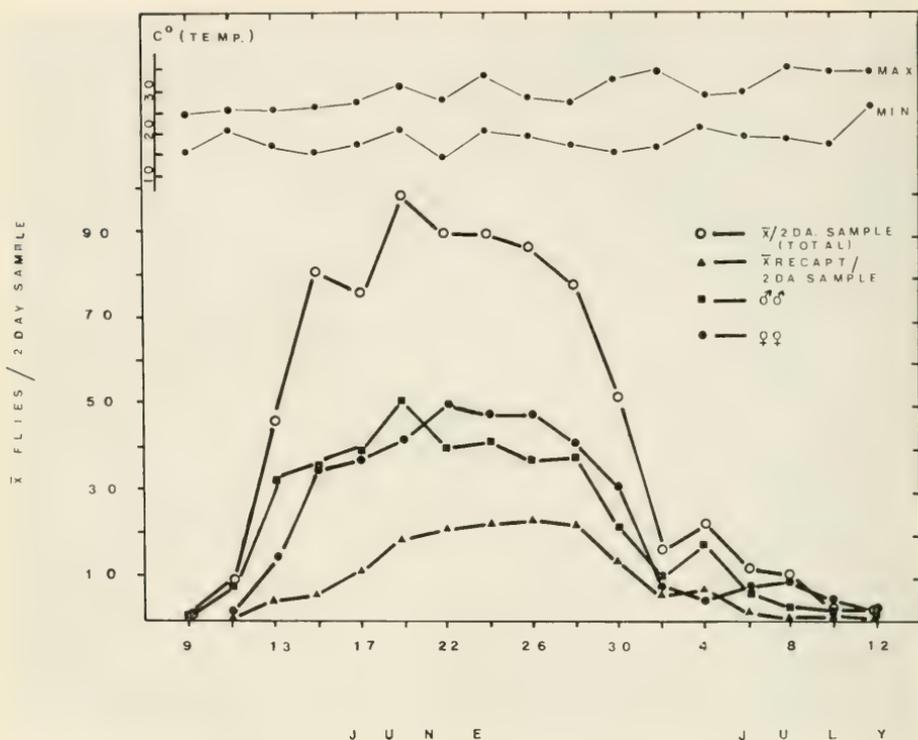


Fig. 2. Seasonal distribution and relative abundance of *Eudiectria tibialis* at the Loch Raven Watershed, Baltimore Co., Maryland, during the 1974 season.

population increase (June 13) was more than five times the previous sample period. The time between the rapid increase and decrease, thus, corresponds closely with an approximate adult life span. The small number of flies that were found in July were probably flies which emerged in late June.

Numbers of males and females per day sampled were variable, but each sex showed similar increases and decreases during the fly season. The proportions, however, of each sex changed as the season progressed ($\chi^2 = 28.58$; $P < .02$). Males were slightly more abundant ($\chi^2 = 2.9$; N.S.) early in the season whereas females were more abundant ($\chi^2 = 4.0$; $P < .05$) in mid- to late June (Fig. 2). The shift in seasonal patterns of sex ratios reported for *E. tibialis* follows that reported for other insects (Hynes, 1976; Alcock et al., 1977; DeLong, 1971; Oliver, 1971) in that males begin to emerge slightly earlier than females, producing a temporary larger proportion of males than females. Conversely, females become abundant in mid- and late phases of the fly season as their emergence extends further into the season and as males are lost through death and dispersion. The selective advantage

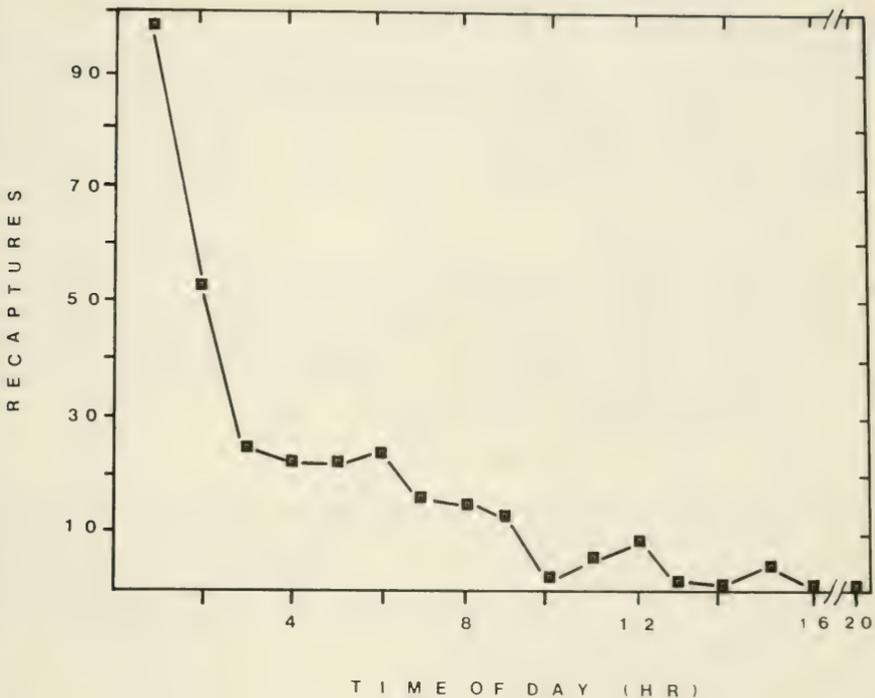


Fig. 3. Number of flies recaptured one or more days following marking and release.

of early emergence lies in the fact that females have a greater opportunity to mate with a greater variety of genetically different males.

Little information exists on seasonal patterns of asilids, although proportions of males and females within populations have been estimated for short periods. For example, sex ratios of *Efferia argyrogaster* (Macquart) (Lavigne, 1979) and *E. frewingi* (Wilcox) (Lavigne et al., 1980) were estimated to be approximately 40:60 and 33.3:66.6% for males and females respectively. The *E. frewingi* population was studied during the late stages of the fly season (28 August–14 September, Laramie, Wyoming), and results reported from that population are similar to the sex ratios found in the final stages of the *E. tibialis* population. The estimate for *E. argyrogaster* was undoubtedly more diagnostic of a small (25 flies), local population rather than a segment of a seasonal pattern characteristic of the fly population.

A total of 1349 flies were marked and released during the 1974 fly season. Of these, 330 were recaptured or observed one or more times at distances less than 100 m from the release point (Table 1). Most flies remained at or revisited the release clearing several days (3–5) before dispersing to other

Table 1. The number of marked flies recaptured and observed at various distances from the release point.

Marked Flies	Distance (m) from Release Point							
	0	10	20	30	40	50	100	200
Captured	261	22	12	15	8	6	—	—
Observed	—	—	—	—	—	—	2	2

clearings. Only four flies were observed beyond 100 m. These flies were found seven and eight days after marking, and following a day when wind-gusts were clocked at 24 mph. Because of their position on the canopy at night and dark periods during the day, they are presumably subjected to indirect dispersion by high winds.

DIURNAL MOVEMENTS

Eudioctria tibialis moved from the forest canopy into sunlit clearings (Fig. 4). The movement into clearings in mid-morning started slowly with the first flies following the front wave of sunlight, and increase with increased sunlit area (Table 2). Flies were most abundant between 1400 and 1800 hrs, but decreased abruptly in late afternoon. Those flies which remained in late afternoon left clearings by flying to the top of the canopy, out of sight. Flies were absent in clearings by 2100 hrs and presumably, remained on the canopy until the following day.

The number of flies censused per hour per day varied considerably, although both sexes showed similar daily increases and decreases (Fig. 4). Both sexes increased in total numbers until mid- to late afternoon when their numbers decreased. The proportion of males and females, however, changed significantly ($\chi^2 = 11.8$; $P < .01$) with time of day. The proportion of females was significantly more abundant from 1000 to 1300 hrs and 1700 to 2000 hrs ($\chi^2 = 40.0, 15.0$ respectively; $P < .01$) whereas males were more abundant from 1400 to 1600 hrs ($\chi^2 = 18.8$; $P < .001$). The change in sex ratios corresponded to times when sexual behaviors were dominant.

Table 2. Comparison of flies perched on sunlit and shaded areas during four 15 minute periods.

Time	No. Samples	Sunlit Space	Perch		χ^2	Significance Level
			Sun	Shaded		
1100-1115	10	40%	36	2	30.2	$P < .001$
1300-1315	12	90%	93	16	54.2	$P < .001$
1600-1615	10	70%	134	47	41.8	$P < .001$
1800-1815	10	20%	53	168	59.8	$P < .001$



Fig. 4. The diurnal movement of *Eudiectria tibialis* into and out of clearings expressed as the number and proportion of flies per hour of the day.

Diurnal movements of flies into an area and out at dusk has been observed for other asilid species (Adamovic, 1963; Lavigne and Holland, 1969; Lavigne, 1970; Musso, 1972; Scarbrough and Norden, 1977; Hesperheide and Rubke, 1977). In contrast, *E. tibialis* may enter clearings or leave them at any time during the active period of the day. Marked flies (N = 352) were observed flying up and over the clearing walls, and out of sight during the middle of the activity period (1200–1600 hrs), only to be found in other clearings or in the same clearing at another census during the same day. Therefore, flies visited clearings one or more times per day. An increase or decrease in fly numbers, then, was influenced by a differential movement of flies into and from clearings.

Eudiectria tibialis perched in brighter areas of clearings (Table 2). These areas were usually in direct sunlight although those in late afternoon (1800–1815 hrs) were in diffused light. When perches became shaded, flies responded by moving to new perches in brighter light. When the sun was



Fig. 5. Number and proportion of flies in clearings involved in three behaviors per hour of the day during June 1975 and 1976. Samples were taken during the first 15-minute period per hour of each 11 hour day on 20 sample days.

blocked by a cloud for 10 to 15 minutes or surrounding trees in late afternoon, flies flew to perches on the vertical wall of clearings or on top of the canopy. On overcast days, about 95% of the flies ($N = 322$, 20 census days, $\chi^2 = 291.5$, $P < .001$) were perched 6 m or more above the ground. Vegetation at the base of clearings was comparatively "dark" at these times. Flies on shaded or dimly lit perches for lengthy periods were frequently mating or feeding, and flew when these activities were completed. In effect, the population responded to shifts in sunlight by moving with it. Similar responses by other asilids have been reported (Musso, 1972; Scarbrough and Norden, 1977; Lavigne, 1970).

Recent studies (Lewis and Taylor, 1964; Linsley, 1972; Dennis and Lavigne, 1975; Scarbrough, 1979; Scarbrough and Sraver, 1979) have shown that some asilids aggregate, exploiting localized concentrations of prey. Published data on insect flight activity (Lewis and Taylor, 1964; Hespeneide, 1975) show that many insects are more often active during the morning,

Table 3. Comparison of the proportion of individuals involved in 3 behaviors between 1000 and 2400 hrs.

Behaviors	D.F.	χ^2	Significance Level
Mating vs. nonmating	10	420.4	$P < .001$
Feeding vs. nonfeeding	10	42.8	$P < .001$
Perching vs. nonperching	10	100.8	$P < .001$

especially after the area becomes sunlit and the temperature rises. Conversely insect activities, and thereby prey densities, are reduced when air temperatures are cold or very hot (Lavigne and Holland, 1969). The importance of temperature in this study is suggested by the absence of *E. tibialis* in clearings before 1000 hrs. Temperature differences between sunlit and shaded areas at this time of day ranged between 8 to 17°C ($\bar{x} = 9.2^\circ\text{C}$, Fig. 4). As clearings became sunlit, the temperature increased rapidly, and insect activity became apparent, e.g. sunning, feeding, flying and mating swarms. Convection currents are produced when the vegetation and ground warms, and prey, especially aphids and similar prey, began flying and are carried by convection into the upper air currents (Dixon, 1973). Thus, it is assumed that *E. tibialis* is initially attracted to clearings by an increase in density of available prey which is temperature related.

DIURNAL BEHAVIOR

In clearings, *Eudiectria tibialis* was involved in three kinds of behavior: feeding, perching, and mating (Fig. 5). Flying was excluded here as a separate behavior since it is preparatory to the others. The number of flies involved in each kind of behavior was significantly correlated ($P < .001$) with the number present. Each kind of behavior was observed after 1100

Table 4. A comparison of behaviors performed by flies in clearings by sex and between sexes per hour of the day during June 1975-76.

Behaviors	D.F.	χ^2		Significance Level
		Female	Male	
Sex				
Feeding vs. nonfeeding	10	70.9	42.9	$P < .001$
Mating vs. nonmating	10	118.0	81.6	$P < .001$
Perching vs. nonperching	10	47.8	65.8	$P < .001$
Between sexes				
Feeding	10		56.1	$P < .001$
Mating	10		0.0	N.S.
Perching	10		239.8	$P < .001$

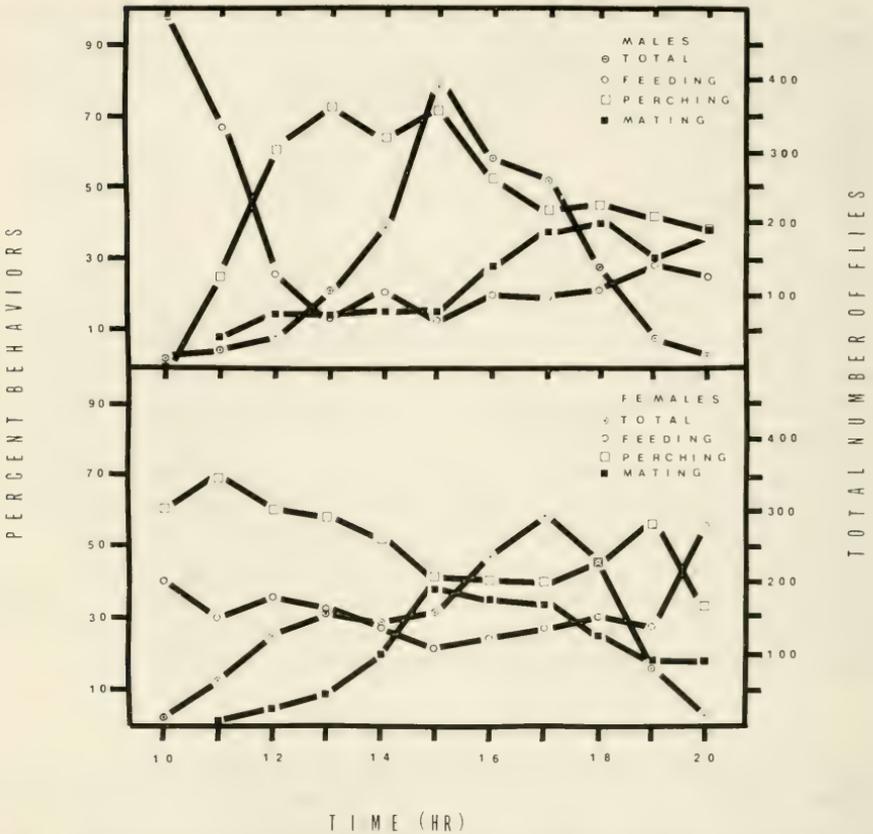


Fig. 6. Number and proportion of flies of each sex in clearings involved in three behaviors per hour of the day during June 1975 and 1976. Data were taken from Fig. 5.

hrs. However, the proportion of flies involved in any one behavior differed significantly with time (Table 3). Feeding was more abundant shortly after flies entered clearings and before dusk but decreased significantly as mating and perching increased. Mating was more common in mid to late afternoons with 70% ($N = 361$) occurring after 1500 hrs ($\chi^2 = 112.0$, $P < .001$). Flies in a perched position were more abundant during the early hours in clearings ($\chi^2 = 19.0$; $P < .001$) than in late afternoon. A decrease in perching was due to a shift in behaviors to feeding and mating, as well as flies leaving clearings. Flies frequently left the area immediately following completion of these behaviors.

A comparison of activities performed by one sex and those between sexes with time also differed significantly (Table 4). These differences were correlated with the time of day when sexes altered one or more behaviors to

accommodate others (Fig. 6). A smaller proportion of males was found with prey than females between 1200 and 1800 hrs. Most males during the early segment of this period were perching, foraging for prey, or searching for females with which to mate. Later (1500 hrs) a greater proportion of males were found mating and fewer perching, indicating a shift in behaviors. Males found with prey did not change significantly during this latter period. In contrast, female activities showed a more gradual transition of behaviors, with both perching and feeding being displaced by mating.

Are activities of flies in clearings reflective of the basic diurnal pattern of the population? Although this study did not deal with flies on top of the canopy, there is no evidence to suggest a significant difference in behavior patterns beyond that of compressing an activity during a shorter period in the day. Feeding and perching undoubtedly started much earlier on the canopy than that reported in clearings. Furthermore, data from this study and those reported for other asilids (Lavigne and Holland, 1969; Musso, 1972; Scarbrough and Norden, 1977) show that movement of flies into an area during the day and out again at some later time is characteristic of the population. Therefore, it is doubtful that many flies remain on the canopy during the greater part of the day, and those which are on the canopy are probably transients, en-route to other clearings. Those behaviors being performed by flies in clearings, therefore, should also be performed by flies on the canopy.

Movement into clearings during the morning initially produced an aggregation of feeding flies in which females were slightly more abundant than males. This imbalance was altered by a switch in behavior of males from foraging-feeding to searching-mating behavior. Thus many males entered clearings in search of females with which to mate, and influenced the rapid rise in male densities in afternoon. Males left clearings when females were no longer available for mating. The selective advantage of flies entering clearings increases the probabilities of exploiting localized prey concentrations (Scarbrough, 1981) when energy demands are greatest (morning and late afternoon) and of male-female contact. Although the behaviors undoubtedly occurred on the canopy, it is doubtful they occur as frequently since flies would be dispersed over a wider area due to minimal opportunities for locating prey concentrations.

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**ETHOLOGY OF *EUDIOCTRIA TIBIALIS* BANKS (DIPTERA:
ASILIDAE) IN MARYLAND: PREY, PREDATOR
BEHAVIOR, AND ENEMIES**

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Abstract.—*Eudioctria tibialis* Banks foraged under bright skies from dimly lit or sunlit perches at temperatures above 16°C. Grooming, prey manipulation, feeding time prey prey, and foraging activities are discussed. Major prey were aphids and lower Diptera, although Isoptera or other insects were taken in large numbers when abundant. Most prey had thin cuticles and were weak fliers. Mean prey size was 3.02 mm. Females selected slightly larger prey than males. A list of prey is given. *Vespula maculata* (L.) may be an important predator of *Eudioctria tibialis* under certain conditions.

At the present time behavioral and ecological information on species of the genus *Eudioctria*, as well as most Asilidae, is limited. Scarbrough (1981) recently reported the seasonal distribution, abundance, and diurnal activities of a population of *Eudioctria tibialis* Banks in Maryland. Some biological information of several European species of *Dioctria* was contributed by Melin (1923) and Poulton (1906). However neither critically examined prey selection, but both concluded that *Dioctria* spp. selected primarily hymenopterous prey. The purpose of this study was to report on predator behavior and prey selection of *E. tibialis* and its enemies.

METHODS

General methods and location of the study site were described previously (Scarbrough, 1981). Data on predator behavior were obtained by censusing individuals at the study site and by following individual flies for extended periods. Hourly observations were made during the fly season to determine maximum variability in behavior patterns of predators and in the selection of prey types. During each census, flies were recorded as feeding or involved in other behaviors. Individual flies were observed in order to obtain information of foraging, feeding and manipulation behaviors. Prey were obtained by capturing feeding flies in a 15 dram snap top plastic vial, with the predator



Fig. 1. Male *Eudiectria tibialis* feeding on an aphid.

being released after the prey was dropped. Prey were later identified and measured from the front of the head to the tip of the abdomen for body length. Predator size was determined by taking similar measurements of 25 predators of each sex.

RESULTS AND DISCUSSION

PREDATOR BEHAVIOR

Eudiectria tibialis foraged under bright skies from dimly lit or sunlit perches at temperatures above 16°C. Asilids perched (N = 5095) horizontally on leaves and twigs of woody and herbaceous plants, overlooking an open space (Fig. 1). Foraging perches were invariably located 50 cm or more above the ground, although their heights varied considerably depending upon time of day and total sunlit area. Most foragers perched along the

vertical walls of the clearing during the early ($N = 832$, 81.0%; 1000–1300 hrs) and late ($N = 1932$, 52.0%; 1700–1900 hrs) observation periods and on the lower floor vegetation at other times ($N = 2331$, 70.0%; 1300–1700 hrs).

Eudioctria tibialis exhibited several behaviors while perching. The fly groomed ($\bar{x} = 9.3$ min, $N = 1092$) its legs, wings, or head. This behavior was correlated with previous activities, e.g. facial and foreleg grooming followed feeding, abdominal and hindleg grooming followed copulation, and wing grooming followed unsuccessful foraging attempts and flights to new perches. Vertical and lateral head movements and body adjustments were also made in response to flying potential prey and other objects. Similar orientation response to flying objects have been described for other asilids (Scarborough, 1978a, 1979; Dennis and Lavigne, 1975; Lavigne and Holland, 1969). Occasional wing flutters and short flights from perches occurred when flying objects moved near the flies. The fly responded to movement of insects or other arthropods, which shared a common perch, with lateral head movements. These were often followed by the fly moving away to another part of the perch or flying to another perch. The asilid was also induced to fly when flying objects came too close to the perch.

A fly may be induced to move to a new perch by other factors. *Eudioctria tibialis* often flew to new perches after a long period of inactivity although other arthropods did not induce the flight and atmospheric or sunlit conditions remained unchanged (Scarborough, 1981). This behavior may be related to insufficient prey density. If this assumption is correct, this behavior had the advantage of exposing greater area and, thereby, increasing the probability of predator-prey contact. Similar observations have been reported for other asilid species (Lavigne and Holland, 1969; Hespeneheide and Kubke, 1977; Scarborough, 1979; Scarborough and Sraver, 1979).

Foraging flights were short ($R = 12$ –150 cm), with most prey captured within 80 cm (92%, $N = 150$) of perches. Absolute distances from perches to interception points of prey varied considerably with larger prey (>3.5 mm) being captured at greater distances than smaller prey, e.g. *Reticulitermes flavipes* (Koller) ($\bar{x} = 4.73$, $N = 63$) were captured within a range of 30 to 150 cm of perches whereas aphids ($\bar{x} = 1.5$ mm, $N = 89$) were captured within a range of 7 to 75 cm.

Flies often failed to capture an intended prey. In only 25.7% of the flights ($N = 2843$) were flies successful in capturing and feeding on prey. In some instances, prey were temporarily captured (5.2%) but were lost or released enroute to perches. Females were more successful (32.3%, $P < .001$) than males (17.3%) but males foraged less ($P < .001$) (Table 1). Perhaps this differential foraging behavior between the sexes is related to greater energy needs to accommodate a larger body and egg production in females (Scarborough, 1978a, b, 1979).

This foraging behavior also differs from that of *Cerotainia albipilosa* Cur-

Table 1. A comparison of foraging activity of male and female *Eudioctria tibialis* Banks per unit time. Data were obtained from observations of males and females during two hour units (N = 10). Data were compared with a 2×4 contingency table (χ^2).

Time	Means (females)		Means (males)	
	Forage	Success	Forage	Success
10-1200	52.6	16.8	40.0	5.6
12-1400	59.6	24.1	25.8	7.6
14-1600	14.1	4.7	28.1	2.5
16-1800	32.4	5.6	32.3	6.1
\bar{x} /fly/day	159.8	51.3	126.1	21.8

ran (Scarborough, 1978a, b, 1979) in that males of the latter species were more successful in capturing prey than females. It was suggested that lengthy courtship displays performed by males in front of non-receptive females disrupted the females' field of vision, and thereby interfered with their foraging behavior, resulting in a decrease in prey capture success. Females spent a significant amount of time discouraging courting males, e.g. threat postures and chasing, between forage flights (Scarborough and Norden, 1977). Males of *E. tibialis* do not utilize courtship displays (Scarborough, 1981), and perhaps the higher prey capture rates of females are related to less male disturbance.

General predator behaviors, e.g. flight patterns, methods of prey capture and immobilization of prey, and site of inserting the hypopharynx into soft and hard bodied prey utilized by *E. tibialis* were similar to those described for other asilid species (Scarborough, 1978b; Scarborough and Sraever, 1979; Scarborough and Sipes, 1973; Dennis et al., 1978). It differed in that only large prey, such as termites, cicadellids, and reproductive ants, were manipulated in flight before returning to perches for feeding. Conversely, smaller prey were impaled upon the hypopharynx immediately upon capture. Flies returned to previous perches or flew to other perches to feed.

While feeding, the fly manipulated prey by "spinning" small prey, e.g. aphids, on its proboscis, using one foretarsus, or removing larger prey from its proboscis, then manipulating it and re-inserted the hypopharynx at a new location, using several tarsi. In the latter, most prey were manipulated with the fore- and hindtarsi while the midlegs and the end of the abdomen formed a "tripod" support of the body. The abdomen was arched down with its tip resting on a substrate.

Mating females usually manipulated prey as previously described, differing only in that their abdomens were arched less and did not rest on a perch. Additional support of the female's body was supplied indirectly by the union with the copulating male. One mating female manipulated a prey with its midtarsi while standing on its fore- and hindtarsi. The fly sometimes fell

upon its pleuron where it manipulated large prey with six tarsi. Other manipulations included inflating the prey's body followed by abdominal pumping of the predator, and adjusting the depth of the hypopharynx in the prey. The latter was accomplished by resting the prey on a perch and forcing the hypopharynx deeper into the prey, or partially withdrawing the hypopharynx and forcing it into the prey again at a different angle. Tarsi were not used in these manipulations.

Feeding upon a prey was completed at a single perch unless the fly was disturbed. Following feeding, prey were usually discarded at perches by using one or both foretarsi or in flight while in pursuit of another prey. In the latter, one or both tarsi were positioned against the prey as the predator flew from the perch. A second or two later, the prey was observed falling through the air within a few cm of the perch. The prey is presumed to be pushed from the predator's mouth parts. The prey was sometimes discarded when the predator adjusted its hypopharynx in the prey's tissue. The predator retracted the hypopharynx and removed the proboscis from the prey while it lay on the perch. Tarsi were not used in this manipulation. Grooming of the head and foretarsi usually followed feeding.

Like most asilid species, the length of time *Eudioctria tibialis* spent feeding on a prey was variable, but correlated with prey size. The average feeding time per prey was 6.3 min (N = 21), ranging between 1 and 37 min. Small prey, e.g. aphids and psyllids, were fed upon for an average of 3.1 min (N = 128, R = 1-10 min) whereas larger prey, e.g. termites, were fed upon for an average of 20.9 min (N = 15, R = 13-37 min).

PREY SELECTION

The numbers, types, and sizes of prey taken by *Eudioctria tibialis* are presented in Table 2. Species of five insect orders formed the major components of the flies' diet, with Homoptera-Hemiptera being the most abundant. The predominant insect prey were aphids, termites, and lower Diptera in order of abundance. At least six other North American asilid species (Hespenheide and Rubke, 1977; Scarbrough and Sraver, 1979) take similar prey with aphids or Homoptera-Hemiptera forming the dominant segments of their diets. The proportion of termites in this sample is not viewed as significant as other prey because of their erratic and temporary appearance in the study area, but it does reflect the adaptability of the species to take advantage of temporary concentrations of prey. Of the prey taken occasionally, species of the orders Araneida (immatures), Thysanoptera, Psocoptera, and Lepidoptera formed less than 4% of the diet. Conversely, European *Dioctria* (Poulton, 1906; Melin, 1923) select predominantly Hymenoptera.

Mean size of all prey was 3.02 mm, ranging from 0.81 to 6.46 mm in body length (Table 2). Specimens of Homoptera-Hemiptera, forming the major

Table 2. Prey of *Eudioctria tibialis* Banks in Maryland. Predator size (N = 25 per sex): ♀ \bar{x} = 9.56 ± 0.54, R 8.5–10.5 mm; ♂ \bar{x} = 8.67 ± 0.57, R 7.0–9.6 mm. Mean size compared by Student's t-test.

Taxa	Total	%	Measured	\bar{x} (mm) ¹ ± S.D.		Range (mm)
Diptera	81	17.5	59	2.49	1.38	1.00–5.10
Coleoptera	43	9.3	33	2.52	0.59	1.34–3.74
Isoptera	93	20.1	89	4.73	1.48	1.48–6.46
Homoptera-Hemiptera	179	38.7	130	1.98	0.93	1.10–5.05
Aphididae	148	32.0	75	1.52	0.50	1.25–2.75
Others	31	6.7	25	3.37	1.53	1.10–5.05
Hymenoptera	51	11.0	42	2.89	1.35	1.36–6.08
Miscellaneous	15	3.2	11	3.14	1.91	0.81–5.40
	462	99.8	364	3.02	1.13	0.81–6.46

¹ Prey means compared by Newman-Keuls multiple range test.

prey items in the flies' diet, were significantly smaller ($P < .001$; Newman-Keuls multiple range test) than other prey. Furthermore, prey in all orders except Isoptera were small, with over 80% less than 4.0 mm in total length. Isoptera were significantly larger ($P < .001$) while Hymenoptera, Coleoptera, and Diptera ($P < .001$) followed in decreasing size order.

Female predators were larger ($P < .001$; Student's t-test) than males and took slightly larger prey (\bar{x} = 3.15 mm ♀♀, N = 176, \bar{x} = 2.72 mm ♂♂, N = 286; $P < .05$) although both sexes took prey in all sizes. Males took proportionally fewer termites (16.2% ♂♂, 23.2% ♀♀) than females. Selectivity of prey is partly based upon predatory-prey size. In the latter, termite swarms occurred when male *E. tibialis* was involved in other behaviors, e.g. searching and mating (Scarborough 1981), and thus the proportion of termites in the male's diet may reflect termite availability rather than size discrimination. Predator-prey ratios were 3.2 and 2.9 for females and males, respectively.

The proportion of prey types in the diet of some asilids change in time and space. This phenomenon is related to differential activity periods of different prey taxa (Hespenheide and Rubke, 1977; Scarborough, 1979; Scarborough and Sraver, 1979; Powell and Stage, 1962). Similar results were apparent in the diet of *E. tibialis* in which swarming termites and ants were captured during short periods of a few days during the study. No significant change ($P \sim .05$) occurred in prey composition among other major taxa, although some species, especially aphids (Dixon, 1973), have a diurnal unimodal or bimodal flight periodicity.

It is generally accepted that asilid predator success is based partly upon flight capabilities and sizes of the fly and its potential prey. Small weak flying prey will invariably be vulnerable to larger, stronger, more agile predators (Hespenheide, 1975). Most prey of *E. tibialis* were small, about one-

third the predator's size, and weak fliers. These prey, especially aphids, utilize convection currents to carry them into the air and subsequently back to ground level (Dixon, 1973). Furthermore, weak fliers usually have soft or thin cuticles. Examination of these prey for punctures revealed that any location on the prey's body may be penetrated by the hypopharynx although the dorsum contained the greater proportion (67%, N = 153) of punctures. Conversely, some larger prey with hard cuticles, e.g. reproductive ants and beetles, were immobilized by inserting the hypopharynx at specific locations of the body where the cuticle was thin or soft. Therefore, size of prey may be less limiting when weak flight abilities and thin or soft cuticles co-exist, e.g. termites.

The following is a list of prey taken by *E. tibialis* at the study site. A few prey are presented only to order or family level since they were too damaged for identification or were not collected. Each notation of prey refers to a single record unless followed by a number in parentheses. The month and year are recorded only once at the end of a series for each prey taxon.

ARANEIDA: Unidentified 14.VI.73. ISOPTERA: Rhinotermitidae, *Reticulitermes flavipes* (Kollar) 14(2).21.23(12).25(8).26(3).27(3).28(2).30(8).VI.75, 7.VII.73, 30(17).VI.74, 18.23.24(3).26(2).28(1).VI.76. PSOCOPTERA: Caecilidae, *Caecilus aurantiacus* (Hagen) 27.VI.74; Lachesillidae, *Lachesilla pallida* (Chapman) 29.VI.74; Psocidae, *Blastopsocopsis lithinus* Chapman 27.VI.73. THYSANOPTERA: 19.VI.74, 8.VII.74, 7.VII.75, 26.27(2).28(3).VI.76; Thripidae, *Ctenothrips bridwelli* (Franklin) 27.VI.73. HOMOPTERA-HEMIPTERA: Aphididae, unidentified 3.VII.72, 15.29.VI.75, 5.7(6), 8(4).10(2).VII.75, 16(3).24(3).26(4).27(5).28(15).29(6).VI.76, 5(2).10.VII.76, *Acyrtosiphon solani* (Kaltenbach) 28.VI.73, *A. dirhodum* (Walker) 5.VII.74, *Amphorophora* spp. 13(3).18(2).29(3).VI.74, *Anoecia corni* (Fabricius) 14.VI.74, *Aphis* spp. 19(3).VI.73, 3(2).VII.74, *A. fabae* Scopoli 29(2).VI.74, *A. gossypii* Glover 19(2).29.VI.73, *A. rumicis* Linnaeus 23.VI.73, *A. sambucifoliae* Fitch 23.24(2).VI.73, 27.30.VI.74, 10.VII.74, *Cavariella aegopodii* (Scopoli) 27.29.VI.74, *Dactynotus* sp. 20.VI.73, 18.VI.74, *D. tisserti* (Boudreaux) 19(2).VI.73, *Eriosoma* sp. 20.VI.73, *E. lanigerum* (Hausmann) 12(2).VII.74, *Hyalodaphis erysimi* (Kaltenbach) 3.VII.74, *Macrosiphum* spp. 19.29(2).VI.73, 23.VI.74, 5(2).VII.74, *M. avenae* (Fabricius) 20(2).VI.73, 20.VI.74, *M. corlyi* Davis 9.VII.74, *M. liriiodendri* (Monell) 25(4).26(3).29(2).30(3).VI.73, 20(2).VI.74, 1.VII.74, *Megoura* sp. 27.VI.73, *Myzus* sp. 3.VII.72, 13(10).28(2).VI.73, *M. cerasis* (Fabricius) 13.VI.73, *Ovatus phyloxae* (Samson) 28.30(9).VI.73, 17(3).18.19.VI.74, 12.VII.74, *Pemphigus* sp. 24.27.VI.73, *Rhopalosiphum fitchii* (Sanderson) 27.VI.74, *R. padi* (Linnaeus) 27.30.VI.74, *Sitomyzus* sp. 18.21.23.VI.74, *S. rhois* (Monell) 23(2).VI.74, *Thecabius* sp. 22.VI.73, *Therioaphis* sp. 18.VI.74, *T. riehmii* (Börner) 30.VI.74, *Tinocalis caryaefoliae* (Davis) 21.VI.73, *Toxoptera viridirubra* Gill and Palmer

27.VI.74; Cercopidae, *Clastoptera obtusa* Say 20.VI.73; Cicadellidae, *Aphrodes* sp. 30(2).VI.74, *Dikraneura* sp. 23.VI.73, *Doratura stylata* (Boheman) 20.VI.73, *Empoasca fabae* (Harris) 27.VI.73, *Endria inimica* (Say) 15.VI.73, *Erythoneura* sp. 23.VI.73, 18.VI.74, *Forcipata lica* DeLong and Caldwell 20.VI.74, *Macrosteles* sp. 30.VI.72, *M. fascifrons* (Stål) 14.VI.73; Cydnidae, *Pangaeus bilineatus* (Say) 29.VI.74; Miridae, *Halticus bractatus* Say 22.VI.73, *Lygus* sp. 21.VI.74, *Lygidea medax?* Reuter 13.VI.73, *Trigonotylus tarsalis* (Reuter) 14.VI.73; Phylloxeridae, unidentified 8.VII.75, 24(2).27(2).VI.76, *Phylloxera* sp. 3.VII.74; Psyllidae, *Trioza diaspyri* Ashmead 21.VI.74. COLEOPTERA: Unidentified 17(4).8(2).75; Anobiidae, *Petalium* sp. 26.VI.73, 14.VI.74; Chrysomelidae, *Chaetosoma* sp. 15.23.VI.73, 19.VI.74, *Hippariphila* sp. 20.VI.73, *Paria* sp. 22.25.VI.73; Curculionidae, *Anthonomus* sp. 20.VI.73, *Dryophthorus americanus* Bedel 21(2).26.VI.73; Scarabaeidae, *Ataenius imbricatus* (Melsh) 26.VI.73; Scolytidae, *Orthotomicus caelatus* (Eichhoff) 20(3).21(2).VI.73, *Delphastus pusillus* (LeConte) 27.VI.74, 26.VI.75, 8.VII.75; Staphylinidae, unidentified 3(2).14.VII.73, 14.19(2).20.21.26(4).VI.73, 19(2).26.29(2).30(2).VI.74, 2.3.4(2).VII.74. DIPTERA: Unidentified 19.VI.73, 6(2).8(2).15.27.VI.75; Agromyzidae, *Cerodontha dorsalis* (Loew) 21.VI.74, *Liriomyza* sp. 24.VI.73; Asilidae, *Cerotainia albipilosa* Curran 9.VII.73; Cecidomyiidae, unidentified 23.VI.73, 14.VI.74, 27.VI.75, 29.VII.75, *Asynapta* (s.l.) sp. 14.VI.73, *Resseliella* sp. 20.VI.74; Chironomidae, Orthocladiinae 7(2).14.VII.72, 20.22.30.BI.73, 17.21(2).23(3).VI.74, 1.3.VII.74; Chloropidae, *Chlorops obscuricornis* Loew 15.VI.73, *Elachiptera costata* (Loew) 15.VI.73, *Oscinella carbonaria* (Loew) 29.VI.74, *Stenoscinis longipes* (Loew) 25.VI.73; Dolichopodidae, unidentified 3(2).10.VII.72, 26.VI.75, *Chrysotus* sp. 3(2).10.VII.72, 14.15.20.VI.73, *Condylostylus* sp. 13.VI.73, *Gymnopternus* sp. 15.VI.73; Drosophilidae, *Scaptomyza pallida* (Zetterstedt) 1.VII.73, 29(2).VI.74; Empididae, *Euhybus purpureus* (Walker) 18.VI.74, *Lactistomyia insolita* Melander 9.VII.73, *Platypalpus* sp. 14.VI.74; Lauxaniidae, *Homoneura philadelphica* (Macquart) 13.15.VI.73, 18.VI.74; Milichiidae, *Neophyllomyza* sp. 17.VI.74, unidentified 26.VI.74; Phoridae, *Megaselia* sp. 3.VII.74; Platystomatidae, *Rivellia pallida* Loew 23.VI.73; Platypezidae, *Platypeza* sp. 3.VII.72, 20.VI.73; Rhagionidae, *Rhagio mystaceus* (Macquart) 18.VI.74; Sciaridae, *Bradysia* sp. 13.VI.72, 22(2).24.26(2).29.30(2).VI.73, 1.VII.73; Sphaeroceridae, *Leptocera* sp. 10.VII.72, 20.VI.73; Stratiomyidae, *Oxycera* sp. 20.VI.73; Syrphidae, unidentified 5.VII.75; Tephritidae, unidentified 3.VII.72; Tipulidae, unidentified 10.VII.72, 29.VI.73, *Atarba picticornis* Osten Sacken 24.25.VI.73, *Dicranoptycha* sp. 20.VI.73, *Cheilotrichia stigmatica* (Osten Sacken) 26.VI.73, *Limnophila* sp. 22.VI.73, *Molophilus* sp. 29.VI.73. LEPIDOPTERA: Unidentified 19.VI.74. HYMENOPTERA: Unidentified 13(2).21(2).VI.73, 27(3).VI.76; Aphidiidae, *Aphidius* sp. 19(2).VI.73, *Ly-*

siphlebus sp. 2.VII.74, *Trioxys* sp. 22.VI.73; Braconidae, unidentified 28.VI.76, *Apanteles* sp. 27.VI.73, *Opius* spp. 20(2).22.VI.73, *Meteorus* sp. 29.VI.73; Ceraphronidae, *Ceraphron* sp. 22.VI.73, 18.VI.74; Megaspilidae, *Megaspilus* sp. 24.VI.73; Chalcidoidea, unidentified 30.VI.73; Cynipidae, unidentified 24.VI.73; Diapriidae, *Belyta* sp. 25(2).VI.73, *Pantoclis* sp. 20(2).VI.73, *Psilus* sp. 28(4).VI.73; Dryinidae, Anteonini 14.VI.73; Eupelmidae 17.VI.74; Eurytomidae, *Harmolita* sp. 15.VI.73; Formicidae, *Ponera* sp. 27.28(2).VII.76; Hybrizontidae, *Hybrizon rileyi* (Ashmead) 25.VI.73; Ichneumonidae, *Endasys* sp. 15.VI.73, *Polyaulon* sp. 13.20(3).23.26(3).VI.73, *Theroscopus* sp. 20.VI.73; Pteromalidae, Lamprotatini 20.VI.73, 11.VI.74, Pteromalini 29.VI.74; Scelionidae, *Calotelea* sp. 14.VI.73, *Trisacantha* sp. 17(2).VI.74; Tenthredinidae, *Ametastegia recens* (Say) 20.VI.73.

PREDATORS OF *EUDIOCTRIA TIBIALIS*

Predaceous arthropods, especially other insects, have been recorded as enemies of asilid flies (Hull, 1962; Lavigne et al., 1978). Some common predators of adult asilids are spiders (Bromley, 1914; Scarbrough, 1978b, 1979), other asilids and conspecifics, e.g. cannibalism, and Hymenoptera (Hull, 1962; Lavigne et al., 1978; Scarbrough, 1978b, 1979). *Eudioctria tibialis* has similar enemies but differs in that cannibalism was absent and a new predator, *Vespula maculata* (L.) (Hymenoptera: Vespidae), was identified. At least 46 attempts at predation and 23 instances of predation were observed: Araneida (7), *Laphria sicula* McAtee (1) (Diptera: Asilidae), and *V. maculata* (15). In addition, eleven carcasses of *E. tibialis* were found, each with a crushed thorax and missing body parts. *Vespula maculata* was probably the predator since it typically mutilates the prey's body as the prey is being immobilized. The wasp crushed the prey's body and removed the wings with its mandibles before flying away with the remainder. Similar immobilization techniques have been reported for the wasp with other prey (Howell, 1973). Sometimes the prey was dropped as the wasp flew away. Three ants (*Formica subsericea* Say) were observed carrying carcasses of *E. tibialis*. The ants may have found the adults emerging from pupal cases (personal communication, D. S. Dennis, June 1980). Because of the similarity of the crushed bodies with those taken from feeding *V. maculata* and the absence of pupal cases in the study area, it is doubtful that the ants were the predators, but probably found them after they were dead.

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ANATOMY AND FUNCTION OF THE STING APPARATUS OF
STINGLESS BEES (HYMENOPTERA: APIDAE:
APINAE: MELIPONINI)

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Abstract.—The anatomy and function of the sting apparatus of five species of stingless bees in the Meliponini are described. All species studied have a sting apparatus, although the stylet is reduced. The rest of the skeletal parts are present, and valvulae III are especially well developed.

A nearly universal character in Aculeate Hymenoptera is the presence in the female of a sting apparatus which has defensive and offensive functions. Traditionally bees in the tribe Meliponini are regarded as lacking a sting (Kerr and Lello, 1962, for example), and they are commonly called stingless bees. However, meliponines have a sting apparatus although it is reduced or atrophied as Schwarz (1948) has pointed out.

Two basic functional parts can be distinguished in the structure of the sting apparatus of Aculeate Hymenoptera: (1) Skeletal with muscles and (2) glandular. Details of the skeletal and glandular parts have been described by many authors (D'Rozario, 1940; Oeser, 1961; Robertson, 1968; Radović, 1976; Richards, 1977; Radović and Hurd, 1980), and they are especially well known for the genus *Apis* (Snodgrass, 1935, 1956).

The glandular part of the sting apparatus of stingless bees was studied by Kerr and Lello (1962) and Lello (1976). However, the skeletal parts are less well known, and, except for reports that they are "reduced," "atrophied," or "functionless," the existing literature does not contain detailed descriptions or illustrations. Therefore, I have concentrated on the skeletal parts of the sting of stingless bees, observed changes in its structure, and determined which skeletal parts are reduced and which are well developed.

MATERIALS AND METHODS

Five species of stingless bees were studied: *Melipona flavipennis* Smith from Peru; *M. interrupta grandis* Guérin-Ménéville from Bolivia; *Trigona fulviventris* Guérin-Ménéville from Mexico; *T. amalthea* (Olivier) from El Salvador; and *Lestrimelitta limao* Smith from Panama.

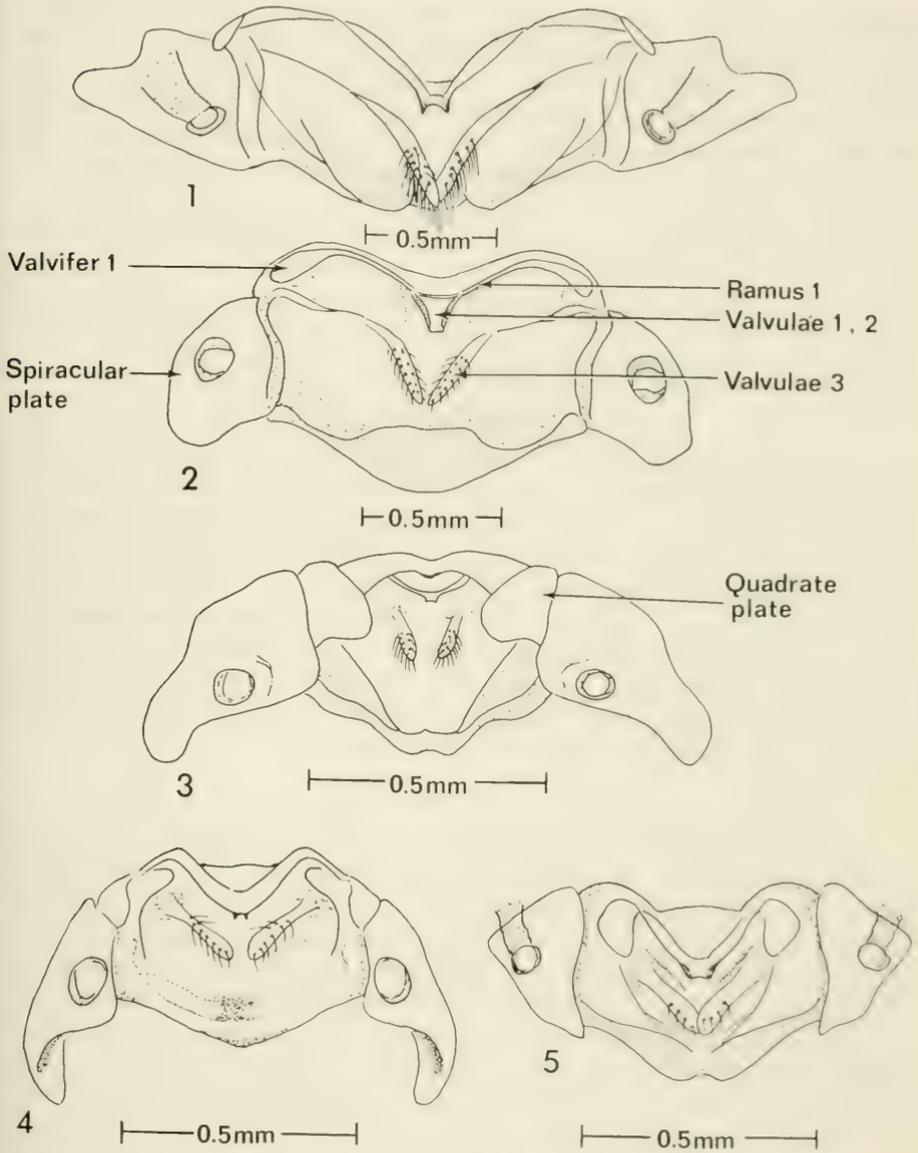
Dry specimens were softened in a relaxer before dissection. Because of their small size and delicate structure, dissection was conducted in 70% ethyl alcohol under a binocular microscope. After dissection, the sting apparatus was taken through series of solutions for cleaning and dehydration (Radović and Hurd, 1980). Lastly, the skeletal parts were mounted in Canada balsam on a microscope slide. All illustrations were prepared by the author with use of a Bausch and Lomb Tri-Simplex microprojector.

RESULTS AND DISCUSSION

The sting apparatus of Apidae are modified skeletal parts of the 8th and 9th abdominal segments. All five species of stingless bees examined have a sting apparatus, the stylets of which are represented by remnants of valvulae I and valvulae II (Figs. 1–5). With such a reduced stylet structure, it is obvious that the stinging function is lost. All five species have arched rami varying in shape and thickness continuing from the base of stylet. The rami end in a triangular plate (valvifer I). The size and shape of the triangular plate varies, but it is largest in *Lestrimelitta limao* (Fig. 5). Oblong plates are membranous and very difficult to detect in all five species. Quadrate plates, remnants of the 9th abdominal tergum, are well developed in *Trigona* (Figs. 3, 4) but are membranous in the two species of *Melipona* (Figs. 1, 2) and in *Lestrimelitta limao* (Fig. 5). Each of the five species have well-developed spiracular plates which are remnants of the 8th abdominal tergum. The last abdominal spiraculum is evident on each of the spiracular plates. In all five species, the middle part of the 9th abdominal segment is folded over the base of the sting and is membranous and thin.

Valvulae III are especially well developed in five species. Females of stinging bees and of other Aculeate Hymenoptera have the inside of valvulae III concave for covering and protecting the stylets; sensory bristles are also present, especially on the top (Maschwitz and Kloft, 1971). However, valvulae III of the stingless bees examined are robust, rounded, and straight inside, and sensory bristles are distributed along the entire top. Valvulae III of stinging bees have a sensory role, and it is assumed that they contact the body of the victim before the stinging act (Snodgrass, 1956). Rathmayer (1962, 1978) stated that the function of valvulae III is to detect nonsclerotized cuticular spots on the body of the victim, and he believed that the bristles, especially those at the top, are mechanoreceptors. But what is the function of valvulae III and their numerous bristles in stingless bees? The many well-developed bristles on valvulae III may act as mechanoreceptors in stingless bees as well, but what is their purpose since the stylet is reduced and there is no stinging?

Stingless bees, although lacking a functional sting apparatus, show a wide range of defense mechanisms which they use to protect their colonies (Kerr and Lello, 1962; Michener, 1974). They use mass attack into the eyes, nose,



Figs. 1-5. Sting apparatus, anterodorsal view. 1, *Melipona flavipennis*. 2, *M. interrupta grandis*. 3, *Trigona fulviventris*. 4, *T. amalthea*. 5, *Lestrimelitta limao*.

ears, or hair of animals or people endangering their colonies (Michener, 1974). Some species of *Trigona* and *Melipona* have powerful mandibles that can penetrate the skin of animals and people. Species of the subgenus *Trigona* (*Oxytrigona*) have special glands at the base of the mandibles that secrete a venom that may cause lesions where the mandibles penetrate (Michener, 1974). There may be certain links between such defense mechanisms and the well-developed valvulae III of stingless bees, i.e. the defensive and aggressive acts may come after contact of the bristles with the body of the victim. Schwarz (1948) stated that stingless bees sometimes simulate the stinging act by pressing the top of the abdomen onto the body of the victim. This simulation of the stinging act may be caused by the stimulation of the mechanoreceptors on the bristles of valvulae III.

CONCLUSIONS

Based on the study of the structure of the sting apparatus of five species of Meliponini, (1) stingless bees, contrary to their name, have a sting apparatus; (2) stingless bees show reduction and atrophy of the stylet (valvulae I and II) and this part is functionless; (3) the basal parts of the sting apparatus are developed; (4) valvulae III are especially well developed, rounded along their length, not concave inside, and have numerous bristles which may act as mechanoreceptors that stimulate certain defense mechanisms; and (5) except for similarities in general structure, all five species studied show morphological differences in some parts of the sting apparatus, and these structures may have some taxonomic importance.

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**HERBIVORY BY SPECIES OF *TRIRHABDA* (COLEOPTERA:
CHRYSOMELIDAE) ON *SOLIDAGO ALTISSIMA*
(ASTERACEAE): VARIATION BETWEEN YEARS**

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Abstract.—Larval and adult *Trirhabda* beetles were more abundant on *Solidago altissima* than on *S. juncea*, and more abundant on both goldenrod species in 1977 than in 1976. Heavier herbivory by species of *Trirhabda* in 1977 stunted the growth and retarded the flowering of *S. altissima*, as compared to 1976; *S. juncea*, with almost no damage by *Trirhabda* species, bloomed earlier in 1977 than in 1976. Despite *Trirhabda* and other abundant herbivores, *S. altissima* is the dominant old-field goldenrod in the region of Ithaca, New York. Years with low densities of *Trirhabda* species may contribute to the success of *S. altissima*.

Several species of the genus *Trirhabda* LeConte feed on *Solidago* L. both as larvae and as adults (Balduf, 1929; Blake, 1931; Capek, 1971; Hogue, 1971; Reid and Harmsen, 1976; Sholes, 1977; Messina, unpublished data). *Trirhabda borealis* Blake was the dominant herbivore on *Solidago canadensis* L., based on biomass and numbers of individuals, at two sites in southern Ontario; however, Reid and Harmsen (1976) did not observe any "obvious, serious defoliation of *S. canadensis*" by species of *Trirhabda* in their study sites, and only rarely elsewhere. Serious defoliation was observed elsewhere in Ontario (Capek, 1971) by larvae and adults of *T. borealis*, and in Ohio (Balduf, 1929), where the larvae of *T. canadensis* Kirby sometimes consumed "much of the foliage" of *Solidago* plants. In this paper, I compare two years of observations of herbivory by *Trirhabda* species on *Solidago altissima* L., a close relative of *S. canadensis* (Fernald, 1950).

THE GENUS *TRIRHABDA*

Beetles in the genus *Trirhabda* (Chrysomelidae: Galerucinae) are often found on goldenrods; of the 22 or 23 species in North America (Blake, 1931; Hogue, 1971), at least eight feed on *Solidago*. The species found near Ith-

aca, *T. virgata* LeConte and *T. borealis* (Sholes, 1980; Messina, unpublished data), are 6–12 mm in length as adults, with an individual dry weight of about 9 mg. The larvae are shiny blue-black dorsally, tan ventrally, and grow to about 10 mm in length. Larvae are found on growing goldenrods in the spring, feeding there until they drop to the soil and pupate in middle or late June. Adults eclose in late June or early July and can be found on *Solidago* from then until late September. Mating occurs on the plants, and the females oviposit in the bases of broken *Solidago* stems; the eggs overwinter and hatch the next spring. Thus, the species are univoltine, and are active through nearly all of the growing season either as larvae or adults (Balduf, 1929; Blake, 1931; Messina, unpublished data; Reid and Harmsen, 1976).

FIELD SITES AND METHODS

As part of a study concerning the arthropod fauna of *Solidago juncea* Aiton and *S. altissima* (Sholes, 1980), I periodically censused *in situ* the arthropods occupying panicles (in 1976) and whole plants (in 1977) of these goldenrods in two old fields near Ithaca, New York.

Field 1, where I studied *S. altissima*, is centered at 76°24'52"W, 42°23'16"N. The elevation is about 258 m, and the slope less than 3% on either side of a 5–10%-slope ridge running the length of the field. Field 2, in which I studied *S. juncea*, is centered at 76°25'54"W, 42°29'36"N. The elevation is about 340 m, and the slope 3% or less (see Sholes, 1980).

In 1976 I established 10 random points in a 20 × 50 m quadrat, then marked the goldenrod plant nearest each point that showed flower bud development and repeated the same process in four contiguous areas for a total of 50 plants in a 50 × 100 m area in each field. I censused *S. juncea* 16 times between 17 July and 6 October, and *S. altissima* 11 times between 17 August and 13 October. In each census, I counted all the arthropods on the panicles of every marked plant while disturbing the plants as little as possible. In each field, 48 plants survived through all the censuses (two in each field were broken off at the ground by large animals).

In 1977 I established 20 points spaced randomly along a 50 m transect running between the midpoints of the 100 m sides of the 50 × 100 m area in each field, then marked the plant showing bud development nearest each point. I censused *S. juncea* 14 times between 10 July and 12 October, and *S. altissima* 9 times between 19 August and 21 October. In these censuses, I counted the arthropods on the entire above-ground plant, noting whether they were on the panicle, or on the stem below.

I measured the height of each plant, the distance to the nearest conspecific plant (decimeters between stem bases), and at each census, the percent of the heads in bloom, the volume of the panicle (the smallest rectangular space containing the entire inflorescence), and the distance to the nearest

Table 1. The number of *Trirhabda* adults on *Solidago* plants in 1976 and 1977 and the height and blooming date of these same plants.

	<i>Solidago</i> Species	1976 (n = 48)	1977 (n = 20)	P ¹
No. of <i>Trirhabda</i> per liter of panicle space	<i>S. altissima</i>	13/1,382 = .009	10/456 = .022	
	<i>S. juncea</i>	0/2,909 = 0	1/775 = .001	
No. of <i>Trirhabda</i> per plant	<i>S. altissima</i>	—	67/180 = .372	
	<i>S. juncea</i>	—	2/280 = .007	
Ht. of plants ($\bar{x} \pm s$) (cm)	<i>S. altissima</i>	118 \pm 23	79 \pm 19	<.001
	<i>S. juncea</i>	85 \pm 18	71 \pm 14	<.005
Peak date of blooming ($\bar{x} \pm s$)	<i>S. altissima</i> ²	16 Sept. \pm 6 days	20 Sept. \pm 4 days	<.01
	<i>S. juncea</i>	24 Aug. \pm 7 days	20 Aug. \pm 7 days	<.05

¹ P values for two-tailed Student's *t*-test; blanks indicate no test was done.

² Variances unequal ($P < .05$) using *F*-test; modified *t*-test for unequal variance used here.

blooming conspecific. Using percent blooming over time, a peak date of blooming was interpolated for each plant, and the mean, variance, and standard deviation were calculated for the peak blooming of each sample population (Sholes, 1980).

I observed the kinds of damage done by the feeding of *Trirhabda* larvae and adults on *Solidago*, especially *S. altissima*. I also made subjective estimates of the relative levels of damage done to goldenrod plants in the two study sites and nearby fields.

Weather data were obtained from the Division of Atmospheric Sciences at Cornell University (Monthly Meteorological Summary, 1976–1977).

RESULTS

Trirhabda adults were much more abundant on *S. altissima* than on *S. juncea* in both years, but were substantially more abundant on both goldenrods in 1977 than in 1976 (Table 1). My subjective estimates of larval abundance agreed with the data on adults.

Solidago altissima plants were shorter and bloomed later in 1977 than in 1976. *Solidago juncea* plants were also shorter in 1977 than in 1976, but in contrast to *S. altissima*, bloomed earlier in 1977 (Table 1). In 1976, taller plants of *S. juncea* tended to bloom earlier than shorter plants; no such relationship existed for *S. altissima*. Product-moment correlations between plant height and date of peak blooming produced coefficients of -0.40 for *S. juncea* ($P < .005$) and 0.15 for *S. altissima* ($P > .3$).

Solidago altissima plants were farther from blooming conspecifics in 1977 than in 1976 (Fig. 1), although the distance between conspecifics, blooming or not, was always 1 dm in both years. *Solidago juncea* showed no major change in distance to blooming conspecifics; in this species, nearest conspecific stems always bloomed (Fig. 1).

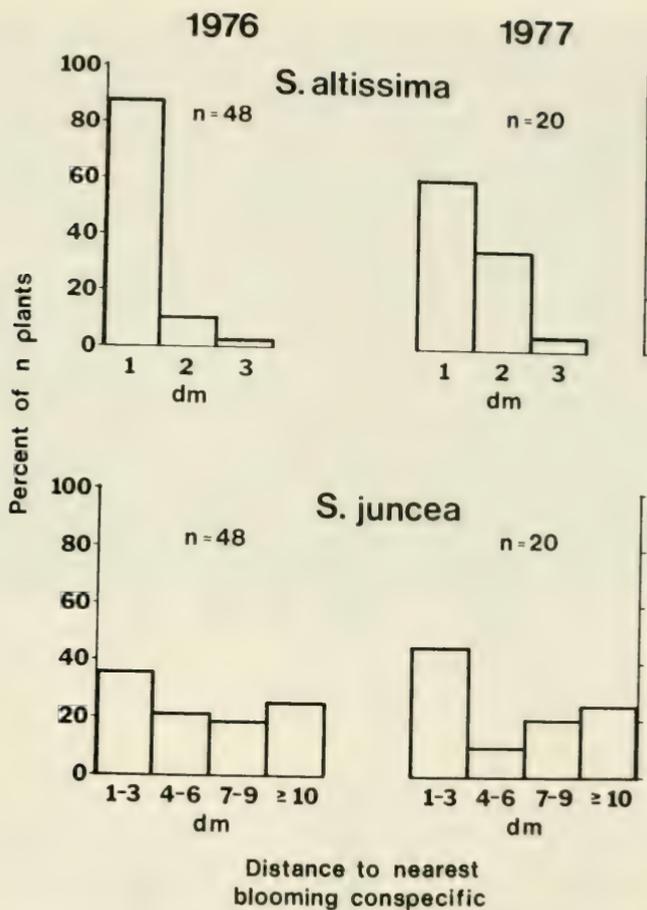


Fig. 1. Distances from marked plants to nearest blooming conspecific plants for *Solidago altissima* and *S. juncea* in 1976 and 1977. For *S. altissima* in both years, the distance to nearest conspecific, blooming or not, was 1 dm for every marked plant (i.e., the density of *S. altissima* stems was the same in both years, but fewer plants bloomed in 1977). In both years, all nearest conspecific stems of *S. juncea* bloomed.

Meteorological information for both years (Fig. 2) shows that, for most months of the growing season, 1977 was warmer than 1976, and that there was about the same amount of total precipitation and total solar radiation in both years. July 1976 and September 1977 had particularly large amounts of rain, and May 1977 had a high total of solar radiation.

A photograph of *S. altissima* stems (Fig. 3) from Field 1 shows the chewing damage done by the larvae (on older, lower leaves) and adults (on younger, upper leaves) of *Trirhabda* beetles in 1977. Damage was not nearly as obvious in 1976.

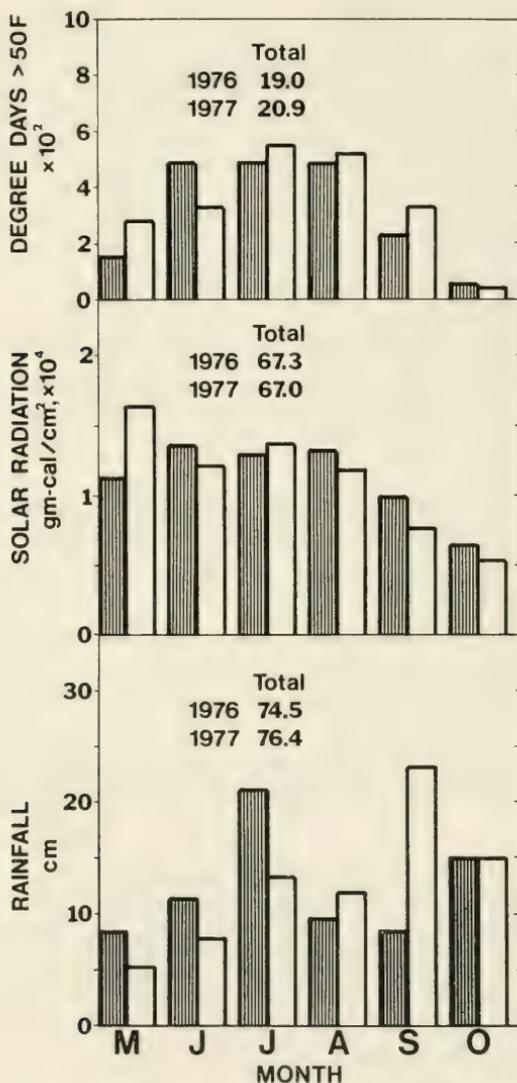


Fig. 2. Monthly meteorological summary data for growing seasons in Ithaca, New York, 1976 (dark bars) and 1977 (open bars).

Both larvae and adults of *Trirhabda* were found feeding along the edges of holes and marginal notches in the leaves, indicating little preference for location in their initiation of feeding. No *Trirhabda* were seen eating stem tissue, and the completely defoliated stems I examined in 1977 showed no damage on the stem itself from chewing insects. Species of *Trirhabda* appear to feed only on leaves.

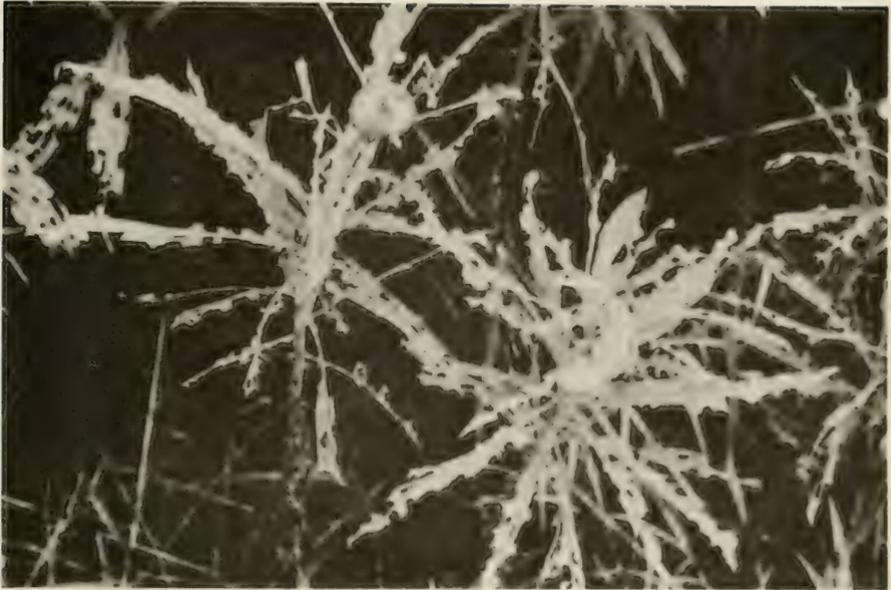


Fig. 3. Results of herbivory by *Trirhabda* species on two *Solidago altissima* stems in 1977. Larvae fed on the lower leaves, adults on the upper leaves. Note the galls of *Eurosta solidaginis* (Fitch) (Tephritidae) near the top of each stem (see Hartnett and Abrahamson, 1979).

DISCUSSION

Differences between years.—Though the evidence is circumstantial, I see no possible cause for the stunted growth and retarded flowering of *Solidago altissima* in 1977 other than the severe defoliation by *Trirhabda* beetles. The warmer weather of 1977 was, if anything, better for plant growth and development than the weather of 1976, as indicated by the earlier blooming of *S. juncea* in 1977. The inclement weather of September 1977 may have contributed to the lateness of *S. altissima* blooming, but at that late stage of *S. altissima* flower development, high precipitation and low solar radiation probably could not have retarded blooming to the extent observed, especially since September 1977 was warmer than September 1976 (Fig. 2).

By removing large amounts of leaf tissue and photosynthetic area from *S. altissima* plants, the beetles apparently influenced plant growth, flower production, and flower phenology. Shorter stem height and reduced frequency of flower development in 1977 were probably related because stems of *S. canadensis* (and presumably *S. altissima*) will not flower unless they reach a certain minimum size (Bradbury, 1974). Delayed blooming was probably a separate consequence of herbivore damage, because stem height and blooming time were not correlated for *S. altissima* plants in 1976. Late-

blooming plants risk having reduced pollination and fruiting success because of the greater likelihood of cold weather late in September and in early October. Thus, herbivory by *Trirhabda* species seems to have had considerable impact on the sexual reproduction of *S. altissima*.

Asexual reproduction is also important for *Solidago* (Bradbury and Hofstra, 1976; Smith and Palmer, 1976). Multiple-year storage in roots and rhizomes (Bradbury, 1974) certainly buffered the losses to *Trirhabda* to some extent, but could not have entirely eliminated their effect. I did not measure root or rhizome growth in this study, but others have shown a reduction in rhizome production caused by stem gall insects (Hartnett and Abrahamson, 1979). I suspect that species of *Trirhabda* have an even greater effect on underground growth of *Solidago* than do stem gall insects (see Fig. 3).

Other work has suggested that *Trirhabda* numbers vary between years (Balduf, 1929; Capek, 1971; Reid and Harmsen, 1976), but the cause(s) of these population fluctuations remain unclear. Food plant quality may be involved in a feedback control mechanism (see Lomnicki, 1977; Mattson and Addy, 1975; Pimentel, 1961). Abiotic factors could be important, especially those affecting egg survival and larval development rate (Andrewartha and Birch, 1954). The incidence of parasitic attack on species of *Trirhabda* is quite variable (Balduf, 1929; Capek, 1971; Hogue, 1971; Messina, unpublished data; Sholes, 1977), and the predatory pentatomid *Perillus circumcinctus* Stål appears to specialize on *Trirhabda* larvae (Evans, 1980).

Differences between *Solidago* species.—My data and field observations indicate that *Trirhabda* beetles have strong preferences between host species within the genus *Solidago*, as suggested by Reid and Harmsen (1976) and Messina (unpublished data). *Solidago juncea*, *S. nemoralis* Ait. and *S. graminifolia* Salisb. all seem to be eaten much less often by *Trirhabda* in the Ithaca area than is *S. altissima*. The differences in *Trirhabda* numbers on *S. juncea* and *S. altissima* (Table 1) partly reflect the difference between fields; within fields, though, the difference in herbivory on the two species was obvious.

CONCLUSIONS

Trirhabda can retard the stem growth, inflorescence production, and blooming time of *Solidago altissima* (and probably its underground growth as well), but only in years of high population density. When other herbivores are also abundant, such as stem gall insects (Hartnett and Abrahamson, 1979, see Fig. 3), *S. altissima* must experience a considerable reduction in productivity. Despite this reduction, and despite the lesser amount of herbivory on some other sympatric *Solidago* species, *S. altissima* is the most abundant old-field goldenrod in the region surrounding Ithaca, New York

(Sholes, 1980; Wiegand and Eames, 1925). Such success in the face of apparent adversity deserves further, long-term study throughout the range of *Solidago altissima*. Perhaps the years of low *Trirhabda* population density are important to that success.

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This paper is dedicated to the memory of Robert H. Whittaker.

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THE PROPER PLACEMENTS OF THE NEARCTIC SOFT SCALE
SPECIES ASSIGNED TO THE GENUS *LECANIUM*
BURMEISTER (HOMOPTERA: COCCIDAE)

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Abstract.—The genus *Lecanium* Burmeister 1835, is a junior synonym of *Coccus* Linnaeus 1758. Therefore, fourteen species of soft scale insects in the Nearctic Region previously assigned to *Lecanium* are placed here in the genera *Eulecanium*, *Mesolecanium*, *Parthenolecanium*, and *Sphaerolecanium*. Three new combinations are presented.

Although the genus *Lecanium* Burmeister, 1835: 69 (Type-species: *Coccus hesperidum* Linnaeus, 1758: 455, by subsequent designation by Cockerell, 1893: 49) is an objective junior synonym of *Coccus* Linnaeus, 1758: 455 (Fernald, 1903: 167), the name has been used in North America for certain taxa since its acceptance by Sanders (1909: 430) (Steinweden, 1929: 225; Richards, 1958: 305; Phillips, 1965: 231; Williams and Kosztarab, 1972: 69). Elsewhere, *Lecanium* was similarly used until Borchsenius (1957: 384) accepted the suppression of the name and reassigned certain included taxa to other genera. Since then, other workers have followed Borchsenius. In order to conform with current concepts, the current names are presented here for the Nearctic species which now belong in the genera *Eulecanium* Cockerell, *Mesolecanium* Cockerell, *Parthenolecanium* Sulc, and *Sphaerolecanium* Sulc.

Eulecanium Cockerell

1893, Am. Entomol. Soc. Trans. 20: 54. Type-species: *Coccus tiliae* Linnaeus, 1758, by original designation.

Eulecanium caryae (Fitch): King, 1902, Can. Entomol. 34: 160.

Lecanium caryae Fitch, 1857, Trans. N.Y. St. Agric. Soc. 16(1856): 443.

Eulecanium cerasorum (Cockerell): Fernald, 1903, Mass. Agric. Exp. Stn. Spec. Bull. 88, p. 184.

Lecanium cerasorum Cockerell, 1900, Psyche (Camb.) 9: 71.

Eulecanium excrescens (Ferris): Lindinger, 1933, Entomol. Anz. Jahrg. 13(11): 159.

Lecanium excrescens Ferris, 1920, Stanford Univ. Publ. Univ. Ser. Biol. Sci. 1(1): 37.

Eulecanium kunoense (Kuwana): Lindinger, 1933, Entomol. Anz. Jahrg. 13(11): 159.

Lecanium kunoensis Kuwana, 1907, Bull. Agric. Exp. Stn. Japan, 1: 191.

Eulecanium tiliae (Linnaeus): Cockerell, 1901, Entomol. 34: 92.

Coccus tiliae Linnaeus, 1758, Syst. Nat. (Ed. 10) 1: 456.

Lecanium coryli (Linnaeus): Marchal, 1908, Ann. Soc. Entomol. Fr. 77: 295.

Lecanium tiliae: Sulc, 1932, Acta Soc. Sci. Nat. Morav. 7(5): 87; Richards, 1958, Can. Entomol. 90(5): 310.

Mesolecanium Cockerell

1902, Ann. Mag. Nat. Hist. (ser. 7) 9: 451. Type-species: *Lecanium nocturnum* Cockerell and Parrott, 1899, by original designation.

Mesolecanium nigrofasciatum (Pergande), NEW COMBINATION

Lecanium nigrofasciatum Pergande, 1898, U.S. Dep. Agric. Div. Entomol. Bull. (n.s.) 18: 26.

Parthenolecanium Sulc

1908, Entomol. Mon. Mag. 44: 36. Type-species: (*Lecanium coryli* Sulc, 1908, nec Linnaeus, 1758) = *Lecanium corni* Bouché, 1844, by original designation.

Parthenolecanium cerasifex (Fitch): Boratynski and Davies, 1971, Biol. J. Linn. Soc. 3(1): 58 (*P. cerasifera* [sic]).

Lecanium cerasifex Fitch, 1857, Trans. N.Y. St. Agric. Soc. 16(1856): 368; Richards, 1958, Can. Entomol. 90(5): 308.

Parthenolecanium corni (Bouché): Borchsenius, 1957, Akad. Nauk Zool. Inst. (n.s. 66) 9: 356.

Lecanium corni Bouché, 1844, Stettin. Entomol. Z. 5: 298.

Lecanium coryli of Sulc, 1908, Entomol. Mon. Mag. 44: 36; Richards 1958, Can. Entomol. 90(5): 306.

Parthenolecanium fletcheri (Cockerell): Borchsenius, 1957, Akad. Nauk Zool. Inst. (n.s. 66) 9: 370.

Lecanium fletcheri Cockerell, 1893, Can. Entomol. 25: 221.

Parthenolecanium persicae (Fabricius): Borchsenius, 1957, Akad. Nauk Zool. Inst. (n.s. 66) 9: 350.

Chermes persicae Fabricius, 1776, Genera Insect. p. 304.

Lecanium persicae: Comstock, 1883, In Cornell Univ. Agric. Exp. Stn. Dept. Entomol. Rep. 2 (1882-83): 134.

Parthenolecanium pruinosum (Coquillett), NEW COMBINATION

Lecanium pruinosum Coquillett, 1891, Insect Life 3: 383.

Parthenolecanium putmani (Phillips): Boratynski and Davies, 1971, Biol. J. Linn. Soc. 3(1): 58 (*P. putnami* [sic]).

Lecanium putmani Phillips, 1965, Can. Entomol. 97(3): 234.

Parthenolecanium quercifex (Fitch), NEW COMBINATION

Lecanium quercifex Fitch, 1859, Trans. N.Y. St. Agric. Soc. 18 (1858): 805.

The species listed for *Parthenolecanium* have appeared in recent North American literature (Richards, 1958; Phillips, 1965; Williams and Kosztarab, 1972; Johnson and Lyon, 1976). Except for *P. persicae*, the Nearctic species are similar morphologically and species such as *P. cerasifex*, *P. corni*, *P. putmani*, and *P. quercifex* can not be differentiated morphologically with any satisfaction. A thorough study of the genus is necessary to clarify the status of most of the Nearctic species.

Sphaerolecanium Sulc

1908, Entomol. Mon. Mag. 44: 36. Type-species: *Coccus prunastri* Fonscolombe, 1834, by original designation and monotypy.

Sphaerolecanium prunastri (Fonscolombe): Sulc, 1908, Entomol. Mon. Mag. 44: 36.

Coccus prunastri Fonscolombe, 1834, Ann. Soc. Entomol. Fr. 3: 211.

Lecanium prunastri: Signoret, 1873, Ann. Soc. Entomol. Fr. (5) 3: 423.

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THE ORIENTAL SPECIES OF THE GENUS *DIBEZZIA* KIEFFER
(DIPTERA: CERATOPOGONIDAE)

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Abstract.—A revised diagnosis is given of the genus *Dibezzia* Kieffer, based on the type-species, *D. clavata* Kieffer, and a new species, *D. debenhamae* which is described from Malaysia and Thailand. Three species previously placed in *Dibezzia* are transferred to other genera: *Dibezzia himalayae* Kieffer to *Palpomyia* Meigen, *Heteromyia indica* Kieffer to *Mackerrasomyia* Debenham, and *Dibezzia longistila* Kieffer to *Johannsenomyia* Malloch. The generic position of *Dibezzia brevistila* Kieffer is doubtful, but it is suggested that the species may belong to *Leehelea* Debenham. Taxonomic notes are given for *Mackerrasomyia indica*.

In his catalog of Oriental Ceratopogonidae Wirth (1973) listed five species of *Dibezzia* Kieffer. We have made a more critical study of Kieffer's descriptions of these species and believe we can more accurately place them in the following genera:

1. *Dibezzia brevistila* Kieffer, 1911a: 122. Bangladesh. Position doubtful, tarsal claws missing; large size, body color, femoral spines, and black punctations on the legs suggest a species of *Leehelea* Debenham.
2. *Dibezzia clavata* Kieffer, 1911a: 120. India. Type-species of *Dibezzia*.
3. *Dibezzia himalayae* Kieffer, 1911b: 328. India. To genus *Palpomyia* Meigen, NEW COMBINATION.
4. *Dibezzia-indica* (Kieffer), 1913: 183 (*Heteromyia*). India. To *Mackerrasomyia* Debenham, NEW COMBINATION.
5. *Dibezzia longistila* Kieffer, 1911a: 121. India. To *Johannsenomyia* Malloch, NEW COMBINATION.

We are taking this opportunity to give a revised diagnosis of *Dibezzia*, adding characters that we have taken from a second Oriental species of the

genus that we are here describing from a series from Malaysia and Thailand. Some notes are also given on *Mackerrasomyia indica*.

Genus *Dibezzia* Kieffer

Dibezzia Kieffer, 1911a: 120 (type-species, *Dibezzia clavata* Kieffer, by original designation); Kieffer, 1913: 165 (in generic key); Kieffer, 1917: 296 (in generic key); Johannsen, 1931: 406 (in generic key); Macfie, 1940: 26 (in generic key; notes); Wirth et al., 1974: 610 (in generic key).

Diagnosis.—Slender, shining black species. Eyes (Fig. 1c) contiguous, bare. Female antenna (Fig. 1a) slender, distal 5 segments very elongate, cylindrical. Palpus (Fig. 1b) short, 5-segmented. Thorax (Fig. 1e) with coarse, bent, integumental microspines as in *Johannsenomyia* Malloch; mesonotum with small, upright, anteromedian spine. Legs (Fig. 1g) long and slender; femora unarmed, slightly clubbed distally except hindpair distinctly clubbed. Tarsi (Fig. 1h) slender, female hindtarsus extremely elongate; 4th tarsomeres cylindrical, greatly elongated on hindleg; female 5th tarsomeres (Fig. 1i) armed ventrally with 4–5 pairs of long, blunt, black batonnets along entire length of segment. Fifth tarsomere of hindleg of male without batonnets. Female claws very unequal on all legs, each with short, blunt, external, basal tooth; on hindleg longer claw may be longer than 5th tarsomere. Wing (Fig. 1f) relatively broad; two radial cells usually present, the crossvein between them sometimes obsolete; costa extending to 0.8 of wing length. Female abdomen (Fig. 1j) petiolate, 8th segment without sclerotization or ventral hair tufts; 2 large spermathecae (Fig. 1k) present. Male genitalia (Fig. 1l) elongate, with greatly elongated, slender basistyle and short, hook-like dististyle; aedeagus simple, tapering; parameres separate, with straight, slightly expanded, paddle-shaped apices. Pupa (Fig. 1n,o) with short, moderately broad respiratory horn; abdomen with lateral posteromarginal tubercles developed as strong spines; last segment with greatly elongated, slender, pointed, apical processes.

Discussion.—The genus *Dibezzia* is most closely related to *Johannsenomyia* Malloch (Wirth et al., 1974), both genera having the legs slender and unarmed with the femora more or less clubbed distally, the abdomen more or less petiolate, the mesonotum with a distinct upright anteromedian spine or tubercle and the integument with characteristic bent spinules arising from distinct microtubercles, the body usually shining dark brown to blackish and the wings not whitish, the costa extending to about 0.8 of the wing length, usually two radial cells present, and the female fifth tarsomeres bearing numerous black ventral batonnets along the length of the segment, the tarsal claws unequal on at least the posterior four legs, and each claw

with a short external basal tooth. In *Johannsenomyia* the claws of the anterior legs of the female are equal, the fourth tarsomere of the hindleg of females is not elongated, the fifth tarsomere of the male hindleg is armed with several pairs of batonnets, the female abdomen bears a pair of hair tufts on the eighth sternum, and the male genitalia are short and stout, whereas in *Dibezzia* the female claws are unequal on all legs, the fifth tarsomere of the male hindleg is unarmed, and the male genitalia are elongate with slender basistyle and extremely short dististyle.

Species of the genus *Xenohoelea* Kieffer have the female claws unequal on all legs and the ventral batonnets extend along the length of the fifth tarsomeres, but the genus is more closely related to *Sphaeromias* Curtis, with whitish pruinose or pollinose body and whitish wings, the costa longer, the female claws long and curving without the external basal teeth, the femora not clubbed, and the abdomen not petiolate.

KEY TO FEMALES OF ORIENTAL SPECIES OF *DIBEZZIA*

1. Larger species, length of body 3.5 mm; femora and tibiae uniformly blackish; longer claw equal to $\frac{2}{3}$ length of 5th tarsomere on all legs; antennal ratio 2.00 *clavata* Kieffer
- Smaller species, wing length about 2.0 mm; femora and tibiae each with broad distal pale bands; longer claw equal to length of 5th tarsomere on first 4 legs, 1.2 as long on hindleg; antennal ratio 2.38 *debenhamae*, new species

Dibezzia clavata Kieffer

Dibezzia clavata Kieffer, 1911a: 120 (female; India; fig. 5th tarsomere and claws of fore- and hindlegs); Brunetti, 1920: 58 (catalog reference: "paratypes" in Indian Museum).

Female (translated from Kieffer's original description).—Length 3.5 mm. A smooth and shining black species. Antennal segments 3–10 and forelegs testaceous; all tarsi except 5th tarsomeres and extreme distal ends of the others pale; halter dull black. Eyes confluent; vertex in a triangle. Proboscis small, equal to $\frac{1}{2}$ the height of face. Face strongly convex; palpus black. 4th segment small. Antennal segments 4–10 slightly longer than broad, sub-cylindrical, 3rd a little longer than 4th; 11th equal to 4 preceding segments combined; 11–15 filiform, together $2\times$ as long as the preceding combined. Mesonotum smooth and densely punctate; thorax a little higher than long. Wing hyaline, with dense microtrichia, fringed on posterior margin; strong veins brown, auxiliary obsolete; cubitus gradually approaching the margin, approximately near wing tip; 1st radial cell nearly reaching tip of radius, $2\times$ as long as broad; 2nd radial cell not broader than 1st, but $3\text{--}4\times$ as long;

medial fork located slightly proximad of crossvein; posterior fork located at level of crossvein; anal vein forked. Femora unarmed, the mid- longer than the fore- but very much shorter than the hindfemur; forefemur sub-cylindrical, the midfemur and very strongly the hindfemur inflated past the middle; all tibiae the same length as femora, the anterior with a yellow and simple comb, the mid- without comb, posterior with a double comb of which the smaller is very dense. Tarsi very much more slender than tibiae. Fore-basitarsus shorter than $\frac{1}{2}$ the length of the tibia, equal to 4 following tarsomeres combined, without palisade setae. Midbasitarsus a little shorter than $\frac{1}{2}$ the length of tibia. Hindbasitarsus longer than entire tibia, equal to following 4 tarsomeres combined; 2 rows of palisade setae on ventral side of first 2 tarsomeres. Fourth tarsomere of hindleg equal to $\frac{2}{3}$ the 5th, $6\times$ as long as broad; 5th tarsomeres of all legs with 4 pairs of long black spines. Anterior claws unequal, with a short basal tooth, the larger more than $\frac{1}{4}$ the length of the other and equal to $\frac{2}{3}$ the tarsomere; midclaws like the anterior; posterior claws very unequal, each with a basal tooth, the larger equal to $\frac{2}{3}$ the segment, the smaller a little longer than basal tooth of the large claw. Abdomen very much longer than rest of body; anterior $\frac{1}{2}$ narrowed in a cylindrical petiole, $2\times$ as long as wide and composed of 2 terga, of which the 1st is $\frac{1}{2}$ as long as the 2nd; posterior $\frac{1}{2}$ of abdomen broadened, depressed, the terga transverse.

Dibezzia debenhamae Wirth and Ratanaworabhan, NEW SPECIES

Fig. 1

Female holotype.—Wing length 2.0 mm; breadth 0.7 mm.

Head: Brown. Eyes (Fig. 1c) meeting in a point, separated by a triangular space above. Antenna (Fig. 1a) brown, proximal halves of segments 3–10 and extreme bases of 11–15 pale; lengths of flagellar segments in proportion of 28–15–15–15–15–15–15–75–60–60–60–60; antennal ratio 2.38, the 5 distal segments extremely elongate, the 11th unusually so. Palpus (Fig. 1b) dark brown, slender; lengths of segments in proportion of 6–15–20–13–15; 3rd segment without sensory pit, a few long capitate sensilla scattered on mesal face. Proboscis (Fig. 1c) short; mandible (Fig. 1d) with 9–10 coarse teeth.

Thorax: Dark brownish black; integument with small setulae arising obliquely from microtubercles (Fig. 1c); mesonotum with distinct upright spine on anteromedian margin. Legs (Fig. 1g) dark brown with yellowish-brown bands on distal halves of fore- and midfemora and all tibiae, and a narrow subapical band on swollen distal portion of hindfemur. Hindtibial comb with 9 yellowish spines, spur poorly developed. Tarsi (Fig. 1h) pale yellowish, distal 3 tarsomeres dark brown; basitarsi of fore- and midlegs

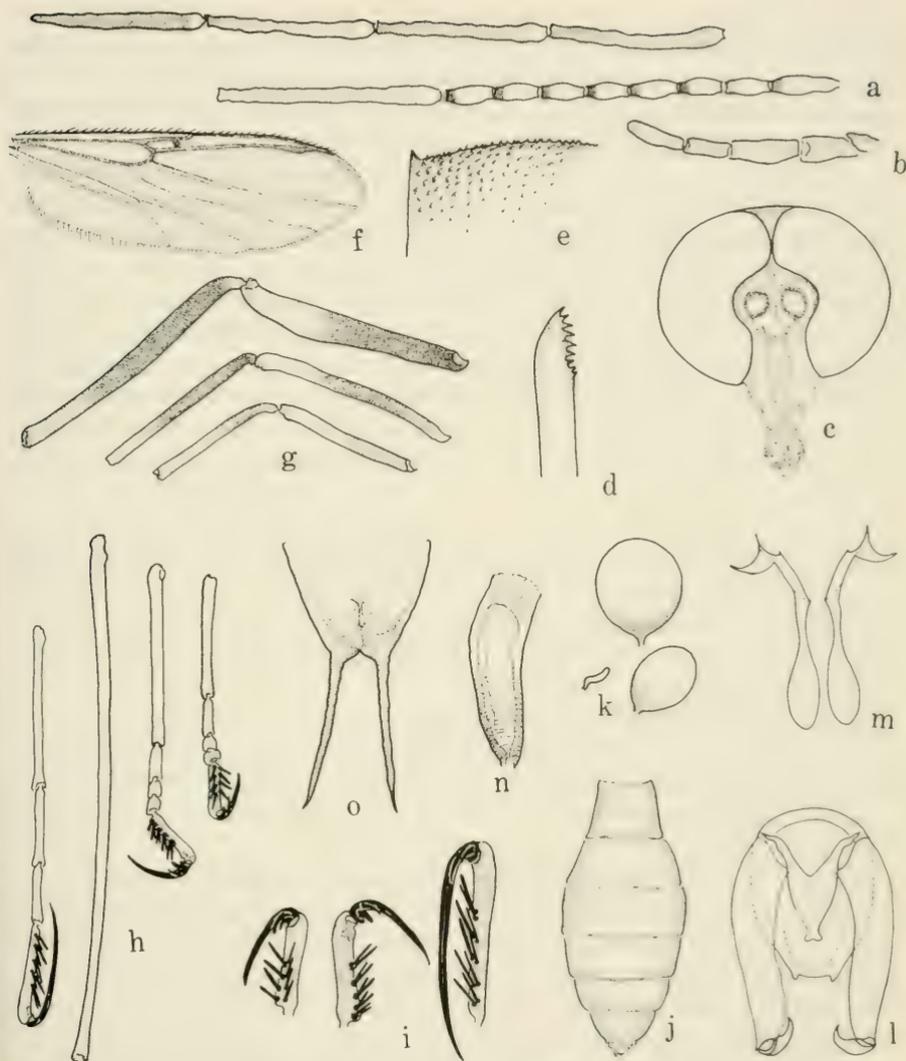


Fig. 1. *Dibezzia debenhamae*. a-k, Female. l-m, Male. n-o, Pupa. a, Antenna, b, Palpus. c, Head, anterior view. d, Mandible. e, Side view of anterior portion of mesonotum. f, Wing. g, Femora and tibiae of (top to bottom) hind-, mid-, and forelegs. h, Farsi of (left to right) hind-, mid-, and forelegs. i, 5th tarsomeres and claws of (left to right) fore-, mid-, and hindlegs. j, Abdomen, dorsal view. k, Spermathecae. l, Male genitalia, parameres removed. m, Parameres. n, Respiratory horn. o, Terminal abdominal segment.

without ventral palisade setae, on hindbasitarsus 1 complete row of palisade setae and a 2nd row on proximal 0.7; midtibia with a strong black distal spine; a pair of strong black ventral spines at apices of tarsomeres 1 and 2 on midlegs; 4th tarsomeres short and transverse but not distinctly cordate on fore- and midlegs, long and cylindrical on hindlegs; hindtarsi extremely long and slender, hindbasitarsus $1.03\times$ as long as its tibia; 5th tarsomeres with 4 pairs of strong black ventral batonnets on fore- and midlegs, 5 pairs on hindleg. Claws (Fig. 1i) long and unequal on all legs, each with a short external basal tooth; the long claw about as long as 5th tarsomere on fore- and midlegs, $1.2\times$ as long on hindleg; the short claw about $\frac{1}{4}$ as long as the other on fore- and midlegs, $0.13\times$ as long on hindleg. Wing (Fig. 1f) pale brownish hyaline, veins dark brown; 2 radial cells, the 2nd $4\times$ as long as 1st; vein R4+5 with a distinct swelling near tip bearing 2 minute hyaline sensory pits; costa prolonged slightly past tip of 2nd radial cell; costal ratio 0.85; media broadly sessile at base; basal cell rather broad distally. Halter dark brown.

Abdomen: Dark brown; petiolate at base (Fig. 1j). Spermathecae (Fig. 1k) 2 plus rudimentary 3rd; unequal, each with short slender neck, the larger nearly spherical, measuring 0.115 by 0.087 mm and the other oval, measuring 0.080 by 0.058 mm including necks.

Presumed δ allotype.—Wing length 1.52 mm; breadth 0.50 mm. Color markings as in female.

Head: Antenna with lengths of flagellar segments in proportion of 35–22–20–18–16–16–16–18–20–46–115–95; antennal ratio 1.30; plume short and sparse, not reaching past tip of segment 13. Palpus with lengths of segments in proportion of 6–10–20–16–20; 3rd segment about $2\times$ as long as broad, without sensory pit.

Thorax: Mesonotum with prominent anterior spine; microtubercles sparse. Legs with sparse coarse bristlelike setae much longer than in female; hindfemur less clavate than in female. Hindtibial comb with 7–9 brownish spines, spur poorly developed. Midleg with 1 row of palisade setae on basitarsus; hindleg with 2 rows on basitarsus, 1 row on 2nd tarsomere. Fourth tarsomeres $1.5\times$ as long as broad, broadened distally but not cordate; 5th tarsomeres unarmed; claws small and equal, nearly straight. Wing brownish infuscated, veins darker; costa shorter than in female, costal ratio 0.75; 2nd radial cell only $2.4\times$ as long as first. Halter pale brown.

Abdomen: Uniformly brownish. Genitalia (Fig. 1l) elongate; 9th sternum a narrow transverse band; 9th tergum ovoid, moderately long, with a pair of short setose apicolateral lobes. Basistyle long and slender, nearly $6\times$ as long as breadth at midlength, surpassing tip of tergum by $\frac{1}{3}$ of its length, nearly straight; dististyle a short, curved, hooklike appendage about $\frac{1}{5}$ as long as basistyle. Aedeagus a typical Y-shaped sclerite with short, nearly

straight basal arms, basal arch extending to nearly $\frac{1}{2}$ of total length; distal portion with sides slightly convex and tapering to moderately slender, slightly bilobed tip. Parameres (Fig. 1m) separate, each with short basal apodeme and slender, nearly straight basal portion; distal $\frac{1}{2}$ gradually expanded in a clavate, paddlelike structure with rounded tip extending not quite to apex of 9th tergum.

Pupal exuviae of ♂ allotype.—Length about 4 mm. Color uniformly yellow, respiratory horns slightly darker amber brown. Respiratory horn (Fig. 1n) 0.63 mm long, $3.6\times$ as long as greatest breadth, narrow at base, slightly bent at distal $\frac{1}{3}$; basal 0.6 with transverse wrinkles; bearing at apex a row of 9–11 spiracular openings. Cephalothorax without prominent spines or tubercles; preapical abdominal segments each with 3 pairs of long, sharp-pointed, lateral posteromarginal spines, other tubercles not developed; terminal segment (Fig. 1o) with a straight, caudally directed pair of long, slender, pointed processes, longer than basal portion of segment.

Distribution.—Malaysia, Thailand.

Types.—Holotype ♀, Kuala Singgora, Pahang, Malaysia, 17 July 1958, R. H. Wharton, light at edge of padi field (type no. 70676, USNM). Allotype male with pupal exuviae, Singapore, June 1959, D. H. Colless, reared from pupa in tree hole (USNM). Paratypes, 2 ♂, 6 ♀, as follows: MALAYSIA: Pahang, same data as for holotype except collected 15 Feb. 1959 at Maran, 1 ♀ (USNM); Singapore, same data as for allotype (CSIRO, Canberra, Australia); Selangor, Ulu Gombak Forest Reserve, 9 Oct. 1960, H. E. McClure, reared, 1 ♂ (USNM). THAILAND: Chiang Mai, April–May 1958, V. Notananda, light trap, 1 ♀ (USNM); Chiang Mai, Ampur Muang, July, Nov. 1962, J. E. Scanlon, light trap, 2 ♀ (Bishop Museum, Honolulu; Thailand Inst. Sci. Tech. Res., Bangkok); Nong Kai, Ta Bo Dist., 15–16 June 1959, Manop R., light trap, 1 ♀ (British Museum [Nat. Hist.], London); Udon Thani, Ampur Muang, Sept. 1962, J. E. Scanlon, light trap, 1 ♀ (USNM).

Discussion.—The species is named for Dr. Margaret L. Debenham of the University of Sydney in recognition of her significant contributions to the taxonomic knowledge of Australian ceratopogonids, especially her monograph on the Australian Heteromyiini and Sphaeromyiini (1974).

Dibezzia debenhamae is readily separated from *D. clavata*, the only other known Oriental species, by the characters given in the key. We are reasonably confident that we have correctly associated the male sex of this species, but some doubt remains because we do not have a reared association with matching pupae. The significantly shorter male costa and second radial cell, as well as the difference in segmental distribution of the palisade setae on the tarsi and the color of the spines in the hindtibial comb, cause us some doubts as to the association.

Mackerrasomyia indica (Kieffer), NEW COMBINATION

Heteromyia indica Kieffer, 1913: 183 (female; India); Brunetti, 1920: 55 (catalog reference); Edwards, 1933: 254 (notes; compared with *Palpomyia pendleburyi* Edwards).

Dibezzia indica (Kieffer); Wirth, 1973: 379 (combination; catalog reference).

Type.—♀, Maddathoray, base of W. Ghats, Travancore, 17 Nov., 1 ♀ (N. Annandale) (in Indian Museum, Calcutta).

Discussion.—Wirth (1973) placed this species in *Dibezzia* on the basis of Kieffer's statement that the female tarsal claws are unequal on all legs. However, on rereading Kieffer's description it appears that Wirth's placement was erroneous for the following reasons: Kieffer described *Heteromyia indica* as having the forefemur very swollen, studded with spinules on all the ventral surface that also is traversed by a longitudinal furrow; the foretibia is weakly arcuate, placed in this furrow in repose. In addition all the fourth tarsomeres are cordiform. The female tarsal claws are described (on all legs) as unequal, the larger simple, equally half the length of the tarsomere, the other slightly shorter, with a curved basal tooth attaining a fourth the length of the claw. The structure of the forefemur and foretibia and the cordiform fourth tarsomeres are characteristic of the genus *Mackerrasomyia* Debenham and not easily confused with *Dibezzia* species; the description of the claw structure is somewhat ambiguous and would fit *Mackerrasomyia* if Kieffer had viewed the claws at an angle so that one would appear foreshortened. Kieffer described the mid- and hindfemora of *indica* as unarmed, which does not fit the known species of *Mackerrasomyia*.

Otherwise *M. indica* is similar to the only other known Oriental species, *Mackerrasomyia caesia* (Macfie) (combination by de Meillon and Wirth, 1979), but the latter differs in having the foretibia dark brown at the base and tip instead of all pale and the midtibia pale on the proximal $\frac{2}{3}$ rather than on the distal half, and the mid- and hindfemora are each armed ventrally with two spines.

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A NEW MICROPTEROUS SPECIES OF *CARVENTUS* STÅL
FROM CHILE (HEMIPTERA: ARADIDAE)

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Abstract.—The new species *Carventus chilensis*, here described, is the second American species of the genus. It is also the second case of micropterism for *Carventus*, the other having been described from Sri Lanka.

Through the kind offices of Henry Brailovsky, Seccion Entomologia, Instituto de Biologia UNAM, Mexico 20, Mexico, I had the privilege of studying two small lots of Aradidae, one from Chile, the other from Central America. For this I express my sincere gratitude.

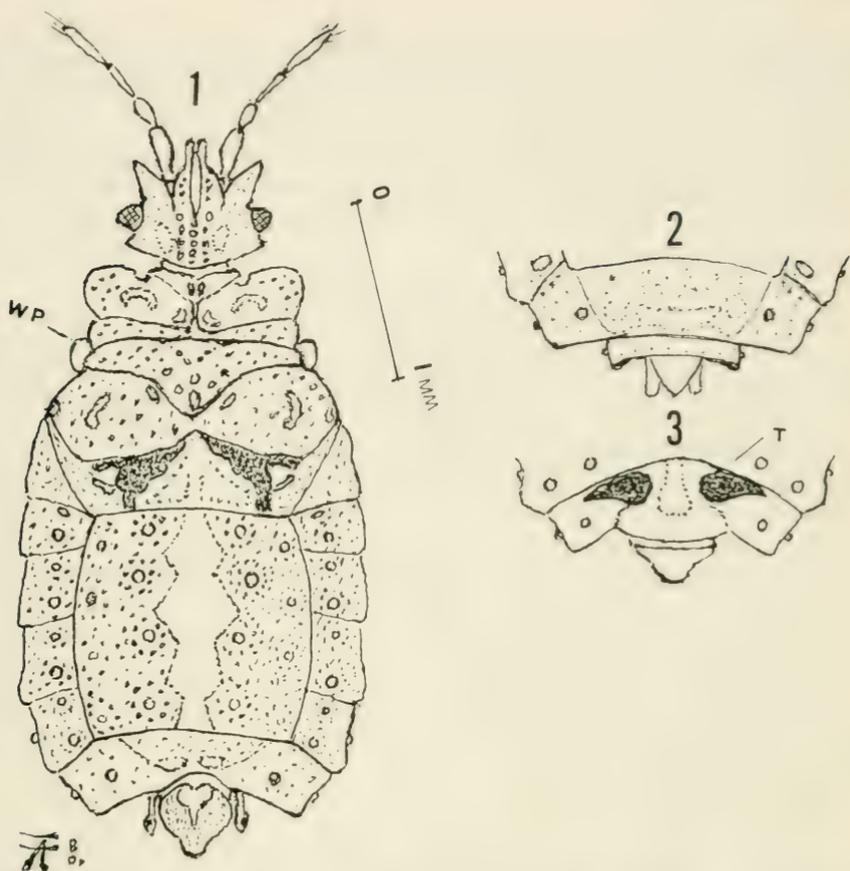
The Chilean specimens, mostly of common species, included two specimens of a new species of the genus *Carventus* Stål (1865). *Carventus* is primarily Australo-Oriental, including some 40 species occurring in the area from Sri Lanka and China south to Samoa and Tasmania. In the Americas, *Carventus* was previously represented by the single species, *Carventus mexicanus* Bergroth (1895), which, like most members of the genus, is macropterous; it was reported from Mexico and Panama. The Chilean Aradidae fauna is poor and now contains six species in five subfamilies: Aradinae, Carventinae, Isoderminae, Mezirinae, and Prosympiestinae.

The Central American collection, mostly of common species, contained a single Costa Rican specimen of *Aneururus hrnyi* Štys (1875) previously reported only from Cuba.

All measurements in this paper were taken with a micromillimeter eyepiece, 25 units = 1 mm. In the ratios the first figure represents the length and the second the width of parts measured.

Subfamily CARVENTINAE
Genus *Carventus* Stål, 1865
Carventus chilensis Kormilev, new species
Figs. 1-3

Male.—Elongate ovate; granulate and covered with thin layer of white incrustation. Micropterous.



Figs. 1-3. *Carventus chilensis*. 1, ♂, aspect from above; WP = wing pads. 2, ♀, tip of abdomen from above. 3, ♂, tip of abdomen from below, T = tubercles on sternum VII.

Head: Shorter than width across eyes (18:21); anterior process slightly constricted laterally, cleft apically, almost reaching tip of antennal segment I. Antenniferous tubercles stout, divaricate, blunt. Eyes small, semiglobose, strongly protruding. Postocular tubercles blunt, not reaching outer borders of eyes. Vertex with three parallel rows of granules; infraocular callosities small, ovate. Antennae thin, slightly longer than width of head across eyes (22.5:21); relative length of segments I to IV, 7:4:6.5:8. Labium reaching hindborder of labial groove, latter closed posteriorly.

Pronotum: Short and wide (10:28), posterior border straight. Hind-lobe strongly abbreviated, on median line $\frac{1}{4}$ as long as forelobe. Collar slightly sinuated anteriorly, separated from disc by deep incisures laterally. Antero-lateral angles broadly rounded, slightly produced forward and sideways, discally forming transverse lobes, granulate on surface. Lateral borders sinuate, without lateral tooth, incised between lobes. Foredisc with 2 (1+1)

short carinae, formed by fused granules, just behind collar; between these carinae and interlobal sulcus extends the narrow, deep median sulcus. Laterad of median sulcus disc granulate, with 4 (2+2) curved callosities. Hind-disc very short medially and slightly longer laterally.

Scutellum: Short and wide (10:28); lateral borders sinuate; apex angular; disc with dispersed granulations laterad of granulate median carina.

Metanotum: Forming 2 (1+1) large, transversely ovate plates, each plate with dispersed granulations and a curved callosity in the middle.

Hemelytra: Reduced to small pads, placed laterad of scutellum.

Abdomen: Subrectangular, longer than its maximum width across segment V (55:46). Tergum I in the form of 2 (1+1) triangular, oblique callosities fused with tergum II. The latter granulate, incrustate and produce forward medially separating callosities of tergum I. Central dorsal plate, consisting of terga III to VI, rectangular and flat; with a large flat median callosity with zig-zag lateral borders. Laterad of median callosity disc is granulate, incrustate, with apodemal impressions formula 1:1:2. Tergum VII is obliquely elevated over base of hypopygium, granulate, and incrustate. Connexivum wide; postero-exterior angles progressively more protruding and rounded; PE-VII rectangular. Paratergites clavate, reaching middle of cordate, declivous hypopygium, latter shorter than its maximum width (10:12). Spiracles II ventral, placed far from border; II to V also ventral but placed nearer to border; VI and VII lateral and visible from above; VIII dorsolateral. Sternum VII with 2 (1+1) large, shiny callosities, laterally attenuate and terminating in a point.

Legs: Unarmed.

Color: Yellow brown, incrustation white.

Female.—Similar to male but larger. Paratergites short, rounded posteriorly, reaching basal $\frac{1}{3}$ of tricuspidate segment IX. Sternum VII without callosities. Spiracles VIII lateral.

Measurements: Head, 20:22; relative length of antennal segments I to IV, 7:4:7.5:9; pronotum, 12:32.5; scutellum, 10:31; abdomen, 65:52 (across segment IV); width of metanotum, 42:5; width of tergum VIII, 18.

Total length.—♂, 3.76, ♀, 4.40 mm; width of pronotum: ♂, 1.12, ♀, 1.30 mm; width of abdomen: ♂, 1.84, ♀, 2.08 mm.

Holotype.—♂, CHILE, Prov. Ñuble, Los Troncos; 25.V.1977, G. Moreno leg. Deposited at the Seccion Entomologia, Instituto de Biologia UNAM, Mexico 20, Mexico.

Allotype.—♀, CHILE, Prov. Concepción, Neuquén; 4.X.1972, T. Cekalovic leg. Deposited in the Kormilev collection.

Remarks.—The presence of callosities on sternum VII of the males allies *C. chilensis* to the Australo-Oriental species, all of which have callosities or calloused tubercles on that segment. In contrast, the single American

species of the genus, *C. mexicanus* Bergroth, and the subgenus *Burgeonia* Schouteden, which contains all the African species of it, lack these modifications of sternum VII of the males.

Carventus chilensis is related to *C. micropterus* Kormilev and Heiss (1979) from Sri Lanka but is smaller in size; has the anterolateral angles of pronotum forming ovate lobes; has the posterior pronotal disc more abbreviated; has antennal segment IV (not I) longest; and has a different positioning of the spiracles.

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DESCRIPTION OF THE ADULT OF *EPHEMERELLA BERNERI* ALLEN
AND EDMUNDS (EPHEMEROPTERA: EPHEMERELLIDAE)
WITH BIOLOGICAL NOTES

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Abstract.—The adult of *Ephemerella berneri* Allen and Edmunds is described for the first time. Male genitalic characters ally this species with *Ephemerella needhami* McDunnough. Notes on the biology and distribution of *E. berneri* are also given.

Ephemerella berneri was described by Allen and Edmunds (1958) from larvae collected in Georgia and Virginia. The adult has remained undescribed (Allen and Edmunds, 1965). We recently found large populations of *E. berneri* larvae in several 5th and 6th order streams in southwestern Virginia. In order to describe the adult, we reared several larvae in the laboratory.

Ephemerella berneri Allen and Edmunds

Male imago (in alcohol).—Body length 12 mm, forewing 10.5 mm. Head predominantly black; clypeus white; antenna black; upper portion of compound eye red, lower portion orange. Thorax black; anterior lateral faces of scutum yellow; areas anterior to mesocoxa yellow; pleural membranes tan; sterna black. Foreleg black, mid- and hindlegs white; all coxae tan. Wings hyaline with longitudinal veins brown; costal area of forewing tinged with tan. Abdominal terga 1-8 chestnut brown, with pale transverse band near posterior margin of each segment; terga 9-10 black; abdominal sterna tan. Penes without spines (Fig. 1), having long apical lobes with a deep median notch; dorsal surface black; ventral surface white. Genital forceps white with 2nd segment expanded apically (Fig. 1) and edged with black. Caudal filaments white with dark brown articulations.



Fig. 1. *Ephemerella bernerii*, dorsal view of male genitalia.

Female imago (in alcohol).—Body length 12 mm, forewing 10.5 mm. Maculation somewhat paler but very similar to male.

Material examined.—Smith River, County Route 674, Henry Co., Virginia, B. C. Kondratieff, 7♂ imagos, 3♀ imagos (reared), emerged 7 May 1980 from larvae collected 26 April 1980; Little River, County Route 787, Montgomery Co., Virginia, B. C. Kondratieff, 1♀ imago (reared), emerged 19 May 1980 from larvae collected same day. All deposited in the VPI & SU Collection.

Remarks.—*Ephemerella bernerii* is allied to *Ephemerella needhami* McDunnough in the structure of the male genitalia. Both species have penes with long apical lobes and a deep median notch and lack penal spines. *Ephemerella bernerii* can be readily distinguished from *E. needhami* by having the second segment of the genital forceps with an apical expansion and by the striking color pattern of the imago. Males of *E. bernerii* can be iden-

tified using the key on page 249 in Allen and Edmunds (1965), with the following modifications:

- 8(7). Penes without spines 8A
 – Penes with dorsal and/or median spines; 2nd segment of genital forceps with a slight apical expansion 9
 8A(8). Second segment of genital forceps without apical expansion *needhami* McDunnough
 – Second segment of genital forceps with apical expansion *berneri* Allen and Edmunds

Biological notes.—*Ephemerella beneri* larvae were collected from thick mats of *Podostemum ceratophyllum* (Michaux) (river weed) on rocks in riffle areas. Larvae were common in several 5th and 6th order rivers in the Ridge and Valley and Piedmont physiographic provinces of Virginia: New River (Montgomery and Carroll Cos.), Little River (Montgomery and Pulaski Cos.), and Smith River (Henry Co.). Larvae were especially abundant in the Smith River below Philpott Reservoir, averaging 210 larvae/m². This site is approximately 5 km below Philpott Dam, a deep release reservoir. The substrate is characterized by exposed bed rock, coarse pebble (32–64 mm), and some cobble (64–256 mm) covered by a thick carpet of riverweed during the warm months. According to Virginia Division of Water Resources (1975) mean annual water temperature at this site is 11.7°C. Dissolved oxygen concentration averages near saturation (93%) and the water exhibits circumneutral pH (range 6.7–7.8, average 7.0).

Subimagoes of *E. beneri* emerged from early afternoon to early evening (ca. 2:00–8:00 PM). Full-grown larvae floated to just below the surface of the water in areas of moderate current and then emerged instantaneously. Water temperature at the time of observed emergence was 13.9°C. Other mayflies associated with *E. beneri* were *Ephemerella invaria* (Walker) and *Serratella serratoides* (McDunnough).

Ephemerella beneri was also common in the Ocoee (Toccoa) River, Georgia, above and below Blue Ridge Reservoir. Here larvae were associated with *Fontinalis* sp. (watermoss) or tangles of exposed roots of riparian vegetation.

ACKNOWLEDGMENTS

We thank Gary J. Griffin, Department of Plant Pathology and Physiology, VPI & SU, for sharing his observations on the biology of *E. beneri*. James H. Kennedy and Douglas A. Howell kindly collected additional material.

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**BIOLOGY AND IMMATURE STAGES OF
LYTOGASTER EXCAVATA, A GRAZER OF BLUE-GREEN
ALGAE (DIPTERA: EPHYDRIDAE)¹**

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Abstract.—Information is presented on the life cycle and larval feeding habits of *Lytogaster excavata* (Sturtevant and Wheeler), a widely distributed species of the ephydrid tribe Hyadini. Larvae are trophically specialized and apparently restricted to feeding on blue-green algae. In northeastern Ohio, the life cycle can be completed in ca. 30 days, and there are probably five generations a year. The egg and mature larva are described and illustrated. The life history strategy of this specialist species is contrasted and compared to that of *Scatella stagnalis* Fallén, a generalist species.

The family Ephydridae, with over 1200 described species distributed in all of the major faunal regions, is one of the largest entities within the acalyprate Diptera (Rohdendorf, 1974). Over 400 species and 68 genera have been recorded from America north of Mexico (Deonier, 1979), and an equally large fauna occurs in the Neotropics (Wirth, 1968). As would be expected in such a large and diverse taxon, considerable adaptive radiation in larval feeding habits has occurred, although the majority of species appear to be microphagous. Larvae are known to utilize a great variety of algae (Brock et al., 1969; Deonier and Regensburg, 1978; Foote, 1979), heterotrophic microorganisms (Eastin and Foote, 1971), and detritus (Busacca and Foote, 1978; Deonier et al., 1979). However, larvae of particular genera have acquired more specialized feeding habits. For example, larvae of *Hydrellia* are leaf miners (Deonier, 1971), those of *Platygyrnopa* utilize decaying snails (Wirth, 1971), *Trimerina* larvae prey on spider eggs (Becker, 1926), and those of *Ochthera* are predators of chironomid and other soft-bodied larvae (Simpson, 1975).

This paper is the second of a series that deals with the biology of species

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of Ephydriidae whose larvae utilize blue-green algae (Foote, 1977). At least nine species of the tribe Hyadini of the subfamily Parydrinae have larvae that are associated with colonies of soil-inhabiting blue-green algae occurring in wetland habitats (Foote, 1977). One of the more common hyadine genera reared from field-collected samples of Cyanophyceae has been *Lytogaster*, a genus that currently contains seven species in the Nearctic Region.

The present paper elucidates the life cycle, discusses the larval feeding habits, and describes and illustrates the immature stages of *L. excavata* (Sturtevant and Wheeler), a widely distributed species that has been repeatedly reared from colonies of the genus *Cylindrospermum*.

MATERIALS AND METHODS

Field work was carried out in Arizona, Montana, and Ohio. Most of the information was obtained from studies initiated in Portage County, Ohio, in the northeastern quadrat of the state. Supplementary observations and rearings were obtained in the foothills of the Santa Catalina Mountains near Tucson, Arizona, and along the south shore of Flathead Lake in northwestern Montana.

The laboratory rearings were carried out in an environmental chamber programmed to give a photoperiod of 15L:9D and a temperature of 22°C. ($\pm 1^\circ\text{C}$). Monocultures of most of the algae used in the larval feeding tests were obtained from the University of Texas Culture Collection of Algae (Starr, 1978). Each algal monoculture was established on a nutrient agar substrate in sterile Petri plates, and feeding tests were performed as outlined in Zack and Foote (1978). Monocultures of algae utilized in the tests, along with their UTEX strain numbers, are listed below. Species lacking UTEX numbers were obtained from the Phycology Laboratory at Kent State University.

Cyanophyceae

- Anabaena variabilis* (B-377)
- Anabaena flos-aquae* (1444)
- Anacystis nidulans* (625)
- Cylindrospermum* sp. (LB-942)
- Gloeocapsa alpicola* (B-589)
- Lynghya* sp. (487)
- Nostoc commune* (584)
- Oscillatoria chalybea* (B-386)
- Oscillatoria tenuis* (B-428)
- Phormidium* sp. (1540)
- Synechococcus leopoliensis* (625)

Chlorophyceae

Chlamydomonas sp.*Chlorella vulgaris* (29)*Cosmarium botrytis* (175)

Bacillariophyceae

Navicula pelliculosa (668)

Chrysophyceae

Botrydiopsis alpina (295)*Botrydium becherianum* (158)

LIFE HISTORY

Adults of *L. excavata* have been swept primarily from shoreline and marshy habitats containing herbaceous vegetation. Deonier (1965) reported this species as occasional in the limnic-wrack, marsh-reed, and sedge-meadow habitats and rare in the sand-shore habitat in Iowa. In northeastern Ohio, Scheiring and Foote (1973) recorded it as abundant in sedge meadows, occasional on limnic wrack and muddy shores, and rare on sandy shores.

The flight period extends throughout the warm season. Adults have been taken as early as mid-May and as late as early October in northeastern Ohio. The overwintering stage is unknown, but many species of Ephydriidae overwinter as adults.

Field-collected adults survived up to 25 days in the laboratory, whereas reared individuals rarely lived more than 20 days. Females had the greater longevity, typically outliving the males by 5–10 days. In laboratory rearing chambers, adults lived for several days in cultures of the blue-green algae *Anabaena* and *Cylindrospermum*, but died within 3–5 days when provided with a monoculture of *Chlorella*. Adults have been observed in nature applying their mouthparts to surfaces of colonies of *Cylindrospermum*, and gut samples of field-collected imagines usually contained numerous trichomes of that genus.

The premating period varied from 3–5 days ($n = 6$) if males were continuously available in the breeding jars. The preoviposition period was somewhat more variable, ranging from 5–10 days ($n = 6$) under laboratory conditions. No overt courtship displays were observed, and mating seemed to be of the "assault" type (Spieth, 1974) in which males attempt to mate with any suitably sized individual.

Mating was observed in a pair of adults collected in a sedge meadow bordering the south shore of Flathead Lake, Montana. The pair was confined to a large petri dish that contained a monoculture of *Cylindrospermum*. When first observed the male was "riding" the relatively immobile female,

being dorsad and parallel to her body. His front tarsal claws were hooked over the anterior edge of her oral cavity. Her wings were spread at about a 45° angle from the longitudinal axis of the body. After 55 seconds, the male moved posteriorly, assumed a nearly vertical position, and grasped the female's genitalia with his claspers. During copulation, his front tarsi repeatedly stroked the anterior surface of the female's mesonotum and the posterior portion of her head. His midtarsi were hooked over the wing bases of the female's divergent wings, while his hind tarsi were loosely appressed to the venter of the female's abdomen slightly anterior to the genital segments. Copulation lasted less than 60 seconds after which the male broke genitalic contact and moved forward to reassume the "riding" position. This alternation of positions occurred three times within a five minute time period before the male decamped.

Four recently mated females were placed for 24-hour periods in petri dishes containing monocultures of algae to determine whether particular algal cultures were more suitable as oviposition sites. Numerous eggs were obtained in cultures of *Anabaena*, *Cylindrospermum*, *Lyngbya*, *Nostoc*, and *Oscillatoria*, but only two eggs were deposited in a *Navicula* plate, and no oviposition occurred in a culture of *Chlorella*. In contrast to the laboratory results, eggs in nature were found only on growths of *Cylindrospermum*, even though numerous colonies of other soil-inhabiting blue-green algal genera were examined. No eggs or larvae were found on colonies of *Anabaena*, *Lyngbya*, *Nostoc*, or *Oscillatoria* that occurred in habitats containing females of *L. excavata*. An additional example of host selectivity by ovipositing females was the discovery of several eggs and larvae of *L. excavata* on a small colony of a species of *Cylindrospermum*, whereas only immature stages of another hyadine species, *Axysta cesta* (Haliday), were found on a growth of *Lyngbya* occurring within 12 cm of the *Cylindrospermum*. Both types of algae were growing on sodden, decaying leaves and soil at the margin of a partly shaded woodland pool. Females of *L. excavata* apparently restrict their oviposition in nature to patches of the host alga, as no eggs were found on moist substrates surrounding an algal colony. A similar selectivity was noticed among females confined to petri plates containing monocultures of blue-green algae. Less than 5% of the eggs were placed on the agar surface itself; most were deposited on the denser algal growths. Eggs were scattered over the surface of the algal colonies or were slightly imbedded. No clustering of eggs was noticed, and they appeared to be deposited singly.

Although exact data were not obtained, some information on the fecundity of individual females is available. A female collected on May 5, 1977, near Kent, Ohio, deposited a total of 34 eggs before dying on May 31. Another female collected on the same date produced 32 eggs before expiring on May 27. The potential fecundity undoubtedly exceeds these values. A field-col-

Table 1. Results of larval feeding tests for *L. excavata* using different algal monocultures.

Alga	Percent Reaching Different Life Stages				
	n	2L	3L	P	A
Cyanophyceae					
<i>Anabaena flos-aquae</i>	30	100	100	20	0
<i>Anabaena variabilis</i>	20	75	70	70	70
<i>Anacystis nidulans</i>	10	0	0	0	0
<i>Cylindrospermum</i> sp.	30	57	47	47	40
<i>Gloeocapsa alpicola</i>	10	0	0	0	0
<i>Lyngbya</i> sp.	10	80	80	80	0
<i>Nostoc commune</i>	10	70	0	0	0
<i>Oscillatoria chalybea</i>	30	0	0	0	0
<i>Oscillatoria tenuis</i>	30	30	0	0	0
<i>Phormidium</i> sp.	30	77	63	33	30
<i>Synechococcus leopoliensis</i>	30	0	0	0	0
Chlorophyceae					
<i>Chlamydomonas</i> sp.	20	0	0	0	0
<i>Chlorella vulgaris</i>	30	0	0	0	0
<i>Cosmarium botrytis</i>	10	0	0	0	0
Bacillariophyceae					
<i>Navicula pelliculosa</i>	30	0	0	0	0
Xanthophyceae					
<i>Botrydiopsis alpina</i>	10	0	0	0	0
<i>Botrydium becherianum</i>	10	0	0	0	0

lected female that was dissected in the laboratory possessed 20 and 21 ovarioles in the two ovaries, respectively. Each ovariole possessed one mature egg, implying a potential fecundity of at least 40 eggs.

The incubation period varied between two and three days and averaged 58 hours ($n = 12$). Newly hatched larvae quickly began feeding on the algal substrate in the immediate vicinity of the eggs.

The results of larval feeding tests using monocultures of 17 species of four classes of algae are presented in Table 1. Larvae completed development and eventually produced adults in cultures of *Anabaena variabilis*, *Cylindrospermum* sp., and *Phormidium* sp., but failed to complete development on *Anabaena flos-aquae*, *Anacystis nidulans*, *Gloeocapsa alpicola*, *Lyngbya* sp., *Nostoc commune*, *Oscillatoria chalybea*, *O. tenuis*, *Chlamydomonas* sp., *Chlorella vulgaris*, *Cosmarium botrytis*, *Navicula pelliculosa*, *Botrydiopsis alpina*, and *Botrydium becherianum*. Eight of ten larvae formed puparia in the *Lyngbya* plates, but failed to produce adults. Somewhat similarly, 20 of 30 newly hatched larvae that were placed in a culture of *A. flos-aquae* eventually reached the third instar but then failed to form

Table 2. Developmental times for *L. excavata* on different algal monocultures.

Alga	Larval Period		Pupal Period		Combined Period	
	\bar{x}	s	\bar{x}	s	\bar{x}	s
<i>Anabaena variabilis</i> (n = 18)	12.3	2.53	14.0	1.94	26.2	3.83
<i>Cylindrospermum</i> sp. (n = 9)	12.3	0.87	11.1	2.37	23.4	3.01
<i>Phormidium</i> sp. (n = 9)	22.3	2.10	18.4	3.95	40.7	4.99

puparia, even after 17 days in the third stadium. In contrast, cultures of the remaining algae apparently were completely unsuitable nutritionally, as all larvae died while still in the first or second stadium.

Differences in the larval and pupal developmental periods were noted even among the algae that were suitable larval foods (Table 2). Thus the combined larval-pupal period was nearly doubled in larvae that were reared on *Phormidium* compared to those that fed on *Anabaena* or *Cylindrospermum*.

The larval period ranged from 11–13 days and averaged 12.3 days when larvae were reared on *Cylindrospermum*. This period was somewhat more variable when *Anabaena* was the larval food, ranging from 10–19 days (\bar{x} = 12.3). In contrast to larvae of many other species of Ephydriidae (Eastin and Foote, 1971; Foote and Eastin, 1974; Deonier and Regensburg, 1978), those of *Lytogaster* usually fed on the surface of the algal colony and made little effort to bury themselves into the substrate, although a few strands of algae commonly were scattered over the dorsal surface of a larva. Larvae feeding within an algal colony moved about very little and seemed quite sluggish compared to other ephydrid larvae. However, larval activity increased significantly when the algal substrate was largely consumed. Larvae established on algal monocultures in petri dishes freely moved to other colonies once the original colony became depleted. Third-instar larvae survived 5–6 days without food, whereas the earlier instars survived only 2 or 3 days.

Table 3. Life cycle data for *L. excavata* in northeastern Ohio. All rearings were maintained at 22°C, with *Cylindrospermum* sp. serving as the adult and larval food.

Flight Period	Mid-May to Late October
Premating Period	3–5 days
Preoviposition period	5–10 days
Incubation period	2–3 days
Larval period	11–13 days
Pupal period	8–13 days
Adult longevity	Ca. 25 days
Fecundity	30 ± eggs/female

Larvae frequently fed together on an algal colony, seemingly without mutual interference. As many as six nearly mature larvae were found in nature on a nearly circular patch of *Cylindrospermum* having a diameter of approximately 3.0 cm. Near Tucson, Arizona, 47 larvae were found in a Petri dish (2.84 cm²) sample of a colony of *Cylindrospermum* growing on moist sand. Larvae of *Lytogaster* commonly occurred together with those of other species of Hyadini. In northeastern Ohio, the associated species were *Hyadina binotata* (Cresson) and, occasionally, *Pelina truncatula* Loew. In southcentral Arizona, larvae of *Lytogaster* were associated with those of *H. binotata* and *P. truncatula*. In all, nine species of Hyadini have been reared from field-collected colonies of *Cylindrospermum* (Foote, 1977).

Approximately 24 hours prior to forming puparia, larvae ceased feeding and moved to slightly higher areas of the algal colony. Puparia were buried in the algal substrate except that the anterior and posterior spiracles typically were exposed to ambient air. The pupal period for larvae that had fed on *Cylindrospermum* in laboratory cultures ranged from 8–13 days and averaged 11.1 days ($n = 9$). In contrast, pupae formed by larvae that had fed on *Phormidium* developed much more slowly, requiring an average of 18.4 days (Table 2).

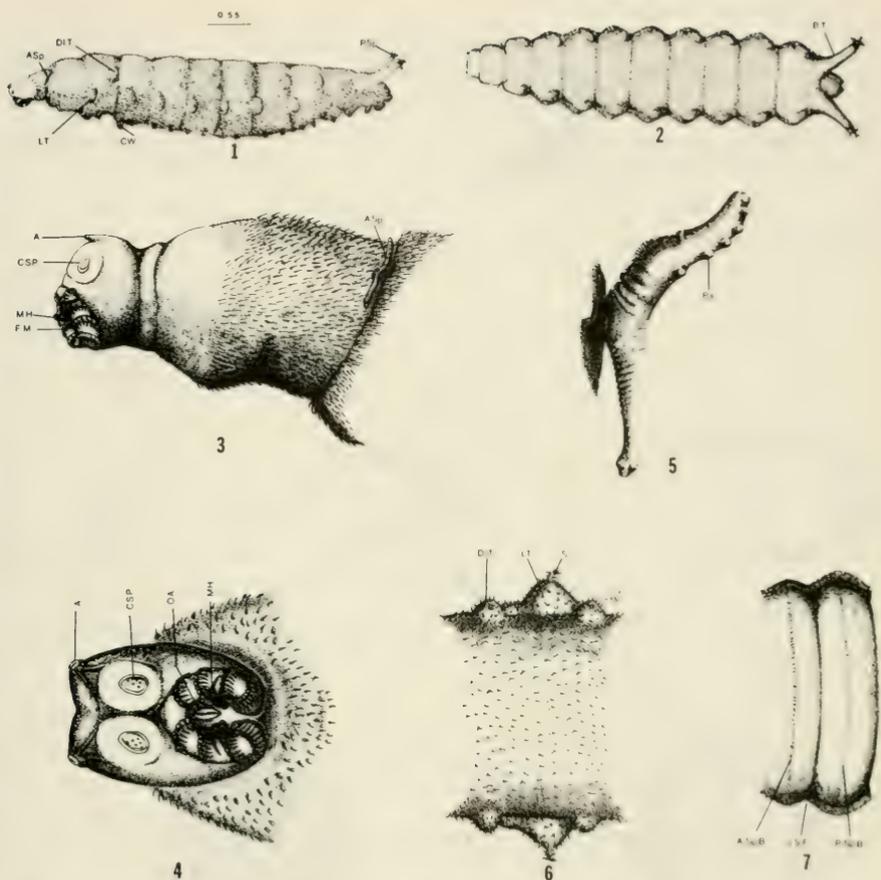
Under laboratory conditions using either *Anabaena* or *Cylindrospermum* as larval food, the life cycle could be completed in approximately 30 days (Table 3). This suggests that 5–6 generations could be produced in northeastern Ohio during a warm season that extends from mid-May to late October (175 days). Adults and larvae were found in nature during February in southern Arizona, suggesting that there is a more or less continuous cycling of generations in more southerly latitudes.

DESCRIPTIONS OF IMMATURE STAGES

Egg (Fig. 15).—Length 0.46–0.54 mm, $\bar{x} = 0.51$; width 0.19–0.23 mm, $\bar{x} = 0.22$ ($n = 10$). Ovoid, more curved ventrally than dorsally. White. Chorion mostly striated; micropylar end upturned and without longitudinal striations, bearing low encircling ridge; opposite end bluntly rounded, slightly upturned but lacking encircling ridge.

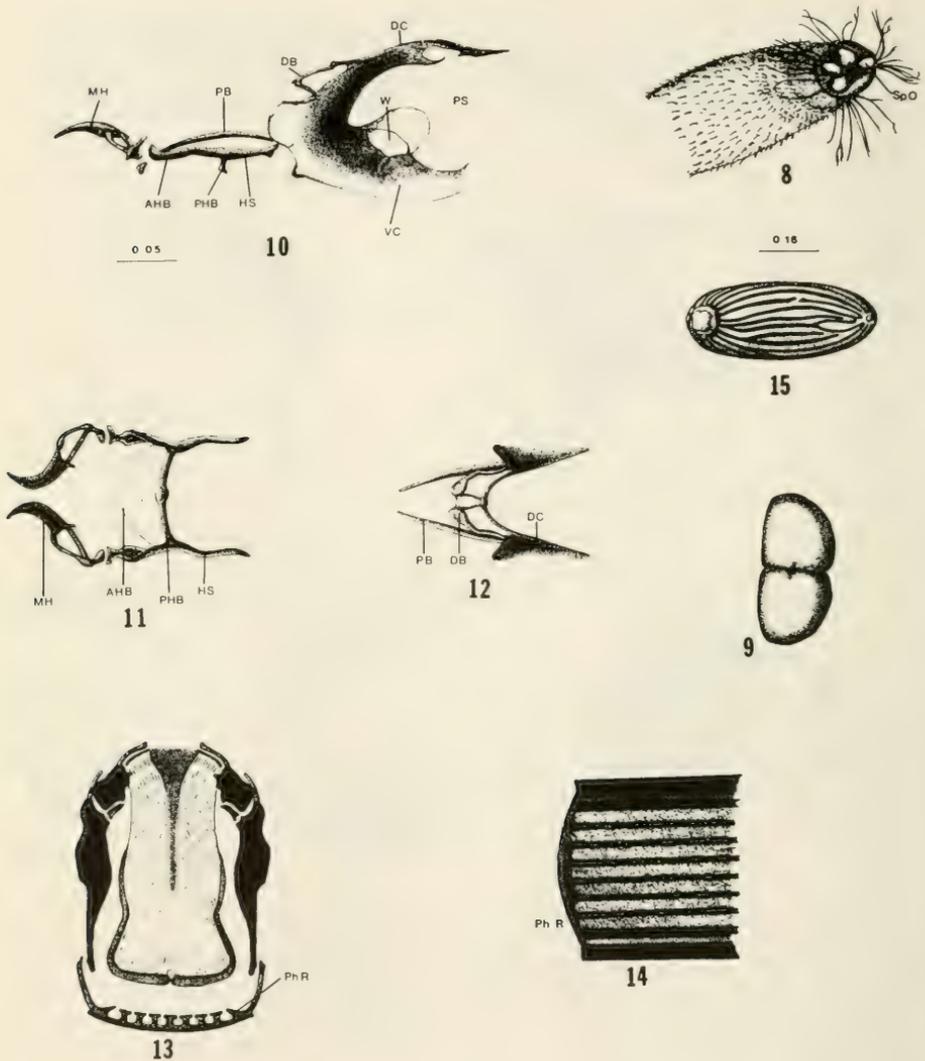
Mature third-instar larva (Figs. 1, 2).—Length 4.2–5.2 mm, $\bar{x} = 4.6$; width 0.70–1.10 mm, $\bar{x} = 0.81$ ($n = 5$). Somewhat flattened dorsoventrally; anterior end tapering, posterior end terminating in 2 strongly diverging breathing tubes borne at apicolateral margins of segment 12; margins of body indented forming double row of low tubercles along length of larva. Integument with numerous pale to blackened hairs.

Segment 1 (pseudocephalic) (Fig. 3) frequently invaginated, bearing antennae apicodorsally, circular sensory plates apicoventrally, and facial mask ventrally; antennae appearing 2-segmented, with both segments wide and



Figs. 1-7. *Lytogaster excavata*, third-instar larva. 1, Lateral habitus. 2, Dorsal habitus. 3, Lateral view of anterior end. 4, Facial mask. 5, Anterior spiracle. 6, Dorsal view of segment 9. 7, Ventral view of segment 9. Abbreviations: A = antenna; ASpB = anterior spinule band; ASp = anterior spiracle; BT = breathing tube; CSP = circular sensory plate; CW = creeping welt; DIT = dorsolateral tubercle; FM = facial mask; ISF = intrasegmental fold; LT = lateral tubercle; MH = mouthhooks; OA = oral aperture; Pa = papilla; PSpB = posterior spinule band; S = sensillum.

short; circular sensory plates with bordering rims complete, each plate with few peg-like structures; facial mask (Fig. 4) with 4 distinct rows of comblike structures on each side of oral aperture, each row consisting of narrow basal piece bearing 7-10 tapering teeth along posterior margin, rows somewhat curved. Segment 2 (prothoracic) spinulose, bearing bifurcate anterior spiracles posterolaterally (Fig. 3); each spiracle (Fig. 5) with 2 strongly diverging branches, upper branch bearing 5-7 papillae along anterolateral surface, lower branch with 3 subapical papillae; base of spiracle arising from



Figs. 8-14. *Lytogaster excavata*, third-instar larva. 8, Posterior spiracle. 9, Perianal pad. 10, Lateral view of cephalopharyngeal skeleton. 11, Ventral view of hypostomal sclerite and mouthhooks. 12, Dorsal view of parastomal bars and dorsal bridge of pharyngeal sclerite. 13, Cross section of ridges in floor of pharyngeal sclerite. 14, Dorsal view of pharyngeal ridges. Fig. 15, Egg. Abbreviations: AHB = anterior hypostomal bridge; DB = dorsal bridge; DC = dorsal cornu; HS = hypostomal sclerite; MH = mouthhooks; PB = parastomal bar; PhR = pharyngeal ridge; PS = pharyngeal sclerite; PHB = posterior hypostomal bridge; SpO = spiracular opening; VC = ventral cornu; W = window.

deeply pigmented ring. Segments 3–11 (Fig. 6) very similar, lateral margins indented and forming lateral and dorsolateral rows of low, bluntly rounded tubercles, lateral tubercles larger and bearing apical sensilla, each sensillum with 3–6 raylike processes, dorsolateral tubercles smaller, more bluntly rounded, and lacking apical sensilla; dorsal surface of each segment with clear areas near dorsolateral tubercles, each area bearing 2 scalelike structures; ventral surface of each segment (Fig. 7) with creeping welt of 2 rows of blackened spinules, spinules of more posterior row longer. Segment 12 bearing perianal pad ventrally and spiracular breathing tubes apicolaterally; perianal pad (Fig. 9) bilobed, each lobe bluntly rounded laterally, no post-anal spinule pad. Breathing tubes elongate, nearly 3 times as long as wide; each tube capped apically by spiracular plate, plates (Fig. 8) bearing 4 oval spiracular openings and 4 long, branched, hair-like processes.

Cephalopharyngeal skeleton (Fig. 10) length 0.37–0.40 mm, $\bar{x} = 0.39$ ($n = 5$). Mouthhooks paired, not connected dorsally, narrow and sicklelike; hook part without accessory teeth along ventral border, basal part with elongate window and with narrow piece projecting posterodorsally. Hypostomal sclerite (Fig. 11) composed of lateral rods connected near midlength by 2 hypostomal bridges; anterior hypostomal bridge very narrow and barely detectable, strongly curved anteriorly; posterior bridge deeply pigmented, straplike. No epistomal sclerite. Parastomal bars (Fig. 12) arising from anterior border of pharyngeal sclerite, running forward above and somewhat between hypostomal sclerite, distal ends not connected and ending just above anterior margin of hypostomal sclerite. Pharyngeal sclerite mostly deeply pigmented; dorsal cornua thin, each with window posteroventrally, connected anterodorsally by dorsal bridge, bridge (Fig. 12) with 2 large windows posteriorly and 2 much smaller windows anteriorly; ventral cornua broad, each bearing large, poorly pigmented lobe anterodorsally; floor of pharyngeal sclerite bearing 9 broad, apically truncate ridges (Fig. 13), lateral ridges incomplete, all ridges lacking lateral lamellae and appearing broad and flat in dorsal view (Fig. 14).

DISCUSSION

In contrast to many species of Ephydriidae, *L. excavata* seems to be a trophic specialist and to occur in more stable habitats. Perhaps the strong trophic specialization found in this species is its most distinctive characteristic. Zack and Foote (1978) reported that another common wetland ephydrid species, *Scatella stagnalis* Fallén, is very generalized trophically, as its larvae could utilize a broad spectrum of microorganisms. They reared larvae to adults on 13 different monocultures representing five classes of algae. Interestingly, larvae of *S. stagnalis* seem unable to utilize the blue-green algal genus *Cylindrospermum*, the preferred larval food of *L. exca-*

Table 4. Life history characteristics of *Scatella stagnalis* and *Lytogaster excavata*.

Characteristic	<i>S. stagnalis</i>	<i>L. excavata</i>
Adult longevity (days)	20-25	25±
Fecundity	500	30±
Developmental period (days)	10-14	21-29
Habitat stability	Low	High
Trophic niche	Broad	Narrow
Dispersal ability	High	Low

vata. The utilization of different algal foods may be one factor allowing for the coexistence of these two species in shoreline habitats.

As expected, *L. excavata* possesses certain life history characteristics that stand in direct contrast to traits displayed by such generalist species as *S. stagnalis* (Table 4). *Lytogaster excavata* has a slightly greater adult longevity, a greatly reduced fecundity, a distinctly longer developmental period, and a less motile larva than *S. stagnalis*. In addition, it usually occurs in habitats that are at least partially vegetated and less susceptible to perturbation by flooding, whereas *S. stagnalis* frequently is most abundant on open shoreline muds that are repeatedly and unpredictably inundated. In summary, *L. excavata* may be more of a K-selected "equilibrium" species, living in more stable habitats, whereas *S. stagnalis* is an r-selected "fugitive" species having high powers of dispersal that enables it to exploit quickly newly appearing spatial and trophic resources.

Blue-green algae are notably recalcitrant to grazing by phycophagous invertebrate animals (Arnold, 1971; Hargrave, 1970; Schindler, 1971). However, Foote (1977) reported that at least 12 species of Ephydriidae can utilize blue-greens. Most of these species belong to the Hyadini, and it appears that this tribe may be unified biologically by its ability to utilize this largely untapped food resource. This certainly holds true for species of *Axysta*, *Hyadina*, and *Lytogaster*, and perhaps for *Pelina*, as their larvae have been reared from field-collected colonies of blue-green algae (Foote, 1977). The three other North American genera that are usually placed in the tribe Hyadini, *Brachydeutera*, *Gastrops*, and *Ochthera*, have distinctly different larval feeding habits and perhaps should be re-evaluated as to their tribal placement.

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A NEW WATER BEETLE, *TROGLOCHARES ASHMOLEI*, N. GEN.,
N. SP., FROM ECUADOR; THE FIRST KNOWN EYELESS
CAVERNICOLOUS HYDROPHILID BEETLE
(COLEOPTERA: HYDROPHILIDAE)

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Abstract.—The first known eyeless cavernicolous hydrophilid, *Troglochares ashmolei*, n. gen., n. sp., is described. Illustrations of its various taxonomic structures are provided, and its relationships to similar genera are discussed. Couplets are given to interpolate this genus in a key to the related genera. This new water scavenger beetle was collected in Los Tayos Cave in Morona-Santiago Province, Ecuador.

During a speleological investigation of several caves in Ecuador in 1976, Dr. Philip Ashmole and his associates collected some epigeal insects as well as cavernicolous animals. Among the specimens collected were some aquatic beetles belonging to the families Dytiscidae and Hydrophilidae. The dytiscids and those of one genus of hydrophilids were epigeal forms collected at the mouth of Los Tayos Cave in Morona-Santiago Province, Ecuador. However, a single eyeless female hydrophilid was collected inside the cave and this specimen represents the first known eyeless cavernicolous genus and species in the family Hydrophilidae. This new and unusual water scavenger beetle is described below.

HYDROBIINAE

Troglochares Spangler, NEW GENUS

Body form ovoid. Eyes absent. Clypeus expanded shelflike above and in front of bases of antennae; shallowly and broadly arcuate anteriorly. Labrum rounded laterally; shallowly and broadly emarginate anteriorly. Antenna 9-segmented; 2 proximal, 3 intermediate, 1 cupule, and 3 club segments. Maxillary palpus long, moderately robust, distinctly longer than antenna; 4-segmented; basal segment very short; 2nd (pseudobasal) segment slightly sinuous and robust, with convexity along posterior (or mesal) mar-

gin, slightly longer than 3rd segment; 4th segment slightly longer than 3rd segment and articulated toward mouth. Mentum strongly emarginate-foveate apicomediaally. Pronotum with lateral margins, anterolateral angles, and posterolateral angles broadly rounded. Prosternum not carinate. Mesosternum with a low, transversely arcuate ridge on posterior $\frac{1}{4}$. All femora densely pubescent on about basal $\frac{2}{3}$; apices glabrous. Metatrochanter not elongated. Metatibia straight, elongate, without fringe of long natatory hairs. Tarsal formula 5-5-5. Elytron without sutural stria. Epipleuron moderately declivous along entire length. Last abdominal sternum not emarginate apicomediaally.

Type-species.—*Troglochaes ashmolei*, new species.

Etymology.—*Troglochaes* from troglodytes, G.—hole dweller, plus *chaes* from related genus *Helochaes*. Gender: masculine.

Remarks.—This new genus may be recognized immediately from all other described hydrophilid genera by the absence of eyes. However, the genus *Troglochaes* keys to the subtribe Hydrobiae in d'Orchymont's (1942) revision of the Hydrobiini (now divided into several subfamilies) and to the genus *Helochaes* in d'Orchymont's (1943) key to the genera in his subtribe Helocharae. From the genus *Helochaes*, the genus *Troglochaes* may be recognized by the following combination of characters: Eyes absent; last segment of the maxillary palpus slightly longer than the preceding segment; last abdominal sternum not emarginate apicomediaally; size, small. The following couplets interpolated in place of couplet 5 in d'Orchymont's (1943) key will separate *Troglochaes* from *Helochaes* and related genera:

- 5a. Antenna of 9 segments or less; 1st abdominal sternum not longitudinally carinate at base; last segment of maxillary palpus much shorter than the preceding segment, or if equal then the palps are very short and the overall size is small 5b
- Antennae less than 9 segments; 1st abdominal sternum longitudinally carinate at base; last segment of maxillary palpus much longer than preceding segment and swollen apically; China and Indonesia *Pelthydrus* d'Orchymont
- 5b. Eyes absent; last segment of maxillary palpus slightly longer than preceding segment; Ecuador *Troglochaes*, new genus
- Eyes present; last segment of maxillary palpus equal to or much shorter than preceding segment 6
- 6. Form convex, never flattened; elytra striate or not; cosmopolitan *Helochaes* Mulsant
- Form very flattened, explanate, in form of a shield, not convex; maxillary palps extremely long; elytron with 10 narrow striae, finely punctate; anterior coxal cavities narrowly open posteriorly; Gabon *Peltochaes* Regimbart

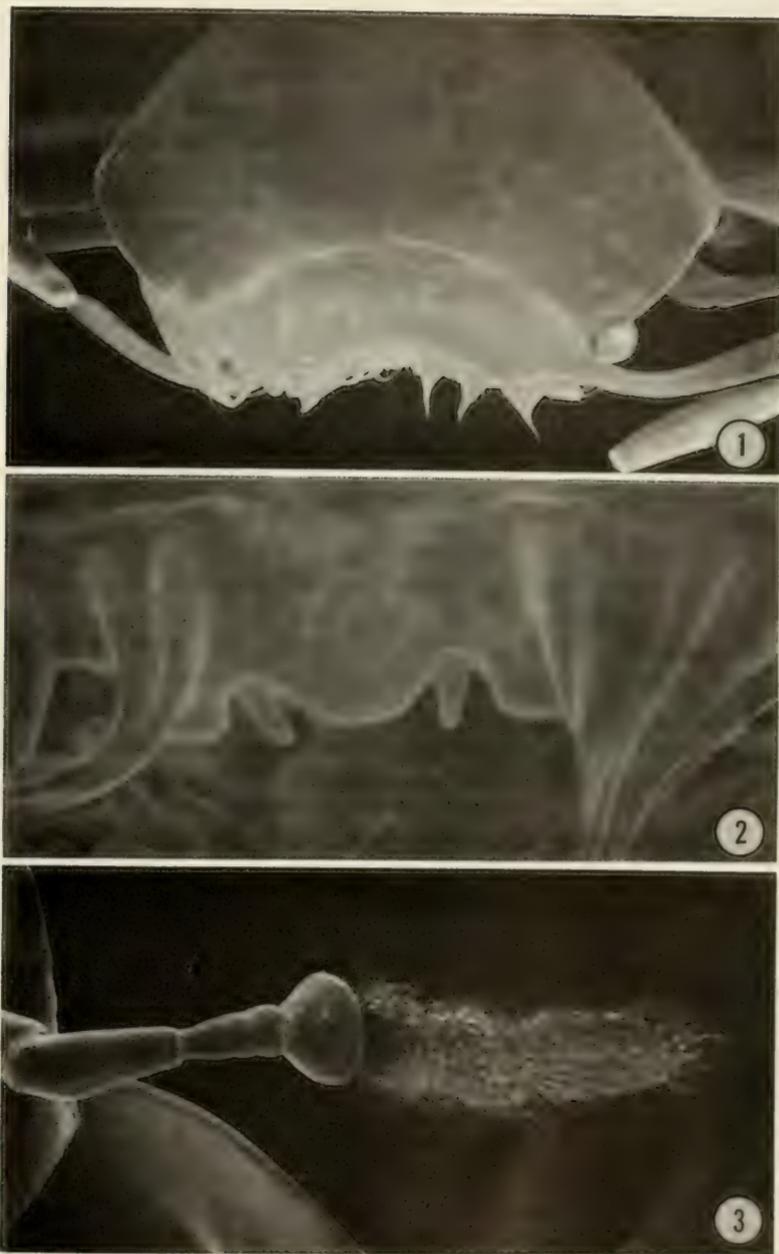
Troglochares ashmolei Spangler, NEW SPECIES

Figs. 1-9

Holotype female.—Body form ovoid; length 1.9 mm; greatest width 1.1 mm at slightly posterior to midlength. Color entirely light brown.

Head: With dual punctuation; punctures on disc fine and separated by 2-4× their width; punctures on side of head coarse, sparse, separated by 1 or 2× their width. Clypeus, above and anterior to bases of antennae, broadly expanded, shelflike; shallowly arcuate anteromedially. Labrum (Fig. 1) with dual punctuation but punctures less coarse than those on head; rounded laterally; with transverse, preapical row of setae; shallowly and moderately broadly emarginate and minutely denticulate apicomediaally (Fig. 1). Eyes absent (Figs. 1, 4). Ventral surface of head behind bases of maxillae microalutaceous. Mentum emarginate-foveolate apicomediaally and moderately rugulose (Fig. 5). Antenna 9-segmented (Fig. 3); 2 basal, 3 intermediate, 1 cupule, and 3 club segments. Maxillary palpus 4-segmented; about as long as antenna; basal segment very short; 2nd (pseudobasal) segment longest, slightly longer than last segment; 3rd segment slightly shorter than last segment. Labial palpus small (Fig. 5); 3-segmented; 1st segment shortest, about ½ as long as 2nd segment; 2nd segment about as long as broader ultimate segment.

Thorax: Pronotum strongly convex; sides, posterolateral angles, and anterolateral angles broadly rounded; narrowly margined laterally; punctures on disc very fine and separated by about 1-3× their width; punctures denser and coarser laterally. Elytron convex; widest at midlength; finely but distinctly margined along entire length; surface very finely, densely punctate; discal punctures separated by about 1 or 2× their width; with 11 rows of slightly coarser punctures; sutural stria absent; epipleuron moderately declivous along entire length. Metathoracic flight wings absent. Scutellum an equal-sided triangle. Prosternum, mesosternum, and metasternum microreticulate and covered with short, moderately dense, golden hydrofuge pubescence; prosternum non-carinate and slightly convex on midline; mesosternum with a low transversely arcuate ridge on posterior ¼ (Fig. 8); metasternum with moderately raised pentagonal discal area. Fore-, mid-, and hindfemora densely covered with short, golden, hydrofuge pubescence on about basal ⅔; apices glabrous. Protibia (Figs. 6, 7) with longitudinal row of slender setae on middle of anterior surface; with a row of short spines and 1 long preapical spine laterally and 3 long spines apically. Foreleg with tarsal segments 1-4 about equal in length; last segment about as long as segments 1-4 combined. Metatrochanters small, not elongate. Metatibia not arcuate. Tarsus of midleg and hindleg each with basal segment short, slightly less than ½ as long as 2nd segment; 2nd segment about ⅓ longer than 3rd segment; 3rd and 4th segments short and subequal; last segment about as long as 3rd and 4th segments combined. Tarsal formula 5-5-5.



Figs. 1-3. *Troglodares ashmolei*. 1. Head, 175 \times . 2. Apicomedial margin of labrum, 1825 \times . 3. Antenna, 300 \times .



Figs. 4-5. *Troglodares ashmolei*. 4, Head, lateral, 175 \times . 5, Labium, ventral, 400 \times .



Figs. 6-7. *Troglodares ashmolei*. 6. Protibia, dorsal surface, 325 \times . 7. Protibial apex, dorsal surface, 750 \times .



Figs. 8-9. *Troglochaes ashmolei*. 8, Mesosternum and metasternum, 80 \times . 9, Last abdominal sternum, 340 \times .

Abdomen: Abdominal sterna microalutaceous; covered with short, moderately dense, golden hydrofuge pubescence; last sternum without apico-medial emargination (Fig. 9).

Male.—Unknown.

Type-data.—Holotype: ECUADOR, Morona-Santiago Province, Los Tayos Cave, 78°12'W, 3°06'S, 23 July 1976, Philip Ashmole; USNM type no. 76879, deposited in the U.S. National Museum of Natural History, Smithsonian Institution.

Etymology.—This unique species is named for the collector, Dr. Philip Ashmole.

Habitat.—According to a label included with the specimen it was collected from the "main cave, chamber above cascades, on calcite formations."

ACKNOWLEDGMENTS

I am deeply grateful to Philip Ashmole for allowing me to study his material and for kindly donating the unique specimen of *Troglochaes ashmolei* to the National Museum of Natural History, Smithsonian Institution. I also extend my thanks to Susann Braden, Smithsonian Institution scanning electron microscopist, for taking the micrographs included herein.

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THE NOCTUOID MOTHS OF THE ANTILLES—PART I
(LEPIDOPTERA: DIOPTIDAE)

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Abstract.—The single species of Dioptidae recorded from the Antilles is *Josia draconis* (Druce). This Central and South American species was reported from Jamaica, but the record is doubtful.

Only one species of the family Dioptidae has been recorded from the Antilles. *Josia draconis* (Druce) was reported from Jamaica by Prout (1918:422). The specimen on which this record was based is in the collection of the British Museum (Natural History). It is labeled "Jamaica 88.30 581." The number "88.30" is a registration number and means No. 30 of 1888. Recorded under this number in the British Museum (Natural History) is the information that this lot contained Lepidoptera from Australia, Chile, etc., and they were purchased from a Mr. Mathew. I question whether the specimen is correctly labeled, and I would be very surprised if subsequently other specimens were discovered that were taken in Jamaica. The last treatment of the moths of Jamaica (Gowdey, 1926) does not list the species nor was Jamaica included as a locality by Hering (1925: 526). Nevertheless the species is treated and illustrated at this time to alert collectors to the possible, if unlikely, occurrence in the Antilles.

Josia draconis (Druce)

Fig. 1

Actea? draconis Druce, 1885: 145, pl. 14, fig. 6. San Juan, Panama.

Brachyglene draconis (Druce), Kirby, 1892: 408.

Josia draconis (Druce), Prout, 1918: 422.—Hering, 1925: 526, pl. 70, row h.—Bryk, 1930: 45.

Twenty-six specimens of this species are in the collection of the U.S. National Museum from Panama, British Guiana, and Amazonian Brazil. The species is illustrated in color by Druce (1885) and Hering (1925). In the series of specimens in the U.S. National Museum, some examples from



1

Fig. 1. *Josia draconis*, adult, dorsal view, 2 \times , from Athajuelo, Panama.

Brazil have the pale transverse bar of the forewing suffused with orange instead of straw yellow. The pale median spot of the hindwings is pink.

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MYCOPHAGY BY *APHAENOCASTER* SPP.
(HYMENOPTERA: FORMICIDAE)

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Abstract.—The myrmicine ants, *Aphaenogaster ashmeadi* (Emery), *A. floridana* M. R. Smith, *A. miamiana* Wheeler sensu lato, and *A. treatae* Forel, chew fragments from Agaricales basidiocarps and carry the pieces to their nests. Fungi of four genera (*Russula*, *Armillariella*, *Marasmiellus*, *Amanita*) are harvested, but *Russula* basidiocarps are attacked most frequently. Laboratory colonies of four additional species of *Aphaenogaster* have accepted pieces of basidiocarp from a species of *Russula*. *Aphaenogaster* spp. appear to feed on the fungal tissue but may only ingest the fluids. *Aphaenogaster tennesseensis* (Mayr) workers present sporophore fragments to their larvae in the same manner they feed them insect tissue. In our observations ant damage to all basidiocarps except those of *Marasmiellus* is generally less serious than that inflicted by coleopterous and dipterous immatures and adults. These findings may shed new light on the question of the evolution of fungus cultivation by ants. To our knowledge this is the first report of non-attine ants feeding extensively on fungi.

The mycophagous habits of the Attini, or fungus-growing ants, are renowned, but fungus-feeding by ants other than attines is poorly understood. The presence of fungal material in the infrabuccal pockets of ants of several genera (*Pseudomyrmex*, *Crematogaster*, *Lasius*) and fungi growing in the ants' nests led Elliott (1914) to speculate that these ants probably ate fungi. Bailey (1920) and Wheeler (1922) questioned such theories. Bailey believed that the fungal material found in infrabuccal pockets was detritus groomed from nestmates or cleaned from nest galleries. However, Wheeler and Bailey (1920) found that *Pseudomyrmex* larvae were fed the contents of the infrabuccal pockets of workers. They did not determine whether the fungal

material in these food pellets was essential for larval growth. A few ants (*Aphaenogaster*, *Formica*, *Leptothorax*, *Lasius*) were found with bracket fungi, but no feeding was observed (Graves and Graves, 1968; Matthewman and Pielou, 1971). Wellenstein (1952) reported that fungi and carrion constituted 0.3% of the diet of *Formica rufa* L. Using radiotracer techniques, Went et al. (1972) demonstrated that the larvae of *Manica hunteri* (Wheeler) ingested mycorrhizal hyphae that had been growing in a nest of *M. bradleyi* (Wheeler). At least one of two *Megalomyrmex* species that were social parasites of attines ate the symbiotic fungus of its host (Weber 1972).

MATERIALS AND METHODS

Field observations were made in Alachua County in north-central Florida. We examined basidiocarps for the presence of ants. When ants were discovered on a basidiocarp, they were observed for at least five minutes to determine whether they were removing pieces from the fungi. We examined microscopically fungal fragments taken from nestward-bound ants.

Laboratory colonies of eight species of native *Aphaenogaster* (*A. ashmeadi* (Emery), *A. flemingi* M. R. Smith, *A. floridana* M. R. Smith, *A. fulva* Roger, *A. lamellidens* Mayr, *A. miamiana* Wheeler sensu lato, *A. tennesseensis* (Mayr), *A. treatae* Forel) were maintained in standard Wilson nests and in transparent plastic shell vials containing moistened tissue paper. These artificial nests were kept in trays that served as foraging areas for the ants. Laboratory colonies were normally fed hamburger and a variety of dead insects. Fragments of the caps of *Russula* sp., each including spore-laden gills, were offered to all laboratory colonies to determine whether ant workers would carry the fungal tissue into their nests. About 50 workers were removed from an *A. tennesseensis* colony and maintained in a separate artificial nest. For three days the main *A. tennesseensis* colony was given only spore-bearing cap fragments of a *Russula* sp. basidiocarp stained with methyl blue and indocyanine dyes, while the group of 50 was maintained on its regular diet. Staining the fungus enhanced the visibility of fungal fragments in observation nests and made it possible to determine by examination of crop contents whether ants were ingesting fungal material in the form of spores, hyphae, or liquids.

The senior author identified the ants we studied.

RESULTS AND DISCUSSION

We observed four species of *Aphaenogaster* (*A. ashmeadi*, *A. floridana*, *A. miamiana* sensu lato, and *A. treatae*, primarily predators and scavengers) removing fragments from mushroom basidiocarps in the field. Basidiocarps of four genera (three families) were harvested by *Aphaenogaster* spp. Species of *Russula* (Russulaceae) were most frequently harvested.

Additionally, workers of *A. flemingi* were seen visiting a species of *Russula*. *Aphaenogaster ashmeadi* also harvested two species of Tricholomataceae, *Armillariella tabescens* (Scop. ex Fr.) Sing. and *Marasmiellus* sp. Once an *A. miamiana* worker was observed removing a piece from an *Amanita* sp. (Amanitaceae) basidiocarp. To a lesser extent *Pheidole* workers also harvested sporophores. Basidiocarps of several other genera of fungi were available in the foraging areas of the *Aphaenogaster* colonies under observation, but workers were not seen harvesting them. We did not find *Aphaenogaster* workers harvesting conks of bracket fungi, although Graves and Graves (1968) found *A. fulva* workers with Polyporaceae and Thelophoraceae in North Carolina.

In the field, we observed *Aphaenogaster* spp. harvesting basidiocarps from May to November. The *Marasmiellus* sp. basidiocarps harvested were small (10 mm tall). These sporophores were clipped off near ground level and were removed in single trips by individual *A. ashmeadi* workers. An *A. ashmeadi* worker would straddle the stipe of a felled *Marasmiellus*, grip it just below the cap with her mandibles, and carry it nestward. *Marasmiellus* basidiocarps taken from foraging ants were slightly immature. Only in the case of *Marasmiellus* did ants apparently damage basidiocarps before spores matured. Large (6 cm tall, 6 cm diam cap) and medium-sized basidiocarps, such as those of some *Russula* spp., never appeared to be entirely removed by ants. *Aphaenogaster* spp. chiefly attacked the caps of *Russula* spp., particularly along the rims. Chunks of basidiocarp tissue up to about 3 mm³ were chewed off by individual *Aphaenogaster* workers and were carried nestward. *Aphaenogaster ashmeadi* took pieces from caps and stipes of *Armillariella tabescens*. One clump of *Ar. tabescens* was harvested by *A. ashmeadi* workers for eight days. During 1 hr in the afternoon 20 *A. ashmeadi* workers carried pieces (most about 2 mm³) of *Ar. tabescens* to their nest. As many as eight *Aphaenogaster* spp. workers were seen simultaneously visiting individual *Russula* basidiocarps. Most basidiocarps harvested were mature or senescent. Individual *Russula* sp. were usually attacked for two to five days by *Aphaenogaster* spp. However, they eventually decayed or were eaten by organisms other than ants. The effect of ant harvesting on spore mortality or dissemination (and thus on the fitness of the fungal organisms) remains to be assessed.

In the laboratory, workers of *A. ashmeadi*, *A. flemingi*, *A. floridana*, *A. fulva*, *A. lamellidens*, *A. miamiana*, *A. tennesseensis*, and *A. treatae* carried pieces of *Russula* into their nests. We observed that basidiocarp fragments carried into artificial nests by foragers were subsequently torn to pieces by the ant workers. One to three ants chewed a fragment. At times *A. tennesseensis* workers held fungal fragments with their mandibles; rather than chewing the fungal tissue, they appeared to imbibe fluid from it. Workers placed larvae on some fungal fragments, and very small fragments were

placed on the upturned venters of larger larvae. The anteriors of the larvae extended in characteristic feeding position. Buschinger (1973) and others have described such larval feeding behavior in *Aphaenogaster* colonies given insects as food. Eventually the ants discarded the masticated tissue within and outside their nests.

Microscopic examination of fungal fragments taken from nestward-bound workers revealed no minute invertebrates, although most sporophores damaged by ants contained coleopterous or dipterous immatures or adults. Crop contents of workers examined before they were given dyed basidiocarp tissue were yellowish-brown, as were those of five workers from the group of 50 *A. tennesseensis* given hamburger during the three day period. Crop contents from 17 of 18 workers from the *A. tennesseensis* colony given dyed pieces of *Russula* daily for three days were blue-green like the dye. *Russula* spores were found in the crop of only one of 18 workers from the *A. tennesseensis* colony given dyed basidiocarp fragments. Some of these workers were collected directly from pieces of fungi on which they were chewing. The absence of spores in the crops containing dye suggested that workers ingested mostly fluids from the fungal tissue. Microscopic examination of the contents of the infrabuccal pockets from ten *A. tennesseensis* workers with blue crop contents showed no spores or hyphae. Whether the ants regurgitated the fungal material from their infrabuccal pockets or it was digested was not shown by these results. However, spores are generally digestible only in solutions of extreme pH and *Russula* spores are small (often $<10 \mu$ diam), reducing the likelihood they are filtered out before they can reach the crop. By comparison Eisner and Happ (1962) have found that corundum particles as large as 100μ diam pass into the crops of workers of the somewhat larger *Camponotus pennsylvanicus* (DeGeer).

Fungal tissue may be more than merely a source of moisture for *Aphaenogaster* spp. Workers drank from moistened balls of tissue paper placed in their foraging areas. Moistened balls of tissue paper were placed in foraging areas of an *A. tennesseensis* colony and an *A. ashmeadi* colony simultaneously with fungal fragments of similar size. About five times as many ants were attracted to the fungal fragments as to the wet tissue paper.

Any nutritive importance of basidiocarps to *Aphaenogaster* spp. remains to be assessed. The symbiotic fungi of the Attini apparently provided those ants their essential nutrients (Weber, 1972). None of the *Aphaenogaster* spp. observed were found tending Homoptera or visiting extrafloral nectaries—important carbohydrate sources for many ants. In the laboratory, however, when *Aphaenogaster* spp. colonies were presented balls of tissue paper soaked with water and other tissue balls soaked with sugar water, the ants swarmed on the balls with sugar water and virtually neglected tissue moistened with plain water. Van Pelt (1958) found *Aphaenogaster* spp. attracted to molasses, and Carroll (1975) found *A. miamiana* visiting sap

exuding from an elm, *Ulmus* sp. We do not know if Agaricales sporophores serve primarily as a carbohydrate source for *Aphaenogaster* spp.

On three occasions we found *Pheidole dentata* Mayr workers harvesting a species of *Russula*, and once we saw a *P. metallescens* Emery worker removing a piece of *Russula* basidiocarp. *P. dentata* workers were twice observed harvesting *Amanita* sp., and one *P. dentata* worker was found carrying some basidiocarp of *Marasmiellus*. We saw no other ants harvest basidiocarps, and the significance of mycophagy in the competition between *Aphaenogaster* spp. and other terrestrially foraging ants was not clarified.

These findings may aid in understanding the evolution of the fungus-growing attines. Several explanations of the phenomenon have been propounded. Attines, according to von Ihering (1894), could have evolved from harvesting ants that ate mold growing on their stored seeds. Goetsch and Gruger (1942) reprised von Ihering's basic hypothesis. Emery (1899) held that cropping of adventitious hyphae on the walls of ant nests by the inhabitants was probably the origin of mycophagy in ants. Forel (1902) felt that proto-attines nested in rotten wood and consumed fungi growing on feces of wood-boring insects. More recently, Weber (1956, 1972) suggested that proto-attines could have begun feeding on fungi growing on the ants' own feces. In 1946 Wolcott observed some workers of the attine *Acromyrmex coronatus* (Fabricius) "eating," i.e., cutting up and removing basidiocarps of *Pleurotus* sp. in the manner we have described for *Aphaenogaster*. He referred to such behavior as "recessive traits," i.e., a reversion from the agricultural state. Wojcik (personal communication) discovered *Cyphomyrmex rimosus* (Spinola) similarly harvesting an unidentified basidiocarp, and the senior author observed *Trachymyrmex septentrionalis* (McCook) workers removing pieces of a *Russula* sp. basidiocarp. Both ants were attines.

We do not wish to imply that attines have evolved from *Aphaenogaster*, but we do suggest that a generalized myrmicine ant with *Aphaenogaster*-like or, perhaps, *Pheidole*-like habits is a plausible ancestor. However, von Ihering (1894) has cited *Aphaenogaster* as one of the genera of seed-harvesters having habits like those of his postulated attine precursor. Perhaps the feeding behavior of the proto-attine resembled that of present day *Aphaenogaster* spp., which Smith (1961) and Buschinger (1973) have described as generalized and in some aspects primitive members of the Myrmicinae. The proto-attines may have carried spore-laden fungal fragments to their nests and, after macerating the fungal tissue, may have discarded it in refuse areas in their nests. Refuse areas of omnivorous ants such as *Aphaenogaster* spp., which also collect seeds (Culver and Beattie, 1978) and floral parts of plants, contain a variety of substrates on which fungi may flourish in humid nest conditions. Such conditions may have favored co-evolution of a symbiosis between the ants and fungi.

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NEW COMBINATIONS AND SYNONYMIES IN PALEARCTIC AND
NEARCTIC SCIOMYZIDAE (DIPTERA)

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Abstract.—*Tetanocera scutellata* Matsumura, 1916, is transferred to the genus *Coremacera*; *Sciomyza goberti* Pandellé, 1902, is transferred to the genus *Pherbellia*, the holotype is redescribed, and the male genitalia are figured; *Pherbellia lapponica* (Ringdahl), 1948, is recorded from North America; *Pherbellia villiersi* Séguy, 1941, is placed as a synonym of *P. nana* (Fallén), 1820; *Sciomyza humilis* Loew, 1876, is placed as a synonym of *Pherbellia parallela* (Walker) 1852; *Tetanocera mallochi* Steyskal, 1959, is placed as a synonym of *T. griseicollis* Frey, 1924; and distributional records for *Tetanocera freyi* Stackelberg, 1963, and *T. silvatica* Meigen, 1830, in North America are given.

The following taxonomic data and hypotheses are presented, as one of a series of papers, in preparation for an analysis of the classification and phylogeny of the genera of snail-killing flies (Sciomyzidae) of the world.

Coremacera scutellata (Matsumura), 1916 (*Tetanocera*)
NEW COMBINATION

The female holotype, in the Hokkaido University Collection (Sapporo, Japan), is in perfect condition except both wings are cracked from the middle of the costal margin into the submarginal cell, and there is verdigris above and below the thorax. The specimen is labeled: Japan, Matsumura (reverse side—Okinawa, XI.07) (white label); *Tetanocera scutellata* (white label); Type, Matsumura (red label). I have labeled the specimen, *Coremacera scutellata* (Matsumura), d. L. Knutson, 1979.

The specimen closely fits the original description except: Middle of face subshiny, whitish pruinose, with brownish area above carina; sides of face yellowish pruinose; frontal spot oval, surrounding anterior fronto-orbital bristle, barely reaching posterior fronto-orbital bristle on right side, not reaching it on left side; lunula, broad midfrontal stripe, and area between orbito-antennal and frontal spots shiny.

In Elberg's key (1968), the type of *C. scutellata* runs to *C. ussuriensis* Elberg (Lebeche, Primorski Krai, far eastern USSR) and can be distinguished from the description of *C. ussuriensis* only by some slight differences in color.

According to my notes taken during a 1973 visit to the Zoological Institute in Leningrad, there is a specimen labeled *Tetanocera scutellata* in that collection. There is no information on this species in J. Verbeke's notes (at the Institut National des Sciences Naturelles, Brussels) of his examinations of the collections in Leningrad and Moscow.

The holotype of *C. scutellata* is distinct from three specimens of an undescribed *Coremacera* species in the U.S. National Museum (USNM) (Chas Yang, Chili, China, 13.IX.1921 Jacot, ♀; Hangchow, 30.III.1929, ♀; and Chas Yang, 6.IX.1921, sex unknown—abdomen missing) in having the following characters: Basal two-thirds of submarginal cell open, without spots; posthumeral bristle as large as humeral bristle (hairlike in the undescribed specimens); front femur with an irregular, double series of strong bristles along the entire dorsal surface (only 2–4 strong bristles dorsally toward apex in the undescribed specimens); bristles on posteroventral surface of hind femur extending from apex to midlength (restricted to 2–4 near apical third in the undescribed specimens).

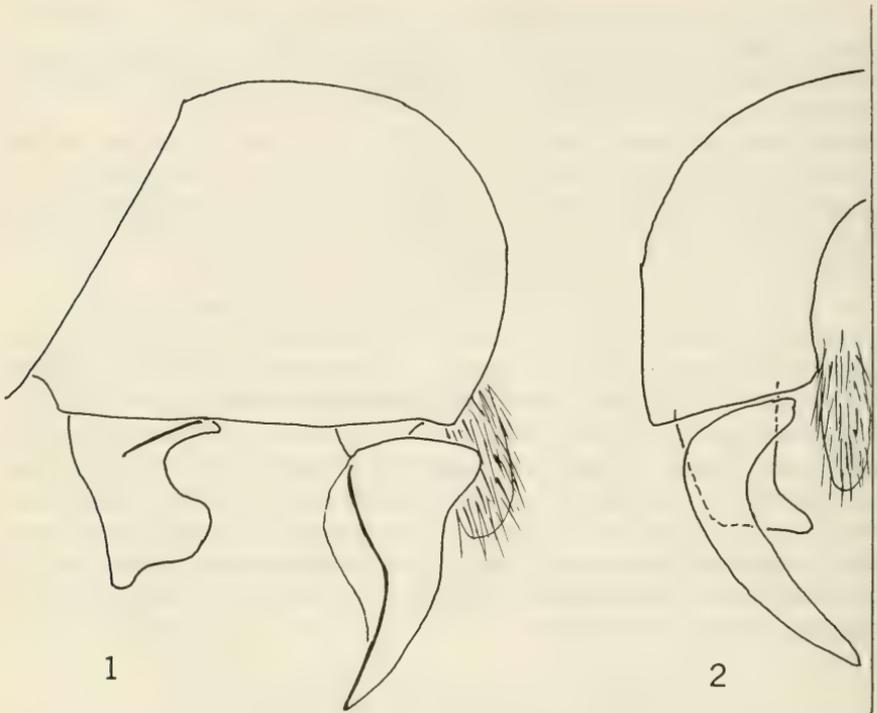
Pherbellia goberti (Pandellé), 1902 (*Sciomyza*)

Figs. 1, 2

Pherbellia goberti (Pandellé), described from Landes, France, is apparently known only from the male holotype in the Paris Museum. The specimen is labeled, 2321 (white label), and *Sciomyza goberti* Pand. (white label folded in half).

The specimen was apparently originally glued to a paper point, and has been carefully reglued at some time in the past. Head, wings, and bristles in good condition; left front leg missing; right front, middle, and hind legs separated from specimen and glued to the point; abdomen prepared with sodium hydroxide and preserved in glycerine in plastic genitalia vial (prepared and dissected by LK).

Description.—Yellowish brown. Face vertical; cheeks narrow, at narrowest point almost as wide as greatest width of 3rd antennal segment. Eyes very large, rounded dorsally, strongly angular ventrally. Frons strongly narrowed anteriorly, width at antennae about $\frac{1}{2}$ the distance between outer vertical bristles; matt, yellowish between orbital plates, brownish from anterior fronto-orbital bristles to antennae, hairs between orbital plates and orbital margin as well as those on middle of frons black, hairs yellowish on lower frons near antennae. Ocellar triangle and orbital plates medium brown, subshiny, with sparse grayish pollinosity; midfrontal stripe not quite



Figs. 1, 2. *Pherbellia goberti*, holotype male, genitalia. 1, Lateral view. 2, Posterior view.

reaching level of anterior fronto-orbital bristles. Orbital margin from antennae to posterior fronto-orbitals narrowly margined with whitish pruinosity. Two strong ocellar bristles, about equal in length to post-ocellars and inner verticals; outer verticals slightly shorter. First antennal segment minute, hidden; 2nd antennal segment yellowish brown, $\frac{1}{3}$ length of 3rd segment; 3rd antennal segment unicolorous yellowish brown, short, rounded apically, upper and lower margins parallel; arista yellowish brown, with medium-length, sparse, darkish hairs, somewhat longer and denser on dorsal surface. Middle of face and area along facial orbits pollinose greyish-brown; lower face on each side matt, yellowish brown, with short black hairs as on lower frons. Palpi yellowish brown, each with 3 moderately-sized, blackish bristles.

Thoracic dorsum subshiny yellowish brown with faint pollinosity, indistinct dark stripes anteriorly; 2 pairs of dorsocentral bristles, anterior pair somewhat shorter than posterior pair; 1 humeral; 1 posthumeral; 2 notopleural; 1 supra-alar; 2 postalar; no prescutellar; 2 pairs of scutellar bristles. Prepleural bristle strong, with 3 short hairs above each front coxa. Meso-

pleuron bare. Pteropleuron with 2 large and 2 medium-sized bristles on left side. Prosternum bare.

Front coxa with a very strong bristle just above middle at outer edge, hind coxa bare above posteriorly. Front femur yellow basally, brownish on apical 2/5; front tibia brownish on apical 2/3, becoming dark brown and concolorous with dark brown tarsi. Middle and hind legs yellow. Front femur with several dorsal bristles toward apex, middle femur with 1 weak bristle outstanding on anterior surface below midlength, and hind femur with 2 outer dorsal bristles toward apex.

Wing membrane and veins yellowish, crossveins imperceptibly clouded, anal vein reaches wing margin, r_4 below apex of r_1 and before middle of wing. Halter yellow.

Male genitalia, Figs. 1 and 2. Posterior surstylus without bristles; in lateral view elongate, triangular with a low, conical, posteriorly directed projection just beyond base and a narrow, lightly pigmented lamina along most of anterior margin; pincerlike in posterior view, bent mesially at 90° angle at basal 1/3. Anterior surstylus with very weak marginal hairs; in lateral view mitten-shaped, with short lobes; general outline somewhat longer than broad, basally with a posteriorly-directed lobe. Aedeagal and ejaculatory apodemes subequal, very large, well sclerotized.

Remarks.—In general appearance, *P. goberti* looks like a small species of *Sciomyza*, but it has the typical characters of *Pherbellia*. The characters cited by Séguy (1934) in his key to species of "*Sciomyza*" and in his brief description agree with the type-specimen except the third antennal segment is yellowish brown, not ". . . roux, tant au plus étroitement noirci à l'apex," and the pteropleura have 3 or 4 bristles, not 2 or 3. Grensted (1946) quoted a personal (*in litt.*) communication from J. E. Collin, "Pandellé's *S. pallidiventris* (5–7 mm.) was probably *sordida* Hendel, and not *pallidiventris* Fln., and I suspect that his *S. goberti* was the true *pallidiventris*." Collin was confused on this point—*P. goberti* and *P. pallidiventris* are abundantly distinct.

Pherbellia lapponica (Ringdahl), 1948 (*Sciomyza*)

Pherbellia lapponica was described from Gällivare, northern Sweden. I have seen additional European specimens from Finland (Paanajarvi, Petsamo, and Muonio) and Sweden (Jamtland, Lulea Lappmark, Lykseele Lappmark, Tornea Lappmark, Norrbotten, and Vasterbotten). I reared this species through the complete life cycle from adults collected near Kvikkjokk, Norrbotten, Sweden in June, 1967.

The following new records are from specimens in the USNM: *Alaska*: N. Coast, Prudhoe Bay; 16.VI.1971, 1 ♂, No. 46; 20.VI.1971, 1 ♀, No. 119; 4.VII.1971, 1 ♂ 1 ♀, No. 256; 8.VII.1971, 1 ♀, No. 311; Deyrup.

Pherbellia nana (Fallén), 1820 (*Sciomyza*)

Pherbellia villiersi Séguy, 1941. NEW SYNONYMY.

The holotype and cotypes of *Pherbellia villiersi* Séguy (3 females, not males as published by Séguy) were examined in the Muséum National d'Histoire Naturelle, Paris. One female is labeled: Dj. Toubkal, Tachdirt, 2,500 m. (white label), Maroc, 15-13 Aout (white label), 251 (white label), Museum Paris, 1938, R. Paulian et Villiers (light green label), TYPE (red label), *Ditaenia villiersi*, Type. E. Séguy vid. (white label). There are two females labeled as above, but without the latter two labels, and with the following label, *Pherbellia villiersi*, Cotype, E. Séguy det. 19.

All three specimens are greasy, and the color patterns of the body are indistinct. The disc of the wing is not as uniformly dark as figured by Séguy. The wing pattern is very similar to typical *P. nana*, but somewhat darker and slightly more extensive, particularly in the holotype specimen. The single specimen of *P. nana* in the general collection in Paris (a ♀ from Kaltwasser, det. Th. Becker) is a lightly-colored specimen with an unusually faint wing pattern. I added the following label: *Pherbellia nana* (Fallén). Det. L. Knutson 1980.

Elberg (1978) examined the hypopygium of the type-specimen of *Sciomyza reticulata* Thomson (1869) and concluded that it is identical with the hypopygium of *Pherbellia nana*. On the basis of the wing pattern, i.e., the presence of spots in cells A, Cu, AM, and D in addition to those in R, R1, R3, and R5, Elberg considered the type-specimen of *S. reticulata* (from Hong Kong) and other Asian specimens that he studied (Transbaikal (Burjatien) to Ussuri Region) to represent a distinct subspecies, *Pherbellia nana reticulata* (Thomson).

Pherbellia parallela (Walker), 1852 (*Sciomyza*)

Sciomyza humilis Loew, 1876. NEW SYNONYMY.

I rediscovered the type-specimen of *Sciomyza parallela* Walker in a drawer of uncurated material at the British Museum (N.H.) in February, 1976. The specimen, a male with the head missing but otherwise in good condition, is labeled, *parallela*, US, 68 4, *parallela* N. Amer. Walk. The genitalia were not dissected but chaetotaxy, color, and other characters clearly show it to be the same species as *Sciomyza humilis* Loew, 1876. This is a Nearctic species.

Tetanocera griseicollis Frey, 1924

Tetanocera mallochi Steyskal, 1959. NEW SYNONYMY.

Tetanocera mallochi was described by Steyskal (1959) from specimens from Manitoba (holotype and allotype), Alaska, Northwest Territories, Al-

berta, Quebec, Labrador, and New Hampshire. I have compared the male holotype of *T. griseicollis* Frey (Helsinki University Museum; genitalia missing) from Dudinka, Siberia, with the following specimens from the Palearctic and Nearctic regions:

PALEARCTIC: *USSR*: Siberia, Verschininsk, 69°5'. 1 ♀, Trybom, Naturhistoriska Riksmuseet, Stockholm. *Sweden*: T. Lpm., S. E. Abisko, Jukkasjarvi, 2.VII.1966, 1 ♀, Hedstrom; Pessinenjaure, Jukkasjarvi, 9.VII.1966, 1 ♀, Hedstrom.

NEARCTIC: *Canada*: NORTHWEST TERRITORIES: Musk Ox Lake, 64°45'N 108°10'W, 20.VII.1953, 1 ♀, Chillcott, Canadian National Collection, Ottawa (CNC) (paratype). Ekalulia Is., Bathurst Inl., 12.VIII.1966, 2 ♂ 3 ♀, Shewell, CNC. Aklavik, 25.VII.1931, 1 ♂, USNM. MANITOBA: Fort Churchill, 21.VII.1952, 1 ♂; 12.VII.1952, 1 ♂; Churchill, 8.VII.1952, 1 ♂ 1 ♀, Chillcott, USNM (paratypes). QUEBEC: Indian House Lake, 20.VII.1954, 1 ♂, Richards, USNM (paratype). *USA*: ALASKA: 15 mi. W. Nebesna, 3.VII.1948, 2 ♂ 1 ♀, Sailer, USNM. Polychrome Pass, 3.VII.1954, 1 ♂ 1 ♀, Frohne, USNM. Richardson Hwy., M. P. 183, 24.VII.1948, 1 ♀, Sailer, USNM. COLORADO: Cameron Pass, 18.VIII.1952, 1 ♂, Severin, CU. WYOMING: Canyon Village, Yellowstone National Park, 21.VII.1971, 1 ♂, Steyskal, USNM.

I have found no specific differences among these specimens. The details of the male genitalia of Palearctic and Nearctic specimens compare exactly. A posterodorsal pre-apical bristle, slightly posterad of the last anterodorsal pre-apical bristle, is usually present on both hind femora, but it may be absent or present only on one side.

Tetanocera sylvatica Meigen, 1830, and *T. freyi* Stackelberg, 1963

Cresson (1920) and Steyskal (1959) recorded *Tetanocera sylvatica* Meigen from North America. In describing *T. freyi* from Luga, Yashchera, USSR, Stackelberg (1963) indicated that Steyskal's specimens of *T. sylvatica* from Alaska (Fig. 29) are *T. freyi*. I have seen the following male specimens (all in the USNM) of *T. sylvatica* and *T. freyi* from North America.

Tetanocera sylvatica.—*USA*: ALASKA: Tanana, 7.VI.1951, Sailer (1). Matanuska Valley, 27.VI.1952, C. O. Berg (2). COLORADO: No further data (2). Rio Grande Co., Beaver Creek, 10,000 ft., 21.VI.1972, Wirth (1). WYOMING: Yellowstone Park, Apollinar Is., 8.VII.1923, Melander (2). SOUTH DAKOTA: Custer, 22.VII.1924 (1). ARIZONA: Greer, Phelps Bot. Area, 23.VI.1957, Butler & Werner (2).

Tetanocera freyi.—*USA*: ALASKA: Matanuska Valley, 27.VI.1952 (10), 1.VII.1950 (4), 8.VII.1950 (2), 2.VIII.1952 (2). Berg. *Canada*: ALBERTA: Bilby, 1.VI.1924 (1), 10.VI.1924 (1), Bryant.

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**THE *TABANUS STRIATUS* COMPLEX (DIPTERA: TABANIDAE):
A REVISION OF SOME ORIENTAL HORSE FLY
VECTORS OF SURRA¹**

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Abstract.—Three distinct species previously confused with and called *Tabanus striatus* are characterized: *Tabanus striatus* Fabricius in the northern and western part of the Oriental Region; *T. partitus* Walker in the eastern and southern part of the Oriental Region and Micronesia; and *T. triceps* Thunberg on the Indian subcontinent. Illustrations and a key are given, along with a review of the previous literature on these bloodsucking pests and vectors of livestock diseases.

Three species of *Tabanus* in the Oriental Region with trivittate abdomen (*Tabanus striatus* Fabricius, *Tabanus partitus* Walker and *Tabanus triceps* Thunberg) have, since their description, been subject to misinterpretation by many authors. One of the species previously called *striatus* has been incriminated as a vector of surra, an important disease of horses. Many of the fundamental studies on this species and others in the complex have been published under incorrect names. Determination of correct synonymy and application of correct names have not been possible with confidence due to inaccessibility of types, a myriad of synonyms incorrectly placed, and critical morphological characters misconstrued or ignored. Burton (1978) aptly termed the problems associated with these species "chaotic." To resolve these taxonomic problems, their history is reviewed. Complete synonymy, diagnosis, history, and distribution are given for each species.

We recognize three distinct taxa previously confused with and called *Tabanus striatus*: *Tabanus striatus* Fabricius in the northern and western part of the Oriental Region, from Pakistan, India, and Sri Lanka to China; *T.*

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partitus Walker from Thailand (and possibly Burma), Malaysia, Indonesia, Philippines, and Micronesia; and *T. triceps* Thunberg from Sri Lanka, India, and Pakistan. These species can be separated by the following key:

1. Females (eyes separated) 2
 - Males (eyes contiguous) 4
2. Usually larger species (14–16 mm); foretibia uniformly orange to orange brown, not noticeably darkened apically (Fig. 3); frontal callosity with basal portion long and narrow, narrowly separated from eye margins ventrally and receding from eye margins dorsally (Fig. 1); abdominal venter uniformly gray tomentose and pale pilose, lacking a median dark stripe (Fig. 7) *triceps* Thunberg
 - Usually smaller species (10–13 mm); foretibia sharply bicolored, pale on basal $\frac{2}{3}$, blackish on apical $\frac{1}{3}$ (Fig. 6); frontal callosity with basal portion contiguous with eye margins for most or all its length (Fig. 2); abdominal venter with distinct broad median dark stripe (Fig. 8) 3
3. Abdomen with dorsal median pale stripe evanescent or absent on tergum 2 (Fig. 5); abdominal ground color blackish *striatus* Fabricius
 - Abdomen with dorsal median pale stripe complete, fully developed on tergum 2 (Fig. 4); abdominal ground color dark brown to brown black *partitus* Walker
4. Foretibia uniformly orange to orange brown (Fig. 3); abdominal venter uniformly pale yellowish white to yellow tomentose and pilose (Fig. 7) *triceps* Thunberg
 - Foretibia bicolored, pale basally, becoming blackish on apical $\frac{1}{4}$ (Fig. 6); abdominal venter yellowish white tomentose with a broad dark midstripe (Fig. 8) 5
5. Costal cell clear, never tinted *striatus* Fabricius
 - Costal cell yellow tinted *partitus* Walker

Tabanus striatus Fabricius

Tabanus striatus Fabricius, 1787: 356. Type-locality: China. Lectotype UZMC. Subsequent references: Surcouf, 1923: 196 (taxonomy); Isaac, 1924b: 108 (biology, immature stages); Chvála and Lyneborg, 1970b: 546 (lectotype designation); Stone, 1972: 639 (taxonomy), 1975: 70 (catalog citation); Burton, 1978: 71 (taxonomy, Laos, Thailand distribution records, biology).

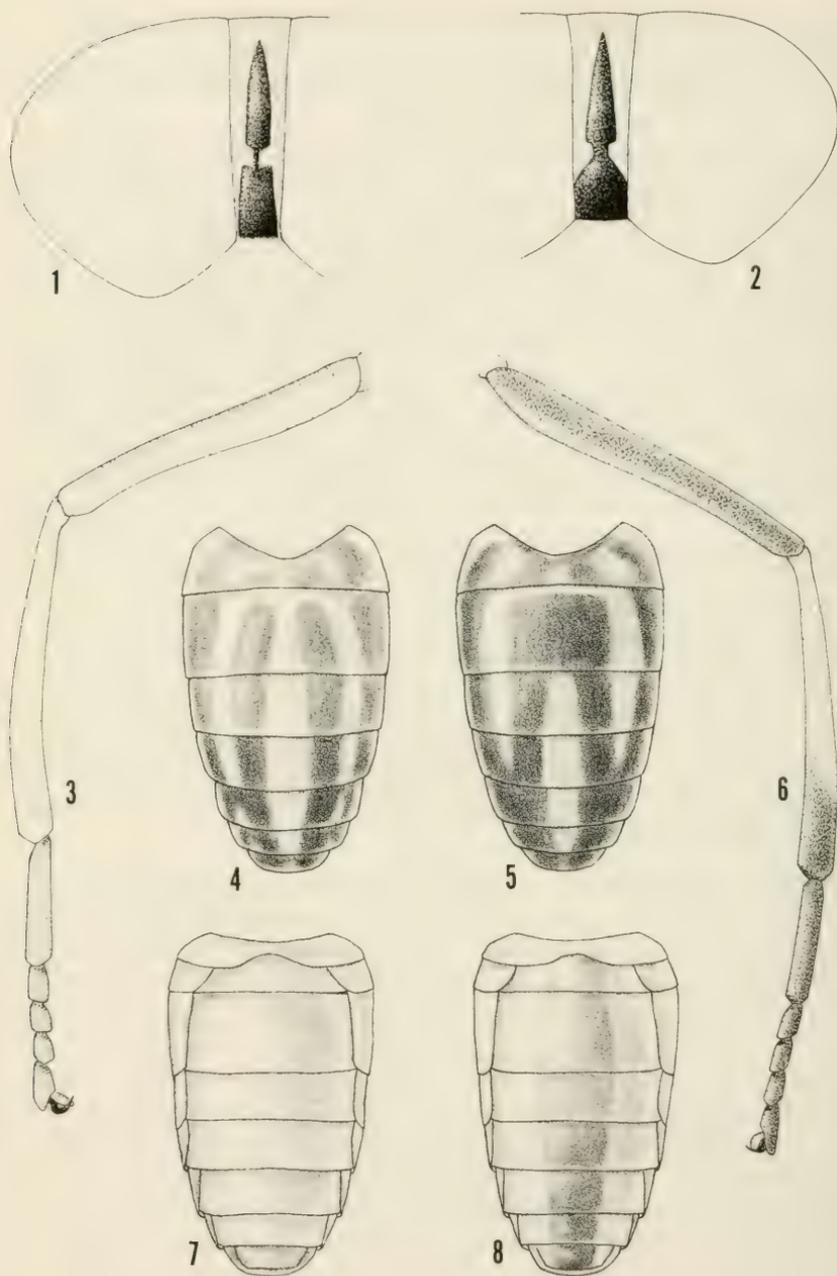
Tabanus hilaris Walker, 1850: 49. Type-locality: East India. Holotype male BM(NH). Subsequent references: Bigot, 1891: 269, van der Wulp, 1896: 60, Kertész, 1900: 53, 1908: 249 (catalog citations); Ricardo, 1911: 153

(taxonomy), 1916: 407 (Hong Kong); Fletcher, 1916 (life history), 1917 (oviposition).

Tabanus tenens subform *cambodiensis* Toumanoff, 1953: 201. Type-locality: not stated (Cambodia). Holotype lost.

Tabanus striatus (in part); Bigot, 1891: 268, van der Wulp, 1896: 58 (catalog citations); Kertész, 1900: 71, 1908: 281 (world catalogs); Ricardo, 1911: 149 (taxonomy); Fletcher, 1916 (life history, surra vector), 1917 (oviposition); Austen, 1922a: 445 (taxonomy); Schuurmans Stekhoven, 1926: 63, 1928: 438, 1932a: 65 (taxonomy, distribution); Senior-White, 1927: 51 (catalog citation); Wu, 1940: 186 (catalog citation); Philip, 1959: 606, 1960: 57, 1973: 60 (taxonomy, synonymy, distribution); Chvála and Lyneborg, 1970a: 365 (taxonomy, distribution); Moucha, 1976: 152 (world catalog). erroneous citations to *striatus* (in total or part): van der Wulp, 1880: 163, 1881: 16, 1885: 71, 1896: 58 (includes also *dorsilinea* and *partitus*); Bigot, 1891: 208 (includes also *dorsilinea* and *partitus*); Kertész, 1900: 71, 1908: 281 (includes also *dorsilinea* and *partitus*); Ricardo, 1911: 149 (includes also *triceps* and *partitus*); Mitzmain, 1913 (refers to *partitus*); Fletcher, 1916, 1917 (may also include *triceps*); Kröber, 1924: 18 (refers to *partitus*); Schuurmans Stekhoven, 1926: 63, 1928: 438, 1932a: 65 (includes *partitus*); Senior-White, 1927: 51 (includes *partitus* and *triceps*); Nieschulz, 1926a-c, 1927a-c, 1928, 1929a-b, 1935a-b, 1936, Nieschulz and Ponto, 1927 (refers to *partitus*); Kelser, 1927 (refers to *partitus*); Wu, 1940: 186 (includes *triceps* and *partitus*); Philip, 1959: 606, 1960: 57, 1973: 60 (includes *partitus*); Stone, 1960: 52 (refers to *partitus*); Chvála and Lyneborg, 1970a: 365 (includes *partitus*); Moucha, 1976: 142 (includes *triceps* and *partitus*).

Diagnosis.—*Tabanus striatus* Fabricius is closely related to *partitus*. Burton (1978) provided characters to separate the two in Thailand (as *striatus* and *megalops*), and these can be applied elsewhere in the range of both species. In particular, females of *striatus* do not have a pale tomentose and pale haired midstripe on the second tergum. These characters will separate it from both *partitus* and *triceps* females that do not have an abbreviated midstripe. The ground color of the dorsal abdominal surface is black in *striatus* females, dark brown in *partitus*. Males of both *striatus* and at least some *partitus* have the midstripe abbreviated, i.e. absent or evanescent on the second tergum, but the costal cell is completely hyaline in *striatus* and yellow tinted in *partitus*. Other differences were noted between *striatus* and *partitus*, but these may not hold up when more material is examined from intervening localities. In females, the apical segment of the palpus is slightly shorter, more stout and less yellowish in *striatus* than in Philippine *partitus*: the scutellum has the black pilosity (pale in *partitus*): the prescutellar sclerite has black pilosity (pale in *partitus*): the foretibia is less extensively or-



Figs. 1-2. Head, frontal view. 3, 6. Foreleg, lateral view. 4-5. Abdomen, dorsal view. 7-8. Abdomen, ventral view. 1, 3, 7, *Tabanus triceps*. 2, 5, 6, 8, *T. striatus*. 4, *T. partitus*.

ange basally, with apical fourth black; the stem of the halter is pale brown (yellowish white in *partitus*); sublateral pale stripes on abdomen are not conspicuously jagged or steplike (distinctly jagged or steplike in *partitus* (see Figs. 4, 5)); the venter is gray tomentose (more yellowish gray in *partitus*). The male of *striatus* always lacks the midstripe on the second abdominal tergum, although traces of pale pilosity may be present. The male of *partitus* has the midstripe on the second abdominal tergum variably developed, being nearly absent on some specimens, or being present and crossing the tergum to greatly narrowed in others.

History.—*Tabanus striatus* was originally described from China by Fabricius (1787). A specimen in the Zoological Museum, Copenhagen was designated as lectotype by Chvála and Lyneborg (1970b). Since its description, this species has been frequently interpreted too broadly, usually including one or more additional species, most commonly a southern "variant form" from Thailand, Malaysia, Indonesia, and the Philippines, now known as *Tabanus partitus* Walker. Confusion about the limits of *striatus* has been discussed by Burton (1978).

Tabanus striatus and *partitus* (Java distribution records) were combined in the work of van der Wulp (1880, 1881, 1885) and the catalogs of Bigot (1891), van der Wulp (1896), and Kertész (1900, 1908), but the greatest source of confusion about the limits of *striatus* was in Ricardo's (1911) work. She included both *triceps* of India (then called *tenens* Walker) and *partitus* under *striatus*. Her concept of *striatus* was hopelessly confused, as later stated by Austen (1922a). Ricardo incorrectly gave Fabricius (1794) as the original citation and "China and Java" as the type-localities of *striatus*. Ricardo even separated *Tabanus hilaris* Walker, a synonym of *striatus*, from *striatus* by the presence of an abbreviated median abdominal stripe, the character Fabricius used to define *striatus* and which Ricardo quoted in her paper.

Most earlier authors (van der Wulp, Bigot, Kertész, Ricardo, and Wu) also included the name *dorsilinea* Wiedemann as a synonym of *striatus*, but, as shown by Burton (1978: 78), this name is the senior synonym for a species previously called *bicallosus* Bigot (Ricardo, 1911: 129) or *macer* Bigot (Austen, 1922b: 264; Senior White, 1927: 44).

Austen (1922a) distinguished *triceps* (as *tenens*) from *striatus*, but combined *partitus* with *striatus*, an interpretation followed by most subsequent workers, including Schuurmans Stekhoven (1926, 1928, 1932), Senior-White (1927), Nieschulz (all papers), Wu (1940), Oldroyd (1957), Philip (1959, 1960, 1973), Stone (1960) and Moucha (1976). Their use of characters, particularly of the legs and abdomen, did not allow differentiation of these two species (*partitus* and *striatus*).

Austen (1922a) described *striatus* as having the midstripe on the second abdominal tergum more or less obsolete, at least much less distinct than on

the following terga. He also stated, however, that specimens of *striatus*, especially those which have the midstripe not obliterated on the second tergum, are liable to be mistaken for examples of *triceps* (as *tenens*). Austen thus included specimens that do have a midstripe on tergum two (i.e. *partitus*) as well as those that do not in his concept of *striatus*. Kröber (1924), discussing "*striatus*" from the Philippines, also mentioned that the midstripe on the abdomen was not always clear, probably a reference to male *partitus*, a species that sometimes has the midstripe evanescent on the second segment.

Surcouf (1923) was the first author to distinguish three distinct taxa throughout the geographic range of the *striatus* complex. He correctly recognized *striatus* Fabricius as distinct from another species in India that he named *strophiatius*, since he mistakenly believed *tenens* Walker to be a synonym of *striatus*. He did, however, correctly associate *hilaris* Walker with *striatus*. Surcouf clearly separated *striatus* from related taxa by restricting *striatus* to those specimens with the median abdominal stripe beginning on the anterior margin of the third tergum. For specimens with the midstripe beginning on the anterior border of the second tergum, Surcouf recognized two species, one he correctly called *partitus* Walker with dark legs, with *ruficallosus* (*lapsus* for *rufocallosus* Bigot) and *manilensis* Schiner as synonyms, and *strophiatius* Surcouf with testaceous legs, a new name for *striatus* of authors from India, China, and Indochina. Surcouf's interpretation of these taxa and their names was accurate except for his mistaken synonymy of *tenens* Walker under *striatus* and the renaming of the true *tenens* (= *triceps*) as *strophiatius*. He did correctly recognize three distinct taxa, utilizing characters that will separate these taxa. Unfortunately these characters were not consistently applied by subsequent authors, who overlooked Surcouf's work.

Schuermans Stekhoven (1926) recognized a northern, "typical" form of *striatus*, and a southern form that showed deviations from a specimen from Punjab, India that was compared with the type of *striatus* by K. L. Hendriksen. Schuurmans Stekhoven found that females caught in "southern areas" had wings with a yellow-brown costal cell and the midstripe paler but not abruptly interrupted on the second tergum. The males had wings with a yellow-brown costal cell. Thus, Schuurmans Stekhoven recognized differences that today are used to separate *striatus* from the related *partitus*, but he did not recognize these "forms" as distinct species.

The use of the name *striatus* in all of Nieschulz's fundamental work on surra and its transmission refers to *partitus* as his studies were restricted to Indonesia, principally Java.

Philip (1959) examined the types of *hilaris* Walker, *partitus* Walker and *rufocallosus* Bigot and concluded that all were variants of *striatus*. He also found that the type of *manilensis* Schiner did not disagree significantly from

the type of *striatus* except for the distally brown foretibia. Philip discussed the variable nature of the middle abdominal stripe on tergum two. He noted that the midstripe was either interrupted on tergum two in many Philippine males (but in only one female) or narrowly extended across the second tergum in "many other males" and most females, with one female showing the stripe "hardly narrowed." Although this character would more closely apply to *triceps* than *striatus*, Philip considered it to be variable throughout the broad range of *striatus* in the Oriental Region.

Isaac (1924b) discussed the life history of *striatus* in India. His illustrations of the male and female show clearly that he was working with true *striatus*.

Stone (1972) studied the types of several supposed synonyms of *striatus* and found that two distinct species were involved. He believed that the original description of *striatus* more closely agreed in abdominal coloration with specimens from China, its type-locality, than with specimens called *striatus* by earlier authors from more southern portions of the Oriental Region. He separated *triceps* (as *tenens*) from *striatus* by the strong middorsal pale stripe present from tergum I-VII, palpus longer and less swollen basally, and with the abdomen yellow brown rather than black brown. Stone believed the complete slender midstripe of *partitus* ruled out conspecificity with *striatus* and *triceps* (as *tenens*). He thereby implied that *partitus* was a distinct species. Although this character is not reliable for both sexes of *partitus*, Stone was the first author since Surcouf to recognize *partitus* as distinct from *striatus*. However, he placed *manilensis* and *rufocallosus* as synonyms of *triceps* (as *tenens*), rather than *partitus*, and did not give any taxonomic characters to support his synonymy.

Moucha (1976) did not follow Stone's interpretation, but reverted to Philip's concept of *striatus*, including under it most of the synonyms of *partitus*, as well as *strophiatius* Surcouf. He did, however, correctly synonymize *tenens* subform *cambodiensis* Toumanoff under *striatus*.

Burton (1978) has completely described *striatus* and thoroughly discussed the confusion of *striatus* with closely related *partitus* (as *megalops*), mentioning that the abdominal striping pattern will not serve to distinguish males of *striatus* and *partitus*. Herein lies at least some of the confusion previous authors encountered in attempting to define the limits of *striatus*, as the midstripe can be interrupted in males of *partitus* as well as *striatus*. However, as Burton pointed out, the yellow tinted costal cell in the male of *partitus* will separate it from *striatus* males which have a hyaline costal cell. Interestingly, this character was mentioned by Schuurmans Stekhoven (1926) in discussing the "southern form" of *striatus*, but was not considered by subsequent authors.

Distribution.—Pakistan, India, Sri Lanka, northern and eastern Thailand, Laos, Cambodia, Vietnam, China.

Specimens examined.—30. INDIA: Madras; Nedungadu; Tanjore Dist.; Sohawa; Jhelum; Karum Bagarum, Assam: Chabua; Dinjan; Doom Dooma. SRI LANKA: 10 localities throughout the island. PAKISTAN: Lahore. THAILAND: Loei. VIETNAM: "Tonkin."

Tabanus partitus Walker

Tabanus partitus Walker, 1856: 9. Type-locality: Singapore. Holotype female BM(NH). Subsequent references: Bigot, 1891: 270, van der Wulp, 1896: 60, Kertész, 1900: 64, 1908: 268 (catalog citations).

Tabanus manilensis Schiner, 1868: 84. Type-locality: Philippines, Manila. Holotype female NMW. Subsequent references: van der Wulp, 1896: 61 (as *manillensis*), Kertész, 1900: 64, 1908: 259 (catalog citations).

Tabanus rufocallosus Bigot, 1892: 197. Type-locality: Java. Holotype female BM(NH). Subsequent references: van der Wulp, 1896: 63, Kertész, 1900: 69, 1908: 276 (catalog citations).

Tabanus tenens (in part): Austen, 1922a: 445 (taxonomy); Senior-White, 1927: 53 (catalog citation); Schuurmans Steknoven, 1928: 438 (Philippines); Wu, 1940: 187 (catalog citation); Oldroyd, 1957: 59 (taxonomy); Stone, 1975: 71 (catalog citation).

Tabanus striatus (in total): Mitzmain, 1913 (biology; surra transmission in the Philippines); Kröber, 1924 (Taxonomy); Nieschulz, 1926a, 1926b (biology), 1926c (breeding sites), 1927a, 1927b (hymenopterous parasites), 1927c, 1928 (anthrax transmission), 1929a, 1929b, 1935a (distribution and abundance), 1935b (larval development), 1936 (biology, description of eggs, larva, and pupa); Nieschulz and Ponto, 1927 (most papers refer to surra transmission studies unless otherwise noted); Nieschulz and Kraneveld, 1929 (haemorrhagic septicaemia of water buffalos, transmission); Kelser, 1927 (surra transmission); Schuurmans Stekhoven, 1932b: 14 (Sumatra); Stone, 1960: 52 (taxonomy, distribution in Micronesia).

Tabanus striatus (in part): Ricardo, 1911: 149 (taxonomy); Kröber, 1924: 18 (taxonomy); Schuurmans Stekhoven, 1926: 63, 1928: 438, 1932a: 65 (taxonomy, distribution); Senior-White, 1927: 51 (catalog citation); Wu, 1940 (catalog citation); Philip, 1959: 606, 1960: 57, 1973: 60 (taxonomy); Chvála and Lyneborg, 1970a: 365 (taxonomy); Moucha, 1976: 142 (world catalog). erroneous citations as *megalops* (in part): Stone, 1972: 639 (taxonomy); Burton, 1978: 74 (taxonomy, synonym, Thailand records, biology, includes *triceps*).

Diagnosis.—*Tabanus partitus* was redescribed in comparison with *striatus* by Burton (1978). Female *partitus* are separated from *striatus* by the presence of a midstripe on the second abdominal tergum (absent in *striatus*), and male *partitus* have a yellow tinted costal cell (hyaline in *striatus*). Also, the general abdominal coloration of *partitus* is paler, brown to gray, than

in *striatus* (black). These characters hold for both species throughout their ranges. Comparison of Burton's specimens of *partitus* (Cornell University Collection, courtesy of L. L. Pechuman) with those from the Philippines revealed differences as follows: The frons is narrower in Philippine specimens, index 1: 6.0–7.5 (1: 4.3–5.6 for Thai specimens); the apical segment of the palpus is slightly more yellowish and stouter than in Thailand specimens; the mesonotum is darker gray; the disc of the scutellum lacks yellowish tones seen on Thai specimens; mid- and hindfemora are blackish distally; the stem of the halter is brown black (yellow white in Thai specimens). Males of *partitus* from the Philippines have no yellowish tint on the scutellum as do those from Thailand.

History.—*Tabanus partitus* was described by Walker (1856) from a female from Singapore. Since its description, it has most commonly been considered a variant form of *Tabanus striatus* Fabricius, with *striatus* of authors considered to be a rather variable and widely distributed Oriental species. Various authors differentiated *striatus* from *triceps* (as *tenens*) found in India and Sri Lanka. Other authors clearly separated *striatus* from *triceps* (as *tenens*), but considered *partitus* to be the same as *triceps*. This difference in concepts was based primarily on whether characters of the head and legs were used (*partitus* + *striatus* and *triceps*) or whether differences in abdominal striping were considered important (*striatus* and *triceps* + *partitus*).

Ricardo (1911) included *partitus* as a synonym of *striatus* even though she quoted van der Wulp's description verbatim (1881: 16) in which the wing of a male from Soerian, Sumatra was described as having a yellow tinted costal cell, a characteristic of *partitus*, not *striatus*.

Mitzmain (1913), working on transmission of surra (*Trypanosoma evansi*) by horse flies in the Philippines, discussed the biology of *Tabanus partitus* (as *striatus*), including a brief description of the male and female. The wing of the female was described as transparent except for the pale brown costal and subcostal cells, a characteristic of *partitus*. We have examined voucher specimens of *striatus sensu* Mitzmain and find them to be *partitus*.

Austen (1922a) attempted to differentiate *striatus* from *triceps* (as *tenens*) by the midstripe being more or less obsolete on the second abdominal tergum, and synonymized *partitus* (as *megalops*) under *triceps* (as *tenens*). However, the tarsal characters he used will not separate *striatus* from *triceps*. Also, because he incorrectly synonymized *hilaris* (= *striatus*) with *triceps* (as *tenens*), his ability to separate these taxa is questionable.

Kröber (1924), in his study of the tabanid fauna of the Philippines discussed *partitus* under the name *striatus*, stating that the midstripe on the abdomen was not always clear on the second tergum and citing a distribution for *striatus* from India to the Moluccas.

Schuermans Stekhoven (1926) clearly distinguished a northern typical

form and a southern form of *striatus*, stating that those from southern localities had wings with yellow-brown costal cells and midstripe on the abdomen paler but not abruptly interrupted on the second segment. Both males and females of *striatus* have a clear costal cell, so Schuurmans Stekhoven's southern form clearly refers to *partitus*. In subsequent papers, Schuurmans Stekhoven (1928, 1932a, b) provided additional collection records from Indonesia, also listing the "typical" form (i.e. *striatus* Fabricius) from Hanoi (Vietnam) and Fukien Province (China).

Nieschulz (1935b, 1936) studied the hatching and development of the immature stages of *partitus* (as *striatus*) in Indonesia. He also provided excellent illustrations of the larva and pupa of *partitus* as well as notes on the larval habitat. The illustrations are among the best available for any Oriental horse fly by early workers and allow comparison with known larvae and pupae of other species. Unfortunately, the larvae of *triceps* and *striatus* are less well illustrated and cannot be compared easily with *partitus*. In all of the fundamental work of Nieschulz on surra, the name *striatus* refers to *partitus*.

Oldroyd (1957) accepted Austen's synonymy of *partitus* (as *megalops*) and *triceps* (as *tenens*), with *triceps* distinguished from *striatus* by the presence of three abdominal stripes, being longer and more gently tapered and the midstripe complete from front to rear. Philip (1959, 1960, 1973), however, continued to consider specimens of *partitus* as variants of *striatus*. His synonymy of *striatus* is confused because he incorrectly placed *partitus* Walker and *rufocallosus* Bigot as synonyms of *striatus* and *partitus* as a synonym of *triceps* Thunberg. He also stated that the type female of *manilensis* Schiner (= *partitus*) "did not differ significantly" from *striatus*, even though in his discussion of *striatus* from the Philippines he mentioned the middorsal pale abdominal stripe on the second tergum as being present in Philippine material.

Stone (1960) recorded *partitus* (as *striatus*) from Guam. We have examined Stone's specimens from Guam in the USNM and did not find any major differences from *partitus*. Stone recognized that the synonymy of *striatus* was confused, involving more than one species, and he clearly distinguished *triceps* of India from his Guam specimens by the larger, browner body, entirely brown forefemora and the venter of the abdomen lacking the darkened midstripe found in *striatus*. Stone did, however, list *triceps* from the Philippines, so he may have included *partitus*, at least in part, in his concept of *triceps*.

Stone (1972), after examining the types of several supposed synonyms of *striatus*, concluded that two species were involved and that most of the synonyms did not apply to *striatus*. He recognized discrepancies between true *striatus* and the variant form from the southern Oriental Region. He

also recognized that *megalops* has a complete but slender midstripe that he believed ruled out conspecificity with either *striatus* or *triceps*. Although Stone was correct in this assertion, the length of the middorsal stripe will not suffice to separate *megalops* from *striatus* complex. Further, Stone erroneously grouped synonyms of *partitus* with *triceps* (as *tenens*) (i.e. *manilensis* and *rufocallosus*), but he was the first author since Surcouf to recognize two distinct taxa. Also he gave *triceps* a much wider distribution than it really has. In the Oriental Diptera Catalog, however, Stone (1975) synonymized *partitus* under *triceps* (as *tenens*).

Moucha (1976), unlike Stone, followed Philip's broad interpretation of *striatus* and placed *partitus*, *manilensis*, and *rufocallosus* in synonymy under *striatus*, as well as *dorsilinea* Wiedemann (as *macer* Bigot), a distinct species.

Burton (1978) summarized the past confusion surrounding the synonyms of *striatus* and *partitus* (as *megalops*) and gave excellent taxonomic characters for separating the two taxa. Unfortunately, he mistakenly believed *Tabanus megalops* Walker from Java to be conspecific with specimens he collected in Thailand. Undoubtedly, Burton was misled by Stone's synonymy. Burger has thoroughly examined the holotype male of *megalops* in the British Museum (Natural History) and compared it to males from Thailand collected and determined as that species by Burton.

The holotype of *megalops*, in fair condition, differs from the Thailand specimens in having the body stouter, costal cell clear, middorsal abdominal pattern being a series of very narrow triangles, not a parallel-sided stripe, forecoxae and femora orange brown, foretibiae uniformly brown, not bicolored, and midventral abdominal dark stripe evanescent. Based on these differences, we believe *megalops* is not conspecific with Burton's Thailand specimens or with other material examined from throughout the southern Oriental Region. The earliest available name for the taxon conspecific with specimens collected by Burton and others examined by us is *Tabanus partitus* Walker. The holotype of *partitus* is in good condition and has distinctly bicolored foretibiae, basal callosity contiguous with eyes below, pale abdominal middorsal stripe complete (although narrowed anteriorly) on tergum two, and distinct midventral dark stripe, all the characteristics of the southern component of the *striatus* complex.

The holotype male of *megalops* closely resembles several males presently in the BM(NH) collection determined as *Tabanus rubidus* Wiedemann by Austen, Oldroyd, and others. The configuration of the abdominal triangles also is reminiscent of some *rubidus* males, but the triangles of the type are narrower than in the presumed *rubidus* males examined. The condition of the type is such that assignment to the *rubidus* group as defined by Burton (1978) is certain, but species assignment is difficult, especially since the

characters separating males of these species are poorly defined at present.

Distribution.—Burma, Thailand, Malaysia, Indonesia, Philippines, Micronesia (Guam).

Specimens examined.—Approximately 300. BURMA: Rangoon. THAILAND: Prae Nakhom Prov., Chon Buri Prov. MALAYSIA: Kuala Lumpur, Selangor. SINGAPORE. INDONESIA: Sumatra, Medan; Java, Passeroean, Buitenzorg. PHILIPPINES: Luzon, Leyte, Palawan, Mindanao, Osmona, Samar, Alaband, Rizel. MICRONESIA: Guam, Togcha Point.

Tabanus triceps Thunberg

Tabanus triceps Thunberg, 1827: 59. Type-locality: Indian subcontinent (as "Cayenne et Brasilia"). Lectotype, Zool. Inst., Univ. Uppsala. Subsequent references: Kertész, 1900: 74, 1908: 286 (world catalogs); Philip, 1959: 609, 1967: 1236 (taxonomy, lectotype designation), 1960: 59 (synonymy, Thailand record), 1970: 450 (differences from *striatus* Fabricius), 1973: 60 (Ceylon records).

Tabanus tenens Walker, 1850: 49. Type-locality: East India. Holotype female BM(NH). Preoccupied by *Tabanus tenens* Walker 1850, a Neotropical species.

Tabanus strophiatius Surcouf, 1923: 197. Type-localities: "Archipel. Indien, Chine, Indo-Chine." Syntypes, at least 56 females, MNHN, Paris.

Tabanus tenens (in total): Bigot 1891: 269, van der Wulp, 1896: 60 (catalog citations); Kertész, 1900: 73, 1908: 285 (world catalog); Austen, 1922a: 445 (taxonomy); Isaac, 1924a (male, female genitalia), 1925 (immature stages); Schuurmans Stekhoven, 1926: 163 (taxonomy).

Tabanus tenens (in part): Schuurmans Stekhoven, 1928: 438 (Ceylon); Senior-White, 1927: 53 (catalog citation); Wu, 1940: 187 (catalog citation); Oldroyd, 1957: 59 (taxonomy); Stone, 1960: 52, 1972: 640 (taxonomy, synonymy), 1975: 71 (catalog citation).

Tabanus triceps (in part): Philip, 1959: 610, 1960: 59; Moucha, 1976: 147 (world catalog).

Tabanus partitus (in part): Burton, 1978: 74 (taxonomy, synonymy).

Tabanus striatus (in part): Ricardo, 1911: 149 (taxonomy)

erroneous citations to *triceps* (in part): Philip, 1959: 610 (includes *partitus*), 1960: 59 (includes *partitus* and *striatus*); Moucha, 1976: 147 (includes *partitus*).

erroneous citations to *tenens* (in part): Senior-White, 1927: 53 (may include *striatus*); Schuurmans Stekhoven, 1928: 438 (includes *partitus*); Wu, 1940: 187 (may include *partitus* and *striatus*).

Diagnosis.—*Tabanus triceps* from India and Sri Lanka is quite distinct from both *striatus* and *partitus*. Thunberg's alpha syntype (lectotype) of *triceps* has a uniformly orange forefemur and tibia, the callosity is not con-

tinguous with the eyes, receding from eye margins above, and the middorsal stripe on the second tergum broadly crosses that segment. It also has distinct thoracic stripes as mentioned by Philip (1959). The lectotype agrees with all the specimens we have seen from India and Sri Lanka previously determined as *tenens* or *triceps*.

Tabanus triceps is easily distinguished from *striatus* by the middorsal stripe of the abdomen distinctly crossing the second tergum in both sexes (occasionally obliterated in greased specimens), the unicolorous foretibia, the callosity narrowed above, not broadly contiguous with the eye margins, and the absence of a dark haired midventral stripe on the abdomen. The males of *triceps* have a yellow tinted costal cell (hyaline in *striatus*).

Tabanus triceps differs from *partitus* in having the callosity narrowly separated from eye margins below and receding from eye margins above, broadly joined to the broad, squared median extension; the apical segment of the palpus slightly longer and more slender basally; the forefemur and tibia entirely orange to orange brown; the sublateral pale abdominal stripes noticeably steplike and the venter uniformly yellowish gray, lacking a broad midventral dark stripe.

Males of *triceps* show the same differences from *partitus* as the females except for sex associated characters of the frons and palpus. The ground color of the abdomen of male *triceps* is blackish, and the middorsal stripe on the second tergum is usually well developed, while *partitus* males have a more reddish-brown abdominal ground color and the middorsal stripe on the second tergum is variably developed. Males of both species have a yellow tinted costal cell.

Most specimens of *partitus* from Thailand, the Philippines, and Java are smaller than *triceps* from Sri Lanka and India. The mean length of *partitus* was 12.7 mm (range 11.2–14.3 mm) for females and 12.2 mm (range 9.6–14.0 mm) for males. *Tabanus triceps* females averaged 15.0 mm (13.6–16.0 mm), while males averaged 14.4 mm (13.6–15.2 mm).

The pupal aster of *triceps* is different from that of *partitus* (see figures of Isaac and Nieschulz), the latter having the lateral arms directed posterodorsally in proximity to the dorsal arms while *triceps* has the lateral arms directed posteroventrally in proximity to the ventral arms.

History.—*Tabanus triceps* Thunberg has been reported under the name *Tabanus tenens* Walker in most of the literature and more recently as *megalops* by Burton (1978). This species generally has been considered distinct from *striatus*, except by Ricardo (1911). Bigot (1891), van der Wulp (1896), Kertész (1900, 1908), Senior-White (1927), and Wu (1940) list it as a distinct species. Austen (1922a) discussed Ricardo's confusion of the two species, but did not cite detailed characters to separate *triceps* (as *tenens*) from *striatus*. He did mention that the description of *striatus* by Wiedemann

(abdomen with three unabbreviated pale stripes; femora reddish rusty brown) applied better to *triceps*.

Surcouf (1923) used the name *strophiatius* for a species with the middorsal abdominal stripe beginning on the anterior border of the second tergum and the legs testaceous, a species he believed had been confused with *striatus*. This species was separated from a related one with dark legs that Surcouf called *partitus*. Thus Surcouf recognized that two species previously confused with *striatus* were distinct, one with dark legs and another with testaceous legs. The species he named *strophiatius* is the same as *triceps* and is synonymized with it.

Isaac (1924a, 1925), in a series of papers on Indian Tabanidae, discussed the immature stages and the male and female genitalia of *triceps* (as *tenens*). Isaac's figures of the adult male and female clearly show that he was dealing with *triceps*. Comparison of his pupal figure for *triceps* with that given by Nieschulz (1935) for *partitus* shows that the pupal aster is distinctly different. Other features of the immature stages could not be compared due to lack of comparable figures.

Schuermans Stekhoven (1926) clearly differentiated *triceps* (as *tenens*) from *striatus*, but considered *partitus* to be a synonym of *triceps* (as *tenens*), based on the very distinct middorsal stripe on the second segment. His description of *tenens* was drawn from Indian specimens and therefore refers to *triceps*.

Philip (1959), in his study of Tabanidae from the Philippine Zoological Expedition of the Field Museum (Chicago), discussed *striatus* and what he considered to be its synonyms. At the same time, he discussed the status of *tenens* vis à vis *striatus*. He found that one syntype (alpha) of *Tabanus triceps*, described by Thunberg (1827) from "Cayenne et Brasilia" was not a Neotropical species, but was closest to *tenens* Walker (the Oriental species). The unpatterned eye, striped thorax, and unicolorous legs did not agree with known Neotropical species. Philip designated this alpha syntype as the lectotype of *triceps*, with *tenens* thus becoming a synonym. Philip also gave characters to separate *triceps* from *striatus*, particularly the unicolorous legs, the uninterrupted broad midstripe on abdominal tergum two, and the basal callosity narrowed above, well separated from the eyes. These characters would separate *triceps* from Philip's concept of *striatus* (= *striatus* + *partitus*), but will not adequately separate *triceps* from *partitus*.

Philip (1967), in his discussion of Thunberg's species of Tabanidae from the New World, designated another lectotype, the gamma syntype, from the type-series in competition with his 1959 designation. Despite this lapse, the earlier designation has precedence, and *triceps* remains the valid name for Walker's *tenens* of the Oriental Region. Philip also stated that the alpha syntype might not have been an original syntype. However, as Thunberg described the thorax as having five white lines and the legs as completely

testaceous, and because these are characters of the alpha syntype, there is no doubt that the alpha syntype was one of the specimens before Thunberg when *triceps* was described.

Philip (1970) stated that Thunberg's gamma syntype of *triceps* might have come from China. However, there seems to be no reason for assuming this syntype is Oriental, based on the taxonomic characters given by Philip himself in 1967. The gamma syntype is the same as *Tabanus dorsiger* var. *dorsovittatus* Macquart, a Neotropical species with a green and purple striped eye pattern and strongly bicolored foretibia. Females of Oriental species related to *striatus* have unicolorous foretibia and unpatterned eyes. The beta syntype agrees with the description and figure of *Tabanus columbus* Fairchild, another Neotropical species. This specimen also had a patterned eye, although the precise pattern could not be discerned due to molding of the eye surface.

Stone (1960) separated *triceps* from *striatus* by its larger size, the entirely brown forefemur and the absence of a darkened ventral abdominal midstripe usually found in *striatus*. Subsequently, Stone (1972) reverted to *tenens* Walker when Philip designated a competing lectotype for *triceps*; thus *triceps* became a junior synonym of *dorsiger*, a Neotropical species. His treatment of these species in the Catalog of Oriental Diptera (Stone, 1975) followed his 1972 work. Moucha, in his catalog of World Tabanidae (1976), recognized Philip's 1959 designation and used *triceps* as the correct name. Both Stone and Moucha, however, continued to synonymize *partitus* and some of its synonyms with *tenens* (Stone) or with both *triceps* and *striatus* (Moucha).

Burton (1978) reviewed the status of *partitus* (as *megalops*), including its synonyms, in his study of the Tabanini of Thailand north of the Isthmus of Kra. He concluded that the types of *tenens* from East India and *megalops* from Java in the British Museum were conspecific, without mentioning the basis for his decision. As the type of *tenens* is a female and the type of *megalops* is a male, the association of the two may have been complicated because this would exclude use of frons characters. Burton compared the types with associated male and female specimens from Thailand. We have examined specimens from throughout the Oriental Region (including the types of *megalops*, *partitus*, *rufocallosus*, and *tenens* and a series determined as *partitus* by Burton) and determined that specimens from India and Sri Lanka (conspecific with the type of *tenens*) are specifically distinct from those collected in Thailand, Indonesia, and the Philippines (conspecific with the type of *partitus*).

We have also had the opportunity to examine Thunberg's syntype series of *triceps*. The alpha syntype (lectotype) agrees with specimens from India and Sri Lanka, which were compared with the type of *tenens*. The uniformly yellowish-orange femora and foretibia, basal portion of the callosity reced-

ing from eyes above, and lack of darker stripe ventrally on the abdomen are particularly distinctive of the lectotype and these other specimens. This confirms Philip's (1959) determination of *triceps* as conspecific with *tenens*. *Tabanus triceps* thus is the correct name for the species found in India and Sri Lanka, while *partitus* is the correct name for the species found in Thailand, Indonesia, the Philippines, and Micronesia.

Burton also found that the name *tenens* for the Indian species is a junior homonym of *Tabanus tenens* Walker described from Brazil, also in 1850, but four months earlier. However, since *triceps* antedates either of Walker's names by 23 years, this homonymy does not affect the correct name of the Indian species.

Distribution.—Pakistan, India, Sri Lanka.

Specimens examined.—78. INDIA: Coimbatore; Karikal; Bombay; Madras; Karum Bagaram; Trichinopoly; Singara, Nilgiri Hills; Tanjire Dist.; Calcutta; Kanchrapara (2 ♀ agree with the type of *tenens* Walker); Bengal; Shimuga; Mysore; Walayar Forest, South Malabar; Chinchona; Anamalai Hills. SRI LANKA: 26 localities throughout the island.

UNPLACED SYNONYMS

Tabanus chinensis Thunberg, 1827.—This species was described briefly by Thunberg with the habitat given both as China and the Cape of Good Hope. It possibly could be a synonym of *striatus*, but this is uncertain from the original description, so it is left unplaced for the present.

Tabanus costalis Lichtenstein, 1796.—Bezzi (1908) first called attention to the names of Anton August Heinrich Lichtenstein. Austen (1908) discussed the Tabanidae listed in Lichtenstein's Catalogus. Since only two copies of Lichtenstein's work were known to Austen, he quoted the description of *costalis* verbatim: "295. *Tabanus striatus*; n. 39 (the number under which Fabricius described *striatus*). Item: *Tabanus costalis*; nobis. *Taban. oculis aeneis*; ferrugineus, alis hyalinis costa flava. Habitat in Coromandel." Ricardo (1911) stated that the species is absolutely indeterminate and should be deleted from the list of *Tabanus* species. Surcouf (1923) considered it a questionable synonym of *striatus*. Stone (1975) did not list the name in the Catalog of Oriental Diptera. Burton (1978) referred to the name under the *Tabanus striatus* complex, indicating its status was yet to be defined.

The name appears in a sale catalog, and, thereby, may not be considered available. The arrangement of the catalog follows Fabricius (1794), and *costalis* is listed under *striatus*, number 295 being the number of the item in the sale catalog. The description is short, but the mention of the yellow costal cell could refer to either *partitus* or *triceps* as the males of both species have a yellow costal cell. The notation "habitat in Coromandel"

may refer to the Coromandel Coast of India (16°–12°N Lat.), including Madras, or to Coromandel in the state of Minas Gerais, Brazil (unlikely possibility, Fairchild, *in litt.*). If the former locality is intended, then *costalis* may refer to *triceps*, but if the latter locality is intended, *costalis* may refer to *dorsiger* Wiedemann or a related species with a tinted costal cell.

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NOTE

Synonymy by Way of Teratology
(Chilopoda: Lithobiomorpha: Lithobiidae)

Not a few chilopod taxa, genera, species, have been founded upon ontogenetic aberrations. This accounts for such freaks or sports being found only once. Confronted with a suspect anomaly, one should take into consideration both the nature of the single bizarre feature and also the rest of the animal.

In 1945 R. V. Chamberlin proposed *Physobius* n.g. for a single species, *rappi* n. sp., from Mahomet, Illinois (Entomol. News 56(8): 197). It is clear from the description that genus and species are really founded upon a single bizarre character: There is only a single prosternal tooth on each side of the diastema. In all other Lithobiomorpha there are two or more teeth per side. Elsewhere in the description, especially in the generic diagnosis, confusing and contradictory statements are made pertinent to various signal features. For instance he compared his species to the sexually dimorphic males of *Garibius*, even though his single specimen was a female. I can only explain such discrepancies by imagining that he must have been examining several different sorts of specimens, in this case species, and not only his single female holotype. In any case the new name must be based upon that female holotype.

I have examined the holotype, which is in the Chamberlin Collection at the U.S. National Museum of Natural History. It has indeed one prosternal tooth on each side; however, such is the nature of the prosternum including the teeth that one cannot avoid suspecting them to be developmental aberrations. Furthermore, if one discounts the original description and the bizarre prosternum, if one takes into account only the rest of the animal, one sees that it can only be *Pokabius bilabiatus* (Wood, 1867). Accordingly, *Physobius* Chamberlin, 1945, is a junior synonym of *Pokabius* Chamberlin, 1912, and *rappi* Chamberlin, 1945, is a junior synonym of *bilabiatus* (Wood, 1867) (NEW SYNONYMIES).

The Wood species is absolutely distinctive; it would be very difficult to confuse either sex with the sexes of any other species; furthermore, it is the most prevalent and ubiquitous lithobiid of the North American steppes. This is a case of what I shall call taxonomic tunnel-vision. It is thus possible to be so immersed in the rapt contemplation of just one extraordinary character that one fails to take the rest of the animal into consideration, in doing so describing nothing but another synonym.

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NOTE

On the True Identity of *Zygethobius pontis* Chamberlin
(Chilopoda: Lithobiomorpha: Henicopidae)

The confident identification of *Zygethobius* (*Zantethobius*) *pontis* Chamberlin, 1911 (Ann. Entomol. Soc. Am. 4(1): 32-48) must prove troublesome to anyone trying to reconcile *pontis* as described in the literature with what one supposes to be *pontis* in nature. In fact, I believe now, *pontis* of the printed page and *pontis* in nature are one and the same in spite of the apparent disparity between them. The source of the long-standing difficulty lies in an error not in Chamberlin's original description but in his later, more comprehensive family revision of 1912 (Bull. Mus. Comp. Zool. 57(1): 1-36).

In 1911 (p. 34) proposing both subgenus *Zantethobius* and species *pontis* as new, Chamberlin separated them from related taxa ascribing to the new subgenus and species tergal productions on body segments 6, 7, 9, 11, and 13. There is no mention of whether or not the 15th tibia has a spinous projection. In 1912 (p. 27) he separated *Zantethobius* and *pontis* again from other taxa, this time specifying "all legs with well-developed tibial processes." On p. 36, again, he attributed a tibial spine to each of the 15th legs and referred to "anal legs" of plate 4, fig. 9. In all other species he believed tibial processes to occur only on legs 1-14, never on 15.

The type-localities of *pontis* are Johnson City, Tennessee, and Natural Bridge, Virginia. For more than 30 years I have examined specimens from the American southeast, especially from Virginia. All agree with Chamberlin's 1912 redescription of *pontis* in every detail except in one: In all of them each 15th tibia lacks a spinous process.

I believe that the types, which cannot be found, had 15th tibiae that had no spinous processes but that such processes did occur upon the 14th and more anterior legs. I suggest that Chamberlin's 1912 figure of a supposed 15th leg was in fact that of a 14th leg. Apart from its possessing a distinct tibial spine, its dimensions and vestiture strengthen this belief. Especially in henicopids the rear legs are easily detached, and when detached they are very easy to confuse with one another.

In summary, I believe that *pontis* in fact lacks a tibial spine on leg 15. Secondly, I find the subgenus *Zantethobius* untenable alone on the basis of its possession of a produced 6th tergite. Its type-species is *pontis* (by monotypy), which is clearly congeneric with *dolichopus* Chamberlin, the type-species of *Zygethobius* (original designation). Accordingly, *Zantethobius* Chamberlin, 1911, is a junior synonym of *Zygethobius* Chamberlin, 1903 (NEW SYNONYMY).

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NOTE

Notes on a European Aphid (Homoptera: Aphididae)
New to North America

Severe distortion of the growing tips of *Lonicera* spp. was observed in northern Illinois during the summer and fall of 1980, and the causative agent seemed to be an aphid. The search for a name and some information on the suspect aphid turned up references in the Russian literature to *Hyadaphis tataricae* (Aizenberg) (1935. Zap. Bolshevskoi Biol. Stn. 7-8: 151-160) (Rapais, 1969. Atlas of the baltic dendrophilous plantlice. Publishing House Zinatne, Riga, pp. 7-361; Shaposhnikov, 1964. In Bei-Bienko, Keys to the insects of the European USSR. Vol. 1, pp. 489-616). Shaposhnikov (1964) described it as being "very injurious in squares and parks of towns, also injurious to protective forest belts" and its distribution as "everywhere."

The first observations of damage by this aphid on *Lonicera* in Illinois were made by Bob McAdams (State Horticultural Inspector of Lake Co.) in the fall of 1979. There were no aphids present on the samples at that time and they were sent to a plant pathologist for diagnosis. From damaged plants observed then, the distribution seemed to have been patchy, but the exact extent is not known. Present distribution is throughout the five contiguous northeastern counties in Illinois (Lake, McHenry, Kane, DuPage, and



Fig. 1. a, Apterous viviparous female of *Hyadaphis tataricae*. b, Diagrammatic sketch of honeysuckle twig showing size reduction and folding of leaves infested with *H. tataricae*.

Cook). Collections have been made also in Rochelle and Kankakee, Illinois, northwestern Indiana, and Madison, Wisconsin. The damage caused is so severe and obvious that it is unlikely that it has been overlooked, and it is assumed that this aphid is of rather recent introduction. Summer collections included alate and apterous viviparae, and collections from mid-September on had alate males and apterous oviparae as well as viviparae.

The response of the plant to infestation by *H. tataricae* is reduced shoot elongation, longitudinal leaf folding with upperside in, and reduction in leaf size (Fig. 1b). The folded leaves form a pouch in which the aphids are located, but in heavy infestations there are aphids on the young shoots also.

The aphids are small (<2 mm) and pale green to cream with pulverulence. The front is somewhat nodulose, antennae are often 5-segmented, and the prosternal furca is more or less pigmented. There is a small lateral tubercle just anterad of each siphunculus and a characteristic arrangement of the six setae on the cauda (Fig. 1a).

This species is considered to feed only on the genus *Lonicera*. In Illinois it has been found on *Lonicera tatarica* L. (all varieties), *L. zabelli* Rehd., and *L. maackii* (Maxim) (Bob McAdams, personal communication).

My thanks to Virgil Knapp, Bob McAdams, and Manya B. Stoetzel (Systematic Entomology Laboratory, USDA) for distributional information on *Hyadaphis tataricae*.

David Voegtlin, *State Natural History Survey, Natural Resources Building, 607 E. Peabody, Champaign, Illinois 61820.*

BOOK REVIEW

Coccoids of the Far East USSR (Homoptera, Coccinea) With a Phylogenetic Analysis of the Coccoid Fauna of the World. 1980. Evelyn M. Danzig. Publisher Nauka, Leningrad, 367 pp., 185 figs., 8 pls. (in Russian). Cost: 5 Rubels and 10 Kopeks (approximately \$6.00).

This volume is number 124 in the series "Studies of the Fauna of USSR, Publications of Zoological Institute of the Academy of Sciences, USSR." The book is divided into general and systematic parts. For non-Russian readers the general part contains the more valuable and unique information that deals with evolution, phylogeny, and higher classification of the coccoids of the world.

The author is a well-known coccidologist of the Zoological Institute in Leningrad and is currently the most active Russian worker in this field. Besides publishing a number of taxonomic revisions, she has studied in detail the coccoid fauna of northwestern USSR, Siberia, far eastern USSR including the Maritime Provinces, and also Afghanistan and Mongolia. She has worked on the ecology, zoogeography, and intraspecific variation, including biotypes of scale insects. Her present work combines the results of many years of work with much new information.

The bulk of the material for this study was collected by the author during 1961-1963, 1967, and 1969. A number of other workers and institutions also provided specimens. The book includes 158 species (excluding those found in greenhouses) from far eastern USSR, of which 56 are reported for the first time in this area, also 47 species and three genera which were described by the author earlier as new to science. A number of taxa are synonymized.

The species discussed were included in only eight families. Other workers, who recognize more families, would have placed the genus *Puto* into a separate family Putoidae, and the genera *Cryptococcus* and *Pseudochermes* into the Cryptococcidae. It is interesting that the members of Acleridae are absent, although their common hosts, grasses, bamboo, and the reed, *Phragmites communis*, occur in the area. Acleridae are known from Central Japan (Omi and Tokyo area), and are distributed as far north as Kansas and New Jersey in North America.

The keys are the serial type, where alternative choices are widely separated. The description of genera includes synonymy and more important pertinent references; the type-species of the genus; short diagnosis of adult females and of the test when present; number of species included; and host plants and distribution. Each species description includes synonyms and references; short description of adult female and test when present; distri-

bution and biology; and affinities. Coccoid parasites and predators are not mentioned.

The book is well illustrated, with 185 figures. Almost all drawings are original, but a few were adopted from Borchsenius' earlier works. With few exceptions, only the adult females are illustrated, these usually with a half or full page size line drawing. Besides enlargements of microscopic characters of the species treated, some coccoids were figured on their host, also tests and egg sacs of some species are illustrated to aid in their recognition. Maps show distributions of ten species and four genera. Additional figures are on life cycles and unique morphological features, such as pores, ducts, and on the anal area. The eight tables provide comparisons for dermal pores, endosymbionts, evolution of life cycles, plesiomorphic and apomorphic conditions in the coccoid families, specialized morphological features in the subfamilies and tribes of Margarodidae, and for some other taxonomic characters.

The major contribution of this book for entomologists is in the phylogenetic analysis of the world coccoids. To appreciate fully her contribution, the reader should know that earlier attempts to present the phylogeny of coccoids were based solely on external morphology of both adults (Balachowsky, 1942. *Grignon École Natl. d'Agric. Ann.* (3)3:34-38), or adult females (Borchsenius, 1958. *Zool. Zh.* 37: 765-780), or adult males (Boratynski and Davies, 1971. *Biol. J. Linn. Soc.* 3: 57-102), or on comparative morphology of mouthparts (Koteja, 1974. *Acta Zool. Cracov.* 19(14): 267-325). In this book, Danzig brings together for the first time in an organized framework the old and recent bits of scattered taxonomic information on the subject and evaluates these with a cladistic method. She utilizes 33 taxonomic characters, including dimensions, mobility, morphological features, type of tests produced, and life cycles. She also evaluates the types of wax producing pores and ducts, and the endosymbionts in each family. Her chapters on direction of evolution include analysis of external morphology, chromosome systems, endosymbionts, food habits, and life cycles.

Her principal suggested changes and reassignments in the traditional classification of coccoid higher taxonomic categories are the following: The scale insects are elevated to suborder level, the Coccinea; two superfamily names replace the earlier artificial group names, Orthezioidea replaces Archaeococcoidea and Coccoidea replaces Neococcoidea; she considers the Margarodidae the most primitive family, replacing Ortheziidae, which became the second in the coccoid phylogenetic sequence; Morrison's (1927. *Proc. Biol. Soc. Wash.* 40: 99-109) margarodid tribes Matsucoccini and Steingeliini are synonymized and included in the subtribe Kuwaniina MacGillivray within the tribe Kuwaniini of MacGillivray (1921. *The Coccidae*, Scarab Co., Urbana, Ill. 502 pp.); among the mealybugs, the tribe Coccurini and the family Putoidae are synonymized with Phenacoccini, the

Planococcini becomes a synonym of Pseudococcini, also Antoniniinae and Serrolecaniinae are synonyms of Sphaerococcini; Eriococcidae include Apiomorphidae, Calycicoccidae, Cryptococcidae, Cylindrococcidae, and Micrococcidae; the families Cerococcidae and Lecanodiaspididae are again included as subfamilies in the family Asterolecaniidae; in the family Coccidae the subfamily Filippinae is synonymized with Eriopeltinae, the tribe Coccini now includes the Paralecaniini; and the family Phoenicococcidae includes the Halimococcidae. After these regroupings she recognizes only 16 families. Because her cladistic analysis uses only four states from among the many taxonomic characters that adult males can provide, and none from the immatures, it is expected that some of the present phylogenetic assignments will change as soon as these stages are studied in more detail.

Danzig rejects Borchsenius' theory that the coccoids evolved before the angiosperms, thus they existed before the Cretaceous Period and were first associated with conifers. She believes that the feeding of coccoids on conifers was secondary, and that there is no evidence that they already evolved before the Cretaceous Period.

The extensive 13-page literature list includes 409 articles. There are indices to scientific names of coccoid taxa, also to host plants by Russian names and another by scientific names. As customary in eastern Europe the table of contents is included on the last page, instead of in front of the book as considered more practical by us. The book is 17 × 26 cm in size, with an attractive beige hard cover. The quality of paper used is between our newsprint and offset. Price is very reasonable, since printing is government subsidized. An English summary would have made this valuable work more readily useable for non-Russian readers.

The author should be complimented for the unique approach and thoroughness with which she presented this study.

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SUMMARY REPORTS OF SOCIETY OFFICERS FOR 1980

Treasurer
(1 November 1979 to 31 October 1980)

Summary:	General Fund	Special Publication Fund	Totals
On hand, 1 November 1979	14,170.68	29,520.14	43,690.82
Total receipts	40,402.23	11,191.09	51,593.52
Total disbursements	33,110.54	7,577.50	40,688.04
On hand, 31 October 1980	21,462.57	33,133.73	54,596.30

EDITOR
(Calendar Year 1980)

Four numbers of the *Proceedings* were published in 1980. The 732 pages plus one foldout represented 75 scientific articles, 12 notes, 5 book reviews, 1 obituary, 4 announcements, and the minutes for 8 Society meetings. Reports of officers for 1979, information for contributors, table of contents for volume 82, index to new taxa in volume 82, and PS Form 3526 were also published.

Editorial charges were waived for 9 articles and 1 note totaling 80 pages. Full editorial charges were paid for immediate publication of 4 articles, 1 book review, and 1 obituary totaling 39 pages. Eight lengthy articles included full editorial charges for 50 pages, and 4 articles by non-members included full editorial charges for 23 pages.

Volume 82 represented the largest volume in the history of the *Proceedings* and included the first foldout published. Because of the increased number of pages, manuscripts were published in six to nine months from date of acceptance.

Publications Committee: E. Eric Grissell, John M. Kingsolver, Wayne N. Mathis, George C. Steyskal, Manya B. Stoetzel, and David R. Smith (*Editor*).

SOCIETY MEETINGS

868th Regular Meeting—April 3, 1980

The 868th Regular Meeting of the Entomological Society of Washington was called to order at 8:00 pm on 3 April 1980 by President T. J. Spilman in the Ecology Theater of the National Museum of Natural History. Twenty-three members and 16 guests attended. Minutes of the previous meeting were read and approved.

Membership Chairman Joyce Utmar read for the first time the name of the following new applicant for membership:

Ross H. Arnett, Jr., 814 A Street S.E., Washington, D.C.

The speaker for the evening, Dr. David A. Nickle, Systematic Entomology Laboratory, USDA, presented a talk entitled "Color Polymorphism in Phaneropterine Katydids or Throw Away the Bottle, Maw, I Just Saw a Pink Katydid." The talk, accompanied by Kodachrome slides, pointed out the genetic inheritance of color forms of the Florida oval-winged katydid, *Amblycorypha floridana* Rehn and Hebard, which occurs in nature in four forms, green, yellow, pink, and orange. The adaptive significance of the polymorphism was also discussed.

NOTES AND EXHIBITIONS

Dr. Ashley B. Gurney displayed the research of Dr. L. M. Roth entitled "A taxonomic revision of the Panesthiinae of the world. II. The genera *Salganea* Stål, *Microdina* Kirby, and *Caeparia* Stål (Dictyoptera: Blattaria: Blaberidae)" in Aust. J. Zool., suppl. ser. No. 69, 201 pp.

The meeting was adjourned at 10:15 pm, after which cookies and punch were served.

David A. Nickle, *Recording Secretary*

869th Regular Meeting—May 1, 1980

The 869th Regular Meeting of the Entomological Society of Washington was called to order by President T. J. Spilman at 8:00 pm, May 1, 1980, in the Ecology Theater, National Museum of Natural History. Twenty-seven members and 11 guests were present. The minutes of the April meeting were read and approved.

Membership Chairman Joyce Utmar read for the first time the names of the following new applicants for membership:

E. Baksh, Stange Canada, Inc., 3340 Orlando Drive, Mississauga, Ontario.

Mary Carver, CSIRO, Division of Entomology, P.O. Box 1700, Canberra City, A.C.T., Australia.

Charles C. Coffman, Plant Pest Control Division, West Virginia Department of Agriculture, Charleston, West Virginia.

Neal L. Evenhuis, Bernice P. Bishop Museum, 1355 Kalihi Street, P.O. Box 1900-A, Honolulu, Hawaii.

Earl R. Oatman, Division of Biological Control, University of California, Riverside, California.

Ivica T. Radović, Institute of Zoology, Faculty of Science, University of Belgrade, 16 Studentski trg, 11000 Beograd, Yugoslavia.

Michael J. Shannon, 2809 Spangler Lane, Bowie, Maryland.

D. Dee Wilder, Department of Entomology, California Academy of Sciences, Golden Gate Park, San Francisco, California.

President-Elect Jack Lipes announced that the joint banquet of the Entomological Society of Washington and the Insecticide Society of Washington will be held June 3 at Fort McNair. Master of Ceremonies will be John Kennedy, past president of the Insecticide Society of Washington. Guest speaker will be Elton Hansens of Rutgers University whose topic will be Kenya Safari—1980.

The speaker of the evening was Dr. Edward F. Knipling, USDA, Beltsville, Maryland. Dr. Knipling spoke on the "Status of the Screwworm Suppression Program in Southwest United States and Mexico." He gave a historical account and also mentioned some problems associated with the suppression program. He illustrated his talk with many slides.

Raymond Gagné presented additional slides showing the screwworm rearing and irradiation facility at Mission, Texas.

NOTES AND EXHIBITIONS

Ashley B. Gurney exhibited the book *Zest of Life or Waldo Had a Pretty Good Run, the Life of Waldo La Salle Schmidt*, by Richard E. Blackwelder, published by Allen Press, Inc., Lawrence, Kansas. Dr. Waldo Schmidt was Chairman of the Department of Zoology at the Smithsonian Institution. Theodore Bissell presented the publication "Chromosome Numbers of the Aphididae and Their Taxonomic Significance," by Roger Blackman of the British Museum.

President Spilman adjourned the meeting, after which punch and cookies were served.

Joyce A. Utmar, *Recording Secretary pro tem*

870th Regular Meeting—June 3, 1980

The Entomological Society of Washington and Insecticide Society of Washington Joint Annual Banquet was held on June 3, 1980, at the Fort McNair Officers' Club, Washington, D.C. Dr. Dale Parrish was host, Jack E. Lipes and William L. Hollis were banquet chairmen, and John Kennedy was the Master of Ceremonies. After the open bar social hour and dinner, Dr. Elton Hansens of Rutgers University presented an innovative slide show entitled "Kenya Safari, 1980."

The banquet was attended by 111 persons. After the presentation by Dr. Hansens, John Kennedy conducted the drawing of several door prizes.

David A. Nickle, *Recording Secretary*

871st Regular Meeting—October 2, 1980

The 871st Regular Meeting of the Entomological Society of Washington was called to order by President T. J. Spilman at 8:00 pm, 2 October 1980, in the Ecology Theater, National Museum of Natural History. Thirty-seven members and 11 guests were present. The minutes of the May and June meetings were read and approved.

Membership Chairman Joyce Utmar read for the first time the names of the following new applicants for membership:

Horace R. Burke, Department of Entomology, Texas A&M University, College Station, Texas.

Wilbur G. Downs, 10 Halstead Lane, Branford, Connecticut.

Francis Edward Giles, Department of Biology, Loyola College, 4501 N. Charles Street, Baltimore, Maryland.

Daniel K. Young, Department of Entomology, Michigan State University, East Lansing, Michigan.

Ronald G. Gunther, 3814 S. Lauder Avenue, Bartonville, Illinois.

Ralph E. Harbach, Medical Entomology Project, Smithsonian Institution, Washington, D.C.

C. Barry Knisley, Department of Biology, Randolph-Macon College, Ashland, Virginia.

Charles E. Miller, APHIS, PPQ, USDA, Federal Center Building, Room 670, Hyattsville, Maryland.

Richard S. Miller, 1553 E. San Jose Avenue #108, Fresno, California.

Mary H. Ross, Department of Entomology, Virginia Polytechnic Institute and State University, Blacksburg, Virginia.

John D. Unzicker, Section of Faunistic Surveys and Insect Identification, Illinois Natural History Survey, Natural Resources Building, Urbana, Illinois.

Chandra A. Viraktamath, Department of Entomology, University of Agricultural Sciences, Bangalore, India.

Kathleen J. DeBold, 4603 Calvert Road, College Park, Maryland.

President-Elect Jack Lipes reported on the events that took place at the joint banquet of the Entomological Society of Washington and Insecticide Society of Washington, June 3 at Fort McNair.

The presentation for the evening was a talk entitled "Aspects of the 16th International Congress of Entomology, Kyoto, Japan." Dr. Donald R. Davis, Department of Entomology, Smithsonian Institution, presented historical aspects of Japan in the Yamoto Region, with special emphasis on religious temples in and around Kyoto; Dr. Curtis W. Sabrosky, Systematic Entomology Laboratory, USDA, presented information about the Congress itself; Dr. Raymond J. Gagné, Systematic Entomology Laboratory, USDA, discussed horticultural practices in the southern island of Kyushu; and Dr. F. Christian Thompson, Systematic Entomology Laboratory, USDA, showed slides of the forests of the northern island of Hokkaido. All speakers presented excellent color slides to accompany their talks.

NOTES AND EXHIBITIONS

Dr. A. B. Gurney displayed and briefly discussed a new paperback book, *The Cockroach Combat Manual* by Austin M. Frishman, Arthur P. Schwartz, and Robert Powell, 192 pp., illus., Wm. Morrow and Co. Inc., New York, New York.

President T. J. Spilman showed the new book, *How to Know the Beetles*, 2nd Edition, by Ross H. Arnett, N. M. Downie, and H. E. Jacques, published by Wm. C. Brown Co., Dubuque, Iowa, \$9.60.

Joyce Utmar presented the book *The Land of the Locusts, Being Some Further Verses on Grigs and Cicadas, Part I, Before 450 AD* by Dr. Keith McE. Kevan, containing selections from Chinese, Greek, Hebrew, and other sources which refer to orthopteroid insects and cicadas. She also showed Erwin Schmitschek's work, *Insekten als Nahrung, in Brauchtum, Kult und Kultur* (Insects as Food, in Folklore, Religion, and Culture) in *Handbuch der Zool.* 4: 1-62, 1968.

Mignon Davis showed the red pendant emblem for the XVIth Congress, symbolizing the common Japanese dragonfly, *Sympetrum frequens* (Selys), whose autumn evening swarms have long been the subject of poems and children's songs. Also shown was a large dragonfly pin with Japanese pearls for head and eyes. This represents the emblem of the Entomological Society of Japan and was acquired through Professor S. Asahima during the XVth Congress in Washington, D.C. in 1976.

Dr. Donald Whitehead displayed a larval cuterebrid that had embedded in his upper arm while he was in Costa Rica.

Visitors were introduced, and President Spilman adjourned the meeting, after which punch and cookies were served.

David A. Nickle, *Recording Secretary*

872nd Regular Meeting—November 6, 1980

The 872nd Regular Meeting of the Entomological Society of Washington was called to order by President T. J. Spilman at 8:00 pm, 6 November 1980 in the Naturalist Center, National Museum of Natural History. Twenty-eight members and 3 guests attended. The minutes of the previous meeting were read and approved.

Membership Chairman Joyce Utmar read for the first time the names of the following five new applicants for membership:

Diane Calabrese, Department of Biology, Trinity College, Washington, D.C.
Edwin Inai, 3402 Medina Lane, Bowie, Maryland.

Burton D. Schaber, Agriculture Canada, Research Station, Lethbridge, Alberta.

Kevin W. Thorpe, Department of Entomology, University of Maryland, College Park, Maryland.

John S. Weaver III, Department of Entomology, Clemson University, Clemson, South Carolina.

Nominating Committee Chairman Don Davis read the names of nominees for offices for 1981: President-Elect, Margaret S. Collins; Treasurer, F. C. Thompson; Recording Secretary, D. A. Nickle; Editor, D. R. Smith; Corresponding Secretary, Mignon Davis; Program Chairman, J. Schaffer; Custodian, S. Nakahara; and Hospitality Chairman, Helen Sollers-Riedel.

The first speaker of the evening was Dr. Donald R. Roberts, Chief, Department of Entomology, Walter Reed Army Institute of Research, whose talk was entitled "Attraction of DDT to *Eufriesia purpurata* in Amazonia," an account of the unusual foraging behavior of male bees upon DDT used in anti-malarial programs in the Amazon Basin.

The second speaker for the evening was Dr. Ashley B. Gurney, Collaborator, Systematic Entomology Laboratory, USDA, whose talk "The career and work of Mrs. Annie Trumbull Slosson (1838–1926): An early American entomologist" described this woman's history, career in entomology, and her creative writing in her popular short stories.

NOTES AND EXHIBITIONS

Joanne Alexander displayed two live cockroaches collected by Dr. Suzanne Batra during her trip to Australia. William Bickley displayed a paper by D. Hille Ris-Lambers entitled "Aphids as botanists?" in *Symb. Bot. Ups.* 22: 114–119, 1979.

J. H. Fales and T. J. Spilman exhibited twigs of *Carya illinoensis*, the pecan, and an adult of *Oncideres cingulata* (Cerambycidae), the twig girdler. The beetle had been found girdling branches on a lawn under pecan trees at Plum Point, Calvert County, Maryland, 12 October 1980.

J. H. Fales also reported that he and W. R. Grooms collected butterflies extensively in Maryland, 1980, and had obtained two new state records in Dorchester County for *Euphyes palatka* (Edwards), the Palatka Skipper (5 July 1980), and *Ascia monuste* (Linnaeus), the Great Southern White (25 September 1980).

The meeting was adjourned at 10:30 pm after which punch and cookies were served.

David A. Nickle, *Recording Secretary*

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Taxonomic Studies on Fruit Flies of the Genus <i>Urophora</i> (Diptera: Tephriti- dae), by George C. Steyskal	2.00

MEMOIRS OF THE ENTOMOLOGICAL SOCIETY OF WASHINGTON

No. 1. The North American Bees of the Genus <i>Osmia</i> , by Grace Sandhouse, 1939	1.00
No. 2. A Classification of Larvae and Adults of the Genus <i>Phyllophaga</i> , by Adam G. Boving, 1942	(out of print)
No. 3. The Nearctic Leafhoppers, a Generic Classification and Check List, by Paul Wilson Deane, 1949	1.00
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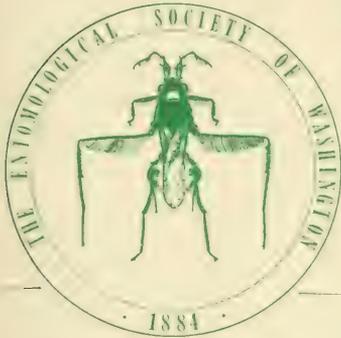
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of the

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of WASHINGTONDEPARTMENT OF ENTOMOLOGY
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Please see p. 183 of the January 1981 issue regarding preparation of manuscripts.

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THE LARVAL HABITATS AND REARING OF SOME COMMON
CHRYSOPS SPECIES (DIPTERA: TABANIDAE)
IN NEW HAMPSHIRE¹

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Department of Entomology, University of New Hampshire, Durham,
New Hampshire 03824.

Abstract.—Approximately 1230 larvae and pupae of ten early season *Chrysops* species were collected and reared over three years, with *Chrysops mitis* Osten Sacken (500), *C. ater* Macquart (225) and *C. indus* Osten Sacken (124) most commonly collected. The most consistently favorable collecting sites were natural or artificial ponds; the least favorable sites were rocky bottomed streams. Permanent ponds with exposed loamy soils just above waterline consistently supported large numbers of common *Chrysops* species. Factors affecting collecting and rearing success include synchronization of prepupal and pupal stages and adult emergence, yearly variation in pupation and emergence time, amount and quality of lacustrine substrate available for pupation, seasonal succession of species cohorts or different species in the same habitat, and abundance of a parasitoid wasp, *Diglochis occidentalis* (Ashmead) (Pteromalidae), in pupae. Yearly variation in amount of favorable pupation substrate most directly affected collecting success in a particular habitat, while percent parasitism by *D. occidentalis* most directly affected rearing success in the laboratory. A brief discussion of *Chrysops* larval habitat types in North America is presented, with a summary of larval habitats for 55 Nearctic species.

In 1977-79, *Chrysops* larvae were collected from several lacustrine habitats in New Hampshire to be reared for studies on adult alimentary canal morphology and ovarian development. Several habitats examined yielded large numbers of some *Chrysops* species. Since the habitats of these species were not the same as those described by Teskey (1969), they were studied to determine what species occur there, whether species composition differs from year to year, to what extent numbers of each species differ from year

¹ Scientific Contribution Number 1065 from the New Hampshire Agricultural Experiment Station.

to year, to document pupation and adult emergence times, and to develop collection and rearing techniques for laboratory studies. Because the *Chrysops* species studied congregate in favorable substrates, pupate, and emerge synchronously and do not seem to be cannibalistic, they can be used for ovarian development and autogeny studies (Lake and Burger, 1980). The data presented represent a summary of observations for three years at two sites, two years at two sites, and one year at six sites in western and northern New Hampshire.

SUMMARY OF KNOWN LARVAL HABITATS OF *CHRYSOPS* SPECIES IN NORTH AMERICA

Deer flies most frequently deposit their eggs in masses on emergent or overhanging vegetation in or near lakes, ponds, ditches, swamps, bogs, and streams. Larvae probably occur in soil beneath water during all but the prepupal stage. Prior to pupation, larvae tend to move above the waterline and may congregate in favorable drier substrates. A mature larva orients itself head up 1–5 cm below the soil surface and pupation occurs in this position. Adult flies emerge 7–14 days following pupation.

During the last 60 years, the larvae and/or larval habitats of about 60 of 85 Nearctic *Chrysops* species have been described, beginning with Marchand (1917, 1920), who emphasized egg laying habits of female *Chrysops* and briefly described the larvae of two species. Cameron (1926) discussed six species in Canada. Other early papers by Stone (1930) and Philip (1931) added twelve more species. Jones and Anthony (1964), Hays and Tidwell (1967), Goodwin (1972), and Tidwell (1973) described the habitats of some *Chrysops* species found in the southeastern United States. Teskey (1969) described the larval habitats of 36 *Chrysops* species from the eastern United States and Canada and provided a comprehensive treatment of their taxonomy and biology. Teskey and Burger (1976) described the immature stages of another species, *Chrysops sequax* Williston. In the western United States, Gjullen and Mote (1945) discussed the larval habitat of *Chrysops discalis* Williston in Utah, Lane (1975) described habitats of six species in California, and Burger (1977) described the larval habitats of three species occurring in Arizona.

Of the 60 *Chrysops* species whose larval stages are known, only 55 have a sufficiently detailed description of the larval habitat to allow comparison with other species. The greatest diversity of *Chrysops* species occurs only or predominantly in lentic habitats such as large or small permanent or temporary ponds and lakes, near ditches, and in bogs or swamps. Twenty-six species (48%) are entirely lentic and another nine species are predominantly so, being only occasionally associated with streams. Thus, 35 of the 55 *Chrysops* species adequately described (65%) may be designated as lentic-inhabiting species.

Six *Chrysops* species (11%) occupy entirely lotic habitats and another four species are found predominantly in lotic habitats, totalling 10 of 55 species (18%) that can be designated lotic-inhabiting species.

Seven species (13%) occupy both lentic and lotic habitats with about equal frequency and apparently are adaptable to a wide variety of habitat types.

The predominance of species preferring lentic habitats occurs in all geographic areas of North America. In eastern North America, 20 species occupy lentic habitats, ten occur in lotic habitats, and four species are found in both. In western North America (west of the 100th meridian), eight species are lentic, two lotic, and one occupies mixed habitats. Of those species occurring in northern areas, occupying an east-west arc across the northern United States and throughout Canada, seven occupy lentic habitats and two occur in both lentic and lotic environments.

LENTIC HABITATS

Chrysops aestuans van der Wulp.—Banks of a temporary pond: muck soil at waterline of permanent pond (Philip, 1931). Lake shores bordering large lakes (Teskey, 1969).

Chrysops atlanticus Pechuman.—Salt marshes (Teskey, 1969). Shallow water area of a brackish pool 300 yds. from the Atlantic Coast (Goodwin, 1972).

Chrysops calvus Pechuman and Teskey.—Clay soil in the banks of a pool (Teskey, 1969).

Chrysops celatus Pechuman.—Wet sand bordering a small stagnant pond (Teskey, 1969). Margin of a lake in slash pine forest (Tidwell, 1973).

Chrysops clavicornis Brennan.—Wet soil bordering a permanent pond with a dense stand of bulrush, *Scirpus acutus* Muhl. and permanent seepage areas (Lane, 1975).

Chrysops coloradensis Bigot.—Margins of permanent ponds covered with moss and *Eleocharis macrostachya* Britton (Lane, 1975).

Chrysops cursim Whitney.—Wet, grassy margin of a pond in a pineland pasture (Jones and Anthony, 1964).

Chrysops delicatulus Osten Sacken.—Cedar swamp and a long abandoned cranberry bog (Teskey, 1969).

Chrysops discalis Williston.—Shores of lakes and ponds in mud with or without vegetation (Gjullen and Mote, 1945).

Chrysops divisus Walker.—Mud along grassy margins of lakes (Jones and Anthony, 1964).

Chrysops frigidus Osten Sacken.—Swamps, saturated moss on stumps, rocks or windfall in woodland swamps (Teskey, 1969). Moist, sandy silt at margin of a beaver pond and in sphagnum moss in a large swampy meadow (see Results).

Chrysops fuliginosus Wiedemann.—Soil in salt marshes (Teskey, 1969).

- Chrysops furcatus* Walker.—Swamps; wet moss banks (Teskey, 1969).
- Chrysops hinei* Daecke.—Grassy margin of a roadside ditch (Jones and Anthony, 1964).
- Chrysops hirsuticallus* Philip.—Margin and bottom of a temporary pond with *Eleocharis*, *Eryngium*, and *Juncus* (Lane, 1975).
- Chrysops mitis* Osten Sacken.—Sloughs (Cameron, 1926). Shore of a lake in deposited sawdust (Philip, 1931). Saturated moss, silt and decaying vegetation of old beaver ponds, woodland pools, alder swamps, and small cattail marshes bordering rivers (Teskey, 1969). Loose sandy silt, loam or gravel at margins of large and small ponds, and the banks of a sluggish drainage canal (see Results).
- Chrysops nigripes* Zetterstedt.—Saturated moss growing on the banks of pools and wet boggy tundra meadows (Teskey, 1969).
- Chrysops parvulus* Daecke.—In moss bordering a cranberry bog drainage channel and on the banks of a pool in a cedar swamp (Teskey, 1969).
- Chrysops pudicus* Osten Sacken.—Wet soil at grassy margin of a roadside ditch (Jones and Anthony, 1964).
- Chrysops reicherti* Fairchild.—Margin of a farm pond (Hays and Tidwell, 1967). Upper 2 inches of wet mud and organic debris at the margin of a lake (Goodwin, 1972). Small ponds in mixed bottomland hardwood forest and the margin of a small lake in a cypress swamp (Tidwell, 1973).
- Chrysops sackeni* Hine.—Margins of temporary ponds (Philip, 1931). Wet, grassy sod bordering small pasture ponds, wet leaf mold covering gravelly soil at edge of woodland pool, saturated duff cover on the cattail-overgrown margin of a stream, soft, oozy mud in an alder swamp, and saturated muck soil in a water-filled depression created by an uprooted tree (Teskey, 1969).
- Chrysops sequax* Williston.—Soft, slimy muck soil on margin of a livestock watering pond in dense growth of *Juncus* (Teskey and Burger, 1976).
- Chrysops surdus* Osten Sacken.—Permanent seepage areas, margin of a permanent pond (Lane, 1975, 1976).
- Chrysops venus* Philip.—Saturated moss bordering partly shaded forest pools (Teskey, 1969).
- Chrysops virgulatus* Bellardi.—Wet soil mixed with decaying vegetation on margin of a large artificial lake and a large permanent desert spring (Burger, 1977).
- Chrysops vittatus floridanus* Johnson.—Highly organic soil at the edges of swamps and among roots of plants in shallow water (Jones and Anthony, 1964).

LOTIC HABITATS

- Chrysops coquilletti* Hine.—Damp sand and silt containing detritus and supporting a stand of cattails (*Typha* sp.) along the banks of the Russian River (Lane, 1975, 1976).

Chrysops macquarti Philip.—Highly organic slightly acidic soil in permanent wet margins of sluggish lowland streams and swamps (Jones and Anthony, 1964).

Chrysops moechus Osten Sacken.—Wet mud and underwater of a small artificial lake (?atypical) (Stone, 1930). In silt along margins of streams (Teskey, 1969).

Chrysops pechumani Philip.—In sand and silt along the Russian River (Lane, 1975, 1976).

Chrysops pikei Whitney.—Muddy margin of a stagnant pool (Jones and Bradley, 1923). Leafy substrate mixed with silt on the banks of a creek (Teskey, 1969). Debris in a narrow, sandy-bottom stream draining a mixed pine-hardwood forest (Tidwell, 1973).

Chrysops univittatus Macquart.—Muddy banks of streams; margins of small ponds (?atypical) (Stone, 1930). Soil in a "pasture draw" (Philip, 1931). Organic muck and decomposing vegetation at the edge of a dairy pond (?atypical) (Hays and Tidwell, 1967). Banks of slow flowing streams (275 larvae) and 1 larva each from the muddy shores of a lake and bottom of a drainage ditch (Teskey, 1969). Margins of a small stream draining a longleaf-slash pine area (Tidwell, 1973).

LENTIC-LOTIC HABITATS

Chrysops aberrans Philip.—Wet, sandy soil at the margins of permanent usually woodland pools and sandy shores or high water pools bordering large lakes (Teskey, 1969).

Chrysops ater Macquart.—Mud or silt rich in organic matter bordering flowing water with a scarcity of vegetation (Teskey, 1969). Loose sandy-silt mixed with organic debris on the banks of beaver dams, coarse sand and gravel banks of a small artificial pond, sandy-silt soil of a large artificial pond, and the banks of a stream in an alder swamp (see Results).

Chrysops brimleyi Hine.—Mucky organic material at edges of lakes and rapidly flowing streams with marsh sedges and grasses (Hays and Tidwell, 1967). Moss or sandy soil with much organic material on the banks of streams, margins of a stagnant pond and organic soils of an abandoned cranberry bog (Teskey, 1969).

Chrysops callidus Osten Sacken.—Mud and decayed leaves on margins of ponds in unshaded localities (Stone, 1930). Shore of a golf pond (Philip, 1931). Substrates around the shores of a lake (Hays and Tidwell, 1967). Wet soil at margins of ponds and silty soils of slow-flowing streams (Teskey, 1969).

Chrysops carbonarius Walker.—Mud among dead leaves and sticks along stream and pond margins (Stone, 1930). Sand and gravel banks of swift streams, with little silt present (Teskey, 1969). Muck soil in a large, marshy meadow adjacent to an alder swamp (see Results).

Chrysops cincticornis Walker.—Muddy margins of ponds and sluggish

woodland streams (Stone, 1930). Muck soil among cattails and sedge of a dairy pond (Hays and Tidwell, 1967). Moss, silt, muck, clay, and sandy soils on the margins of stagnant and freshwater ponds or lakes and along slow flowing streams (Teskey, 1969). Margin of a small stream (Tidwell, 1973).

Chrysops cuclux Whitney.—Very wet mud of sluggish streams or margins of artificial ponds (Stone, 1930). Saturated clay, silt or muck soil bordering streams (Teskey, 1969).

Chrysops dimmocki Hine.—Mud along the grassy margins of lakes (Jones and Anthony, 1964). Wet sand on the margin of a small stagnant pond (Teskey, 1969).

Chrysops excitans Walker.—Shores of a lake (Cameron, 1926). Debris along a lake shore and margin of a temporary pond (Philip, 1931). Wet moss, living and dead vegetation at the margins of a marsh lake, bog ponds, semi-woodland swamp pools and several large northern lakes (Teskey, 1969). Sandy banks of a small stream and sand-silt banks of a slowly flowing drainage canal (see Results).

Chrysops facialis Townsend.—Mineral soil, sod, and moss along margins of permanent streams and ponds (Burger, 1977).

Chrysops flavidus Wiedemann.—Bottom of a small brook (Jones and Bradley, 1923). Wet soil along margins of lakes, streams, and brackish water (Jones and Anthony, 1964). Margins of ponds (Hays and Tidwell, 1967). Sandy bank, freshwater pond (Teskey, 1969). Margins of ponds and waterways (Tidwell, 1973).

Chrysops fulvaster Osten Sacken.—Swamps in ravines and banks of small, sluggish streams (Cameron, 1926).

Chrysops geminatus Wiedemann.—Luxuriant moss in spring-fed drainage beds, margins of a bog lake, silty banks of a stream in an alder swamp and loamy soils at the edge of a flood pool (Teskey, 1969).

Chrysops indus Osten Sacken.—Mud at margins of a small pond and backwater (Stone, 1930). Muck along a creek and temporary ponds with partial shade (Philip, 1931). Sand, silt, clay, organic muck soil and moss at margins of marshy lakes, open and woodland ponds, streams, small rivers, drainage ditches, and farm ponds (Teskey, 1969). Sandy loam soil at margins of large and small natural and artificial ponds, including beaver ponds and alder swamps (see Results).

Chrysops lateralis Wiedemann.—Wet muck soils of small woodland meadows, a boggy backwater of a river, and wet, silty-loam soil beside a pool in a river flood channel (Teskey, 1969).

Chrysops montanus Osten Sacken.—Shore of a small pond in coarse sand saturated with water (Stone, 1930). Shore of a lake (Philip, 1931). Muddy banks of a creek (Teskey, 1969).

Chrysops niger Macquart.—Wet mud in unshaded boggy meadow and

banks of a creek (Stone, 1930). Wet silty mud on the banks of small ponds, streams and rivers, sphagnum bogs, lake margins, and swampy spring-fed seepage beds (Teskey, 1969). Margins of a small stream and a small farm pond (Tidwell, 1973). Muck soil adjacent to an alder swamp and stony clay soil at the margin of a large farm pond (see Results).

Chrysops nigribimbo Whitney.—Wet moss on the banks of streams (Teskey, 1969). Lake margin (Tidwell, 1973).

Chrysops obsoletus Wiedemann.—Highly organic mud on margins of freshwater lakes and streams (Jones and Anthony, 1964).

Chrysops pachycerus var. *hungerfordi* Brennan.—Soil mixed with vegetable debris along the margins of lakes, ponds, cienegas, and small streams (Burger, 1977).

Chrysops shermani Hine.—Denuded sand bar in a river (Teskey, 1969). Sandy silt and muck soils on the banks of small beaver ponds and muck soil adjacent to an alder swamp (see Results).

Chrysops striatus Osten Sacken.—Along shoreline of golf ponds (Philip, 1931). Silty margins of a creek (Teskey, 1969).

Chrysops vittatus Wiedemann.—Wet mud at margins of ponds and streams (Stone, 1930). Wet soil of a wooded seepage area (Jones and Anthony, 1964). Organic debris at edge of a lake (Hays and Tidwell, 1967). Widely distributed in most types of wetland habitats, except for sphagnum bogs (Teskey, 1969). Mud along the margin of a ditch and margin of a river (Tidwell, 1973). Wet sandy silt soil on the banks of a small cattail pond and clay banks of a large reservoir (see Results).

MATERIALS AND METHODS

During May–July 1977–79, *Chrysops* larvae and pupae were collected throughout the western and northern parts of New Hampshire. Collecting began during the second week of May each year when species of late spring *Chrysops* (especially *C. ater*, *C. mitis*, and *C. indus*) congregated above the waterline to pupate.

Soil was sifted by hand with a three-pronged garden fork and soil clumps were subdivided by hand to collect all larvae and pupae present. Soil was sampled from the waterline to 1 m above waterline and 10 cm deep. Larvae and pupae collected were separated by site and transported to the laboratory in large plastic cups containing wet sphagnum moss and soil substrate.

Mature larvae and pupae were held in large glass dishes furnished with damp sphagnum moss and soil from the larval habitat. Emerging adults were collected once a day and females were caged with 10% sucrose pads for ovarian studies. After emergence was completed, unemerged specimens were counted to determine percent mortality of larvae, prepupae, and pupae collected and the rate of parasitism by a pteromalid wasp, *Diglochis occidentalis* (Ashmead).

RESULTS

Approximately 1230 larvae and pupae of ten *Chrysops* species were collected from ten sites, mostly in Coos County, New Hampshire, during 1977–79. One site, the Colebrook Trout Hatchery, yielded 55% (679) of all larvae and pupae collected. Three sites produced about 80% (979) of all specimens collected. Thus, relatively large samples can be collected from a few sites, yielding abundant study material with minimum collecting effort.

Chrysops mitis, *C. ater*, and *C. indus* were the most abundant species collected. These also occurred in the largest number of collecting sites. Since emphasis was on collection of late spring species, later season species such as *Chrysops lateralis* were not actively sought.

Chrysops mitis Osten Sacken (500).—Larvae and pupae of *C. mitis* were collected from seven sites (six lentic, one lotic). Most of them (447) were found at two sites, the Colebrook Trout Hatchery and the Dixville Golf Course ponds. Preferred habitats seem to be large or small ponds containing emergent vegetation, with loose soil occurring above the waterline, and where rooted vegetation along the banks is sparse. Both larvae and pupae occurred up to 1 m above the waterline 1–5 cm deep in the soil. Both of the above sites are artificial ponds, but have existed for at least 20 years and therefore have natural vegetation occurring in the habitat. Larvae also were collected from a small, gravel-banked artificial pond in Pittsburg, in coarse gravel mixed with sand on a 1 × 0.5 m gravel bar above waterline (21), the steep sandy-silt banks of a slowly flowing drainage canal (16), in wet soil excavated by beavers and deposited above waterline on beaver dams in small ponds (3), and in hard-packed silty soil of a large, artificial farm pond (2). Only the drainage canal could be considered a lotic habitat, but since water flow was imperceptible, it was effectively lentic in the collection area.

Chrysops ater Macquart (225).—Larvae and pupae of *C. ater* were collected from six lentic habitats. All but eight of the larvae were collected from a large beaver pond with loose sandy-silt soil mixed with organic debris on the upper face of the dam and a small artificial pond in Pittsburg with coarse sand and gravel banks. This soil had been excavated by beavers and was sparsely colonized by grasses only. Larvae from the Pittsburg pond were in coarse sand and gravel eroded from the road bed adjacent to the pond. The banks were steep and larvae occurred up to 1 m above waterline. In 1979, most larvae occurred in a gravel bar at one end of the pond, with larvae and prepupae concentrated just above the waterline. Other *C. ater* sites were the Colebrook Trout Hatchery pond (3), a small, active beaver pond (2), an alder swamp with large grassy hummocks above waterline (1), and a large, artificial farm pond (1).

Chrysops indus Osten Sacken (124).—*Chrysops indus* larvae and pupae were collected from five lentic habitats. All but 28 specimens were found along the margin of the Colebrook Trout Hatchery pond, in moist silty loam

soil. Larvae and pupae were associated with *C. mitis*, although adults emerged an average of five days later than *mitis*. Twenty larvae and prepupae were found in loose soil excavated by rodents near the waterline of a golf course pond in Dixville. *Chrysops indus* prepupae also were found in a marshy meadow adjacent to an alder swamp, with larvae occurring in water-saturated loamy soil at the base of grassy hummocks projecting above water (5), in coarse sandy-silt soil at the margin of a small pool with emergent cattail vegetation (2), and in the loose sandy loam soil of an abandoned beaver pond (1).

Chrysops shermani Hine (23).—Larvae and pupae occurred in three lentic sites. Four prepupae were collected on June 15, 1979 from the sand-silt banks of a 15 × 30 m abandoned beaver pond with little emergent vegetation. Predominant vegetation at the collecting site was black and white spruce, balsam fir, white birch, and larch. The larval collection site was sparsely covered with short grasses, but did not have a sod covering. The soil was predominantly sand and dark colored silt, with sticks and grass rootlets intermixed. The soil was loose and friable, easily turned with a garden fork. Prepupae and pupae were found 10–20 cm above waterline at 1–3 cm depth. No specimens were found in muck soil near the waterline.

On July 5, 1979, ten prepupae and five pupae were collected at the same site but in muck soil overlain with a thin layer of sandy silt. All specimens were in soil above the waterline.

One larva was collected from a small marshy meadow adjacent to an alder swamp in Colebrook and three larvae were taken from moist silty soil in the dam of a small, active beaver pond in Waterville Valley.

Chrysops excitans Walker (20).—All larvae, prepupae, and pupae, except one, were collected from the banks of a small stream below the Colebrook Trout Hatchery pond or the banks of a slowly-flowing drainage canal. Examination of numerous apparently favorable lentic habitats where *C. excitans* adults are always abundant failed to produce additional specimens. Sixteen *C. excitans* prepupae and pupae were found in the relatively steep banks of the canal that drains a 5 ha lake and provides water for the Balsams Hotel Reservoir in Dixville Notch. Canal depth at the collection site was approximately 1.7–2.5 m. Because of siltation, it is periodically dredged. Silt is deposited on the sparsely vegetated banks. The friable sandy-silt soil and steep moisture gradient provide ideal habitat for deer fly pupation. *Chrysops excitans* larvae occurred about 5–10 cm above the waterline in moist silt-sand soil, 1–5 cm below the soil surface. Prepupae occurred only where the bank was undercut and where stony substrates and densely matted root systems of grasses did not prevent migration of larvae above the waterline. Generally, prepupae tended to occur in groups of two to four individuals, possibly because larvae congregate in areas favorable for pupation.

Chrysops vittatus Wiedemann (13).—All larvae and prepupae were collected from lentic habitats, especially an abandoned beaver pond, associated with larvae of *C. shermani* (see habitat description under *shermani* above). Larvae also were collected from heavy clay soil on the banks of an old reservoir in Durham (2) and in the wet sandy-silt soil of a small cattail pond in Carroll (2). This last record is particularly interesting because it is the first known record of *C. vittatus* occurring in Coos County, north of the higher mountain peaks in the White Mountains.

Chrysops carbonarius Walker (5).—Five prepupae were collected in a small marshy meadow adjacent to an alder swamp. The area abuts Route 147 northeast of Colebrook and has been extensively flooded by beavers damming a small stream. Surrounding vegetation is predominantly spruce-fir and white birch forest. Prepupae occurred in the highest point of saturated muck soil on a small grassy hummock above the waterline. Specimens of *C. carbonarius* were associated with *C. indus* (5), *C. ater* (1), *C. shermani* (1), and *C. niger* (1).

Chrysops niger Macquart (2).—Only two prepupae of *C. niger* were collected, one from the site described above under *carbonarius* and another from wet stony clay on the shore of a 30 × 50 m artificial farm pond. No shoreline vegetation was present at the farm pond site and the substrate seemed unsuitable for *Chrysops* larvae because it was highly compacted and stony. Two prepupae of *C. mitis* and one of *C. ater* were associated with *niger* at the farm pond site.

Chrysops frigidus Osten Sacken (2).—One prepupa of *C. frigidus* was collected from moist sandy silt soil on a beaver dam, associated with large numbers of *C. ater* prepupae and pupae. Another larva was collected in sphagnum moss in a large, swampy meadow, associated with larvae of *Tabanus marginalis* Fabricius.

Chrysops sordidus Osten Sacken (1).—A single larva (male) of *C. sordidus* was collected in moist silt-loam soil with large numbers of *C. mitis* and *C. indus* from the margin of the Colebrook Trout Hatchery pond. The immature stages of this species have not been reared or described previously. Since the specimen was mixed with *indus* and *mitis*, the last larval exuvium and pupal exuvium was not retained. Although *C. sordidus* is one of the commonest early summer species in northern New Hampshire, breeding sites of the immature stages remain virtually unknown. The reared male is only the second known male specimen in collections.

DISCUSSION

The most consistently favorable collecting sites for larvae were permanent natural or artificial ponds. The three most productive sites in this study were a 15 × 10 m artificial pond, a 40 × 50 m abandoned beaver pond with a large dam still present, and a 40 × 70 m trout hatchery pond maintained for

breeding trout. The least favorable collecting sites for *Chrysops* larvae to date have been the numerous streams of northern Coos County, most of which have granite beds and rocky banks apparently unsuitable for *Chrysops* larvae. Small sphagnum bogs also have not yielded any larvae to date, although this habitat has been only slightly explored.

More than half the larvae, prepupae, and pupae collected came from the Colebrook Trout Hatchery pond. This site was formed by damming a small spring-fed stream and has existed in its present location for at least 75 years, according to records of the New Hampshire Fish and Game Department (Howard Nowell, personal communication). The site is located 2 km east of Colebrook. Dominant vegetation at the site is spruce-fir forest. Grass and herbaceous vegetation surround the pond margin during the summer, becoming quite dense by mid-summer. In spring, the pond margin has little vegetation except the accumulation of the previous years grass stems. Emergent aquatic grasses, particularly American mannagrass (*Glyceria grandis* S. Watson), are present on the north and east banks of the pond. High nutrient water empties into the north end of the pond from trout holding tanks where young fingerlings are given a food slurry.

Larvae, prepupae, and pupae of *Chrysops mitis* and *C. indus* were collected from wet loamy soil around the north and east margins of the pond up to 1 m above the waterline. Prepupae and pupae were higher above the waterline and in drier soil than larvae. Possibly, larvae collected were moving to higher, drier sites prior to the prepupation period. The preferred soil for pupation was a fine-grained mineral soil with mixed loam and plant debris. Most specimens were found where the ground gradually sloped away from the waterline and where soil was relatively loose and wet. Larvae and prepupae were not collected in muck soil at or below the waterline. Some larvae occurred in steeper banks up to 25 cm above waterline, especially where soil was loose, but were rarely found in strongly compacted soil or where grass roots made digging difficult.

Larvae were found 3–5 cm below the soil surface. Prior to the prepupal period, larvae probably seek an optimum moisture content along the moisture gradient from water-saturated to dry soil. At the time of pupation, the prepupa moves vertically upward to within 1 cm of the surface, where pupation occurs. Larvae tend to congregate in especially favorable pupation sites and up to 20 larvae, prepupae, and pupae were collected per 150 cm³ of soil.

The entire bank of the pond up to 50 cm from the waterline and 5 cm deep was sampled for immature stages of *Chrysops* in 1978 and 1979, yielding 372 and 297 specimens respectively in those years.

Adults of *C. mitis* were first observed ovipositing on blades of American mannagrass (*Glyceria grandis*) on 15 June in 1979. Mannagrass occurred from the waterline to 3 m from the shore in the pond. Oviposition occurred

predominantly on plants in at least 5–10 cm deep water. Up to ten egg masses were found per blade, usually on the underside. The egg masses of *C. mitis* were oval-elongate pointed above and rounded below, 6–9 mm long, 3–5 mm wide, and multi-tiered, unlike the long single tiered masses of some other *Chrysops* species. Of the grasses growing in the larval habitat, only mannagrass, with blades 9–13 mm wide, had a surface suitable for *Chrysops* oviposition. Other grasses had blades narrower than the egg masses observed and were not used for oviposition during this study.

Approximately 217 specimens of *Chrysops ater* were collected from a large beaver pond in Woodstock, near Kinsman Notch, and in a small artificial pond in Pittsburg. The beaver pond is approximately 40 × 50 m and in mixed maple-birch and spruce-fir forest. All larvae, prepupae, and pupae from the beaver pond were collected from soil used by beavers to plug the dam.

The dam on the pond side gradually sloped up from the waterline for about 1 m, then steeply up to the top of the dam, about 1.5 m above the water surface. Prepupae and pupae were concentrated in a 10 m long gradually sloping section of the dam. No specimens were collected in the steeply sloped part of the dam. Pupation occurred in moist, loose sandy-loam soil mixed with organic detritus, grass rootlets, sticks, and small pebbles. The soil probably was deposited on the dam by beavers when the area was active.

In 1979, 115 specimens were collected from the dam; all but four were *C. ater*. Seventy percent of the specimens were pupae on the date of collection (16 May); the remainder were prepupae. Specimens were found up to 1 m from the edge of the water and 1–3 cm deep in the soil. No specimens were collected at or below the waterline.

There is no emergent vegetation in the pond through the growing season. Adults of *C. ater* may have deposited eggs on the leaves of trees overhanging the pond. Subsequent collecting at this site in June and July, 1979 failed to produce additional *Chrysops* specimens. Specimens of *Chrysops mitis* (2), *C. indus* (1), and *C. frigidus* (1) were associated with *C. ater* at this site. All the soil on the surface of the dam was examined for larvae and pupae, but specimens were found only in the 10 m section gradually sloping from the water.

Approximately 110 specimens of *C. ater* were collected during a three year period (1977–79) from a small, artificial pond in Pittsburg. Most of the shore line of this pond is hard, compacted clay, but gravel and sand fill from road shoulder construction has spilled over part of the shore adjacent to the main highway, creating favorable habitat for *C. ater* and other species. The pond is 15 × 10 m, 5–7 m deep, unshaded, and fed by a small stream that enters through an inlet pipe from the north and drains out the south end. Cattails grow along the north bank; shrubby willows and alders overhang the south bank.

Specimens of *Chrysops ater* and *C. mitis* were concentrated along the northern and western banks where loose sand and gravel reached the waterline. Prepupae and pupae were found 5–70 cm from the waterline in moist gravel and sand, usually 2–5 cm below the surface. The coarse, well-drained gravel is apparently the only favorable pupation site around the pond, resulting in concentration of larvae in small areas.

In 1979, a narrow bar (1 × 0.5 m) of sand and coarse gravel was deposited in the pond just below the inlet pipe. Over 100 larvae were collected from this small bar 5–10 cm above the waterline at the highest point of the bar, indicating that subtle changes in the available substrates can drastically affect collecting success at a given site. The previous year (1978) only 13 specimens were collected from the entire shoreline.

No *Chrysops* eggs were discovered on the cattails or on the leaves of alders and willows overhanging the pond in May, June, or July. No larvae or pupae were found at this site later in the season.

Our collection data for *Chrysops* species over a three year period suggest that certain habitats consistently produce large numbers of deer flies and can be used to generate specimens for biological studies on the immature stages and adults of common *Chrysops* species. This is particularly true for some early summer species considered to be pests of humans, livestock, and wild mammals in northern New Hampshire (*Chrysops ater*, *C. mitis*, *C. indus*). Other common pest species (*Chrysops excitans*, *C. sordidus*) have been collected less consistently because their preferred larval habitats have not been discovered or they occur in small numbers in a variety of habitats scattered over a large geographic area inaccessible to intensive collecting.

Several factors appear to affect collecting and rearing success in a given year in the habitats described above. Those encountered in this study were: (1) Synchronization of prepupal and pupal stages and adult emergence; (2) yearly variation in pupation and emergence time; (3) amount and quality of lacustrine substrate available for pupation; (4) seasonal succession of different species in the same habitat; and (5) abundance of parasitoids attacking *Chrysops* larvae.

Prepupal and pupal development in early season deer flies was surprisingly synchronous in 1978 and 1979. During the three year study period, date of pupation of *Chrysops mitis* varied only seven days (17–24 May). Therefore, to collect large numbers of prepupae and pupae, collections must be made after larvae have migrated above the waterline prior to prepupation, but before adults emerge, a period of approximately 15–20 days, from mid-May to the first week of June in northern New Hampshire.

Adult emergence data from 1978–79 laboratory studies suggest that there is a definite pattern of emergence in four early season species studied, the earliest being *Chrysops ater*, followed by *C. mitis*, *C. excitans*, and *C. indus*. *Chrysops ater* adults emerged between 20–30 May, with most adults

appearing during the period 23–27 May. *Chrysops mitis* adults emerged between 20 May–6 June, but most emergence was in the period 23–30 May. *Chrysops excitans* adults emerged between 1–6 June, but since only 11 specimens were reared, this may not reflect the true emergence interval. *Chrysops indus* is the last commonly reared species to emerge, most adults appearing during the period 3–12 June. This sequence occurs within a single collection site as well as between sites, so this pattern would be expected at all sites, with some modification for later emergence at higher altitudes. Successful collecting, therefore, depends on correct timing for collection of prepupae and pupae of early season *Chrysops* species.

Amount of favorable substrate available for pupation was relatively constant at some sites, but quite variable from year to year at others. Loose soil and gravel-sand substrates were easiest to sample and contained the largest number of larvae and pupae. Numbers collected were particularly variable at two sites: the small, artificial pond in Pittsburg and the golf course ponds at Dixville Notch. A total of 40, 13, and 142 *Chrysops* immature stages were collected in 1977, 1978, and 1979, respectively, from the Pittsburg site. Collecting success was governed by compaction of the sand-gravel banks of the pond adjacent to the road. In 1977, one section of bank, apparently recently formed, was loose and provided a favorable moisture gradient for migrating larvae. In 1978, most of the bank was compacted and difficult to dig, possibly preventing larvae from migrating to drier areas for pupation and greatly reducing collecting success. In 1979, a sand-gravel bar was washed into the pond through the inlet pipe, creating an ideal area for *Chrysops* larvae to congregate above the water. Collecting success thus increased more than 10-fold, since most specimens were collected from the bar.

Turfgrass is maintained around the golf course ponds in Dixville, and most ponds have little loose soil around the margins suitable for pupation. Loose soil is deposited where moles have excavated holes near the waterline, providing ideal habitat for *Chrysops* larvae to migrate and pupate. In 1977, about 60 prepupae were collected from animal-deposited soil above the waterline. In 1979, no animal activity occurred adjacent to the ponds sampled and no prepupae or pupae were collected. Thus, transient year-to-year changes in the nature of substrates at some sites may affect collecting success. *Chrysops* may continue to inhabit these sites, but ability to collect them is limited by the difficulty of sampling sod and compacted soil substrates.

There may be a seasonal succession of species occurring in some of the habitats studied or certain habitats may support species that emerge later in the summer, although this was not studied in detail. One site, a small, abandoned beaver pond, yielded no *Chrysops* when sampled on 16 May 1979. During subsequent sampling on 15 June, prepupae and pupae of *Chry-*

sops shermani and *C. vittatus* were collected from a 2 m section of shoreline. The entire bank of the pond was spot sampled but no additional specimens were found. On 5 July, more larvae and prepupae of *C. shermani* and *C. vittatus* were collected from the same site, indicating that cohorts of larvae, possibly from separate egg masses, were maturing at different times during the season.

Parasitoids of *Chrysops* larvae and pupae may affect rearing success once prepupae and pupae are collected for rearing. Teskey (1969) reviewed the parasitoids associated with immature Tabanidae in North America, including *Diglochis occidentalis* (Ashmead). This pteromalid was particularly common in 1979 at the Colebrook Trout Hatchery site, and we suspect that it may be occasionally abundant enough in particular sites to noticeably reduce adult emergence of *Chrysops*, and therefore affect rearing success in the laboratory. Further studies of this parasitoid in our study sites are in progress.

Despite the vagaries of collecting and rearing large numbers of *Chrysops* adults in the laboratory for biological studies, if highly productive breeding sites can be identified and the sequence of prepupation, pupation, and adult emergence of common species determined, quantities of adult flies for ovarian development studies can be successfully reared and maintained in the laboratory. Since mature larvae appear not to be cannibalistic, many flies can be reared together in containers, in contrast to other Tabanidae that must be reared individually, a very time-consuming process. *Chrysops* species also tend to aggregate in sites favorable for pupation, allowing collection of hundreds of individuals with minimum effort.

We were able to maintain adult flies in cages for up to 11 days in the laboratory with 10% sucrose as the only energy source. Flies were best maintained in a cool room with relatively little light, since strong light increased flying activity and caused flies to beat themselves against the wire screen cages. We believe that adults can be maintained for up to 21 days in cool, dark conditions.

By utilizing the above collection and maintenance methods for *Chrysops* species and by collecting in the field at appropriate times, we believe that quantities of *Chrysops* adults can be reared and maintained in the laboratory and that these heretofore poorly studied haematophagous insects can be used more commonly for biological studies, particularly morphological studies, feeding studies, and analysis of the ovarian development.

One of the major unsolved problems of rearing *Chrysops* larvae is ignorance of their food preferences. Larvae of some species are thought to be predaceous; others will not attack small, soft-bodied animals and may feed on particulate matter in the mud of streams and ponds. Burger (1977) was able to rear half-grown larvae of *Chrysops pachycerus* var. *hungerfordi* and *C. virgulatus* by mixing soil from the larval habitat and macerated house

fly larvae (*Musca domestica* L.) into a small pellet. Until a suitable food material is discovered for *Chrysops* larvae, studies utilizing reared adults will have to rely on collection of mature larvae, prepupae, and pupae during the relatively short period when they are easily accessible in the field. Once a suitable food source is discovered, larvae can be reared from egg masses collected in the field or from caged wild-caught, blood-engorged female flies.

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NOTE

New Records for *Eriotremex* (Hymenoptera: Siricidae) from Southeast Asia and New Guinea

Specimens of *Eriotremex* are not commonly collected. The ten known species are native to Southeast Asia and New Guinea, but one species, *E. formosanus* (Matsumura), was accidentally introduced into the southeastern United States. The following records are from specimens in the Bernice P. Bishop Museum, Honolulu, Hawaii. I thank Gordon Nishida of that Museum for loaning the material.

Eriotremex formosanus (Matsumura).—Described from Taiwan and recorded from Vietnam, Laos, and southeastern United States. LAOS: Vientiane Prov., Phou Kou Khouei, 800 m, 12-13.IV.1965, J. L. Gressitt (3 ♀).

Eriotremex foveopygus Maa.—Recorded from the islands of Negros and Samar in the Philippines. The following are the first records for Mindanao. PHILIPPINES: Misamis Or., Mt. Empagatao, 1050-1200 m, 19-30.IV.1961, W. Torrevillas (1 ♀); Misamis Or., Mt. Balatukan, 15 km SW of Gingoog, 1000-2000 m, 27-30.IV.1960, H. Torrevillas (2 ♀); Misamis Or., Minalwang, 31.III.1961, H. Ton. (1 ♀).

Eriotremex insignis (F. Smith).—Described from Aru Island, Indonesia and also recorded from West Irian, Indonesia and Papua New Guinea. PAPA NEW GUINEA: NE, Bupu R., Sitium Vill., 19 km NE of Lae, 30+, Forest, 15.IV-15.V.1970, light trap, N. R. Spencer (1 ♀); Fly R., Kiunga, 35 m, VIII.1969, J. and M. Sedlacek (1 ♀).

Eriotremex sp., ♂.—The taxonomy of *Eriotremex* is based on females; very few males have been associated. This unidentified male may represent a described species. It is the first record of the genus from Thailand. THAILAND: NW, Chiangmai: Doi Pui, 1360 m, 2.V.1958, T. C. Maa (1 ♂).

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THE MOTHER-OFFSPRING RELATIONSHIP OF SOME BLABERID
COCKROACHES (DICTYOPTERA: BLATTARIA: BLABERIDAE)

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Abstract.—Nymphs of the ovoviviparous cockroach *Perisphaerus* sp. cling to the undersurface of the mother for at least two instars. These small nymphs are blind and have specialized, non-chewing-type mouthparts. The latter suggests that the nymphs obtain nourishment from the mother, or possibly from plant tissue. If the former is true, then the apophyses, to which muscles are attached and which open externally between the mid- and hindcoxae, may have evolved a secondary function of producing nourishment for the immatures.

What little is known about the mother-offspring relationship of *Perisphaerus* is based almost entirely on data associated with pinned museum specimens. Observations on living material are needed to elucidate the maternal and nymphal behavior of this interesting genus of subsocial insects.

Observations on several species of ovoviviparous Blaberidae suggest a close postparturient relationship between females and their offspring (Roth and Willis, 1960; Liechti and Bell, 1975). A female *Phlebonotus pallens* (Serville) from Ceylon, for example, was found with young cockroaches moving about under her tegmina, on the upper surface of her abdomen. This female cannot fly because her wings are greatly reduced. Her tegmina are large and arched, however, and the upper surface of her abdomen is depressed with its sides raised, forming a chamber in which the new-born can be carried about (Shelford, 1906). A female of this species carrying more than a dozen nymphs was collected in south India; the young were packed so neatly that it was impossible to detect them, and they did not interfere with the activities of the mother. This appears to be a good method for protecting young and dispersing the species (Pruthi, 1933).

Arched tegmina also are found in the closely related genera *Thorax* Saussure and *Phoraspis* Serville, and perhaps these cockroaches too show maternal care. At the slightest alarm the young of some species of "phoras-

pidinae" creep under the dome-shaped tegmina of the mother (Karny, 1925). In her 1964 classification, McKittrick included two of these genera in the Epilamprinae, tribes Thoracini (*Thorax*) and Audreiini (*Phoraspis*). In 1972 I placed *Phoraspis* in the Phoraspidini and *Thorax* in the Thoracini.

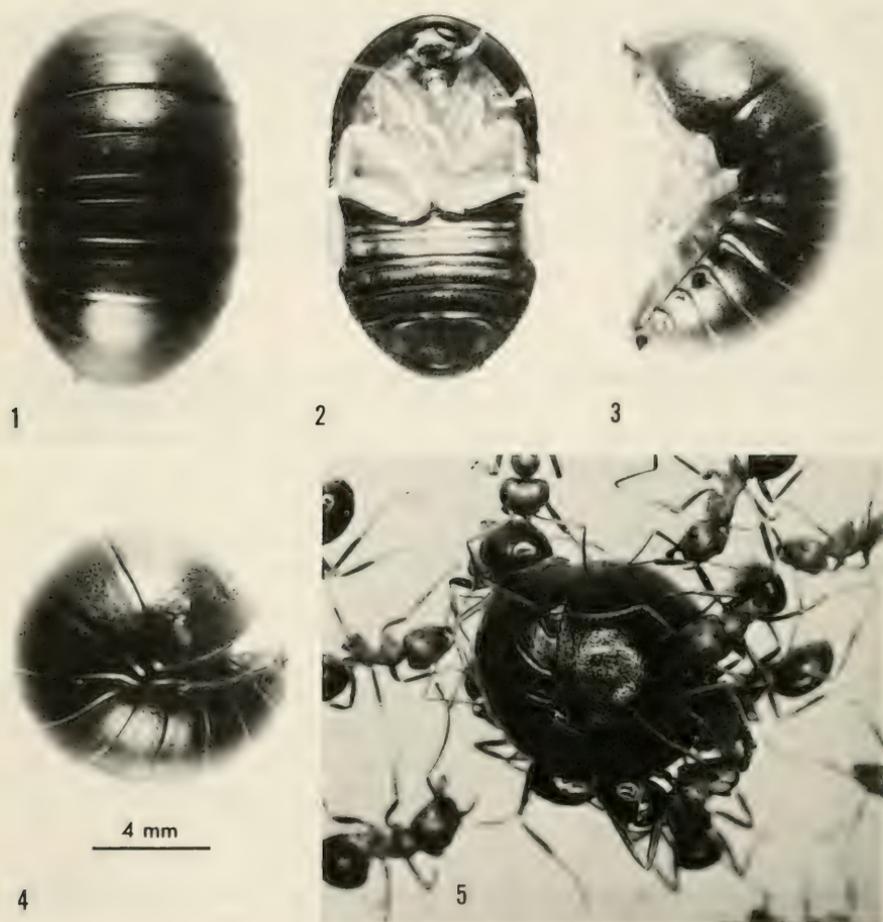
In Luzon in the Philippines, collectors have found the apterous female of *Perisphaerus glomeriformis* Lucas (Perisphaeriinae) with nymphs clinging to her undersurface (Hanitsch, 1933); a similar behavior was reported in nymphs of *Pseudophoraspis nebulosa* (Burmeister) from Borneo (Shelford, 1906). In a brief abstract Gurney (1954) reported that the nymphs of *Perisphaerus* sp. are born alive and cling to the lower side of the mother's body, "The head of the first instar nymph has a very elongate face and slender specialized galeae."

In 1968 Noel Kobayashi sent me four living females of *Perisphaerus semilunatus* (Hanitsch) from Sakaerat, Khorat Province, Thailand. When disturbed the apterous females roll up into spherical balls that resemble pillbugs because of their convex form and shiny black color (Figs. 1-4). It is unknown whether species of this genus are distasteful to predators, and it is doubtful that they mimic a particular species of pillbug (Shelford, 1912). In the ball position, however, they are protected from invertebrate predators by their hard integument. These insects have become so modified morphologically that, rolled up, the edges of the pro-, meso-, and metanotum meet and fit tightly against the edges of the abdominal terga. Females of *P. semilunatus* roll up so tightly when handled that it is almost impossible to straighten them out without damaging their cuticles. All of the vulnerable structures of a rolled-up female are completely hidden, insuring her safety from the attacks of ants (Fig. 5; Eisner, personal communication). Sexual dimorphism is outstanding, the males are fully winged and do not roll up in a ball.

Ball-forming behavior, which probably evolved independently in cockroaches and millipedes (Shelford, 1912), may be nothing more than an exaggeration of a reflex common to many cockroaches, i.e., the arched position these insects assume when they immobilize themselves in response to certain stimuli (Chopard, 1938).

Recently I examined some of the specimens of *Perisphaerus* sp. mentioned briefly by Gurney (1954). I believe that information can be added to the little we know about the mother-offspring relationship. Among the specimens in the U.S. National Museum, two females had been dissected, and all nymphs detached from their mothers and mounted on slides or pins, or their heads had been placed in glass tubes. The adult females (Figs. 6, 8) in the collection bear the following information on labels associated with the specimens:

1. Mindanao, Davao Province, Mt. Galintan, May 1927, R. C. McGregor.
"Perisphaerus female with 9 young among legs when rolled up like a *Glom-*



Figs. 1-5. *Perisphaerus semilunatus*, female from Thailand. 1, Dorsal, 2, Ventral, 3, Lateral, 4, Lateral and rolled up in ball position. 5, Rolled up and being attacked by ants.

eris; 1 young left with specialized mouthparts in intercoxal gland orifice . . . H. S. Barber, 1931." (The last mentioned nymph apparently had been removed by a later examiner.)

2. Surigao, Mindanao, Baker. "*Perisphaerus* female with 1 young clinging to middle coxa—no ootheca . . . H.S.B., 14.v.1931."

3. Mt. Makiling, Luzon, Baker. "Egg mass from cavity in abdomen lost . . . 3 young clinging to coxae."

4. Sibuyan Island, Baker. "*Perisphaerus* female with 1 broken youngster between mid and post coxae—removed and mounted in 2 beads—no eggs in pouch. H.S.B., 15.v.1931."

5. San Pedro, Culion Is., P. I. (Calamianes Group); nr. sea level,

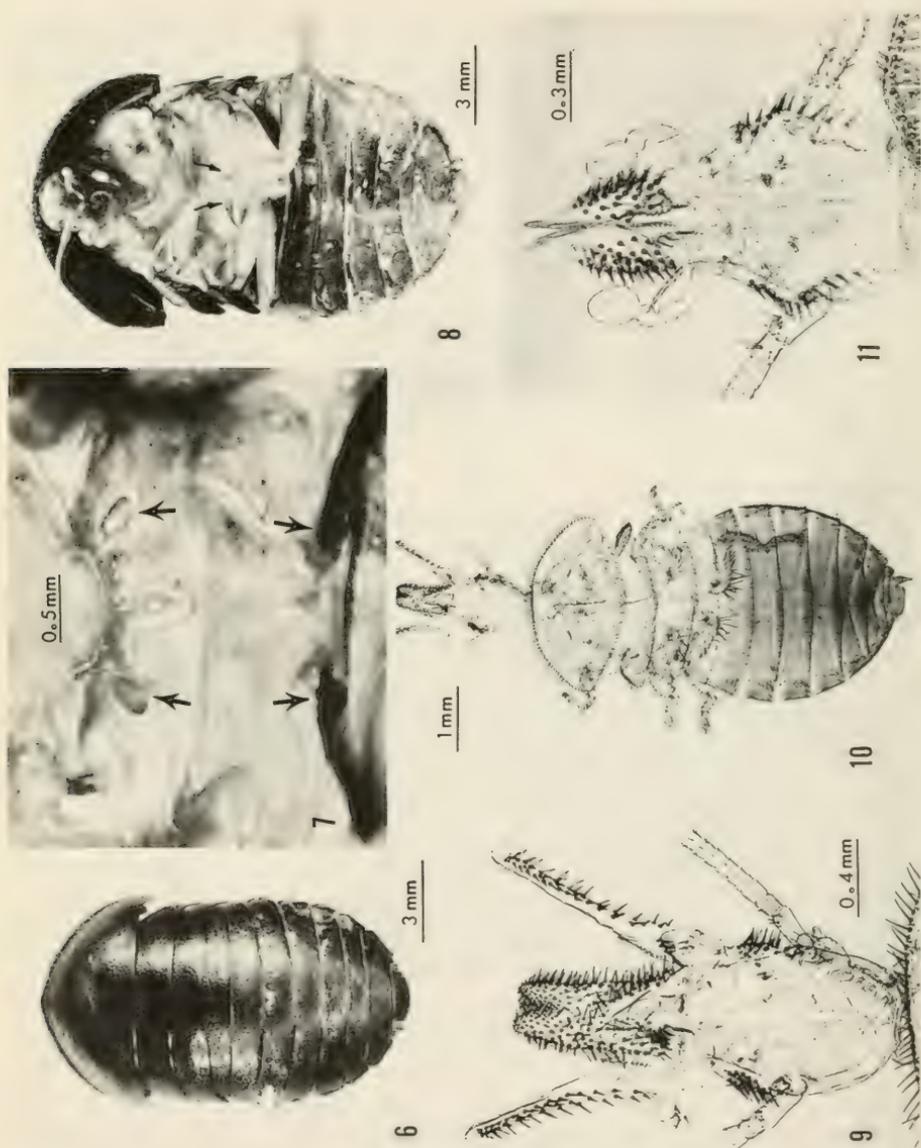
29.iii.1947. CNHM (=Chicago Natural History Museum) Philippine Zool. Exp. 1946-47, H. Hoogstraal. *Pandanus* Mangrove Zone—In terminal leaf axils of *Pandanus*. 3 nymphs, "cling to underside of female."

These data inspire the following questions: Can nymphs of *Perisphaerus* remain attached to their mother when she rolls herself into a ball, and thereby be protected from potential predators? The information on labels associated with female number one shows that they can, and that at least nine nymphs are able to remain attached when the female assumes the defensive position.

Removing the oothecae from four females (15-16 mm long) collected on the eastern slope of Mt. McKinley, Davao Province, Mindanao, P. I., I found that the respective numbers of eggs in the egg cases were 11, 12, 15, and 16. Three larger females (23 mm long) of a different species from Sibuyan Island had 15, 17, and 18 eggs in their oothecae. Whereas these numbers appear small for an ovoviviparous species, the mother cockroach probably would have a difficult time carrying around even this relatively small number of young for any length of time. Based on differences in mouthpart structures (cf. Figs. 9, 11) nymphs from Mindanao found clinging to the mother, probably stay attached to her through at least two instars. The unusually developed pulvilli (Fig. 12) probably are used by the nymphs for holding on to the female.

The structure of the nymphal head suggests more than a casual mother-nymph relationship, and that it is not simply a case of phoresy. The mouthparts are greatly modified (Figs. 9-11, 12, 13) and in female number one, a nymph had its specialized mouthparts in an "intercoxal gland orifice." The unusual proboscis-like mouthparts (Fig. 12) appear to be adapted for insertion into the holes; the "proboscis" of this nymph is about 0.3 mm wide, which is about the same as the width of the intercoxal openings. One is tempted to suggest that some kind of nourishment is produced by the mother and accumulates in the intercoxal depressions where it is fed upon by the nymphs.

However, the fact that a nymph had its mouthparts in one of the openings may have been accidental and of no significance. There are four distinct orifices (Figs. 7, 8), a pair occurring between the coxae of the mid- and hindlegs; in addition there is a less distinct medial opening between the holes of the midcoxae. Cuticular preparations of the intercoxal areas show that the holes are the openings of elongated apodemes (furcal arms) which are tubular for most of their length, and which extend laterally (Fig. 17). The additional small hole between the midcoxae is a shorter vertical spina. Muscles are attached to these structures, the usual function of apodemes, but whether or not glandular cells are associated with the furcal arms could not be determined from the cuticular (KOH treated) preparations of dried specimens. There were no visible cuticular ducts which one might expect if secretory cells were associated with the organs.



Figs. 6-11. *Perisphaerus* sp. from the Philippines. 6, Adult female from Mt. Galintan, Mindanao (dorsal). 7, Orifices (arrows) of apophyses between mid- and hindcoxae of a female from Mt. Makiling, Luzon. 8, Ventral view of female shown in Fig. 6 (arrows indicate orifices between hindcoxae). 9, Head of nymph shown in Fig. 10. 10, Nymph (probably second-instar) that had been attached to an adult female. 11, Head of nymph (probably first-instar) that had been attached to an adult female. (Figs. 9-11 are chitin preparations).

I examined the intercoxal areas of females of the following ovoviviparous (Blaberidae) cockroaches: *Leucophaea maderae* (Fabricius) (Oxyhaloinae), *Jagrehnia madecassa* (Saussure) (Oxyhaloinae), *Byrsotria fumigata* (Guérin) (Blaberinae), *Eublaberus distanti* (Kirby) (Blaberinae), and *Gyna sculpturata* Shelford (Perisphaeriinae). All have large intercoxal apodemes between the mid- and hindcoxae, but they open externally through relatively narrow slits, or do not open externally (openings are represented by narrow grooves, or there are no grooves at all). None have round openings as large (relative to the size of the furcal arms) as those found in the species of *Perisphaerus* I examined. It is possible that in *Perisphaerus*, the intercoxal apodemes not only serve for muscle attachment, but have evolved an additional function.

However, if the nymphs do not obtain nourishment from their mothers, how does one explain their unusual mouthparts? These are not chewing mouthparts typical of cockroaches, and seem to be adapted for obtaining nourishment in some other manner. Perhaps they are inserted into plant tissue, or are used to feed on oozing plant material. If true the nymphs would have to leave the mother, and return to her after feeding. There is evidence that these insects are associated with plants (female number five, and below). Only observations on living or fresh material can resolve these questions.

Not reported previously is the fact that the young nymphs lack eyes which makes them even more dependent on the mother for survival. The stage in which the eyes develop is unknown but, in one species at least, the first two instars are blind (Figs. 9, 11). Three nymphs taken attached to females on Culion Island (number five) may belong to a different species. Two of these (3.8–4.0 mm long) resemble the other immatures (Fig. 10) except that their mouthparts (Figs. 12, 13) are more proboscis-like and lack the numerous setae on the elongated portion; also adult-like mandibles (Fig. 13) are present. They lack eyes, but eyes can be seen beneath the cuticle, and probably the nymphs were near their molting period. A third nymph (4.5 mm long) having similar collection data, taken clinging to the underside of a female, looks like an adult female (Figs. 14, 15). It is darkly sclerotized, has well developed eyes, and adult-like mouthparts (Fig. 16). This specimen may have molted recently, for although it is darkly pigmented, its eyes and head are lighter in color than other similar nymphs. At this stage it is likely that the nymphs no longer depend on the mother and may begin to shift for themselves, although they probably remain gregarious in family groups (see below).

Huber (1976) found that first-instar nymphs of the primitive cockroach *Cryptocercus punctulatus* Scudder, which lives in family groups in rotting logs, are blind, and that the eyes appear in the second-instar as small reddish-brown pigmented structures. The eyes of adult *Cryptocercus* are re-



duced in size, compared to that of other cockroaches, and Huber suggested that reduction in eye size is an adaptation to living in a termite-like niche. In *Perisphaerus* probably the first two instars are blind and the eyes appear suddenly as well-developed structures in a later instar. When the nymphal eyes first appear, they are similar to those of the adult, which are well developed and typical of other cockroaches. The significance of blindness in small *Perisphaerus* nymphs is unknown. Blindness or dramatic reduction of eyes in cockroaches usually is associated with forms that live only in caves (Mackerras, 1967).

From this brief report it is obvious that much can be learned from a study of the maternal care and nymphal behavior shown by *Perisphaerus*. Princis (1964, 1971) lists 17 species of *Perisphaerus*, a genus widely distributed in Asia, Indonesia, New Guinea, the Philippines, and other Pacific Islands. When he collected a species of *Perisphaerus* in the Iron Range on the northern Cape York Peninsula of Australia, Monteith (personal communication) noted that "Most of my specimens have been obtained by beating vegetation, especially when it included dead branches and vines. I recall one occasion when a whole batch, consisting of a couple of adults and many nymphs, came onto the beating sheet at once. This indicates that the adults and immatures are certainly gregarious. Another time I found a number of specimens together inside the hollow rotted out core of some vines hanging from a tree. They also are gotten by beating in New Guinea." Let us hope that this note brings to the attention of biologists a behavior in a group of subsocial insects that is worthy of investigation.

ACKNOWLEDGMENTS

I thank the following for sending me specimens of *Perisphaerus*: David A. Nickle, Systematic Entomology Laboratory, USDA, and Marc Roth, U.S. National Museum of Natural History, Washington, D.C.; G. B. Monteith, Queensland Museum, Australia; and Margaret A. Schneider, University of Queensland, Australia.

I am grateful also to Judith Marshall, British Museum (Natural History), London, England, Gordon Nishida, Bernice P. Bishop Museum, Honolulu, Hawaii, and Marc Roth, U.S. National Museum of Natural History for

←

Figs. 12-17. *Perisphaerus* sp. from the Philippines: 12-16, from Culion Island, nymphs taken clinging to undersurface of mother. 12, Thorax and part of abdomen, ventral view, showing head with its proboscis-like mouthparts, and large tarsal pulvilli (arrow). 13, Chitin preparation of head of a nymph in same stage of development as that shown in Fig. 12 (arrow indicates adult-like mandible). 14, 15, Habitus of an adult-like nymph, dorsal and ventral views, respectively. 16, Head of nymph shown in Fig. 15. 17, Chitin preparation of intercoxal furcal arms of an adult female from Sibuyan Island.

examining large numbers of *Perisphaerus* for the presence of young attached to females.

I thank Thomas Eisner for Figure 5. The late Karlis Princis identified my specimens of *Perisphaerus semilunatus* (Hanitsch) from Thailand.

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A NEW EASTERN UNITED STATES *PSALLUS* FIEBER
(HETEROPTERA: MIRIDAE) FROM
PHYSOCARPUS (ROSACEAE)

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Abstract.—*Psallus physocarpi*, n. sp., is described from New York and Pennsylvania on *Physocarpus opulifolius* (L.). Photographs of the adult female and figures of male genitalia are provided. Characters are given to separate *P. physocarpi* from *P. amorphae* Knight, its nearest known relative.

The following new species of phyline mirid is described to provide a name to be used in a forthcoming paper on the insects associated with ninebark, *Physocarpus opulifolius* (L.) Maxim. (Rosaceae), by A. G. Wheeler, Jr., Pennsylvania Department of Agriculture, Harrisburg (PDA), and E. Richard Hoebeke, Department of Entomology, Cornell University, Ithaca, N.Y.(CU).

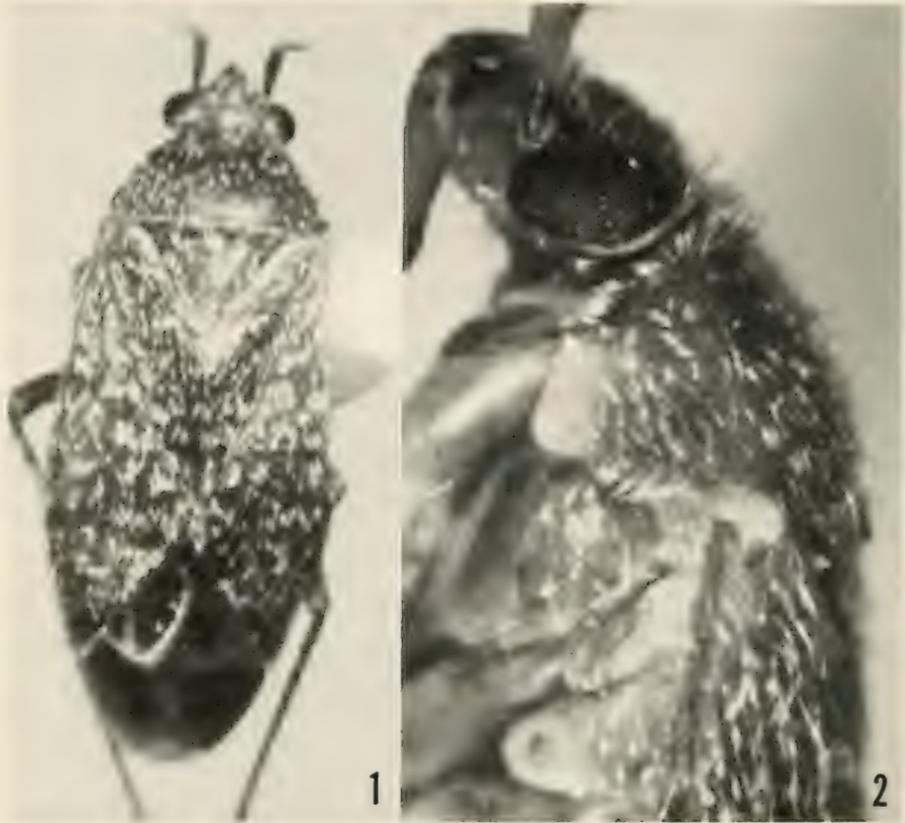
The genera *Plagiognathus* Fieber and *Psallus* Fieber are in great need of revision in North America. The generic limits, as defined by Knight (1941), are often difficult to interpret, with only the type of pubescence on the propleura "clearly" separating them (simple setae vs. sericeous or scalelike setae, respectively). Several species of *Psallus* have body forms remarkably similar to *Plagiognathus* and, if rubbed, are impossible to separate from the latter, viz. *Psallus parshleyi* Knight. Male genitalia seem to offer good specific differences and may prove valuable for separating the two genera or, at least, species groups within them; female genitalia are extremely simplified and only appear to confirm that the two taxa are closely related.

In this paper, I describe the new species *physocarpi* in the genus *Psallus* as characterized by the strongly flattened scalelike setae on the propleura and dorsum. Photographs of the dorsal and lateral views of the adult and figures of male genitalia are provided to facilitate recognition.

Psallus physocarpi Henry, NEW SPECIES

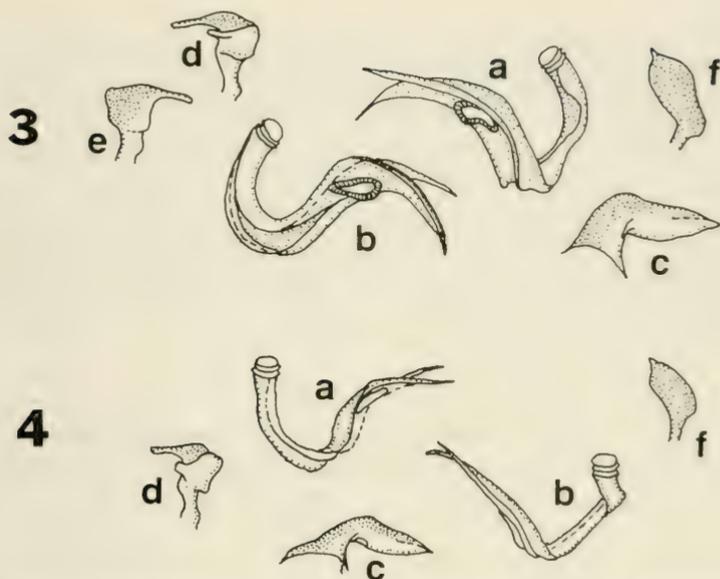
Figs. 1-3

Holotype male.—Length 3.36 mm (range of lengths and average length for paratypes: 3.28-3.60 \bar{x} = 3.42, n = 10), width 1.40 mm. *Head*: Width



Figs. 1-2. *Psallus physocarpi*, adult female. 1, Dorsal aspect. 2, Lateral aspect.

0.68 mm, vertex 0.32 mm, uniformly shiny black, posterior edge of vertex pale, thickly clothed with silvery flattened setae. *Rostrum*: Length 1.64 mm, uniformly fuscous, reaching beyond metacoxa to 3rd abdominal segment. *Antennae*: I, length 0.28 mm, uniformly black with 2 erect bristlelike setae near apex; II, 0.94 mm, yellowish brown or testaceous, fuscous at base (0.14 mm); III, 0.70 mm, testaceous; IV, 0.44 mm, testaceous. *Pronotum*: Length 0.56 mm, basal width 1.08 mm, black, thickly clothed with silvery flattened setae, intermixed with recumbent silvery, simple setae; mesoscutum and scutellum black with similar pubescence. *Hemelytra*: Uniformly fuscous to black, thickly clothed with silvery flattened and simple setae, cuneus less pubescent; membrane black, gradually clearing toward apex, veins pale, adjacent margins and area bordering apices of cunei clear. *Venter*: Uniformly fuscous, ventral margins of propleura and ostiolar openings pale; prosternum, sides of mesosternum, pro-, meso- and metapleura and



Figs. 3-4. Male genitalia. 3, *Psallus physocarpus*. 4, *P. amorphae*. a, Vesica, lateral view. b, Vesica, lateral view opposite side. c, Phallosome. d, Left paramere, lateral view. e, Left paramere, lateral view opposite side. f, Right paramere.

abdomen thickly clothed with silvery flattened setae. *Legs*: Coxae and femora fuscous; tibiae pallid or testaceous with fuscous spines and large fuscous spots at bases; tarsi pale, apices of last tarsal segments and claws fuscous. *Male Genitalia*: Fig. 3.

Allotype female.—Very similar to male only slightly broader in form. Length 3.48 mm (3.32–3.44, \bar{x} = 3.44, n = 10), width 1.44 mm. *Head*: Width 0.70 mm, vertex 0.32 mm. *Rostrum*: Length 1.68 mm. *Antennae*: I, length 0.30 mm; II, 1.00 mm; III, 0.76 mm; IV, 0.36 mm. *Pronotum*: Length 0.56 mm, basal width 1.12 mm.

Types.—*Holotype* ♂: Pennsylvania, Dauphin Co., Middle Paxton Twp., Rt. 443, Fishing Creek Valley School, June 27, 1979, A. G. Wheeler, Jr. coll., taken on *Physocarpus opulifolius* flowers (USNM type no. 76357). *Allotype* ♀: Same data as for holotype (USNM). *Paratypes*: 10 ♂, 4 ♀, same data as for holotype (PDA, USNM); 12 ♂, 14 ♀, Pa., Dauphin Co., Rt. 443, West Hanover Twp., nr. Middle Paxton Twp. line, June 21 and July 3, 1979, T. J. Henry and A. G. Wheeler, Jr. colls., taken on *P. opulifolius* flowers (PDA, USNM); 16 ♂, 25 ♀, New York, Tompkins Co., Ludlowville, Salmon Creek Rd., July 3 and 7, 1979, E. R. Hoebeke coll., taken on *P. opulifolius* flowers (CU, USNM).

Remarks.—This new species is most similar to *Psallus amorphae* Knight

and will key to the latter in Knight (1941: 43). *Psallus physocarpi* can be separated by its larger size (3.3–3.6 mm compared to 3.0–3.2 mm for *amorphae*), by the more strongly flattened scalelike setae, by the longer rostrum that reaches beyond the apices of the metacoxae, and by the male genitalia (Fig. 3). The vesica of *physocarpi* (Fig. 3a–b) is much thicker than that of *amorphae* (Fig. 4a–b) and has the secondary gonopore more heavily ringed. Also, the right arm of the left paramere is slenderly produced in *physocarpi*, whereas the same process in *amorphae* is truncate. Thus far, *P. physocarpi* is known to breed only on *Physocarpus opulifolius*, while *P. amorphae* apparently is restricted to *Amorpha fruticosa* L. (Leguminosae) and only has been taken in Illinois, Iowa, and Minnesota.

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A NEW "BOBO" FLY FROM THE GULF OF CALIFORNIA
(DIPTERA: CHAMAEMYIIDAE: *PARALEUCOPIS MEXICANA*)

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Abstract.—A new species of Chamaemyiidae, *Paraleucopis mexicana* is described at this time to provide a name for use in the following article by Robert L. Smith dealing with its habits. A key to the three species of *Paraleucopis* is given.

The type-species of the genus *Paraleucopis*, *P. corvina* Malloch, was described in 1913 and remained the sole known species of the genus until I (Steyskal, 1971) described *P. boydensis*. Malloch's species was taken in New Mexico, and I recorded a specimen from Dallas, Texas when I described *P. boydensis* from the Boyd Desert Research Center, Riverside County, California. The third species, here described, is from the shores and islands of the Gulf of California (States of Sonora, Baja California, and Baja California Sur). The designation "bobo," a Spanish language vernacular name for these flies, seems applicable to all three species, inasmuch as the little that is known of the habits of the first two species seems to indicate habits common to all of them.

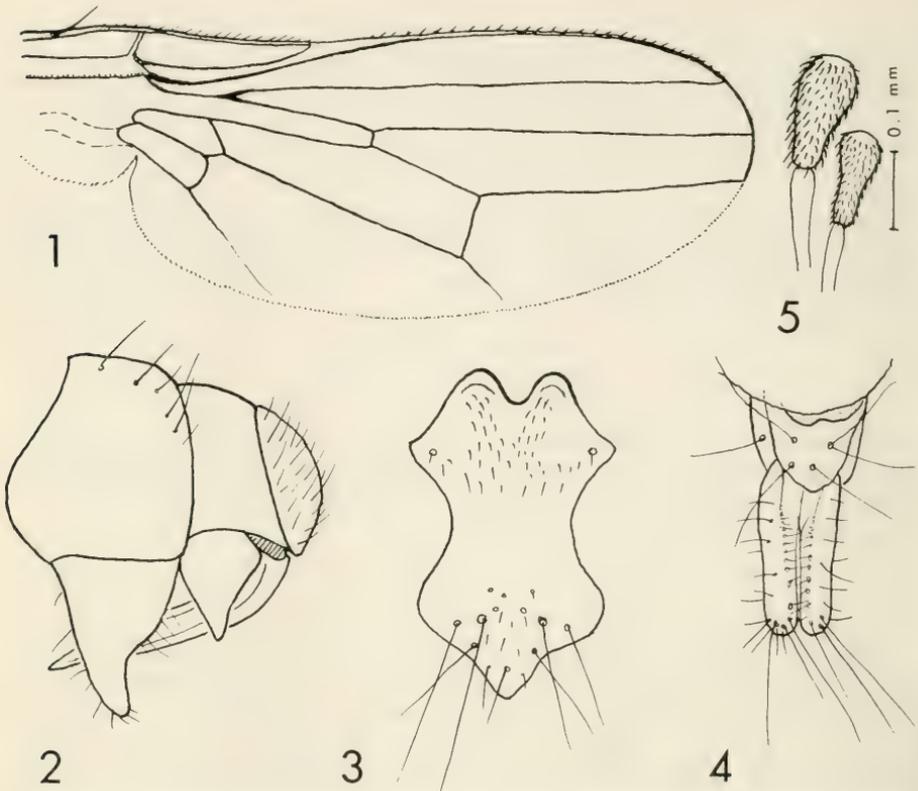
Paraleucopis mexicana Steyskal, NEW SPECIES

Figs. 1-5

Inasmuch as all distinctive features that I have been able to discern are cited in the following key and figures, they may serve as a formal description of the species.

KEY TO SPECIES OF *PARALEUCOPIS* MALLOCH

- 1(2). Hindfemur yellowish; last 2 or 3 segments of all tarsi blackish or at least distinctly infuscated; antennae broadly separated at bases by about 1.5× basal diameter of one of them; wing length of male 2.3-2.5 mm, of female 2.5-2.9 mm; wing venation as in Fig. 1.



Figs. 1-5. *Paraleucopis mexicana*. 1, Wing. 2, Lateral view of male postabdomen. 3, Basal dorsal sclerite of ovipositor. 4, Tip of ovipositor, dorsal view. 5, Spermathecae.

same in both sexes; orbital setae in 2 pairs, nearly as long as ocellar setae; parafacials, lateral margin of face, and part of gena immediately below eye usually yellowish in contrast with adjacent black parts of head; postabdomen of male as in Fig. 2, surstylus with sinuate posterior margin, basal $\frac{1}{2}$ of surstylus considerably broader than apical $\frac{1}{2}$ but both halves tapered in profile and with several marginal setae; ovipositor of female as in Figs. 3-5, basal dorsal sclerite (Fig. 3) constricted in middle, basal and apical portions of nearly equal width *mexicana*, new species (Holotype ♂, allotype, and 10 paratypes, Kino Bay, Sonora, Mexico, 8 April 1978, R. L. Smith, in the U.S. National Museum of Natural History, Washington, D.C.; topotypical paratypes in the University of Arizona; numerous paratypes from Cabo San Lucas, Isla Datil, Isla Ildefonso, Isla La Partida, Isla Salsipuedes, Isla San Lorenzo, Isla Raza, and Pond Island, all in either Baja

California or Baja California Sur, and deposited in the U.S. National Museum of Natural History, California Academy of Sciences, and Loma Linda University).

- 2(1). Hindfemur mostly black; tarsi wholly yellowish, at most with last 2 segments a little infuscated; antennae separated by no more than diameter of base of an antenna; wing length of male at most 2.4 mm, of female 2.5 mm; orbital setae various; parts of head around lower eye black.
- 3(4). Fronto-orbital setae 2, well developed; male postabdomen with posterior margin of surstylus zigzagged, basal $\frac{1}{2}$ of surstylus about $3\times$ as wide as digitiform apical $\frac{1}{2}$, with a few posterior setae on basal $\frac{1}{2}$; female with basal dorsal sclerite of ovipositor nearly parallel-sided, basal margin arcuate and with small mesal emargination *boydensis* Steyskal
- 4(3). Fronto-orbital setae minute, scarcely distinguishable; male postabdomen with posterior margin of surstylus concave except close to base, without setae, surstylus rather evenly tapering to sharp tip; female with basal dorsal sclerite of ovipositor with concave lateral margins, basal margin biarcuate, entire sclerite narrowest medially and much the widest basally *corvina* Malloch

ACKNOWLEDGMENTS

I am very grateful to Robert L. Smith, R. E. Ryckman, and C. P. Christianson for making these interesting specimens available to me and for permission to deposit many of them in the U.S. National Museum of Natural History.

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THE TROUBLE WITH "BOBOS," *PARALEUCOPIS MEXICANA*
STEYSKAL, AT KINO BAY, SONORA, MEXICO
(DIPTERA: CHAMAEMYIIDAE)

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Abstract.—*Paraleucopis mexicana* Steyskal from Kino Bay, Sonora, Mexico, is annoying to humans. The flies have muscoid mouthparts and do not bite. They are parasitic on the eyes of marine birds that inhabit an island in Kino Bay, and their larvae may develop in bird nests. Data on the distribution and biology of *P. mexicana* suggest that the genus has recently and dramatically diverged from other members of the family Chamaemyiidae.

In April 1978, the Department of Entomology at the University of Arizona was requested to assist a government-sponsored development corporation (Patronato del Fraccionamiento de Bahia Kino) in the state of Sonora, Mexico, on a problem with an unidentified annoying fly in the Kino Bay (Bahia Kino) area on the Gulf of California. Accordingly, I visited Kino Bay on 23 April, 19 May, and 26 December 1978, and again on 5 April 1979. During my first visit, I found only one species of irritating fly in significant numbers. This was an undescribed species in the chamaemyiid genus *Paraleucopis*. George Steyskal, Systematic Entomology Laboratory, USDA, confirmed this determination and has described the species as *Paraleucopis mexicana* in the preceding paper (Steyskal, 1981). This short communication reports some habits of the adult flies and delineates the problem at Kino Bay.

LOCATION

Kino Bay is a developing resort area on the west coast of Sonora, Mexico, approximately 110 km west of Hermosillo. The developed shore is approximately 12.5 km long and faces south. It is bordered by a rocky point on the west (Cerro Prieto) and the village of Old Kino (Pueblo de Kino) on the east. A small (1 × 2 km), sparsely vegetated rocky island (Isla de Alcatraz) is situated about 1 km offshore to the south of Old Kino. The island is home and nesting ground for a variety of marine birds including brown pelicans, double crested cormorants, yellow-crowned night herons, Heermann's

gulls, western gulls, frigate birds, oystercatchers, and ospreys. In addition to the birds, Alcatraz is inhabited by two species of very large lizards, the San Esteban Island chuckwalla, and the black chuckwalla (Keasey 1976). This island and its vertebrate fauna seem to figure prominently in the biology of *Paraleucopis mexicana*.

THE PROBLEM

The flies, "bobos" as they are referred to by natives of this region, are attracted to humans. They have the habit of walking on exposed skin and hair with particular affinity for the face and eyes. These insects do not bite, but move constantly on human skin and are extremely annoying. It is not uncommon for more than 50 individuals to simultaneously swarm about and assemble on the face and head of a person (Fig. 1). Brushing the flies away provides but a few seconds of relief. They are extraordinarily persistent and quickly resetttle after being disturbed. Consequently, it is unpleasant to walk or stand fully clothed on the beach when the flies are active. During their peaks of activity, all but the most tolerant sunbathers abandon the beach for shelter. The flies are most abundant around Easter at the height of the Mexican tourist season. The Patronato regards the activities of these insects to be a significant deterrent to tourism and development in the Kino Bay area.

SEASONAL APPEARANCE AND DIEL ACTIVITY PATTERNS

Interrogation of native Mexicans and Seri Indians that have inhabited this region for generations revealed that the bobos have appeared in mid-March for as long as they can remember. Natives reported that the flies always vanish by mid-June. My observations confirm these reports.

The flies are inactive at night. They begin to fly each morning when air temperatures reach about 26°C. During my visits, this occurred between 0700 and 0900 hours. The flies are most active and annoying in warm still air from mid-morning to late afternoon. They have reduced activity in breezes from about 8 km/hr and cease flying when winds reach an estimated 24 km/hr.

Throughout the night and when breezes are in excess of 24 km/hr, the flies seek protected roosts where they rest until morning or calm. On the developed portion of the beach, *P. mexicana* commonly roosts on the underside of beach house and condominium balconies (Fig. 2). On the island (Alcatraz), rocky caves and overhangs are utilized as natural roosting sites, as well as the undersides of palm frond cabanas constructed along the north-facing island beach.

DISTRIBUTION OF ADULT FLIES

Bobos in the Kino Bay area were distributed only along the shore. Their numbers declined steadily inland to a distance of about 1.5 km. None were found during several visits 5 km inland. Native fishermen unanimously ex-



Figs. 1, 2. *Paraleucopis mexicana*. 1, On the face of a boy. 2, Roosting on the under surface of a beach house.

pressed their belief that the bobos come from the island (Alcatraz) and indicated that the flies are annually first observed in its vicinity. G. C. Steyskal (personal communication) reports that the U.S. National Museum collection contains large series of this species taken on a number of islands in the Gulf of California. Consistent with these reports, I always found relatively much higher populations on Alcatraz as compared with the Kino beach. It seems possible that flies on the coast have been displaced from the island by onshore winds. The roosting behavior of these flies in response to winds may be an adaptation to minimize the possibility of their being disadvantageously dispersed from islands.

ADULT FOOD AND FEEDING HABITS

Three days during my April 1978 visit to Kino Bay were devoted to a survey of the adult flies' feeding habits. In the developed areas, I observed flies to feed on insects smashed on automobile grills and apparently on the secretions of human skin, hair, and eyes. They were also extremely fond of human blood and always surrounded a superficial wound to feed on it (Fig. 3). Among the potential food sources definitely not utilized by the flies were vertebrate carcasses including seal, dolphin, sea birds, bony fish and sharks, and marine crustaceans such as shrimp and crabs, all of which were abundant on the island and Kino Bay beaches. *Paraleucopis mexicana* likewise



Figs. 3, 4. *Paraleucopis mexicana*. 3, Feeding on human blood at the site of a superficial wound on a finger. 4, Head showing oral disc (scanning electron micrograph).

was not associated with marine algae, human or other animal feces, or garbage in the village of Old Kino.

Feeding habits of this species seem to be most closely associated with marine avifauna and lizards on the island. Every bird and lizard I observed on the island, including adults and immatures of all the aforementioned species, were being swarmed by the flies, and each individual inevitably had a ring of flies around its eyes. These were obviously feeding on eye secretions. The birds seemed almost defenseless against this parasitism. Only occasionally did they attempt to shed their parasites by shaking or brushing their heads against their shoulders. These actions provided the birds only a few seconds of respite. For the most part, birds tolerated the feeding flies.

Bobos have a sponging lapping (muscoïd) type labellum with a rather broad oral disc (Fig. 4). It does not appear that the pseudotracheae on the oral disc are furnished with spines as is the case with certain eye-feeding Oscinidae (Graham-Smith, 1930). Some oscinids have been reported to ulcerate human eye mucosae and to vector microbes causing conjunctivitis, but a local physician, Dr. Augustine Araiza, told me he had not observed an increase in the incidence of conjunctivitis following the annual bobo emergence in Kino Bay.

COURTSHIP, MATING, AND REPRODUCTIVE CONDITION OF FEMALES

Mating behavior was frequently observed among flies on human skin. Courtship was quite abbreviated. Typically, a male approached a potential mate, stroked her abdomen with his front legs and immediately mounted. Although males were repeatedly observed riding the backs of females, they rarely (<1%; $n > 50$) succeeded in copulating. It was usual for males to remain mounted for less than 10 seconds if rejected by the female. Pairs that succeeded in copulation remained coupled for as long as two minutes.

A 30-second head sweep taken on 23 April 1978 produced a 3:1 female to male sex ratio. Fifty females from this sample were crushed on a microscope slide and their eggs counted. Thirty-six of the 50 contained $\bar{x} = 17.76 \pm 5.46$ SD mature eggs, 11 contained only immature eggs (not counted), and three contained no eggs.

Oviposition by this species was never observed although I actively searched for oviposition sites. Again a variety of potential sites were examined. They included those mentioned as possible feeding sites as well as mud flats, tidal pools, vegetation, plant litter, and bird nests.

SPECULATION ON THE LIFE HISTORY

No bobo larvae were found during any of my visits to Kino Bay and Alcatraz Island. This was particularly disappointing because location of larvae was the principal objective of my second, third, and fourth trips. I concentrated my search on the island, looking principally at birds' nests and

in and under mats of guano. One of two previously described species in this genus, *Paraleucopis corvina* Malloch, was taken from birds' nests (Malloch, 1913; Wheeler, 1959). This, coupled with my observations on the ecological dependence of adult bobos on marine birds, and their seasonal first appearance on the island, suggested that bird nests would be the place to look for larvae. In spite of my failure to find larvae in bird nests, I have not abandoned this bias. It could be that my visits occurred before the eggs of *P. mexicana* had hatched. The brief three-month appearance of adults suggests that the species is univoltine. If this is the case, eggs may diapause for approximately 9–10 months of the year. Hatching may be synchronous with the nesting of one or more species of marine birds on the island.

DISCUSSION

Both the distribution of species and what is known of the biology of *Paraleucopis* suggest that the genus has recently and dramatically diverged from the other chamaemyiid genera. All of the genera except *Pseudodinia* and *Paraleucopis* are cosmopolitan. *Pseudodinia* is exclusively North American, and the three described species of *Paraleucopis* are from the Southwestern United States and Mexico (Steyskal, 1971, 1981, and personal communication).

Four of seven genera that comprise the family have larvae predaceous on aphids, mealy bugs, and scale insects (see Sluss and Foote, 1971), and adults belonging to all of the genera except *Paraleucopis* have been observed to feed on aphid honeydew and nectar (Oldroyd, 1964; Sluss, personal communication). These larval and adult habits are apparently ancestral characteristics for the family.

Members of the genus *Paraleucopis* are biologically quite different. *Paraleucopis corvina* has been independently associated with a crow's nest in New Mexico (Malloch, 1913), and a great horned owl's nest in Texas (Wheeler, 1959). Although not explicitly stated in the aforesaid papers, it seems that the larvae of this species probably develop in birds' nests. *Paraleucopis boydensis* Steyskal was described from specimens "that were hovering about the faces and getting into the eyes of workers" at the Boyd Desert Research Center, Riverside Co., California. Finally, *P. mexicana* combines these characteristics. It is parasitic on marine birds, suspected of breeding in bird nests, and is annoying to humans. I plan to continue my search for the larvae of *P. mexicana* and would certainly welcome any information on this problem from entomologists and biologists working on islands in the Gulf of California.

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I thank the Patronato del Fraccionamiento de Bahía Kino and especially Lic. Javier Morales Valdez for his generous assistance during my visits to

Kino Bay. Carl Olsen identified the flies to genus and George Steyskal confirmed our determination and provided additional information on the species. Greg Lanzaro, Jill Smith, and Scot Smith all assisted in the field. This research was supported in part by Arizona Agric. Exp. Stn. Project 2014-4161-17, Arthropods of Public Health Importance. Ariz. Agric. Exp. Stn. M.S. No. 3035.

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**DISTINGUISHING CHARACTERS OF THE REPRODUCTIVE SYSTEM
AND GENITALIA OF *XESTIA DOLOSA* AND *XESTIA ADELA*
(LEPIDOPTERA: NOCTUIDAE)**

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Abstract.—The spiral fertilization canal of females and the aedeagus of males are described and can be used to identify *Xestia dolosa* Franclemont and *Xestia adela* Franclemont in sympatric populations in eastern and southwestern Ontario.

Xestia dolosa Franclemont and *Xestia adela* Franclemont, until recently known as the large and small forms of *Amathes c-nigrum* (Linnaeus), were described as two new species by Franclemont (1980) on the basis of differences in size, colour, and genitalia of both males and females. The shape of the ostial plate and its excavation in the females of the two species is quite distinct in most specimens, although specimens intermediate in size are often intermediate in this character also, at least in the eastern and southwestern Ontario populations we have examined (Hudson and Lefkovitch, 1980). Characters of the male genitalia are also difficult to interpret in individuals of intermediate size.

During a study of isozyme variation in the two species, Hudson and Lefkovitch (1980) found that two allozymes of adenylate kinase could be used to distinguish *X. dolosa* from *X. adela* in sympatric populations in Ontario; a faster moving band Adk^f characterized *adela*, whereas *dolosa* was distinguished by a slower band Adk^s. Examination of the reproductive systems and genitalia of moths segregated in this way revealed two additional characters useful for identification.

This paper describes the differences seen between the species in the sclerotized portion of the spermathecal duct (fertilization canal) of the females, and in the extent and number of spines on the sclerotized plate (keel-like carina of Callahan and Chapin, 1960) at the distal end of the aedeagus of the males.

MATERIALS AND METHODS

The moths used for this study were collected in light traps set in North Gower near Ottawa, London, and Harrow, Ontario. Genitalia and repro-

ductive systems of both sexes were examined by light microscopy and with a scanning electron microscope.

1. Light microscopy.—Female reproductive systems were dissected in water, fixed in Kahle's fluid, stained with carmine, and mounted in venetian turpentine in absolute alcohol. Male genitalia were dissected in water, dehydrated through an alcohol series, cleared in xylol, and mounted in Permount.

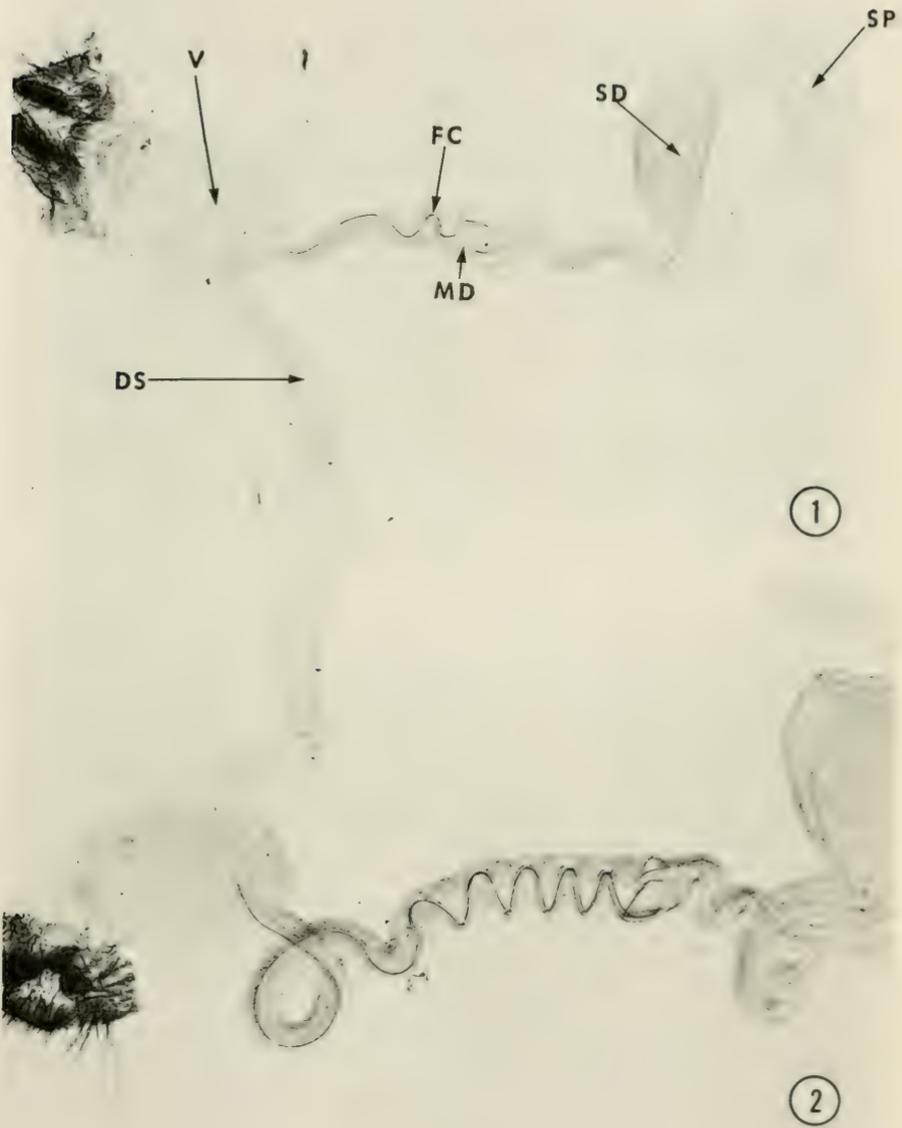
2. Electron microscopy.—The dissected aedeagi were attached to the specimen holder with silver conductive paint, coated with gold, and examined in a Cambridge Stereoscan microscope.

RESULTS

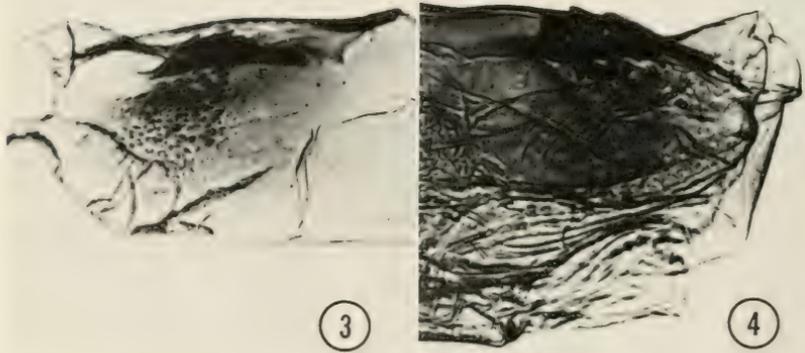
The spermatheca of *X. adela* is a "U-shaped" sac with distinct proximal and distal regions, although it is not clearly separated into two lobes as it is in *Peridroma saucia* (Huebner) (Callahan and Cascio, 1963). The proximal region of the sac appears to be surrounded by circular muscle whereas the distal region is distinguished by a change to longitudinal fibres (Fig. 1). A spermathecal gland (not shown in Fig. 1) approximately 2.0 cm long extends anteriorly from the apex of the proximal region and consists of a central duct surrounded by secretory cells as described in *Heliothis zea* (Boddie) by Callahan and Cascio (1963) and in *Choristoneura fumiferana* (Clemens) by Outram (1971). The distal end of the spermatheca extends into the spermathecal duct, which is itself composed of three parts. The most anterior part of the duct is variously coiled in different individuals, the length of this region being $1.12 \text{ mm} \pm 0.13$ ($n = 11$). In the second (central) part, the main duct widens and remains straight, and contains the sclerotized spiral segment of the fertilization canal (Fig. 1). The length of the main duct containing the spiral is $1.08 \text{ mm} \pm 0.23$; the spiral consists of two gyres. At the distal end, the fertilization canal straightens and continues within the main duct to the opening into the vestibulum at a point slightly to the left of the seminal duct openings. The length of this third portion of the duct is $0.89 \text{ mm} \pm 0.15$. The total length of the spermathecal duct in *X. adela* is $2.98 \text{ mm} \pm 0.71$.

In *X. dolosa* the spermatheca and the spermathecal gland are similar to those of *X. adela*, but the spermathecal duct is different (Fig. 2). The first portion is longer, $2.48 \text{ mm} \pm 0.29$ ($n = 12$), and more tightly coiled. The length of the main duct containing the spiral fertilization canal is also longer, $2.12 \text{ mm} \pm 0.14$, and the spiral itself consists of four gyres. The main duct containing the fertilization canal coils again before entering the vestibulum, and is much longer in proportion to the other two parts of the duct than it is in *X. adela*. The total length of the spermathecal duct in *X. dolosa* is $8.50 \text{ mm} \pm 0.40$.

The male genitalia of *X. dolosa* and *X. adela* as figured by Franclemont



Figs. 1, 2. Spermatheca and spermathecal duct. 1, *Xestia adela*. 2, *X. dolosa*. DS = ductus seminalis; FC = fertilization canal; MD = main spermathecal duct; SD = distal lobe of spermatheca; SP = proximal lobe of spermatheca; V = vestibulum.

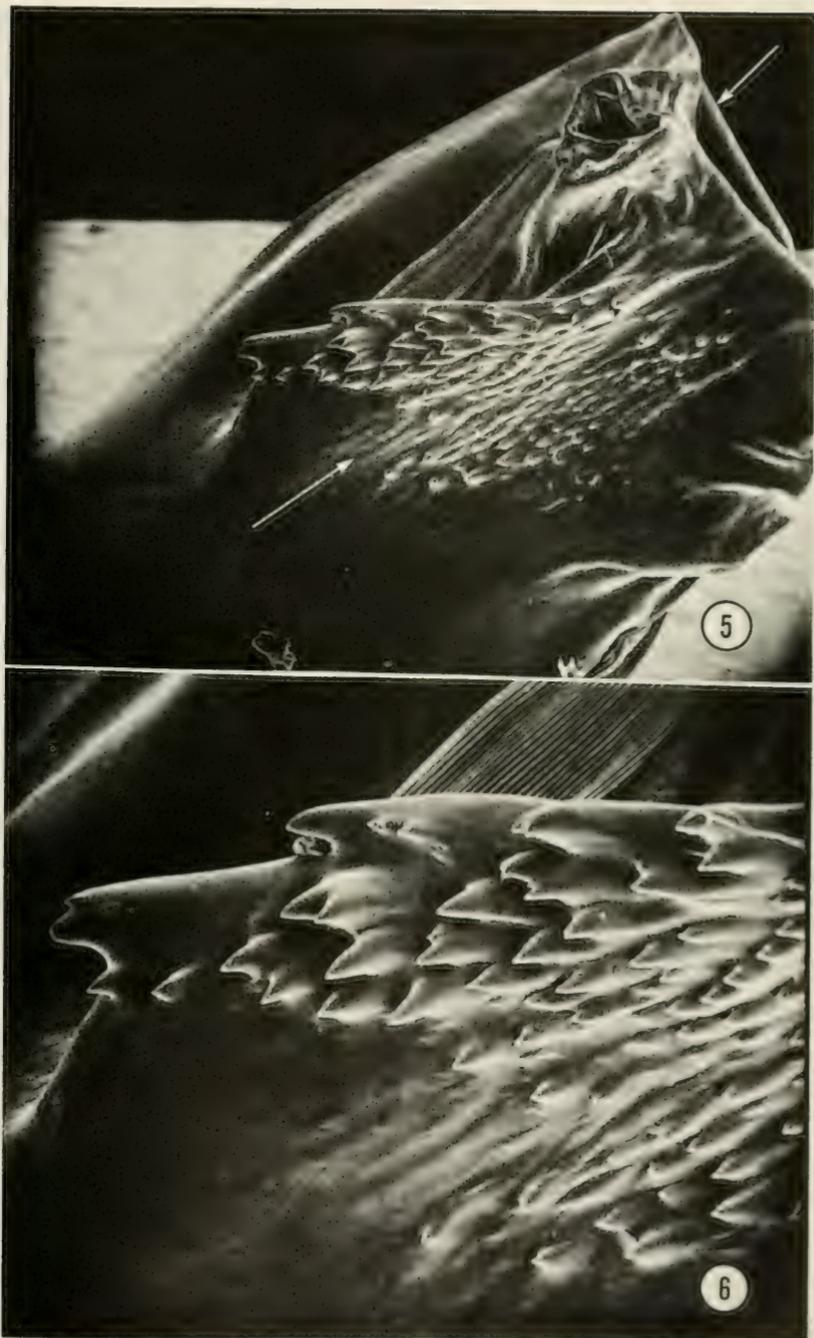


Figs. 3, 4. Carina on aedeagus. 3, *Xestia adela*. 4, *X. dolosa*.

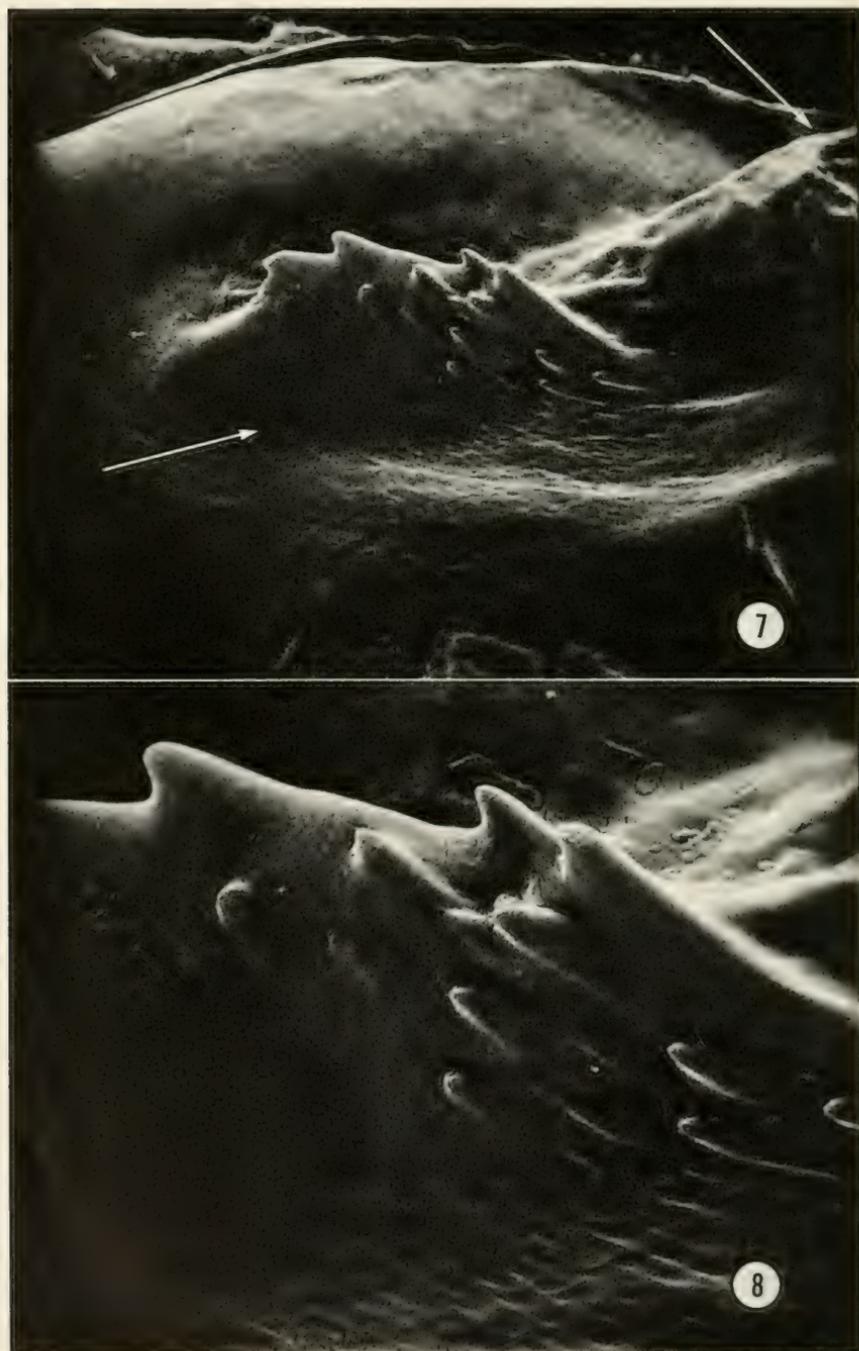
(1980) show some differences in size and in the expansion of the sacculus. We have examined individuals identified by electrophoresis and Adk assay and found that the aedeagus offers the most easily recognizable morphological character in the males. It is bow-shaped in both species approximately $3.30 \text{ mm} \pm 0.01$ long in *X. dolosa* and $3.00 \text{ mm} \pm 0.01$ in *X. adela* ($n = 20$). The armature at the distal end appears as a keel-shaped structure situated on the ventral side of a slight distal cleft. The area is dark in colour and is similar in length in both species ($0.33 \text{ mm} \pm 0.01$ in *X. dolosa* and 0.329 ± 0.02 in *X. adela*, $n = 20$). The differences in general appearance and arrangement of the spicules are as figured (Figs. 3–8). The large number of subsidiary spicules in *X. adela* males are easily visible through the manica on dissection and are absent in *X. dolosa* (Figs. 3, 4).

DISCUSSION

In sympatric populations collected in the Ottawa area, London, and Harrow, Ontario, the two characters described herein can be used reliably to identify *X. dolosa* and *X. adela*. The spiral fertilization canal has been described in several species of Lepidoptera, e.g., *Dioryctria abietella* (Denis and Schiffermüller) (Fatzinger, 1970), *Pseudaletia unipuncta* (Haworth) (Callahan and Chapin, 1960), and *Euxoa auxiliaris* (Grote) (Drecktrah, 1978). Wilkes (personal communication) examined the spiral canal in 36 species of Noctuidae and found that in the genus *Euxoa* the number of gyres varied from 1–14, but the number found in a single species was generally constant.



Figs. 5, 6. Scanning electron micrograph of the carina of *Xestia adela*. 5. $\times 170$; upper arrow = distal end of aedeagus; lower arrow = carina. 6, $\times 450$.



Figs. 7, 8. Scanning electron micrograph of the carina of *Xestia dolosa*. 7, $\times 200$. 8, $\times 500$. Arrows as for Fig. 5.

The patterns of spines and clusters of cornuti on the aedeagi of Lepidoptera are frequently included in species descriptions of male genitalia, but are seldom viewed in detail. McDunnough (1943) mentioned that these characters were the most useful in identifying species of *Nycteola* (Noctuidae). Franclemont (1951) illustrated the aedeagi of a number of species of *Pseudaletia* (Noctuidae), showing what appear to be distinctly characteristic patterns of spicules.

In a detailed study of the reproductive systems of *Pseudaletia unipuncta* and *Peridroma saucia* (as *P. margaritosa* (Haworth)), Callahan and Chapin (1960) described a keel-like carina situated on the posterior region of the sclerotized portion of the aedeagus of the latter. They observed that, while inserted, the carina hooked behind the anterior inner edge of the lamella antevaginalis, and suggested that since in *P. saucia* the bursa is a membranous sac and the endophallus bears no cornuti, the carina might serve to lock the organs together during mating.

The structures observed on the aedeagi of *X. dolosa* and *X. adela* have the same general shape as the carina of *P. saucia* and may function in the same way, although the bursae in both are bisacculate with the long arm-bearing signa, and the endophallus appears to be spiculate.

ACKNOWLEDGMENTS

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BIOSYSTEMATICS OF GROUND-NESTING SPECIES OF *PISON* IN
AUSTRALIA (HYMENOPTERA: SPHECIDAE: TRYPOXYLINI)

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Abstract.—Four species of *Pison* are reported nesting in the ground in eastern Australia. Three of these are described as new: **areniferum**, n. sp., **ciliatum**, n. sp., and **barbatum**, n. sp. (all from Queensland). All three nest in dry, sandy soil and have a well-developed psammophore which is used in carrying soil from the nest in flight; all three prey upon spiders of the family Oxyopidae. A fourth species, *auriventre* Turner, also carries soil in this manner, but digs in firm, clay soil and preys upon Lycosidae.

Pison is a large genus of wide distribution, the members of which prey upon spiders and for the most part make nest partitions or entire nests of mud, as in the related genus *Trypoxylon* (Bohart and Menke, 1976). There are only two published records of *Pison* species nesting in the ground. Krombein (1950) reported *nigellum* Krombein nesting in holes in a clay bank along a forest trail on Ponape (Micronesia), but it is uncertain whether these holes were dug by the wasps or were holes that had been abandoned by some other arthropod. *Pison chilense* Spinola evidently does dig a burrow in firm soil near streams, but is reported to moisten the soil with water prior to digging and to make mud partitions between the cells much as twig-nesting *Pison* do (Janvier, 1928).

The present report concerns several species of ground-nesting *Pison* occurring in eastern Australia. One of these (*auriventre* Turner) nests in firm soil near streams and carries soil from the nest and deposits it elsewhere; a weakly developed psammophore evidently assists in this behavior. Three other species (all previously undescribed) nest in dry, sandy substrates and have an unusually well-developed psammophore consisting of stiff hairs on the genae, prosternum, and front legs. Nesting of *Pison* species in sandy soil and without use of water in nest construction or closure is previously unreported. Also, no other species of the genus are reported to possess a psammophore.

The species treated here all belong to the subgenus *Pison*. That none of the sand-inhabiting species is conspecific with any of the species described

by F. Smith or R. E. Turner has been confirmed by study of the types of the those species in the British Museum (Natural History). Types of the species described below have been placed in the Queensland Museum, Brisbane, with paratypes and voucher specimens at the University of Queensland, Brisbane.

Pison areniferum Evans, NEW SPECIES

Type.—♀, QUEENSLAND: Amby, 22–27 November 1979 (H. E. Evans, note no. 2748).

Description of female type.—Length 10 mm; forewing 7.5 mm. Body and legs black, mandible in part dark ferruginous; antenna fuscous, suffused with dull ferruginous on outer surface; tegula translucent, testaceous posteriorly; wings subhyaline, slightly darkened in a broad band along outer margins. Body clothed with silvery pubescence which is especially dense and conspicuous on clypeus, front, gena, pronotum, front femur, mesopleuron, propodeum posteriorly and laterally, and broad apical bands on terga 1–5. Mandible with a series of long, curved, golden setae below; gena with a series of long, curved, somewhat golden setae margining a broad, polished area surrounding the mouthparts ventrally; foretrochanter and femur fringed with long, curved setae below; forecoxa and prosternum also with long setae.

Clypeus with a broad, polished median lobe with a convex apical margin; front, vertex, and gena with contiguous, minute punctures which give the surface a somewhat granulate appearance; distance between eyes at their lower end (across middle of clypeus) $1.8 \times$ minimum interocular distance at vertex; distance between eyes at their greatest emargination $2.35 \times$ minimum interocular distance at vertex; posterior ocelli separated from eyes by a distance very slightly exceeding their own diameters. First 4 antennal segments in a ratio of 5:2:4:4, segment 3 $0.43 \times$ as long as minimum interocular distance at vertex. Mesoscutum and scutellum shining, with small punctures which for the most part are separated by slightly more than their own diameters; dorsum of propodeum with minute, close punctures, faintly striatopunctate; midline with a linear impression which is deepened as it passes down the declivity. Terga of gaster densely micropunctate, weakly shining, broadly depressed along posterior margins, where the silvery bands occur; venter much more shining and sparsely punctate. Forewing with petiole of 2nd submarginal cell subequal in length to height of that cell; 1st recurrent vein interstitial with 1st transverse cubital vein; 2nd recurrent interstitial with 2nd transverse cubital.

Remarks.—This species is known only from the type. It runs to *punctulatum* Kohl in the key of Turner (1916), but that is a more coarsely punctate species without a psammophore and with constrictions between segments of the gaster.

Nesting behavior.—The female described above was found nesting in a flat, sparsely vegetated sandy area among numerous nests of *Bembix tuberculiventris* Turner. A second female nested 80 cm away, both females carrying sand from the burrow in their mouthparts and front legs and flying with it about 1 m downwind, dropping it from a height of 30–40 cm. Digging continued for several hours in the morning, intervals between flights varying from 30 seconds to several minutes. On the following day one nest had been closed at the entrance and the other was open and apparently abandoned. On the third day still another female (or perhaps the one that had abandoned her nest) was seen digging nearby in the same manner. On this date the nest that had been closed was excavated. The burrow was found to descend at about a 45° angle; it was 14 cm long and reached a cell at a depth of 9 cm. It was open all the way to the cell aside from a closure of sand at the entrance about 1 cm thick. The cell contained a single paralyzed spider but no egg, and was evidently still being provisioned. A second cell was found 1.5 cm away, at a depth of 10 cm. It had been closed off with sand and contained five spiders which had been partially consumed by a fly maggot. Four spiders were saved for identification and all found to be Oxyopidae: *Oxyopes mundulus* Koch (3) and *O. punctatus* Koch (1).

Pison ciliatum Evans, NEW SPECIES

Type.—♀, QUEENSLAND: Amby, 22–27 November 1979 (H. E. Evans, note no. 2754).

Description of female type.—Length 7 mm; forewing 5.6 mm. Head black, mandible and anterior margin of clypeus castaneous; antenna fuscous on upper surface, castaneous beneath; thorax and propodeum black; tegula testaceous; coxae black, trochanters and forefemur partially infuscated, legs otherwise rufous; gaster black except apical and lateral margins of basal 5 segments broadly brownish; wings subhyaline. Body with extensive, rather coarse, pale pubescence, on clypeus and sides and venter of thorax silvery, on most of head and dorsum of thorax and propodeum golden; gaster with golden pubescence which is much more coarse and dense on the apical tergal bands. Mandible with numerous long, curved, golden setae beneath; margin of labrum with several stiff setae which protrude from beneath margin of clypeus; gena with a psammophore of long setae margining a broad, polished area surrounding the ventral mouthparts; foretrochanter and femur with numerous curved setae on lower margin; forecoxa and prosternum also with prominent setae.

Clypeus similar to that of *areniferum*: front, vertex, and temples with subcontiguous, minute, shallow punctures; distance between eyes at lower end (across middle of clypeus) 1.8× minimum interocular distance at vertex; distance between eyes at their greatest emargination 2.4× minimum interocular distance at vertex; posterior ocelli separated from eyes by a distance

subequal to their own diameters. First 4 antennal segments in a ratio of 9:4:7:7, segment 3 $0.37\times$ as long as minimum interocular distance at vertex. Microsculpture of thorax similar to that of head; dorsum of propodeum with a slight tendency to be obliquely striatopunctate, median carina strong, continuing down declivity as a deep sulcus. Gaster also micropunctate, punctures on dorsum subcontiguous, those on venter separated by mostly somewhat more than their own diameters. Venation as described for *areniferum*.

Paratypes.—3 ♀, same data as type except one of them dated 25–26 October 1979 and all without note numbers.

Remarks.—The paratypes resemble the type closely in size and in all major details. In two of them the petiole of the second submarginal cell is considerably longer than the height of the cell. This species runs to couplets 42–47 of Turner's key (1916), but there is no close resemblance to any of the species separated there. In size and color it is perhaps closest to *inconspicuum* Turner, but that species (described from a male from Western Australia) differs greatly from *ciliatum* in structural features and is not likely to be the male of that species. The development of the psammophore and associated structures is shared only with the preceding and the following species.

Nesting behavior.—This species was found nesting in the same area as *areniferum*, also among *Bembix* nests, but on a small hillock some 50 m away. The substrate was similar, consisting of fine-grained sand of reddish color. Several females were seen, but only one was found nesting. She was first seen flying slowly and hovering 5–10 cm high, moving in a circuitous pattern while holding a small spider in her mandibles. She plunged into an open hole in the sand at 1115 hours and emerged two minutes later, when she was taken. The burrow was found to be oblique for the first 3 cm, below that vertical, reaching a depth of 16 cm, where there was a small cell containing five spiders. The cell was evidently not fully provisioned, as there was no egg. All spiders were *Oxyopes mundulus* (Koch), one of the species being employed by *Pison areniferum* in the same locality. Although females of *P. ciliatum* were not observed digging, the presence of a well-developed psammophore suggests that sand is carried in the same manner as in *areniferum*.

Pison barbatum EVANS, NEW SPECIES

Type.—♀, QUEENSLAND: Port Douglas, 25 April 1980 (H. E. and M. A. Evans, note no. 2895).

Description of female type.—Length 7.5 mm; forewing 5 mm. Head black, mandible in part deep ferruginous; antenna black; thorax and propodeum black; tegula in part translucent, testaceous; legs black; gaster black except terga 1–5 narrowly brownish along apical margins; wings subhyaline, very slightly darker along apical margins. Body extensively clothed with silvery

pubescence which is especially dense and conspicuous on clypeus, face, gena, pronotum, mesopleuron, posterior angles of propodeum (where it is suberect), and narrow apical bands on terga 1-5. Distribution of setae of psammophore and adjacent body parts exactly as described for *ciliatum*.

Clypeus of the same form as in *ciliatum* and *areniferum*; front, vertex, mesoscutum, and scutellum with well-defined but small, subcontiguous punctures, weakly shining; distance between eyes at lower ends (across middle of clypeus) $2.4\times$ minimum interocular distance at vertex; distance between eyes at the greatest emargination $3.15\times$ minimum interocular distance at vertex; posterior ocelli separated from eyes by about $\frac{1}{2}$ their own diameters. First 4 antennal segments in a ratio of 9:4:8:8, segment 3 $0.5\times$ as long as minimum interocular distance at vertex. Dorsum of propodeum obliquely striatopunctate, with a delicate median carina which becomes a deep sulcus on declivity. Gaster micropunctate, punctures of terga separated by about or less than their own diameters, those on venter by $1-2\times$ their own diameters, though more crowded laterally. Forewing with petiole of 2nd submarginal cell slightly longer than height of cell; 1st recurrent vein interstitial with 1st transverse cubital, 2nd recurrent meeting cubitus slightly before junction of 2nd transverse cubital.

Paratype.—1 ♀, same data as for type except without note number.

Remarks.—The paratype is closely similar to the type in all details. This species differs from *ciliatum* not only in the color of the legs and pubescence, but also in having the eyes more strongly convergent at the vertex and the posterior ocelli closer to the eye margins.

The type-specimen was taken on flat, sandy soil adjacent to a mangrove swamp. It was on the sand, apparently struggling with a small spider, which it presently grasped with the mandibles and began to fly away with. At this point it was taken, and the spider later found to be a male of the genus *Oxyopes* (Oxyopidae). The presence of a psammophore in this species suggests that the nest was probably in sandy soil not far away.

Pison auriventre Turner

This species was described by Turner (1908) from females from Brisbane, Queensland, and from Victoria. I studied the type in the British Museum (Natural History) and found my specimens to be conspecific. This species has a weakly developed psammophore; the mandibles have a series of short, curved bristles beneath and the labrum has several stiff bristles; the ventral surface of the head is moderately polished adjacent to the mouthparts, but this area is bordered by only a few short setae on the lower gena; the prosternum has a tuft of setae and the foretrochanter several strong setae, but the forefemur lacks prominent setae. It is probably significant that this species nests in firm clay soil, such that pellets from the nest remain more or less intact without assistance from long genal and femoral setae.

Nesting behavior.—Two female *auriventre* were seen nesting 35 cm apart on the crest of a clay bank bordering Blunder Creek, in a *Melaleuca-Eucalyptus* woodland in the southern part of the city of Brisbane, on 8 November 1979. Both were digging a vertical hole by backing out with small lumps of soil in their mandibles and flying off about a meter and dropping the soil from a height of about half a meter. Thus no soil accumulated at the entrances, which were about 40 cm away from an active nest of *Cerceris antipodes* Smith. Three days later one of the wasps was seen bringing in small spiders, carrying them in her mandibles in flight, landing near the entrance, and walking directly into the open hole with the prey. This nest was excavated the same day and found to have a vertical burrow 3 mm in diameter and 4.5 cm long, terminating in an oblique cell measuring 11 mm long and 5 mm in diameter. This cell contained four paralyzed spiders and no egg, so was apparently still being provisioned. A second cell 1 cm away had been fully provisioned and closed off. It contained nine spiders, the one uppermost in the cell bearing the wasp's egg dorsally, obliquely at the extreme base of the abdomen. All spiders were very small and all were Lycosidae: *Trochosa expolita* Koch (12) and *Lycosa laeta* Koch (1).

DISCUSSION

There can be little question of the close relationship of the three species *areniferum*, *ciliatum*, and *barbatum*. All inhabit areas of bare, fine-grained sand, and two of them are known to make short burrows terminating in a cell in which the spiders are placed. One species, *areniferum*, has been found to make a second cell, and it is probable that most nests are multicellular. There is no evidence that these wasps use water at any stage in nest construction, and the presence of an unusually well-developed psammophore in all three suggests that sand is carried in the manner described for *areniferum*. The apparent exclusive use of spiders of the family Oxyopidae is further evidence of the close relationship of these species.

In contrast, *auriventre* has a poorly-developed psammophore, doubtless correlated with the firm clay soil in which this species nests. However, soil is still carried from the nest in flight and dropped some distance away, and there is no present evidence of the use of moistened soil at any point in the nesting process. This stands in contrast to most other species of *Pison*, which have no evidence whatever of a psammophore or of a smooth area adjacent to the ventral mouthparts and which use mud in nest construction. In its use of Lycosidae rather than Oxyopidae as prey, *auriventre* may be said to be more like the mud-using species, several of which are known to employ Lycosidae. On the other hand, this may simply reflect differences in habitat rather than a real difference in hunting behavior.

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NOTES ON FOOD RESOURCES AND BEHAVIOR OF THE FAMILY
COREIDAE (HEMIPTERA) IN A SEMI-DECIDUOUS
TROPICAL FOREST

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Abstract.—Seventeen species of the family Coreidae were collected in a semi-deciduous tropical forest of Guanacaste Province, Costa Rica. Observations were made on the feeding behavior and food plants for 11 species. These observations indicated a remarkable specificity between the insects and plants. Other types of behavior, such as aggregation, and sex ratios are included when available.

While on an *Organization for Tropical Studies* (OTS) Tropical Biology course (77-1), the senior author made observations on the food habits and behavior of the family Coreidae at Hacienda Palo Verde, Guanacaste Province, Costa Rica (10°20'S, 85°24'W) in the early part of July 1976.

The study area comprises a short range of limestone hills about 100 m high along the north side of the Río Tempisque flood plain. The OTS field station at Palo Verde is located at the base of these hills. The vegetation forms a mosaic of mature, semi-deciduous forest on the hillsides, with some secondary woody growth and open pasture in more level places. Cattle graze freely throughout the area, although access to the steeper rocky areas is limited by the terrain.

Characteristic woody plants of the forest and secondary growth are: *Acacia collinsii* Safford; *A. farnesiana* (L.) Willd.; *Astronium graveolens* Jacq.; *Bursera simarouba* (L.) Sarg.; *Calycophyllum candidissimum* (Vahl.) DC.; *Casearia corymbosa* HBK.; *Guazuma ulmifolia* Lam.; *Lonchocarpus costaricensis* Pittier; *Luehea candida* (Moc. and Sesse ex DC.) Mart. and Zucc.; *Myrospermum frutescens* Jacq.; *Pterocarpus rohrii* Vahl.; *Randia subcordata* Standl.; *Spondias mombin* L.; *Stemmadenia obovata* (Hook. and Arn.) K. Schum.; *Tabebuia chrysantha* (Jacq.) Nichols.; and *T. rosea* (Berthol.) DC.

During the observation period, midway through the rainy season, 11 of

Table 1. Food resources of Coreidae. Numbers in parentheses refer to collection numbers of the senior author; insect specimens deposited in the U.S. National Museum of Natural History, Washington, D.C. and identified by the junior author. Vouchers for the plant species are deposited at the Missouri Botanical Garden (MO), St. Louis, Missouri.

Species of Coreidae	Food Plant	No. Captured While				Sex	
		Feeding	Resting	Flying	Male	Female	Ratio M/F
<i>Acanthocephala declivis</i> (Say) (38, 39, 46, 48)	<i>Pithecoctenium crucigerum</i> (L.) A. Gentry (Bignoniaceae)	4	4	3	5	6	—
<i>Anasa bellator</i> (Fabricius) (12, 35, 44)		—	2	—	—	2	—
<i>Anasa scorbaticus</i> (Fabricius) (11)		—	—	1	—	1	—
<i>Anisoscelis affinis</i> Westwood (36)	<i>Passiflora</i> sp. (Passifloraceae) (L. Gilbert, pers. comm.)	—	1	—	1	—	—
<i>Capaneus</i> sp. (a) (4, 5)	<i>Acacia collinsii</i> Safford (Leguminosae)	1	2	1	2	2	—
<i>Capaneus</i> sp. (b) (13, 14)	<i>Stemmadenia obovata</i> (Hook. and Arn.) K. Schum. (Apocynaceae)	1	1	—	—	2	—
<i>Capaneus odiosus</i> Stål (32, 33, 34)	<i>Pachyrrhizus erosus</i> (L.) Urban (Leguminosae)	72	48	—	66	54	1/1.82
<i>Hiriculus</i> sp. (21, 22)		—	2	—	1	1	—
<i>Holyomenia histrio</i> (Fabricius) (19, 20)	<i>Passiflora platyloba</i> Killip (Passifloraceae)	2	—	—	—	2	—
<i>Hypselonotus fulvus</i> (De Geer) (6, 7, 51, 52, 53, 54, 55)	<i>Julocroton argenteus</i> (L.) Didr. (Euphorbiaceae)	74	41	—	26	89	1/3.4
<i>Leptoglossus zonatus</i> (Dallas) (23, 24, 45)		—	—	3	1	2	—
<i>Machitima crucigera</i> (Fabricius) (3)		—	—	—	—	—	—
<i>Mozena</i> sp. (a) (1, 2, 25)	<i>Acacia farnesiana</i> (L.) Willd. (Leguminosae)	102	57	2	98	63	1/1.64
<i>Mozena</i> sp. (b) (4, 5)	<i>Pithecellobium oblongum</i> Benth. (Leguminosae)	3	9	2	8	6	—
<i>Phthia picta</i> (Drury) (30, 31)	<i>Julocroton argenteus</i> (L.) Didr. (Euphorbiaceae)	1	1	—	1	1	—
<i>Savius jurgiosus</i> Stål (8, 9, 10)		—	3	—	1	2	—
<i>Stenoscelidea aeneusens</i> Stål (27, 28, 29)	<i>Lonchocarpus costaricensis</i> Pétier (Leguminosae)	16	22	—	20	18	1/1.9

the 17 species of coreids collected were found to utilize eight genera of plants in six diverse families for food (Table 1). The most striking aspect of the data was the high degree of specificity exhibited regarding food preference. Each coreid species was found feeding on one, and only one, species of plant.

Because of the extended dry season (6–7 months), we assume that most of the coreids modify their habits or change habitats with its onset. This may involve diapause, a change of food plant or particular plant part, high mortality with subsequent recolonization each wet season, or migration to a more suitable environment, e.g. gallery forest. The two species, *Anisocelis affinis* Westwood and *Holymeria histrio* (Fabricius), which are obligate feeders on *Passiflora* spp. (L. Gilbert, personal communication), do not change food plants, and thus, must utilize some other modification in their life histories to escape the dry season. *Capaneus* sp. (a), which feeds on *Acacia collinsii*, may not need to modify its feeding habits for the duration of the dry season. *Acacia collinsii* continues to flush new growth throughout the year because of its dependence on ants of the genus *Pseudomyrmex* (several species) for control of competition from other plants and protection from predation by herbivores (Janzen, 1974). The three individuals of *Capaneus* sp. (a) which were not flying when captured, were found feeding or resting on *A. collinsii* shrubs unoccupied by *Pseudomyrmex*.

Two other species are known to attack a wide variety of plants, including a number of economically important ones on which they may be serious pests. *Leptoglossus zonatus* (Dallas) has been reported to feed on corn, cotton, dates, oranges, pomegranates (transmits "heart rot" of this crop), peaches, sorghum, and watermelon; *Phthia picta* (Drury), which also feeds on *Solanum nigrum* L., damages tomato fruits and squash vines.

The coreids exhibited a wide range of aggregation behavior, from solitary to highly clumped. For example, *Mozena* sp. (a) (identified as *M. lunata* in Real et al., 1974) was abundantly distributed throughout areas of secondary growth, where its host species, *Acacia farnesiana*, is more or less restricted. However, not every plant of *A. farnesiana* was infested with individuals of *Mozena* sp. (a). In fact, many plants showed no evidence of feeding activity, as damaged twigs exhibit a characteristic wilted appearance. Wherever an individual of *Mozena* sp. (a) was found, other individuals, both adult and juvenile, were also likely to be found congregating on the same twig. A previous OTS study reported on a characteristic clumped distribution for this species (Real et al., 1974). In another study (Aldrich, 1975), an unidentified coreid feeding on *Pithecellobium oblongum* (*P. dulce*) (possibly *Mozena* sp. (b) in Table 1), was found to aggregate through some type of pheromone perception via the antennae. Aggregation behavior also seemed to be utilized by *Capaneus odiosus* Stål, since individuals tended to be clumped on various plant parts, e.g. young stems, old stems, or petioles;

however, this was not tested in any statistical manner. *Hypselonotus fulvus* (De Geer), which feeds on *Julocroton argenteus* in open pastures, was shown by Real et al. (1974) to be randomly distributed.

Sex ratios were determined for species in which adequate numbers of individuals were examined (Table 1). *Mozena* sp. (a) had a strong bias towards males, while most specimens of *Hypselonotus fulvus* were female. *Capaneus odiosus* and *Stenoscelidea aenescens* Stål also showed a slight preponderance of males. The strong bias in *Mozena* sp. (a) may be due to differential development times of each sex, as many nymphs were encountered.

In feeding and disturbance behavior, all of the species exhibited similar characteristics. Most fed on young shoots, buds, or inflorescences where the plant tissues are relatively soft and easily penetrated by the sucking mouth parts. The only exception to this was one individual of *Acanthocephalus declivis* (Say), which was observed feeding on a bark-covered stem of *Pithecoctenium crucigerum* about 4 cm in diameter. When disturbed, the normal response was to move to the opposite side of the leaf, twig, or stem, so as to hide from the source of disturbance. If the disturbance continued, the insect usually escaped by flying. All of the coreids exhibited strong, if somewhat slow and deliberate, flight.

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**ETHOLOGY OF *EUDIOCTRIA TIBIALIS* BANKS
(DIPTERA: ASILIDAE) IN MARYLAND:
REPRODUCTIVE BEHAVIOR**

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Abstract.—Precopulatory behavior in *Eudioctria tibialis* Banks consists of males making short darting flights from perch to perch in search of females with which to mate. Search flights and copulations are most common in sunlit clearings during mid-afternoons. Searching males attempt to copulate with conspecifics either in flight or while they rest on perches. Copulations occur in the tail-to-tail position, and are short, with most lasting less than 15 min. Females show varying degrees of receptivity, copulate several times, and produce eggs continuously throughout their adult lives. Eggs are laid singly at a number of locations. Eggs are described and reproductive strategies are discussed.

In the first paper in this series on the ethology of *Eudioctria tibialis* Banks (Scarborough, 1981a), correlations were made between certain diurnal behaviors and the time of day. Three discrete behaviors (foraging, mating, and perching) were identified. Each behavior was recorded per hour of the day in clearings at Loch Raven Watershed, Baltimore Co., Maryland. Proportions of individuals actively involved in each behavior were used as criteria to determine the asilids diurnal behavior pattern. Results showed that as one behavior decreased in frequency others increased. Feeding was more frequent soon after the asilids entered clearings and before they left in late afternoon (Scarborough, 1981b). Feeding rates decreased during mid-afternoon as reproductive behaviors increased. This paper reports the reproductive behavior of the species.

METHODS

General methods and techniques used in this study were described earlier (Scarborough and Norden, 1977; Scarborough, 1981a). Data of flight activities of males were obtained by observing an individual fly during the first 15 minutes of each hour (1000-1800) of the day. A different individual ($N =$

15) was selected at random for observation during each 15 minute period. Activities were recorded as searching flights (short-darting flights in search of receptive females), forage flights (flights made toward flying potential prey), or orientation flights (discrete flights from one perch to another in response to changing environmental conditions and subsequent reduction in prey activities or densities). Data on each behavior were arranged in two-hour blocks. General observations of copulation, oviposition, and related behaviors were taken during the 1972-76 summers. Some females ($N = 20$) were captured while copulating and retained for 24 hours in large glass containers in the laboratory. The deposited eggs were later counted and measured. Each female was then dissected and eggs with tanned chorions found within the oviducts were counted.

RESULTS AND DISCUSSION

Precopulation Behavior.—Scarbrough and Norden (1977) defined search flights of *Cerotainia albipilosa* Curran as short-darting flights made by males in search of receptive females with which to mate. These flights usually terminated in the vicinity of perched females where males landed on nearby perches or immediately began to exhibit courtship displays in front of females. Search flights were the only discernable activity associated with precopulation behavior exhibited by *Eudioctria tibialis* males.

Flights were similar to those described for *C. albipilosa* in that they were short (ca. 1-3 m), rapid flights over vegetation, and were often terminated at perches near conspecifics or other insects which exhibited similar body features. They differed in that the male remained perched for a short time (ca. 1-10 sec) before flying to another perch or attempting to copulate.

Males sometimes hovered momentarily in flight above perched insects or tall vegetation spikes without landing. Males of *Dioctria* spp. (Melin, 1923) and *C. albipilosa* (Scarbrough, 1978) have been reported to oscillate above perched conspecifics, other insects, and various objects, e.g. twigs, nails, leaf tips. It has been suggested that this is partly reflective of the asilids limited visual acuity. However, this behavior may be significant in terms of males locating receptive females with which to mate. In each observation where male *E. tibialis* hovered above perched insects ($N = 42$), the latter invariably flew with the male following. This "flushing behavior" may have selective value in that it could increase the frequency of male-female encounters.

Foraging and orientation flights differed from search flights in that males remained perched for longer periods between flights (Scarbrough, 1981a, b). Forage flights also differed from search flights in that pursuit was directed at a wide range of dissimilar flying prey rather than flying or perched conspecifics or similar appearing insects.

A two-by-four contingency table of flight activities arranged for four con-

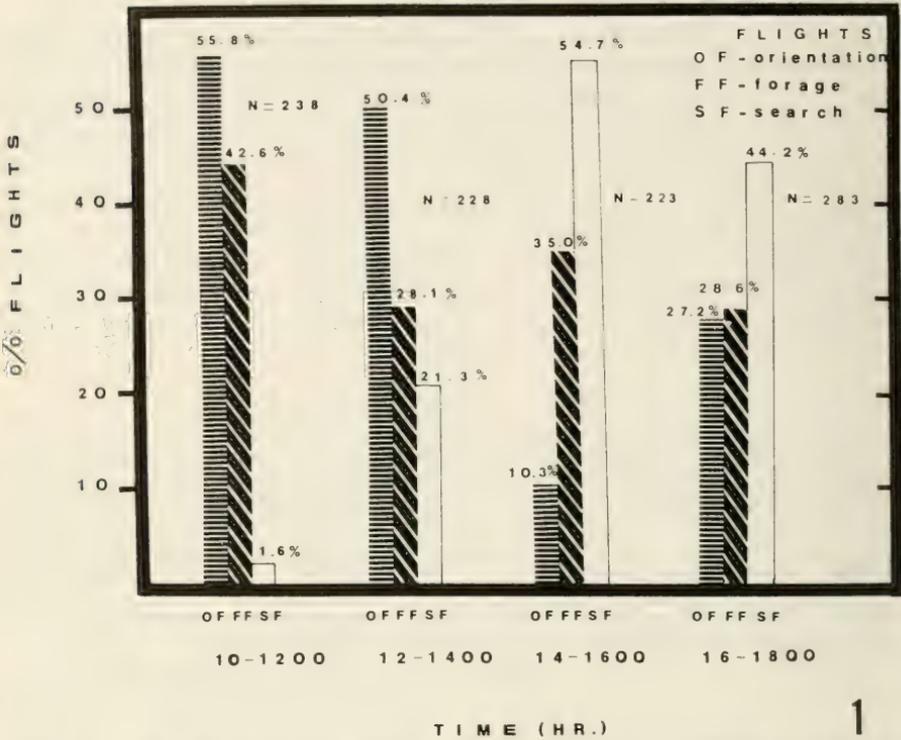


Fig. 1. Diurnal flight activities of male *Eudioctria tibialis* in sunlit clearings at the Loch Raven Watershed, Baltimore Co., Maryland.

secutive periods showed that as one activity decreased, other activities increased ($\chi^2 = 89.2$, $P < .001$; Fig. 1). Search flights occurred throughout the observation period, although they were more frequent during mid-late afternoon when flight activities associated with feeding and orientation had decreased. Similar responses have been reported for other asilid species (Dennis and Lavigne, 1975; Lavigne and Dennis, 1975; Musso, 1971, 1972; Scarbrough and Norden, 1977; Scarbrough, 1979; Scarbrough and Sraver, 1979).

Copulation.—While searching, males attempted to copulate with conspecifics either in flight or while they rested on perches. When females were encountered in flight, males followed and usually overtook them in flight where copulation was attempted. In some instances, males followed females to perches and landed on nearby perches. Occasionally males flew from their perches and attempted to copulate with the perched females. However, they usually remained perched until the females flew again. The males then followed them, overtaking them in flight. Males often followed females to several perches before attempting to copulate. In still other instances, males



Fig. 2. Copulating pair of *Eudiectria tibialis*.

“flushed” females from perches by hovering above them only to overtake them in flight or as they landed. Melin (1923) reported a similar behavior pattern where both *D. rufipes* DeGeer and *D. hyalipennis* Meigen oscillated above perched females. When the females flew, the males followed and often overtook them in flight.

A male attempted to mate as soon as a female was located. Copulation was initiated at perches when the male landed on the female's thorax (42.7%, N = 495). He quickly moved laterally to her pleuron, holding onto her legs, dorsum of the thorax and wings. He rotated his abdomen ca. 90° below that of the female's and probed at her genitalia. Sometimes the female fell on her pleuron in which case the male moved to her sternum. Union of their genitalia occurred as the two lay on their sides. However, most copulations (57.3%, N = 495) began when the male overtook the female in flight. The male grasped her wings and/or dorsum of the thorax. The grappling pair then fell to the ground or into vegetation where copulation ensued. Immediately following union of the pair's genitalia, the male moved behind the female into a straight line, assuming a tail-to-tail position (Fig. 2). The copulating pair then usually flew to another perch in the clearing, and remained quiet, not moving unless disturbed. The female initiated the flight, pulling the male behind her.

The copulating pair perched on a leaf with the female located at its tip

and in a position similar to that used for foraging (Fig. 2). The male was low in profile, with its legs spread more lateral than usual, and its weight distributed on all tarsomeres, which were in contact with the leaf surface. His wings were spread at an angle ca. 50–70° to the long axis of its body, and his abdomen was curved down and under the female's genitalia. In contrast, the female stood higher in profile with the legs closer to her body and her weight distributed on the apical two or three tarsomeres. Her abdomen was straight, and wings were folded above her body.

Visible movements exhibited by the mating pair consisted of abdominal pumping, head movements and grooming. Both sexes frequently produced irregular peristaltic contractions, beginning at abdominal segment 5 or 6 and radiating posteriorly to the end of the body. Sometimes these waves were sufficiently strong to produce a rapid jerking motion of the abdomen. These movements were presumably associated with sperm transfer by males and, perhaps, the forcible movement of fluid into the spermatheca by females (Dennis and Lavigne, 1975). Both sexes were aware of movement and insects near them, but did not forage while copulating. They moved their heads quickly in the insects' direction as they passed. Head movements were more apparent and frequent with females than males and, presumably, were related to the position of the female on the leaf which gave her a wider field of vision. Females frequently (31.0%, N = 184) fed during copulation, although the prey were captured before copulation commenced.

Most attempts at copulation by males were unsuccessful, and in other cases, several attempts were made before copulation was accomplished. Females expressed varying degrees of non-receptivity by 1) moving their abdomens and genitalia away from the male's, and concurrently moving her legs and kicking vigorously at the male, 2) when free, the wings were vibrated, producing a low pitched buzzing sound, or 3) flew to new perches. In cases of immediate copulation, females remained passive, showing no obvious attempts to prevent copulation. Like many asilid species studied (Lavigne et al., 1978), *E. tibialis* females exhibited no clearly defined response, other than avoidance, to males prior to physical contact that would indicate either receptivity or non-receptivity.

Males also attempted to copulate with conspecific males and other insects, e.g. muscoid and conopid flies and braconid wasps, which had similar body shapes and colors. Copulations were attempted with conspecific males in flight and on perches, whereas attempts to mate with non-asilids occurred at perches only. The latter could not be construed as foraging since all evidence concerning foraging behavior of *E. tibialis* indicated that the potential prey are flying and are usually smaller than the predator (Scarborough, 1981b). Apparently males cannot recognize an insect as a female until they have made physical contact.

A second male sometimes attempted to copulate with a copulating pair. The intruder landed on the perch, quickly grasping one member of the pair, usually the female. However, this response is not believed to be an indicator of recognition of a female, but rather it is more likely related to the usual position of a perched asilid on the tip of the leaf. The pair responded by moving to another area of the leaf, then kicking and finally flight to a different area of the study site when the intruder continued the disturbance. In one instance, a mating male released his grasp on the female, and the intruding male quickly clasped the female's genitalia and copulated with her. The female remained quiescent during the entire episode.

Copulations were usually short (\bar{x} = 13.6 min, N = 50) ranging between 3 and 55 minutes. Thirty-five (70%) copulations lasted less than 15 minutes. These data agree with those reported for other species in the *Dasyopogoninae* (Dennis and Lavigne, 1975).

Separation (N = 42) was usually initiated at the perch by the female, kicking the male with her hind legs. He would then release her genitalia, and fly immediately to a new perch. In many instances he left (N = 21) the clearing. The female groomed her abdomen or genitalia, and flew (N = 44) to another perch in the vicinity or foraged. Only 6 females flew from the clearing following copulation. In a few cases, no noticeable signal was detected to indicate cessation of copulation. The male released his grasp on her genitalia and flew away. Conversely, the female remained perched for a few seconds and then foraged toward a passing insect.

A few species of asilids have recently been reported (Scarborough, 1968; Bullington and Lavigne, 1980; Lavigne et al., 1980) to mate several times. *Eudioctria tibialis* behaved similarly with some females copulating with two or more males. Four marked females copulated with two different males during one afternoon and a fifth with three males. Males were not observed to mate with several females, although they undoubtedly do copulate several times. Males frequently attempted to copulate with other females immediately following separation from another.

Figure 3 shows the proportion of copulating pairs found in clearings during an eleven hour day for 15 days in 1976. Mating pairs were more common between 1300 and 1500 hrs, which corresponds to periods when males were most abundant in clearings and when foraging-feeding activities were low (Scarborough, 1981a).

Oviposition Habits.—The method used by an asilid to deposit eggs is directly correlated with the degree and type of specialization of the female ovipositor (Melin, 1923). The ovipositor of *Eudioctria* spp. (Adisoemarto and Wood, 1975) in general, and *E. tibialis* (Scarborough, unpublished data) specifically, lacks specialization for digging into or penetrating substrates into which to deposit eggs. This suggests that *E. tibialis* drop their eggs

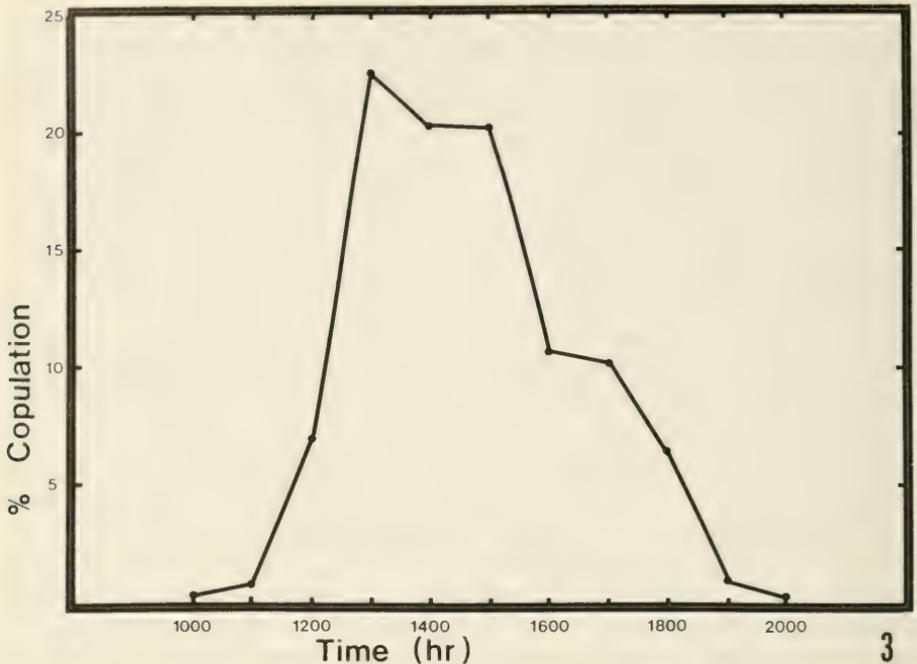


Fig. 3. Proportion of copulating pairs of *Eudioctria tibialis* in sunlit clearings during an eleven hour day per day in the Loch Raven Watershed.

either in flight or deposit them on substrates. Field observations support this hypothesis. Three females were observed depositing eggs. One female flew to perches on three different plants. At each perch, she arched the apex of the abdomen slightly downward and touched its end to the leaf surface. A slight peristaltic contraction was produced at the tip of the abdomen and was followed by the release of an egg which fell to the ground. The female then groomed the abdomen and genitalia and flew to a new location. A second and third female were found ovipositing while perched on exposed, loose sandy soil along a footpath and on the ground below sparsely spaced vegetation, respectively. Both females repeated the above behavior pattern. An egg was recovered at each site.

At least four European species of *Dioctria* (*hyalipennis*, *rufipes*, *atricapilla* Meigen, *oelandica* L.) possess similar ovipositors and oviposition habits (Melin, 1923). Females fly from perch to perch in their respective habitats, land on vegetation or leaf layer on the forest floor, and drop eggs singly at each site.

The total number of eggs produced by an asilid is difficult to determine by direct observation or by dissection (Melin, 1923). Field observations

suggest that gravid females of *E. tibialis* deposit eggs singly at a number of locations per day. Females (N = 20) captured (1100–1200 hrs) late in the fly season and placed in 256 dram glass containers deposited 6 to 30 (\bar{x} = 12.1) eggs within 24 hours. Dissection of these females revealed that they possessed a large number of eggs (<50) in their genital tracts, representing various stages of development. The common oviducts of all females dissected contained 2 to 13 (\bar{x} = 6.0) eggs, which were indistinguishable in size and color of their chorions from those deposited in the field. The lateral oviducts also contained several eggs of equal size, although their chorions were lighter in color. Furthermore, females dissected shortly after the beginning of the fly season (Scarborough, 1981a) lacked eggs in their oviducts, and none of the eggs in the ovaries had tanned chorions (Scarborough, unpublished data). These preliminary results suggest that 1) egg production continues throughout the life of an adult female *E. tibialis*, 2) a small number of eggs are deposited per day, and 3) deposition of eggs is delayed for some period after emergence, because time and nutritional requirements are necessary for their development.

Eggs.—The eggs of *E. tibialis* are oval with one end more pointed than the other (Fig. 4). The chorion is highly sclerotized, reddish brown and possesses elevated facet-like (5–7 sided, 100 \times) ridges. At least four other genera have species that produce eggs with ridges on their chorions (*Holcocephala*, Dennis, 1979; *Cerotainia*, Scarborough, 1978; *Laphria* and *Dioctria*, Melin, 1923). These ridges face away toward the pointed end, forming a smooth surface. The pointed end has a lighter color than the surrounding chorion, and it contains the micropyle (300 \times) at its center. The lighter color is probable related to the thinness of the chorion of this area, which is more easily broken than other areas of the egg surface. This end is probably the location (operculum) where a larva ecludes from the egg. Eggs are uniform in size (N = 200, 10 from each of 20 females; \bar{x} = 0.53 L \times 0.44 mm W; R = 0.50–0.56 mm L, R = 0.42–0.48 mm W).

Reproductive Strategies.—Scarborough (1981a) reported earlier that adults of *E. tibialis* were attracted to natural or artificial disruptions (clearings) in the forest canopy initially by localized prey aggregations and later by males searching for females with which to mate. The first movement into sunlit clearings produces a temporary aggregation in which females are slightly more abundant than males. Later in the day, males become more abundant than females as they replace foraging-feeding for searching-copulation behaviors. Males leave one clearing and fly to another as the density of receptive females decreases.

Female remain in clearings during most of the day insofar as prey densities are adequate and/or when physical-climatic conditions do not restrict predator-prey activity (Scarborough, 1981a, b). Upon leaving a clearing, females move to the forest canopy where they remain until conditions return to

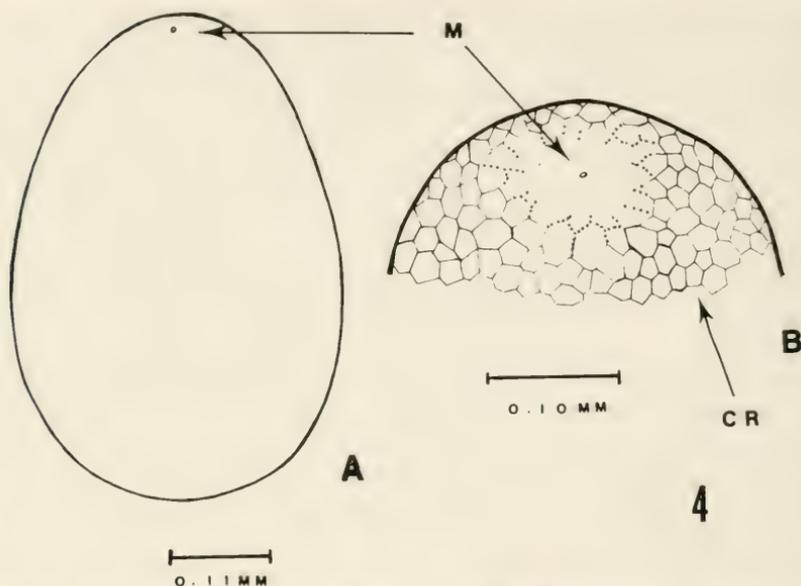


Fig. 4. Egg of *Eudioctria tibialis*. A, Shape of egg; M = micropyle. B, Chorionic ridge pattern (CR) which grades into a smooth surface surrounding micropyle.

optimum. They then either return to the same clearing or move to another. The selective advantage of remaining in clearings with optimal food resources for long periods permits greater energy expenditures for egg production rather than for increased flight in areas where resources are more dispersed. It also permits a greater opportunity for male-female contact in that females are basically stationary (Scarborough, 1981a) and, thereby, males can more readily locate them. If females were moving into and out of clearings as frequently as males in mid-afternoon, males would undoubtedly expend a greater amount of energy in order to locate them.

Foraging females in clearings will mate with several males during their adult lives. Because female *E. tibialis* produces eggs continuously during her life, with only a few maturing each day, the sperms she receives during one copulation are insufficient to fertilize all the eggs that she will produce. In this case, multiple copulations are advantageous in that they maximize genetic variability through copulation with several different males. However multiple copulations may be costly in that they occupy time that could be spent foraging (Alcock, 1980). Furthermore, because of clumped distribution of resources (localized prey concentrations) in the forest, a female may find it difficult to locate adequate prey resources for egg production in other areas where resources are less than optimal. In clearings where prey densities are more optimal, she may be forced to submit to short copulations and, yet, obtain adequate food resources.

The absence of an adequate quantity of viable sperms or some factor(s) associated with it in the spermatheca enhances multiple copulation (Manning, 1962a, b). Transfer of an adequate supply tends to temporarily inhibit multiple copulation, e.g. suppressing female receptivity. The data presented herein suggest that *E. tibialis* copulates several times during their lives and, sometimes, two or more times per day. It is probable that when a female copulates two or three times during one day, it is because of an insufficient quantity and/or quality of sperms transferred at a single copulation. Additional copulations then follow until the sperm supply in the female's genital tract rises to a point that it inhibits copulation. Copulations then cease until the sperm level falls below a minimum threshold, and subsequent internal factor(s) remove the inhibition.

Upon leaving clearings in late afternoon or during inclement weather, females may disperse to other clearings where their eggs could be more widely deposited throughout the forest. This behavior would decrease competition for larval developmental sites and increase the possibility of success of their progeny.

Like many species of bees, males of *E. tibialis* maximize their access to females through "scramble-competition." Males move into clearings where females are feeding and attempt to copulate with them as soon as possible to exclude competitors. The males' reproductive success is based solely upon their ability to locate potential females before their competitors do (Alcock, 1980).

In multiple copulation systems, the last male to copulate with a female prior to oviposition is the one that fertilized all or most of the eggs deposited at the next oviposition (Parker, 1970). Receptive females of *E. tibialis* copulate repeatedly accepting any male that can grasp them until an adequate sperm supply is obtained. Males which enter clearings with females early in the day have a maximum sperm supply. Because they have not copulated since the previous day, these males are more likely to transfer a sufficient amount of sperms to their mates, producing an inhibition of the mating process. This stimulates non-receptivity in the females and insures fertilization of her mature eggs with his sperms.

As the day progresses more and more males enter clearings and join the scramble for mates. The new arrivals originate from areas in the Watershed where receptive females were absent. The proportion of copulations increases in early afternoon, corresponding with the time of the rapid increase of males in clearings. In mid- to late afternoon, the proportion of copulations decreases, indicating that most females have copulated and received sufficient sperms to inhibit future copulations. Conversely, some females remain receptive because they received insufficient sperms or receptivity has been restored through removal of inhibition via oviposition. Thus, receptive females in mid-late afternoon contain sub-threshold levels of sperms. Males with sperms that locate these females are at a selective advantage. Fewer

sperms are needed to inhibit future copulations at this time of day than earlier. Therefore, these males contribute more genetically to succeeding generations than others.

ACKNOWLEDGMENTS

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NOTE

Synonymical Notes on New World Bruchidae
(Coleoptera), and an Emendation

J. Decelle called my attention to an error in our recent publication "Revision del genero *Megacerus* (Coleoptera: Bruchidae)" (Teran, A. L. and J. M. Kingsolver. 1977. Opera Lilloana 25: 1–287), p. 103. The citation "*B[ruchus] pygidionotatus* Pic, 1929, p. 36" under *Megacerus lunulatus* (Pic) should be corrected to "*Pachybruchus pygidionotatus* Pic, 1952, p. 15," described from Peru (Échange, Vol. 68). The citation on p. 106 (Teran and Kingsolver) giving the type-locality is correct for *Pachybruchus pygidionotatus*.

Examination of the type-specimen of *Bruchus bipustulatus* Fabricius, 1801 (Syst. Eleuth. 2, p. 238) disclosed that this name is a senior synonym of *Megacerus* (*Pachybruchus*) *acerbus* Teran and Kingsolver, 1977: 143. NEW SYNONYMY, NEW COMBINATION.

The name *Amblycerus baracoensis* Kingsolver, 1970 (Trans. Am. Entomol. Soc. 96: 484) is hereby emended to *A. baracoensis*.

From examination of type-specimens, the West Indian *Amblycerus martorelli* Bridwell, 1944 (J. Agric. Univ. P.R. 27: 133) is a junior synonym of *Amblycerus sallei* (Jekel), 1855 (Insecta Saundersiana, p. 30). NEW SYNONYMY.

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A REVIEW OF NEARCTIC SPECIES OF *ACMOPOLYNEMA* OGLOBIN
(HYMENOPTERA: MYMARIDAE)¹

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Abstract.—Four new species of *Acmopolynema* (Hymenoptera: Mymaridae) from North America are described and illustrated, *A. sema*, *A. miamiense*, *A. uma*, and *A. immaculatum*. Lectotypes are designated for *A. varium* (Girault) n. status, and *A. bifasciatipenne* (Girault); *A. vittatipenne* (Dozier) is a new combination. A key to the seven Nearctic species is presented.

When the genus *Acmopolynema* was described (Oglobin, 1946), its author noted that he possessed several undescribed species from South America and speculated that the genus originated in the Neotropics, although the type-species (*A. bifasciatipenne* (Girault)) was from North America. Since that time, several species have been described; one from Japan (Taguchi, 1971), two from Africa (Mathot, 1968; Risbec, 1957), one from the Philippines (Soyka, 1956), and two from South America (Gomes, 1948; Soyka, 1956), and several undescribed species have been collected from the Neotropics (C. Yoshimoto, personal communication).

Recently, I examined material from several sources in North America, and have found new combinations, specimens which represent new species, and species for which holotypes had not been designated. In this paper, I have attempted to remedy these problems and give a review of the species from the Nearctic Region.

The biology of species of *Acmopolynema* remains largely unknown. *Acmopolynema varium* (Girault) has been reared from the eggs of *Oecanthus niveus* (DeGeer), *O. nigricornis nigricornis* Walker, and *O. nigricornis quadripunctatus* Beutenmuller (Gryllidae) and *A. bifasciatipenne* has been reared from *Anaxipha exigua* (Say) (Gryllidae). In addition, Gomes (1948) reported *Sphenorhina liturata* (Lepelletier and Serville) (Cercopidae) as the

¹ Scientific Article No. A2874, Contribution No. 5927 of the Maryland Agricultural Experiment Station, Department of Entomology, University of Maryland.

host of *A. hervali* Gomes, and *A. sema*, n.sp., was reared from *Homalodisca insoleta* (Walker) (Cicadellidae).

Terminology used for morphological features is that of DeBauche (1948) and Eady (1968). All ratios were measured at 100× with a dissecting microscope and eyepiece reticle. Funicle segments, coxae, wings, etc. were measured at their widest point, scape length includes radicula, and the thorax was measured dorsally along the midline. Measurements of ovipositor length refer only to that part that extends past the tip of the abdomen. The abbreviation LMC refers to the longest marginal cilia of the forewing. Although species of *Acmopolynema* are large for mymarids, some characters cannot be seen without the aid of a compound microscope; in particular, the sensory structures of the antennae and wing setae. Characters which cannot be reliably evaluated with a dissecting microscope have been set off by parentheses in the species key.

GENERIC DIAGNOSIS AND DISCUSSION

Annecke and Doutt (1961) place *Acmopolynema* in the subfamily Myrmarinae (abdomen convexly rounded at base; phragma barely or not projecting into the abdomen), tribe Mymarini (four tarsal segments and petiolate abdomen). In their key to genera, they distinguish the genus on the basis of the following combination of characters: Antenna 9-segmented, club simple; propodeum with two keels converging above the petiolar insertion (Figs. 1, 2) to form a more or less distinct process; discal setae of forewing often with enlarged bases (tormae); and forewings often banded. Oglobin (1946), in his original description of the genus included the following: Scape transversely striate; pronotum completely divided medially, with spiracles at posterolateral angles; scutellum with a transverse row of small foveae; and male antenna 13-segmented. In addition, the median, frontal, and supraorbital carinae are complete; the frontal groove present, and the ocelli are in a curved line, with the median ocellus slightly forward of the laterals (Fig. 3).

Most species of this genus are readily recognizable, being quite large for mymarids (over 1 mm) and having prominently banded forewings. Oglobin (1946) stated that members of the genus have the propodeal keels forming a stout tooth directed caudally, and the combined length of the hindtarsi shorter than their tibia. However, it is now known that some of the species have neither character. *Acmopolynema miamiense*, n.sp., and *A. vittatipenne* (Dozier) have their hindtarsi longer than the tibia, and in *A. immaculatum*, n.sp., and *A. miamiense*, n.sp., the tooth formed by the propodeal keels is indistinct or not visible at all (the tooth can be seen in the male of *immaculatum*). Dr. C. Yoshimoto (personal communication) has noted that in some Neotropical species the pronotum is undivided and the posterior margin of the scutellum may extend over the anterior part of the propodeum. The form of the propodeal keels may vary from a simple V-shape as in *A.*

immaculatum, to a "V" with transverse anterior carinae attached (Fig. 2) as in *A. sema*, n.sp., or a "V" formed of several smaller carinae, such as seen in some specimens of *A. varium*. Finally, many of the species exhibit an external enlargement of the opening of the prothoracic spiracle (Fig. 1) which may be directed outward or posteriorly.

The discal setae of the forewing (Fig. 4) vary in structure and placement among the various species. However, the interpretation of their structure under the compound microscope can be difficult. The modified discal setae (types A–E) are representative of the large setae covering the dorsal surface of the proximal large stained area of the wing. Setal types F–H are found spread throughout the surface of the wing, especially in the distal stained area, the nyaline areas, and the wing margins. They are often found both dorsally and ventrally. It should be emphasized that the relative lengths of the setae and placement of barbs, swellings, etc. are quite variable, and the illustrations are presented as a guide to help in identifying the various types.

KEY TO FEMALES OF NEARCTIC *ACMOPOLYNEMA*

1. Forewing hyaline (Fig. 13), discal setae evenly scattered over surface *immaculatum*, new species
- 1'. Forewing with 2 or 3 stained areas (Figs. 12, 14–18), setae not evenly scattered over surface 2
2. Longest marginal cilia of forewing less than $\frac{1}{2}$ wing width; (funicles 5 and 6 each with a pair of sensory ridges; Figs. 10–11) 3
- 2'. Longest marginal cilia of forewing equaling at least $\frac{1}{2}$ wing width; (funicles 5 and 6 without sensory ridges) 4
3. Funicles 2 and 3 $15\times$ as long as wide (Fig. 10); scutum equal in length to scutellum (modified discal setae of type D (Fig. 4), spread over both large stained areas) *miamiense*, new species
- 3'. Funicles 2 and 3 about $10\times$ as long as wide (Fig. 11), scutum longer than scutellum; (modified discal setae of type E (Fig. 4), restricted to basal large stained area) *varium* (Girault)
4. Hindcoxa reticulate; apical stained area of forewing reaching wing tip (Fig. 17) *uma*, new species
- 4'. Hindcoxa alutaceous or smooth; apical stained area of forewing not reaching wing tip 5
5. Ovipositor exerted a distance equal to length of abdomen; pronotum less than $\frac{1}{2}$ length of the scutum *vittatipenne* (Dozier)
- 5'. Ovipositor exerted less than length of abdomen, pronotum more than $\frac{1}{2}$ length of scutum 6
6. Hindtarsus longer than tibia; scutum longer than scutellum, body length about 2.0 mm *bifasciatipenne* (Girault)
- 6'. Hindtarsus shorter than tibia; scutum equal to or less than scutellum; body length about 1.2 mm *sema*, new species



Figs. 1-3. *Acrompolynema sema*, habitus view. 1, Lateral view of thorax. 2, Closeup of propodeum. 3, Head.

Acrompolynema sema Schauff, NEW SPECIES

Figs. 1-3, 5, 16

Holotype female.—Length 1.2 mm. Color dark brown: face, hindcoxa, and median abdomen lighter, the following yellow: Scape, pedicel, 1st funicle segment, foreleg except proximal $\frac{1}{2}$ of femur and last tarsal segment, midcoxa, proximal tip of tibia and first 3 tarsi, apical tip of hindfemur, proximal tip of tibia and first 3 tarsi, and petiole. Ratio head:thorax:abdomen:ovipositor 16:52:60:10. Head alutaceous, postfrontal carina incomplete, occipital suture nearly reaching foramen, POL:OOL:interocular distance at vertex 10:3:23, eye height:malar distance 15:10, toruli removed 1 diameter from median carina; antennal ratio (Fig. 5) beginning with scape 12:7:8:15:12:7:7:6:21, scape width $0.5 \times$ length, fu-

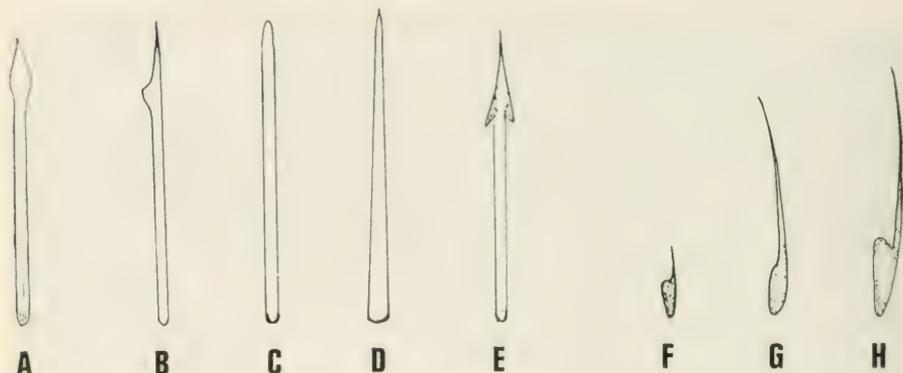


Fig. 4. Modified wing setae types of *Acropolynema*.

nicles becoming wider apically, club width $0.4 \times$ length, with 9 sensory ridges; ratio pronotum:scutum:scutellum:propodeum 10:15:20:7, pronotum faintly alutaceous dorsally, coriaceous posterolaterally, with a pair of stout setae laterad of median carina posteriorly, laterally with a row of 9 setae, spiracle enlarged, directed outward; scutum and scutellum alutaceous, notauli constricted anteriorly (Fig. 1), scutellum with transverse row of fovea across posterior $\frac{1}{3}$, a small row of fovea anterolaterally, axillae each with a small seta; propodeum smooth, median keels forming a distinct V, flaring anteriorly and running parallel to metanotum, not reaching spiracle, forming a small tooth posteriorly, lateral carina well developed, not reaching spiracle, with a seta posterolaterally, spiracle slightly raised, with a shallow depression between end of keels and spiracle; ratio femur:tibia:tarsi 1:2:3:4 as follows: Foreleg 35:32:16:9:6:9, midleg 27:45:20:10:8:10, hindleg 35:57:28:10:7:10, hindcoxa length:width 20:8, lightly alutaceous, with few setae laterally and ventrally; forewing as in Fig. 16, length:width:LMC 150:36:20, modified discal setae of type B, restricted to proximal large stained area; hindwings length:width 110:3; abdomen elliptic, ovipositor exerted $0.18 \times$ abdomen length.

Allotype male.—Length 1.0 mm. As for female, except for following: 2nd funicle segment yellow, fore- and midlegs entirely yellow except for the last tarsal segment, hindcoxae yellow; antennal ratio beginning with scape 10:7:14:16:14:14:14:15:13:11:11:12, funicles all equal in width; forewing length:width:LMC 134:32:21; abdomen ovate, shorter than thorax.

Types.—Holotype ♀, "Georgia, Ft. Valley, IX-1956, G.H. Kaboostian, reared from *Homalodisca insoleta*"; deposited in the USNM, type no. 76793; donated by the Florida State Collection of Arthropods (FSCA), Gainesville, Florida. Allotype ♂, 28 ♀, 8 ♂ paratypes, same data as holotype, deposited in USNM and FSCA.

Other specimens examined.—Florida, Alachua and DeLeon Counties 13 ♀, 2 ♂; Texas, Hidalgo Co. 13 ♀.

Etymology.—The species epithet is an arbitrary combination of letters.

Variation.—Length 1.1–1.3 mm excluding ovipositor. Color generally as for holotype, with the following exceptions: Antennal funicle segments occasionally all yellow to light brown, rarely with scape and pedicel light brown. Median and supraorbital carinae may be partially stained darker than the rest of the head. Forecoxa, femur and tibia ranging from light yellow to light brown, same for midlegs. Hindcoxa may be nearly all yellow. Prothorax occasionally lighter brown or red brown; abdomen may be concolorous dark brown without a lightened area to concolorous red brown.

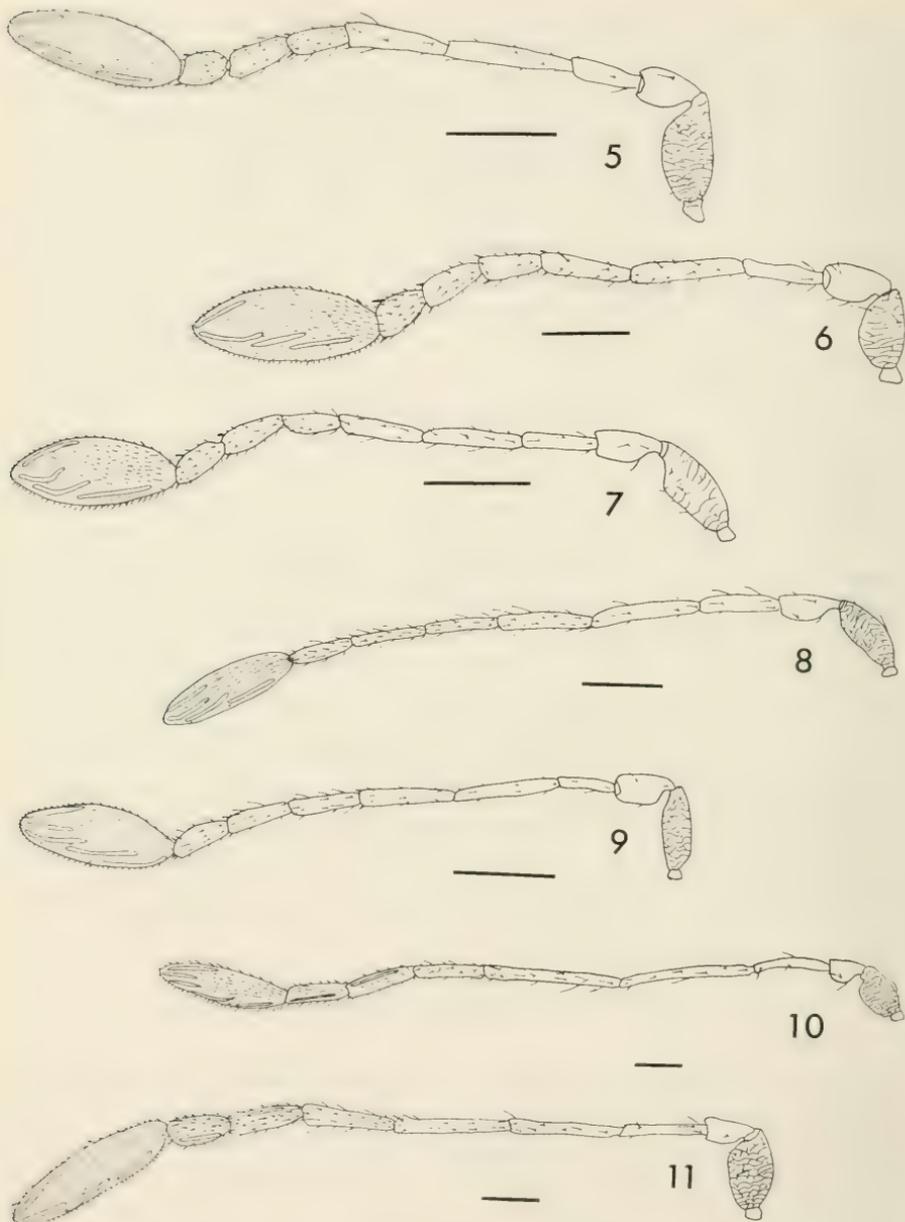
Antennal segments may vary + or – one unit from those given for the type. Pronotum occasionally with 2 pairs of setae laterad of the median carina; 7–11 setae in row at lateral edge of pronotum. Forewing length:width:LMC 134–150:32–36:19–21. The small stained area under the venation is generally very light on this species and may be reduced to a small fuscous area along the posterior wing margin. The larger stained areas vary somewhat in size and placement, but are generally very similar to the type. The numbers of setae in the stained areas and in the hyaline area also vary slightly in number and length; however, the enlarged setae of the proximal stained area seem to be restricted to that general area of the wing. In lateral view, the female abdomen is generally somewhat elongate, the length being about 3× the width. However, in some specimens the abdomen appears more ovate, the length being only about 2× the width.

Diagnosis and Discussion.—This species may be recognized by the following combination of characters: Propodeal keels flaring anteriorly and running parallel to metanotum, LMC equal to or greater than half the wing width, enlarged discal setae restricted to the proximal large stained area, hindtarsi shorter than tibia, ovipositor slightly exerted, length about 1.2 mm, and overall dark brown in color.

Acropolynema miamiense Schauff, NEW SPECIES

Figs. 10, 15

Holotype female.—Length 1.8 mm. Color brown; median and supraorbital carinae, posterior abdomen darker; forecoxa, apical and basal tip of mid- and hindcoxae white; the following yellow: Antenna except club, apical ½ of foretibia and foretarsus, midtarsus, apical ⅓ of 1st hindtarsus, last three tarsi. Ratio head:thorax:abdomen:ovipositor 18:85:85:90. Head alutaceous, postfrontal carina incomplete; occipital suture reaching just past ocellus. POL:OOL:interocular distance at vertex 10:4:25, eye height:malar distance 20:12, toruli removed 1 diameter from median carina; antennal ratio (Fig. 10) beginning with scape 12:8:20:32:32:17:18:14:30, scape width 0.6× length, funicles only slightly wider apically, club width 0.33× length, funicles 5 and



Figs. 5-11. Female *Acropolynema* antennae (black line equals 0.1 mm). 5, *A. sema*. 6, *A. immaculatum*. 7, *A. uma*. 8, *A. bifasciatipenne*. 9, *A. vittatipenne*. 10, *A. miamiense*. 11, *A. varium*.

6 each with a pair of sensory ridges; club with 12 sensory ridges; ratio pronotum:scutum:scutellum:propodeum 18:27:27:13; pronotum with very faint striations dorsally, alutaceous postero-laterally, pair of small setae laterad of median carinae medially, larger pair near posterior margin, lateral edge with row of 7 setae, spiracle enlarged, directed posteriorly; scutum alutaceous dorsally, coriaceous laterally, notauli a broad straight groove; scutellum alutaceous, with transverse row of fovea across posterior $\frac{1}{3}$, axilla each with a large seta; propodeum smooth, median keels forming a distinct V, not forming a tooth posteriorly; flaring anteriorly and running parallel to metanotum, nearly reaching lateral carinae, lateral carinae distinct, nearly reaching spiracle, with a seta laterad in posterior $\frac{1}{3}$, spiracle slightly raised. Ratio of femur:tibia:tarsi 1:2:3:4 as follows: Forelegs 50:50:54:12:10:10; midlegs 38:58:65:12:10:10; hindleg 52:82:92:12:10:10; hindcoxa length:width 35:10, alutaceous; forewing as in Fig. 15, length:width:LMC 205:52:14, modified discal setae of type D, present in both large stained areas; hindwing length:width 160:3; abdomen elongate elliptic, ovipositor exerted $1.1\times$ length.

Male.—Unknown.

Types.—Holotype ♀ data as follows: "Miami, Fla. Mar. 6, 1963. black light trap coll, A.S. Mills"; deposited in the USNM type no. 76794.

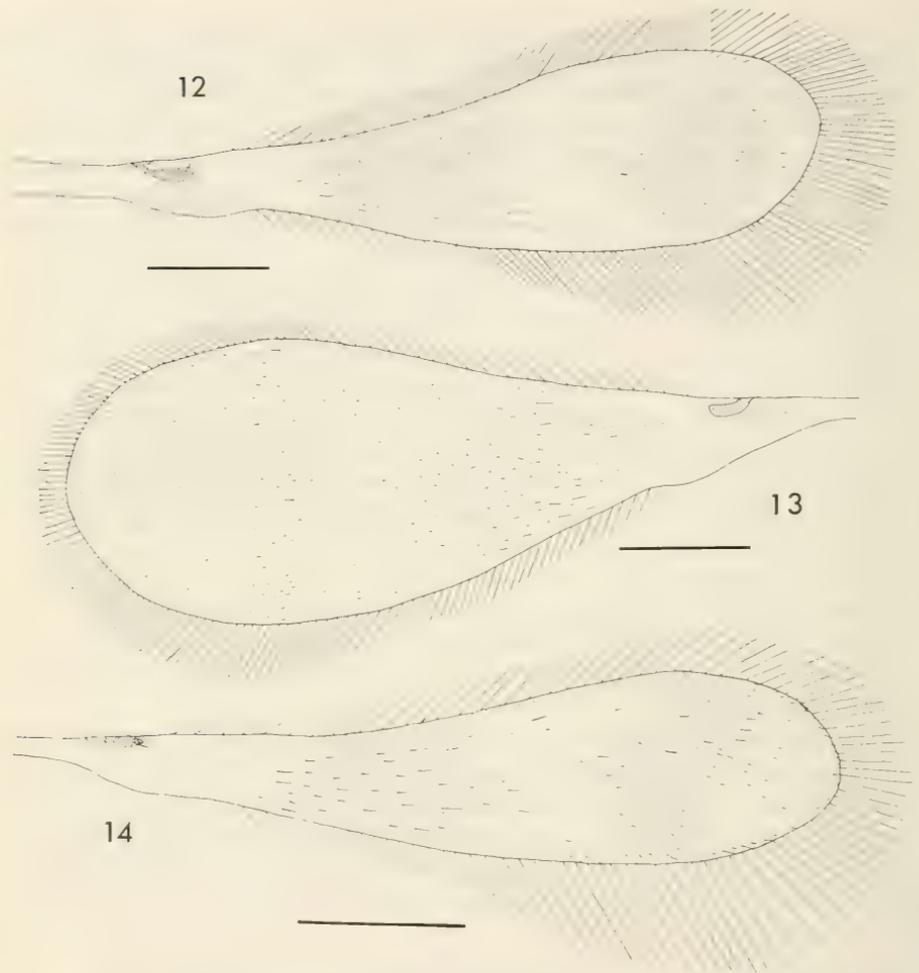
Etymology.—The species epithet *miamiense* refers to the place of collection (Miami, Fla.).

Diagnosis and Discussion.—This is one of the largest of the species studied, and can be recognized by the following combination of characters: Funicles 2 and 3 $15\times$ as long as wide, funicles 5 and 6 each with a pair of sensory ridges; hindtarsus longer than tibia; ovipositor extruded a distance equal to the length of the abdomen or more; LMC equal to less than half the wing width. The sensory ridges on funicles 5 and 6 are found only in this species and in *A. varium*.

Acmopolynema uma Schauff, NEW SPECIES

Figs. 7, 17

Holotype female.—Length 1.2 mm. Color yellow brown, except the following darker: Median and supraorbital carinae, funicles 2, 3, 5 and club; mid- and hindfemora, midtibia medially, apical $\frac{2}{3}$ of hindtibia, last tarsal segment of all legs, abdomen; fore- and apical tip of mid- and hindcoxae white. Ratio head:thorax:abdomen:ovipositor 15:47:68:5, head alutaceous, postfrontal carina incomplete, occipital suture reaching the foramen, POL:OOL:interocular distance at vertex 9:4:18, eye height:malar distance 15:9, toruli removed 1 diameter from median carina; antennal ratio (Fig. 7) beginning with scape 12:6:7:10:9:5:6:5:18, scape width $0.4\times$ length, funicles



Figs. 12-14. Forewings of *Acropolynema* (black line equals 0.2 mm). 12, *A. bifasciatipenne*. 13, *A. immaculatum*. 14, *A. vittatipenne*.

becoming wider apically, club width $0.33 \times$ length, with 9 sensory ridges; ratio pronotum:scutum:scutellum:propodeum 10:14:14:9, pronotum alutaceous posterolaterally, with a pair of setae laterad of median carina at posterior margin, laterally with a row of 10 setae, spiracle enlarged, directed posteriorly; scutum and scutellum alutaceous, notauli a straight groove, scutellum with transverse row of fovea across posterior $\frac{1}{3}$, few fovea at margin of scutellum and axillae, axillae each with a small seta; propodeum smooth, median keels forming a broad V, forming a tooth posteriorly, lateral carinae well developed, reaching spiracle, with a seta posterolaterally, spi-

racle placed in a small depression, ratio femur:tibia:tarsi 1:2:3:4 as follows: foreleg 29:27:15:6:5:7; midleg 22:39:20:9:6:7; hindleg 30:47:25:10:5:8; hind-coxa length:width 20:7, reticulate; forewing as in Fig. 17, length:width:LMC 115:32:20, modified discal setae of type A and C, with a few extending into anterior margin of distal stained area, hindwing length:width 90:3, abdomen elliptic, ovipositor exerted $0.1 \times$ abdomen length.

Male.—Unknown.

Types.—Holotype ♀, "13906 Cutler Road, Miami, Florida (Dade Co.), 8 January, 1979, L. Stange collector, pan trap"; deposited in the USNM, type no. 76795, donated by the Florida State Collection of Arthropods, Gainesville, Florida. Paratype ♀, same data as above, deposited in the FSCA.

Etymology.—The species epithet is derived from an arbitrary combination of letters.

Variation.—Observed differences in the specimens available for study were limited to minor variation in size, and the exact number and placement of wing setae.

Diagnosis and Discussion.—This species is distinct from other Nearctic species, being the only one in which the distal stained area of the forewing reaches the tip of the wing. In addition, the hindcoxae are reticulate, the scutum is equal in length to the scutellum, the propodeal keels form a broad V, and the LMC is equal to or slightly greater than one half the wing width.

Acmapolynema immaculatum Schauff, NEW SPECIES

Figs. 6, 13

Holotype female.—Length 1.4 mm. Color dark brown; funicle segments, hindcoxa, and basal tip of mid- and hindtibiae lighter brown; pedicel, 1st 3 tarsi of all legs, and petiole yellow. Ratio head:thorax:abdomen:ovipositor 16:55:70:5, head lightly alutaceous, postfrontal carina incomplete, occipital suture reaching the foramen, POL:OOL:interocular distance at vertex 11:2:19, eye height:malar distance 15:10, toruli removed 1 diameter from median carina; antennal ratio (Fig. 6) beginning with scape 9:7:10:14:10:7:7:6:22; scape width $0.6 \times$ length, funicles becoming wider apically, club width $0.4 \times$ length, with 9 sensory ridges; ratio pronotum:scutum:scutellum:propodeum 10:15:20:10; pronotum alutaceous posterolaterally, with a pair of setae medially at posterior margin, laterally with row of 6 setae, spiracle enlarged, directed posteriorly; scutum and scutellum alutaceous, notauli a straight groove, scutellum with a transverse row of fovea medially, axillae without setae; propodeum smooth, median keels forming a distinct broad V, not forming a tooth posterior, lateral carina reduced to a short ridge above hindcoxa, with a seta laterad, spiracle flush with surface; ratio of femur:tibia:tarsi 1:2:3:4 as follows: Foreleg 40:30:15:6:5:7; midleg 25:40:19:8:7:6; hindleg 25:50:22:9:8:8; hindcoxa

length:width 20:7, smooth, and with many white setae anteriorly and ventrally; forewing as in Fig. 13, length:width:LMC 150:50:13, modified discal setae all of type F-H evenly scattered over wing; hindwing length:width 110:4; abdomen ovate elliptic, ovipositor exerted $0.1\times$ abdomen length.

Allotype male.—Structurally as for female except for the following: Only the 1st 3 tarsi of the legs yellow, rest of body brown. Antennal ratio beginning with scape 7:5:13:13:13:13:14:14:14:14:13:13; scape width $0.9\times$ length, broadened medially; funicles all of equal width. Propodeal keels form a distinct posteriorly directed tooth. Abdomen ovate.

Types.—Holotype ♀ deposited in the Canadian National Collection, type no. 16148, with data as follows: "Aldershot, N.S., Aug. 18, 1950, coll. A. McPhee." Allotype with same data as above. Paratypes, 3 ♂, 1 ♀, Sask. Landing, Sask. 23-VI-56, O. Peck. 1 ♂, Wrightsville, Ont. 17-VII-1951, E.H.N. Smith, on Virginia creeper; 1 ♂, Lawrence, Tex. 57, Aug. 17/47, W.B. Specht." One paratype deposited in USNM.

Etymology.—The species epithet is derived from the Latin *immacula*, meaning unspotted or unstained, and refers to the wholly hyaline front wings.

Variation.—Differences in the specimen available for study were limited to slight variation in size; wing length:width:LMC 140-170:48-57:12-14.

Diagnosis and Discussion.—This species is the only one currently known from the Nearctic Region that lacks stained areas on the front wings. In addition, the discal cilia are not enlarged, LMC equals about one-fourth width of wing, the lateral carinae on the propodeum are reduced, and the median carina is a simple V-shape. *Acmopolynema brasiliense* (Ashmead), from South America, also has wholly hyaline front wings; however, it can be distinguished from *immaculatum* by the following characters: Scape and forelegs yellow (brown in *immaculatum*); ovipositor exerted half the length of abdomen (barely reaching past the tip in *immaculatum*); discal setae of forewing thickened and blunt (narrow and pointed in *immaculatum*).

Acmopolynema vittatipenne (Dozier), NEW COMBINATION

Figs. 9, 14

Polynema vittatipennis Dozier, 1932: 83.

Although Dozier's original description was quite detailed, I would add the following from the paratype: Female length 1.2 mm; color light brown; ratio head:thorax:abdomen:ovipositor 9:36:40:45, POL:OOL 7:4, occipital suture nearly reaching foramen, antennal ratio (Fig. 9) beginning with scape 9:6:7:11:10:8:6:6:16, club width $0.45\times$ length, with 9 sensory ridges, ratio pronotum:scutum:scutellum:propodeum 5:12:12:7, spiracle directed posteriorly, scutum and scutellum alutaceous, notauli a thin groove, constricted anteriorly, propodeum smooth, median keels a narrow V with transverse anterior extensions running parallel to the metanotum, ending in a tooth,

lateral carinae nearly reaching spiracle; ratio femur:tibia:tarsi 1:2:3:4 as follows: foreleg 27:25:17:7:5:6; midleg 20:40:24:9:8:8; hindleg 25:45:29:9:7:8; hindcoxa length:width 17:6, alutaceous; forewing as in Fig. 14, LMC = 15, modified discal setae of types A and B (Fig. 4), a few reaching distal stained area; abdomen elliptic, ovipositor exerted $1.1\times$ length.

Male.—Unknown.

Types.—Paratype ♀ on slide labeled as follows: "*Polynema vittatipennis* Dozier. Reared from sweet potato infested with *Copicerus irroratus* etc. Port-au-Prince, Haiti. Dec. 30, 1929, H.L. Dozier." Deposited in USNM, type no. 43877.

Other specimens examined.—Female on slide with data: "Florida, Dade Co. Homestead Exp. Sta. 6-XI-1973, W.H. Pierce, Malaise Trap."

Variation.—Differences in the two specimens available for study were limited to minor variation in size and color.

Diagnosis and Discussion.—This species can be recognized by the following combination of characters: Overall dark brown in color; ovipositor exerted the length of the abdomen; pronotum shorter than scutum; scutum and scutellum equal in length; hindtarsus longer than hindtibia; forewing with only two stained areas (no stain under venation); LMC greater than half the width of the wing. This species was described from two females reared by Dozier. He states that they probably emerged from the eggs of a small cricket; however, this host record must remain in doubt since leafhoppers and delphacids were also present on the plant. Although the Dozier collection is now in the USNM, I have been unable to locate the holotype; therefore, the data given are based on the paratype.

Acmopolynema bifasciatipenne (Girault)

Figs. 8, 12

Stichothrix bifasciatipennis Girault, 1908: 9.

Polynema bifasciatipenne Girault, 1910: 254 (n. comb.).

Acmopolynema bifasciatipenne (Girault): Oglobin, 1946: 286 (n. comb.).

Acmopolynema bifasciatipenne var. *varium* (Girault): Burks, 1979: 1031 (incorrect synonymy).

To aid in the recognition of this species, I would add the following to that given by Girault: Female length 2.0 mm, color brown, ratio head: thorax:abdomen:ovipositor 20:65:105:10; POL:OOL 11:5, occipital suture short, reaching just past lateral ocellus, antennal ratio (Fig. 8) beginning with scape 11:8:11:16:15:10:11:8:23, scape width $0.6\times$ length, club width $0.3\times$ length, with 9 sensory ridges; ratio pronotum:scutum:scutellum:propodeum 16:24:15:10, spiracle directed posteriorly, scutum and scutellum alutaceous, notauli a narrow line, propodeum smooth, median keels forming a short V, ending with a tooth, lateral carinae nearly reaching spiracle; ratio femur:tibia:tarsi 1:2:3:4 as follows: foreleg 35:32:22:10:8:10; midleg

27:45:36:10:8:9; hindleg 35:65:40:10:9:9; hindcoxa length:width 25:7, alutaceous; forewing as in Fig. 12, length:width:LMC 170:41:20, modified discal setae of types B and D, some reaching distal stained area, hindwing length:width 120:2, abdomen elongate elliptic, ovipositor exerted $0.1\times$ length.

Male.—Unknown.

Types.—LECTOTYPE ♀, by present designation, on slide, USNM type no. 11846, deposited in USNM, with data: "*Stichothrix bifasciatipennis* Girault, from eggs of *Anaxipha exigua*, D.C. May 29, 1905." Paralectotype ♀ on slide, same data as above except collected May 6, 1905. Deposited in the Illinois Natural History Survey, Urbana.

Other specimens examined.—One ♀ with data: "Williamsville, Mo. 15-viii-10-ix-69. J. T. Becker, Malaise Trap." Known from Washington, D.C. and Missouri.

Variation.—The paralectotype female is considerably lighter in color than the lectotype; however, this is probably due to clearing during the mounting of the specimen. The occipital suture of the lectotype is obscured, but in the other specimens, it reaches the foramen. Other differences were limited to minor variations in size, numbers of setae on the forewings, and position of the stained areas.

Diagnosis and Discussion.—This species can be identified by the following combination of characters: Pronotum slightly shorter than scutum; propodeal keels a short V; forewing with LMC equal to at least one half wing width; modified discal setae reaching apical stained area; hindtarsus longer than tibia; and ovipositor slightly extruded.

Although Girault's original description of this species was adequate, he later redescribed it (Girault, 1910) in great detail after having examined several additional specimens in the USNM. However, after examining those specimens, I have found that the redescription was based entirely on specimens of *A. varium* which Girault considered to be conspecific (see discussion of *A. varium*). Later, Burks (1979) incorrectly placed *varium* into synonymy with *bifasciatipenne*. In addition, Girault did not designate either of the original two females of *bifasciatipenne* as the holotype. Therefore, I have designated the USNM specimen (type no. 11846) as lectotype.

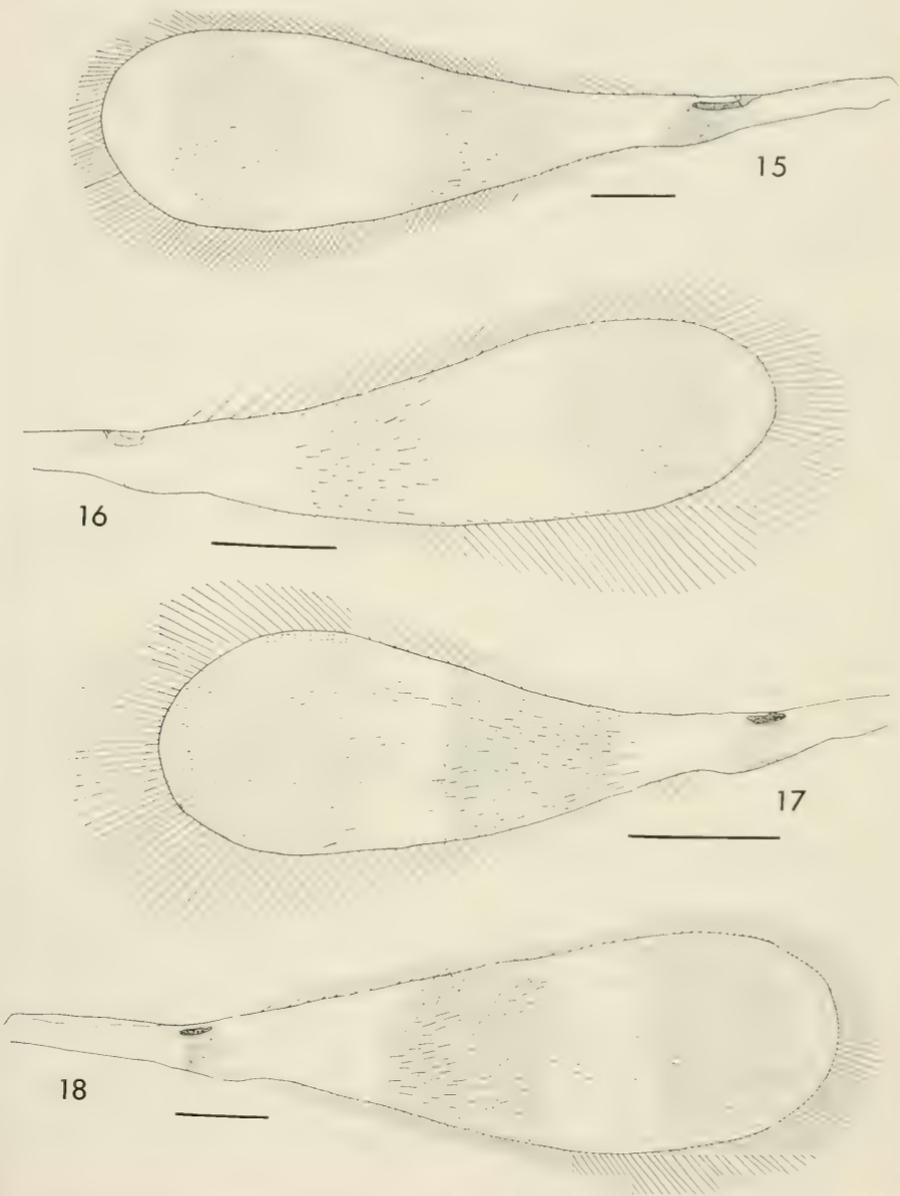
Acmopolynema varium (Girault) NEW STATUS

Figs. 11, 18

Polynema bifasciatipenne var. *varium* Girault, 1917: 92.

Acmopolynema bifasciatipenne (Girault); Oglobin, 1946: 286 (n. comb).

The following characters are added to aid in the recognition of this species: Female length 2.0 mm.; ratio head:thorax:abdomen:ovipositor 27:95:105:40; overall color yellow; POL:OOL 10:6; occipital suture indistinct, reaching just past lateral ocellus, antennal ratio (Fig. 11) beginning with scape



Figs. 15-18. Forewings of *Acropolytnema* (black line equals 0.2 mm). 15, *A. miamiense*. 16, *A. sema*. 17, *A. uma*. 18, *A. varium*.

15:8:16:20:20:15:11:10:32, scape width $0.5 \times$ length, club width $0.3 \times$ length, funicles 5 and 6 each with a pair of sensory ridges, club with 9 sensory ridges: ratio pronotum:scutum:scutellum:propodeum 20:30:25:20; spiracle directed posteriorly, scutum and scutellum alutaceous, notauli a broad groove, not constricted anteriorly, propodeum smooth, median keels form a broad V, with a transverse carina between the anterior margin at the V, ending in a tooth, lateral carinae nearly reaching spiracle, a depression between median keels and spiracle; ratio femur:tibia:tarsi 1:2:3:4 as follows: foreleg 52:55:45:15:10:12; midleg 35:68:45:15:10:12; hindleg 55:90:65:17:11:11; hindcoxa length:width 32:11, alutaceous; forewing as in Fig. 18, length:width:LMC 200:54:14, modified discal setae of type E, restricted to basal large stained area, hindwing length:width 156:5; abdomen elongate elliptic, ovipositor extruded $0.4 \times$ abdomen length.

Male as for female except for following: Antennal ratio 12:7:19:23:22:21:20:20:18:18:17:17:18; abdomen length about 0.6 mm.

Types.—LECTOTYPE ♀, by present designation, on point (wing and antenna on slide), USNM paratype no. 20599, with data as follows: "no. 860.E, reared from eggs of *Oe. niveus* in resin weed, June 3, 1881." Two ♀ paralectotypes on points, USNM type no. 20599, with data as above, except collected on June 7 and June 10, 1881.

Other specimens examined.—This is the most commonly collected of the species studied. Specimens (50 ♀, 14 ♂) have been collected throughout North America in the following states and provinces: Maryland, Delaware, New Jersey, Virginia, District of Columbia, Massachusetts, Maine, Michigan, Tennessee, Iowa, Kansas, Oklahoma, Texas, California, Ontario, and Quebec.

Variation.—The vast majority of specimens studied have the body almost entirely yellow or yellow brown, with the apical funicle segments, club, median carina, supraorbital carina, area around the ocelli, and last tarsal segment darker. The funicle segments may be light brown or amber colored, the areas around the notauli darker than the rest of the thorax, and the hindtibia and posterior abdomen may be dark brown. A specimen from Texas has the antennae wholly light brown, two females from California have the body almost entirely dark brown except for portions of the antennae, petiole, and legs. Measurements varied as follows: Length 2.0–2.2 mm excluding ovipositor; antennal ratios may vary + or – one unit from the type, slightly more for the club (28–32); forewing length:width:LMC 195–240:55–70:12–16. The large stained areas of the wing may vary slightly in size, as can the number of modified discal setae. The median propodeal keels are usually similar to those of the lectotype. However, the transverse carinae at the anterior margin of the V may be missing or fragmented, and in a few specimens, the carinae which form the V are fragmented.

Diagnosis and Discussion.—This species can generally be recognized by

its yellow color. However, the following combination of characters should be checked: Funicles 2 and 3 about $10\times$ as long as wide; funicles 5 and 6 each with a pair of sensory ridges; scutum longer than scutellum; LMC less than half width of wing; and ovipositor extruded about half the length of the abdomen.

In 1908, Girault described *Stichothrix bifasciatipennis* from two females. Then Girault (1910) moved the species to the genus *Polynema*, and re-described it based on his examination of a number of specimens in the USNM. Seven years later Girault (1917) described *Polynema bifasciatipenne* var. *varium* from three females and one male and differentiated it on the basis of "differing from the typical form in being light yellowish brown" and with the "ovipositor . . . more extruded." Oglobin (1946) then used *bifasciatipenne* as the type of his new genus *Acmopolynema*. Finally, Burks (1979) synonymized the two forms (*bifasciatipenne* and *bifasciatipenne* var. *varium*) under the name *Acmopolynema bifasciatipenne*. My study has revealed that specimens originally described as var. *varium* by Girault and many other specimens in the USNM collection that were identified as *varium* constitute a valid species different from *bifasciatipenne*. The two species can be differentiated by 1) the presence of sensory ridges on funicles 5 and 6 in *varium*, 2) LMC greater than half the wing width in *varium*, less than half in *bifasciatipenne*, and 3) ovipositor exerted at least half length of abdomen in *varium*, exerted just past tip of abdomen in *bifasciatipenne*. Since no holotype was designated by Girault, I have designated a lectotype.

ACKNOWLEDGMENTS

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A REVISION OF THE GENUS *OREOTHALIA* MELANDER
(DIPTERA: EMPIDIDAE)

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Abstract.—The Nearctic clinocerine empidid genus *Oreothalia* Melander is revised. Redescriptions of the genus and two previously described species, *O. pelops* and *O. rupestris*, are given. Three species are described as new, *O. spinitarsis*, *O. sierrensis*, and *O. chillcotti*. Illustrations of wings and genitalia are presented for each species.

Flies of the genus *Oreothalia* Melander are typical clinocerine empidids, usually found on water films in seepage areas or on exposed rocks. They are predaceous, feeding on small fragile arthropods. Mating takes place near the water. Nothing is known of the immature stages.

Oreothalia adults are not easily collected because of their habit of remaining close to the substrate, even during their short flights. The only effective means of collecting is with an aspirator. A sweep net swung close to the substrate will sometimes produce a few specimens.

A. L. Melander (1902) named the genus for the single western species *Oreothalia pelops* Melander. The only other described species is *Oreothalia rupestris* Vaillant (1960) from the eastern United States.

Recent collecting of clinocerines in the western United States has added greatly to the number of specimens of *Oreothalia* available for study. It has shown that what has been called *O. pelops* is actually two species, both commonly collected. Representatives of two additional species have also been found.

Oreothalia Melander

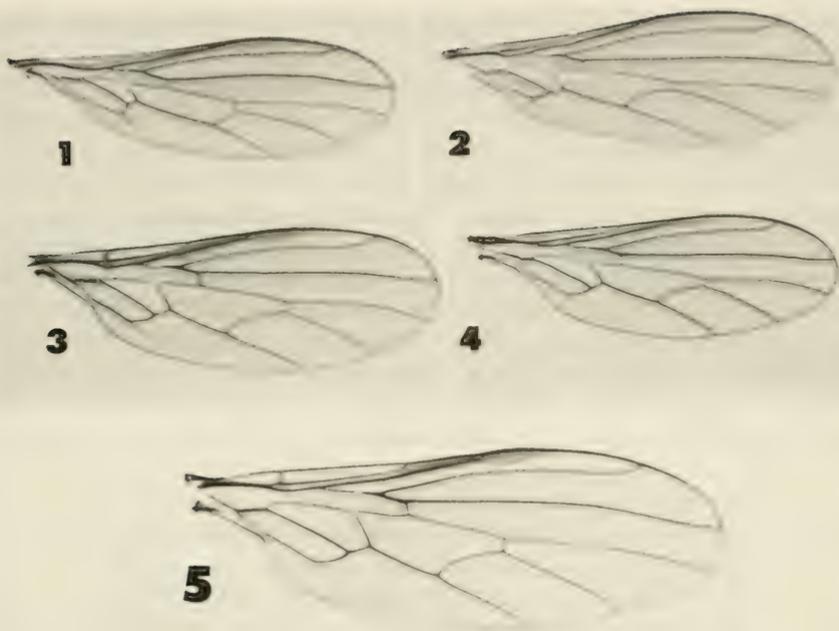
Oreothalia Melander, 1902: 232. Type species, *pelops* Melander (monotypic)

Description.—Delicate opaque black flies generally resembling *Clinocera* Meigen species, but with R_{1+5} not forked. *Head*: Oval, slightly narrowed ventrally; eye large, covering entire side of face and reaching oral margin, therefore separating gena from face, facets uniform in size, pubescent; an-

tenna emargination broad and distinct. Sides of the front divergent to occiput, broader in female; face wide with sides slightly sinuate, wider and with straight sides in female. Ocellar triangle elevated, occupying a slightly anterior position on front; 1 pair of strong ocellar setae, several small postocellar hairs; 2 irregular rows of postocular bristles. First antennal joint narrow, apparently inset on dry specimens, 2nd longer than 1st with a few black hairs, 3rd segment oval, pubescent; arista 1-segmented, terminal, thick, tomentose. Labrum short, broadly triangular, tomentose, labellae large, chitinized, curving towards each other, meeting in front of labrum. Palpi small, oval, appressed, tomentose with a few hairs. *Thorax*: Longer than broad, not much arched above. Pronotum with a few weak setae; sternum and episterna with sparse pale hairs; mesonotum with 5 strong dorsocentrals, minute acrostichals present anterior to 1st dorsocentral; 1 humeral, 1 posthumeral, 1-2 notopleurals, sometimes 1 intra-alar and 1 post-alar, and 1 pair of marginal scutellars; metapleurae with dense yellow hairs; sternopleuron with some long white hairs on posterior edge. *Legs*: Slender, front coxa lengthened, at least twice as long as other 2; front femur slightly swollen with strong, anteriorly inclined thornlike setae on ventral surface; hind tibia setose, no tibial spurs; claws, empodia and puvilli long. *Wing*: Anal angle slightly projecting, costa encompassing wing; 2 (sometimes 1) long costal bristles present; subcosta strong, complete; R_{4+5} unbranched; discal cell emitting 3 veins; 1st basal cell longer than 2nd, 2nd subequal to anal cell; anal crossvein variable, anal vein present or evanescent; calypter small with a thick, nearly straight edge and a strong, pale fringe; stigma present, usually weak. *Abdomen*: Cylindrical, tomentose and with loose pale hairs; segments with 1 or 2 rows of dorsal pittings and 2 lateral pittings (often obscured). Pygidium reflexed, aedeagus conical; female with terminal segment compressed laterally, 2 small cerci present.

KEY TO SPECIES OF *OREOTHALIA* MELANDER

1. Wing with discal cell blunt apically (Fig. 1), 1 basal costal bristle; 2 notopleural and no supra-alar or intra-alar bristles; terminalia as figured (Fig. 9) *rupestris* Vaillant
- Wing with discal cell attenuate apically (Figs. 2-4), 2 basal costal bristles; 1 notopleural, 1 supra-alar and 1 intra-alar bristle 2
2. Wing hyaline or subhyaline, stigma distinct; pleurae uniformly grey tomentose; male terminalia with dorsal valve round to oval and densely setose mesally (Figs. 6, 12) 3
- Wing infuscated, often more so around wing veins, stigma pale, indistinct; pleurae with some greenish or brownish tomentum as on notum; male terminalia with dorsal valve either long and narrow or broad and truncate dorsally, nearly bare mesally (Figs. 7, 8) 4
3. Large species (3-4 mm); stigma dark, distinct, wing veins blackish (Fig. 5); pale anteroventral and posteroventral cilia on femur III



Figs. 1-5. Wings. 1, *Oreothalia rupestris*. 2, *O. spinitarsis*. 3, *O. chillcotti*, 4, *O. pelops*, 5, *O. sierrensis*.

- longer than femur width; femora with a distinct bluish cast; halter black *sierrensis*, new species
- Smaller species (2.5-3.0 mm); stigma pale but distinct, wing veins brown (Fig. 3); pale anteroventral and posteroventral cilia on femur III shorter than femur width; femora with at most a pale greenish cast; halter brown *chillcotti*, new species
- 4. Basitarsis III with at least 4 strong, distinct ventral bristles (Fig. 11); female face grey, brown near oral margin; terminalia as figured (Fig. 7) *spinitarsis*, new species
- Basitarsis III with only weak or irregular ventral bristles (Fig. 10); female face uniform brown; terminalia usually as figured (Fig. 8), rarely as in Fig. 7 *pelops* Melander

Oreothalia rupestris Vaillant

Figs. 1, 9

Oreothalia rupestris Vaillant, 1960: 118.

Description.—Body length 2 to 3 mm; general color brown, closely covered with brown and greenish tomentum. *Head*: Occiput and front covered with thin green tomentum; face of male grey, of female greenish. Antenna

black, arista short, $3\times$ the length of 3rd antennal segment. *Thorax*: Notum dull, covered with brown tomentum with green highlights, median stripe, if present, indistinct; 5 long dorsocentrals, 1 humeral, 1 posthumeral, 2 notopleurals with a few additional pale hairs, 2 divergent marginal scutellars; pleuron greyish with uniform green and purple highlights. *Legs*: Light brown with pale tomentum. Anterior femur with 4 to 5 ventral spinelike setae which are regular in size and arrangement, on the apical $\frac{1}{2}$ (usually apical $\frac{1}{3}$) and shorter than width of tibia. Tibia I with apical oblique comb of divergent, widely-spaced pale setae on anterior face; row of uniform short setae on ventral surface; tibia III with a variable number of weak dorsal setae and some ventral hairs. *Wing*: Fig. 1; brown with discal cell blunt, anal cell truncate, anal vein short, distinct; stigma obsolete; 1 basal costal bristle. *Abdomen*: Brown, subshining with sparse green and purple tomentum. Terminalia (Fig. 9) large, dorsal process very long, narrow, black, polished.

Type Material.—Holotype ♂ (not examined), Laurel Falls, 800 m, 20-VIII-1955, North Carolina, coll. by F. Vaillant. Deposited in Vaillant's private collection.

Diagnosis.—Adults of *O. rupestris* are the most distinctive of the genus. They can be distinguished by the blunt discal cell and truncate anal cell in the wing, the presence of only one costal bristle, the absence of intra-alar and postalar bristles, and the presence of two notopleural bristles. The terminalia are also distinctive.

Specimens Examined.—(DDWC indicates specimens in my personal collection, other abbreviations are listed in the acknowledgments.) Total number of specimens examined, 31. *North Carolina*: Highlands, Whiteside Mt., 4600' [ca. 1400 m], July; Wilson's Gap, 3100' [ca. 940 m], May; Bubbling Spring Creek, nr. Tennessee Bald, 5100' [ca. 1550 m], July; Mt. Pisgah, 4–5000' [ca. 1220–1520 m], July (CNCI, FSCA). *Tennessee*: Van Buren Co., May (USNM). Other specimens (not examined) have been collected at: Great Smoky Mountains National Park: Between Clingman's Dome and Gatlinburg, 900 m, August; Mt. Le Comte, 1950 m, August.

Remarks.—*Oreothalia rupestris* adults are found near the water surface in streams and seepages at elevations above 900 m in the Smoky Mountains. The larvae are presumably aquatic. This is the only species in the genus which occurs east of the Rocky Mountains. Although certainly belonging in the genus, it is remarkably different from the western species.

Oreothalia pelops Melander

Figs. 4, 8, 10

Oreothalia pelops Melander, 1902: 233. Melander 1927: 223 (in redescription of genus).

Description.—Body length 2.5 to 3.5 mm; general color brown to dark brown, closely covered with greenish tomentum. *Head*: Occiput and front

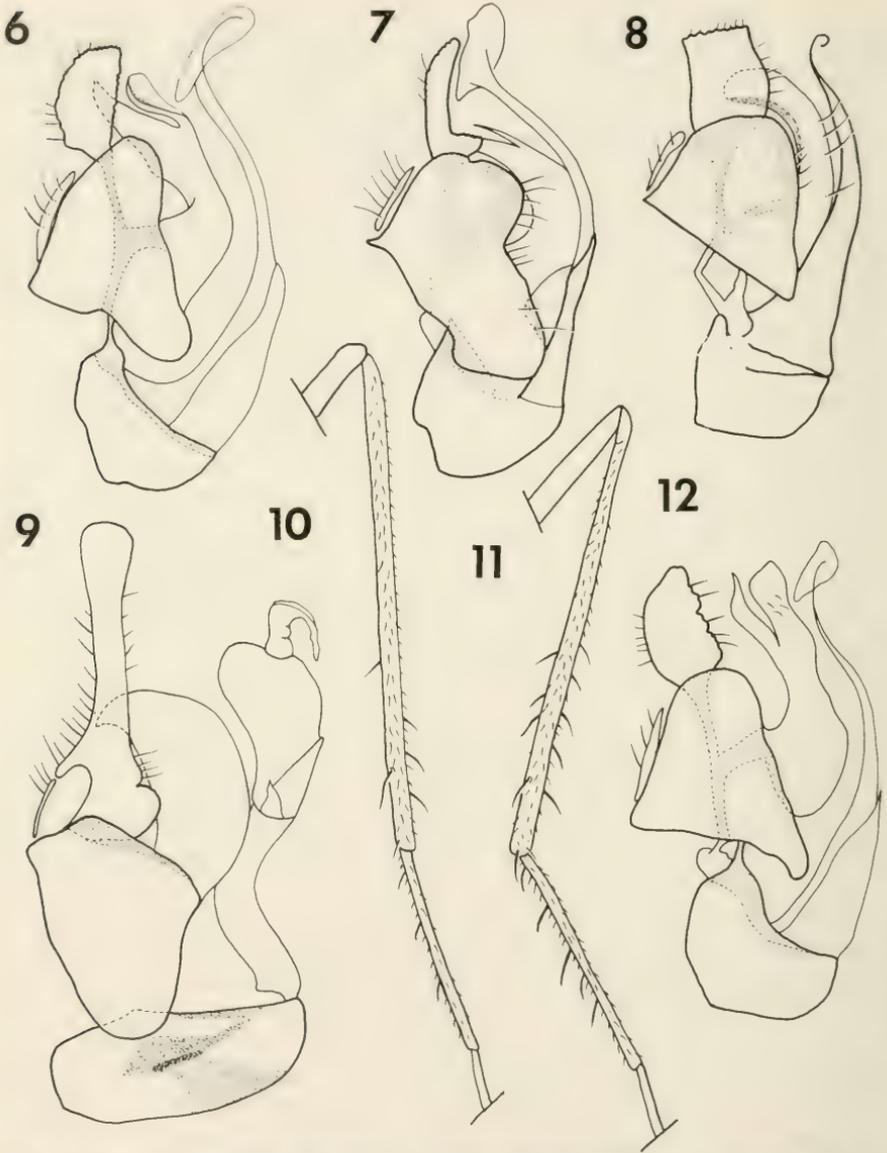
covered with greenish brown tomentum, postocciput and gena greenish; face of male silvery white, of female dull greenish brown. Antenna dark brown to black, arista usually 3.5–4.5× the length of 3rd antennal segment. *Thorax*: Notum dull greenish with a brown median stripe; 5 dorsocentrals, 1 humeral, 1 posthumeral, 1 notopleural bristle, and 1 to several small hairs, 1 intra-alar, 1 postalar, 1 pair of convergent or parallel marginal scutellars and several additional marginal hairs; pleuron grey tomentose, greenish along pleural suture and cluster of metapleural hairs. *Legs*: Brown with green reflections. Anterior femur with ventral spinelike setae which are irregular in size and arrangement, but usually on apical $\frac{3}{4}$ of femur and longer than the width of anterior tibia. Tibia I with an apical oblique comb of closely set short setae on the anterior face; a row of uniform, short, dark, appressed setae on the ventral surface; tibia III with 2 to 4 dorsal setae and 1 to 3 shorter ventral setae on apical $\frac{1}{3}$; basitarsis III with weak, irregular ventral setae (Fig. 10), if setae are long, there are no more than three. *Wing*: Fig. 4; slightly infuscated, often darker around veins, broadest at end of R_1 ; discal cell elongate dorsally; stigma pale, distinct; 2 strong basal costal bristles. *Abdomen*: Brown with thin green, brown and purple tomentum, sparse yellow hairs. Terminalia (Fig. 8) with dorsal process usually broad, truncate dorsally, partially tomentose, slightly concave mesally with a few small hairs. Few individuals with dorsal process as in Fig. 7.

Type Material.—LECTOTYPE ♂ (here designated) labeled "Kendrick/Idaho" "JMAldrich/coll" "Cotype/No. 29184/U.S.N.M." 4 ♂ and 2 ♀ paralectotypes with the same data are all deposited in USNM.

Diagnosis.—*Oreothalia pelops* adults can be distinguished from those of the closely related *O. spinitarsis* by the absence of four strong setae on the basitarsus, the shorter arista, the uniform brown face of the female, and the distinctive male terminalia.

Specimens Examined.—153. *Alberta*: Banff, August (CNCI). *California*: Tuolumne Co.: Brightman Flat, July. Yosemite National Park: Nevada Falls, 5907' [1800 m], Aug. (CASC, DDWC). *Idaho*: Latah Co.: Kendrick, Aug. (USNM). *Oregon*: Benton Co.: Mary's Peak, June. Wallowa Co.: Enterprise, 3400' [1040 m], June (WSUC, DDWC). *Washington*: Grays Harbor Co.: Montesano, July. King Co.: Vashon, May. Mt. Rainier Nat. Park: Alta Vista; Berkeley Park; creek draining E. end Yakima Park; Ohanapecosh; Paradise Park; Sluiskin; Summerland.; White River; Yakima Park, July, Aug. Pierce Co.: Tacoma, July, Aug. Yakima Co.: Chinook Pass, 5400' [1650 m], Aug. (USNM, DDWC, NEWC).

Remarks.—Adults of *O. pelops* can be separated easily from those of the closely related *spinitarsis* on the basis of the characters listed in the diagnosis. The genitalia are, in most cases, distinctive. However, in a few cases certain individual specimens showing all the usual character states of *pelops* will have genitalia in the form typical of *spinitarsis*. This structural dimorphism may be the result of hybridization. Whatever the genetic basis of this



Figs. 6-9. Male genitalia (macerated). 6, *Oreothalia sierrensis*. 7, *O. spinitarsis*. 8, *O. pelops*. 9, *O. rupestris*. Figs. 10-11. Hindtibia and basitarsis in anterior view. 10, *O. pelops*. 11, *O. spinitarsis*. Fig. 12. Male genitalia, *O. chillcotti*.

phenomenon, I feel that the constancy of the other characters warrants placing such specimens with *O. pelops*. These flies are found in moist seepage areas, under waterfalls and on rocks in streams from northern California to Alberta. Although they are sympatric with *O. spinitarsis*, the two species

are only rarely collected together. Life history study and breeding experiments with these two interesting species of flies are necessary to elucidate their true relationship.

Oreothalia spinitarsis Wilder, NEW SPECIES

Figs. 2, 7, 11

Description: Body length 2.5 to 3.5 mm; general color brown to dark brown, closely covered with brown and/or green tomentum. *Head*: Occiput and front covered with greenish-brown tomentum, post-occiput and gena greenish; face of male silvery white, of female brown near oral margin, blending into grey or green near antennal base. Antennae brown to black, arista 4–5× length of 3rd segment. *Thorax*: Notum dull greenish with a brown median stripe; 5 dorsocentrals, 1 humeral, 1 posthumeral, 1 notopleural with a variable number of associated dark hairs, 1 intra-alar, 1 post-alar, 2 marginal scutellars, and a few short marginal hairs; pleuron grey tomentose, greenish along a wide area from anterior spiracle to metapleural hairs. *Legs*: Brown, covered with green or brown tomentum. Anterior femur with ventral spinelike setae irregular in size and arrangement, but usually on anterior $\frac{2}{3}$ on femur and subequal to the width of anterior tibia. Tibia I with an apical oblique comb of closely set short setae on anterior face; a row of uniform short dark setae on ventral surface; tibia III with 3–6 strong dorsal and 2–4 shorter ventral setae on apical $\frac{1}{2}$; basitarsis III with at least 4 distinct ventral setae (Fig. 11). *Wing*: Fig. 2; infuscated, often darker around veins, broadest beyond end of R_1 ; discal cell elongate dorsally; stigma pale; 2 strong basal costal bristles. *Abdomen*: Brown with thin brown or grey tomentum, sparse yellow hairs. Terminalia (Fig. 7) with dorsal process long and narrow, polished, serrate on anterior edge, not haired mesally.

Type-Material: Holotype, ♂, "U.S.A.: WASHINGTON:/Gray's Harbor County/Olympic Natl. Forest/Willaby Cpgd. 21-VII-/1978. D. Dee Wilder," "D. Dee Wilder/Collection," "Holotype *Oreothalia spinitarsis* Wilder 1980," "Calif. Acad. Sci. Type No. 13676." Allotype ♀ with the same data. Paratypes: 114 specimens with the same data or with the addition of "Rec. Loop Trail" or the date, "20-VII-1978." Holotype and allotype are deposited in the collection of the California Academy of Sciences.

Diagnosis: *Oreothalia spinitarsis* adults differ from those of *O. pelops* by the more spinous basitarsis III, the longer arista, the bicolored face of the female, the shape of the wing, and the distinctive male terminalia.

Specimens examined.—470 (all paratypes). *British Columbia*: 1 ♂, Cowichan Lake, July. 10 ♀, 15 ♂, Horseshoe Bay, 0–300' [0–90 m], May. 1 ♀, Goldstream Provincial Park, July. 1 ♂, Mt. Thornhill, Terrace, July; 2 ♂, 1 ♀, nr. Terrace. 3500', 4300', 5300' [1070, 1310, 1620 m] July; 1 ♀, 5 mi. S. Terrace, June; 1 ♀, 49 mi. W. Terrace, July; 1 ♂, 50 mi. S.W. Terrace, June. 1 ♀, Squamish, 3200' [ca. 980 m], Aug. (CNCI, CASC).

Alaska: 2 ♂, Thane, May (WSUC). $\frac{1}{2}$ California: Humboldt Co.: 2 ♂, Humboldt Redwoods St. Pk., May; 2 ♂, 3 ♀, Orlick, June. Madera Co.: 1 ♀, Upper Chiquito Campground, 6820' [ca. 2080 m], Aug. Mendocino Co.: 1 ♂, Buck Rock Creek at INO2, June (USNM, DDWC, CASC). *Idaho*: Benewah Co.: 1 ♀, Thorn Creek, nr. St. Maries, June. Bonner Co.: 1 ♂, 1 ♀, Priest Lake; Indian Creek, Lookout Mt., Aug., Sept. (DDWC, USNM). *Oregon*: Benton Co.: 2 ♂, 2 ♀, Mary's Peak, June, July; 5 ♂, 3 ♀, Yew Creek, June. Douglas Co.: 1 ♂, Divide, June. Hood River Co.: 1 ♂, Starvation Creek St. Pk., June. Jackson Co.: 1 ♂, 3 ♀, Dead Indian Soda Spring, May. Klamath Co.: 1 ♀, Crater Lake, Sept. Lane Co.: 1 ♀, McKenzie Bridge Cpgd., June. Linn Co.: 2 ♂, 2 ♀, Monument Peak Guard Sta., 4000' [ca. 1220 m], July, Aug. Marion Co.: 1 ♀, Silver Falls St. Park, June. Multnomah Co.: 1 ♂, Multnomah Falls, June; 1 ♀, Oneonta Gorge, Sept. Umatilla Co.: 1 ♂, Dead Man Pass, July (DDWC, WSUC, USNM, CASC). *Washington*: Clallam Co.: 2 ♂, 3 ♀, Bogachiel, June; 1 ♂, Lake Crescent, Fairholm, July; 1 ♂ Tumbling Rapids Rec. Area, June. Gray's Harbor Co.: 60 ♂, 54 ♀, Willaby Cpgd., July. Jefferson Co.: 1 ♀, 15 km. N.E. Quinault, June. King Co.: 4 ♂, 3 ♀, Vashon, May. Kittitas Co.: 5 ♂, 1 ♀, Lake Keechelus, Sept. Lewis Co.: 1 ♂, 2 ♀, Adna, July; 1 ♂, 3 ♀, Toledo, June. Mason Co.: 2 ♀, Dewatto, June, Aug.; 2 ♀, Lake Cushman, June, July; 2 ♂, Lilliwaup, July. Mt. Rainier Nat. Park: 2 ♀, above Christine Falls, 3700' [ca. 1130 m], 4500' [ca. 1370 m]; 1 ♂, Cayuse Pass; 12 ♂, 8 ♀, Comet Falls Trail, 4500' [ca. 1370 m]; 8 ♂, 13 ♀, Cowlitz Divide Trail, 640 m; 2 ♂, 3 ♀, creek draining E. end Yakima Park, 1830 m; 2 ♂, 3 ♀, Eagle Peak; 2 ♂, 1 ♀, Fairfax Trail; 12 ♂, 10 ♀, Fish Creek at West Side Rd., 910 m; 1 ♀, Frying Pan Trail; 4 ♂, Longmire; 1 ♂, 4 ♀, Mazama Ridge; 3 ♂, 2 ♀, Ohanapecosh; 2 ♂, 1 ♀, Panther Creek, 720 m; 5 ♂ 6 ♀, Paradise Park; 17 ♂, 16 ♀, Stevens Creek at Stevens Cyn. Rd., 4000–4500' [ca. 1220–1370 m]. July–October. Olympic Nat. Park: 1 ♂, 2 ♀, Lake Creek, 650 m; 2 ♂, 3 ♀, T26N R13W Sec. 28, sweeping coastal forest. July. Pacific Co.: 17 ♂, 30 ♀, Ilwaco, May, July; 1 ♀, South Bend, May. 1 ♂, 1 ♀, Pluvis, June. Pierce Co.: 13 ♂, 6 ♀, La Wis Wis, 390 m, Oct.; 7 ♂, 6 ♀, Tacoma, May, July, Aug. San Juan Co.: 1 ♂, 1 ♀, Mt. Constitution, May. Skagit Co.: 1 ♀, Baker Lake, May. Snohomish Co.: 1 ♂, Everett, June; 2 ♂, 2 ♀, Granite Falls, Aug. Whatcom Co.: 2 ♂, 1 ♀, Bagley Creek, 850 m, Oct.; 1 ♂, Glacier, Sept.; 2 ♂, Thompson Creek, Mt. Baker, 400 m, Oct. (USNM, DDWC, WSUC, CNCI, CASC, FSCA).

Remarks.—Members of this species are distinctly different from those of the closely related *O. pelops*, although *spinatarsis* adults have, in the past, frequently been determined as *pelops*.

These flies are found on rocks in small to large streams from northern California to British Columbia. They have also been collected under waterfalls, in boggy seepage areas, and on tundra.

The specific epithet refers to the conspicuous spines on the hind basitarsis.

Oreothalia sierrensis Wilder, NEW SPECIES

Figs. 5, 6

Description.—Body length 3.0 to 4.0 mm, general color brown dorsally, grey laterally, heavily tomentose. *Head*: Occiput and front greenish-brown tomentose; postocciput and gena grey with blue highlights; face of male grey tomentose, of female, brown. Antenna black, arista short, $3\times$ length of the 3rd segment. *Thorax*: Notum dull brown with red and green reflections; median stripe, if present, indistinct. Five dorsocentrals, 1 humeral, 1 posthumeral, 1 notopleural with several pale hairs, 1 intra-alar, 1 postalar, and 2 long marginal scutellars with several dark marginal hairs; pleuron and coxae uniformly grey tomentose; halter black. *Legs*: Black, femora bluish-green tomentose. Anterior femur with ventral spinelike setae evenly spaced and of approximately equal length on anterior $\frac{2}{3}$ (usually anterior $\frac{1}{2}$) of femur and longer than the width of the anterior tibia; femur ciliate with posterior and posteroventral rows of white hairs. Tibia I with an apical oblique comb of short setae on the anterior face; a row of small uniform curved dark setae on the ventral surface. Tibia III with 2–5 dorsal and 0–3 shorter ventral setae on apical $\frac{1}{3}$; basitarsis III with weak hairs; femur III ciliate with 1 row each anteroventral and posteroventral long white hairs. *Wing*: Fig. 5; hyaline; veins, stigma and subcostal cell dark, distinct; anal vein weak, evanescent; 2 strong basal costal bristles. *Abdomen*: Grey tomentose with a median greenish-brown stripe, female abdomen often without stripe. Terminalia (Fig. 6) with dorsal process round-oval, polished, mesal surface concave, covered with stiff hairs.

Type-Material.—Holotype ♂, "U.S.A.: CALIFORNIA:/Fresno Co. Sierra N.F./E.&W. Forks Camp 61 Cr./nr. Forebay Lk. 2200 m/T7S R26E Sec. 19.31/July 1979 D.D. Wilder," "D. Dee Wilder/Collection," "Holotype *Oreothalia sierrensis* Wilder 1980," "Calif. Acad. Sci. Type No. 13675." Allotype, ♀ with the same data. Holotype and allotype are deposited in the collection of the California Academy of Sciences.

Diagnosis.—Members of this species can be distinguished from all other *Oreothalia* adults by the following combination of character states: Large, hyaline wings with a dark, distinct stigma; long pale anteroventral and posteroventral hairs on femur III; halteres black; and distinctive male genitalia (Fig. 6).

Specimens Examined.—23, all paratypes. *California*: Fresno Co.: 5 ♂ 4 ♀, same date and locality as type; 1 ♂ 4 ♀, Huntington Lake along Bear Creek, 2100 m, August; 3 ♂, unnamed creek near Kaiser Pass, 2700 m, August; 1 ♂ Badger Flat Campground, 2500 m, August. Los Angeles Co.: 1 ♀, Windy Spring, June. Madera Co.: 2 ♂, Willow Meadow, 7550' [ca.

2500 m], Aug. Mono Co.: 1 ♂, 4 mi. E. Monitor Pass, June. Tuolumne Co.: 1 ♀ Clark's Fork River below Sand Flat, July (DDWC, CASC, WSUC).

Remarks.—This species has been collected from rocks and waterfalls in small, fast-flowing, clear mountain streams. The name, *sierrensis*, refers to the Sierra Nevada Mountains where most specimens have been collected.

Oreothalia chillcotti Wilder, NEW SPECIES

Figs. 3, 12

Description.—Body length 2.5 to 3.0 mm, general body color dull brown. *Head*: Occiput and front reddish-brown tomentose, postocciput and gena dull grey; face of male white, of female, brown. Antenna black, arista short, 3× length of the 3rd segment. *Thorax*: Notum uniform dull brown with faint greenish highlights, 2 lateral stripes visible on female. Five dorsocentrals, 1 humeral, 1 posthumeral, 1 notopleural with 1 or more long pale hairs, 1 intra-alar, 1 postalar, and 2 cruciate marginal scutellars with additional marginal hairs; pleuron and coxae dull grey tomentose, halter brown. *Legs*: Dark brown, femora lightly dusted greyish. Anterior femur with ventral spinelike setae irregularly spaced on apical ½, but uniformly shorter than tibia width; male with short, dark, erect setae on ventral surface of tibia. Tibia III with rows of dorsal and ventral, regularly arranged, hairlike setae, apical 1 or 2 slightly differentiated; basitarsis III with a few small, irregular setae. *Wing*: Fig. 3; pale brown, veins brown; stigma present, faint; anal vein present, evanescent; 2 basal costal bristles. *Abdomen*: brown tomentum dorsally, greenish grey laterally with a few sparse, pale hairs. Terminalia (Fig. 12) with dorsal process oval, polished, concave and strongly haired mesally.

Type-Material.—Holotype ♂, "Summit L. 12,800' [ca. 3900 m]/Mt. Evans, COLO./July 24 1961/W.R.M. Mason," "Holotype *Oreothalia chillcotti* Wilder 1980." Allotype, "Mt. Evans, COLO./Wet meadow 13,200' [ca. 4020 m]/4.VIII.1961/J. G. Chillcott," "Allotype *Oreothalia chillcotti* Wilder 1980." Both holotype and allotype are deposited in the Canadian National Collection of Insects.

Diagnosis.—Adults of this species can be distinguished from those of *pelops* and *spinitarsis* by the genitalia and the pale wings, and from those of *sierrensis* by the size, the pale halteres, the lack of the blue tomentum on the legs, and the short white hairs on femur III.

Specimens Examined.—Only one additional specimen (paratype) was examined: *Colorado*: Boulder Co.: ♀, Corona Pass, 10,600' [ca. 3230 m] (CNCI).

Remarks.—Although only three specimens were available for study, I feel this species is distinct enough to be described as new. The most closely related species, *sierrensis*, is different in several morphological characters and occurs only in and around the Sierra Nevada Mountains.

Oreothalia chillcotti is named for the late Dr. J. G. Chillcott who collected two of the three specimens examined.

ACKNOWLEDGMENTS

The following institutions and individuals loaned the material upon which this paper is based: P. H. Arnaud, Jr., California Academy of Sciences, San Francisco (CASC); H. J. Teskey, Biosystematics Research Institute, Agriculture Canada, Ottawa (Canadian National Collection, CNCI); H. V. Weems, Florida State Collection of Arthropods, Gainesville (FSCA); L. Knutson, IIBIII, U.S. Department of Agriculture (U. S. National Museum of Natural History, Washington, D.C., USNM); W. Turner, Washington State University, Pullman (WSUC); and N. E. Woodley, Harvard University, Cambridge, Massachusetts (NEWC). D. H. Kavanaugh kindly provided space and facilities at the California Academy of Sciences.

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THREE NEW SPECIES OF ANOBIIDAE FROM SOUTHWESTERN
UNITED STATES AND NORTHWESTERN MEXICO (COLEOPTERA)

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Abstract.—*Tricorynus dudleyae*, *Trichodesma fuliginosa*, and *Byrrhodes ovatus* are described as new. The new species are illustrated, and characters are given that distinguish them from their nearest relatives. For the first time illustrations of certain closely related species of the genus *Trichodesma* are presented for comparative purposes.

The new species described below are further contributions resulting from my studies on Anobiidae.

The species of *Tricorynus* was reared from *Dudleya edulis* (Nuttall) by Richard L. Westcott of the Oregon Department of Agriculture and is described so the name can be used in Westcott's studies on Buprestidae. The host plant is a succulent that is endemic to southern California and northwestern Baja California. A species of *Chrysobothris* (Coleoptera: Buprestidae) was also reared from the plant, and it, too, is undescribed.

Although pubescent patterns and other characters of members of *Trichodesma* generally allow species to be distinguished easily, the often subtle nature of these features makes it very difficult to describe them effectively. This makes the assigning of names on the basis of descriptions very risky; attempts to assign names are often in vain due to uncertainty of correct interpretation of a description. I have long felt that drawings are needed to best show the characters of these beetles, and in this paper I illustrate three closely related species of *Trichodesma*, one of which I describe as new.

The new species of *Byrrhodes* is from a collection of anobiids that was sent to me for identification.

The museum designations used herein are explained in acknowledgments.

Tricorynus dudleyae White, NEW SPECIES

Figs. 1, 2

Description.—*General*: Dorsal surface and metasternum reddish brown to dark reddish brown, head, abdomen, and sometimes elytral apex lighter

red brown. Pubescence dull yellowish, moderately dense, not obscuring surface sculpture. Body in profile stout and moderately elongated, not gibbous. Punctuation dual, large punctures at side of pronotum fine and dense, separated on an average by less than diameter of a puncture.

Head: Eyes separated by 2.2–2.7× vertical diameter of an eye, bulging to weakly flattened. Eighth antennal segment nearly 1.5× as long as wide. Last segment of maxillary palpus about 2× as long as wide.

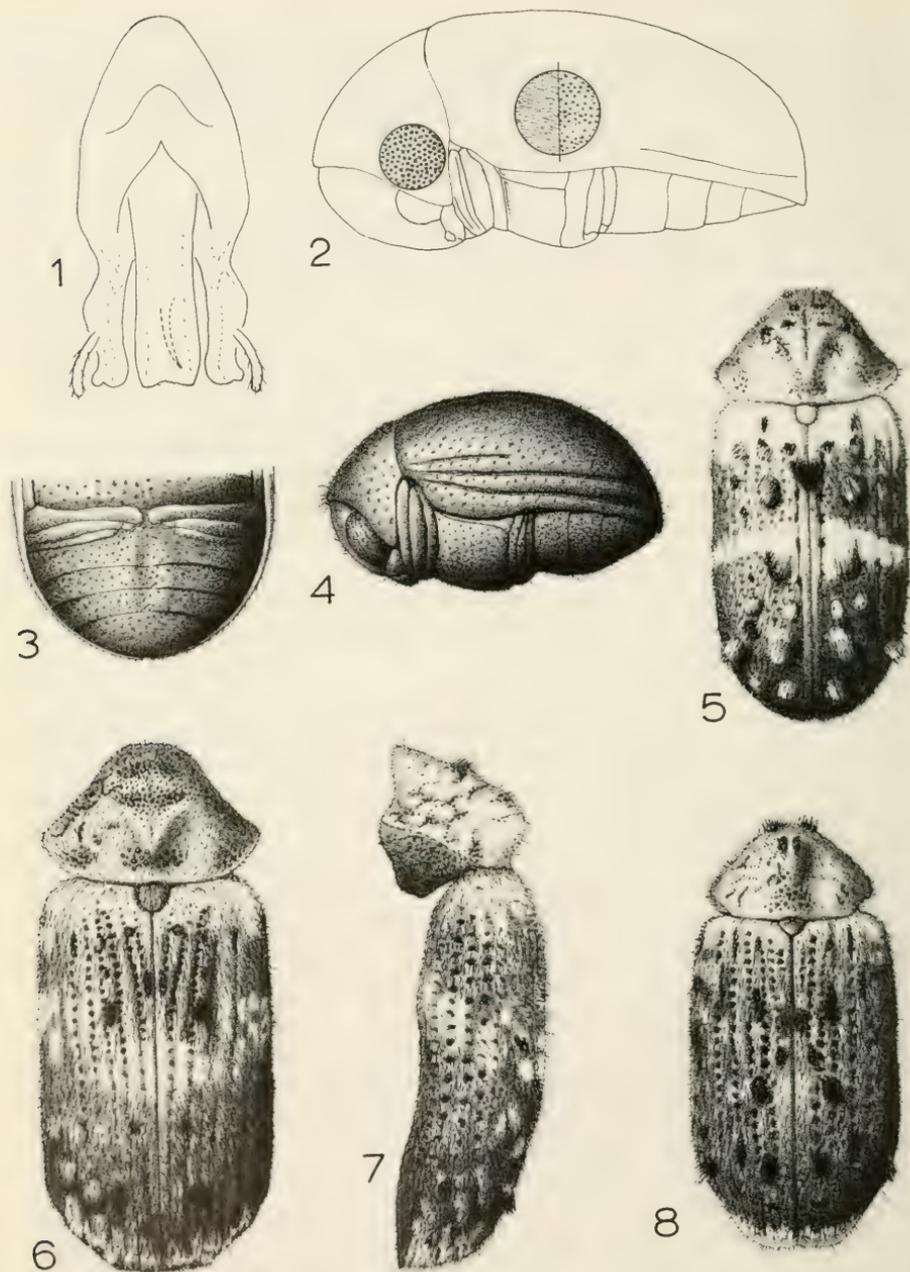
Dorsal surface: Pronotum at side moderately bulging above anterior angle, margin immediately above anterior angle not outwardly arcuate as usual, but depressed and nearly straight to (usually) weakly, inwardly arcuate. Large punctures of elytra with a feeble tendency to be aligned in longitudinal bands; at apical ½ of elytron laterally with a distinct stria, above this with a shallow, weakly indicated to almost completely obsolete groove.

Ventral surface: Anterior tibia bistrate; anterior groove more or less weak, not marginal, roughly ½ length of tibia; posterior groove very deeply impressed and broad, extending nearly entire length of tibia, not marginal; middle tibia not grooved. Metasternum at middle weakly rounded front to back, at side very strongly rounded front to back, most strongly rounded before posterior margin; larger punctures becoming distinctly smaller, sparser laterally, not attaining side; side anteriorly with an elongated, narrow fovea, with a small fovea internally.

Length: 2.6–3.7 mm.

Types.—Described from 29 specimens: ♂ holotype (USNM no. 76478) and 13 paratypes: *USA*, California, San Diego Co., Otay Mesa, Jct. Otay Valley and Heritage Roads, R. L. Westcott, reared from *Dudleya edulis*, coll. 9-V-1977, emerged 13-V to 29-VI-1977 (8 in USNM, 2 in CAS, 2 in LACM, 2 in UI) (holotype, 13-V). Fifteen paratypes: *Mexico*, Baja California, 1 mi. E. Rodriguez Dam, Hy. 2, km. 164, slopes above railroad, R. L. Westcott, 1 taken on 9-V-1977, 14 reared from *D. edulis* collected on 9-V-1977 and emerged 29-V to 20-VI-1977, 1 emerged 23-IV-1979 (13 in USNM, 1 in CAS, 1 in LACM). Paratypes have not been sexed because internal dissections are required to do this.

Remarks.—According to R. L. Westcott (personal communication) this beetle was reared from caudices of *Dudleya edulis* that had been killed by the boring of *Chrysobothris* or pyralid larvae, or by unknown causes. The plant occurs in the coastal sagebrush community of southwestern California and northwestern Baja California. Four or five other species of *Dudleya* were examined in Baja California, but none showed evidence of anobiid infestation. Although most of the adult beetles emerged within two months after the material was collected, one adult emerged two years later, and numerous live larvae were found in the plant remains in October 1979; the latter could have resulted from reinfestation, or from slowed development due to dry conditions in the laboratory.



Figs. 1-2. *Tricorynus dudleyae*. 1, Male genitalia, dorsal view. 2, Lateral view. Figs. 3-4. *Byrrhodes ovatus*. 3, Abdomen. 4, Lateral view. Figs. 5-8. *Trichodesma* spp. 5, *T. sordida*, dorsal view. 6, *T. fuliginosa*, dorsal view. 7, *T. fuliginosa*, lateral view. 8, *T. pictipennis*, dorsal view.

In my key to species of *Tricorynus* (White, 1965: 296), *T. dudleyae* runs to couplet 77 (which includes *T. obliteratus* White and *T. mancus* (Fall)) and is most nearly related to *T. obliteratus*. I offer the following modification of my key to accommodate *T. dudleyae*:

- 77(76). Large punctures at side of elytron confused, with no tendency to form bands; southern $\frac{2}{3}$ of California to northwestern Mexico *mancus* (Fall)
- Large punctures at side of elytron weakly to obscurely tending to form bands; extreme southern California, southern Arizona, and northwestern Mexico 77a
- 77a(77) Pronotum at extreme side nearly evenly rounded, not bulging; eyes separated by 1.5–2.1 \times vertical diameter of an eye; length 1.9–3.2 mm; extreme southern California, southern Arizona, and northwestern Mexico *obliteratus* White
- Pronotum at extreme side more or less clearly bulging; eyes separated by 2.2–2.7 \times vertical diameter of an eye; length 2.6–3.7 mm; southern California and northwestern Mexico *dudleyae*, new species

Other characters aid in distinguishing *T. dudleyae* from *T. obliteratus*. In *T. obliteratus* the pronotal margin immediately above the anterior angle is weakly depressed and straight or nearly so and farther up below the posterior angle is (as usual) outwardly arcuate. In *T. dudleyae* the pronotal margin immediately above the anterior angle is clearly depressed and often inwardly arcuate and farther up the margin is outwardly arcuate, so that in many specimens the entire pronotal margin between the anterior and posterior angles is sinuate from a posterior view. Also, the large punctures at the side of the pronotum are larger in *T. dudleyae* and are separated by, on an average, the diameter of a puncture or less, whereas in *T. obliteratus* they are separated by, on an average, the diameter of a puncture or a little more.

Trichodesma fuliginosa White, NEW SPECIES

Figs. 6, 7

Description.—*General*: Predominantly dark brown, this color determined largely by ground color not being concealed by mostly sparse pubescence. Pubescence of dorsal surface mostly dark brown to black, not dense, dark pubescence on elytra forming numerous small tufts; some pubescence tan, denser than dark pubescence, and concealing most of surface beneath it, tan pubescence most dense basally on pronotum, basally, medially, and apically on elytra. Bristling hairs short, not dense.

Head: Eyes large, bulging, separated by 1.4–1.5 \times vertical diameter of an eye, bearing bristling hairs. Tan pubescence not dense, granulate surface visible beneath. Antenna not long, if laid beside body extending from an-

terior tip of pronotum to basal $\frac{1}{4}$ of elytron; last 3 segments together about $1.5\times$ as long as basal 8 segments together. Last segment of maxillary palpus fusiform, about $2\times$ as long as wide; last segment of labial palpus fusiform, less than $2\times$ as long as wide.

Dorsal surface: Pronotum nearly as wide to as wide as elytra at base; lateral margin not toothed, weakly sinuate; in lateral view with a crest (Fig. 7); dark hairs forming a pair of feeble tufts between crest and anterior margin, tufts variable in development; large granules showing through pubescence, granules most dense on anterior half of pronotum. Elytra with large punctures more or less clearly aligned in rows; all dark elytral tufts small, first interval with 2 tufts, 3rd interval with 5 or 6, 5th interval with 3 or 4, often with 7th and 9th intervals each bearing a tuft before declivity; apex of elytra not truncate, nearly evenly rounded; lateral margin at apex sinuate.

Ventral surface: With tan pubescence that obscures but does not conceal surface; abdomen medially with numerous short, irregularly aligned series of granules, at sides and apex granules forming more distinct series; segments 3 and 4 produced at sides; segment 4 at middle flattened to shallowly concave, segment 5 at middle very broadly, shallowly concave.

Length: 4.3–5.8 mm.

Types.— δ holotype (USNM no. 76456) and 3 paratypes (USNM): USA, Texas, nr. Alamo, San. Ana Nat. Refuge, 18 Nov. 66, bl. lt., A. Blanchard; collected at black light. One paratype (USNM), Texas, near Brownsville, XI-22-1967, A. and M. E. Blanchard. One paratype (in Robert Turnbow collection), Texas, Starr Co., r.a. on 83, 4 mi. W. Sullivan City, R. Turnbow; on *Cordia boissieri* A. DC. I have not dissected the paratypes to determine the sex.

Remarks.—Of the described Mexican species, *T. fuliginosa* is most similar to *T. pictipennis* Champion (Fig. 8); there is a specimen of the latter in the USNM that I compared with the type in the British Museum (Natural History) in London. *Trichodesma pictipennis* occurs in Guatemala and southern Mexico (the USNM specimen is from the junction of Routes 190 and 195 in Chiapas, Mexico) and differs from *T. fuliginosa* in form and color. The pronotum is clearly narrower than the elytra basally, and the light-colored pubescence of the dorsal surface is predominantly tan but with patches of near white hairs before the elytral apex that are best seen in a near end-on view. In *T. fuliginosa* the pronotum is as wide as the elytra basally, and all light-colored pubescence of the dorsal surface is tan. The paired anterior tufts of dark hairs on the pronotum of *T. pictipennis* are much denser than the similar tufts of *T. fuliginosa*. The elytral margin of *T. pictipennis* is swollen and angulate apically on each side of the suture; in *T. fuliginosa* the margin is not swollen and is sinuate. As a final point of difference, the bristling hairs of *T. pictipennis* are longer than those of *T. fuliginosa*.

Trichodesma sordida Horn (Fig. 5), from Brownsville, Texas, is also similar to *T. fuliginosa*. However, it bears light-colored pubescence that is off white and densest basally on the pronotum, and basally, medially, and in scattered tufts apically on the elytra; also scattered tufts on the elytra are orange to brown. The light-colored pubescence of *T. fuliginosa* is tan, and all elytral tufts are black. In Fall's key to *Trichodesma* species (1905: 172), *T. fuliginosa* closely agrees with the notes given for *T. sordida*, but differs by the above characters.

Byrrhodes ovatus White, NEW SPECIES

Figs. 3, 4

Description.—*General*: Broadly oval, $1.4\times$ as long as wide. Body primarily bright reddish brown, but hue of dorsal surface nearly orange brown, and body margins often dark; antenna orange brown. Pubescence short, bristling, not obscuring surface, dull yellow; elytral disk with rows of hairs alternating in direction. Surfaces shining. Most surfaces punctured, punctures on elytra largest, weakly arranged in rows, punctures of pronotum and metasternum nearly comparable in size and density, those of abdomen smaller and sparser, those of head smallest and sparsest.

Head: Eyes large, separated by about their vertical diameter. Antenna apparently 9-segmented (intermediate segments minute), 7th segment wider than long, apical margin markedly sinuate, 8th segment a little less than $2\times$ as long as wide, 9th segment a little over $2\times$ as long as wide. Last segment of maxillary palpus subtriangular, almost $2\times$ as long as wide, apical margin nearly straight; last segment of labial palpus subtriangular, a little longer than wide, apical margin broadly notched.

Dorsal surface: Pronotum at side weakly convex. Elytron at side with 2 deep grooves, extending from above fovea for middle leg almost to suture at apex, lower groove a little longer than upper groove, interval between grooves distinctly convex except near base, with a short, distinct, 3rd, subhumeral groove extending to level of hindcoxa, interval between 2nd and 3rd grooves convex.

Ventral surface: Metasternum lacking a median fovea, but with a weakly impressed, longitudinal groove from near middle to apex; anterior metasternal lobe constricted by tarsal grooves. Abdominal sutures 2, 3, and 4 most distinct at sides, weaker but evident at middle, sutures evenly arcuate or only 2nd feebly bisinuate; surface near middle concave, each side of concavity produced and rounded, produced portion most distinct on 3rd segment, but continued on 2nd and 4th segments.

Length: 1.7 mm.

Types.—Holotype (δ ?; no. 76483 in USNM) and one paratype (C DFA): USA, Arizona, S.W.R.S., Cochise Co., 5400', 5 mi. W. Portal, 1975, shelf fungus off walnut. The initials refer to the Southwestern Research Station.

Remarks.—This species is most closely related to *B. granus* (LeConte.) and in my key (White, 1973: 53) runs to *granus* at couplet 4. *Byrrhodes ovatus* differs from *B. granus* as follows: The length of *B. ovatus* is 1.7 mm, the abdomen is concave medially and protuberant on each side of the concavity, and it occurs in Arizona. *Byrrhodes granus* is 1.3–1.5 mm long, the abdomen is neither concave nor protuberant medially, and it occurs only in southern Florida. I consider the abdominal characters of *B. ovatus* as possibly sexual; therefore, both the holotype and paratype may be males. Because of the tightly fitting body parts and small size of this species, I have not dissected the genitalia; the chance of permanent damage to the specimens is too great.

ACKNOWLEDGMENTS

My thanks are offered to Richard L. Westcott, Oregon Department of Agriculture, Salem for donation of specimens and biological data; Fred Andrews, California Department of Food and Agriculture, Sacramento (CDFA) for loan of specimens and allowing retention of a holotype; and Robert Turnbow, Jr., Department of Entomology, Texas A. and M. University, College Station, Texas, for loan of a specimen. Other museum designations used herein follow: USNM, United States National Museum of Natural History, Washington, D.C.; CAS, California Academy of Sciences, San Francisco; LACM, Los Angeles County Museum of Natural History, Los Angeles, California; UI, University of Idaho, Moscow.

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**NEOMACHLOTICA, A NEW GENUS OF GLYPHIPTERIGIDAE
(LEPIDOPTERA)**

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Abstract.—*Neomachlotica*, new genus, and *N. spiraea*, new species, are described in Glyphipterigidae. Species transferred to *Neomachlotica* are *Glyphipterix actinota* Walsingham, *Machlotica atractias* Meyrick, and *Machlotica nebras* Meyrick, all Neotropical. *Neomachlotica spiraea* occurs in Florida, and the larvae feed on *Boehmeria cylindrica* (Linnaeus) Schwarz (Urticaceae).

In anticipation of a synopsis of Glyphipterigidae, the following new generic name is published here ahead of a Nearctic revision of the family to make this name available for three Neotropical species currently misplaced in other genera.

Neomachlotica Heppner, NEW GENUS

Type-species.—*Neomachlotica spiraea* Heppner, new species.

This genus may be distinguished from related genera like *Abrenthia* Busck and *Machlotica* Meyrick by the convergent veins CuA1 and CuA2 at the termen of the forewing.

Description.—Adults small (forewing length 3.0–4.0 mm). *Head*: Frons and vertex smooth scaled; labial palpus recurved and very dorsoventrally flattened on apical 2 segments, with basal and 2nd segments subequal in length, apical segment twice as long as basal segment; maxillary palpus 3-segmented with very long 2nd segment; anterior tentorial pits widely separated (Fig. 2); haustellum developed; pilifers large; eye large; ocellus present; antenna filiform. *Thorax*: Smooth scaled; forewing oblong, with pterostigma; costal margin straight to pterostigmal convexity, then rounded to apex; termen very oblique to indistinct tornus; dorsal margin straight to rounded anal angle; chorda developed, with central vertical vein; no vein in cell; Sc to costal margin before $\frac{1}{2}$ of forewing length; R1–R5 to costal margin; M1 to apex; M1–M3 equidistant at end of cell; CuA2 arising distant from end of cell and greatly convergent to CuA1 at termen; CuP present at

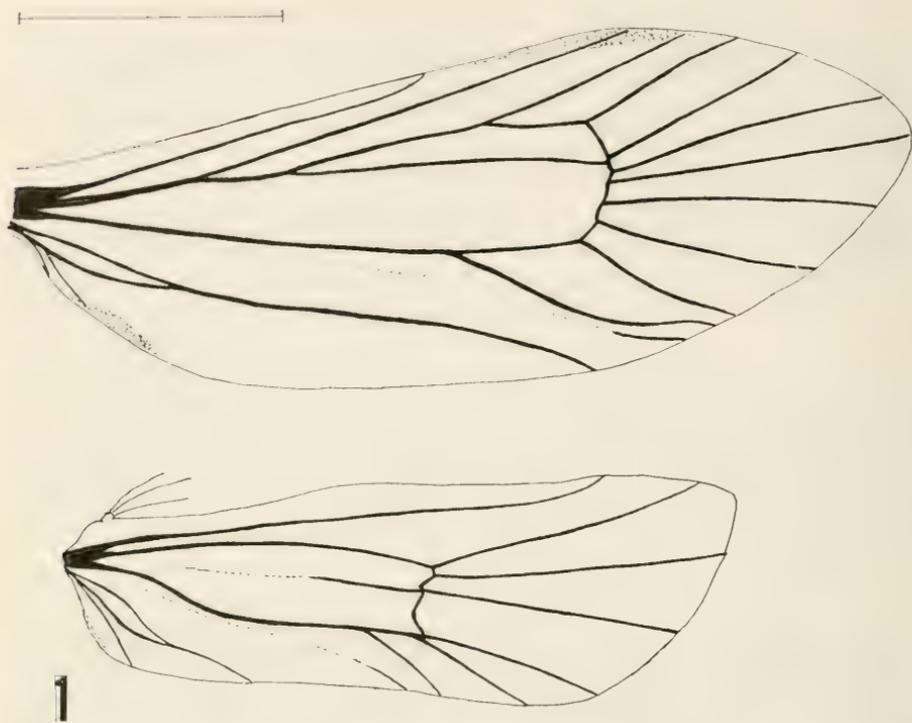


Fig. 1. *Neomachlotica spiraea*, wing venation (scale line = 1 mm) [USNM slide 77225].

tornus; A1 + A2 with prominent basal stalk; hindwing with Sc + R1 to $\frac{3}{4}$ of wing; Rs directed up to costal margin before apex; M1 and M2 close together at end of cell, distant from M3; M3 approximate to CuA1 at end of cell; CuA2 nearly parallel to CuA1; A1 + A2 with long basal stalk. *Abdomen*: Posterior segment modified in male as genitalia hood with ventral split; no coremata. *Male genitalia*: Tegumen stout and fused with broad vinculum; saccus absent; tuba analis prominent; valva simple, setaceous mesally, with large corema (deciduous) on lateral side near base; valval base formed into elongate dorsal transtillar process and ventral process forming base of anellus; anellus a short tube with aedeagus attached at tip of anellus; aedeagus without a phallobase, with enlarged tip having a ring of recurved hooks and a band of spines and setae. *Female genitalia*: Ovipositor with moderately heavily sclerotized papilla analis; apophyses moderately long; ostium bursae a sclerotized cup with a central cone on intersegmental membrane between segments 7 and 8, or simple and in proximity to ductus bursae enlargement; ductus bursae thin, membranous, usually expanded before bursa by enlargement for juncture with ductus seminalis; bursa cop-

ulatrix ovate, with smaller accessory bursa anteriorly; signum on main bursal sac, a line of fused spicules or more diffuse spicule patch; ductus seminalis arising from enlarged section of ductus bursa; bulla seminalis small. *Larva*: Small; prolegs vestigial (Needham, 1955). *Pupa*: Not protruded (Needham, 1955).

Remarks.—*Neomachlotica* is related to *Machlotica*, *Abrenthia*, and *Trapeziophora* Walsingham, and is largely a Neotropical genus with only the type-species entering North America in southern Florida. Two species, currently undescribed, are known from northeastern Mexico and may eventually be collected in subtropical southeastern Texas. Wing venation and the unusual characters of the genitalia form the main differences from related genera. In none of the above three related genera are veins CuA1 and CuA2 of the forewings convergent at the wing margin as in *Neomachlotica* and the other genera also do not have the unique genital characters of *Neomachlotica*: The unusual aedeagus and transtillar process of the male and the conelike ostium of the female (in most *Neomachlotica* females). The only genus I have seen that has a similar conelike ostium in females is in the genus *Brenthia* Clemens of the family Choreutidae.

The only biological information known is that the Florida species described below feeds on *Boehmeria cylindrica* (Linnaeus) Schwarz (Urticaeae) as a terminal bud- and stem-boring larva (Needham, 1955).

The following Neotropical species are hereby transferred to *Neomachlotica*:

Neomachlotica actinota (Walsingham, 1914) (*Glyphipteryx* [sic]), NEW COMBINATION.

Neomachlotica atractias (Meyrick, 1909) (*Machlotica*), NEW COMBINATION.

Neomachlotica nebras (Meyrick, 1909) (*Machlotica*), NEW COMBINATION.

Together with the new species described below, there are four described species in the genus. I have examined three additional undescribed species from Mexico and the West Indies that also belong in *Neomachlotica*.

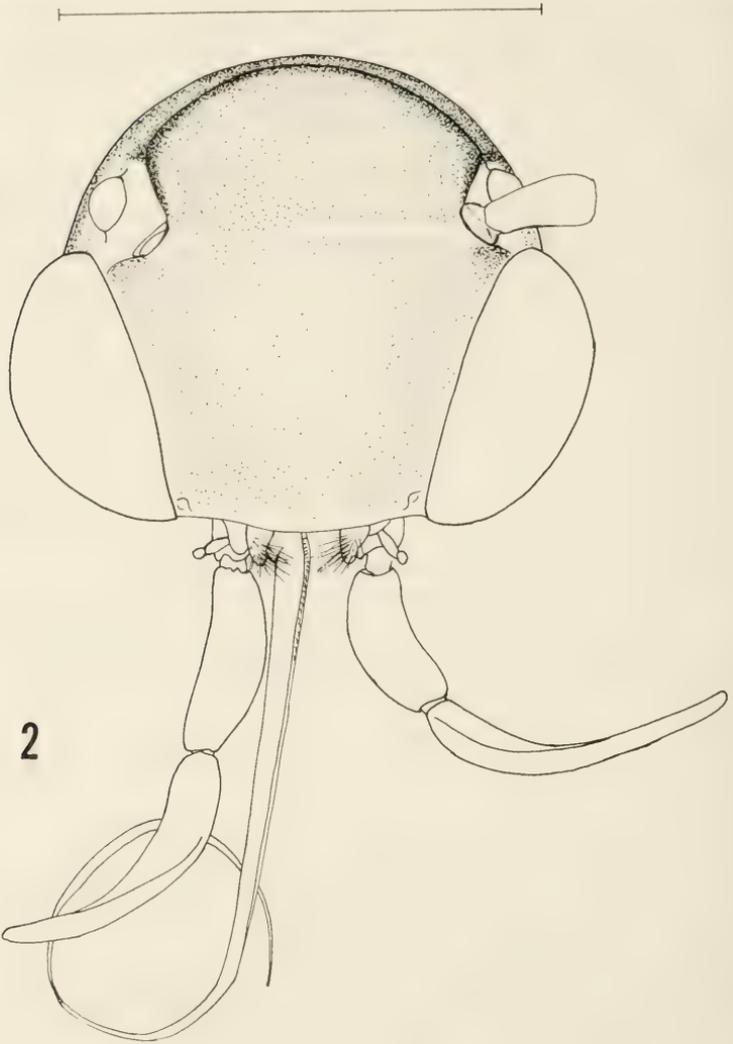
The name of the genus is derived from the Greek for "new *Machlotica* [fighting lotus]."

Neomachlotica spiraea Heppner, NEW SPECIES

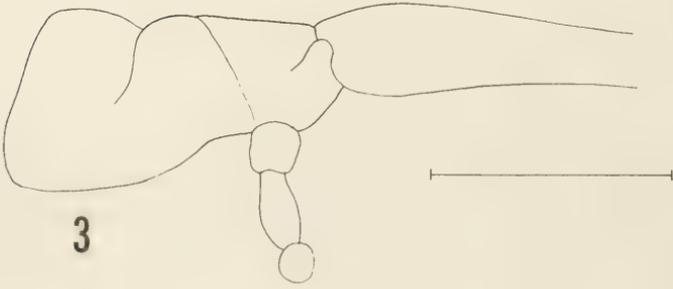
Machlotica n. sp., Needham, 1955: 351.

Machlotica sp., Kimball, 1965: 287.

Male.—Forewing length 3.2–4.0 mm. *Head*: Dark fuscous with purple iridescence; frons with buff along clypeal and lateral edges; labial palpus with basal segment buff, 2nd segment dark fuscous with 2 buff transverse lines ventrally and buff dorsally, and apical segment fuscous dorsally and



2



3

dark fuscous ventrally with buff lateral borders; maxillary palpus with very elongate middle segment (ca. twice length of basal segment); antenna with fuscous dorsal scales. *Thorax*: Fuscous; patagia fuscous with purple iridescence; venter white; legs fuscous with white at joints. *Forewing*: Dark fuscous with approximately 14 narrow dotted longitudinal striae of greenish yellow from base to middle of wing, with distal end of striae field convex; dorsal margin near base with yellow scale line; middle of wing with distally convex fuscous fascia, bordered distally by a short silver fascia from the costal margin and greenish-yellow scale striae towards tornus; middle silver fascia from costa followed by yellow longitudinal striae and then by two more short silver fasciae toward apex; apex and part of termen with silver border; fringe fuscous; ventral surface gray fuscous. *Abdomen*: Fuscous with silvery scales on posterior margin of each segment; venter mostly white. *Hindwing*: Gray fuscous basally merging to fuscous near termen; fringe fuscous; ventral surface buff gray merging to fuscous near apex, with 3 silver short fasciae from costal margin near apex. *Genitalia*: Tuba analis long, wide; tegumen rounded; vinculum rounded, convex, without saccus; valva elongate, oblong, with rounded apex, setaceous; valva with coremata setae on lateral side; base of valva extended as narrow transtilla, overlapping with same from each valva; anellus short, tubular; aedeagus short, nearly subequal to valval length, narrow, without phallobase; aedeagus tip bulbous with wide ring of stout recurved hooks surrounded by spicule hood; cornutus a short tubule; ductus ejaculatorius emergent from base of aedeagus, with campanulate hood.

Female.—Forewing length 3.2–3.5 mm. Similar to male. *Genitalia*: Ovipositor short; papilla analis sclerotized with sharp, incurving tip; apophyses long, thin, with posterior pair slightly longer than anterior pair; ostium bursae a shallow cup with a central cone having a very small ostial opening, all in a larger oval depression bordered laterally by 2 semi-circular ridges; ductus bursae long and as wide as ostial opening, to sclerotized bulbous area near bursa where ductus seminalis emerges; bursa copulatrix ovate with an accessory bursa half its size attached anteriorly by a short duct; signum a linear fused spicule line on ventrum of bursa, $\frac{1}{2}$ as long as longer bursal diameter.

Larva.—Pale, with black head capsule and prothoracic tergal plate; prolegs vestigial (Needham, 1955).

Pupa.—Lacking dorsal abdominal setae, probably due to nonprotrusion from cocoon (Needham, 1955).

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Figs. 2–3. *Neomachlotica spiraea*. 2, Head (scale line = 0.5 mm). 3, Maxillary palpus (enlarged) (scale line = 0.1 mm) [USNM slide 77721].

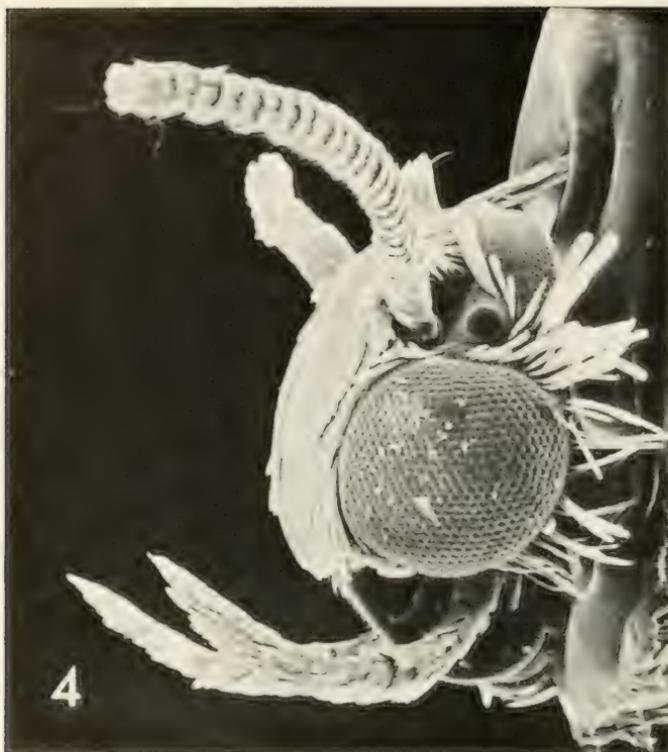


Fig. 4. *Neomachlotica spiraea*, head of male (100 \times) [SEM slide, USNM 77342].

Types.—*Holotype* ♂: Fisheating Creek, 2 mi. SE Palmdale, Glades Co., Florida, 6 May 1975, on flowers *Pluchea purpurascens*, J. B. Heppner (USNM). Paratypes (3 ♂, 5 ♀). *Florida*: Dade Co.: Florida City, 21 Feb 1954 (2 ♀), M. O. Gleen (USNM); 25 Feb 1954 (1 ♂), M. O. Glenn (USNM). Glades Co.: same date as for holotype (1 ♀) (JBH). Highlands Co.: Archbold Biological Sta., 12 Jan 1965 (1 ♂), S. W. Frost (CPK); 23 Jan 1979, (1 ♂), H. V. Weems, Jr. and S. Halkin (FSCA); 3 Mar 1952, reared ex *Boehmeria cylindrica* (emerged 27 Mar 1952), (2 ♀), J. G. Needham (USNM). (Paratype to BMNH.)

Additional specimens (3 ♂).—*Florida*: Monroe Co.: Garden Key, Dry Tortugas, 8 May 1961, R. E. Woodruff (CPK and FSCA).

Distribution.—Known only from central to southern Florida.

Flight period.—January to March; May.

Hosts.—*Boehmeria cylindrica* (Linnaeus) Schwarz (Urticaceae).

Biology.—The species has been reared by Needham (1955) but no larval or pupal specimens could be located in museum collections. The larva is a

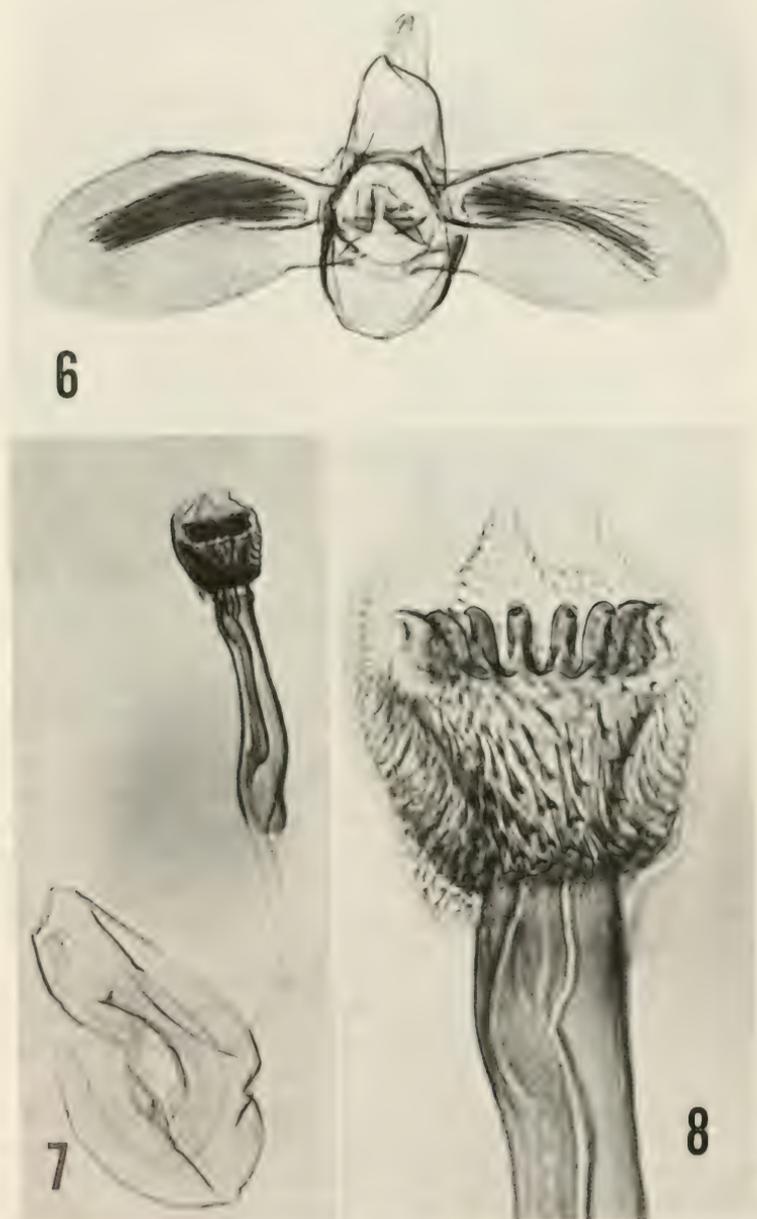


Fig. 5. *Neomachlotica spiraea*, female paratype, Fisheating Cr., Glades Co., Florida.

terminal bud borer according to Needham, entering the terminal portion of the stem as well. Needham noted that a gall is formed where the larva feeds extensively in the stem. The terminal bud of the host, together with young leaves, is tied with silk. Pupation is near the bud or away from the host plant in a protected area. The cocoon is a fluted structure of amber silk formed as a filigreed network of strands according to Needham (1955); this is very similar to cocoons of *Ussara* species, a genus of mostly Neotropical Glyphipterigidae.

More recently adults were collected while feeding on flowers of *Pluchea purpurascens* (Schwartz) de Candolle (Compositae) in an open cypress swamp along Fisheating Creek, Florida, from which series the holotype was selected.

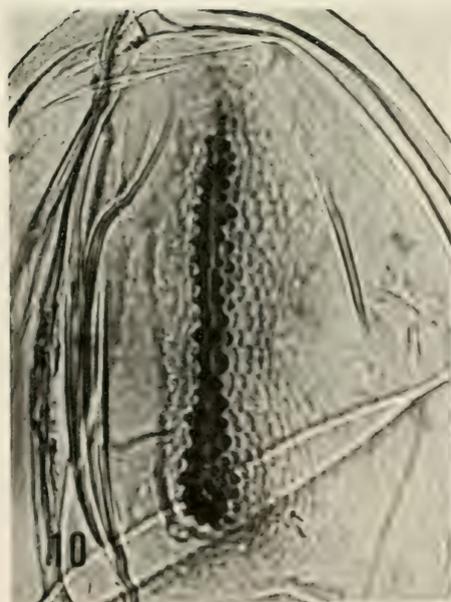
Remarks.—Available specimens of *Neomachlotica spiraea* show no marked variations in wing pattern or coloration. As noted under the generic discussion, there are several species in Mexico, Central and South America, that superficially are very similar to *N. spiraea* but that have distinct genitalia. The specimens of *N. spiraea* from the Dry Tortugas are too poor to designate as paratypes but appear to be the same species as the mainland specimens. Until the species is reared again, no further details of the immature stages can be given.



Figs. 6-8. *Neomachlotica spiraea*, male holotype. 6, Male genitalia. 7, Aedeagus (enlarged). 8, Detail of tip of aedeagus (Fisheating Cr., Glades Co., Florida) [USNM slide 77151].



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Figs. 9-11. *Neomachlotica spiraea*, female paratype (Fisheating Cr., Glades Co., Florida).
9, Female genitalia. 10, Signum detail. 11, Ostium detail [USNM slide 77152].

The specific name, *spiraea*, is derived from Latin for "the meadow-sweet."

ACKNOWLEDGMENTS

My colleagues D. R. Davis and J. F. G. Clarke, Smithsonian Institution, kindly reviewed the manuscript for this report. Field studies involved in the collection of some of the type-series were facilitated by the Department of Entomology and Nematology, University of Florida, and D. H. Habeck, of the same institution. Collections consulted include the C. P. Kimball Collection, Barnstable, Massachusetts (CPK); British Museum (Natural History), London, England (BMNH); Florida State Collection of Arthropods, Gainesville (FSCA); Smithsonian Institution, Washington, D.C. (USNM); and J. B. Heppner Collection, Washington, D.C. (JBH).

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TERMINALIA OF NORTH AMERICAN SPECIES OF GROUP II
MEGASELIA (APHIOCHAETA), AND DESCRIPTIONS OF
FOUR NEW SPECIES (DIPTERA: PHORIDAE)

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Abstract.—In the large genus *Megaselia*, the male epandrium and hypandrium, and the female tergum and sternum 6 provide excellent distinguishing characters. This work presents a diagnosis and figures of the male and female terminalia of the following species of the subgenus *Aphiochaeta*: *Megaselia aequalis* (Wood), *M. amplicornis* Borgmeier, *M. atratula* Borgmeier, *M. basispinata* (Lundbeck), *M. carola*, new species, *M. cirripes* Borgmeier, *M. diplothrix* Borgmeier, *M. ectopia* Borgmeier, *M. fungivora* (Wood), *M. lanata*, new species, *M. meconicera* (Speiser), *M. monticola* (Malloch), *M. perdita* (Malloch), *M. pilicrus* Borgmeier, *M. pleuralis* (Wood), *M. rotunda*, new species, and *M. ungulata*, new species. Four new synonymies are proposed.

Although the North American *Megaselia* species have been revised by Borgmeier (1964, 1966), there is still difficulty in accurately determining some of the species. Borgmeier provided descriptions and keys for about 260 *Megaselia* species, but detailed descriptions and figures of the external terminalia of the male and female were not included. Robinson (1978) provided a brief diagnosis and detailed figures of male (epandrium and hypandrium) and female (tergum and sternum 6) terminalia of *Megaselia* species in Borgmeier's (1964) Group I.

The purpose of this work is to provide a brief diagnosis and the first detailed figures of the male and female terminalia of the *Megaselia* species in Group II of Borgmeier. Four new species are described: *Megaselia* (*Aphiochaeta*) *carola*, *M. (A.) lanata*, *M. (A.) rotunda*, and *M. (A.) ungulata*.

MATERIALS AND METHODS

This work is based on the study of 700 Nearctic specimens of Group II *Megaselia*. Specimens were seen from most states and provinces of the United States and Canada, but not from Greenland and Mexico. I have

examined, or received information on the holotypes of all the Nearctic species of Group II. Specimens of the type-series of Holarctic species were not available for examination at this time. Information on original descriptions and synonymies can be found in Borgmeier (1964).

The methods used for removing and preparing terminalia for study were similar to those used by other workers. Terminalia were permanently stored in 4×11 mm plastic vials, partially filled with glycerine and capped with rubber stoppers, and placed on the same pin as the insect.

EXTERNAL TERMINALIA OF *MEGASELIA*

A brief description and illustration of the male terminalia was presented by Robinson (1978). A description and illustration of the female terminalia is presented here.

The oviscapt of the female (Fig. 1) consists of an elongate ovipositor that telescopes within segment 6. The ovipositor is entirely membranous, never forming a horny, nonretractile stylet. Terga and sterna 7 and 8 are reduced and sometimes absent. The cerci are distinct and bear numerous setae.

GROUP II *MEGASELIA* (*APHIOCHAETA*)

Group II contains 17 described species occurring in the Nearctic Region, including four described as new in this paper. The species in this group can be distinguished by the character combination: Scutellum with 2 bristles; mesanepisternum with 1 or more bristles; and costa 44–55% of wing length.

Females are known for seven Group II species. Biological information is available for a few of the Nearctic species, including *M. aequalis* (Wood), *M. fungivora* (Wood), *M. meconicera* (Speiser), *M. perdita* (Malloch), and *M. pleuralis* (Wood).

I examined the holotype of *M. franconiensis* (Malloch) and noted that the costa is 42% of the wing length. In the male of *M. ventralis* Borgmeier the costa is 41% of the wing length. Both these species are best placed in Group III.

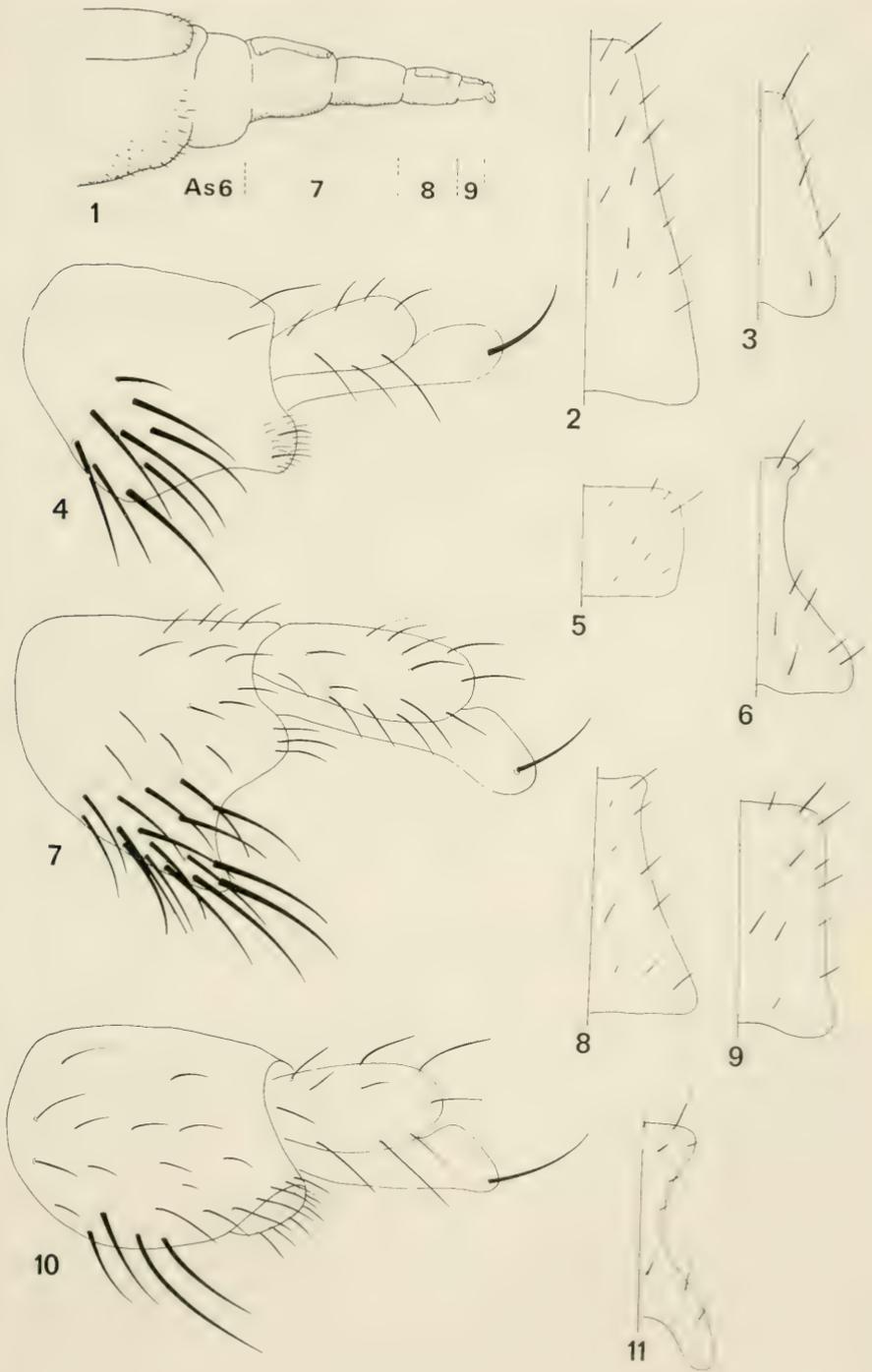
Megaselia (*Aphiochaeta*) *aequalis* (Wood)

Figs. 2, 20, 24

Aphiochaeta nasoni Malloch, 1914: 58. NEW SYNONYMY.

Megaselia (*Aphiochaeta*) *confulgens* Borgmeier, 1964: 203–204. NEW SYNONYMY.

Figs. 1–11. *Megaselia* spp., terminalia. 1, *Megaselia* sp., female terminalia. 2, *M. aequalis*, female tergum 7. 3, *M. meconicera*. 4, *M. ungulata*, male epandrium. 5, *M. ungulata*, female tergum 7. 6, *M. fungivora*, female tergum 7. 7, *M. atratula*, male epandrium. 8, *M. pleuralis*, female tergum 7. 9, *M. pilicrus*, female tergum 7. 10, *M. amplicornis*, male epandrium. 11, *M. perdita*, female tergum 7. As 6 = abdominal segment 6; 7 = abdominal segment 7; 8 = abdominal segment 8; 9 = abdominal segment 9.



Diagnosis.—This species differs from other Nearctic Group II species by the character combination: Halter yellowish brown; costa 43–45% of wing length; costals short; frons generally glossy. *Terminalia*: Epandrium (Fig. 20) narrow dorsally, with scattered setae and 3–5 particularly long bristles ventrally; hypandrium (Fig. 24) setulose, lobe broad at base and with long setulae at apex. *Oviscapt*: Tergum VII (Fig. 2) long and slightly narrow apically setulose on apical $\frac{1}{3}$; sternum VII long and narrow, with 3 apical setae and scattered setulae on apical $\frac{1}{5}$.

Known distribution.—British Columbia, District of Columbia, Illinois, Indiana, Iowa, Maine, Manitoba, Massachusetts, Nebraska, New Hampshire, New York, North Carolina, Ohio, Ontario, Pennsylvania, Quebec, Saskatchewan, Tennessee, Virginia, Wisconsin.

Material Examined.—124 ♂, 125 ♀.

Remarks.—Variation in the male and female body color and the occurrence of an abbreviated 4th abdominal segment in the female has caused confusion between *M. nasoni*, *M. confulgens*, and *M. aequalis*. Close examination and comparison of the male and female terminalia show there is apparently one species involved.

Biology.—This species apparently is restricted to feeding on the eggs of the slug, *Deroceras laevae* (Muller). The female oviposits directly onto the slug eggs or occasionally onto nearby vegetation. The first-instar larva penetrates the outer gelatinous covering of the egg and begins feeding on the perivitelline fluid. The first-instar larva does not feed on the developing slug embryo. The second-instar larva also remains within the egg, but it usually destroys the embryo. The third-instar larva feeds on 4–6 slug eggs. When full grown the third-instar larva abandons the slug eggs and pupariates in the soil. For a more detailed description of the life history and immature stages, see Robinson and Foote (1968).

Megaselia (Aphiochaeta) perdita (Malloch)

Figs. 11, 16, 41

Diagnosis.—This species differs from other Nearctic Group II species by the character combination: 2 notopleural bristles; 1 weak intra-alar; mesanepisternum with 1 bristle. *Terminalia*: Epandrium (Fig. 16) with short projection beneath proctiger, 3–4 bristles posterolaterally; hypandrium (Fig. 41) small, setulae sparse laterally, lobe setulose. *Oviscapt*: Tergum VII (Fig.

→

Figs. 12–20. *Megaselia* spp., male terminalia. 12, *M. carola*, male epandrium. 13, *M. monticola*, male epandrium. 14, *M. diplothrix*, epandrium. 15, *M. basispinata*, epandrium. 16, *M. perdita*, epandrium. 17, *M. fungivora*, epandrium. 18, *M. cirripes*, epandrium. 19, *M. meconicera* hypandrium. 20, *M. aequalis*, epandrium.



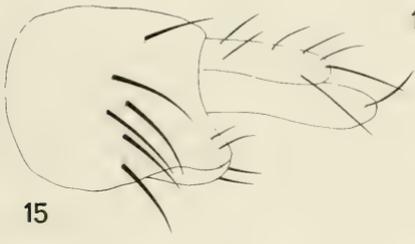
12



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11) inverted Y-shaped, 1 seta at apical corners and on each fork of the Y, scattered setulae laterally; sternum VII narrow, clavate, with 2 long and 2 short spical setulae; tergum VIII short, broad and setulose laterally.

Known distribution.—Arizona, Florida, Iowa, Kansas, Maryland, New York, North Carolina, Ontario, Quebec, South Carolina, Texas, Virginia.

Material examined.—22 ♂, 25 ♀.

Biology.—Borgmeier (1964) speculated that the male of this species was myrmecophilous. Muma (1954) reported that the larva of *Megaselia* sp. (which I later determined to be *M. perdita*) is predaceous on a land snail. I have collected *M. perdita* females in jar traps baited with rotten cheese. The females oviposited on the cheese and the resulting larvae fed on it. Apparently the adults are not restricted to associating with ants, and the larvae are probably able to develop in a variety of substrates.

Megaselia (Aphiochaeta) amplicornis Borgmeier

Figs. 10, 31

Diagnosis.—The male differs from other Nearctic Group II species by the character combination: Halter dark brown; costa 46–47% of wing length; antenna enlarged to $\frac{1}{5}$ – $\frac{1}{6}$ frontal width. *Terminalia*: Epandrium (Fig. 10) with scattered setae and 4–5 bristles ventrally; hypandrium (Fig. 31) with scattered setulae, bilobed, lobes small and setulose.

Known distribution.—British Columbia, California, Ontario, Quebec, Washington.

Material examined.—5 ♂.

Megaselia (Aphiochaeta) atratula Borgmeier

Figs. 7, 30

Diagnosis.—This species differs from other Nearctic Group II species by the character combination: Halter brown to blackish brown; forebasitarsus as broad as apex of foretibia; palpus narrow and with bristles only at apex. *Terminalia*: Epandrium (Fig. 7) strongly arched and with strong bristles posteroventrally at left; hypandrium (Fig. 30) setulose, lobe small and setulose. *Oviscapt*: Tergum VII broad, slightly arched basally, 6 apical setulae and scattered setulae on apical $\frac{1}{6}$.

Known distribution.—British Columbia, New Hampshire, North Carolina, Quebec.

Material examined.—3 ♂, 1 ♀.

Remarks.—The holotype is in poor condition; the palps and many important setae are missing or broken. This species is close to *M. scopalis* Brues and *M. aciculata* Borgmeier (Group III), but differs by the long costa and normal-sized antenna.

Megaselia (Aphiochaeta) basispinata (Lundbeck)

Figs. 15, 32

Diagnosis.—The male differs from other Nearctic Group II species by the character combination: Halter yellowish brown; costa 44–52% of wing length; costals long; hindfemur with 2 rows of 4–6 bristles on basal $\frac{1}{3}$. *Terminalia*: Epandrium (Fig. 15) with 6–8 strong bristles; hypandrium (Fig. 32) setulose, lobe large, serrate apically. Female unknown.

Known distribution.—Alaska, Arizona, California, District of Columbia, Iowa, Massachusetts, Michigan, Minnesota, Missouri, Montana, New Hampshire, New York, Oregon, Quebec, South Dakota, Utah, Washington, Wisconsin.

Material examined.—32 ♂.

Megaselia (Aphiochaeta) carola Robinson, NEW SPECIES

Figs. 12, 29

Diagnosis.—The male differs from other Nearctic Group II species by the character combination: Palpus narrow and straight ventrally; forebasitarsus enlarged; mesanepisternum with numerous short bristles. Female unknown.

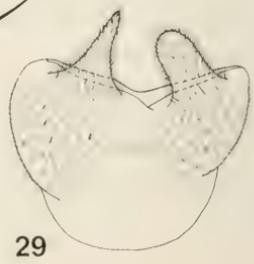
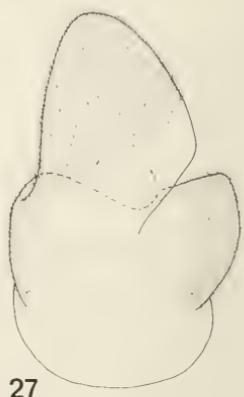
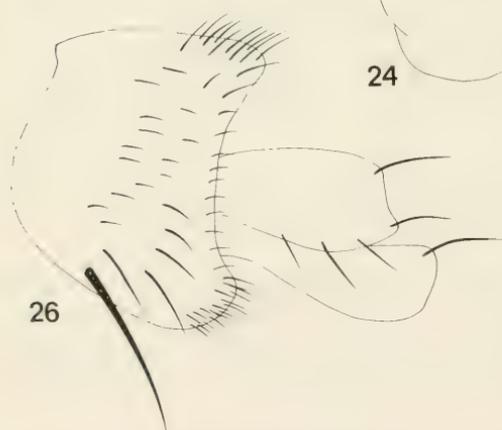
Description of male.—Body brown to blackish brown. Frons subshining, setulae distinct, as wide as high; supra-antennals equal, as long as lower fronto-orbital bristle upper as far as preocellar from coronal suture; lower fronto-orbital bristle closer to anterior fronto-orbital bristle than to upper supra-antennal. Parafacia with 3 bristles. Third antennal segment dark brown. Palpus narrow and straight ventrally.

Thorax brown; propleuron without scattered setulae; 4 propleural bristles, 2 dorsal propleural bristles; mesanepisternum with 10 short bristles. Scutellum with 2 bristles.

Abdominal terga and venter brown. Terminalia dark brown, setose, procotiger pale brown; epandrium (Fig. 12) with 7–9 bristles posteroventrally at left, right side large and curved outward forming a groove; hypandrium (Fig. 29) with setulae in groups of 3 or 4, bilobed and each lobe small and with long setae.

Legs brown; foretibia slightly enlarged apically, small anterodorsal bristles; 12 posterodorsal bristles; forebasitarsus broad and dorsoventrally flattened, larger than base of foretibia. Midtibia with 8 short anterodorsal bristles, posterodorsal bristles small, hair seam extending to $\frac{1}{6}$; midbasitarsus with 1 strong bristle at basal $\frac{1}{3}$. Hindfemur with 6–8 setae ventrally on basal $\frac{1}{4}$; hindtibia with small anterodorsal bristles, 12 weak posterodorsal bristles.

Wing 1.48 mm long; membrane hyaline, veins brown; costa 44% of wing length; ratio of first 2 costal divisions 1:1; costal bristles long; 3 axillary bristles. Halter dark brown.



Material examined.—Holotype.

Holotype.—♂, Mound Valley, State Experiment Station, Labette Co., Kansas, V-15-1965, Malaise trap, G. J. Williams. Deposited in the U.S. National Museum of Natural History, type no. 76565.

Megaselia (Aphiochaeta) cirripes Borgmeier

Figs. 18, 33

Diagnosis.—The male differs from other Nearctic Group II species by the character combination: Halter yellowish brown; costa 47–49% of wing length; costals long; hindfemur with 10–12 curved bristles ventrally on basal ½. *Terminalia*: Epandrium (Fig. 18) with a few short bristles posteriorly and 4–6 longer and stronger bristles posteroventrally; hypandrium (Fig. 33) setulose. Female unknown.

Known distribution.—Idaho, Iowa, Ontario, Washington.

Material examined.—9 ♂.

Remarks.—This species seems very close to the Palearctic species *M. stichata* (Lundbeck); both possess curved bristles with bent apices on the hindfemur.

Megaselia (Aphiochaeta) diplothrix Borgmeier

Figs. 14, 34

Diagnosis.—The male differs from other Nearctic Group II species by the character combination: Halter yellowish-brown; 2–3 mesanepisternal bristles; 2 strongly curved bristles at base of hindfemur. *Terminalia*: Epandrium (Fig. 14) with row of 6 bristles laterally and 2 short bristles beneath proctiger; hypandrium (Fig. 34) setulose laterally at right, lobe large and cleft, with scattered setulae apically. Female unknown.

Known distribution.—Maryland, Quebec, Tennessee, Virginia

Material examined.—8 ♂.

Remarks.—The type is in poor condition; one antenna, both palpi and the proctiger are missing. I do not consider the two females from Falls Church, Virginia, mentioned by Borgmeier (1964) as paratypes, to be *M. diplothrix*. These specimens seem to be a *Megaselia* species in Group IV.

Megaselia (Aphiochaeta) ectopia Borgmeier

Figs. 22, 36

Diagnosis.—The male differs from other Nearctic Group II species by the character combination: Halter brown; forebasitarsus as broad as apex of

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Figs. 21–29. *Megaselia* spp., male terminalia. 21. *M. pilicrus*, epandrium. 22. *M. ectopia*, epandrium. 23. *M. lanata*, epandrium. 24. *M. aequalis*, hypandrium. 25. *M. rotunda*, hypandrium. 26. *M. rotunda*, epandrium. 27. *M. meconicera*, hypandrium. 28. *M. pleuralis*, epandrium. 29. *M. carola*, hypandrium.

foretibia. *Terminalia*: Epandrium (Fig. 22) cleft posterolaterally, with 5 long bristles anterior to the cleft and numerous setulae posterior to the cleft; hypandrium (Fig. 36) with scattered setulae apically. Female unknown.

Known distribution.—Washington.

Material examined.—Holotype.

Remarks.—The head of the holotype is missing.

Megaselia (Aphiochaeta) fungivora (Wood)

Figs. 6, 17, 35

Aphiochaeta limburgensis Schmitz, 1918: 57–58. NEW SYNONYMY.

Megaselia pullifrons Borgmeier, 1964: 306–307. Preoccupied by *M. pullifrons* Beyer, 1958. NEW SYNONYMY.

Megaselia (Aphiochaeta) morenifrons Borgmeier, 1967: 62. New name for *Megaselia pullifrons* Borgmeier.

Diagnosis.—This species differs from other Nearctic Group II species by the character combination: Costa 50–54% of wing length; lower fronto-orbital close to anterior front-orbital; supra-antennals unequal. *Terminalia*: Epandrium (Fig. 17) with 10–14 scattered bristles and 1 very long bristle ventrally; hypandrium (Fig. 35) setulose, lobe broad and with long setulae apically. *Oviscapt*: Tergum VII (Fig. 6) broad basally and narrow apically, 4 apical setulae and 4–6 scattered setulae basally; sternum VII absent.

Known distribution.—British Columbia, Georgia, Idaho, Montana, Iowa, New York, North Carolina, Quebec, Tennessee, Washington.

Material examined.—34 ♂, 31 ♀.

Remarks.—Type material of *M. limburgensis* (Schmitz) and *M. fungivora* was not seen. However, descriptions by Schmitz (1957) and Borgmeier (1964) and available specimens indicate that *M. limburgensis* is a synonym of *M. fungivora*. Schmitz (1957) reported two males and two females of *M. imberbis* Schmitz among the type-material of *M. fungivora*.

Borgmeier (1964) described *M. pullifrons*, but incorrectly gave the author as Beyer in litt. Borgmeier (1967) stated that *M. pullifrons* Borgmeier was preoccupied by *M. pullifrons* Beyer (1958), and provided *M. morenifrons* as a new name. I have studied the *M. pullifrons* Borgmeier type and therefore the *M. morenifrons* type.

Biology.—Adults have been reported as associated with fungi and mammal burrows, and the larvae under bark (see Robinson 1971).

Megaselia (Aphiochaeta) lanata Robinson, NEW SPECIES

Figs. 23, 40

Diagnosis.—The male differs from other Nearctic Group II species by the character combination: Palpus broad and rounded apically; costa 46% of wing length; costal bristles short (0.08–0.09 mm); halter dark brown. Female unknown.

Description of male.—Body brown to dark brown. Frons subshining, as wide as high; supra-antennals subequal; lower slightly closer than upper to coronal suture, upper closer than preocellar to coronal suture; lower fronto-orbital bristle closer to anterior fronto-orbital bristle than to upper supra-antennal; posterior fronto-orbital level with preocellar. Parafacia with 5–6 bristles. Third antennae segment dark brown. Palpus yellowish brown, rounded apically.

Thorax brown to dark brown; propleuron without scattered setulae; 2–3 propleural bristles and 2 dorsal propleural bristles; mesanepisternum with 7–8 setulae and 1 bristle. Scutellum with 2 bristles.

Abdominal terga dark brown, venter brown. Terminalia dark brown, setose; proctiger pale brown; epandrium (Fig. 23) with 9–10 bristles posteriorly; hypandrium (Fig. 40) setulose laterally, lobe long and broad, with long curved setae apically.

Legs brown; foretibia with small anterodorsal bristles, 11–12 postero-dorsal bristles. Midtibia with small anterodorsal bristles, 6–7 widely spaced posterodorsal bristles; hair seam extending to $\frac{1}{5}$; midbasitarsus with 1 weak bristle at basal $\frac{1}{3}$. Hindfemur with 10–12 short setae on basal $\frac{1}{6}$; hindtibia with small anterodorsals; 10–13 posterodorsal bristles, weak on basal $\frac{1}{3}$ of row.

Wing 1.37–1.42 mm long; membrane hyaline, veins pale brown; costa 46% of wing length; ratio of first 2 costal divisions 1:1; costal bristles short (0.88–0.89 mm); 2 axillary bristles. Halter dark brown.

Material examined.—1 ♂, Downie Creek, Selkirk Mts., British Columbia VIII-14-1905, J. Ch. Bradley. 1 ♂, Milford Woods; Sec. 10, T98N, R37W; Dickinson Co., Iowa, VI-15-1969, on *Ulmus fulva*, Wm H Robinson.

Holotype.—♂, Milford Woods; Sec. 10, T98N, R37W; Dickinson Co., Iowa, VI-15-1969, on *Ulmus fulva*, Wm. H Robinson. Deposited in the U.S. National Museum of Natural History, type no. 76566.

Megaselia (Aphiochaeta) meconicera (Speiser)

Figs. 3, 19, 27

Diagnosis.—This species differs from other Nearctic Group II species by the character combination: Halter yellowish-brown; costals long; costa 42–40% of wing length; foretibia enlarged. *Terminalia*: Epandrium (Fig. 27) with scattered bristles dorsally and posteroventrally beneath proctiger, 4–6 strong bristles laterally; hypandrium (Fig. 19) larger than epandrium, setulose. *Oviscapt*: Tergum VII (Fig. 3) long, with scattered setulae; sternum VII long, narrow and Y-shaped, with 1 long apical seta on each fork of the Y and 3–6 setulae medially.

Known distribution.—Alberta, California, Indiana, Iowa, Kansas, Maryland, Minnesota, Newfoundland, New York, Ontario, Virginia.

Material examined.—24 ♂, 9 ♀.

Biology.—Adults collected in burrow of *Microtus* sp. (Hackman 1963).

Megaselia (Aphiochaeta) monticola (Malloch)

Fig. 13

Diagnosis.—The male differs from other Nearctic Group II species by the character combination: Halter dark brown; costa 47% of wing length; supra-antennals unequal. *Terminalia*: Epandrium (Fig. 13) with a few short bristles posteriorly and 3 strong bristles posteroventrally. Female unknown.

Known distribution.—British Columbia

Material examined.—Holotype.

Remarks.—The hypandrium is damaged in the holotype.

Megaselia (Aphiochaeta) pilicrus Borgmeier

Figs. 9, 21, 36

Diagnosis.—This species differs from other Nearctic Group II species by the character combination: Halter brown to dark brown; costa 44–56% of wing length; foretarsus slender. *Terminalia*: Epandrium (Fig. 21) setose posteroventrally; hypandrium (Fig. 36) setulose and bilobed, lobes small and with long curved setulae. *Oviscapt*: Tergum VII (Fig. 9) broad and slightly arched basally, 6 apical setulae and 4–6 lateral setulae; sternum VII indistinct, with 5–6 apical setulae and a few scattered setulae on apical $\frac{1}{3}$.

Known distribution.—Connecticut, Iowa, Kansas, Maryland, New York, North Carolina, Quebec, Virginia.

Material examined.—19 ♂, 4 ♀.

Megaselia (Aphiochaeta) pleuralis (Wood)

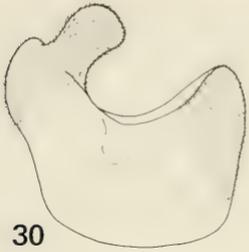
Figs. 8, 28, 39

Diagnosis.—This species differs from other Nearctic Group II species by the character combination: Halter yellowish brown; costa 50–54% of wing length; costal division I as long as divisions I and II; costals long. *Terminalia*: Epandrium (Fig. 28) with 5–6 dorsal bristles and 2–4 short postero-dorsal bristles, with 6 strong bristles laterally; hypandrium (Fig. 39) broad, bilobed, right lobe broad and with short setulae apically, left lobe narrow, slightly club-shaped and with long setulae apically. *Oviscapt*: Tergum VII (Fig. 8) triangular, truncate or pointed apically; sternum VII club-shaped, narrow at base, with 3–5 apical setulae.

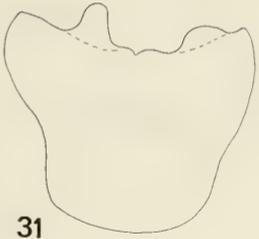
Known distribution.—Alaska, Alberta, British Columbia, California, Colorado, Connecticut, District of Columbia, Georgia, Illinois, Iowa, Maine, Manitoba, Maryland, Massachusetts, Michigan, Minnesota, Montana, New-

→

Figs. 30–41. *Megaselia* spp., male hypandria. 30, *M. atratula*. 31, *M. amplicornia*. 32, *M. basispinata*. 33, *M. cirripes*. 34, *M. diplothrix*. 35, *M. fungivora*. 36, *M. ectopia*. 37, *M. pilicrus*. 38, *M. unguata*. 39, *M. pleuralis*. 40, *M. lanata*. 41, *M. perdita*.



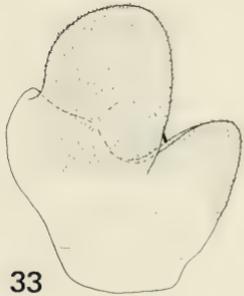
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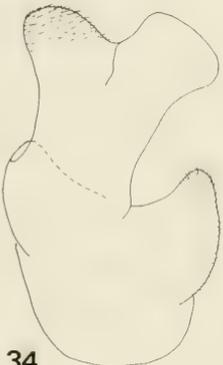
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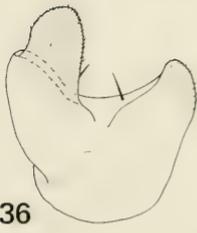
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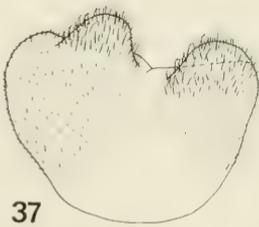
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41

foundland, New Hampshire, New York, North Carolina, Ontario, Oregon, Quebec, Saskatchewan, Tennessee, Utah, Virginia, Washington, Wyoming.

Material examined.—209 ♂, 42 ♀.

Remarks.—Size and coloration are quite variable in this species. The absence of a mesanepisternal bristle in some specimens may result in confusion with Group IV species.

Biology.—Adults have been reported associated with rotten logs, ant nests, caves, mammal burrows, flowers, plant galls, and decaying plants (see Robinson 1971).

Megaselia (Aphiochaeta) rotunda Robinson, NEW SPECIES

Figs. 25, 26

Diagnosis.—The male differs from other Nearctic Group II species by the character combination: Costa 44–58% of wing length; costal bristles long, lower fronto-orbital close to anterior fronto-orbital; forebasitarsus slender. Female unknown.

Description of male.—Body dark brown to blackish brown. Frons dull to subshining, as wide as high; supra-antennals long and equal, lower slightly closer than upper to coronal suture, upper slightly closer than preocellar to coronal suture; lower fronto-orbital bristle closer to anterior fronto-orbital bristle, posterior fronto-orbital bristle on a higher level than preocellar bristle. Parafacia with 6 bristles. Third antennal segment dark brown to blackish brown. Palpus brown to blackish brown.

Thorax brown to blackish brown; propleuron without scattered setulae; 4 propleural bristles and 3 strong dorsal propleural bristles; mesanepisternum with 6–8 setulae and 4 bristles. Scutellum with 2 bristles.

Abdominal terga and sterna dark brown. Terminalia large and rounded, setose; proctiger large, pale brown; epandrium (Fig. 26) rounded with scattered setae and particularly long setae dorsally and ventrally, 1 strong seta ventrally; hypandrium (Fig. 25) setulose, lobe large and narrow apically.

Legs dark brown; foretibia with small anterodorsal bristles, and 12–13 posterodorsal bristles midtibia with antero- and posterodorsal bristles small; hair seam extending $\frac{1}{8}$ length of tibia; midbasitarsus with 2–3 bristles on basal $\frac{1}{5}$. Hindfemur with 12–14 bristles on basal $\frac{1}{5}$; hindtibia with indistinct anterodorsal bristles; 13–15 posterodorsal bristles, weak on basal $\frac{1}{3}$ of row.

Wing 1.75–2.15 mm long; membrane hyaline, veins brown; costa 44–58% of wing length; ratio of first 2 costal divisions 1:1; costal bristles very long; 3–4 axillary bristles. Halter brown.

Material examined.—1 ♂, Lake Fontanillis, 8500', El Dorado Co., California, VII-21-1955, E. I. Schlinger. 1 ♂, Atkinson, Summit Co., Utah, VIII-23-1939, G. F. Knowlton.

Holotype.—♂, Atkinson, Summit Co., Utah, VIII-23-1939, G. F. Knowton. Deposited in U.S. National Museum of Natural History, type no. 76567.

Megaselia (Aphiochaeta) ungulata Robinson, NEW SPECIES

Figs. 4, 5, 38

Diagnosis.—This species differs from other Nearctic Group II species by the character combination: Palpus narrow ventrally; forebasitarsus slender; costa 45–46% of wing length; costal bristles short.

Description.—Body brown to dark brown. Frons dull to subshining, as wide as high; supra-antennals strong and equal, lower closer than upper to coronal suture, upper as far as preocellar from coronal suture; lower fronto-orbital bristle on a slightly higher level than preocellar bristle. Parafacia with 3 bristles. Third antennal segment brown. Palpus pale brown, narrow ventrally and pointed apically.

Thorax brown; propleuron without scattered setulae; 2 propleural bristles, 1–2 dorsal propleural bristles; mesanepisternum with 3–5 setulae and 1 bristle.

Abdominal terga and venter brown. Terminalia dark brown, setose, proctiger pale brown; epandrium (Fig. 4) with 9–11 bristles posteroventrally at left; hypandrium (Fig. 38) setulose laterally and bilobed; left lobe large, clawlike and with long setae; right lobe short and with scattered long setae; tergum VII (Fig. 5) short and rectangular, with 3 setae on each apical corner, sternum VII triangular and with 6 apical setae.

Legs brown; foretibia with small anterodorsal bristles; 9–10 small posterodorsal bristles. Midtibia with small anterodorsal bristles; 4–7 posterodorsal bristles (widely separated in some specimens); hair seam extending to $\frac{1}{6}$; midbasitarsus with 4–5 bristles on basal $\frac{1}{5}$. Hindfemur with small anterodorsal bristles; 10–12 posterodorsal bristles, weak at base and apex of row; hindbasitarsus with 2 bristles at basal $\frac{1}{5}$.

Wing of male 1.07–1.12 mm long, female wing 1.19–1.27 mm long; membrane hyaline, veins light brown; costa 45–46% of wing length; ratio of first 2 costal divisions 1:1; costal bristles short; 2 axillary bristles. Halter dark brown.

Material examined.—1 ♂, Ames, Iowa, VIII-27-1969, Wm. H. Robinson; 1 ♀, Ames, Iowa, V-24-1951, W. L. Downes; 1 ♂, Ames, Iowa, VI-4-1953, W. L. Downes; 4 ♂, 2 ♀, 7 mi. nw. Milford, Iowa, VI-24-1969, Wm. H. Robinson; 2 ♂, 1 ♀, 7 mi. nw. Milford, Iowa, VI-29-1969; 1 ♂, 1 ♀, Chatterton, Ontario, VII-2-1951, J. C. Martin.

Holotype.—♂, 7 mi. nw. Milford, Dickinson Co., Iowa, VI-24-1969, Wm. H. Robinson. Deposited in U.S. National Museum of Natural History, type no. 76568.

DISCUSSION

There is considerable range in the shape of the male epandrium and hypandrium in Group II *Megaselia* species (North America). The species with the most primitive, platypezid-like terminalia include *M. amplicornis*, *M. atratula*, *M. ectopia*, *M. perdita*, *M. pilicrus*, *M. pleuralis*, *M. lanata*, and *M. carola*. The male terminalia of these species are characterized by unsegmented processes on the epandrium and/or a bilobed hypandrium. The species in which these conditions can be seen best are *M. lanata* and *M. pleuralis*. In *M. lanata* the epandrium (Fig. 23) has an unsegmented process on the right side. The hypandrium of *M. pleuralis* is bilobed, and the lobes are of nearly equal size.

The left lobe of the hypandrium is very specialized in several Group II species. The hypandrium of *M. diplothrix*, *M. basispinata*, and *M. unguolata* represents the most derived, specialized condition in Group II (North America).

ACKNOWLEDGMENTS

I gratefully acknowledge the patience and support of my wife and children during the time devoted to this study.

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NEW SPECIES OF *GYPONA*, GYPONINAE (HOMOPTERA:
CICADELLIDAE) WITH DESCRIPTION OF A
NEW SUBGENUS

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Abstract.—Seven new species of *Gypona* are described. Four new species, **metalana**, **rubranura**, **decorana** and **quadra**, are placed in the subgenus *Gypona*. Two new species, **mocamba** and **platona**, are placed in the subgenus *Marganalana*. One new species, **colomella**, is placed in a new subgenus **Carnoseta**.

A revisional study of *Gypona* was published by DeLong and Freytag (1964) including some 140 species and four subgenera. New species have been described since by DeLong and Martinson (1972), DeLong and Kolbe (1974, 1975), DeLong and Freytag (1975) and DeLong and Linnavuori (1977). Seven new species and a new subgenus are described in this paper.

Gypona (Gypona) metalana DeLong, NEW SPECIES

Figs. 1-5

Description.—Length of male 8.5 mm, female unknown. Crown more than twice as wide at base between eyes as median length. Color brown, mostly with yellow spots surrounding ocelli and small yellow spots at base, behind ocelli. Pronotum dark brown to black except lateral margins and a diagonal yellowish line, each side, extending from basal margin, behind ocelli, to humeral angles. Scutellum black with bright yellow basal and apical angles. Forewings gray subhyaline, veins pale brown.

Male plates $2\frac{1}{2}\times$ as long as broad, apices broadly rounded. Style broadened on apical $\frac{1}{4}$, lateral margins of broadened portion convexly rounded. Apex slightly concavely rounded. Aedeagus bearing a pair of lateral processes at $\frac{3}{4}$ its length which extend basad along shaft for almost $\frac{3}{4}$ length of shaft. The apical $\frac{1}{4}$ of shaft slightly sclerotized, composed of a median shaftlike portion, which is blunt at apex, and giving rise to a slender, lateral, pointed spine on each side. Spines extend to apex or median portion. Pygofer broadly rounded apically.

Holotype.—♂, Sonora, Mexico, 7 mi. S of Benjamin Hill, X-1-1968, at black light. E. L. Sleeper and F. L. Moore colls., in the DeLong collection, The Ohio State University.

Remarks.—*Gypona meialana* is placed in the subgenus *Gypona* and is related to *G. melanota* Spangberg, from which it can be separated by the apical portion of the aedeagus which is notched on each side at apex, producing two apical spines.

Gypona (Gypona) rubranura DeLong, NEW SPECIES

Figs. 6–10

Description.—Length of male 8 mm, female unknown. Crown more than $\frac{1}{2}$ as long as middle as basal width between eyes. Color, crown, pronotum and scutellum pale brown, forewings dark brown, often with yellow costal margins. Pygofer bright red.

Male plates slender, $3\frac{1}{2} \times$ as long as width at middle, apices narrow, rounded. Style broadened at middle and at truncate apex. Aedeagus elongate, apical $\frac{1}{2}$ slender, a pair of short lateral processes, $\frac{1}{6} \times$ length of shaft, arise at $\frac{2}{3}$ length of shaft and extend laterally and basally along shaft. The apical $\frac{1}{3}$ of shaft only slightly sclerotized, with blunt apex and bearing a pair of slender, lateral, subapical processes which are pointed and extend along shaft to its apex. Pygofer broadly rounded apically.

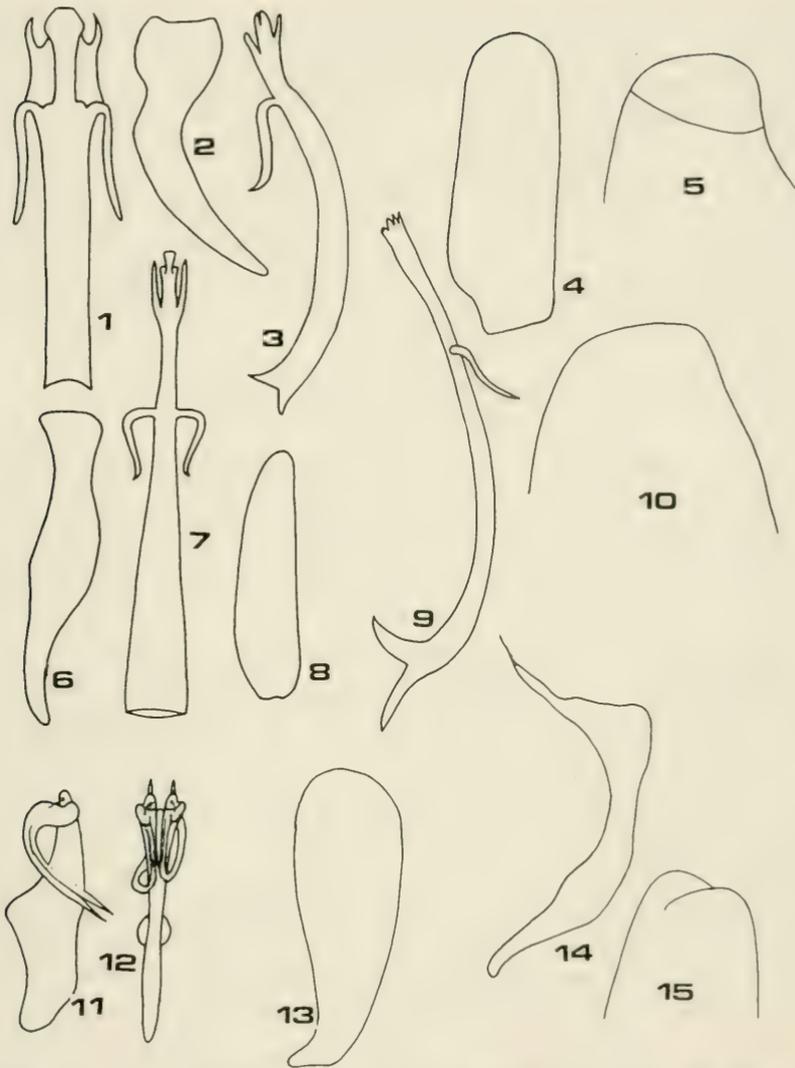
Types.—Holotype ♂, El Pilar, 1000 ft. el. Baja Calif. Mexico Sur. XI-6-1968, E. L. Sleeper and F. L. Moore colls., at black light. Paratypes (all from Baja California, Mexico): 6♂, X-10-68, 2 mi. NW Eltriufa 1400 ft.; 5♂, same except X-11-68, 7.5 mi. W 1600 ft. el.; 6♂ X-18-68, 3 mi. E of Burrera; 2♂, X-8-68, 5.5 mi. SE Valle Perido, 1600 ft.; 1♂, same except X-15-68, 2.5 mi. SE 2000 ft.; 3♂, X-27-68, Casas Vigas, 800 ft. el.; 2♂, X-30-68, 7 mi. W Santiago 1600 ft. el.; 2♂, X-31-68, 3.5 mi. SW of San Bartolo, 1400 ft. el.; 1♂, X-26-68, 6 mi. E. San Jose del Cabo, 400 ft. el.; 1♂, X-29-68, El Charro, 2.5 mi. SW Agra Caliente, 900 ft. el.; 1♂, XI-3-68, 8 mi. SE of La Paz, 1000 ft. el. Holotype and paratypes in DeLong Collection, The Ohio State University, paratypes in collection of E. L. Sleeper.

Remarks.—*Gypona rubranura* is placed in the subgenus *Gypona* and is related to *G. extrema* DeLong, from which it can be separated by the longer apical portion of the aedeagus beyond the apical processes.

Gypona (Gypona) decorana DeLong, NEW SPECIES

Figs. 11–15

Description.—Length of male 9 mm, female unknown. Crown with thin margin, almost twice as wide at base between eyes as median length. Color, crown dark brown. Pronotum paler brown, scutellum dark brown. Forewings brown, veins of median and claval areas, dark brown.



Figs. 1-15. 1-5, *Gypona metalana*. 6-10, *G. rubranura*. 11-15, *G. decorana*. 1, 7, 12, Aedeagus ventrally. 2, 6, 14, Style laterally. 3, 9, 11, Aedeagus laterally. 4, 8, 13, Plate ventrally. 5, 10, 15, Pygofer laterally, apical portion.

Male genital plates more than twice as long as wide at middle, apices broadened, rounded. Style narrowed at $\frac{2}{3}$ its length, broadened and rounded ventrally at middle then tapered to a narrow twisted apical portion which is notched on ventral margin at $\frac{4}{5}$ its length. Aedeagal shaft short, narrowed

to a pointed apex. Two pairs of subapical processes arise near apex, and slightly basad to these, a long pair arises which extends dorsally, then curves basally and ventrally, and tapers to pointed apices. Apex of aedeagus divided dorsocaudally (Fig. 12).

Holotype.—♂, Ullnga, Pará, Brazil, XI-30-1961, J. and B. Bechyne, colls. Holotype in Museu de Zoologia da Universidade de São Paulo, Brazil.

Remarks.—*Gypona decorana* is placed in the subgenus *Gypona*. It is closely related to *G. decorata* (Fowler) but can be distinguished by the notched, apically twisted style, the shorter, broader aedeagus and its subapical processes which are broader basally and hide the shorter subapical processes which are beneath the longer pair.

Gypona (Gypona) quadra DeLong, NEW SPECIES

Figs. 16–20

Description.—Length of male 14 mm, female unknown. Crown flat, foliaceous, $\frac{2}{3}$ as long at middle as basal width between eyes. Color, crown, pronotum, and scutellum dull yellow. Margin of crown with a black line. A small black spot $\frac{1}{2}$ length of pronotum, each side. Forewings brownish subhyaline, veins of costal area dark brown, remainder of wing veins pale brown.

Male genital plates 3× as long as broad at middle, apices narrowed, rounded. Style slightly narrowed subapically, apex blunt. Aedeagus with a pair of apical and a pair of subapical processes. The apical processes curve basally and extend almost to base of shaft. The subapical processes arise just basad to apical processes and extend basally and laterally about $\frac{1}{2}$ length of apical processes. Pygofer with a small rounded process arising at dorsoapical margin.

Holotype.—♂, Guajara Mu. Ananindeus, Pará, Brazil, I-1-65, Apol Sousa coll. Holotype in Museu de Zoologia da Universidade de São Paulo, Brazil.

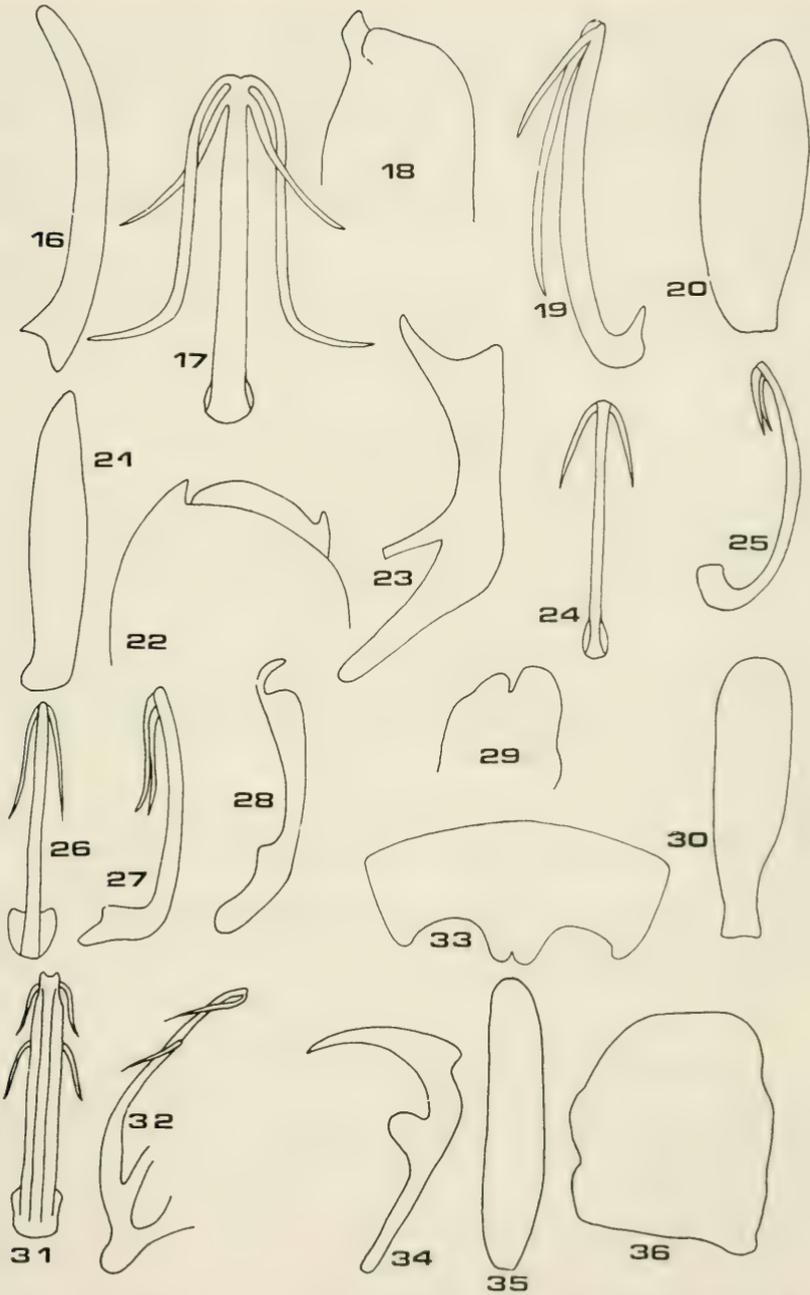
Remarks.—*Gypona quadra* is placed in the subgenus *Gypona* and is closely related to *G. securo* DeLong and Freytag from which it can be separated by the longer apical and subapical aedeagal processes.

Gypona (Marganalana) mocamba DeLong, NEW SPECIES

Figs. 21–25

Description.—Length of male 8.5 mm, female unknown. Crown broadly rounded, foliaceous, more than twice as wide at base between eyes as median length. Color dark green and black. Crown mostly black with dark green along anterior margin. Pronotum with anterior portion dull blackish gray, caudal $\frac{1}{2}$ dark green. Scutellum blackish gray. Forewings subhyaline, tinted with green on claval area.

Male genital plates 5× as long as median width, apices bluntly pointed. Style narrowed at middle, broadened and broadly rounded apically with a broad finger-like projection on dorsocaudal margin. Aedeagal shaft long,



Figs. 16-36. 16-20, *Gypona quadra*. 21-25, *G. mocamba*. 26-30, *G. platona*. 31-36, *G. colomella*. 16, 23, 28, 34, Style laterally. 17, 24, 26, 31, Aedeagus ventrally. 18, 22, 29, Pygofer laterally, apical portion. 19, 25, 27, 32, Aedeagus laterally. 20, 21, 30, 35, Plate ventrally. 33, Female 7th sternum. 36, Pygofer laterally.

slender, bearing a pair of apical processes which extend caudally $\frac{1}{2}$ length of shaft. Pygofer broadly rounded apically with a rounded, short, fingerlike process extending at dorsocaudal margin. A hidden portion protrudes beneath the caudal margin which is also broadly rounded and bears a similar apical process at its ventrocaudal margin.

Holotype.—♂, Belém Mocambo, Pará, Brazil, March 17, 1977, M. F. Terror coll. Holotype in Museu de Zoologia da Universidade de São Paulo, Brazil.

Remarks.—*Gypona mocamba* is placed in the subgenus *Marganalana* but is not closely related to any described species. The shape of the style and the apex of the pygofer are not similar to any described species of *Gypona*.

Gypona (Marganalana) platona DeLong, NEW SPECIES

Figs. 26–30

Description.—Length of male 9 mm, female unknown. Crown broadly rounded, margin thin, more than twice as wide at base between eyes as median length. Color, one specimen uniformly green, the other uniformly brown. Each has a small, round, black spot on each side of the pronotum at $\frac{1}{3}$ its length.

Male genital plates 4× as long as width at middle, apices rounded. Style broadened and rounded apically, bearing a long curved apical spine on ventral margin. Aedeagal shaft long, slender, with a pair of apical processes, $\frac{1}{2}$ length of shaft, extending basally. Pygofer with a conspicuous notch at middle of caudal margin.

Holotype.—♂, Porto Platon, Amapá, Brazil, July 20, 1961, J. and B. Bechyne colls. Holotype in Museu de Zoologia da Universidade de São Paulo, Brazil.

Remarks.—*Gypona platona* is placed in the subgenus *Marganalana*, is most closely related to *G. axena* DeLong and Freytag, and can be separated by the narrow curved apex of the style.

Gypona subgenus *Carnoseta* DeLong, NEW SUBGENUS

Description.—Crown produced and broadly rounded, median length slightly greater than width at base between eyes. Ocelli at $\frac{1}{2}$ length of crown, closer to median line than to eyes. Crown slightly concave with apex curved upwardly.

Remarks.—In general appearance *G. colomella*, n. sp., resembles a species of *Prairiana* Ball but the aedeagus has no paraphyses and the genital structures in general resemble those of *Gypona*.

Type-species of subgenus.—*Gypona (Carnoseta) colomella*, n. sp.

Gypona (Carnoseta) colomella DeLong, NEW SPECIES

Figs. 31-36

Description.—Length of male 6 mm, female 7 mm. Crown produced and broadly rounded at apex, more than $\frac{1}{2}$ as long at middle as wide at base between eyes. Crown slightly concave with apex curved upward. Ocelli $\frac{1}{2}$ length of crown, closer to median line than to eyes. Pronotum yellow tinged with brown. Scutellum pale yellowish. Forewings variable in coloration normally yellow with clavus pale or dark brown. With two round black spots along clavus on corium.

Female 7th sternum with posterior margin angularly excavated on each side of a broad median tooth, $\frac{1}{4}$ width of segment which is produced beyond length of lateral angles and is notched at middle forming 2 minute rounded lobes.

Male genital plates elongate, narrow, $4\times$ as long as wide at middle, apices rounded. Style enlarged at $\frac{2}{3}$ its length, apical $\frac{1}{3}$ curved dorsally and gradually tapered to a slender pointed apex. Aedeagal shaft broadened in ventral aspect, narrowed apically with blunt apex and bearing 2 pairs of processes. A pair of apical processes arise on each side at apex and extend $\frac{1}{3}$ distance to base. A pair of subapical processes arise at $\frac{2}{3}$ length of shaft and extend basally to middle of shaft. Pygofer broadly rounded apically.

Types.—Holotype ♂, Tunga, Colombia Bay, Atena, Colombia, V-30-96. Paratypes: 1 ♂ and 1 ♀, same data as for holotype. Holotype and paratypes in DeLong Collection, The Ohio State University.

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A DISTINCTIVE NEW SPECIES OF *STENONEMA*
(EPHEMEROPTERA: HEPTAGENIIDAE) FROM
KENTUCKY AND MISSOURI¹

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Abstract.—The new species, *Stenonema bednariki*, is described from larval specimens taken from streams in Kentucky and Missouri. The species, which is easily identifiable by its unique head pattern, is closely related to *S. pulchellum* (Walsh) and is a member of Cluster III-A of the subgenus *Maccaffertium*.

A new, "comprehensive" revision of a genus often leads to the user's ability to recognize enigmatic populations, which may in fact be new species. Thus, the revision precipitates new taxonomic discoveries. Such was the case when aquatic biologists, working independently in Kentucky and Missouri and using the recent revision of *Stenonema* (Bednarik and McCafferty, 1979), noticed that certain larval specimens of *Stenonema* taken in stream surveys could not be keyed. My study of these materials indicates that they represent a distinctive new species. Although adults remain unknown, a comparative species taxonomy of *Stenonema* is thoroughly established for the larval stage. The new species is named after Dr. Andrew Bednarik.

Stenonema bednariki McCafferty, NEW SPECIES

Fig. 1

Larva (in alcohol).—Mature length excluding caudal filaments: 6.0–7.5 mm.

Head: Dorsally dark brown with conspicuous large pale markings but lacking pale speckling; 3 pale yellow markings anterior to compound eyes consisting of single large diamond or crown-shaped marking medially between antennal bases and pair of obliquely transverse bars anterior to antennal bases; lateral margins of head capsule nearly straight and seemingly

¹ Purdue Agriculture Experiment Station Journal No. 8358.

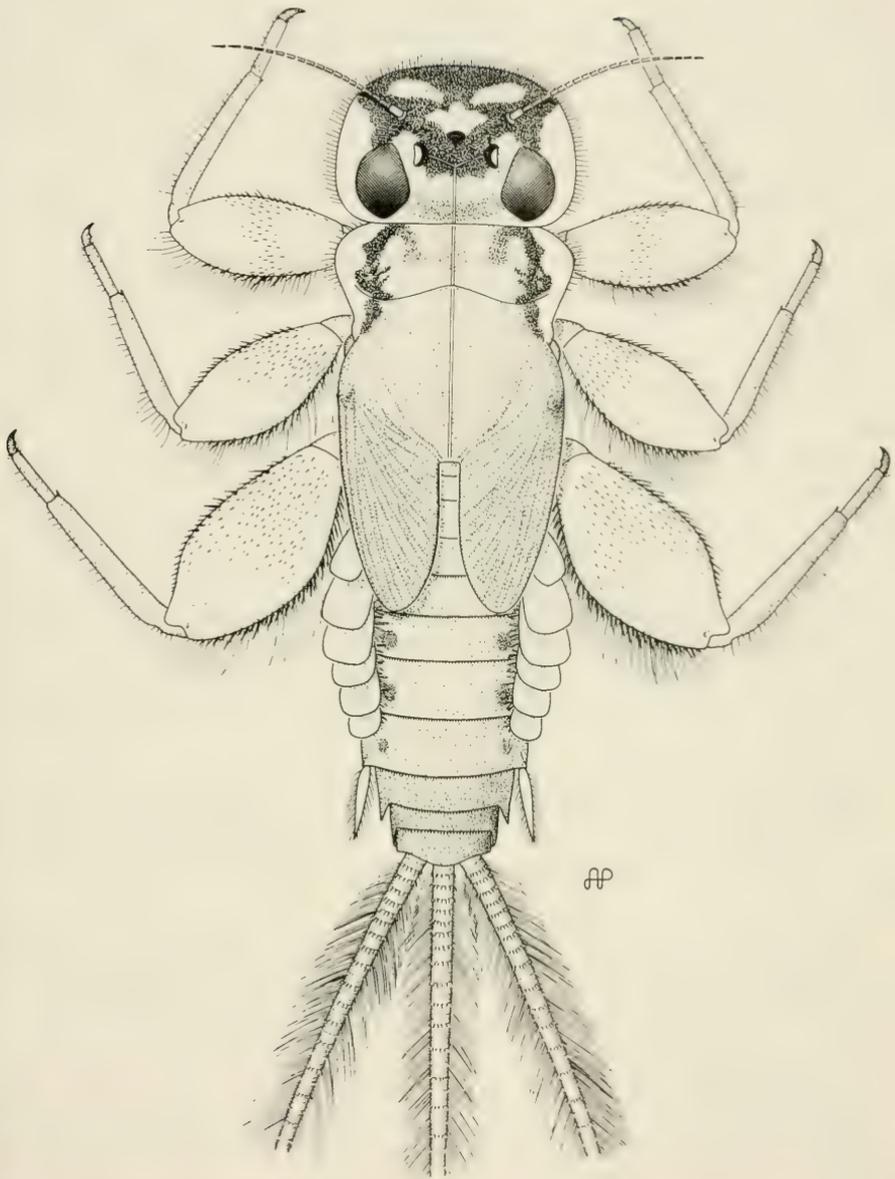


Fig. 1. *Stenonema bednariki*, larva.

lacking any pigment up to anterolateral corners; rounded, unpigmented areas at anteromedial margins of compound eyes and overlying lateral ocelli. Mandibles each with 5–7 teeth on inner margin of outer incisor; maxillae each with 4 or 5 spinelike setae and no hair setae on crown, and 16–20 hair setae in submedial row.

Thorax: Pronotum yellow to light brown, with pair of sublateral longitudinal brown stripes bending medially at anterior margin and then posteriorly for about $\frac{1}{2}$ length of pronotum so as to resemble pair of inverted U-shaped markings, sometimes connected medially by transverse bar. Some individuals with brown spot at apices of hindwing pads. Forefemur with sparse dorsal armature restricted to medial $\frac{1}{3}$ and consisting of elongate paddle-shaped setae and some pointed spinelike setae; spinelike setae present along anterior margin; hair setae and few spinelike setae present along posterior margin. Foretarsal claw adenticulate in mature individuals. Hindfemur much broader than fore- and midfemora.

Abdomen: Dorsally yellow to light brown, with segments 6–10 sometimes slightly darker than anterior segments; sublateral pair of brown spots (varying in size among individuals but usually very small) present on each of segments 1–7 and sometimes faintly evident posterior to segment 7. Lateral projections absent on abdominal segments anterior to segment 6. Ventrally pale yellow and lacking conspicuous markings although faint pair of submedian spots at base of segment 8 in some, and segment 9 slightly darker in some. Gill lamellae of segments 1–6 truncate apically. Caudal filaments uniformly yellow to brown and each with very thick, silver setae along lateral margins.

Holotype.—Kentucky: Pulaski County, Fishing Creek, 10.3 km south of confluence of Lick Creek, 31-VII-1979, S. M. Call. Deposited in the Entomological Research Collection, Purdue University, West Lafayette, Indiana.

Paratypes.—5 larvae, same data and deposition as for holotype; 5 larvae, same data as for holotype, deposited in the U.S. National Museum, Washington, D.C.; 3 larvae, Missouri, Iron County, Strother Creek, 22-VII-1979, L. Trial, deposited in the Entomology Museum, University of Missouri, Columbia, Missouri.

Additional material examined.—47 larvae from Crawford, Iron, and McDonald counties, Missouri, deposited in the Entomological Research Collection, Purdue University or the Entomology Museum, University of Missouri.

Discussion.—*Stenonema bednariki* is most easily diagnosed by the unique and highly conspicuous markings of the larval head capsule. In addition, the broad hind femur, thick setae of the caudal filaments, and the restricted dorsal armature of the forefemur are all readily evident and unusual for the genus. Mouthpart structure is most similar to that of *S. pulchellum* (Walsh),

exiguum Traver, and *terminatum* (Walsh), but color patterns and setal distribution on *S. bednariki* are different. *Stenonema bednariki* is also a relatively small-sized species (mature larvae are 6–7.5 mm). Among other mature *Stenonema* larvae, only *S. integrum* (McDunnough), *mediopunctatum* (McDunnough), *pulchellum*, and *smithae* Traver are ever this small.

Stenonema bednariki is a member of the subgenus *Maccaffertium* as evidenced by its gill structure. Within *Maccaffertium*, *S. bednariki* is phylogenetically most closely related to *S. pulchellum*, *terminatum*, *exiguum*, and *merivulatum* Carle and Lewis; all share the apomorphic losses of maxillary crown hair setae and anterior abdominal projections. These species belong to the Cluster III-A group as defined by Bednarik and McCafferty (1979). Owing to the similar reduction in spinelike maxillary crown setae and possibly body size, it appears that *S. bednariki* is most closely related to *S. pulchellum*.

The holotype and paratypes from Kentucky were taken in the Upper Cumberland River Basin on predominantly slab rubble and gravelly substrates of a fourth-order stream. The gradient of the stream was moderate and the water quality good at the open-canopy-area collection site. Three other species of *Stenonema* (*mediopunctatum*, *vicarium* (Walker), and *femoratum* (Say)), as well as *Stenacron interpunctatum* (Say) were taken at the same site. Missouri collection sites were all located in the southern part of that state in habitats similar to the site in Kentucky.

ACKNOWLEDGMENTS

My thanks are due to Samuel M. Call and the Kentucky Nature Preserves Commission and to Linden Trial and the Missouri Department of Conservation for providing the specimens; to Arwin Provonsha for the illustration; and to Andrew Bednarik for verifying the description.

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A NEW NEARCTIC *DIXA* (DIPTERA: DIXIDAE)¹

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Abstract.—*Dixa pseudindiana*, new species, from Minnesota is described with illustrations of the wing and both male and female terminalia. The immature stages are unknown.

The Cedar Creek Natural History area just outside the Minneapolis St. Paul metropolitan area of Minnesota, is where I had my first contact with dixid midges. This area was the source of materials for many of my earliest observations and rearings. In fact, the large numbers of *Dixella indiana* (Dyar) used in the morphological study included in Peters and Cook (1966) were collected from this area during several visits.

The first specimen of the species described herein was set aside when I first examined it in the early 1960's. Although I marked the slide "like none" as I was grouping phena, I really considered that I had simply mounted the specimen poorly and that it was indeed only a distorted specimen of *D. indiana*. During a current reorganization of my dixid collection I ran across three additional slides with the same collection date and locality in a box containing materials accumulated when I was originally learning to slide-mount dixids. In backtracking through notebooks and jars, I found a single jar bearing my collection notebook #45 and labeled "*D. indiana* and *D. dorsalis*." The "*D. dorsalis*" were all in fact the new species described in this paper. As far as I can determine I did not collect this new species in any of my other trips to Cedar Creek Natural History area nor in the many other collections I made throughout the state of Minnesota.

Dixid swarms were flying 4 to 20 inches above the water level and up against the overhanging vegetation on Sept. 14, 1962. The swarms numbered 2-15 individuals and may have been mixtures of *D. indiana* and this new species. The swarming adults were essentially all males. A female now and then was observed to fly slowly by a swarm, but no mating was observed. Observations made on a swarm disclosed that every few minutes one or

¹ Research supported by project MS-27 of the Massachusetts Agricultural Experiment Station.

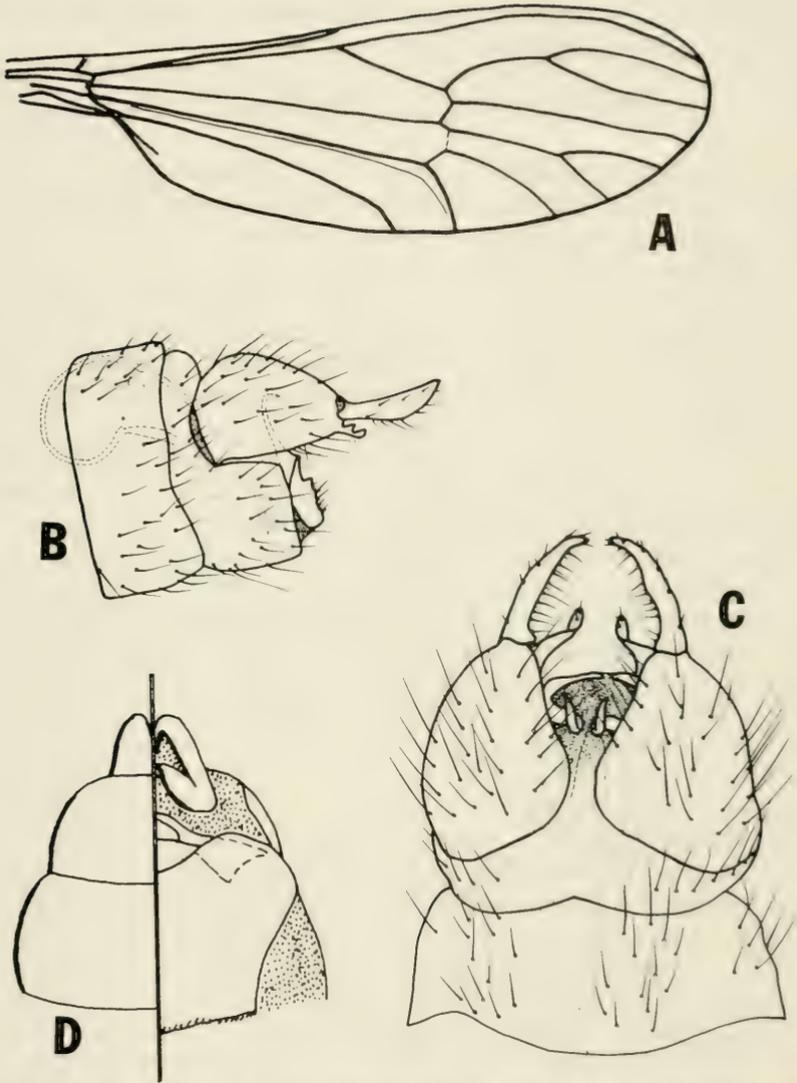


Fig. 1. Wing and terminalia of *Dixia pseudindiana*. A. Wing. B. Male terminalia, lateral view. C. Male terminalia, dorsal view (rotated). D. Split drawing of female terminalia: left dorsal, right ventral.

two males would fly over to a blade of grass and rest. In two to four minutes the resting male would rejoin the swarm.

The name of this species reflects the similarities in genitalic morphology between it and *D. indiana*. The great similarity in the male cercus and in

the apical lobe of the basistyle may cause misidentification. The dististyles of the two species, however, are very distinct.

Dixa pseudindiana Peters, NEW SPECIES

Figs. 1A-D

Type-material.—Holotype ♂, Cedar Creek Natural History Area, East Bethel, Anoka Co., Minnesota, Sept. 14, 1962. In the T. Michael Peters dixid collection at the Department of Entomology, University of Massachusetts, Amherst. Paratypes, 38 ♂, 3 ♀, with same data as for holotype.

Diagnosis.—In the key to the genus *Dixa* by Peters and Cook (1966) *Dixa pseudindiana* males come out as either *D. terna* Loew or *D. similis* Johannsen. However, both of these previously described species have the basal lobe of the basistyle well developed whereas it is essentially absent in *D. pseudindiana*.

Females are distinguishable from all other previously described Nearctic *Dixa* because of the sinuous sclerotized ridge in the bursa copulatrix, a pattern entirely unique in the Nearctic *Dixa* fauna.

Description.—*Head*: Medium brown; covered with microtrichia; a line of setae from just above the foramen magnum diagonally across vertex toward each eye, continuing posteriorly just medial to periphery of compound eye, extending around posterior of head, totaling 24–25 setae. Frontoclypeus with a group of 4–5 setae. Scape and pedicel concolorous with head. Flagellum slightly lighter. First flagellomere fusiform (subcylindrical, but with basal portion swollen) length about 10× its distal width, 6.7× its maximum width.

Thorax: Rather uniformly medium brown in specimens preserved in alcohol. Vittae of scutum visible as texturally distinct but concolorous regions. Area just above mesothoracic spiracle with 6–10 setae. Ten–11 setae extend diagonally from anterior edge of scutum along lateral border of medial vitta. A line of 5 setae spread along entire saggital line of median vitta. Scutellum with a transverse line of 11 moderately long setae, the medial one originating slightly posterior of the others.

Wing and Halter: Wing clear, without pigmented areas; length 2.60–2.86 mm in males, 3.00–3.20 mm in females. In males M3+4:MI+2 as 1:1.42–1.59; M3+4:Mst as 1:1.47–2.06; M1+2:Mst as 1:0.96–1.33; R2+3:R3 as 1:1.53–2.25; R2+3:R2 as 1:1.53–2.30. In paratype females vein length ratios fall within ranges for male except M3+4:MI+2 as 1:1.40–1.44; R2+3:R3 as 1:1.29–1.59 and R2+3:R2 as 1:1.20–1.67. Crossvein m-cu incomplete. Halter hyaline.

Leg: Distal spiniform seta on 3rd tarsomere of mid- and hindlegs in all specimens, both male and female. Foreleg without such setae. Male rarely with distal spiniform seta on 2nd tarsomere of midleg. Claws of female simple; male with 2–5 ventral teeth on fore- and on midleg, the basal one

compound and with 3 prongs; hindleg with 4 ventral teeth, including 1 basal. Foreleg femoral:tibial:tarsal length as 1:0.92-1.00:1.38-1.50; midleg as 1:0.87-0.93:1.20-1.21; of hindleg as 1:1.07-1.14:1.50-1.54. In female foreleg 1:0.92-0.93:1.36-1.43, midleg 1:0.88-1.15:1.12-1.38, hindleg 1:1.07-1.13:1.43-1.60.

Abdomen: Darker than thorax, a mixture of brown (as light as thorax) with much darker brown patches, giving an overall mottled, almost grainy appearance. In male, sclerites of 9th segment fused. Sternal area much narrower than tergal area. Tergum 10 divided into 2 semicircular pieces each bearing a non-segmented cercal element that extends dorsoposteriorly (in rotated genitalia) between basistyles. Basistyle without distinct basal lobe, apical lobe flattened, slightly tapering and twisted. Dististyle as in Fig. 1B and C. Ejaculatory duct long, looping anteriorly past sternum 8. Claspette without serrations and not sharply pointed. Penis valve with 5-6 large serrations on lateral margin.

Female terminalia as in Fig. 1D. Form of sclerotized inflections of bursa copulatrix not conforming to the several patterns found among Nearctic dixids (thornlike, spinose and semi-spherical, or setal clumps). Instead, a sclerotized ridge extends around bursa, forming a partial ring (about 120°). Ridge slightly sinuous and irregular, giving rise to a lightly sclerotized piece at one end extending at an acute angle from the main ridge.

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THE DISTRIBUTION AND SEASONAL HISTORY OF
SLATEROCORIS PALLIPES (KNIGHT)
(HEMIPTERA: MIRIDAE)

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Abstract.—The distribution and seasonal history of a little-known mirid, *Slaterocoris pallipes* (Knight), are reviewed. New Jersey and New York are reported as new state records, and additional localities are listed for Maryland and North Carolina. In the Piedmont Region of North Carolina eggs hatch in early April with leaf flush of the host plant, *Baccharis halimifolia* L., a shrubby composite common in coastal salt marshes. Nymphs are vegetative feeders that discolor and distort host foliage; adults first appear in late May and are present until mid- to late June. *Slaterocoris pallipes* is a univoltine, specialist species restricted to the genus *Baccharis*.

Knight (1926) described *Strongylocoris pallipes* from coastal Maryland, North Carolina, and Virginia, noting that this mirid injured foliage of the shrubby composite, *Baccharis halimifolia* L. This undoubtedly is the species Uhler (1878) had reported under the name *Stiphrosoma stygica* Say from the same plant in tidewater Maryland; I have seen several of Uhler's Maryland specimens of *pallipes* that he determined as a variety of *S. stygica*. Wagner (1956), following the lead of Slater (1950), showed that the New World species assigned to *Strongylocoris* are not congeneric with Palearctic species and proposed for them the new genus *Slaterocoris*. Since Knight's original description, no new localities have been added to the range of *S. pallipes*, a mirid poorly represented in collections and seldom mentioned in entomological literature. In this paper I review the known distribution of *S. pallipes*, giving additional records from the eastern U.S., and report its seasonal history on *B. halimifolia* in North Carolina.

Study Site and Methods.—*Baccharis halimifolia*, a common plant of coastal salt marshes, was sampled in an old field at Monroe, Union Co., North Carolina. Other dominant woody plants in the field were red cedar (*Juniperus virginiana* L.), short-leaf pine (*Pinus echinata* P. Mill.), red maple (*Acer rubrum* L.), and shining sumac (*Rhus copallina* L.). Various com-

posites (*Eupatorium*, *Solidago*), field garlic (*Allium vineale* L.), and grasses were common herbaceous plants.

Beginning in early April 1979 and 1980, *B. halimifolia* was observed for the first hatching of overwintered eggs. Thereafter, nymphs of *S. pallipes* (usually 5–10) were collected by tapping foliage over a 10" × 12" tray, preserved in 70% ethanol, and sorted to instar in the laboratory. The host plants were sampled through July to determine whether *S. pallipes* produced a second generation. Additional collections were made during mid-June 1977 and 1980 in New Jersey.

Distribution.—*Slaterocoris pallipes* has been recorded only from North Beach, Maryland; Beaufort, North Carolina; and the type-locality, Battle Point, Virginia (Knight 1926) which could not be located by the U.S. Board on Geographic Names, Reston, Virginia. I have collected this species from two additional localities in North Carolina, both considerably inland from previous records (Mecklenburg Co., near Pineville and Union Co., Monroe) and from New Jersey (Cape May Co., near Goshen and Ocean Co., Mystic Islands). The U.S. National Museum of Natural History, Washington, D.C., contains specimens from additional localities in Maryland (Calvert Co.: Chesapeake Beach, Plum Point; Dorchester Co.: nr. Lloyds; and St. Marys Co.: Piney Point) and from Long Island, New York (Suffolk Co.: Orient, Northwest, and Riverhead).

Although *B. halimifolia*, groundsel tree or sea myrtle, occurs in coastal marshes from Massachusetts south to Florida and west to Texas and Mexico (Fernald, 1950), *S. pallipes* may not range as far south as its host. It was not recorded in the recent list of Georgia mirids (Henry and Smith, 1979) and is not represented in identified material in the Florida State Collection of Arthropods, Gainesville, Florida. I have not taken *S. pallipes* from *Baccharis* spp. while collecting along the coasts of Georgia and Florida.

Seasonal History.—Populations of *S. pallipes* developed similarly in both years of study in North Carolina (Fig. 1). Eggs, which are inserted in lateral shoots of the current season, are flush with the stem surface and visible only as brown scars (Fig. 2). Overwintered eggs began to hatch shortly after the first flush of leaves, 7 April in 1979 and 5 April in 1980. The reddish-brown early instars feed on tender new growth, and within a few weeks host foliage appears chlorotic (Fig. 3) and spotted with black excrement. By the first week of May 1979, fourth-instars were present with fewer numbers of fifth-instars; in 1980 fourth-instars also predominated with third- and fifth-instars present. The late instars are shiny black like those of other *Slaterocoris* spp. (see Leonard, 1919, for nymphal descriptions of *S. stygicus* (Say)) but can be distinguished from those of other eastern species of the genus by the yellowish-orange legs. In both years adults began to appear during the third week of May (Fig. 1). Mating and oviposition take place from late May to early June, and by 15 June only a few adults (mostly

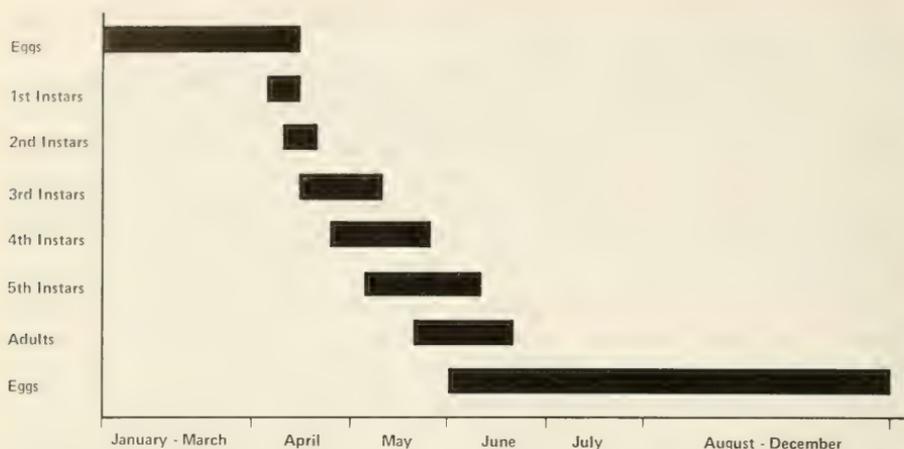
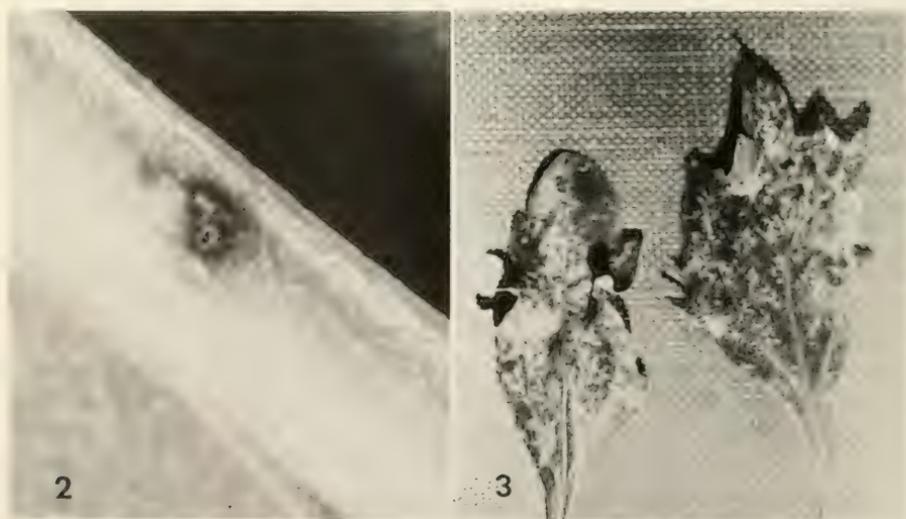


Fig. 1. Generalized seasonal history of *Slaterocoris pallipes* in North Carolina, 1979-80.

females) of this univoltine species were seen. The severe mottling and distortion of the foliage become less obvious through the growing season but sometimes are still visible at the time of leaf drop in late fall.

In more northern areas of its range *S. pallipes* develops about three weeks later. On the New Jersey coast several populations consisted mainly of fourth- and fifth-instars and only a few adults during mid-June 1977 and



Figs. 2-3. *Slaterocoris pallipes* on *Baccharis halimifolia*. 2, Oviposition scar on stem. 3, Injury to foliage.

1980. On eastern Long Island adults have been collected as early as 12 June and as late as 4 August (USNM collection).

Slaterocoris pallipes thus is a relatively early-season, univoltine species that is present in North Carolina as nymphs from early April to late May and as adults until mid-June. Like other species of *Slaterocoris* whose habits are known (Messina, 1978), *pallipes* feeds strictly on vegetative tissue. *Baccharis halimifolia* is the only known host, and this mirid may well be a specialist limited to the genus *Baccharis*. Kraft and Denno (1978) characterized the chrysomelid *Trirhabda baccharidis* (Weber) as a specialist adapted to *B. halimifolia* and suggested that this plant is free of most insect herbivory during summer and fall, possibly owing to increasing leaf toughness or presence of secondary chemicals.

ACKNOWLEDGMENTS

I thank A. R. Kendrick and F. R. Wheeler for their help in making field collections and my colleague J. F. Stimmel for taking the photographs. T. J. Henry, Systematic Entomology Laboratory, USDA, Washington, D.C. kindly made available specimens for study from the U.S. National Museum of Natural History; D. J. Orth, Executive Secretary, Domestic Geographic Names, U.S. Board on Geographic Names, Reston, Virginia, attempted to identify "Battle Point, Virginia."

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AN ILLUSTRATED KEY TO THE SPECIES OF *TYRRELLIA*
(PROSTIGMATA: LIMNESIIDAE)

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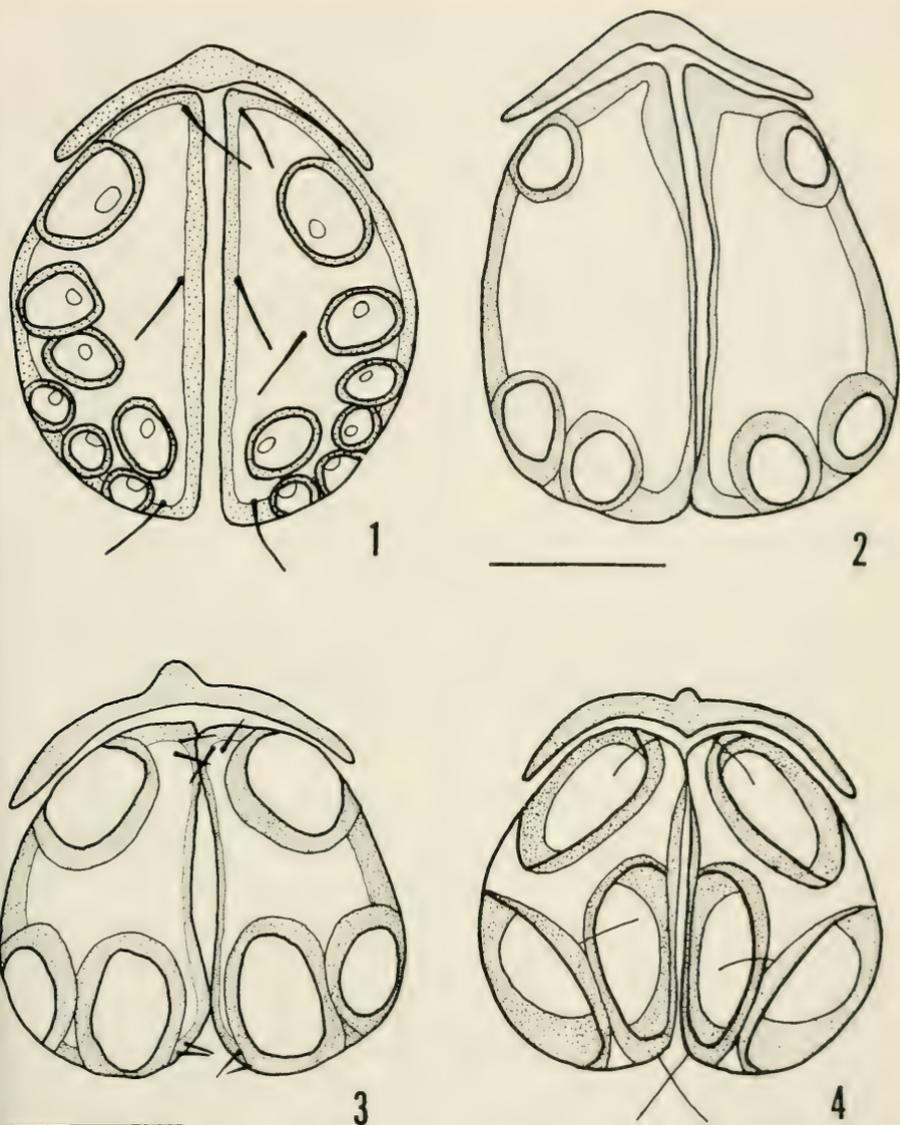
Abstract.—Water mites of the New World genus *Tyrrellia* Koenike are reviewed, and a key is presented for the seven known species.

The New World genus *Tyrrellia* is a small genus of water mites composed of seven described species. The typical habitats of these mites are the moist margins of both running and standing water (Cook, 1974). Specimens seem to be more commonly collected at the edges of springs and springbrooks than in other aquatic environments. Mitchell and Mitchell (1958) have discussed several of the adaptations of *Tyrrellia* for existence in the thin film of water characteristic of their habitat. The genus is thought to have originated in South America (Mitchell and Mitchell, 1958).

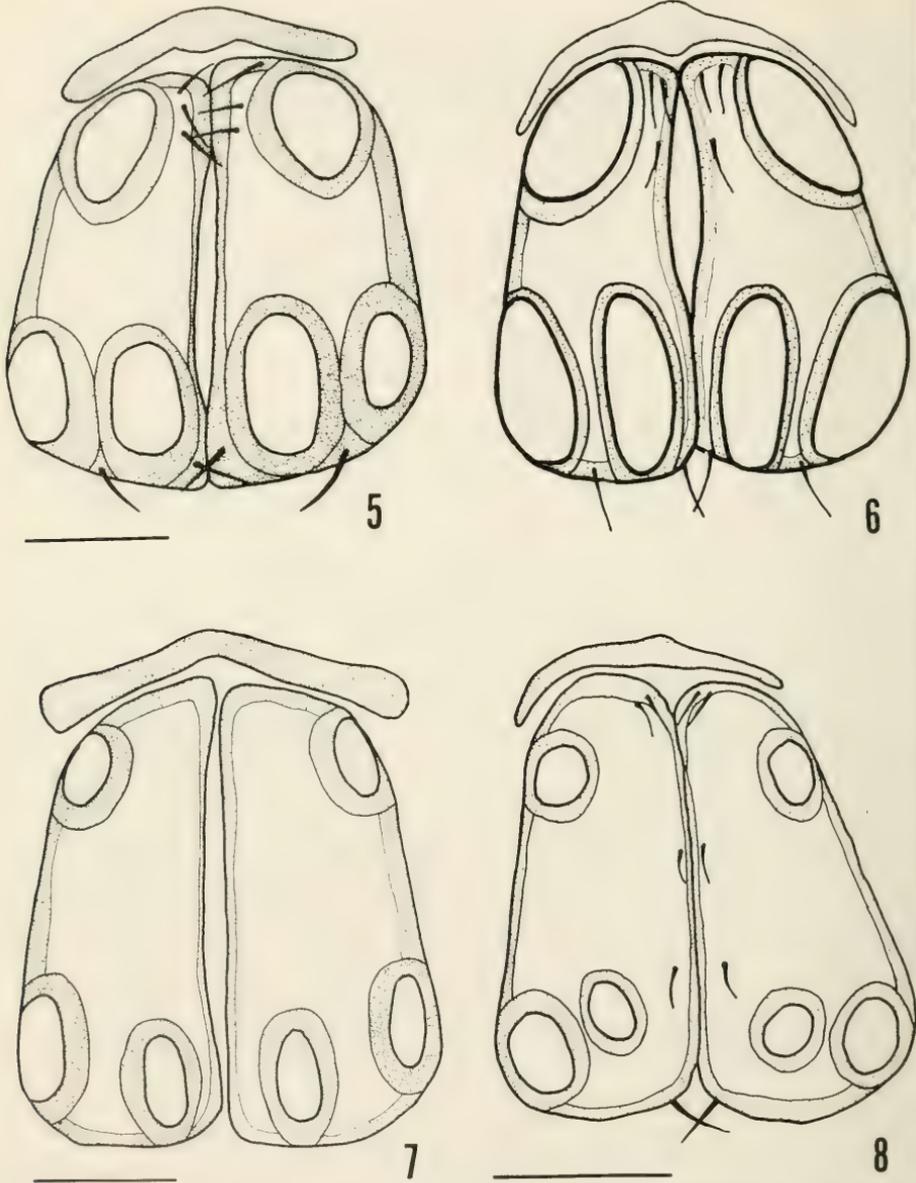
Diagnostic characteristics of the family Limnesiidae and the genus *Tyrrellia* are treated in some detail by Marshall (1940) and Cook (1974). Besch (1962) gave a key to the species of *Tyrrellia*, but the key contained several diagnostic errors.

KEY TO SPECIES OF ADULT *TYRRELLIA*

1. Six to 7 pairs of genital acetabula (Fig. 1); Florida (subgenus *Scutotyrellia*) *scutata* Cook
- Three pairs of genital acetabula (Fig. 2) (subgenus *Tyrrellia*) 2
2. Anterior dorsal plate unpaired (Figs. 9, 10) 3
- Anterior dorsal plate paired (Figs. 11, 12) 4
3. Acetabula small and uncrowded (Fig. 2); structure of 4th leg as in Fig. 15; Chile *noodti* Besch
- Acetabula large and crowded (Fig. 3); structure of 4th leg as in Fig. 16; North America *circularis* Koenike
4. Anterior dorsal plates extending to or above the rear of the eyes (Fig. 11) 5



Figs. 1-4. Genital field of adult *Tyrrellia* spp., ventral view. 1, *T. scutata*, ♀ (redrawn from Cook, 1974). 2, *T. noodti*, ♀. 3, *T. circularis*, ♀. 4, *T. crenophila*, ♂ (redrawn from Lundblad, 1941). Scale lines = 100 μ m.



Figs. 5-8. Genital field of adult *Tyrrellia* spp., ventral view. 5, *T. hibbardi*, ♀. 6, *T. ovalis*, ♀ (redrawn from Marshall, 1940). 7, *T. ovalis*, juvenile ♀. 8, *T. australis*, ♀. Scale lines = 100 μ m.

- Anterior dorsal plates not extending to or beyond the rear of the eyes (Fig. 12) 6
- 5. Acetabula of male and female large and crowded (Fig. 4); structure of 4th leg as in Fig. 17; Central and South America *crenophila* Lundblad
- Acetabula of male and female small and uncrowded (Fig. 5); structure of 4th leg as in Fig. 18; Kansas .. *hibbardi* Mitchell and Mitchell
- 6. Anterior dorsal plates small and oval, only slightly longer than wide (Fig. 13); 4th leg less than 300 μm in length (Fig. 19); female with acetabula large and oval (Fig. 6); North America *ovalis* Marshall
- Anterior dorsal plates rectangular, more than twice as long as wide (Fig. 12); 4th leg greater than 300 μm in length (Fig. 20); female with acetabula small and round (Fig. 8); Chile *australis* Besch

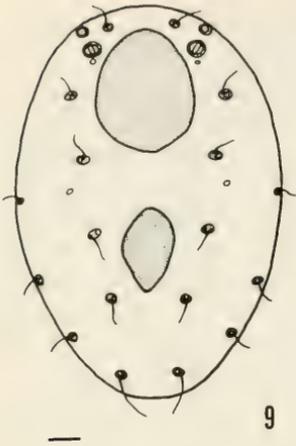
REMARKS ON *TYRRELLIA* SPECIES

Tyrrellia scutata is the only species in the subgenus *Scutotyrrellia* and is known only from its type-locality in Florida (Cook, 1974). Though the actual habitat is unknown, Cook (1974) suggested that the species inhabits open water rather than the water margin, based on the length of the leg segments.

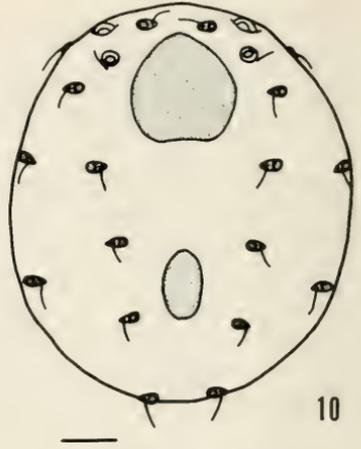
Tyrrellia australis and *T. noodti* are known only from Chile where they occur at the margins of springs (Besch, 1962). *Tyrrellia crenophila* is another South American species, recorded from Brazil and Paraguay as well as El Salvador (Lundblad, 1941). It was collected in seepage areas at the water margin.

The species with the most widespread distribution is *T. circularis*. Specimens have been collected throughout North America in California, Colorado, Texas, Kansas, North Dakota, Michigan, Illinois, Ohio, Tennessee, North Carolina, Florida, and Ontario. It usually occurs at the wet margins of streams and lakes, but specimens have been collected at the edges of hot springs (Marshall, 1940) and mineral springs (Young, 1969). McDaniel and Bolen (1979) collected a single female of *T. circularis* in a soil sample taken two meters from a lake shore. In Besch's 1962 key, *T. circularis* is separated from *T. noodti*, in part, by lacking a tapering posterior margin on the rear dorsal plate. The shape of this plate in *T. circularis* is highly variable, often tapering posteriorly. Habeeb (1975) described a new subspecies, *T. circularis bicentensis*, based on this atypical tapering of the rear dorsal plate. Lanciani (1978) reported larvae of *T. circularis* parasitic on pupae and adults of two species of Ceratopogonidae, *Dasyhelea grisea* (Coquillett) and *D. mutabilis* (Coquillett). The adult stage of the mite was found to be predaceous on the immature stages of several ceratopogonids.

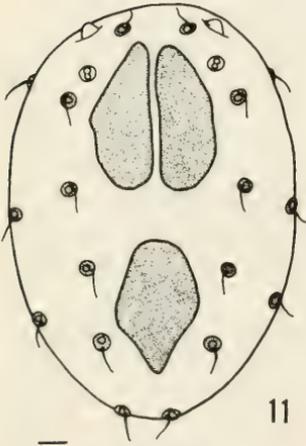
Tyrrellia hibbardi is known only from several springs in southwestern Kansas. It is restricted to wet margins at the spring source where water



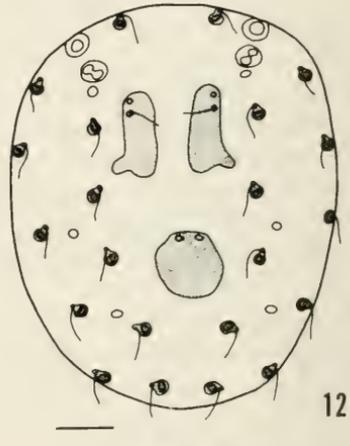
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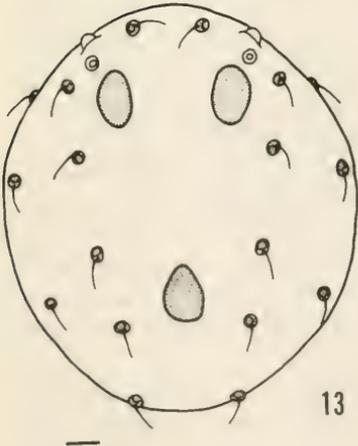
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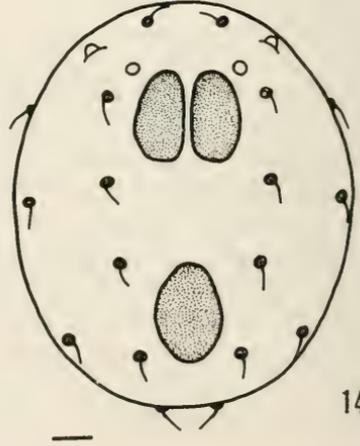
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temperature remains relatively constant year round (Mitchell and Mitchell, 1958). In the springbrooks, *T. hibbardii* is replaced by *T. circularis* and *T. ovalis*.

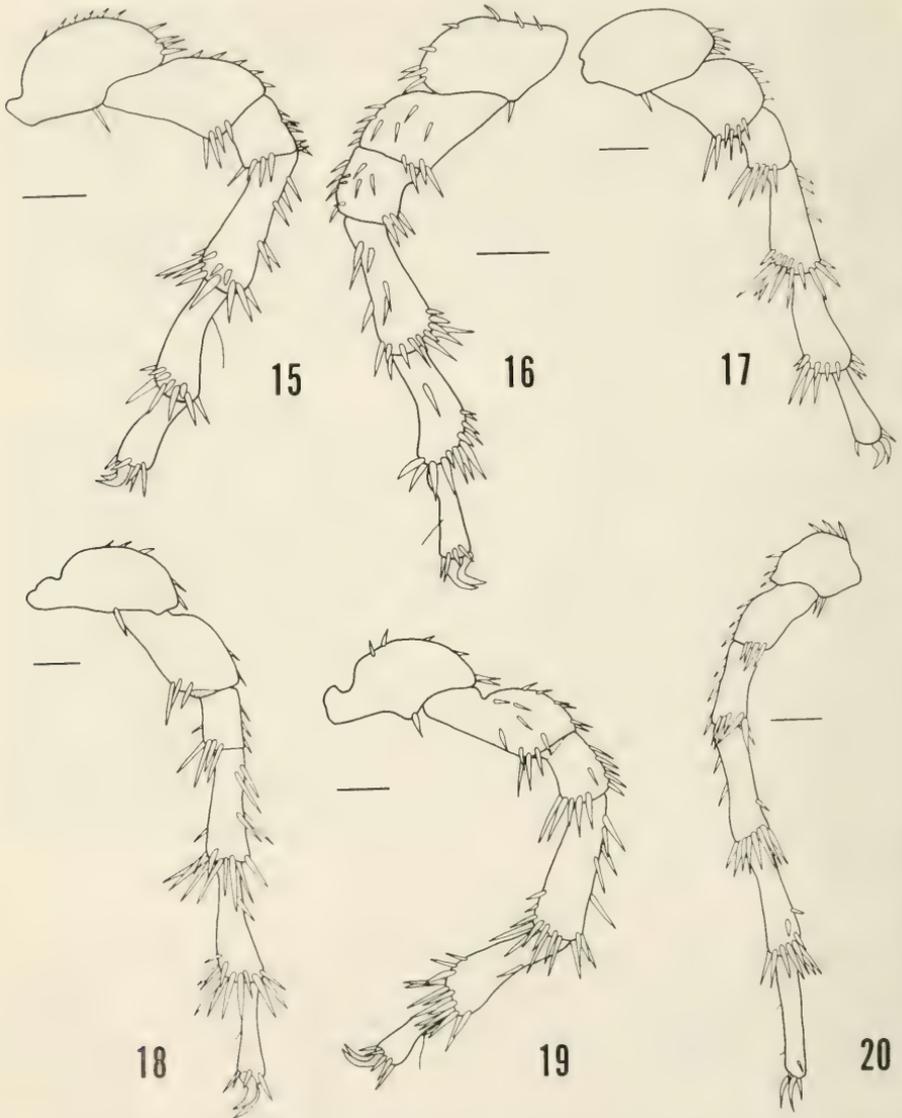
The records for *T. ovalis* are rather scattered, though it is probably a widely distributed species in North America. It has been recorded from Kansas, North Dakota, Wisconsin, Michigan, and Illinois. As for other *Tyrrellia*, it occurs at the margins of lakes and streams. In Besch's 1962 key, *T. ovalis* is identified on the basis of a paired posterior dorsal plate. In the original description, Marshall (1932) described two small posterior plates, but in a redescription, Marshall (1940) said this character was extremely rare. In the 61 specimens I examined from throughout the United States, the posterior dorsal plate is entire.

In collections of *T. ovalis*, juveniles are usually more abundant than adults. Only 12 adults were found, and only juveniles were present in collections from North Dakota, Kansas, and Illinois. Although there was no significant morphological variation detected in the various populations of juveniles examined, the juvenile form was noticeably different from the adult in overall size (Table 1) and in the form of both the acetabula (Fig. 7) and the anterior dorsal plates (Fig. 14). The overall size difference was significant ($P \leq 0.01$) as was the distance between the anterior plates ($P \leq 0.01$). Evidently, as the mite grows larger the anterior plates spread apart. Without careful identification, the juvenile of *T. ovalis* could be confused with the female of *T. hibbardii*; however, the shape of the acetabula (Figs. 5, 7) and the overall body size (Figs. 11, 14) will clearly distinguish the two species. Measurements of *T. hibbardii*, the only other North American *Tyrrellia* with paired anterior plates, were tabulated by Mitchell and Mitchell (1958).

ACKNOWLEDGMENTS

I thank E. Smith, Field Museum of Natural History, Chicago, Illinois, and W. Welbourn and D. Johnston, Ohio State University, Columbus, for the loan of specimens. D. Cook, Wayne State University, Detroit, Michigan, and E. Cross, University of Alabama, University, are due thanks for reviewing the manuscript and suggesting improvements. I also thank T. Deason, University of Alabama, for translating the German publications, H. Smith, University of Alabama, for help in preparing the photographic plates.

←
Figs. 9-14. Dorsal surfaces of adult *Tyrrellia* spp. 9, *T. noodi*, ♂. 10, *T. circularis*, ♂. 11, *T. hibbardii*, ♂. 12, *T. australis*, ♀. 13, *T. ovalis*, ♀. 14, *T. ovalis*, juvenile ♀. Scale lines = 100 μm .



Figs. 15-20. Fourth leg of adult *Tyrrellia* spp., ventral view. 15, *T. noodti*, ♀. 16, *T. circularis*, ♀. 17, *T. crenophila*, ♂ (redrawn from Lundblad, 1941). 18, *T. hibbardi*, ♀. 19, *T. ovalis*, ♀. 20, *T. australis*, ♀. Scale line = 100 μ m.

Table 1. Means and standard deviations (μm) for several morphological parameters of *Tyrrellia ovalis*.

	Juvenile	Adult
Overall length	855.0 \pm 194.3	1365.7 \pm 307.9
Overall width	740.0 \pm 148.0	1156.4 \pm 206.2
Length of anterior plates	154.7 \pm 62.6	144.2 \pm 33.3
Width of anterior plates	81.4 \pm 14.4	104.7 \pm 32.9
Distance between anterior plates	63.5 \pm 32.0	118.8 \pm 25.4
Length of posterior plate	155.7 \pm 38.5	140.3 \pm 59.7
Width of posterior plate	115.7 \pm 18.9	114.6 \pm 22.9

and G. Mullen, Auburn University, for providing several literature references.

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**ELSIELLA, A NEW GENUS FOR *EBORA PLANA* WALKER, 1867
(HEMIPTERA: PENTATOMIDAE)**

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Abstract.—**Elsiella**, a new genus for the "lost" Ecuadorian species *Ebora plana* Walker, 1867, belongs among those genera of the tribe Pentatomini characterized by the specialized elevations on the midline of the pro-, meso-, and metasterna. Its siblingship appears to lie with the genus *Serdia* Stål.

The Ecuadorian species *Ebora plana* was described by Walker (1867: 416-417), along with three Australian species, in his new genus *Ebora*. Commenting upon this species he wrote, "This species may be the type of a distinct genus." Much later Kirkaldy (1909: XXXII) selected the Australian species *Ebora circumdata* Walker as the type-species of *Ebora* and then (1909: 186) placed that genus in synonymy under the genus *Notius* Dallas (1851: 155) in the tribe Halyini; he placed the species *Ebora plana* in his list of "Pentatominae of uncertain position," a status which it has retained.

Now, through the kind and persistent searching of the collection of the British Museum (Natural History) by Dr. W. R. Dolling, Walker's type-specimen has been located. That specimen is in reasonable study condition but the pin broke the scutellum, dislocated the pronotum, and in passing out of the insect's body exploded the metasternal elevation; in addition, dermestids damaged the dorsum of the abdomen and destroyed all the membrane on one wing and the base of the other membrane. Fortunately at least one of each appendage is present. Thus it was possible for my wife, Elsie Herbold Froeschner, to reconstruct nearly the entire dorsal aspect of the holotype (except the base of the membranes) in her drawing (Fig. 1). The original locality label bearing the word "Archidona" is still present. Because the holotype appears so very brittle and has had the abdomen cleaned out by dermestids I made no attempt to dissect it.

Unfortunately the original description omitted mention of most of the important structural characters and thus prevented subsequent generic

placement of the species. The following combination of characters necessitates considering "*Ebora*" *plana* as a member of the tribe Pentatomini in the subfamily Pentatominae: Head without a preocular angulation; labium arising near anterior ends of the parallel bucculae; antennophores not visible dorsally; antenna five-segmented; pronotum laterally not explanate; elongate scutellum extending beyond apices of frena; hemelytral membranal veins not anastomosing; abdomen ventrally transversely convex (no longitudinal median sulcus) without stridular areas; trichobothria of abdominal segment VII (last pregenital) laterad of line connecting outer margins of spiracles; and three-segmented tarsi.

"*Ebora*" *plana* belongs to that section of the tribe Pentatomini characterized by specialized elevations of the midline of the pro-, meso- and metasterna, the latter abutting against the subbasal elevation of the abdomen. In Rolston et al. (1980) key to American genera of this group, "*Ebora*" *plana* would be a member of the genus *Serdia* Stål. In spite of the close sibblingship with *Serdia* implied by common possession of the specialized elevations of the sterna and abdomen and the derived condition of elongate juga meeting anterior to the clypeus, the general aspect of "*Ebora*" *plana* and certain details of structure are certainly not included in the present concept of *Serdia*. To avoid destroying the current uniformity of *Serdia* by expanding it to accommodate "*Ebora*" *plana* before genitalic features can be examined, a new genus *Elsiella* is proposed for that species.

The following couplet presents a ready means of separating the two genera:

- Antennal segment II much shortened, distinctly less than $\frac{1}{2}$ as long as segment III. Metapleural evaporatium not rugose. General coloration dull sordid yellow with numerous fuscous punctures
 *Serdia* Stål
- Antennal segment II much longer, about $\frac{4}{5}$ as long as segment III. Metapleural evaporatium strongly rugose. General coloration shining reddish chestnut with concolorous punctures *Elsiella*, new genus

Elsiella Froeschner, NEW GENUS

Figs. 1, 2

Description.—Broadly oblong oval; greatest width (across abdomen near apex of scutellum) slightly more than $\frac{1}{2}$ length (ratio 60:112). Dorsal and ventral surfaces shining, former with numerous close set fine distinct punctures, venter distinctly convex, strongly punctate on pleura, vaguely punctate on sides of abdomen. Head and anterior $\frac{2}{3}$ of pronotum declivitous.

Head triangular, median length equalling width of vertex plus one eye; eye immersed about $\frac{1}{2}$ way in head, in contact with anterior margin of pronotum (distorted in pinned holotype, hence illustrated (Fig. 1) as re-



Fig. 1. *Elsiella plana*. Dorsal view of holotype (partially reconstructed: head probably should be inserted up to eyes).

moved from anterior margin); juga with apices obliquely elevated, distinctly surpassing and contiguous anterior to apex of clypeus. Ocelli situated well behind imaginary line connecting posterior margins of eyes. Interocellar space approximately $3\times$ space between ocellus and closest eye. Antenna slender, cylindrical, 5-segmented, segment I attaining apex of head, ratio of segments I-V, 40:35:45:60:97. Bucculae as long as labial segment I, gradually evanescent posteriorly. Labium reaching between posterior coxae, segments I-IV in the ratios 45:85:65:58.

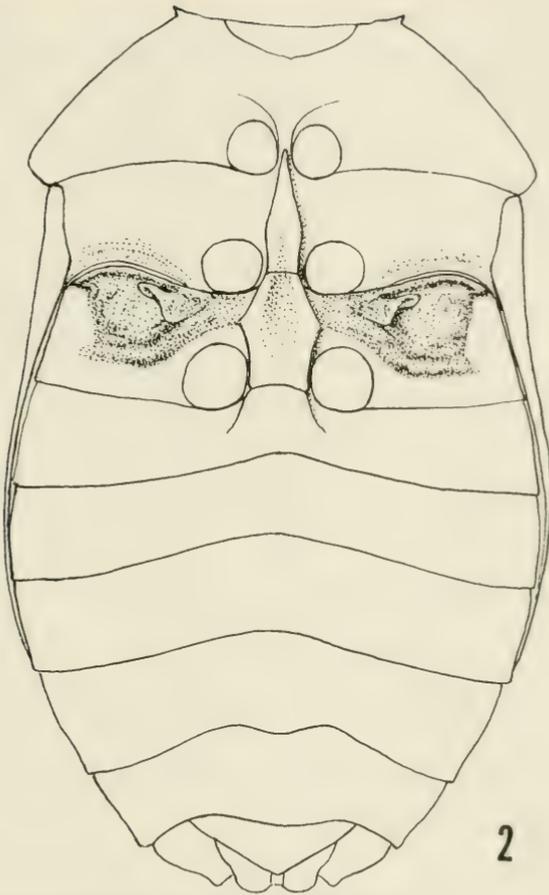


Fig. 2. *Elsiella plana*. Ventral view of thorax and abdomen.

Pronotum more than twice as wide as median length (ratio 154:65). Lateral margins slightly but distinctly recurved. Anterolateral angle projecting laterally as a very small, acute tooth. Humeral angle roundly subrectangular, not produced. Posterior margin gently concave. Median line marked by a slight, irregular carina.

Scutellum nearly $1\frac{1}{2}\times$ as long as basal width (ratio 114:81). Surface more sparsely punctate than pronotum or corium. Each basal angle with a deep, concolorous fovea. Frenum reaching apical $\frac{1}{3}$.

Hemelytron with costal outline weakly concave on basal $\frac{1}{4}$, convex beyond. Apical margin of corium mostly straight, convexly curved near scutellum. Punctures close set throughout, somewhat denser on exocorium. Membrane (reconstructed on drawing) reaching apex of abdomen: venation mostly simple, one vein with 2 branches.

Femur not armed. Tibia terete, dorsal surface with a very shallow sulcus ending basally at an obsolete conical tubercle. Tarsal segment I subequal to II plus III, II very short.

Prosternum transversely slightly elevated. Mesopleuron with posterior $\frac{1}{4}$ bearing a distinctly rugose, impunctate, dulled evaporatorium. Mesosternal median line narrowly pentagonally elevated; elevation longitudinally convex, transversely flattened; broadest basal part slightly wider than labial segment III; posterior margin weakly concave, abutting against elevated metasternum. Metapleural evaporatorium occupying all but broad lateral and posterior margins of segment. Ostiolar sulcus short, reaching less than $\frac{1}{2}$ way from ostiole to lateral margin of metapleuron. Metasternum elevated, surface slightly impressed; anteriorly as wide as elevation of mesosternum; sides diverging for about $\frac{1}{2}$ their length, thence subparallel; widest part between posterior coxae about as wide as a coxal diameter; posterior margin shallowly concave, abutting against the broad subbasal elevation of the abdomen. Abdomen, except for the polished, impunctate, broad, median stripe and lateral edges, with numerous well-separated weak to obscure punctures.

Type-species: *Ebora plana* Walker, monotypy and present designation.

This genus is named for my wife, Elsie Herbold Froeschner, whose more than 40 years of companionship, knowledge of science, artistic abilities, and sympathetic understanding of systematic entomology have made my life and my works better than they could have been without her.

Elsiella plana (Walker), NEW COMBINATION

Ebora? plana Walker, 1867: 416–417.

Length, 11.8 mm.

So far this species is known only from the type-specimen.

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TWO NEW SPECIES OF BITING MIDGES AND A CHECK LIST OF
THE GENUS *CULICOIDES* (DIPTERA: CERATOPOGONIDAE)
FROM SRI LANKA

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Abstract.—Two new species of *Culicoides*, *C. schramae* and *C. krombeini* from Sri Lanka, are described and illustrated. Characters are presented to separate them from other species in the *similis* and *neavei* groups. A check list is presented of the 27 known *Culicoides* species of Sri Lanka.

The *Culicoides* fauna of Sri Lanka is poorly known and no check list has been published for this genus. Delfinado and Hardy (1973) listed 13 species occurring there, and an examination of the collections of Asian *Culicoides* at the U.S. National Museum of Natural History (USNM) adds records for two more species from Sri Lanka. Our studies of material collected by Davis and Rowe in 1970 and Messersmith and party in 1975 add 12 more species for a total of 27 species representing six subgenera. Two new species found in the latter collections are described here.

CHECK LIST OF THE *CULICOIDES* SPECIES OF SRI LANKA

Species	Delfinado and Hardy (1973)	In UNSM Collection before 1970	Sri Lanka Collections of 1970 and 1975
Subgenus <i>Avaritia</i> Fox			
<i>actoni</i> Smith	+	-	+
<i>boophagus</i> Macfie	+	-	-
<i>brevipalpis</i> Delfinado	+	-	-
<i>brevitarsis</i> Kieffer	-	-	+
<i>jacobsoni</i> Macfie	-	-	+

¹ The fieldwork of D. H. Messersmith was funded by a Smithsonian Research Foundation Grant, "Biosystematic Studies of the Insects of Ceylon."

CHECK LIST OF THE *CULICOIDES* SPECIES OF SRI LANKA (Continued)

Species	Delfinado and Hardy (1973)	In UNSM Collection before 1970	Sri Lanka Collections of 1970 and 1975
Subgenus <i>Culicoides</i> Latreille			
<i>amamiensis</i> Tokunaga	—	—	+
<i>indianus</i> Macfie	—	—	+
<i>innoxius</i> Sen and Das Gupta	+	+	+
<i>peregrinus</i> Kieffer	—	+	+
<i>recurvus</i> Delfinado	+	—	—
Subgenus <i>Haemophoructus</i> Macfie			
<i>gemellus</i> Macfie	—	—	+
<i>gentilis</i> Macfie	—	+	—
Subgenus <i>Meijerehelea</i> Wirth and Hubert			
<i>histrion</i> Johannsen	+	—	—
Subgenus <i>Oecacta</i> Poey			
<i>schantzei</i> (Enderlein)	+	—	+
Subgenus <i>Trithecoides</i> Wirth and Hubert			
<i>anophelis</i> Edwards	+	+	—
<i>elbeli</i> Wirth and Hubert	—	—	+
<i>flaviscutatus</i> Wirth and Hubert	+	+	+
<i>palpifer</i> Das Gupta and Ghosh	—	—	+
<i>paraflavescens</i> Wirth and Hubert	+	+	—
Subgenus Uncertain			
<i>bilobatus</i> Kieffer	+	—	—
<i>ceylanicus</i> Kieffer	+	—	—
<i>distinctus</i> Sen and Das Gupta	—	—	+
<i>huffi</i> Causey	+	—	+
<i>krombeini</i> , new species	—	—	+
new species 78, Wirth and Hubert, MS	—	—	+
<i>parviscriptus</i> Tokunaga	—	—	+
<i>schramae</i> , new species	—	—	+

Descriptions in this paper are based on ratios measured and determined with the following methods. The antennal ratio (AR) is determined by dividing the combined lengths of the last five flagellar segments by those of the first eight flagellar segments. The palpal ratio (PR) is obtained by dividing the length of the third palpal segment by its greatest breadth. In palpal proportions a line halfway between the oblique junction of the first two segments is the base line for measuring these segments. The proboscis/head ratio (P/H) is obtained by dividing the distance from the tip of the labrum-epipharynx to the torus, by the distance from the latter to the interocular seta base. Wing length is measured from the basal arculus to the wing tip,

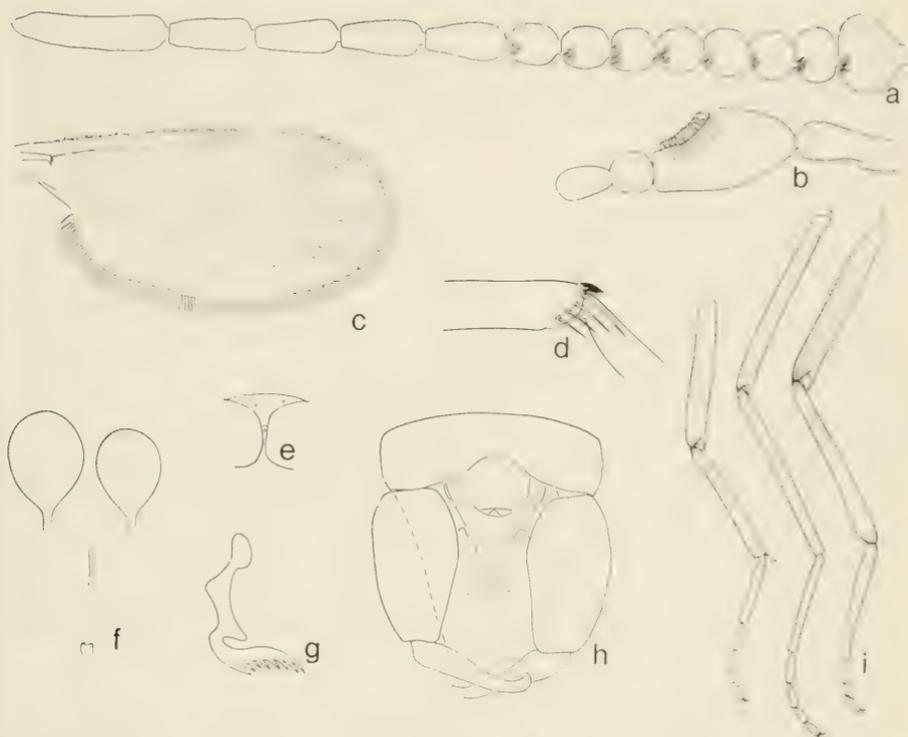


Fig. 1. *Culicoides schraemae*. a-f, i, Female. g-h, Male. a, Antenna. b, Palpus. c, Wing. d, Tibial comb. e, Eye separation. f, Spermathecae. g, Parameres. h, Genitalia, parameres removed. i, Legs.

and the costal ratio (CR) is determined by measuring the distance from the basal arculus to the end of the costal vein and dividing this value by the wing length. The spermathecal measurements include the sclerotized portion of the neck.

Culicoides schraemae Giles, Wirth, and Messersmith, NEW SPECIES

Fig. 1

Female Holotype.—Wing length 0.85 mm.

Head: Eyes bare, almost contiguous, interocular space (Fig. 1e) narrowly wedge-shaped. Antennal flagellar segments (Fig. 1a) with lengths in proportion of 13-9-9-10-11-11-11-11-18-19-19-20-34, AR 1.29; sensilla coeloconica present on antennal segments 3-10. Palpal segments (Fig. 1b) with lengths in proportion of 10-30-50-17-20; 3rd segment moderately swollen, sensory pit broad and shallow; PR 1.79. Proboscis short, P/H 0.63; mandible with 9 well-developed teeth.

Thorax: Dark brown. Legs (Fig. 1i) pale brown, knee spots black; femora pale at bases with faint subapical bands on fore- and midlegs; tibiae with subbasal pale rings; hindtibia with distal $\frac{1}{2}$ pale, extreme tip slightly darkened; hindtibial comb (Fig. 1d) with 4 spines, the one nearest the spur longest.

Wing: Fig. 1c, pale spot over r-m crossvein covering $\frac{3}{4}$ of 1st radial cell, extending from vein M1 to broadly meet costa; stigma dark, extending to tip of 2nd radial cell; cell R5 with 2 poststigmatic pale spots almost merging, anterior one lying nearly entirely distad of costa, posterior one smaller and lying behind distal end of the 1st and touching vein M1 posteriorly; large distal pale spot in cell R5 indented on proximal side, not touching vein M1, broadening anterodistally on wing margin; cell M1 with 2 pale spots, proximal one extending into cell M2 but broken by the dark line of vein M2, distal one ovate and reaching wing margin; cell M2 with pale streak from basal arculus to medial fork, small pale spot lying just behind medial fork, larger pale spot lying just in front of mediocubital fork, the distal pale spot quadrate and meeting wing margin; anal cell pale at base with large pale subapical spot, the latter with posterior extension that weakly, but broadly, meets wing margin. Cell M4 with large quadrate, subapical pale spot that meets wing margin. Macrotrichia sparse on distal $\frac{1}{2}$ of wing; CR 0.55. Halter pale.

Abdomen: Pale brownish with 9th segment dark brownish. Spermathecae (Fig. 1f) 2, slightly unequal, measuring 0.062 by 0.039 mm and 0.055 by 0.032 mm, oval with long slender necks; rudimentary spermatheca and sclerotized ring present.

Male Allotype.—Genitalia (Fig. 1h) with 9th sternum short with shallow and moderately broad caudomedian excavation; 9th tergum moderately long with apicolateral processes short and slender. Basistyle moderately stout with roots long, heavy and well sclerotized; dististyle short, slender, and gently curved. Aedeagus with short basal arms, basal arch extending $\frac{1}{3}$ of total length; tapering sharply to slender distal process with slender beadlike tip. Parameres (Fig. 1g) each stout with basal portion slightly bent anterolaterally; basal knob moderately expanded; stem stout, with ventral process well developed and directed ventrally; distal portion expanded, flat, blade-like, stout to tip, with lateral fringing spines.

Distribution.—Sri Lanka.

Types.—All on slides in phenol-balsam. Holotype ♀, Uggalkaltota, Sri Lanka, 5 Feb. 1970, coll. D. Davis and W. Rowe, light trap (type no. 72202, USNM). Allotype ♂ and paratype ♀, Kalli Villu, Wilpattu National Park, Sri Lanka, 12–13 June 1975, coll. D. H. Messersmith, G. L. Williams, and P. B. Karunaratne, at light; deposited in USNM. Paratype ♀, Medawachchiya, Anuradhapura District, Sri Lanka, 15 June 1975, same collectors as allotype, at light; will be deposited in the Colombo National Museum, Co-

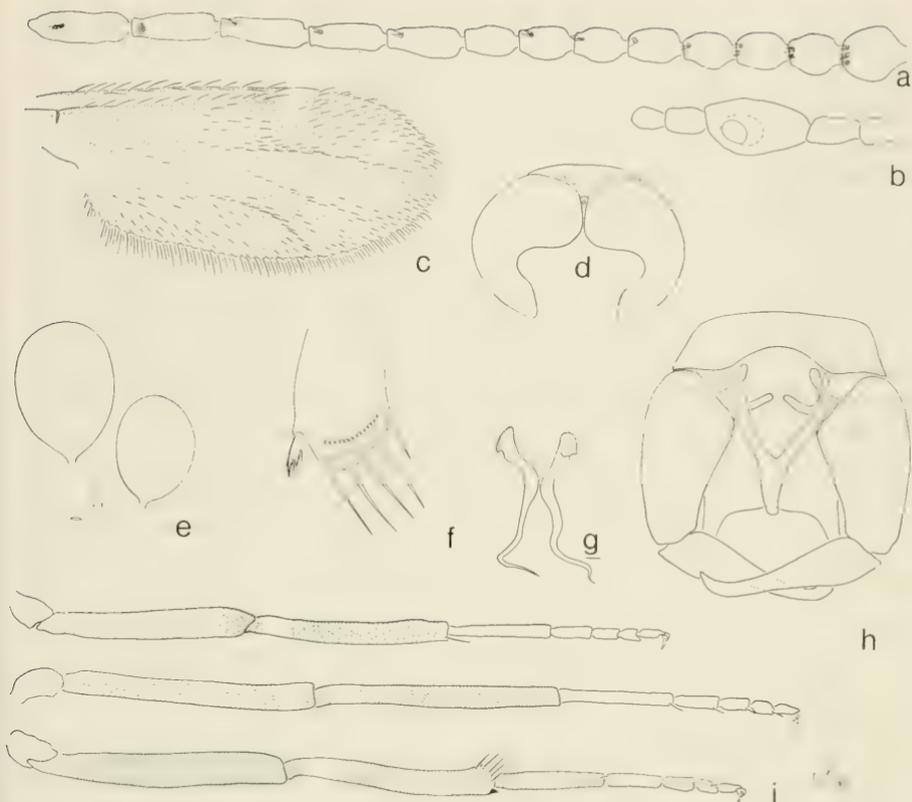


Fig. 2. *Culicoides krombeini*. a-f, i, Female. g-h, Male. a, Antenna. b, Palpus. c, Wing. d, Eye separation. e, Spermathecae. f, Tibial comb. g, Parameres. h, Genitalia, parameres removed. i, Legs.

lombo, Sri Lanka. Paratype ♀, Inginiyagala, Monaragala District, Sri Lanka, 1-5 June 1975, same collectors as allotype, deposited in USNM. Two paratype ♀, Kalutaluwewa, Colombo, Sri Lanka, 19 Feb. 1958, Medical Research Institute, light trap; one deposited in USNM, the other will be deposited in the National Museum at the University of Sri Lanka at Peradeniya.

Discussion.—The species is named for Ms. M'Lou Schram in recognition of her help during this study.

Culicoides schramae is similar to *C. huffi* Causey and *C. similis* Carter, Ingram, and Macfie of the *similis* group. *Culicoides huffi* differs in having sensilla coeloconica on antennal segments 3, 5, 7-10, AR 1.46, the distal pale spot in cell R5 rounder, and the proximal pale spot in cell M1 not lapping over into cell M2. *C. similis* has sensilla coeloconica like those of

C. huffi, and the posterior poststigmatic pale spot in cell R5 does not come in contact with vein M1.

Culicoides krombeini Giles, Wirth, and Messersmith, NEW SPECIES
Fig. 2

Female Holotype.—Wing length 0.94 mm.

Head: Eyes bare, almost contiguous, interocular space (Fig. 2d) narrowly wedge-shaped. Antennal flagellar segments (Fig. 2a) with lengths in proportion of 20-15-16-15-14-15-15-15-22-22-25-24-30, AR 1.07; sensilla coeloconica present on antennal segments 3-9 and 11-15. Palpal segments (Fig. 2b) with lengths in proportion of 8-16-32-12-11; 3rd segment moderately swollen, sensory pit moderately broad and deep, opening by slightly smaller pore; PR 2.0. Proboscis moderately short, P/H 0.72. Mandible with 13 fine, well-developed teeth.

Thorax: Dark brown with small anterior portion and pleural regions lighter. Legs (Fig. 2i) with dark brown knee spots; forefemur pale brown, mid- and hindfemora darker brown with base and apex of midfemur lighter and base of hindfemur lighter; tibiae dark brown with subbasal pale bands; hind-tibial comb (Fig. 2f) with 4 spines, the one nearest the spur but slightly longer.

Wing: Fig. 2c, second radial cell long and narrow. Pale spot over r-m crossvein covering base of 1st radial cell, extending from vein M1 to radius; stigma moderately dark, covering all of 2nd radial cell and about $\frac{3}{4}$ of 1st radial cell; poststigmatic pale spot narrowly quadrate and extending posterad about $\frac{1}{2}$ width of cell R5; cells R5, M1, M2, M4 and anal cell distally each with distinct, moderately small, round, pale spot not attaining wing margin; cell M1 with moderately large basal pale spot in line with poststigmatic spot; cell M2 with moderately large, elongate pale spot lying behind medial fork and pale streak lying $\frac{1}{2}$ way between the latter and distal pale spot; anal cell with small triangular pale spot basally; small pale spot just distad of arculus; macrotrichia long, coarse and abundant, extending nearly to base of wing; CR 0.59. Halter with dark brown knob, pale pedicel.

Abdomen: Light brown. Spermathecae (Fig. 2e) 2, unequal, measuring 0.067 by 0.023 mm and 0.051 by 0.037 mm, oval with very short necks; rudimentary spermatheca and sclerotized ring present.

Male Allotype.—Genitalia (Fig. 2h) with 9th sternum short with moderately deep and broad caudomedian excavation; 9th tergum relatively long, apicolateral processes long and slender. Basistyle moderately stout with roots long and slender; dististyle slender and slightly hooked. Aedeagus with slender basal arms, basal arch extending $\frac{3}{5}$ of total length; distal process slender with rounded tip. Parameres (Fig. 2g) each with expanded, sclerotized basal knob; sinuous midportion slightly swollen proximally and gradually tapering distally to end in simple filamentous tip abruptly bent ventrally.

Distribution.—Sri Lanka.

Types.—All on slides in phenol-balsam. Holotype ♀, Kalli Villu, Wilpattu National Park, Puttalam District, Sri Lanka, 13 June 1975, coll. D. H. Messersmith, G. L. Williams, P. B. Karunaratne, at light (type no. 72205, USNM). Allotype ♂ and paratype ♀, same data as holotype. Holotype and allotype deposited in USNM. Paratype female will be deposited in the Colombo National Museum at Colombo, Sri Lanka.

Discussion.—This species is named in honor of Dr. Karl V. Krombein of the Smithsonian Institution in recognition of his leadership in organizing and directing the Smithsonian Ceylonese Insect Project.

Culicoides krombeini is similar to *C. shermani* Causey in the *neavei* group. The latter species, however, has wing macrotrichia that are longer and coarser and covering more of the wing; a dark area on the anterior margin of cell R5 distal to the poststigmatic spot, a smaller basal pale spot in cell M1, the distal pale spot in the anal cell elongate rather than round; and, most distinctive of all, a much deeper palpal pit with a small, longitudinal, oval pore.

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Doris in her late teens.

DORIS HOLMES BLAKE
January 11, 1892-December 3, 1978

With steadfastness and dedication, New England born Doris Holmes Blake pursued her study of beetles (Chrysomelidae) from about 1920 until illness overtook her in the fall of 1978. For the last forty years she worked

virtually without remuneration and payed her own transportation on her daily pilgrimage to the Smithsonian's National Museum of Natural History.

Doris Mildred Holmes, daughter of Arthur Lake Holmes and his wife Lucy Wentworth, was born in the little town of Stoughton, Massachusetts. Her parents, both of long New England lineages, were frugal, hardworking, conscientious people who encouraged reading and study. In later years Doris often recounted the remembrance of her very first day of school. The teacher asked if anyone could recite the alphabet. A boy stood up and recited it well, impressing the teacher and the whole class. Doris dashed home and asked her mother to teach her the alphabet. The next day she proudly recited it in class and duly impressed everyone. That boy was Sidney Fay Blake who was to become her husband in 1918. All through school she and Sidney vied with each other to be the most excellent scholar.

In those formative years, both Doris and Sidney came under the influence of Dr. Robert G. Leavitt of the Ames Botanical Laboratory of Harvard University. He lived nearby and held informal classes dealing with the flora of the Stoughton area for those townfolks who wished to learn of their native plants. Doris Holmes and Sidney Blake soon outshone all others. This initiation into the scientific world was to blossom into lifelong, deeply dedicated careers in science—his in Botany and hers in Entomology.

Curiously, her college program at Boston University was not in science but emphasized the Classics, Greek and Latin, and Philosophy. Alongside she studied all the secretarial skills her father insisted on—he, being a practical man, thought those accomplishments provided a surer way to earn a living.

Following graduation in 1913 her training earned for her a position as an Intern under the well-known psychologist Dr. Herman Adler of the Boston Psychopathic Hospital. Doris' powers of scientific observation and her careful dedication to detail soon had her screening incoming patients, writing up case histories and even presenting these to the young doctors who came over from Harvard Medical School.

This was followed by work under Dr. Robert Yerkes the outstanding American primate psychologist. It was during this period that she was encouraged to attend Radcliffe College from which she received an M.A. degree in 1917.

Then followed a period of psychological work at the Bedford Hills Reformatory for Women. This ended shortly when Dr. Sidney Fay Blake returned from two years of botanical study in Europe and having entered a new federal position in Washington, D.C. asked her to marry him in May of 1918.

Her first entomological work came under Dr. Frank Chittenden in the Division of Truck Crops Insects of the United States Department of Agriculture. She remained in that position until the Depression times of the

1930's when only one person in a family could continue to work for the government. She returned to do independent research work at the Smithsonian's National Museum of Natural History where Dr. Alexander Wetmore found for her a desk, a microscope, and a work space up under the dome of the museum. It was very cold in winter and extremely hot in summer. But as she said, its merits were no telephones or other interruptions. The Entomology Department had no extra space, and, for at least twenty-five years, she remained up under the dome. Later, workspace for her last fifteen years was kindly provided by her friend Dr. Doris Cochran and the Herpetology Department. In 1959 she was temporarily employed by the Smithsonian Division of Entomology to incorporate the Munros Collection of beetles into the Smithsonian Collection.

From 1904 on she faithfully kept diaries, the first ones childlike, but the later ones with rare insight and developed writing skills. She recounted each day—the weather, followed by the events of the day and depiction of people. She could describe in a picturesque, candid, and witty way people's stature, faces, clothes, actions, interrelationships, and pertinent bits of conversation. A real pleasure to read—if one is proficient in German script! Her diaries are in the English language but in German script from her high school days on. She used this script to keep her father from reading her inmost teenage thoughts. In this manner she continued writing for nearly seventy years her happy or sad informative chronicle according to the way her life unfolded.

Her ability to analyze people by concise, colorful word sketches tinged with wit and an impish quality and yet with a deep understanding of their intellectual abilities reached a high point in her writing "Two Old Coleopterists" (1951e and 1952a). It was the story of Dr. Frank Chittenden "a towering grouch" and Dr. Eugene Schwarz a most gentle and kindly man. Doris Blake understood them both so well. Smithsonian Secretary Alexander Wetmore wrote to her about these word-portraits, "You have made a valuable record in a most sympathetic and understanding manner" and expressed much pleasure and satisfaction. Many others enjoyed that paper and it formed the basis of much that John Sherwood wrote in his excellent feature article on Doris Blake, "The Courtly Coleopterist," in the Washington Star, January 9, 1977. To her, Sherwood's article was a crowning event on a long dedicated career carried on in spite of private life adversities such as loss of a baby son, death of her husband and the sudden passing of her only daughter.

The need to consult types in collections led to her trips to Europe, the first in 1925 another in 1951. Following her husband's death, she spent four months in France, England, and Germany in 1960 studying the genus *Neobrotica* on a National Science Foundation Grant. In the middle sixties Doris Blake and her friend, herpetologist Dr. Doris Cochran of the U.S. National Museum of Natural History, toured South America from Rio de Janeiro

south to Argentina and back through Peru, Colombia, and Panama, collecting specimens and visiting scientists and museums along the way. She also made a short collecting and study trip to Jamaica. Earlier she and her husband shared many collecting trips in the United States.

As a productive chrysomelid specialist she proposed 25 generic and 818 species-group names [see Appendix II] in 96 papers published between 1924 and 1978 [see Appendix I]. All but one of her own species and nearly all other species considered in her taxonomic work were visually communicated by a full dorsal habitus figure and sometimes with additional figures. Many of her papers were revisionary in scope and provided useful keys [see Appendix III]. She kept no personal collection of beetles.

Richard Blackwelder, in his article entitled "Twenty-five Years of Taxonomy" (Systematic Zoology June 1977), championed Doris Blake and evaluated her work as follows: "In 1927 Doris H. Blake, wife of a U.S.N.M [!] botanist, began to do revisionary work on chrysomelid beetles. From then until the present day Mrs. Blake has completed dozens of revisions in this family. Recently while typing the Checklist (described under Taxonomic Monographs and under Computers below), I came to realize that Mrs. Blake's work has stood the test of use by other people better than most others of the prolific writers in this field in this period. Her new species are almost without exception accepted as valid species, whereas this can be said of few other taxonomists in the fields of rapid growth and frequent revision. Some taxonomists, who describe occasional species, have a very high rate of synonymy (or reduction to subspecies), whereas many of these who do revisionary work as specialists on particular groups produce synonyms at a low rate, but one which mounts up in time in their voluminous works. Mrs. Blake is one of the productive revisers and even here her record in outstanding."

Her artistic ability was expressed in two areas. With pen and ink she accurately and artistically drew hundreds of illustrations for her own papers and for her husband's studies in the plant family Compositae. In addition to her scientific illustrating she had a flair for doing charming pictures with watercolors and oils, an ability that was furthered by the study of art with Hugo Inden of the Abbott School of Art and later with Eugene Weisz of the Corcoran Art School.

As a young woman she was slender, blonde and, as she described herself in her diary, of "Renaissance fairness." She retained her slenderness and athletic agility even to her eighty-sixth summer when she still took her daily swim. The staidness of her demeanor concealed an impish sense of humor that often showed as a twinkle of merriment in her clear blue eyes. While not one for casual chit-chat, she could be a charming conversationalist expressing in vivid language her thoughts and experiences gained from many years of active living and studying.

Many will remember Mrs. Blake as the benevolent keeper of an eighteen-



Doris in her 86th year, with her lizard [reprinted with permission of *The Washington Star*].

inch long, heavy-bodied African lizard of the genus *Uromastyx*. Visitors marveled at the "toilet-trained lizard" and his close association with his keeper. From the windowsill by her desk he watched people and buses travelling by; when he tired of this he climbed down her books, crawled into her middle desk drawer which she then closed while the lizard enjoyed a mid-day nap of perhaps a half hour.

Doris Holmes Blake continued to work at the Smithsonian Natural History Museum well into her eighty-seventh year, loathe to give up on the work that gave her happiness and fulfillment. A month before her eighty-seventh birthday, heart problems brought an end to her life.

APPENDIX I. LIST OF PUBLICATIONS, 1924–1978, BY
DORIS HOLMES BLAKE

- 1924a. Note on the habits of *Sphenophorus pontederiae*. *Psyche* (Camb. Mass.) 31(6): 311.

- 1927a. Revision of the beetles of the genus *Oedionychis* occurring in America north of Mexico. Proc. U.S. Natl. Mus. 70(23): 1-44, pls. 1-2.
- 1928a. Notes on some West Indian Chrysomelidae. Bull. Brooklyn Entomol. Soc. 23(2): 93-98.
- 1928b. Two new Clavicorns from the U.S. Psyche (Camb. Mass.) 35(2): 108-113.
- 1928c. Notes on the habits of *Lixus blakeae* Chttn. Pan-Pac. Entomol. 5(1): 42-44.
- 1928d. A new species of *Luperodes* from Mt. Mitchell, N.C. Bull. Brooklyn Entomol. Soc. 24(4): 183-184.
- 1930a. Synonymies of Antillean Chrysomelidae with descriptions of new species. Bull. Brooklyn Entomol. Soc. 25(4): 209-224, pl. 13.
- 1931a. Revision of the species of beetles of the genus *Trirhabda* north of Mexico. Proc. U.S. Natl. Mus. 79(2): 1-36, pls. 1-2.
- 1931b. Notes on West Indian and Central American flea-beetles (Halticinae). Bull. Brooklyn Entomol. Soc. 26(2): 76-83, pl. 3.
- 1933a. Two new species of *Systema* with notes of sexual differences in coloration. Proc. Entomol. Soc. Wash. 35(8): 180-183.
- 1933b. Revision of the beetles of the genus *Disonycha* occurring in America north of Mexico. Proc. U.S. Natl. Mus. 82(28): 1-66, pls. 1-8.
- 1934a. New West Indian and Central American Chrysomelidae. Bull. Brooklyn Entomol. Soc. 29(2): 45-65.
- 1935a. Notes on *Systema*. Bull. Brooklyn Entomol. Soc. 30(3): 89-109, pl. 3.
- 1936a. *Altica bimarginata* Say, with description of new species and varieties. Proc. Entomol. Soc. Wash. 36(2): 13-24.
- 1936b. A redispotion of *Monoxia puncticollis* and allied species. J. Wash. Acad. Sci. 26(10): 424-430.
- 1937a. The Templeton Crocker Expedition. V. A new chrysomelid beetle of the genus *Monoxia* from Lower California. Zoologica, New York Zool. Soc. 22(1): 89-91.
- 1937b. Ten new species of West Indian Chrysomelidae. Proc. Entomol. Soc. Wash. 39(4): 67-78.
- 1938a. Eight new species of West Indian Chrysomelidae. Proc. Entomol. Soc. Wash. 40(2): 44-52.
- 1939a. A study of Leconte's types of the beetles of the genus *Monoxia*, with descriptions of new species. Proc. U.S. Natl. Mus. 87(3072): 145-170, pls. 18-19.
- 1939b. Eight new Chrysomelidae (Coleoptera) from the Dominican Republic. Proc. Entomol. Soc. Wash. 41(8): 231-239.
- 1940a. A new genus of Galerucini (Coleoptera) from the West Indies. Proc. Entomol. Soc. Wash. 42(5): 96-104.
- 1940b. *Oedionychis fasciata* (Fabr.) and closely related species. Proc. Entomol. Soc. Wash. 42(8): 170-175.

- 1941a. New species of *Chaetocnema* and other Chrysomelids (Coleoptera) from the West Indies. Proc. Entomol. Soc. Wash. 43(8): 171-180.
- 1942a. The chrysomelid beetles *Luperodes bivittatus* (Leconte) and *varicornis* (Leconte) and some allied species. Proc. U.S. Natl. Mus. 92(3129): 57-74, pls. 5-6.
- 1943a. New species of the genus *Hadropoda* Suffrian from the West Indies. Bull. Mus. Comp. Zool. Harv. Univ. 92(8): 413-441, pls. 1-4.
- 1943b. The generic position of *Hypolampsis pilosa* (Illiger) and some related new species (Coleoptera, Halticidae). Proc. Entomol. Soc. Wash. 45(9): 207-221.
- 1944a. Notes on five West Indian Chrysomelidae (Coleoptera). Proc. Entomol. Soc. Wash. 46(9): 249-253.
- 1945a. The genus *Galeruca* in North America (Coleoptera: Galerucinae). Proc. Entomol. Soc. Wash. 47(3): 53-63.
- 1945b. Five new flea beetles from the West Indies. J. Wash. Acad. Sci. 35(3): 89-92.
- 1945c. Six new species of beetles of a eumolpid genus new to the West Indies. J. Wash. Acad. Sci. 35(10): 323-327.
- 1946a. Nine new species of *Metachroma* (Coleoptera) from the West Indies. J. Wash. Acad. Sci. 36(1): 22-27.
- 1946b. Seven new species of West Indian Chrysomelidae (Coleoptera). Proc. Entomol. Soc. Wash. 48(5): 111-119.
- 1946c. Species of beetles of the genus *Lactica* from the West Indies closely related to *L. tibialis* (Olivier). J. Wash. Acad. Sci. 36(8): 267-269.
- 1947a. The species of *Myochrous* from the West Indies (Coleoptera). Proc. Entomol. Soc. Wash. 49(1): 22-26.
- 1947b. A new genus of flea beetles from the West Indies. J. Wash. Acad. Sci. 37(3): 92-95.
- 1947c. New eumolpid beetles from the West Indies. J. Wash. Acad. Sci. 37(9): 310-315.
- 1948a. Six new species of West Indian Chrysomelidae. Proc. Entomol. Soc. Wash. 50(5): 121-127.
- 1948b. New species of *Metachroma* and other chrysomelid beetles from the West Indies. J. Wash. Acad. Sci. 38(8): 274-279.
- 1948c. Seven new flea beetles from the West Indies (Coleoptera, Chrysomelidae). Psyche (Camb. Mass.) 55(3): 141-149.
- 1949a. Notes on some West Indian Chrysomelidae. J. Wash. Acad. Sci. 39(11): 367-371.
- 1950a. A new genus of flea beetles from the West Indies. Psyche (Camb. Mass.) 57(1): 10-25.
- 1950b. The generic status of *Altica picta* Say with descriptions of four closely related species (Coleoptera, Chrysomelidae). Proc. Entomol. Soc. Wash. 52(4): 178-183.

- 1950c. A revision of the beetles of the genus *Myochrous*. Proc. U.S. Natl. Mus. 101(3271): 1-64, pls. 1-8.
- 1951a. Hunting for Fabrician types. Coleopt. Bull. 5(3): 39-41.
- 1951b. Synonymies and new species of flea beetles (Coleoptera, Chrysomelidae). Proc. Entomol. Soc. Wash. 53(3): 138-147.
- 1951c. New Species of chrysomelid Beetles of the genera *Trirhabda* and *Disonycha* (Coleoptera, Chrysomelidae). J. Wash. Acad. Sci. 41(10): 324-328.
- 1951d. Revision of the Beetles of the Genus *Chalcosicya* Blake (Chrysomelidae). Bull. Mus. Comp. Zool. Harv. Univ. 106(7): 287-312.
- 1951e. Two old coleopterists. Coleopt. Bull. 5(4): 49-54; (5-6): 65-72.
- 1952a. Two old coleopterists (continued). Coleopt. Bull. 6(1): 3-9; (2): 19-26; (3): 35-41.
- 1952b. Six new species of *Megistops* with key to the known species. Psyche (Camb. Mass.) 59(1): 1-12.
- 1952c. Two new species of *Glyptoscelis* (Col. Chrysomelidae) from Argentina. Acta Zool. Lilloana 10: 163-165.
- 1952d. American Chrysomelidae in the Bosc collection. Proc. Entomol. Soc. Wash. 54(2): 57-68.
- 1953a. The chrysomelid beetles of the genus *Strabala* Chevrolat. Proc. U.S. Natl. Mus. 103(3319): 121-134.
- 1953b. Eight new neotropical chrysomelid beetles (Coleoptera). J. Wash. Acad. Sci. 43(7): 232-237.
- 1954a. Five new species of chrysomelid beetles. J. Wash. Acad. Sci. 44(8): 246-250.
- 1954b. Chrysomelid beetles of the *Oedionychis miniatus* complex. Proc. Entomol. Soc. Wash. 56(3): 139-147.
- 1955a. Note on the rearing of *Anolisimyia blakeae* sarcophagid fly from the American chamelion, *Anolis carolinensis* Voigt. Proc. Entomol. Soc. Wash. 57(4): 187-188.
- 1955b. A study of LeConte's species of the chrysomelid genus *Graphops* with descriptions of some new species. Bull. Mus. Comp. Zool. Harv. Univ. 113(4): 263-301, pls. 1-6.
- 1955c. A revision of the vittate species of the chrysomelid genus *Disonycha* from the Americas south of the United States. Proc. U.S. Natl. Mus. 104(3338): 1-86.
- 1955d. Mabel Colcord (1872-1954). Proc. Entomol. Soc. Wash. 57(2): 88-91. [Hawes, I. L., Blake, and J. S. Wade].
- 1956a. Three new neotropical flea beetles. J. Wash. Acad. Sci. 46(5): 142-44.
- 1956b. Species of *Phyllobrotica* occurring in the Pacific coast states (Coleoptera, Chrysomelidae). Proc. Entomol. Soc. Wash. 58(5): 259-63.

- 1957a. A note on two chrysomelid beetles. *Proc. Entomol. Soc. Wash.* 5(6): 278.
- 1958a. A review of some galerucine beetles with excised middle tibiae in the male. *Proc. U.S. Natl. Mus.* 108(3395): 59-101.
- 1958b. Ina Louise Hawes, 1896-1957. *Proc. Entomol. Soc. Wash.* 60(2): 87-90.
- 1958c. Francisco de Asis Monros, 1922-1956. *Proc. Entomol. Soc. Wash.* 60(4): 188-189.
- 1959a. Seven galerucid beetles from the West Indies. *J. Wash. Acad. Sci.* 49(6): 178-182.
- 1959b. Ten new flea-beetles from Cuba. *Proc. Entomol. Soc. Wash.* 61(6): 241-248.
- 1960a. Some new West Indian eumolpid beetles. *Psyche (Camb. Mass.)* 65(4): 91-98, (1958).
- 1960b. Seven new species of West Indian Chrysomelidae. *Proc. Entomol. Soc. Wash.* 62(2): 97-103.
- 1960c. Sidney Fay Blake (1892-1959). *Taxon* 9(5): 129-141.
- 1961a. A note on the Monros collection. *Proc. Entomol. Soc. Wash.* 63(3): 207-208.
- 1962a. Eight new species of *Metachroma* from the West Indies (Coleoptera: Chrysomelidae). *Proc. Entomol. Soc. Wash.* 64(3): 175-180.
- 1963a. Eight new chrysomelid beetles from the West Indies (Coleoptera). *Proc. Entomol. Soc. Wash.* 65(1): 14-20.
- 1964a. Notes on new and old species of Alticinae (Coleoptera) from the West Indies. *Proc. U.S. Natl. Mus.* 115(3477): 9-29.
- 1964b. Some insect collections in South America. *Proc. Entomol. Soc. Wash.* 66(1): 55-59.
- 1965a. Fourteen new chrysomelid beetles from the West Indies. *Proc. Entomol. Soc. Wash.* 67(2): 101-111.
- 1965b. Twelve new species of chrysomelid beetles from the West Indies (Coleoptera, Chrysomelidae). *Am. Mus. Novit.* 2217: 1-13.
- 1966a. More new galerucine beetles with excised middle tibiae in the male. *Proc. U.S. Natl. Mus.* 118(3528): 233-266.
- 1966b. A review of the beetles of the genus *Neobrotica* and some closely related genera. *Proc. U.S. Natl. Mus.* 118(3529): 267-372.
- 1966c. Ten new chrysomelid Beetles from the West Indies and Key West. *Proc. Entomol. Soc. Wash.* 68(3): 213-222.
- 1967a. Some new and old species of *Colaspis* in the West Indies. *Proc. Entomol. Soc. Wash.* 69(3): 225-237.
- 1967b. A revision of the chrysomelid genus *Glyptoscelis* (Coleoptera, Chrysomelidae). *Proc. U.S. Natl. Mus.* 123(3604): 1-53.
- 1968a. Ten new chrysomelid beetles from Dominica and Jamaica. *Proc. Entomol. Soc. Wash.* 70(1): 60-67.

- 1969a. Fourteen new chrysomelid beetles from Jamaica. Proc. Entomol. Soc. Wash. 71(2): 161-174.
- 1970a. Notes on some chrysomelid beetles from the United States and Argentina. Proc. Entomol. Soc. Wash. 72(3): 320-324.
- 1970b. A review of the beetles of the genus *Metachroma* Chevrolat (Coleoptera: Chrysomelidae). Smithson. Contrib. Zool. 57: 1-111.
- 1970c. Some new chrysomelid beetles from Cuba. Cas. Morav. Mus. Brne. 55: 115-126, figs. 1-14.
- 1971a. Fifteen new West Indian chrysomelid beetles. Proc. Entomol. Soc. Wash. 73(3): 269-282.
- 1973a. *Colaspis fulvotestacea* Lefevre and its close relatives. Proc. Entomol. Soc. Wash. 75(1): 84-88.
- 1974a. Two new species of the genus *Metachroma* Chevrolat. Proc. Entomol. Soc. Wash. 75(4): 408-410 (1973).
- 1974b. The costate species of *Colaspis* in the United States (Coleoptera: Chrysomelidae). Smithson. Contrib. Zool. 181: i-iii, 1-24.
- 1976a. *Colaspis melancholica* Jacoby and its close relatives (Coleoptera: Chrysomelidae). J. Wash. Acad. Sci. 65(4): 158-162 (1975).
- 1976b. A note on four old species names in *Colaspis* (Coleoptera: Chrysomelidae). Coleopt. Bull. 30(3): 291-292.
- 1976c. The brown semicostate and costate species of *Colaspis* in Mexico and Central America (Coleoptera: Chrysomelidae). U.S. Dep. Agric. Tech. Bull. 1534: i, 1-40.
- 1977a. *Colaspis favosa* Say and its close relatives (Coleoptera: Chrysomelidae). Proc. Entomol. Soc. Wash. 79(2): 209-215.
- 1977b. *Colaspis chrysis* Olivier and its close relatives (Coleoptera: Chrysomelidae). Proc. Entomol. Soc. Wash. 79(3): 417-421.
- 1978a. *Colaspis quattuordecimcostata* Lefevre and its close relatives in Brazil. J. Wash. Acad. Sci. 68(2): 82-85.

APPENDIX II. TAXONOMIC NAMES PROPOSED BY DORIS H. BLAKE

Each species name listed has affixed a series of initials indicating the collection in which the holotype was originally stated to be deposited. In only one instance, for *Colaspis brownsvillensis*, was the depository omitted; a specimen labeled as holotype in Doris Blake's handwriting is in the collection of the United States National Museum of Natural History. The initials are identified by the tabulations below.

- AMNH—American Museum of Natural History, New York, New York.
BM —British Museum (Natural History), London, England.
CAS —California Academy of Sciences, San Francisco, California.
CNC —Canadian National Collection, Ottawa, Canada.
CU —Cornell University, Ithaca, New York.

- FM -F. Monros Collection, now in the U.S. National Museum.
 FZ -F. de Zayas Collection, Habana, Cuba.
 GFM -G. Fry Museum, Tutzing bei München, Germany.
 JAW -J. A. Wilcox, New York State Museum, Albany, New York.
 LACM -Natural History Museum of Los Angeles County, Los Angeles, California.
 MCZ -Museum of Comparative Zoology, Harvard University, Cambridge, Massachusetts.
 MLI -Miguel Lillo Institute, Tucumán, Argentina.
 MM -Musei Moraviae, Brno, Czechoslovakia.
 UK -University of Kansas, Lawrence, Kansas.
 USNM -United States National Museum, Washington, D.C.
 ZS -Zoologische Sammlung des Bayerischen Staates, München, Germany.

The following list of names is as given in the original descriptions even though certain errors and grammatical inconsistencies have been detected.

FAMILY CHRYSOMELIDAE

- Agroiconata cubana* 1970c: 125 MM
Alethaxius acunai 1947c: 314 USNM
Alethaxius bruneri 1949a: 367 USNM
Alethaxius darlingtoni 1945c: 324 MCZ
Alethaxius dominicae 1968a: 61 USNM
Alethaxius hispaniolae 1945c: 323 MCZ
Alethaxius integer 1945c: 324 MCZ
Alethaxius meliae 1945c: 326 USNM
Alethaxius puertoricensis 1945c: 327 MCZ
Alethaxius semicostatus 1946b: 118 USNM
Alethaxius tortuensis 1947c: 314 MCZ
Alethaxius turquinesis 1945c: 326 MCZ
Alethaxius yunquensis 1946b: 118 MCZ
Altica ambiens var. *latiplicata* 1936a: 21 USNM
Altica caurina 1936a: 24 USNM
Altica napensis 1936a: 23 CAS
Aphthona crucifera 1964a: 9 USNM
Aphthona elachia 1948b: 276 MCZ
Aphthona fraterna 1948c: 147 MCZ
Aphthona inornata 1949a: 368 USNM
Aphthona insularis 1964a: 11 USNM
Aphthona lamprocyanea 1964a: 11 USNM
Aphthona lepta 1964a: 10 USNM
Aphthona nana 1949a: 368 USNM
Aphthona ruficollis 1970c: 123 MM
Aphthona schwarzi 1949a: 368 USNM
Apraea anaeae 1969a: 170 CNC
Apraea eleutherensis 1965b: 8 AMNH
Apraea fulgens 1963a: 20 USNM
Apraea jamaicensis 1963a: 19 USNM
Apraea maculata 1969a: 171 CNC
Apraea minima 1970c: 124 MM
Argopistes coronatus 1951b: 145 USNM
Argopistes rubicundus 1934a: 53 USNM
Asteriza darlingtoni 1939b: 238 MCZ
Batonota pubescens 1939b: 234 MCZ
Blepharida haitiensis 1938a: 48 MCZ
Blepharida pallida 1954a: 246 CAS
Chaetocnema brunnescens jamaicensis 1969a: 166 CNC
Chaetocnema cyanoptera 1964a: 23 USNM
Chaetocnema elachia 1941a: 178 USNM
Chaetocnema laticeps 1941a: 176 MCZ
Chaetocnema perplexa 1941a: 177 USNM
Chaetocnema platicephala 1969a: 166 [new name for *C. laticeps* Blake, 1941]
Chaetocnema plicipennis 1941a: 174 MCZ
Chaetocnema sternura 1969a: 165 CNC
Chalcosicya 1930a: 215
Chalcosicya acuminata 1951d: 291 MCZ
Chalcosicya alayoi 1960a: 91 USNM
Chalcosicya androsensis 1965b: 1 AMNH
Chalcosicya aptera 1951d: 300 USNM

- Chalcosicya constanzae* 1951d: 303 MCZ
Chalcosicya convexa 1951d: 304 MCZ
Chalcosicya costata 1938a: 45 USNM
Chalcosicya crotonis var. *acuta* 1951d: 295 USNM
Chalcosicya crotonis var. *angularis* 1951d: 294 USNM
Chalcosicya crotonis var. *parguerensis* 1951d: 294 USNM
Chalcosicya crotonis var. *septentrionalis* 1951d: 294 USNM
Chalcosicya darlingtoni 1951d: 303 MCZ
Chalcosicya dirrichtota 1938a: 46 MCZ
Chalcosicya eleutheriae 1951d: 298 USNM
Chalcosicya farri 1966c: 213 USNM
Chalcosicya fraterna 1951d: 309 MCZ
Chalcosicya gemina 1951d: 308 MCZ
Chalcosicya glabra 1951d: 307 MCZ
Chalcosicya grandis 1951d: 299 USNM
Chalcosicya humeralis 1971a: 270 USNM
Chalcosicya maestrensis 1930a: 216 USNM
Chalcosicya parsonsi 1951d: 301 MCZ
Chalcosicya parvula 1951d: 311 MCZ
Chalcosicya plana 1951d: 295 USNM
Chalcosicya rotunda 1938a: 44 USNM
Chalcosicya semicostata 1951d: 300 MCZ
Chalcosicya senilis 1951d: 306 MCZ
Chalcosicya setosella 1971a: 269 USNM
Chalcosicya teres 1951d: 308 MCZ
Chalcosicya truncata 1951d: 310 MCZ
Chalcosicya villosa 1951d: 305 MCZ
Chthoneis ferruginea 1963a: 14 MCZ
Chthoneis hispaniolae 1948a: 122 MCZ
Chthoneis insulana 1946a: 113 USNM
Chthoneis vittata 1959a: 180 USNM
Colaspis amplicollis 1971a: 272 USNM
Colaspis amplicosta 1970c: 118 MM
Colaspis atrisuturalis 1976c: 12 USNM
Colaspis barberi 1967a: 232 USNM
Colaspis braxatibiae 1978a: 83 USNM
Colaspis brownsvillensis 1976a: 161 MCZ
Colaspis cacaui 1973a: 87 USNM
Colaspis carolinensis 1974b: 10 USNM
Colaspis cartwrighti 1977b: 420 USNM
Colaspis chapalensis 1976c: 24 USNM
Colaspis chloropsis 1976c: 29 USNM
Colaspis consanguinea 1976c: 20 USNM
Colaspis corumbensis 1978a: 83 USNM
Colaspis crinicornis chittendeni 1974b: 11 USNM
Colaspis cruriflava 1977a: 215 USNM
Colaspis cubensis 1967a: 226 USNM
Colaspis darlingtoni 1967a: 234 MCZ
Colaspis diduma 1976a: 162 MCZ
Colaspis ekraspedona 1978a: 83 USNM
Colaspis farri 1967a: 235 USNM
Colaspis flavantenna 1978a: 84 USNM
Colaspis flavocostata avaloni 1974b: 14 USNM
Colaspis floridana 1977a: 210 USNM
Colaspis fulva 1976c: 12 BM
Colaspis grandicollis 1976c: 14 USNM
Colaspis guatemalensis 1976a: 160 BM
Colaspis hesperia 1974b: 8 USNM
Colaspis homia 1976c: 6 USNM
Colaspis juxtaoculus 1978a: 85 USNM
Colaspis keyensis 1974b: 11 USNM
Colaspis kirra 1976c: 27 MCZ
Colaspis lampomela 1978a: 83 USNM
Colaspis leiosomata 1973a: 85 USNM
Colaspis levicostata 1976c: 19 USNM
Colaspis longipennis 1976c: 16 BM
Colaspis lousianae 1974b: 6 USNM
Colaspis luciae 1976a: 236 USNM
Colaspis macroptera 1976c: 15 BM
Colaspis manausa 1978a: 85 USNM
Colaspis melaina 1974b: 16 USNM
Colaspis orientalis 1967a: 227 MCZ
Colaspis ostmarki 1973a: 86 USNM
Colaspis panamensis 1976c: 21 USNM
Colaspis paracostata 1978a: 82 USNM
Colaspis planicostata 1974b: 7 USNM
Colaspis purpurata 1978a: 85 USNM
Colaspis purpurea 1971a: 271 USNM
Colaspis recurva 1974b: 10 USNM
Colaspis sanguinea 1977a: 214 USNM
Colaspis shuteae 1976a: 162 BM
Colaspis similis 1976c: 32 USNM
Colaspis similis 1977a: 212 USNM
Colaspis spadix 1976c: 13 USNM
Colaspis spinigera 1976a: 160 MCZ
Colaspis stenorachis 1976c: 26 USNM
Colaspis suggona 1977a: 212 USNM
Colaspis suilla borealis 1974b: 9 USNM
Colaspis thaleia 1977b: 418 USNM
Colaspis uncotibialis 1976c: 20 USNM
Colaspis variabilis 1976c: 17 BM
Colaspis viridiceps australis 1976c: 34 USNM
Colaspis zanthophaiia 1976c: 25 USNM
Cryptocephalus adelphicus 1970c: 117 MM
Cryptocephalus maestrensis 1970c: 115 MM
Cryptocephalus platus 1970c: 116 MM
Cyclotrypema 1966b: 354
Cyrsylus cubensis 1959b: 247 USNM

- Cyrsylus hispaniolae* 1949a: 371 USNM
Cyrsylus jamaicanus 1969a: 163 CNC
Cyrsylus montserratii 1949a: 371 USNM
Cyrsylus trinitatis 1951b: 144 BM
Cyrtoclista cyanea insulæ 1971a: 281 USNM
Deinocladus 1966a: 259
Deinocladus cartwrighti 1966a: 260 USNM
Deinocladus fascicollis 1966a: 261 CAS
Derospidea 1931a: 32
Deuterobrotica bechynei 1966a: 257 GFM
Diabrotica darlingtoni 1937b: 69 MCZ
Diabrotica farri 1965a: 103 USNM
Diabrotica hispaniolæ 1963a: 18 USNM
Diabrotica luciana 1965a: 104 USNM
Diabrotica marcanoi 1971a: 277 USNM
Diabrotica neoallardi 1953b: 232 USNM
Dicoelotrachelus 1941a: 171
Dicoelotrachelus brevicollis 1941a: 173 MCZ
Dicoelotrachelus cubensis 1946b: 111 MCZ
Dicoelotrachelus darlingtoni 1941a: 172 MCZ
Dicoelotrachelus depilatus 1941a: 173 MCZ
Dicoelotrachelus glaber 1946b: 113 MCZ
Dicoelotrachelus sulcatus 1946b: 112 MCZ
Dicoelotrachelus violaceus 1948a: 121 MCZ
Disonycha amplipennis 1955c: 63 MCZ
Disonycha annulata 1955c: 51 USNM
Disonycha aplicata 1955c: 55 MCZ
Disonycha arizonæ var. *borealis* 1933b: 31 USNM
Disonycha balsbaughi 1970a: 320 USNM
Disonycha barberi 1951c: 327 USNM
Disonycha colombiana 1955c: 33 MCZ
Disonycha cordigera 1955c: 50 MCZ
Disonycha crassicornis 1955c: 56 MCZ
Disonycha cratera 1955c: 56 USNM
Disonycha darlingtoni 1938a: 50 MCZ
Disonycha didyma 1955c: 49 USNM
Disonycha dorsata var. *flavolimbata* 1931b: 79 USNM
Disonycha explanata 1955c: 59 MCZ
Disonycha gracilis 1955c: 37 USNM
Disonycha immaculata 1955c: 13 MCZ
Disonycha jalapensis 1955c: 32 AMNH
Disonycha juruensis 1955c: 63 BM
Disonycha knabi 1955c: 25 USNM
Disonycha longipennis 1955c: 42 USNM
Disonycha manni 1955c: 47 USNM
Disonycha megaspilota 1955c: 53 MCZ
Disonycha multivittata 1955c: 58 MCZ
Disonycha ovata 1931b: 79 USNM
Disonycha paula 1955c: 62 BM
Disonycha pittieri 1955c: 38 USNM
Disonycha plagifera 1955c: 58 USNM
Disonycha sapucayensis 1955c: 20 USNM
Disonycha schaefferi 1933b: 24 USNM
Disonycha scisso vittata 1955c: 73 BM
Disonycha septemmaculata 1955c: 69 USNM
Disonycha spilotrachela 1928a: 96 USNM
Disonycha teapensis 1933b: 38 USNM
Disonycha triangularis var. *montanensis* 1933b: 59 USNM
Disonycha tridyma 1955c: 49 MCZ
Disonycha trimaculata 1955c: 57 USNM
Disonycha trivittata 1955c: 45 USNM
Disonycha turrialbensis 1955c: 38 MCZ
Disonycha varia 1955c: 14 USNM
Disonycha weismanni 1957a: 278 USNM
Disonycha yurimaguensis 1955c: 15 MCZ
Disonycha xanthomelas atrella 1933b: 57 MCZ
Distigmoptera 1943b: 209
Distigmoptera apicalis 1943b: 214 USNM
Distigmoptera borealis 1943b: 217 USNM
Distigmoptera brevihirta 1943b: 220 USNM
Distigmoptera capillosa 1943b: 220 USNM
Distigmoptera chrysodaedala 1951b: 142 USNM
Distigmoptera falli 1943b: 218 MCZ
Distigmoptera impennata 1943b: 216 MCZ
Distigmoptera mesochorea 1943b: 212 USNM
Distigmoptera orchidophila 1951b: 141 USNM
Distigmoptera schwarzi 1943b: 215 USNM
Distigmoptera texana 1943b: 215 USNM
Eccoctopsis 1966b: 339
Eccoctopsis argentinensis 1966b: 347 BM
Eccoctopsis boliviensis 1966b: 343 MCZ
Eccoctopsis clara 1966b: 344 MCZ
Eccoctopsis costaricensis 1966b: 341 USNM
Eccoctopsis cyanocosmesa 1966b: 346 BM
Eccoctopsis mexicana 1966b: 348 USNM
Eccoctopsis laticollis 1966b: 342 MCZ
Eccoctopsis piceofasciata 1966b: 345 BM
Eccoctopsis quadrimaculata 1966b: 350 USNM
Ectmesopus 1940a: 96
Ectmesopus angusticollis 1940a: 101 USNM
Ectmesopus crassicornis 1940a: 97 MCZ
Ectmesopus darlingtoni 1940a: 103 MCZ
Ectmesopus leonardarum 1958a: 97 USNM
Ectmesopus longicornis 1940a: 103 USNM
Ectmesopus nigrolimbatus 1959a: 181 FZ
Ectmesopus occipitalis 1940a: 100 USNM
Ectmesopus pallidus 1940a: 98 MCZ
Ectmesopus rhabdotus 1966a: 243 USNM

- Ectmesopus tristis* 1940a: 99 USNM
Ectmesopus vitticollis 1940a: 99 USNM
Ectmesopus zayasi 1959a: 181 FZ
Ectmesopus zonatus 1940a: 100 MCZ
Elytrogona gemmata 1930a: 222 USNM
Elytrogona nigrodorsata 1937b: 78 MCZ
Erynephala 1936b: 425
Erynephala brightii 1970a: 322 CNC
Erynephala glabra 1936b: 430 MCZ
Euryepepla calochroma floridensis 1966c: 221 USNM
Exoceras flinti 1966c: 217 USNM
Exochognathus 1946b: 114
Exochognathus limbatus 1946b: 116 USNM
Galerucella brevicollis 1934b: 46 USNM
Galerucella brevivittata 1968a: 62 USNM
Galerucella browni 1945a: 60 CNC
Galerucella chrysur 1939b: 232 MCZ
Galerucella conjuncta 1937b: 68 USNM
Galerucella constanzae 1939b: 231 MCZ
Galerucella costatissima 1945a: 62 USNM
Galerucella cyclopea 1934a: 47 USNM
Galerucella decemvittata 1971a: 274 USNM
Galerucella hexarhabdota 1965a: 101 USNM
Galerucella immaculata 1938a: 48 MCZ
Galerucella jamaicensis 1965a: 101 USNM
Galerucella maculata 1970c: 121 MM
Galerucella maculipes 1930a: 217 USNM
Galerucella melanocephala 1959a: 178 USNM
Galerucella orthodera 1934a: 48 USDA
Galerucella oteroi 1934a: 49 USNM
Galerucella pauperata 1934a: 49 USNM
Galerucella popenoei 1945a: 61 USNM
Galerucella spilopecta 1959a: 180 USNM
Glyptobregma 1947b: 92
Glyptobregma aeneum 1948a: 124 MCZ
Glyptobregma bruneri 1948a: 123 USNM
Glyptobregma cyanellum 1948a: 126 USNM
Glyptobregma orphnum 1948a: 123 MCZ
Glyptobregma portoricensis 1947b: 94 USNM
Glyptobregma turquinense 1947b: 94 MCZ
Glyptoscelis artemisiae 1967b: 27 USNM
Glyptoscelis cahitae 1967b: 36 CAS
Glyptoscelis coloradensis 1967b: 25 CAS
Glyptoscelis cylindrica 1967b: 33 CAS
Glyptoscelis guatemalensis 1967b: 38 BM
Glyptoscelis idahoensis 1967b: 19 USNM
Glyptoscelis juniperi 1967b: 21 CAS
Glyptoscelis juniperi zanthocoma 1967b: 22 CAS
Glyptoscelis monrosi 1952c: 163 "MLI" In error! FM
Glyptoscelis paula 1967b: 29 USNM
Glyptoscelis peperii 1967b: 18 CAS
Glyptoscelis pinnigera 1952c: 165 FM
Glyptoscelis septentrionalis 1967b: 25 USNM
Glyptoscelis sonorensis 1967b: 35 CAS
Graphops barberi 1955b: 293 USNM
Graphops comosa 1955b: 294 USNM
Graphops curtipennis schwarzi 1955b: 277 USNM
Graphops exilis 1955b: 283 USNM
Graphops floridana 1955b: 296 USNM
Graphops floridana borealis 1955b: 298 USNM
Graphops marcessita pugitana 1955b: 287 USNM
Graphops nigellae 1955b: 280 USNM
Graphops punctata 1955b: 298 MCZ
Graphops tenuis 1955b: 281 USNM
Graphops viridis 1955b: 295 USNM
Graphops wyomingensis 1955b: 292 USNM
Habrophora thelmae 1968a: 60 USNM
Hadropoda albicincta 1945b: 89 MCZ
Hadropoda aspila 1944a: 253 USNM
Hadropoda barberi 1943a: 440 USNM
Hadropoda calva 1943a: 426 MCZ
Hadropoda comosa 1943a: 419 MCZ
Hadropoda constanzae 1943a: 432 MCZ
Hadropoda corrugata 1943a: 425 MCZ
Hadropoda crispula 1943a: 426 MCZ
Hadropoda darlingtoni 1943a: 420 MCZ
Hadropoda dominicae 1943a: 438 USNM
Hadropoda elachia 1943a: 431 MCZ
Hadropoda eugeniae 1943a: 423 USNM
Hadropoda fennahi 1943a: 434 USNM
Hadropoda flavicom 1943a: 436 MCZ
Hadropoda fuscomaculata 1953b: 235 USNM
Hadropoda glabra 1943a: 424 USNM
Hadropoda glabroguttata 1943a: 421 MCZ
Hadropoda gracilentia 1943a: 429 MCZ
Hadropoda guttata 1943a: 419 MCZ
Hadropoda hoffmani 1943a: 435 USNM
Hadropoda hugonis 1943a: 439 MCZ
Hadropoda minuta 1943a: 430 MCZ
Hadropoda morrisoni 1943a: 433 USNM
Hadropoda oakleyi 1943a: 422 USNM
Hadropoda pallida 1943a: 435 MCZ
Hadropoda poikila 1944a: 252 USNM
Hadropoda robusta 1943a: 431 MCZ
Hadropoda rugosa 1943a: 427 MCZ
Hadropoda stenotrachela 1943a: 438 USNM
Hadropoda tabebuiae 1943a: 437 USNM
Hadropoda turquinensis 1943a: 429 MCZ

- Hadropoda varicornis* 1943a: 423 USNM
Hadropoda verrucosa 1943a: 428 MCZ
Hadropoda xanthoura 1968a: 63 USNM
Heikertingerella darlingtoni 1963a: 19 MCZ
Heikertingerella dominicae 1960b: 101 USNM
Heikertingerella fusca 1960b: 102 USNM
Heikertingerella quadeloupensis 1960b: 103 USNM
Heikertingerella jamaicae 1969a: 173 USNM
Heikertingerella wirthi 1968a: 65 USNM
Hemilactica 1937b: 72
Hemilactica clara 1959b: 244 USNM
Hemilactica crucifera 1959b: 245 FZ
Hemilactica fasciata 1938a: 50 MCZ
Hemilactica graphica 1939b: 233 MCZ
Hemilactica portoricensis 1964a: 20 USNM
Hemilactica pulchella 1937b: 73 USNM
Hemilactica rugosa 1937b: 74 USNM
Hemisphaerota bimaculata 1971a: 279 USNM
Hemisphaerota quadrimaculata 1971a: 280 USNM
Hermaphroditia bahamensis 1965b: 9 AMNH
Hermaphroditia beckeri 1969a: 167 CNC
Hermaphroditia constanzae 1965a: 108 MCZ
Hermaphroditia cuprea 1951b: 143 USNM
Hermaphroditia darlingtoni 1965a: 108 MCZ
Hermaphroditia farri 1969a: 168 USNM
Hermaphroditia jamaicensis 1964a: 19 USNM
Hermaphroditia maldonadoi 1965a: 109 USNM
Hermaphroditia nigrorubra 1951b: 144 USNM
Hermaphroditia punctata 1965a: 109 MCZ
Homoschema 1950a: 12
Homoschema androsense 1950a: 25 MCZ
Homoschema buscki 1950a: 20 USNM
Homoschema darlingtoni 1950a: 24 MCZ
Homoschema dominicae 1968a: 67 USNM
Homoschema felis 1950a: 18 MCZ
Homoschema fraternum 1950a: 19 USNM
Homoschema hoffnani 1950a: 15 USNM
Homoschema jamaicense 1950a: 19 USNM
Homoschema latitarsum 1950a: 16 MCZ
Homoschema latum 1950a: 20 USNM
Homoschema leucurum 1950a: 15 USNM
Homoschema longense 1965b: 10 AMNH
Homoschema manni 1950a: 24 USNM
Homoschema nigriventre 1950a: 18 USNM
Homoschema obesum 1950a: 22 USNM
Homoschema opimum 1950a: 23 MCZ
Homoschema orientense 1950: 23 USNM
Homoschema ornatum 1950a: 16 USNM
Homoschema pingue 1950a: 22 MCZ
Homoschema xanthocyaneum 1964a: 22 USNM
Hylodromus clarki 1953b: 236 USNM
Hystiopsis 1966b: 324
Hystiopsis bella 1966b: 332 USNM
Hystiopsis beniensis 1966b: 327 MCZ
Hystiopsis bryanti 1966b: 331 BM
Hystiopsis exarata 1966b: 338 MCZ
Hystiopsis flavipes 1966b: 329 JAW
Hystiopsis grossa 1966b: 337 MCZ
Hystiopsis irritans 1966b: 334 ZS
Hystiopsis maculata 1966b: 334 USNM
Hystiopsis mansei 1966b: 330 MCZ
Hystiopsis maxirii 1966b: 331 MCZ
Hystiopsis maxima 1966b: 335 BM
Hystiopsis megala 1966b: 336 BM
Hystiopsis nigriventris 1966b: 326 CAS
Hystiopsis peruensis 1966b: 328 MCZ
Hystiopsis phaica 1966b: 336 BM
Hystiopsis terminalis 1966b: 328 BM
Hystiopsis zonata 1966b: 333 CAS
Iceloceras 1958a: 76
Iceloceras biplagiatum 1958a: 87 USNM
Iceloceras flavipes 1958a: 81 USNM
Iceloceras flavocyaneum 1958a: 89 USNM
Iceloceras latiplagiatum 1958a: 83 USNM
Iceloceras maximum 1958a: 80 USNM
Iceloceras parviplagiatum 1958a: 84 USNM
Iceloceras parviplagiatum teapensis 1958a: 85 MCZ
Iceloceras verbesinae 1958a: 82 USNM
Iceloceras vittatum 1958a: 86 USNM
Lactica albina 1946c: 269 USNM
Lactica albiterminata 1969a: 163 CNC
Lactica androsensis 1946c: 269 MCZ
Lactica darlingtoni 1948c: 142 MCZ
Lactica dominicae 1946c: 267 USNM
Lactica eleutherae 1946c: 269 USNM
Lactica flinti 1968a: 64 USNM
Lactica grenadensis 1963a: 19 USNM
Lactica jamaicensis 1937b: 70 USNM
Lactica megaspila 1948c: 144 MCZ
Lactica nigripes 1965b: 11 USNM
Lactica porphyrea 1948c: 143 MCZ
Lactica xanthopus 1971a: 276 USNM
Lactica xanthotrachela 1948c: 141 MCZ
Leptonesiotes 1958a: 75
Leptonesiotes quadrimaculata 1959a: 182 FZ
Leucocera cyanea 1971a: 273 USNM
Leucocera hoffnani 1928a: 93 USNM
Leucocera spilota 1971a: 273 USNM
Longitarsus atypicus 1964a: 16 USNM

- Longitarsus chlanidotus* 1964a: 14 USNM
Longitarsus cylindricus 1964a: 12 USNM
Longitarsus felis 1965a: 106 MCZ
Longitarsus hoffmani 1965a: 107 USNM
Longitarsus howdeni 1969a: 167 CNC
Longitarsus impennatus 1970c: 122 MM
Longitarsus oakleyi 1964a: 16 USNM
Longitarsus photinus 1965a: 107 MCZ
Longitarsus portoricensis 1965a: 106 MCZ
Longitarsus providensis 1965b: 7 AMNH
Longitarsus prokopi 1970c: 123 MM
Longitarsus pterotus 1970c: 122 MM
Longitarsus rhabdotus 1965a: 104 USNM
Longitarsus rosensis 1965b: 8 AMNH
Luperodes antillarum 1937b: 69 USNM
Luperodes bimarginata 1928d: 183 USNM
Luperodes chiricahuensis 1942a: 71 CAS
Luperodes convexus 1942a: 71 USNM
Luperodes diegensis 1942a: 60 USNM
Luperodes elachistus 1942a: 69 USNM
Luperodes flavoniger 1942a: 64 USNM
Luperodes melanolomatus 1942a: 63 CAS
Luperodes monorhabdus 1942a: 61 USNM
Luperodes nebrodes 1942a: 64 USNM
Luperodes ocularis 1942a: 72 CAS
Luperodes pallidulus 1942a: 68 USNM
Luperodes popenoei 1942a: 70 USNM
Luperodes punctatissimus 1942a: 73 USNM
Luperodes rugipennis 1942a: 68 USNM
Luperodes tuberculatus 1942a: 62 LACM
Luperodes vandykei 1942a: 73 CAS
Luperosoma nigricolle 1966a: 244 CAS
Luperosoma nigrum 1958a: 91 MCZ
Luperosoma vittatum 1966a: 244 USNM
Megasus semivittatus 1948b: 274 USNM
Megistops argentinensis 1952b: 8 USNM
Megistops bahamensis 1952b: 6 USNM
Megistops bryanti 1952b: 4 USNM
Megistops coeruleipennis 1959b: 247 USNM
Megistops costaricensis 1952b: 11 USNM
Megistops dissita 1931b: 81 USNM
Megistops melanoloma 1952b: 8 USNM
Megistops parvula 1969a: 172 CNC
Megistops rhabdota 1969a: 172 CNC
Megistops tabebuiae 1937b: 75 USNM
Megistops taurops 1952b: 10 MCZ
Metriona quadrisignata jamaicensis 1966c: 220 USNM
Metachroma acunai 1946a: 22 MCZ
Metachroma acutululum 1962a: 178 USNM
Metachroma amplicolle 1947c: 312 MCZ
Metachroma angusticolle 1974a: 410 USNM
Metachroma annulare 1970b: 80 CNC
Metachroma argentinense 1970b: 48 GFM
Metachroma ashtoni 1966c: 215 USNM
Metachroma barahonense 1964a: 23 MCZ
Metachroma bimarginatum 1970b: 43 UK
Metachroma bredeni 1960a: 94 USNM
Metachroma bridwelli 1970b: 24 USNM
Metachroma bzevstriatum 1946a: 23 MCZ
Metachroma californicum anatolicum 1970b: 22 USNM
Metachroma carolinense 1970b: 9 USNM
Metachroma cartagenense 1970b: 46 MCZ
Metachroma castaneum 1965b: 5 USNM
Metachroma cavicolle 1960b: 97 USNM
Metachroma chapini 1944a: 250 USNM
Metachroma cinctipes 1946a: 26 MCZ
Metachroma clarkei 1970b: 40 USNM
Metachroma clarum 1970b: 74 CNC
Metachroma cornutum 1960a: 93 USNM
Metachroma darlingtoni 1946a: 24 MCZ
Metachroma dentatum 1965b: 5 AMNH
Metachroma dicoelotrachelus 1970b: 75 CNC
Metachroma elachistus 1960b: 97 USNM
Metachroma ensiforme 1947e: 310 MCZ
Metachroma farri 1962a: 180 USNM
Metachroma felis 1948b: 276 MCZ
Metachroma fenestratum 1947c: 312 MCZ
Metachroma flavolimbatum 1948b: 277 USNM
Metachroma fuscifrons 1970b: 74 CNC
Metachroma gagnei 1968a: 62 USNM
Metachroma gracile 1937b: 67 USNM
Metachroma grande 1960a: 98 FZ
Metachroma hardwarense 1970b: 72 CNC
Metachroma haydeni 1965b: 3 AMNH
Metachroma hirsutum 1970b: 39 CAS
Metachroma hottense 1948b: 279 MCZ
Metachroma howdenae 1970b: 72 CNC
Metachroma ignotum 1970b: 44 USNM
Metachroma imitans 1947c: 310 MCZ
Metachroma immaculatum 1970b: 26 USNM
Metachroma inconstans 1970b: 33 MCZ
Metachroma laevius 1946a: 22 MCZ
Metachroma leiotrachelus 1970b: 71 MCZ
Metachroma leonardi 1970b: 61 USNM
Metachroma leucurum 1970b: 66 BM
Metachroma longicorne 1966c: 216 MCZ
Metachroma longipennis 1970b: 25 CAS
Metachroma longipunctatum 1966c: 217 MCZ
Metachroma longitarsum 1946a: 24 MCZ
Metachroma lucidum 1970b: 39 USNM

- Metachroma macrum* 1962a: 176 USNM
Metachroma magnipunctatum 1970b: 18 GFM
Metachroma maniocae 1966c: 216 USNM
Metachroma melanochrotum 1970b: 66 BM
Metachroma mendozae 1970b: 48 USNM
Metachroma metrium 1947c: 311 MCZ
Metachroma moaense 1962a: 176 USNM
Metachroma montanense 1970b: 30 USNM
Metachroma multipunctatum 1960a: 96 USNM
Metachroma mutabile 1970b: 35 MCZ
Metachroma nanum 1960a: 96 USNM
Metachroma nassauense 1962a: 175 USNM
Metachroma nigricollis 1970b: 40 BM
Metachroma nigromaculatum 1962a: 175 USNM
Metachroma nigrosignatum 1970b: 24 CAS
Metachroma nigroviride 1948b: 278 MCZ
Metachroma oakleyi 1970b: 71 USNM
Metachroma obesum 1946a: 23 MCZ
Metachroma obscuricollis 1970b: 58 USNM
Metachroma occidentale 1970b: 23 USNM
Metachroma odontotum 1970b: 60 USNM
Metachroma orientale 1970b: 8 MCZ
Metachroma oteroi 1944a: 252 USNM
Metachroma panamense 1970b: 41 USNM
Metachroma paulum 1962a: 178 USNM
Metachroma piceum 1948b: 278 MCZ
Metachroma presidiense 1970b: 22 USNM
Metachroma prognathus 1970b: 81 USNM
Metachroma quintanae 1970b: 34 USNM
Metachroma rhizophorae 1974a: 408 USNM
Metachroma rubellum 1970c: 120 MM
Metachroma rugicollis 1970b: 80 CNC
Metachroma rugosum 1962a: 179 USNM
Metachroma sandersoni 1970b: 29 UK
Metachroma schwarzi 1948b: 276 USNM
Metachroma septentrionale 1970b: 56 MCZ
Metachroma simile 1970b: 56 USNM
Metachroma tricharthrum 1946a: 26 MCZ
Metachroma utahensis 1970b: 28 CAS
Metachroma varium 1970b: 73 CNC
Metachroma vittipennis 1970b: 37 CNC
Metachroma vulgare 1970b: 32 USNM
Metachroma xanthacrum 1947c: 311 MCZ
Metachroma zayasi 1960a: 92 USNM
Metriona quadrisignata jamaicensis 1966c: 220 USNM
Monocesta cubensis 1959a: 178 FZ
Monoxia apicalis 1939a: 170 USNM
Monoxia beebei 1937a: 89 USNM
Monoxia brisleyi 1939a: 171 USNM
Monoxia elegans 1939a: 164 USNM
Monoxia grisea 1939a: 163 USNM
Monoxia inornata 1939a: 162 USNM
Monoxia minuta 1939a: 169 USNM
Monoxia obesula 1939a: 167 USNM
Monoxia pallida 1939a: 168 USNM
Monoxia puberula 1939a: 165 USNM
Monoxia schizonycha 1939a: 166 USNM
Myochrous austrinus 1950c: 18 USNM
Myochrous barbadensis 1947a: 26 USNM
Myochrous bolivianus 1950c: 43 USNM
Myochrous brunneus 1950c: 56 MCZ
Myochrous bryanti 1950c: 48 BM
Myochrous calcariferus 1950c: 63 MLI
Myochrous chacoensis 1950c: 44 MLI
Myochrous coenus 1950c: 34 USNM
Myochrous crassimarginatus 1950c: 45 MCZ
Myochrous cubensis 1947c: 23 USNM
Myochrous cyphus 1950c: 16 USNM
Myochrous darlingtoni 1950c: 42 MCZ
Myochrous elachius 1950c: 38 USNM
Myochrous floridanus texanus 1950c: 28 USNM
Myochrous geminus 1950c: 37 USNM
Myochrous hispaniolae 1947a: 26 MCZ
Myochrous intermedius 1950c: 22 USNM
Myochrous jamaicensis 1947a: 26 USNM
Myochrous latisetiger 1950c: 36 USNM
Myochrous leucurus 1950c: 46 MCZ
Myochrous longipes 1950c: 56 USNM
Myochrous mamorensis 1950c: 57 MLI
Myochrous monrosi 1950c: 52 MLI
Myochrous nanus 1950c: 40 MCZ
Myochrous normalis 1950c: 51 MCZ
Myochrous paulus 1950c: 39 USNM
Myochrous platylonchus 1950c: 37 USNM
Myochrous portoricensis 1947a: 25 USNM
Myochrous ranella 1950c: 25 USNM
Myochrous rhabdotus 1950c: 41 MCZ
Myochrous sapucayensis 1950c: 50 USNM
Myochrous severini 1950c: 23 USNM
Myochrous spinipes 1950c: 62 USNM
Myochrous stenomorphus 1950c: 51 BM
Myochrous whitei 1950c: 32 CAS
Neobrotica atrilineata 1966b: 313 GFM
Neobrotica cartwrighti 1966b: 281 USNM
Neobrotica colombiensis 1966b: 303 USNM
Neobrotica confusa 1966b: 279 MCZ
Neobrotica decimsignata 1966b: 297 USNM

- Neobrotica dentata* 1966b: 277 USNM
Neobrotica duodecimstignata 1966b: 286 BM
Neobrotica flavipes 1966b: 302 MCZ
Neobrotica flavolimbata 1966b: 314 BM
Neobrotica germaini 1966b: 317 MCZ
Neobrotica grandis 1966b: 321 MCZ
Neobrotica matamorasensis 1966b: 294 MCZ
Neobrotica meridensis 1966b: 304 USNM
Neobrotica noumenia 1966b: 276 MCZ
Neobrotica octosignata 1966b: 320 MCZ
Neobrotica pentaspilota 1966b: 299 USNM
Neobrotica piceofasciata 1966b: 280 M
Neobrotica poecila 1966b: 305 MCZ
Neobrotica perota 1966b: 291 BM
Neobrotica quadrimaculata 1966b: 322 BM
Neobrotica regularis 1966b: 319 MCZ
Neobrotica rendalli 1966b: 311 MCZ
Neobrotica roaguaensis 1966b: 315 USNM
Neobrotica ruficollis 1966b: 311 USNM
Neobrotica schausi 1966b: 275 AMNH
Neobrotica septemmaculata 1966b: 298 MCZ
Neobrotica spilocephala 1966b: 287 BM
Neobrotica stalagma 1966b: 312 MCZ
Neobrotica tampicensis 1966b: 295 USNM
Neobrotica trichops 1966b: 283 USNM
Neobrotica zonata 1966b: 281 BM
Neotrichota 1966a: 241
Neotrichota flavipennis 1966a: 242 USNM
Nephrica macrops 1956a: 142 USNM
Nesaecrepida 1964a: 21
Nesaecrepida rufomarginata 1964a: 22 USNM
Nyctiplanctus 1963a: 15
Nyctiplanctus farri 1963a: 17 USNM
Nyctiplanctus jamaicensis 1963a: 17 USNM
 "Oedionychis"—See *Oedionychus*
Oedionychus amplilimbatus 1959b: 244 FZ
 "Oedionychis" *amplivittata* 1927a: 24 BM
Oedionychus barberi 1954b: 145 USNM
Oedionychus brachyscelus 1965b: 6 AMNH
Oedionychus cristalensis 1959b: 242 FZ
Oedionychus floridanus 1954b: 146 USNM
Oedionychus gurneyi 1968a: 63 USNM
 "Oedionychis" *lantanae* 1928a: 95 USNM
 "Oedionychis" *lugens* var. *lamprocyanea* 1927a: 11 USNM
 "Oedionychis" *megalopia* 1939b: 233 MCZ
 "Oedionychis" *obsidiana* var. *flava* 1927a: 40 USNM
Oedionychus orientensis 1959b: 241 USNM
Oedionychus perplexus 1954b: 144 USNM
 "Oedionychis" *pervittata* 1927a: 31 USNM
 "Oedionychis" *petaurista* var. *pallida* 1927a: 23 USNM
 "Oedionychis" *pseudofasciata* 1940b: 173 MCZ
 "Oedionychis" *pseudothoracica* 1945b: 90 USNM
Oedionychus punctipennis 1971a: 277 USNM
 "Oedionychis" *purpurella* 1940b: 172 USNM
Oedionychus rhabdotus 1954a: 249 USNM
 "Oedionychis" *spilonota* 1928a: 36 USNM
 "Oedionychis" *vians* var. *badia* 1927a: 14 USNM
Oedionychus viridipennis 1971a: 278 USNM
Oedionychus weismanni 1954b: 146 USNM
Oedionychus zayasi 1959b: 242 USNM
Ophraea maculicollis 1953b: 234 USNM
Oroetes wilcoxi 1966a: 255 USNM
Oxygona limbata 1953b: 234 USNM
Palaeothona arizonensis 1950b: 180 USNM
Palaeothona hoffmani 1950b: 183 USNM
Palaeothona melanocyanea 1950b: 181 MCZ
Palaeothona rubroviridis 1950b: 180 MCZ
Panchrestus denticollis 1953b: 234 USNM
Paratrikona ovata 1938a: 51 MCZ
Paratrikona rubescens 1939b: 238 MCZ
Paratrikona turritella 1937b: 76 USNM
Paratrikona variegata 1939b: 236 MCZ
Phaedon barberi 1953b: 232 USNM
Phaedon cubensis 1960b: 98 USNM
Phaedon zayasi 1960b: 100 FZ
Phyllobrotica leechi 1956b: 260 USNM
Phyllobrotica sequoiensis 1956b: 260 CAS
Phyllobrotica viridipennis mokenensis 1956b: 262 CAS
Physimerus melanchimus 1953b: 237 USNM
Platymorpha albiventris 1958a: 99 CU
Platymorpha homoia 1966a: 247 USNM
Porechontes 1966a: 251
Porechontes wilcoxi 1966a: 252 MCZ
Potambrotica 1966b: 351
Potambrotica trifasciata 1966b: 351 USNM
Potambrotica viridis 1966b: 353 BM
Psalidonota calochroma 1956b: 12 AMNH
Psalidonota dentata 1965a: 110 USNM
Pseudodisonycha 1954a: 248
Pseudodisonycha hispaniolae 1954a: 249 MCZ
Pseudodisonycha portoricensis 1954a: 248 MCZ
Pseudodisonycha turquinensis 1956a: 144 USNM

- Pseudoepitrix brasiliensis* 1964a: 24 USNM
Pseudoepitrix darlingtoni 1945b: 92 MCZ
Pseudoepitrix hispaniolae 1941a: 174 MCZ
Pseudoepitrix hottensis 1948c: 145 MCZ
Pseudoepitrix jamaicensis 1941a: 175 MCZ
Pseudoepitrix longicornis 1945b: 90 MCZ
Pseudoepitrix punctatissima 1948c: 146 MCZ
Pseudoepitrix rugosa 1964a: 24 USNM
Pseudoepitrix tetraspilota 1945b: 90 MCZ
Pseudogona subcostata 1956a: 142 USNM
Rachicephala 1966b: 353
Sidfaya 1964a: 26
Sidfaya bicolor 1969a: 169 CNC
Sidfaya entima 1969a: 169 CNC
Sidfaya philtata 1968a: 65 USNM
Sidfaya polutima 1964a: 27 USNM
Sidfaya punctatissima 1964a: 28 MCZ
Simopsis 1966a: 253
Simopsis neobroticoides 1966a: 254 BM
Stoiba bruneri 1930a: 219 USNM
Stoiba decemmaculata 1930a: 221 USNM
Stoiba fascicollis 1934a: 54 USNM
Stoiba fuscicornis 1966c: 219 USNM
Stoiba indivisa 1930a: 218 USNM
Stoiba marginata 1934a: 53 USNM
Stoiba rufa 1966c: 218 USNM
Strabala acuminata 1953a: 128 USNM
Strabala acuminata costaricensis 1953a: 129 USNM
Strabala acuminata teapensis 1953a: 129 BM
Strabala ambulans jamaicensis 1953a: 131 USNM
Strabala ambulans puertoricensis 1953a: 132 USNM
Strabala colombiana 1953a: 133 MCZ
Strabala rotunda 1953a: 130 USNM
Strabala rufa floridana 1953a: 128 USNM
Strabala trinitatis 1953a: 134 BM
Systema californica 1953a: 101 USNM
Systema carri 1935a: 102 USNM
Systema dimorpha 1933a: 181 USNM
Systema gracilentia 1933a: 180 USNM
Systema laevis 1935a: 100 USNM
Systema mesochlora 1935a: 96 USNM
Systema plicata 1959b: 246 USNM
Trichobrotica egenis 1966a: 237 BM
Trichobrotica fenestrata 1966a: 240 CAS
Trichobrotica nigripennis 1966a: 238 BM
Trichobrotica nymphaea flavicollis 1966a: 236 USNM
Trichobrotica rhabdota 1966a: 237 MCZ
Trirhabda adela 1931a: 14 USNM
Trirhabda borealis 1931a: 16 USNM
Trirhabda borealis var. *indigooptera* 1931a: 17 USNM
Trirhabda confusa 1931a: 27 USNM
Trirhabda gurneyi 1951c: 326 USNM
Trirhabda neoscotiae 1931a: 17 USNM
Trirhabda nigriventris 1951c: 327 USNM
Trirhabda pilosa 1931a: 20 USNM
Trirhabda pubicollis 1951c: 326 USNM
Trirhabda schwarzi 1951c: 324 USNM
Trirhabda sericotrachyla 1931a: 28 USNM
Trirhabda viridicyanea 1931a: 19 USNM
Typophorus habanae 1970c: 119 MM
Xanthonia flavoannulata 1954a: 246 USNM
Xenochalepus cyanura 1971a: 279 USNM

FAMILY CRYPTOPHAGIDAE

- Cryptophagus maximus* 1928b: 109 USNM
Pharaxonotha zaminae 1928b: 111 USNM

APPENDIX III. KEYS PROVIDED IN DORIS H. BLAKE PAPERS

KEYS TO GENERA

- Galerucini: *Luperosoma* and related genera: 1966a: 235–236 (11 genera).
Neobrotica and related genera: 1966b: 271 (7 genera).
Phyllecthrus and related genera: 1958a: 69 (9 genera).

KEYS TO SPECIES

- Altica*: *Altica bimarginata* and related species: 1936a: 15 (7 species).
Chalcosicya: West Indies species: 1951d: 288–290 (24 species).
Colaspis: a) Costate species in United States: 1974b: 3–4 (20 species).

b) *Colaspis melancholica* and related species: 1974c: 158 (7 species).

c) Brown semi-costate and costate species in Mexico and Central America: 1976b: 3-5 (34 species).

Disonycha: a) Species in America north of Mexico: 1927a: 5-9 (34 species).

b) Vittate species in Mexico and Central America: 1955c: 4-6 (36 species).

c) Vittate species in South America: 1955c: 6-9 (41 species).

Distigmoptera: Known species: 1943b: 210-211 (11 species).

Eccoptopis: Known species: 1966b: 340 (11 species).

Ectmesopus: a) Known species: 1940a: 96-97 (10 species).

b) Known species: 1958a: 96-97 (11 species).

Galeruca: North American species: 1945a: 54 (5 species).

Glyptobregma: Known species: 1947b: 94 (6 species).

Glyptoscelis: a) U.S. species: 1967b: 4-6 (22 species).

b) Mexican and Central American species: 1967b: 34-35 (5 species).

c) South American species: 1967b: 39-40 (8 species).

Graphops: Known species: 1955b: 269-271 (18 species).

Hadropora: Known species: 1943a: 415-418 (32 species).

Homoschema: Known species: 1950a: 13-14 (16 species).

Hystiopsis: Known species: 1966b: 324-325 (18 species).

Iceloceras: Known species: 1958a: 77-78 (11 species).

Luperodes: Known species: 1942a: 58-59 (21 species).

Luperosoma: Known species: 1958a: 90 (6 species).

Megistops: a) West Indies species: 1952b: 2-3 (12 species.).

b) South American species: 1952b: 3-4 (12 species).

Metachroma: a) Eastern and central U.S.: 1970b: 5-6 (21 species).

b) Western Texas to Rocky Mountains and California: 1970b: 20-21 (16 species).

c) Mexico and Central America: 1970b: 30-31 (24 species).

d) South America: 1970b: 45 (7 species).

e) Bahamas: 1970b: 49 (3 species).

f) Cuba: 1970b: 50-51 (21 species).

g) Hispaniola: 1970b: 60-61 (15 species).

h) Puerto Rico: 1970b: 67-68 (8 species).

i) Jamaica: 1970b: 72 (19 species).

j) Dominica: 1970b: 82 (2 species).

Monoxia: Known species: 1939a: 150-152 (17 species).

Myochrous: a) America north of Mexico: 1950c: 10-11 (13 species).

b) Mexico and Central America: 1950c: 11-12 (11 species).

c) South America: 1950c: 12-14 (27 species).

Neobrotica: a) North and Central America: 1966b: 271-273 (36 species).

b) South America: 1966b: 301-307 (28 species).

Oedionychis: a) America north of Mexico: 1927a: 5–9 (34 species).

b) *Miniatus*-complex: 1954b: 140 (8 species).

Phyllecthrus: Known species: 1958a: 71 (3 species).

Phyllobrotica: Pacific coast of U.S.: 1956b: 259–260 (5 species).

Strabala: Known species: 1953a: 127 (8 species).

Trirhabda: America north of Mexico: 1931a: 9–12 (22 species).

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The following item appeared after this paper was sent to the printer:

1981a. A note on three old species of Chrysomelidae. *Caribb. J. Sci.* 16(1–4): 63–64 (1980).

This title raises the number to 97 but adds neither new taxa nor keys to the preceding summaries.

PROC. ENTOMOL. SOC. WASH.
83(3), 1981, pp. 564–569



EDSON J. HAMBLETON
1902–1980

Edson Jorge Hambleton, President of the Entomological Society of Washington in 1971 and an active member of the Society since 1944, died unexpectedly of a heart attack in Washington, D.C., November 5, 1980.

Mr. Hambleton was born February 13, 1902, in Columbus, Ohio, one of 9 children of James Chase and Sara Paulsen Hambleton. He grew up in

Columbus, attended public schools there and Ohio State University where he was awarded a B.S. degree in 1926. He then matriculated in the College of Agriculture of Cornell University and received a M.S. degree in 1928.

As a youth, Edson seemed to have a bent toward natural history. This interest was nurtured by his father, a naturalist of note as well as the principal of a vocational school, and by an older brother, James Isaac Hambleton, who became a foremost apiculturist. Edson accompanied his father on collecting trips around Columbus and early in life experienced the exhilaration of finding special plants and animals. Although he had considerable interest in botany, his greatest interest, as a youth and as a University student, was in entomology. With the encouragement of University professors, Edson entered into the study of insects with an enthusiasm that persisted throughout his entire life.

Mr. Hambleton's professional career began while he was a graduate student at Cornell when he served as an Extension Specialist in Entomology from 1927 to 1929. Thereafter he embarked upon a challenging career in South America, one that would acquaint him with the entomologists, museums, laboratories and insect problems of that continent.

He was a professor and department head at Escola Superior de Agricultura e Veterinária, Viçosa, Brazil, from 1929 to 1934. Next, he served as entomologist at the Instituto Biológico, São Paulo, from 1934 to 1939. From São Paulo Mr. Hambleton moved to Sociedad Nacional Agraria, Lima, Peru, where he remained until 1943. During the years in South America, he travelled widely, collected extensively, and acquired many insects of known and unknown economic importance.

After Mr. Hambleton's return to the United States in 1943, he became an employee of the U.S. Department of Agriculture. Owing to his broad experience in South America, he was exceptionally well qualified for the work of a field service consultant in the Office of Foreign Agricultural Relations, a position that he occupied until 1952. During this period he visited Central and South America, investigating problems that included insects on such diverse plants as pine trees, lemon grass, and cinchona. In 1952 and 1953 he was staff assistant in the office of the Chief of the Bureau of Entomology and Plant Quarantine. Later in 1953 he was placed in charge of foreign technical programs of the Plant Pest Control Branch, Agricultural Research Service. He held this position, and served concurrently as assistant to the director from 1959 until his retirement in 1964.

Mr. Hambleton was deeply involved in technical programs in Latin America, Africa, the Middle East and South Asia. At times 30 or more Ministries of Agriculture or Departments of Plant Protection cooperated with the United States, and as many as 22 full time entomologists were assigned to foreign posts to work side by side with Nationals on different phases of applied entomology. Mr. Hambleton was largely responsible for the selection of personnel and for the administration of programs that dealt

with such varied subjects as field experiments to test methods of insect control, training plant protection personnel, and development of techniques to assist quarantine officials and extension entomologists. He rendered outstanding service to the Department and to the cooperating agencies in the study of pest problems, especially in the biology and control of cotton pests and in control measures for migratory locusts.

Subsequent to retirement from the Department, Mr. Hambleton was consultant to Asociación de Productores de Aceites Esenciales, Guatemala, until 1966. From 1970 until his death, he was a Cooperating Scientist, Systematic Entomology Laboratory, IIBIII, Agricultural Research, Science and Education Administration, U.S. Department of Agriculture.

Over the years Mr. Hambleton's work was largely in the field of applied entomology, and it encompassed several orders of insects, particularly the pests of cotton. But he had a primal, enduring interest in systematic studies, and his preference among the orders was the Hemiptera. He coauthored articles with C. J. Drake on the taxonomy of the Tingidae and published independently on the Pseudococcidae. His latest research was directed to *Rhizoecus* and closely related genera of the Pseudococcidae. He became a world specialist on the pest species of these genera. A list of Mr. Hambleton's publications is appended.

Mr. Hambleton was a United States delegate at the Conference on Locust Control, Food and Agriculture Organization, held in Damascus, Syria, in 1955 and in Rome, Italy, in 1959. He attended the 4th International Congress of Entomology in Ithaca, New York, in 1928, the 10th held in Montreal, Canada, in 1956, and the 15th in Washington, D.C., in 1976. He often attended national and regional meetings of the Entomological Society of America. He was a member of the latter society, the American Association for the Advancement of Science, and the Washington Academy of Sciences in addition to the Entomological Society of Washington. He also belonged to Alpha Gamma Rho and the Cosmos Club.

Entomology was Mr. Hambleton's dominant interest, and horticulture was his hobby. He was the complete gardener, a grower of flowers, vegetables, fruits, and ornamentals. He delighted in operating a tractor and a roto tiller on a small farm in nearby Virginia where he and Mrs. Hambleton often enjoyed country living. He was courteous, sociable, kind, helpful, a person of strong convictions, a cherished friend.

Mr. Hambleton is survived by his wife, Miriam Roush Hambleton of Bethesda, Maryland; a daughter, Mrs. Eleanor Hambleton Farr of Takoma Park, Maryland; a son, E. James Hambleton of Silver Spring, Maryland; four grandchildren; two sisters and two brothers.

PUBLICATIONS OF E. J. HAMBLETON

- 1932 *Stephanoderes hampei* (Ferr.) reported in State of Minas Gerais. Rev. Entomol. (Rio de J.) 2: 384.
- 1934 Brazilian Tingitidae (Hemiptera). Part I. Rev. Entomol. (Rio de J.) 4: 435-451, illus. With C. J. Drake.
- 1935 Em defesa do algodoeiro. Biologico (São Paulo) 1: 105-108.
- 1935 Alguns dados sobre lepidopteros brasileiros do Estado de Minas Gerais. Rev. Entomol. (Rio de J.) 5: 1-7.
- 1935 Conselhos para a defesa do algodoeiro. Interessantes consideracoes do entomologista. Algodao (Rio de J.) 2: 2 pp.
- 1935 A "Lagarta rosada" nos algodoes paulistas. Biologico (São Paulo) 1: 147-148.
- 1935 Aspectos das principais pragas do algodoeiro em São Paulo durante os anos de 1934-35. Biologico (São Paulo) 1: 295-298.
- 1935 Notas sobre Pseudococcinae de importancia economica no Brasil com a descricao de quatro especies novas. Arch. Inst. Biol. (São Paulo) 6: 105-120, illus.
- 1935 New Brazilian Tingitidae (Hemiptera). Part II. Arch. Inst. Biol. (São Paulo) 6: 141-154, illus. With C. J. Drake.
- 1935 Uma lista de Lepidoptera (Heterocera) do Estado de Minas Gerais. Arch. Inst. Biol. (São Paulo) 6: 213-256. With W. T. M. Forbes.
- 1936 Sugestoes para o combate a broca do algodoeiro. Biologico (São Paulo) 2: 307-314, illus.; Rev. Soc. Rur. Bras. (São Paulo) 16(194): 32-35, illus.
- 1936 As pragas do algodoeiro. Rev. Soc. Rur. Bras. (São Paulo) 16(195): 45-47, illus.
- 1937 A lagarta rosada nos algodoads de S. Paulo. Rev. Soc. Rur. Bras. (São Paulo) 17(198): 36-37.
- 1937 Influencia das praticas culturais no combate a broca do algodoeiro. Rev. Soc. Rur. Bras. (São Paulo) 17(200): 40-43, illus.; Biologico (São Paulo) 3: 178-182.
- 1937 Uma nova especie de *Gasterocercodes* Pierce, broca do algodoeiro no Brasil (Col. Curculionidae). Rev. Entomol. (Rio de J.) 7: 345-350, illus.
- 1937 A broca do algodoeiro do Brasil, *Gasterocercodes brasiliensis* Hambleton (Col. Curcul.). Arch. Inst. Biol. (São Paulo) 8: 47-106, illus.
- 1937 A existencia da *Platyedra gossypiella* (Saunders) na floracao dos algodoeiros em S. Paulo, durante 1936-1937. Arch. Inst. Biol. (São Paulo) 8: 249-254, illus.
- 1937 Em defesa da cultura algodoeira. A broca do algodoeiro e a lagarta rosada. Rev. Soc. Rur. Bras. (São Paulo) 17(207): 44-45, illus.

- 1938 Concerning Brazilian Tingitidae (Hemiptera). Part. III. Rev. Entomol. (Rio de J.) 8: 44-68, illus. With C. J. Drake.
- 1938 Brazilian Tingitoidea (Hemiptera). Part IV. Arch. Inst. Biol. (São Paulo) 9: 51-57, illus. With C. J. Drake.
- 1938 O percevejo "*Horcius nobilellus* Berg" como nova praga do algodoeiro em Sao Paulo. Observacoes preliminares. Arch. Inst. Biol. (São Paulo) 9: 85-92, illus.
- 1938 Observacoes sobre as pragas da cultura algodoeira no Nordeste e Norte do Brasil. Arch. Inst. Biol. (São Paulo) 9: 319-330. With H. F. G. Sauer.
- 1939 Conselhos do Instituto Biologico de Sao Paulo sobre as pragas do algodoeiro. Agr. e Pecuar. (Rio de J.) No. 195: 10-12.
- 1939 Twenty new Brazilian Tingitidae (Hemiptera). Part V. Arch. Inst. Biol. (São Paulo) 10: 153-163. With C. J. Drake.
- 1939 Experiencias para combater o percevejo "*Horcius nobilellus* (Berg)" do algodao. Arch. Inst. Biol. (São Paulo) 10: 217-218, illus.
- 1939 Notas sobre os lepidopteros que atacam os algodoeiros no Brasil. Arch. Inst. Biol. (São Paulo) 10: 235-248.
- 1940 New Brazilian Tingitidae (Hemiptera). Part VI. Rev. Entomol. (Rio de J.) 11: 533-537. With C. J. Drake.
- 1942 Percevejo do algodoeiro. Sit. e Faz. (São Paulo) 5: 93.
- 1942 Two new Peruvian Tingitidae (Hemiptera). Iowa State Coll. J. Sci. 16: 329-330. With C. J. Drake.
- 1942 Seven new South American Tingitidae (Hemiptera). Rev. Entomol. (Rio de J.) 13: 76-81. With C. J. Drake.
- 1944 Four new American Tingitidae (Hemiptera). Proc. Entomol. Soc. Wash. 46: 94-96. With C. J. Drake.
- 1944 Concerning Neotropical Tingitidae (Hemiptera). J. Wash. Acad. Sci. 34: 120-129, illus. With C. J. Drake.
- 1945 Concerning Neotropical Tingitidae (Hemiptera). J. Wash. Acad. Sci. 35: 356-367. With C. J. Drake.
- 1946 New species and new genera of American Tingidae (Hemiptera). Proc. Biol. Soc. Wash. 59: 9-16. With C. J. Drake.
- 1946 Three new species and a new genus of American Tingidae (Hemiptera). Entomol. News 57: 121-125. With C. J. Drake.
- 1946 Studies of hypogeic mealybugs. Rev. Entomol. (Rio de J.) 17: 1-77, illus.
- 1946 A new name for a mealybug. Proc. Biol. Soc. Wash. 59: 177.
- 1958 United States technical assistance approach to problems in applied entomology. Proc. 10th Int. Congr. Entomol. (1956) 3: 75-78.
- 1968 New state records for a lace bug (*Dictyla echii*). Coop. Econ. Insect Rep. 18(28): 658.

- 1973 Florida mealybugs of the genus *Rhizoecus* with description of a new species (Homoptera: Pseudococcidae). Proc. Entomol. Soc. Wash. 1: 62-71, illus.
- 1974 Three new species of *Rhizoecus* (Homoptera: Pseudococcidae) from New Zealand, with notes and redescription of others. N.Z. J. Zool. 1: 147-158, illus.
- 1976 A revision of the new world mealybugs of the genus *Rhizoecus* (Homoptera: Pseudococcidae). U.S. Dep. Agric. Tech. Bull. 1522, 88 pp., illus.
- 1977 A review of *Pseudorhizoecus* Green, with a description of a related new genus (Homoptera: Pseudococcidae). J. Wash. Acad. Sci. 67: 38-41, illus.
- 1977 Notes on the species of *Neorhizoecus* Hambleton, a synonym of *Rhizoecus* Künckel d'Herculeis (Homoptera: Pseudococcidae). Proc. Entomol. Soc. Wash. 79: 367- 376, illus.
- 1978 Three new Neotropical *Rhizoecus* (Homoptera: Pseudococcidae). Proc. Entomol. Soc. Wash. 80: 156-163, illus.
- 1979 New information on the *Rhizoecus* of Florida including descriptions of four new species. Fla. Entomol. 62: 140-149, illus.
- 1979 *Rhizoecus* mealybugs of Texas, with description of a new species (Homoptera: Pseudococcidae). Proc. Entomol. Soc. Wash. 81: 650-652, illus.
- 1979 The status of *Rhizoecus amorphophalli* Betram, a little known Oriental mealybug (Homoptera: Pseudococcidae). J. Wash. Acad. Sci. 69: 62-64, illus.

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BOOK REVIEW

Entomology. 1980. C. Gillott. Plenum Press, New York. 729 pp. Cost: \$49.50 (hardcover); \$22.50 (paperback)

Cedric Gillott of the Department of Biology, University of Saskatchewan, has published a voluminous textbook that he says is intended for "senior undergraduates taking their first course in entomology." The text is divided into 24 chapters arranged in four main sections: Evolution and Diversity, Anatomy and Physiology, Reproduction and Development, and Ecology. The majority of the chapters have useful summaries.

In an attempt to assess this book, I re-examined the other four recent American general entomology textbooks: Atkins (1978. *Insects in Perspective*. MacMillan, New York. 513 pp.), Borror, DeLong, and Triplehorn (1976. *An Introduction to the Study of Insects*. 4th Ed. Holt, Rinehart, and Winston, New York. 852 pp.), Elzinga (1978. *Fundamentals of Entomology*. Prentice-Hall, Englewood Cliffs, New Jersey. 325 pp.), and Daly, Doyen, and Ehrlich (1978. *Introduction to Insect Biology and Diversity*. McGraw-Hill, New York. 564 pp.). Based on my correspondence with the texts' authors and their respective publishing companies, I discovered that Atkins (1978) is used in about 52 colleges and universities in the U.S. and about 5500 copies have been sold in the last two years; Borror et al. (1976), an unknown number of schools, 8083 copies; Elzinga (1978), information not available; and Daly et al. (1978), 49 schools, 4260 copies. In 1981, the fifth edition of Borror et al. and the second edition of Elzinga should be available according to the publishers.

In examining the present editions of these five books, I approximated the percentages of the total number of pages that each devotes to specific main topics (Table 1). Because of interrelationships of subjects, I stress that these are approximations. However, I think that the Table indicates the main emphases on subjects that the authors make in their texts. Based on percentages of pages in decreasing order, the main emphases in Atkins (1978) are agricultural entomology, behavior, and physiology; Borror et al. (1976), insect taxonomy and anatomy; Daly et al. (1978), taxonomy, ecology, and physiology; Elzinga (1978), taxonomy, anatomy, and behavior; and Gillott, taxonomy, physiology, ecology, and development. Moreover, each text has a good coverage of at least some material not detailed in any of the others. There is not total agreement about the "facts" among the texts. For example, Atkins (1978) and Daly et al. (1978) call the Protura, Collembola, and Diplura entognathus noninsectan hexapods; Borror et al. (1976) and Elzinga (1978), insects; and Gillott, apterygote noninsectan hexapods.

Table 1. Approximate percents of pages of five general entomology textbooks that are devoted to different topics. A = Atkins (1978); B = Borror et al. (1976); D = Daly et al. (1978); E = Elzinga (1978); G = Gillott (1980). Percentages do not add up to 100% for each book due to rounding and the exclusion of prefaces and acknowledgment sections. Abbreviations: a, no specific section is included on this subject; b, includes physiology; c, includes keys to classes, orders, or families, depending on the taxonomic group; d, includes keys to families or subfamilies, depending on the taxonomic group; e, includes keys to orders and families, depending on the taxonomic group; f, includes evolution; g, includes anatomy and behavior; h, includes medical entomology; i, references are given at ends of chapters, chapter sections, or both; j, includes a key to orders.

Topic	Book					Average
	A	B	D	E	G	
Why study entomology	a	a	a	a	a	0
Beneficial aspects of insects	3.7	0.8	0.2	3.7	0.8	1.8
Brief history of entomology	2.3	a	a	a	a	0.5
Insect anatomy	3.3	4.1	4.3	21.1,b	4.8	7.5
Insect (and kin) evolution	1.8	a	3.4	a	6.6	2.4
Classification:						
Insect kin	1.8	4.9,c	0.1	5.1	0.3,f,j	2.4
Insects	7.4	67.4,d	39.7,e	20.6,e	30.4,f	33.1
Insect physiology	14.4	1.8	8.7,e	a	27.8,g	10.5
Insect endocrinology	1.2	0.1	0.4	0.8	2.1	0.9
Insect development	2.7	1.5	3.7	7.1	8.0	4.6
Insect behavior	18.9	2.4	4.4	17.5	a	8.6
Population biology	4.1	a	5.3	2.5	a	2.4
Insect ecology	4.1	a	14.5	7.1	8.5	6.8
Agricultural entomology	22.6	1.4,h	3.3,h	5.2	3.8	7.3
Medical entomology	4.3	a	a	1.5	0.4	1.2
Collecting, observing, and studying insects	a	5.6	a	2.2	a	1.6
Glossary	2.5	2.1	1.9	1.8	a	1.7
Literature cited	a,i	a,i	4.4	2.2	a,i	—
Index	2.5	7.5	4.4	3.1	5.1	4.5
Total pages	513	852	564	325	729	596.6

Both Gillott and Borror et al. (1976) could be classified more as reference-type textbooks than the other three books. The extensive keys in Borror et al. (1976) make it especially useful for North American insect identification to the family and sometimes subfamily levels. Gillott includes keys only to the insect orders.

For a dynamic, complex science like entomology, it is difficult to establish how much of a general textbook should be devoted to each subdiscipline. Yet it seems that a well balanced text should include the sections listed in Table 1. From the Table, it can be seen that Gillott writes more than the average percent of pages on physiology, endocrinology, development, evolution of insect groups, and ecology. He does not present specific sections

on subjects such as the history of entomology, behavior, and collecting, observing, and studying insects. He omits a glossary although one could be quite helpful for beginning entomology students.

Gillott's writing style is basically straightforward and his text is accurate and of good quality. There are relatively few flaws in style and English, but "who" is used anthropomorphically in referring to an insect (526, 632). Parts of the book sound teleological; e.g., on page 651, one reads: "To obtain effective cross-pollination: (1) plants must produce the correct amount of nectar to maintain insects' "interest," yet stimulate visits to other plants of the same species; and (2) insects must be able to recognize members of the same plant species." Gillott does not always use common names that are approved by the Entomological Society of America: e.g., "scorpion flies" (217), "caddis fly" (221), "bumblebee and honeybee" (316), "house-fly" (261), "blowfly" (262), and "ichneumon fly" (299). The text has an adequate number of good, helpful illustrations including dendrograms of many taxonomic groups. Unfortunately some poor quality illustrations (originally from Swan and Papp, 1972 [*The Common Insects of North America*. Harper and Row, New York. 750 pp.]) are used, e.g., pages 185, 189, 235, 238, 240, 280, and 284.

In accordance with the aim of a general entomology text, Gillott emphasizes basic information, sufficiently covering many facets of the science. Yet, regarding subjects that are especially interesting to me, e.g., behavior and ecology, I feel that the text could be more modern. Concerning behavior, nowhere in the book do I find mention of a main unifying concept— inclusive fitness (that also refers to biology in general). Intriguing evolutionary aspects of insect reproductive behavior such as mate-finding strategies, sperm precedence, and parental investment are omitted. Feeding theory (including foraging bioenergetics) and pollination seem slighted. Moreover with respect to applied entomology, I found only a meager amount of information on important new developments such as quantitative analysis and computer modeling in integrated pest management (687) (Geise et al., 1975 [*Science* 187: 1045–1057]).

All in all, instructors who favor a textbook that is particularly strong in taxonomy, evolution of insect groups, physiology, and development might wish to examine Gillott's *Entomology* for possible course adoption. Students no doubt would find the price of the hardcover edition exorbitant even in these inflationary times.

Dr. Cedric Gillott reviewed a preliminary draft of this review; he does not agree with all of my comments. Drs. Atkins, Borrer, Daly, and Elzinga critiqued Table 1.

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THE CAUSTICA GROUP OF THE GENUS *EPICAUTA*
(COLEOPTERA: MELOIDAE)

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Abstract.—The Caustica Group is defined on the basis of characters of courtship behavior and larval and adult anatomy to include the Neotropical species *Epicauta caustica* Rojas; *E. floydwerner*i Martínez (formerly in the Vittata Group); *E. brasiler*a, new species (Brazil); and *E. crucera*, new species (Bolivia). Adults of these species are keyed, described, and figured. Courtship behavior and the first-instar larva are described and figured for *E. floydwerner*i. Available ecological information is summarized.

Epicauta caustica Rojas, *E. floydwerner*i Martínez, and two new species of the nominate subgenus of *Epicauta* Dejean form a distinctive, previously unrecognized taxon that I propose to call the Caustica Group. This group occurs in the New World tropics from Panamá and Venezuela south to Bolivia, extreme northern Argentina, and southern Brazil (Fig. 1). It appears to have a major disjunction of range through the heart of the Amazon Basin, but all known species surely have more extensive distributions than shown on the map, and it is not unlikely that additional species await discovery in northern and central Brazil, if not elsewhere.

There are many anatomical similarities between the Caustica Group and Vittata Group in both the adult and larval stages: *E. floydwerner*i was, in fact, included in the latter group by Adams and Selander (1979). Adult feeding behavior and patterns of geographic distribution in South America are also similar. There are, however, major anatomical and behavioral differences, including unusual modifications of the male head and antennae in the Caustica Group that are associated with a highly distinctive form of courtship behavior.

MATERIALS AND METHODS

Twelve males and ten females of *Epicauta floydwerner*i taken 11-12 December 1973 at the Saavedra Agricultural Experiment Station, Santa Cruz, Bolivia, were housed in two plastic cages each measuring 18 by 13 by 10



Fig. 1. Geographic distribution of the Caustica Group. The open circle and square represent, respectively, country and state records.

(height) cm and provided with a floor covering of blotter paper, a dish containing moist (10% water) silica sand (depth 25 mm), and cuttings of plants as food. From 29 December 1973 on, the beetles were held at 25°C under a 12/12 daily photophase.

Courtship behavior was observed in sunlight or under a bank of fluorescent lamps at temperatures ranging from 27°C to 28½°C. The sexes were usually separated for 2–3 days before an observation period. The total duration of all observation periods was about ten hours. Details of the positioning and movement of the male antennae during courtship were determined from 300 ft of 16 mm motion picture film (24 fps) using a projector that permits inspection of single frames.

Egg masses were incubated individually in cotton-stoppered 3-dram glass vials in darkness at 27°C and 100% RH in a commercial environmental chamber. First-instar larvae were killed in 70% ethyl alcohol (in water) and later treated with KOH, dehydrated through an alcohol series, cleared in oil of wintergreen and toluene, and mounted on slides in Harleco Synthetic Resin.

Anatomical descriptions of adults of the group are based on material from the Cornell University Insect Collection, Ithaca, New York; Field Museum of Natural History, Chicago, Illinois; Departamento de Zoología, Secretaria de Agricultura, São Paulo, Brazil; Instituto Miguel Lillo, Tucumán, Argentina; Museo de La Plata, La Plata, Argentina; U.S. National Museum, Washington, D.C.; Universidad Central de Venezuela, Maracay; and my own collection.

In the text, sample means are accompanied, in parentheses, by estimates of their standard errors.

ECOLOGY AND BEHAVIOR

The recorded seasonal distribution of adults of *E. caustica* extends from 30 April to 8 August. Adults of *E. crucera* have been collected in November, those of *E. brasileria* from October to February, and those of *E. floydwerneri* from November to January. Eight of 22 adults of the last species taken in Bolivia in mid-December survived until mid-March, when they were killed.

In the time of Rojas (1857), adults of *E. caustica* were apparently well known to the natives of San Fernando de Apure, Venezuela, as a *plaga del tomate* (*Lycopersicum esculentum* Mill.); a more recent record is from potato (*Solanum tuberosum* L.) at Valencia, Venezuela. At Saavedra, Bolivia, we found adults of *E. floydwerneri* in an area of rank vegetation bordering agricultural fields, where they occurred singly or in small groups on *Amaranthus* sp., particularly delicate plants 20–30 cm in height. Captive adults readily ate leaves and stems of several species of *Amaranthus* as well as leaves of potato and an unidentified, succulent *Solanum* sp. from Paraguay.

Available evidence suggests that the group is primarily nocturnal in the adult stage. Rojas collected specimens of *E. caustica* by placing a light in his window, and several specimens from Panamá are labeled as collected at ultraviolet light. In the case of *E. floydwerneri*, we had difficulty finding adults in the afternoon, obtaining only six individuals in about three hours of searching. However, in a period of two hours beginning at dusk we found 17 individuals (16 collected), nine of which were taken by visiting a single, small *Amaranthus* plant three times. Captive adults were more active at night than in the day. Under bright light they tended to hide under their food material.

Rojas, who reportedly used cantharidin derived from adults of *E. caustica*

in the treatment of "neuralgia," established experimentally that both live adults and alcohol in which adults had been preserved are capable of producing blisters on human skin. Adults were described as flying and running very actively.

Adults of *Epicauta floydwernerii* are among the most wary and easily disturbed blister beetles that I have seen, and on this account, as well as their tendency to shun bright light, it is difficult to study their behavior. Individuals swept into a collecting net invariably folded the antennae and legs against the body and feigned death, a response quite different from the typical running and hiding behavior of adults of the Vittata Group (Adams and Selander, 1979).

Courtship behavior, presently known only for *E. floydwernerii*, is described in the following section.

COURTSHIP BEHAVIOR IN *EPICAUTA FLOYDWERNERII*

Courtship in *Epicauta floydwernerii* may be described conveniently in terms of (1) an *orientation* phase, in which the male stands near the female and tries to grasp her antennae with his own; (2) a *mounted* phase, in which the male is mounted directly over the female and facing in the same direction; and (3) a *precopulatory sequence*, initiated during the mounted phase and terminating in copulation. Before considering courtship behavior as a whole, it will be useful to describe four characteristic acts of male display.

In *antennal wrapping*, the male grasps the female's antennae by winding his own antennae around them. Beginning from above the female's antenna, the male's antenna makes $1\frac{1}{2}$ turns. Invariably the antenna curves like a ram's horn; that is, with respect to its base, the antenna spirals outward, turning clockwise if on the left side of the head and anti-clockwise if on the right (Fig. 2). Intimate contact with the female's antennae is made by the ventral surfaces of segments III-VI. The first turn, involving segments III-V, is tight; the following half turn, beginning with segment VI, is looser.

Antennal coiling is the act of making wrapping-like turns in the antennae without attempting to grasp the female's antennae.

Given the opportunity, a mounted male that has wrapped his antennae around the female's pulls them straight up, aligns them nearly side by side directly in front of his head, and presses their free ends against his epicranium. While *pressing* the female's antennae in this manner, the male usually performs repeated bouts of foretarsal *rubbing*, each consisting of a flurry of rapid but not particularly vigorous strokes of the inner side of the foretarsus against the side of the female's head.

Temporal patterning of courtship behavior.—In reading the following account, it will be helpful to refer to the diagram in Fig. 3.

Orientation phase: On encountering a female at a distance of no more than a few centimeters, the male becomes alert, extends the maxillary palpi

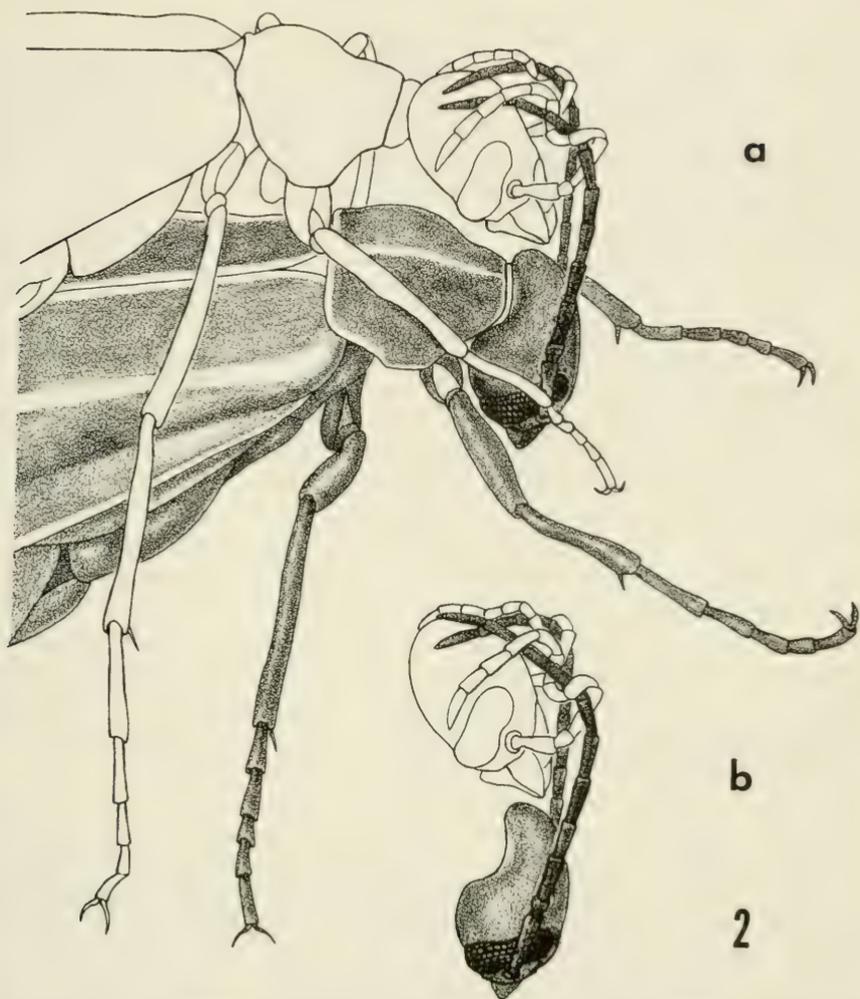
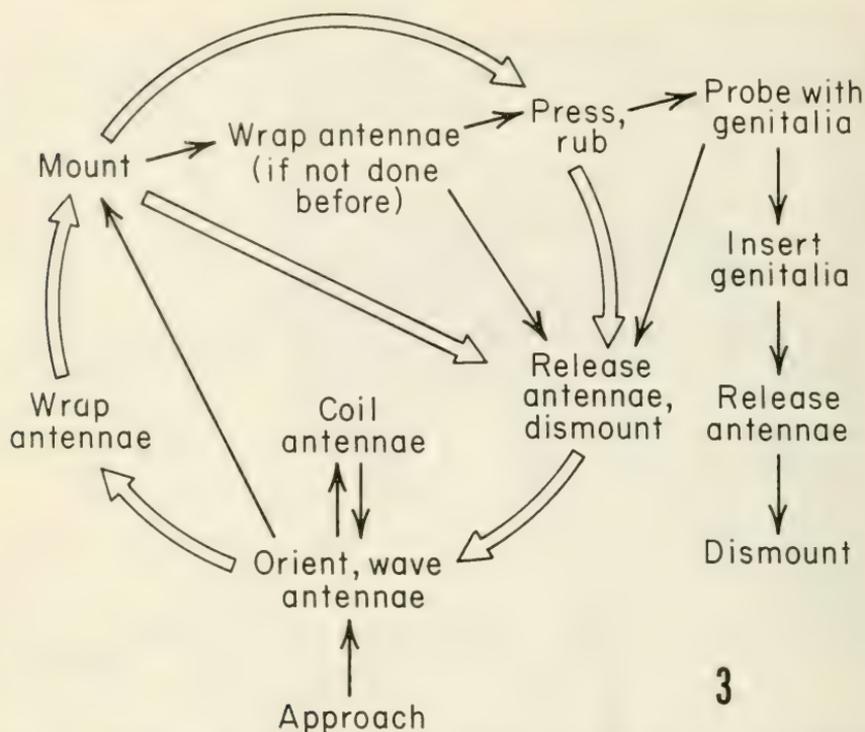


Fig. 2. Courtship behavior in *Epicauta floydwernerii*. a, The male, above female, has wrapped his antennae around hers and pulled them up in front of his head. b, The male presses the ends of the female's antennae against his epicranium.

straight forward, and begins to wave the antennae up and down, alternately, as though seeking or receiving an olfactory stimulus. He then approaches warily, brings the antennae over the female, and folds the palpi to their normal position. While orienting, he may shift his position with respect to the female, but there is no clear tendency to move to the front, as in the Albida Group, or to the rear, as in the Vittata Group. Moreover, there is no antennal contact with the female during courtship except for wrapping and no palpal contact whatsoever.



3

Fig. 3. Sequence of male sexual behavior in *Epicauta floydwernerii*. The more commonly observed transitions are indicated by heavy arrows.

Once the female's antennae are within reach, the male quickly attempts to perform antennal wrapping with one or both of his antennae. In all but a very few cases that I observed the male mounted the female as soon as wrapping occurred. Occasionally, when the female was walking, a male momentarily wrapped one of his antennae around one of hers without trying to mount. In this situation in particular, the agility and speed with which males move their antennae is impressive. By examining single frames of motion picture film, I determined that full wrapping and unwrapping of the antenna may be accomplished within $1/12$ s.

Antennal coiling was observed only in males standing in front of females and then only rarely. It was always preceded and followed by bouts of antennal wrapping.

Mounted phase: Typically, the male is able to wrap only one of the female's antennae while orienting, in which case he immediately attempts to wrap the other one once he mounts. Rarely a male orienting from the rear will mount the female and then attempt to wrap the antennae. In any event, males that cannot control both of the female's antennae on attaining

the mounted position almost immediately release the female and dismount. This pattern of behavior, which characterized perhaps 95% of the 150 or so mounts that I observed, is expressed even if the female does not show an overt negative response.

When the male is mounted, his head is directly over the female's. The forelegs are placed so that the base of the tarsus is against the side of the female's thorax, either in front of her forelegs or behind them. Placement of the other legs by the male is highly variable; in many cases one or more of them remained on the substrate, as in Fig. 2a.

A male that successfully wraps both of the female's antennae brings them rapidly into the pressing position and holds them against his head during the remainder of the mounted phase (Fig. 2b). In general, however, males showed little persistence in the mounted phase unless the female was cooperative. Thus, in response to negative behavior (see below), males usually released the female's antennae and dismounted after only 1-4 s of pressing. Only rarely did the sequence of activities proceed to the point where the male extruded the genitalia.

Precopulatory sequence: If the female becomes still in response to pressing and rubbing, the male extrudes his genitalia and probes with the tip on her dorsum. In response, a receptive female turns the end of the abdomen slightly upward, and the male then inserts his genitalia in hers. Insertion of the genitalia by a small male requires that he first move backward; in doing so, he allows his grasp of the female's antennae to slip distad.

Once the genitalia are coupled, the male suddenly releases the female's antennae and extends his. He then continues to hold his partner loosely with the legs for a short period of time before dismounting by falling over backward. Immediately on dismounting he rights himself and the pair thus assumes the linear copulatory position characteristic of the *Meloinae*.

In one sequence filmed in its entirety, elapsed times from the beginning of pressing to genital extrusion, genital insertion, and release of the antennae were 2, 9, and 10.5 s, respectively. There then followed a period of 95 s before the male dismounted.

Response of the female.—Females of *E. floydwernerii* show little of the tolerance of male attention characteristic of most species of the *Vittata* Group and in this respect more closely resemble females of the *Albida* Group. Low level negative response in the orientation phase of courtship consists of pushing the male with the mid- or hindlegs. If this does not discourage him, the female may attack or threaten to do so. Attacks are not persistent, however, and none that I saw caused injury.

When mounted by a male, an unreceptive female lowers the free antenna (or antennae) to the side of the head and directs it straight back, where it is virtually impossible for the male to wrap it. In addition, she frequently tries to dislodge the male by brushing her legs over her back.

In response to pressing, receptive females become nearly comatose. When the antennae are released the head is lowered to the substrate and the antennae fall limply to either side. Recovery occurs a few seconds after the male dismounts.

Discussion.—Modifications of the male epicranium, antennae, and foretarsi of *E. floydwernerii* of obvious adaptive significance in courtship are described later in this paper. Similar modifications occur in *E. caustica* and *E. brasileria*, and on this basis it is likely that males of both species perform wrapping, pressing, and rubbing much as in *E. floydwernerii*. On the same basis, the male of *E. crucera* probably does wrapping and rubbing, but since the male's head is not much modified, the act of pressing is perhaps quite different in form or absent.

Courtship in *E. floydwernerii* resembles in several respects that of the Albida Subgroup of the Albida Group, as described by Selander and Mathieu (1969). In both taxa the male wraps the antennae around those of the female and intersperses orientation with frequent mounts of short duration. There are, however, numerous differences, and I would not suggest that any of the special similarities are homologous. In particular, in the Albida Subgroup (1) antennal wrapping not only involves different segments but is initiated from beneath the female's antenna, so that the direction of spiraling is reversed; (2) the male does not press the female's antennae against his head; (3) the male behaves in orientation as though attempting to stimulate the female visually; (4) the male antennates and palpates the body of the female; (5) the male raises his middle legs in the precopulatory sequence; and (6) a receptive female solicits mounting by tipping the body.

None of the several patterns of courtship described in the Vittata Group by Adams and Selander (1979) is particularly suggestive of the pattern in *E. floydwernerii*. Moreover, most of the characteristic features of courtship recorded in the Vittata Group, such as antennation, palpation, regularly repeated genital presentation, hindleg rubbing, and head nodding and tucking are lacking in *E. floydwernerii*. Still, there is one similarity that is perhaps highly significant phylogenetically. That is the fact that full antennal curling in the Vittata Group and antennal coiling in *E. floydwernerii* are topologically identical.

OVIPOSITION IN *EPICAUTA FLOYDWERNERI*

During the period 6 January to 16 March 1974, captive females of *E. floydwernerii* laid 21 egg masses, most of which were deposited in the sand provided for that purpose. Inexplicably, embryonic development occurred in only nine of the masses, an abnormally small percentage (42.9%). Moreover, among those nine the mean percentage of eggs developing was only 32.6 (10.47)% and the mean percentage hatching only 15.4 (6.66)%.

The mean number of eggs in 12 masses was 108.3 (6.59), with a range

from 64 (in a mass laid 13 March) to 127. Three masses, including two that produced larvae, contained twice the average number of eggs. Abnormal masses of this nature evidently result from completion of successive reproductive cycles without an intervening oviposition. They have been reported previously in *Epicauta* in the Vittata Group (Adams and Selander, 1979).

Two of the double masses of *E. floydwerner* contained eggs of average size as well as much smaller ones; larvae from these masses were all undersized, evidently because they eclosed from the smaller eggs.

Incubation time in nine masses at 27°C ranged from 22 to 33 days, with a mean of 26.6 (1.06).

THE FIRST-INSTAR LARVA OF *EPICAUTA FLOYDWERNER*

The following description of the first-instar larva of *E. floydwerner* is based on an examination of 36 specimens from nine egg masses laid by females from Saavedra, Santa Cruz, Bolivia.

Description.—Light brown except pronotum, metanotum, and abdominal terga I and VI–VIII and sides of II dark brown. Head surface reticulate dorsally in basal constricted region; pronotum reticulate laterally and posteriorly, the disk and anterior margin smooth; reticulations evaginated on meso- and metanotum only in median anterior region; reticulations strongly evaginated throughout on abdominal terga I–VII, very weakly so on VIII, not so on IX. Head (Fig. 4a) strongly narrowed basally; length of gula slightly greater than $\frac{1}{2}$ greatest width of head; gular setae reaching anterior margin of gula. Antenna with segment II twice as long as III, with inner and outer setae on ventral side nearly equal in length, more than $\frac{3}{4}$ as long as II; sensory organ $\frac{1}{3}$ wider and $\frac{1}{5}$ longer than III, about $\frac{9}{10}$ as long as II. Mandible moderately slender, with about 13 teeth (9 visible in outline); teeth rectangular, prominent. Maxillary palpus with segment III $\frac{2}{5}$ to $\frac{3}{5}$ longer than wide, expanded on outer basal margin; sensory area of III extending about $\frac{2}{3}$ length of segment; papillae moderately long, separated by a distance about equal to their length, not obscuring one another in dorsal view; length of 2-segmented sensory appendix equal to width of segment II of labial palpus at middle. Labial palpus with segment II $2\frac{4}{5}$ as long as wide, with 1 or 2 setae; setae exceeding apex; sensory appendix as large as that of maxillary palpus. Thorax with line of dehiscence well developed and complete on pro- and mesonotum, weakly developed on metanotum; pronotum $\frac{1}{4}$ longer than meso- and metanotum combined. Abdomen with pleurites ventral; sterna I–VII weakly sclerotized, VIII–IX strongly so; 14 setae in posterior marginal row of terga I–VIII; setae not divided; spinelike evaginations at bases of marginal setae moderately developed throughout on terga I–VII, vestigial on VIII, usually with prominent lateral spines; evaginations at bases of median transverse row vestigial; tergum V about $3\times$ as wide as long; setae of posterior marginal row of V as long as tergum; setae of median

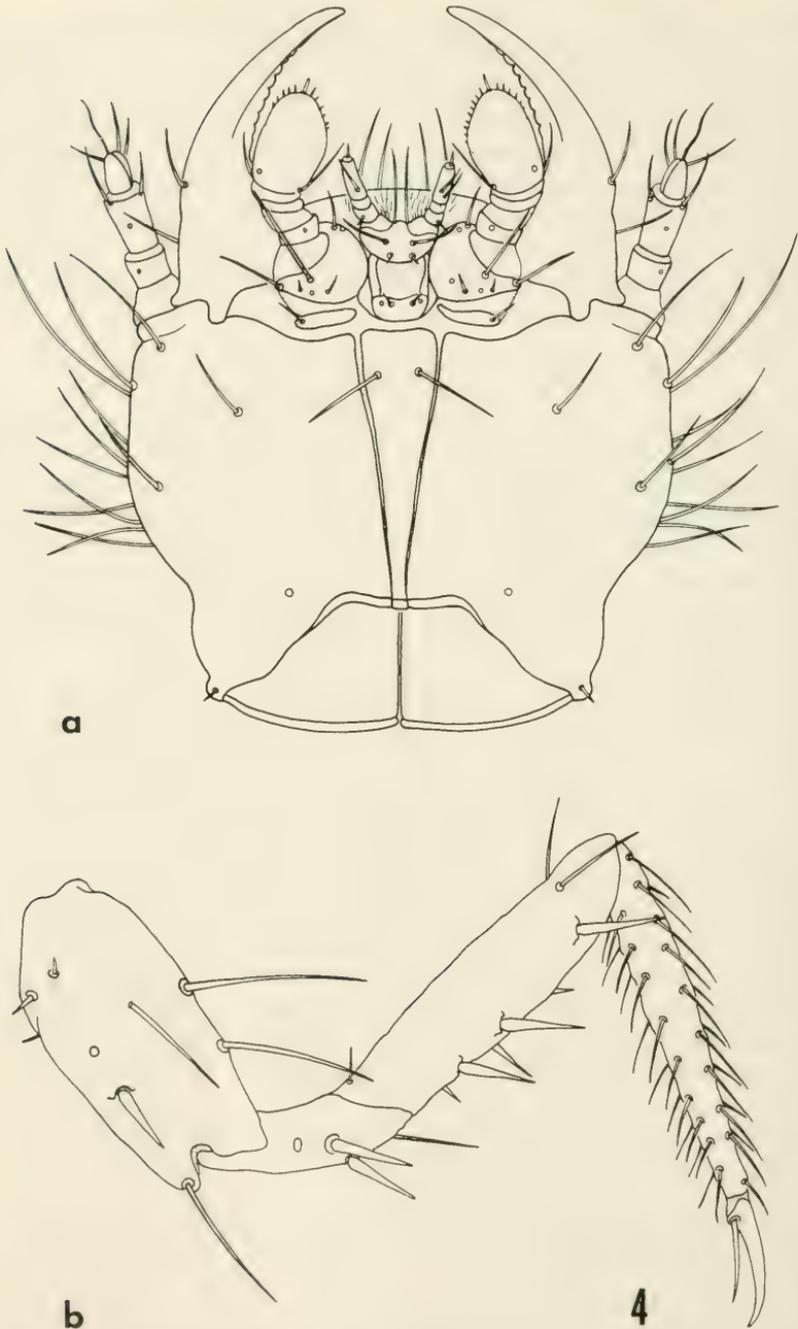


Fig. 4. First-instar (triungulin) larva of *Epicauta floydwerneri*. a, Head, ventral view. b, Leg I, anterior view.

transverse row fine, $\frac{1}{6}$ as long as posterior marginal setae; pleurite V as wide as long, with spiracle in lateral $\frac{1}{3}$; diameter of abdominal spiracle I $\frac{4}{7}$ that of mesothoracic spiracle, $\frac{2}{5}$ greater than that of abdominal spiracle II; spiracles II–VIII equal in diameter; caudal setae shorter than abdominal segments VIII–IX combined. Leg I (Fig. 4b) with coxa about twice as long as wide; femur I with 7 lanceolate setae (3 anterior, 4 posterior), femora II and III each with 7 or 8; tarsungulus I with longer seta reaching apical $\frac{1}{4}$. Body length 2.6–3.4 mm.

Remarks.—Mean body length is 3.4 (.01) mm in 17 larvae from several normal egg masses and 2.7 (.05) in 10 larvae from 2 double masses.

The larva of *Epicauta floydwerner* agrees in most respects with the description of the larva of the Vittata Group given by Agafitei and Selander (1980). There are, however, several important differences: (1) The terminal seta of antennal segment III is longer; (2) femur I has only seven lanceolate setae; and (3) the reticulations of the abdominal terga are not markedly stronger anteriorly and medianly, as in the Vittata Group, but instead moderately developed throughout. Two setae are present on segment II of each of the labial palpi in about half the specimens of *E. floydwerner* examined and one in most of the others; two specimens have two setae on one palpus and one on the other.

ADULT ANATOMY

Adults of the Caustica Group are characterized anatomically as follows.

Description.—Head quadrate. Male epicranium often flattened or impressed medianly from level of middle of eyes to vertex or normal in shape; deformation of male head reflected in female but usually to a much lesser degree; surface of male epicranium minutely granulate, satiny in texture, dull, more finely and sparsely punctate than in female; pubescence of median area of male epicranium absent or shortened and sparse, at least near midline. Male antennal callosities much enlarged, deeply dimpled, smooth, very shiny, glabrous, the smooth area on each side extending obliquely mesad and fusing between eyes to form an arch in some species. Antenna slender, filiform except for modification of basal segments in male. Male antenna with segments I–V swollen, sparsely punctate, shiny; ventral surface of III–V flattened, excavate, impunctate, glabrous, the impression lined anteriorly with very short, thick, black, spinelike setae or not; VI broadened, flattened but not excavate ventrally, with or without spinelike setae, with at least dorsal surface like that of following segments. Pronotum with a median pale vitta, sometimes marked in pubescence only. Foretibial spurs spinelike, subequal in both sexes. Hindtibial spurs moderately thickened, obliquely truncate except in *E. crucera*. Male foretarsus somewhat thickened, with tarsal pads better developed than in female. Elytra with dark vittae exten-

sive, fused apically, so that pale areas between them appear as a pale discal vitta and a less distinct pale lateral one (sometimes absent).

Remarks.—The enlargement of the antennal callosities is a functional correlate of the prominent role of the male antennae in courtship behavior. In particular, the mesal extension of the callosities to form a frontal arch would seem to reflect strengthening of the musculature involved in bringing the female's antennae together in front of the male's head and holding them there during pressing. The texture of the epicranial surface of the male is unusual for Meloidae; possibly it facilitates the distribution of a glandular product on the cuticle. The modified segments of the male's antennae are, as we have seen, precisely those making intimate contact with the female's antennae in the courtship act of wrapping.

KEY TO SPECIES (ADULTS) OF THE CAUSTICA GROUP

1. Epicranium not deformed; male antennal callosities not fused medianly between eyes; male antennal segments III–V lacking a row of spinelike setae ventrally; head and pronotum orange, black maculate. Bolivia *E. crucera*, new species
- Epicranium flattened or impressed, more strongly so in male than in female; male antennal callosities fused medianly between eyes; male antennal segments III–V usually with a row of spinelike setae ventrally; color variable 2
2. Head orange, black maculate; pronotum and elytra largely dark brown; epicranium very deeply impressed in male, moderately so in female. Panamá to Venezuela *E. caustica* Rojas
- Head chestnut brown, immaculate; epicranium shallowly impressed or flattened. Central South America 3
3. Elytra tan or light brown, generally paler than head and pronotum; epicranium impressed in both sexes; median area of epicranium glabrous in male; pubescence on head largely white
..... *E. brasileria*, new species
- Elytra chocolate brown, darker than head and pronotum; epicranium flattened; median area of epicranium sparsely pubescent in male; pubescence on head largely black *E. floydwerneri* Martínez

Epicauta caustica Rojas

Figs. 5a, 6a

Epicauta caustica Rojas, 1857: 441 [Type-material from San Fernando de Apure, Apure, Venezuela, presumably lost; NEOTYPE, ♂, from San Juan de los Morros, Guarico, Venezuela, 8 August 1964, J. and B. Bechyne, in the collection of the Instituto de Zoología Agrícola, Universidad Central de Venezuela, Maracay, hereby designated]. Denier, 1935a: 22; 1936b: 154.

Lytta caustica, Haag-Rutenberg, 1880: 53.

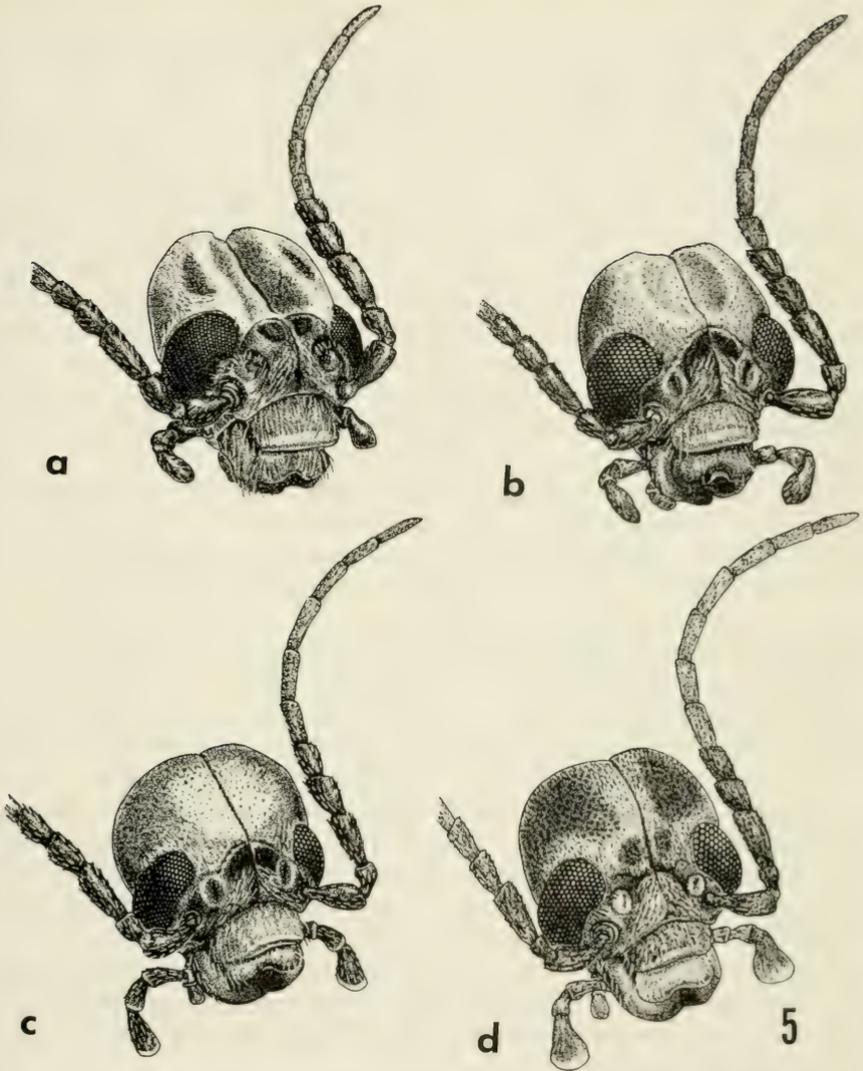


Fig. 5. Heads of males. a, *Epicauta caustica*. b, *E. brasileria*. c, *E. floydwerneri*. d, *E. crucera*.

Description of adult.—Length 11–19 mm. Head orange with a pair of small, narrowly separated black spots on front between eyes and a pair of large black spots on epicranium halfway between upper margin of eyes and vertex (lacking in one male from Venezuela); pubescence white except (usually) on and around large black spots. Antenna and palpi black. Pronotum dark brown except for a broad orange-testaceous median vitta, which is paler than head except at apex; vittae at middle little more than $\frac{1}{4}$ width

of pronotum, gradually widened anteriorly and posteriorly; setae white on vitta and margins, brown, finer, not greatly affecting coloration elsewhere. Scutellum orange testaceous, densely white pubescent. Elytra dark brown, densely clothed with brown recumbent setae (as on pronotum), except on margins and discal vitta, which are orange testaceous and densely clothed with white setae; discal vitta extending to near apex, as wide as pronotal vitta at its middle, very cleanly delimited, as is the white margin; lateral pale vitta marked in pubescence only, rather diffused, usually vestigial; entire elytral surface sparsely, regularly set with long, thick, nearly erect sericeous brown setae. Venter of thorax dark brown, densely, finely pubescent, the setae brown laterally, becoming white on ventral $\frac{1}{2}$. Legs brown; pubescence fine, whitish, especially fine on anterior surfaces of mid- and hindfemora. Abdomen dark brown; pubescence dense, sericeous brown, except white on posterior margins of sterna. Pronotum $\frac{35}{40}$ as wide as long; sides parallel for basal $\frac{3}{4}$.

Male: Epicranium very deeply, broadly impressed medianly from middle of eyes to vertex, which is deeply notched; surface for most part minutely granulate; impression impunctate, glabrous; pubescence at tempora shorter and sparser than in female; front smooth, incorporating spots between eyes. Antennal segments I–V strongly swollen; ventral surface of segments III–VI lined anteriorly with spinelike setae; VI clearly broadened, ventrally flat and glabrous; ratio of lengths of segments I–XI (to a total length of 1000) 125, 87, 125, 68, 58, 77, 102, 100, 110, 108, 140; segments I and III less than $\frac{1}{2}$ as wide as long, IV nearly $\frac{9}{10}$, V nearly quadrate, VI $\frac{6}{10}$ as wide as long, VII–VIII about $\frac{4}{10}$, IX–X about $\frac{3}{10}$, XI about $\frac{1}{4}$.

Female: Head impressed but not nearly so deeply as in male; impression punctate and pubescent.

Nomenclature.—This species was incorrectly synonymized with *E. capitata* (Castelnau) by Wellman (1910: 23) and was listed in the synonymy of both that species and *E. philaemata* (Klug) by Borchmann (1917).

Geographic distribution.—Canal Zone of Panamá eastward to the states of Guarico and Bolívar, Venezuela (Fig. 1). The species has not been reported previously from Panamá and is not presently recorded from Colombia, although it undoubtedly occurs there.

PANAMÁ: *Canal Zone:* Barro Colorado Island, 23 June 1948, 1; 10/17 May 1964, 1; 17 October 1964, Duckworth, 3; 23 June 1967, 2; 3 July 1967, 1. VENEZUELA: *Apure:* San Fernando de Apure, 230 m [Rojas, 1857]. *Bolívar:* La Vergarena, 17 July 1955, 2. *Aragua:* Maracay, 450 m, 12 July 1965, Rivas, 1. *Carabobo:* Naguanagua, 30 May 1966, Díaz Sierra, 1; Valencia, 3 June 1939, 5. *Guarico:* Ortiz, 2 July 1950, 2; San Juan de los Morros, 8 August 1964, Bechynes, 5. *Tachira:* La Fría, 300 m, 10 June 1972, Joly, 1. *Zulia:* Carrasquero, km 20, 2 May 1960, Rosales, 2; El Tucuco, 420 m,

21/27 May 1971, Rosales et al., 5; km 80, carretera entre Valera [in Trujillo] and Maracaibo, 30 April 1960, 3.

Epicauta brasiler Selander, NEW SPECIES

Figs. 5b, 6b

Description of adult.—Length 11–14 mm. Head and pronotum chestnut brown. Antenna and palpi piceous. Elytra tan to light brown, generally paler than head and pronotum. Venter and legs darker brown. Head immaculate, sparsely white pubescent. Antenna and palpi piceous. Pronotum sparsely white pubescent, with a median pale vitta marked in pubescence only, generally poorly defined. Elytra with pubescence usually white, in which case the margins and vittae are marked only by the setae being denser than elsewhere; pubescence varying to brown, in which case margins and vittae are more conspicuous; in any case, cuticle not paler beneath margins and vittae; vittae similar in size to those of *E. caustica* but less well differentiated from rest of surface; lateral vitta absent in 1 specimen; lateral white margin of elytra much wider than sutural one, not sharply delimited; surface with long setae nearly recumbent, pale, not conspicuous. Venter entirely white pubescent. Pronotum $\frac{8}{10}$ to nearly $\frac{9}{10}$ as wide as long; sides parallel for basal $\frac{3}{4}$.

Male: Epicranium shallowly, very broadly impressed medianly from middle of eyes to vertex; impression impunctate, glabrous; pubescence at tempora shorter and sparser than in female. Antenna with segments I–V not quite so strongly swollen as in *E. caustica*; ventral surface of III–V lined anteriorly with spinelike setae; VI not so broad as in *E. caustica*, flattened ventrally but not glabrous and with spinelike setae frequently absent; ratio of lengths of segments I–XI (to a total length of 1000) 97, 51, 105, 73, 66, 75, 97, 107, 105, 102, 122; segment IV $\frac{7}{10}$ as wide as long, V $\frac{2}{3}$, VI $\frac{1}{2}$, VII–X about $\frac{3}{10}$, XI about $\frac{1}{4}$.

Female: Head more shallowly impressed but definitely so; impression punctate and pubescent.

Type designation.—Holotype, ♂, from S[ão] Domingos, Mato Grosso do Sul, Brasil, October 1949, deposited in the Field Museum of Natural History.

The holotype was selected because of its good physical condition. Unfortunately, with four settlements of the name "São Domingos" in Mato Grosso do Sul (United States Board on Geographic Names, 1963), the type-locality cannot be identified precisely.

Geographic distribution.—States of Goiás, Mato Grosso, Mato Grosso do Sul, and São Paulo, Brazil (Fig. 1).

BRAZIL: Goiás: Campinas, February 1936, 1; Rio Verde, 1. Mato Grosso: R[io] das Mortes [incorrectly specified as in Goiás], 9 Novem-

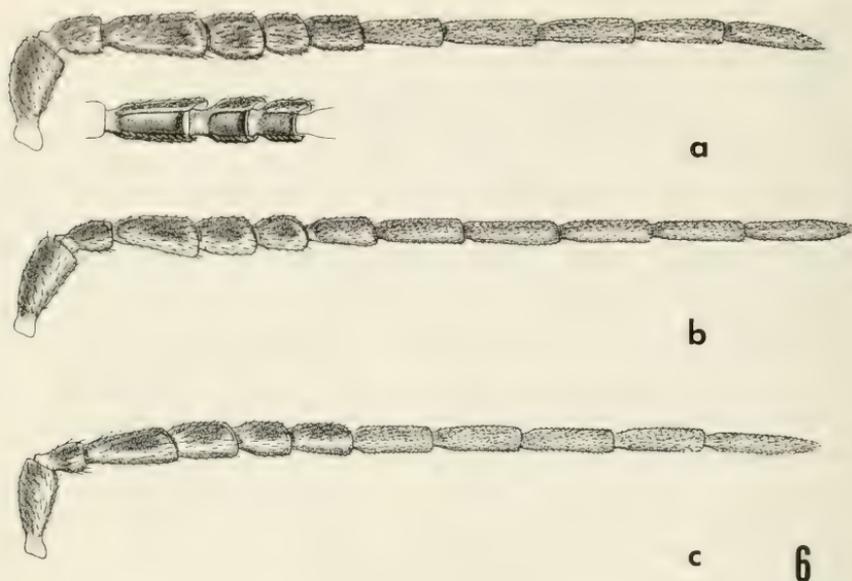


Fig. 6. Antennae of males. a, *Epicauta caustica*. b, *E. brasileria*. c, *E. floydwernerii*.

ber 1937, 6. *Mato Grosso do Sul*: Corumbá, 1; São Domingos [ambiguous; not mapped], October 1949, 5. *State Unknown*: Santa Cruz, P. Ringer, Halle, 1. *São Paulo*: State label only, 3.

Epicauta floydwernerii Martínez

Figs. 5c, 6c

Lytta rubriceps Blanchard, in Blanchard and Brullé, 1843: 200, pl. 15, fig. 8 [Type material from the province of Santa Cruz, Bolivia, presumably in the Muséum National d'Histoire Naturelle, Paris].

Epicauta rubriceps, Borchmann, 1917: 80 (in part). Denier, 1935a: 24 (in part); 1935b: 159 (in part).

Epicauta floydwernerii Martínez, 1955: 58 [New name for *E. rubriceps* (Blanchard, 1843), not *E. rubriceps* (Redtenbacher, 1842: 535)].

Description of adult.—Length 9–17 mm. Head and pronotum deep chestnut brown. Antenna and palpi black. Elytra and venter of thorax rich chocolate brown. Legs brown. Abdomen chocolate brown to dark brown. Head immaculate; surface for the most part finely punctate, minutely granulate, satiny; pubescence short, sparse, that on midline at vertex, around eyes, and on underside of head white, the rest black; epicranium flattened, equally so in the sexes. Pronotum $\frac{7}{10}$ as wide as long; sides parallel for basal $\frac{3}{4}$; pubescence black except on deflexed lateral areas, anterior and posterior margins, and along fine median vitta; vitta about $\frac{1}{7}$ width of pronotum at

middle, flared to base of pronotum; cuticle not paler beneath margins and vitta. Elytra black pubescent except finely, cleanly margined with white pubescence and with a pair of neat white vittae; outer vitta generally less densely pubescent, arising at about basal $\frac{1}{4}$, although it may extend forward (marked by few pale setae only) to join discal vitta at humerus; cuticle of margins and discal vitta about same color as head and pronotum; lateral vitta not or not so well marked in cuticle; long, nearly erect setae confined to apical region. Venter of thorax with pubescence black or dark at sides, becoming white in middle $\frac{1}{2}$. Legs largely gray-white pubescent. Abdomen black pubescent except for white fringing setae.

Male: Epicranium flattened, not impressed, more finely punctate and with sparser black setae than in female, especially medianly. Antenna with segments I–V slightly less strongly swollen than in *E. brasileria*; ventral surface of III–V lined anteriorly with spinelike setae; VI hardly broadened, flattened and with spinelike setae ventrally but not glabrous; ratio of lengths of segments (to a total length of 1000) 94, 47, 100, 72, 66, 81, 98, 104, 106, 106, 126; segment IV less than $\frac{7}{10}$ as wide as long, V $\frac{6}{10}$, VI $\frac{4}{10}$, VII–IX about $\frac{3}{10}$, X $\frac{1}{4}$, XI $\frac{1}{5}$.

Female: Front of head flattened, as in male.

Geographic distribution.—Southeastern Boliva, northern Argentina, and Paraguay (Fig. 1). There is a female in the Pereira Collection labeled "Paraiba/Arena/7.VI.953," presumably from the state of Paraiba, Brazil. The extension of range is so great that, under the circumstances, I am inclined to question the accuracy of the label.

ARGENTINA: *Formosa*: Formosa, November 1952, Peña, 1. *Misiones*: San Ignacio, Bades, 1; province label only, Rodríguez, 2. BOLIVIA: *Santa Cruz*: [San José de] Chiquitos, 700 m, November 1959, 2; El Cidral, 1/28 January 1962, Golbach, 4; Saavedra Agricultural Experiment Station, 11/12 December 1973, Selander and Bouseman, 22. PARAGUAY: Country label only, 1.

Epicauta crucera Selander, NEW SPECIES

Fig. 5d

Description of adult.—Length 9–10 mm. Head orange; much of epicranium on each side of midline occupied by a large black spot that extends onto the front between the eyes where it is interrupted, producing a small, round spot on each side of midline; pubescence black, regular. Antenna and palpi black. Pronotum fully $\frac{9}{10}$ as wide as long; sides slightly divergent from base to apical $\frac{1}{4}$; color orange, with an extensive lunate black spot on each side; surface densely, rather coarsely punctate, moderately shiny; pubescence black on black spots, sericeous yellow elsewhere, not affecting coloration. Elytra dark brown with a narrow discal vitta and lateral margin straw yellow; surface finely punctate, minutely granulate; pubescence black

except yellow on vitta and lateral margin; thick, nearly erect setae absent; discal vitta sharply delimited, very narrow; pale lateral margin very narrow, extending to about apical $\frac{1}{5}$ of elytron; lateral vitta faintly suggested by a few yellow setae. Venter dark brown; pubescence fine, off-white, the setae thicker and more conspicuous along posterior margins of abdominal sterna. Legs dark brown, largely off-white pubescent; hindtibial spurs thicker than those of fore- and midlegs but not so thick as in other species of the group, not flared, flattened posteriorly, not obliquely truncate.

Male: Head with epicranium neither impressed nor flattened; antennal callosities enlarged, deeply dimpled but not extending mesad to form an arch; epicranial surface minutely granulate, satiny, rather densely punctate except along midline; pubescence sparse. Antenna not so elongate and slender as in other species; ventral surface of III–VI lacking spinelike setae; VI hardly broadened, flattened and glabrous in basal $\frac{2}{3}$; ratio of lengths of segments I–XI (to a total length of 1000) 125, 47, 125, 75, 75, 100, 107, 110, 103, 109, 154; segment IV nearly $\frac{4}{5}$ as wide as long, V $\frac{2}{3}$, VI more than $\frac{4}{10}$, VII–VIII less than $\frac{4}{10}$, IX–X $\frac{1}{3}$, XI more than $\frac{1}{4}$.

Female: Unknown.

Type designation.—Holotype, ♂, from [San José de] Chiquitos, 700 m, Santa Cruz, Bolivia, November 1959, from Walz, formerly in my collection, deposited in the Field Museum of Natural History.

Geographic distribution.—The species is known only from the type-locality, in southeastern Bolivia, where it occurs with *E. floydwernerii* (Fig. 1).

BOLIVIA: *Santa Cruz:* [San José de] Chiquitos, 700 m, November 1959, 2.

Remarks.—The male antennae are similar to those of *E. floydwernerii* but lack the ventral spinelike setae. The antennal callosities are less modified than in other species of the group. The shape of the epicranium is normal, although the surface is modified.

ACKNOWLEDGMENTS

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**THE FOREST COCKROACH, *ECTOBIUS SYLVESTRIS* (PODA),
A EUROPEAN SPECIES NEWLY DISCOVERED IN NORTH
AMERICA (DICTYOPTERA: BLATTODEA: ECTOBIIDAE)**

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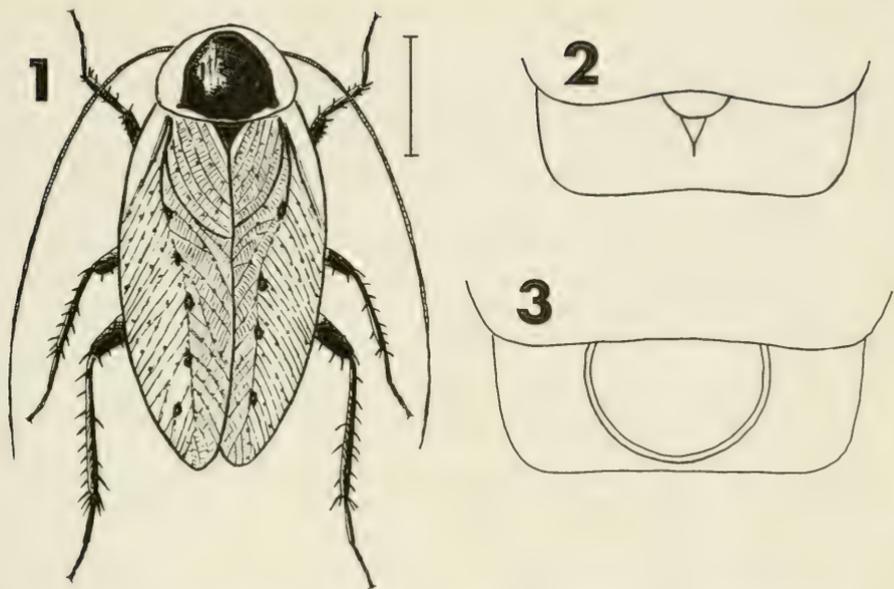
Abstract.—*Ectobius sylvestris* (Poda) was collected in 1980 in New York State, the first record of this European species for North America. This is the second European member of the genus *Ectobius* potentially to become established in North America. *Ectobius sylvestris* is described briefly, and its dorsal habitus and external male characters are illustrated. Helfer's key to the cockroach species occurring in North America is modified to include *E. sylvestris*.

A European cockroach, *Ectobius sylvestris* (Poda), was detected in North America in June 1980 with the collection of a single male specimen in a home at Geneva, New York¹. One of us (ERH) received this specimen for identification; it did not agree with any of the native North American species, but it did key readily to *E. sylvestris* in the European literature (Chopard, 1951; Princis, 1965; Harz and Kaltenbach, 1976). This specimen was sent to DAN for confirmation.

In this paper, we discuss recognition features, known distribution, biology, and habits of *E. sylvestris*. Only one other species of the genus *Ectobius*, *E. pallidus* (Olivier), has been reported in the United States (Flint, 1951; cited as *lividus* (Fabricius)). Distinctive characters of *E. pallidus* and available information on its distribution and general bionomics are discussed by Gurney (1953; cited as *livens* (Turton)). At present it is known to occur in Massachusetts and Michigan (Gurney, 1968).

Ectobius sylvestris (Fig. 1) is a relatively small species, about 7.5 to 11

¹ Since the submission of this paper for publication, 2 ♂ and 4 ♀ of this species have been collected by Siegfried Lienk between May 25 and July 16, 1981 at another locality in Geneva, New York. Two specimens were found in a home, while the other 4 were collected in traps out of doors.



Figs. 1, 3. *Ectobius sylvestris*. Fig. 2. *E. pallidus*. 1, Dorsal habitus, male (scale line = 2.5 mm). 2, 3, Dorsal abdominal glandular depression of 7th tergum, male (adapted from Princis, 1965).

mm in overall length (range in length is based on available literature: the New York specimen is approximately 10 mm in length); general color yellowish brown; head and antennae blackish; pronotum black or blackish red with pale, transparent margins; tegmina (fully developed in male; reduced and truncate in female) pale yellowish brown with a few darker blotches, and a few small black spots; nerves pale; hindwings fully developed in male, slightly infuscated, with a distinctive intercalated triangle (see Gurney, 1968: 686, fig. 2); legs, abdomen, and cerci dark.

Based on the dorsal habitus, there are a few native North American species which might be confused with *E. sylvestris*. *Pseudomops septentrionalis* Hebard, *Leurolestes pallidus* (Brunner), and two species of *Parcoblatta*, *P. divisa* (Saussure and Zehntner) and *P. pennsylvanica* (De Geer), all resemble *E. sylvestris* rather closely in having a dark pronotal disc with pale, transparent margins. However, they differ from *E. sylvestris* in lacking the well-developed intercalated triangle of the hindwing and are generally larger in overall length.

We have modified Helfer's (1963) key to include both species of *Ectobius* now known to occur in North America: couplet #45 (p. 58) is altered as follows. Figure numbers herein refer to those in this paper.

- 45a. Ventroposterior margin of anterior femur with conspicuous spines (*Ectobius*) 45'
- 45'a. Pronotal disc pale yellowish brown with marginal area transparent, marked with reddish brown spots; male dorsal abdominal glandular depression oval, slightly transverse, hindmargin not reaching middle of 7th tergum (Fig. 2); Spotted Mediterranean cockroach *Ectobius pallidus* (Olivier)
- 45'b. Pronotal disc black or blackish red with marginal area transparent (Fig. 1); male dorsal abdominal glandular depression round and large, hindmargin convex and nearly reaching apical margin of 7th tergum (Fig. 3); Forest cockroach *Ectobius sylvestris* (Poda)
- 45b. Ventroposterior margin of anterior femur lacking conspicuous spines or with a fringe of stiff hairs and one spine at apex 46

Ectobius sylvestris occurs throughout most of Europe (excluding the British Isles), including Sweden, Finland, Denmark, Holland, Belgium, France, Germany, Switzerland, northern Italy, Australia, Czechoslovakia, Yugoslavia, Bulgaria, Hungary, Rumania, Poland, and European USSR (Princis, 1971; Harz and Kaltenbach, 1976). Three subspecies of *E. sylvestris*, *sylvestris* (Poda), *discrepans* Adelung, and *lucidus* (Hagenbach), based primarily on pronotal disc color differences, are recognized in Europe. The specimen from Geneva, N.Y., agrees with the subspecies *discrepans*.

Only one American locality is known at present for *E. sylvestris*, i.e., Geneva, N.Y. One male specimen was collected some time before the end of June 1980 by Mrs. L. K. Brandt and submitted for identification by S. E. Lienk of the New York State Agricultural Experiment Station, Cornell University, Geneva, N.Y. Mrs. Brandt stated that the specimen was found in her kitchen. She noted also that a son had returned from Europe the previous summer and that much of his baggage and goods were stored in the basement. It is possible then that there is an established population in the basement of the Brandt residence and that this species is not found elsewhere.

Ectobius sylvestris, like the related species *E. lapponicus* (L.) and *E. pallidus*, lives in a variety of outdoor habitats. It is found commonly on the ground in forests, particularly in mountainous areas (Dierl, 1978). A summary of the biology, mating, and oviposition habits of *E. sylvestris* is provided by Harz (1960).

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THE DISCOVERY OF *HYDORA*, A HITHERTO
AUSTRALIAN-NEW ZEALAND GENUS OF
RIFFLE BEETLES, IN AUSTRAL SOUTH AMERICA
(COLEOPTERA: ELMIDAE)

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Abstract.—The genus *Hydora* (Coleoptera: Elmidae), previously known only from New Zealand and Australia, is reported from southern Chile and Argentina for the first time. Two new taxa, *Hydora annectens*, n. sp., and *Hydora lenta*, n. sp., are described, keyed, and compared with New Zealand congeners; their distinguishing characters and typical biotopes are illustrated. The known distributions of the new taxa are plotted on a map.

Among various Chilean aquatic beetles received for identification from Allan Ashworth were five specimens of an interesting larine elmid beetle which keys readily to the genus *Hydora* in Hinton's (1940) key to the tribes (now subfamilies) of Elmidae. Other specimens of this genus had been found previously by a few other collectors but the species remained undescribed; the earliest collection known to us was made by W. Wittmer in 1950. This was followed by collections made by A. Kovacs (1958, 1959, 1961); R. L. Usinger (1962); O. S. Flint, Jr. (1966, 1969, 1974, 1978); H. P. Brown (1971); A. C. Ashworth, J. W. Hoganson, and H. Mooers (1977, 1979); and P. J. Spangler (1978). These taxa are described below to make the names available for use by Allan Ashworth and his associates in their studies of fossil insects in Chilean peat bogs and to report, for the first time, the occurrence in austral South America of this Australian-New Zealand genus.

The new elmid beetles described below represent the fifth genus of aquatic beetles (other than some cosmopolitan genera) that are known to occur or whose closest relatives are known to occur in austral South America and New Zealand and Australia. The four genera previously reported are: *Austrolimnius*, Elmidae (Hinton, 1965); *Lancetes*, Dytiscidae (Sharp, 1882); *Meropathus*, Hydraenidae (Perkins, 1980); and *Cylorygmus*, Hydrophilidae

Table 1. Comparison of characters between New Zealand and austral South American taxa.

	New Zealand Taxa	Austral South American Taxa
1. Constriction across apical $\frac{1}{3}$ of pronotum.	Very shallow and indistinct in some species, distinct in others.	Moderately impressed dorsally, distinct laterally.
2. Elytra.	With 11 rows of coarse, distinct punctures; 2nd (accessory) row incomplete, restricted to basal $\frac{1}{5}$ of length; all rows distinct on base in most species.	With 11 rows of coarse to moderately fine punctures; 2nd (accessory) row incomplete, restricted to basal $\frac{1}{5}$ of length; 2nd, 3rd, and 4th rows fine to effaced on base (<i>H. lenta</i>) or all distinct on base (<i>H. annectens</i>).
3. Elytral disc at basal $\frac{1}{3}$.	Evenly rounded in some species, distinctly depressed in others.	Distinctly depressed.
4. Ultimate segment of maxillary and labial palpi.	Moderately to strongly swollen.	Strongly swollen.

(d'Orchymont, 1933). The occurrence of taxa of *Hydora* in Argentina and Chile thus represents the second genus in the Elmidae with congeners in the Australian-New Zealand areas.

Specimens of *Hydora* are uncommon in collections. As far as we know, only 97 specimens representing the genus have been collected in austral South America since the first specimens were collected 30 years ago. To determine whether they were congeneric taxa, the two new species from South America were compared with 25 specimens from New Zealand representing *Hydora angusticollis* (Pascoe), *H. obsoleta* Broun, *H. picea* (Broun), and other species. Although many of the specimens from New Zealand were old and missing some of their appendages, comparisons of male genitalia and several external characters were possible and showed that all taxa examined are very similar in most characters and the differences are minor and ones of degree (see Table 1). Therefore, the South American taxa are considered to be congeners of the genus *Hydora*.

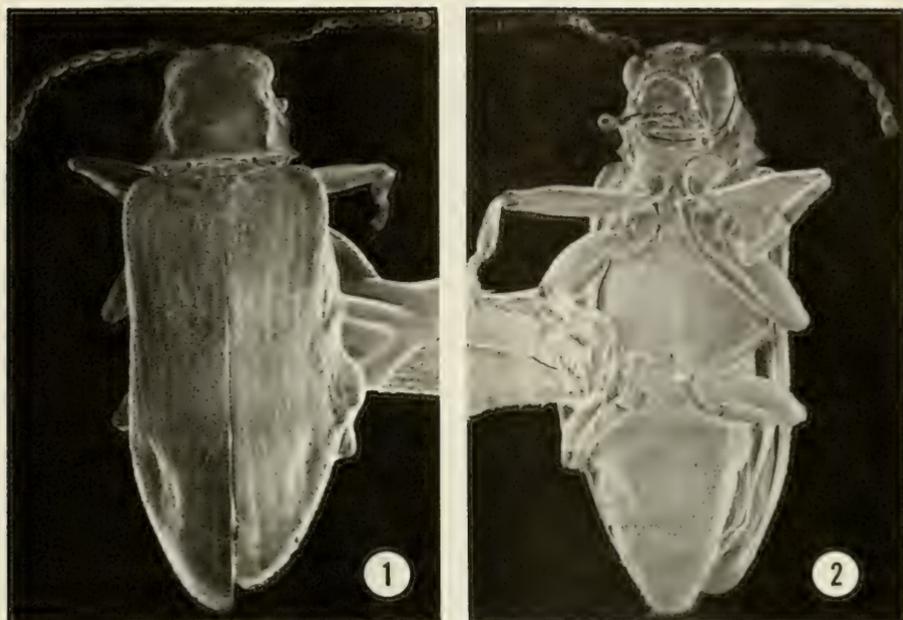
In comparing the specimens from both continents we also found that the total length of each antenna of all available males from austral South America was slightly more than twice as long as the side of the pronotum, whereas the total length of the antennae of the females was only about one-third longer than the length of the side of the pronotum. This sexual difference in antennal length does not appear to hold true for New Zealand species.

INTERCONTINENTAL RELATIONSHIPS

In his revision of the Australian species of the intercontinental elmid genus *Austrolimnius*, Hinton (1965) mentions that the environmental requirements of many organisms are known well enough to distinguish between those which can tolerate a wide range of ecological conditions and those which have much more rigid requirements. Furthermore, he points out that (1) organisms that have narrowly restricted ecological requirements tend to disperse slowly and are not commonly transported accidentally; and, conversely, (2) tolerant taxa disperse rapidly and are more liable to be transported accidentally. Therefore, if the first situation applies, the evidence for past land connections is strengthened and, conversely, if the second situation applies, the evidence is much weakened. Most elmids have narrowly restricted ecological requirements and they are good subjects for biogeographical analysis when they exhibit discontinuous distribution such as seen in *Austrolimnius* and now in *Hydora*.

However, the arguments for past continental connections between austral South America and New Zealand-Australia are not quite as convincing for the genus *Hydora* as they are for *Austrolimnius* for the following reasons. Members of the genus *Austrolimnius*, like all other elmids, obtain their oxygen supply under water by a plastron, i.e., a dense covering of hairlike or scalelike setae usually on various parts of their ventral surface. This method of obtaining oxygen is restricting because it requires water with a high oxygen content. Furthermore, *Austrolimnius* belongs to the subfamily Elminae and members of this subfamily normally are capable of flight for only a few days after they become adults and before they enter their aquatic habitat where their wing muscles soon atrophy, for they spend the remainder of their lives under water. Therefore, the presence in both South America and New Zealand-Australia of congeneric taxa of *Austrolimnius* which are restricted by habitat requirements and extremely low flight potential provides strong support for the hypothesis that the two continents were formerly one that divided, drifted apart, and carried ancestral taxa along on both land masses.

The disjunct distribution of members of the genus *Hydora* is somewhat less convincing evidence of past drifting of continents because the members of the genus belong to the elmid subfamily Larinae and larvae normally live above water, usually at or near the air-water interface. Although larvae generally occur in oxygen-rich, clean streams and brooks, they seem to be less restricted than the members of the Elminae because they do retain functional flight muscles and most are not restricted to a life under water. (However, the calcareous encrustations on certain specimens of *Hydora* from New Zealand suggest prolonged immersion.) The specimens of *Hydora* we collected were notably passive and could be easily approached and collected by hand. Specimens of *Hydora* evidently do fly



Figs. 1, 2. *Hydora annectens*, habitus. 1, Dorsum, 24 \times . 2, Venter, 24 \times .

under certain conditions because a few specimens were collected by Ashworth et al. by "light trapping," but we believe they do not fly as readily as do most members of the subfamily with which we are familiar. Therefore, we believe the presence of the genus *Hydora* in South America as well as New Zealand-Australia is additional supportive evidence of dispersal of congeners by drifting continents.

Hydora annectens Spangler and Brown, NEW SPECIES

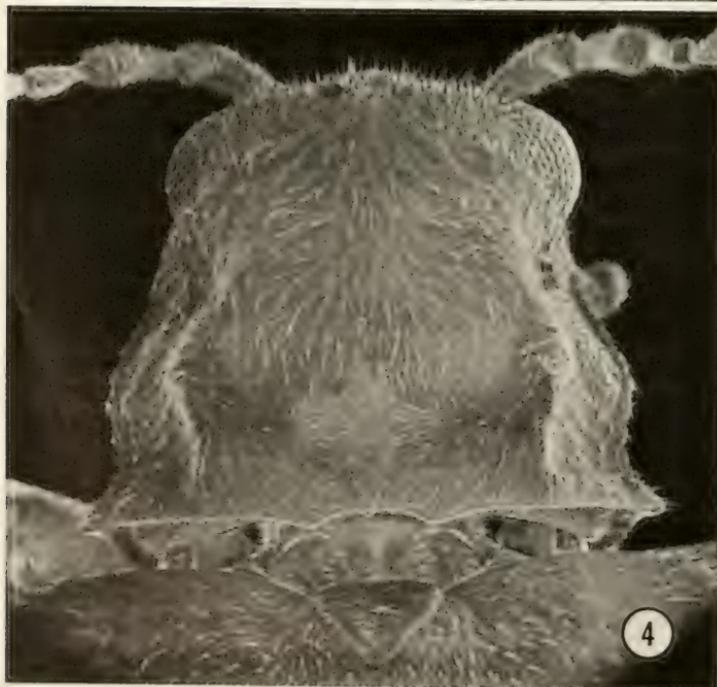
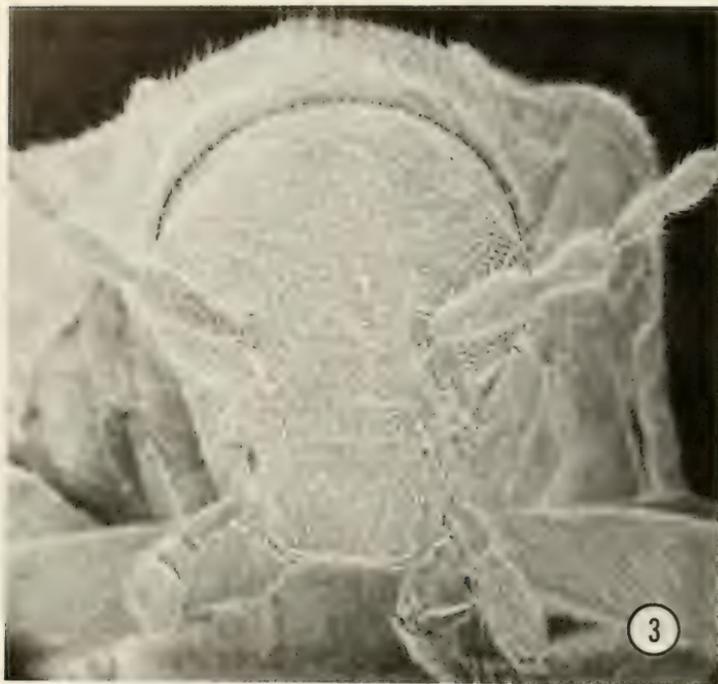
Figs. 1-5, 8

Holotype male.—Body form and size: Elongate, narrow, subparallel (Figs. 1, 2); dorsal surface feebly convex. Length 3.6 mm; greatest width 1.5 mm.

Coloration: Integument nigro-cinereous except trochanters and basal $\frac{2}{3}$ of femora dark yellowish brown. Body covered with dense, short, recumbent, yellowish hairlike setae.

Head (Fig. 3): Microreticulate and finely, densely punctate; punctures separated by their width. Interocular width twice width of an eye. Antenna long; total length twice as long as side of pronotum; arising from lower inner corner of eye.

Thorax: Pronotum (Fig. 4) about $\frac{4}{5}$ as long as width of base; transverse constriction across apical $\frac{1}{3}$, moderately impressed dorsally and distinctly



Figs. 3, 4. *Hydora annectens*. 3, Head, 75 \times . 4, Pronotum, 75 \times .

impressed laterally; anterior margin feebly arcuate; anterolateral angles obtuse, not produced; sides sinuous; base trisinate; posterolateral angles acute, not produced posteriorly; a broad sublateral carina on basal $\frac{1}{2}$; disc between carinae tumid; depressed between sublateral carinae and posterolateral angles; surface microreticulate and punctate as on head but punctures obscured by pubescence. Elytra almost $5\times$ longer than pronotum; depressed on disc at about basal $\frac{1}{3}$; apices evenly rounded; humeri moderately gibbous. Each elytron with 11 rows of coarse punctures; 2nd (accessory) row incomplete and restricted to about basal $\frac{1}{5}$; coarse punctures separated by $\frac{1}{2}$ their width or by their width; intervals almost flat, finely punctate, punctures separated by about their diameter. Scutellum rather flat, moderately large, triangular; sides slightly longer than width of base. Prosternum short in front of forecoxae; prosternal process elongate, moderately narrow (Fig. 2), about $3.6\times$ longer than wide, apex blunt and fitting into a deep fovea in mesosternum. Mesosternum with a deep transverse depression between midcoxae. Metasternum ridgelike behind mesosternal depression then depressed before becoming swollen on discal area; entire surface pubescent; short, narrow, glabrous, longitudinal groove on posterior $\frac{1}{2}$ in front of hindcoxae. Tarsal claws moderately stout, unmodified.

Abdomen (Fig. 2): Sterna uniformly pubescent; moderately coarsely, densely punctate; punctures separated by $\frac{1}{2}$ to $2\times$ their width. Lateral margins of sterna 1 to 4 (but especially 2 and 3) expanded and upturned forming a flange which clasps epipleura.

Male genitalia: As illustrated (Fig. 5).

Female.—Similar to male except antenna shorter, only about $\frac{1}{3}$ longer than side of pronotum.

Variations.—Specimens varied as follows. Prosternal process shows slight variation in width; in a few specimens, process shows a weak to moderate (strong in 1 specimen) longitudinal carina on apical $\frac{2}{3}$. Sublateral carinae on base of pronotum are distinct but vary from low to high ridges. Several specimens show a metallic blue-green reflection on pronotum and sometimes elsewhere as the light of the illuminator strikes the cuticle at different angles. Specimens varied in length from 3.6–4.5 mm.

Type-data.—Holotype δ : CHILE: *Llanquihue Province*: Pt. Varas (24 km E), Parque Nacional de Puyehue, Site 7, El. 50 m, 20 Nov. 1977, Ashworth, Hoganson, Mooers; USNM Type No. 76182, deposited in the National Museum of Natural History, Smithsonian Institution. Allotype: same data as for holotype.

Paratypes: ARGENTINA: *Neuquén Province*: Rio Quilquihue, at Quilquihue, 26 Jan. 1974, O. S. Flint, Jr., 4 δ , 19 ♀ (USNM); Trib. Arroyo Trompul W. San Martín de los Andes, 23 Feb. 1978, C. M. and O. S. Flint, Jr., 1 ♀ (USNM). *Rio Negro Province*: El Bolson, 20 Sept. 1958, A. Kovacs, 3 ♀ (BMNH); El Bolson, 20 Oct. 1958, A. Kovacs, 2 δ , 11 ♀

(BMNH): El Bolson, 5 Dec. 1958, 10 ♀; El Bolson, 18 Dec. 1958, A. Kovacs, 2 ♂, 21 ♀ (BMNH); El Bolson, 20 Feb. 1959, A. Kovacs, 1 ♀ (BMNH); El Bolson, 29 Nov. 1950, W. Wittmer, 1 ♀ (BMNH); Ñorquincó, 24 Feb. 1961, A. Kovacs, 1 ♀. All specimens collected by A. Kovacs and listed above are mislabeled "CHILE." CHILE: *Cautín Province*: Rio Pedregosos, 4 Jan. 1966, Flint and Cekalovic, 1 ♀ (USNM). *Llanquihue Province*: Same data as for holotype, 1 ♂; Ensenada, Lago Llanquihue, 3 Jan. 1962, R. L. Usinger, 1 ♀ (JFL). *Malleco Province*: Tolhuaca, 9 Jan. 1962, R. L. Usinger, 1 ♂ (JFL). *Ñuble Province*: East of Chilán, Rio Pinto, 24 Oct. 1969, Flint and Barria, 5 ♀ (USNM). *Osorno Province*: Aguas Calientes, Parque Nacional de Puyehue, Site 16A, El. 460 m, 9 Jan. 1979, A. C. Ashworth, J. W. Hoganson, 1 ♀ (UND); Playa Puyehue, Parque Nacional de Puyehue, Site 30, El. 185 m, 22 Dec. 1977, Ashworth, Hoganson, Mooers, 1 ♂ (UND). *Talca Province*: Rio Claro, SW Molina, 1 Nov. 1971, Harley P. Brown, 5 ♂, 2 ♀ (SMNH).

Specimens will be deposited in the British Museum (Natural History), London; California Academy of Sciences, San Francisco; Canadian National Collection, Ottawa; Museo Argentino de Ciencias Naturales, "Bernardino Rivadavia," Buenos Aires; Museo Nacional de Historia Natural, Santiago; Muséum National d'Histoire Naturelle, Paris; Institut royal des Sciences Naturelles de Belgique, Bruxelles; Stovall Museum of Science and History, Norman, Oklahoma; and Zoologische Sammlung Bayerischen Staates, München.

Etymology.—The name *annectens* is from *annectens*, L.—linking, joining; in reference to the suggestion that the occurrence of congeners of *Hydora* in austral South America and New Zealand-Australia is evidence of continental drift.

Habitat.—The specimens described above were collected at light traps, by trampling marginal vegetation in aquatic habitats, under rocks near aquatic habitats, and picking by hand from piles of driftwood stranded by receding flood waters in and along the margins of streams.

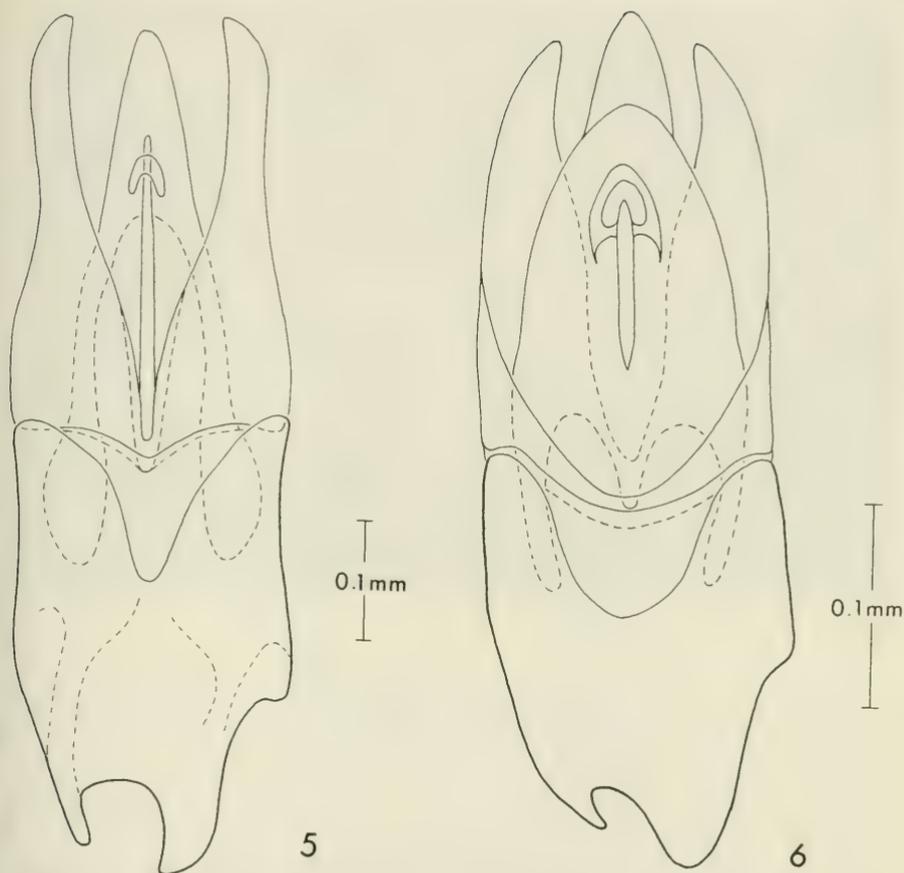
Hydora lenta Spangler and Brown, NEW SPECIES

Figs. 6-8

Holotype male.—Body form and size: Elongate, narrow, subparallel; dorsal surface feebly convex except each elytron with a broad, shallow depression each side of suture at about basal $\frac{1}{3}$ and each elytron with a shallow, elongate sublateral depression at about apical $\frac{1}{4}$. Length 2.9 mm; greatest width 1.1 mm.

Coloration: Integument nigro-cinereous except forecoxa, midcoxa, trochanters, and basal $\frac{4}{5}$ of femora reddish yellow. Body covered with dense, short, recumbent, yellowish hairlike setae.

Head: Microalutaceous; with few moderately coarse punctures on clype-



Figs. 5, 6. Male genitalia, ventral view. 5, *Hydora annectens*. 6, *H. lenta*.

eus and labrum, punctures obscured by pubescence. Interocular width slightly more than twice width of an eye. Antenna long; total length twice as long as length of pronotum; arising from lower inner corner of eye.

Thorax: Pronotum about $\frac{5}{6}$ as long as width of base; transverse constriction across apical $\frac{1}{3}$, moderately impressed dorsally, distinctly impressed laterally; anterior margin feebly arcuate; anterolateral angles obtuse, not produced; sides sinuous; base trisinate; posterolateral angles acute, not produced posteriorly; a broad sublateral carina on basal $\frac{1}{2}$; disc between carinae tumid; depressed between sublateral carinae and posterolateral angles; surface microalutaceous; with few moderately coarse punctures as on head, punctures obscured by pubescence. Elytra almost $5\times$ longer than pronotum; depressed on disc at about basal $\frac{1}{3}$; apices evenly



Fig. 7. *Hydora lenta*, type-locality.

rounded; humeri moderately swollen. Each elytron with 11 rows of coarse punctures but rows (including accessory row) effaced on basal $\frac{1}{3}$ and very indistinct on apical $\frac{2}{3}$; only lateral rows 7 to 11 reasonably distinct near midlength; coarse punctures of lateral rows separated by about width of a puncture. Scutellum swollen, triangular; sides shorter than basal width. Prosternum short in front of forecoxae. Prosternal process elongate, extremely narrow; about $9.3\times$ longer than wide; apex blunt and fitting into a deep fovea in mesosternum. Mesosternum with a broad, shallow depression between midcoxae. Metasternum with strong ridge behind mesosternal depression then depressed before becoming swollen on discal area; entire surface pubescent. Tarsal claws moderately stout, unmodified.

Abdomen: Sterna uniformly pubescent; microalutaceous and moderately coarsely and sparsely punctate; punctures separated by $2\times$ their width and obscured by pubescence. Lateral margins of sterna 1-4 (but especially 2 and 3) expanded and upturned forming a flange which clasps epipleura.

Male genitalia: As illustrated (Fig. 6).

Female.—Unknown.

Type-data.—Holotype δ : CHILE: *Osorno Province*: Parque Nacional de Puyehue, Anticura, in Rio Anticura, 1 Feb. 1978, Paul J. Spangler; USNM Type No. 76183, deposited in the National Museum of Natural History, Smithsonian Institution.



Fig. 8. *Hydora annectens* and *H. lenta*, known distribution.

Paratype: CHILE: *Osorno Province*: Parque Nacional de Puyehue, Anticura (4 km W), 330 m, 3 Feb. 1978, Paul J. Spangler, 1 male; deposited in the National Museum of Natural History, Smithsonian Institution.

Etymology.—The name *lenta* is from *lentus*, L.—slow; in reference to the slow moving behavior of the type-specimens when they were collected.

Habitat.—The holotype was found by pulling limbs and logs out of a logjam (Fig. 7) in the middle of the Rio Anticura; the specimen was found above water on a damp log.

Comparative notes.—*Hydora lenta* may be distinguished from *Hydora annectens* by the following combination of characters: (1) Elytral rows of coarse punctures effaced on basal third and indistinct or effaced apically; (2) scutellum swollen and sides shorter than basal width; (3) elytra with shallow, elongate sublateral depression at about apical fourth in addition to the broad depressions on each side of suture at basal third; (4) male genitalia with parameres short and broad apically (Fig. 6); and (5) size smaller, 2.9 mm vs. 3.6 to 4.5 mm.

KEY TO THE SPECIES OF *HYDORA* FROM AUSTRAL SOUTH AMERICA

- Elytral rows of punctures coarse and distinct from base to apex; prosternal process moderately wide between procoxae, $3.6\times$ longer than wide: total body length 3.6 to 4.5 mm *annectens*, new species
- Elytral rows of punctures fine to effaced on base and on apex; prosternal process exceptionally narrow between procoxae, $9.3\times$ longer than wide: total body length 2.9 mm *lenta*, new species

ACKNOWLEDGMENTS

We are indebted to Christine von Hayek, British Museum (Natural History) (BMNH) for lending specimens which allowed us to compare the austral South American material with species from New Zealand. Also, this article would have been impossible without the specimens collected or lent by the following individuals, and to all of these contributors to this article we extend our most grateful thanks: O. S. Flint, Jr., National Museum of Natural History, Smithsonian Institution (USNM); John F. Lawrence, Commonwealth Scientific and Industrial Research Organization, Canberra, Australia (JFL); Allan C. Ashworth, John Hoganson, and Howard Mooers, University of North Dakota (UND). Furthermore, specimens collected by Flint (1969) and Spangler (1978) were obtained through cooperative fieldwork with Luis E. Peña G. and his associates. For financial assistance for fieldwork during which some of these new taxa were collected we are grateful to the combined auspices of the J. I. Molina Institute of Studies and Publications of Chile and the administrators of the Smithsonian Institution's Fluid Research fund. Letters in parentheses identify the sources of specimens reported in the descriptions; specimens collected by Dr. Harley P. Brown and used in this study are deposited in the Stovall Museum of Science and History (SMSH) at the University of Oklahoma.

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**BIOLOGY AND IMMATURE STAGES OF *PELINA TRUNCATULA*,
A CONSUMER OF BLUE-GREEN ALGAE
(DIPTERA: EPHYDRIDAE)¹**

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Abstract.—Information is presented on the life cycle and feeding habits of *Pelina truncatula* Loew, a common and widely distributed shore fly whose larvae feed on colonies of the blue-green algal genus *Cylindrospermum*. The egg, mature larva, and puparium are described and illustrated. A key is given that distinguishes the immature stages of *P. truncatula* from those of *Lytogaster excavata* (Sturtevant and Wheeler), another common inhabitant of *Cylindrospermum* colonies.

Containing at least 1200 species, the family Ephydriidae is one of the largest entities within the acalyprate Diptera. It is generally placed close to the family Drosophilidae in the superfamily Drosophiloidea (Griffiths, 1972). Although larvae of both families are basically microphagous in feeding habits, the drosophilids mostly utilize yeasts and other heterotrophic microorganisms, whereas the ephydriids primarily ingest autotrophic algal cells. Foote (1979) discussed the utilization of algae by different groups of Ephydriidae and emphasized that certain species are trophically generalized (e.g. *Scatella stagnalis* (Fallén); Zack and Foote, 1978), while others are quite specialized (e.g. *Parydra quadrituberculata* Loew; Deonier and Reagensburg, 1978).

This is the third contribution in a series dealing with the utilization of blue-green algae by ephydriid larvae. The first paper (Foote, 1977) presented general observations on the feeding habits of 12 species, and the second elucidated the life cycle and natural history of *Lytogaster excavata* (Sturtevant and Wheeler), a consumer of soil-inhabiting blue-green algae belonging to the genus *Cylindrospermum* (Foote, 1981). The present paper is concerned with another grazer of *Cylindrospermum*, *Pelina truncatula* Loew, a common and widely distributed species in shoreline and wetland habitats. Information is given on the life cycle and larval feeding habits, along with descriptions and illustrations of the egg, mature larva, and puparium.

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MATERIALS AND METHODS

Most of the field and all of the laboratory work was carried out in north-eastern Ohio. Supplementary field observations were obtained in south central Arizona near Tucson and in northwestern Montana along the shores of Flathead Lake.

The laboratory rearings involved monocultures of 21 different species of algae that were maintained in an environmental chamber programmed to give a photoperiod of 15L:9D and a temperature of 22°C ($\pm 1.0^\circ\text{C}$). Each algal culture was established on a nutrient agar substrate in sterile petri dishes, and larval feeding tests were performed utilizing procedures given by Zack and Foote (1978). Most of the algal monocultures were obtained from the University of Texas Culture Collection of Algae (Starr, 1978). Monocultures utilized in the larval feeding tests are listed below, along with their UTEX strain numbers. Algae lacking strain numbers were obtained from the Phycology Laboratory at Kent State University.

Cyanophyceae

- Anabaena flos-aquae* (1444)
- Anabaena variabilis* (B377)
- Anabaena* sp.
- Cylindrospermum* sp. (LB942)
- Gloeocapsa alpicola* (B589)
- Gloeocapsa* sp.
- Lyngbya spiralis* (B1831)
- Nostoc commune* (584)
- Oscillatoria tenuis* (B428)
- Oscillatoria* sp.
- Phormidium* sp. (1540)
- Synechococcus leopoliensis* (625)

Chlorophyceae

- Chlamydomonas eugametos* (9)
- Chlamydomonas* sp.
- Chlorella vulgaris* (29)
- Cosmarium botrytis* (175)
- Scenedesmus quadricauda* (76)
- Vaucheria* sp.

Xanthophyceae

- Botrydiopsis alpina* (295)
- Botrydium becherianum* (158)

Bacillariophyceae

Navicula pelliculosa (668)

LIFE HISTORY

Although the genus *Pelina* contains seven species in the Nearctic Region (Clausen, 1973), none is presently recorded from the Neotropics (Wirth, 1968). It also occurs in the Palaearctic Region, with some six species listed for that area (Becker, 1926), and the Afrotropical Region (two species; Coogan, 1980). According to Clausen (1973), *P. truncatula* is the most common and widespread of the Nearctic species, having been recorded from throughout North America south of southern Canada. Although Clausen (1973) recognizes four subspecies, *P. t. truncatula* is the only one recorded from the eastern states, and most of the life history observations given here undoubtedly refer to that taxon. All descriptions of the immature stages are based on material collected in northeastern Ohio.

Deonier (1965) reported adults of *P. truncatula* to be occasional in marsh-reeds, sedge-meadow, and limnic-wrack habitats in Iowa, while Scheiring and Foote (1973) stated that the species was collected commonly in limnic-wrack and mud-shore habitats in Ohio. I swept adults from the sandy margins of a drying tributary in Sabino Canyon near Tucson and from the sewage-laden shores of a small stream (Sonoita Creek) at Patagonia, Arizona. In northwestern Montana, adults were taken commonly from sandy shorelines of Flathead Lake and from low marshy areas bordering streams. Adults for rearing purposes were obtained in northeastern Ohio by sweeping over the shaded margins of the outlet of a package sewage plant. Soil algae, particularly species of blue-green genera, were abundant on the moist substrates in all collecting sites.

Adults were present throughout the warm season in the Ohio and Montana study sites and throughout the year in south central Arizona. The earliest record for adults in northeastern Ohio was obtained on April 25; the latest, on October 5.

A few data were obtained concerning adult longevity. One male and two females that were collected in nature near Kent, Ohio, on April 29 died on May 19, giving a longevity of at least 21 days. In contrast, laboratory reared adults rarely survived more than 15 days when confined in petri dishes containing monocultures of *Anabaena* sp. or *Cylindrospermum* sp. The pre mating period in a single reared pair was four days; the preoviposition period, six days. No courtship behavior was observed, and mating seemed to be of the assault type (Spieth, 1974).

Fecundity records were obtained from the two females collected in nature on April 29. One female deposited 28 eggs; the other, 37 over a 16-day

period. No eggs were deposited by either female during the last five days of adult life. The potential fecundity probably is at least twice that obtained in the laboratory rearings, as a female collected in nature during early May possessed a total of 43 ovarioles, with each ovariole containing one nearly mature egg and 3-5 less developed oocytes. Assuming that each ovariole releases at least four eggs during the adult life of a female, the potential fecundity would exceed 170 eggs (4×43 ovarioles = 172 eggs).

In the laboratory, eggs were scattered widely into the blue-green algal cultures. In contrast to the white eggs of another blue-green feeding species, *Lytogaster excavata* (Foote, 1981), the eggs of *P. truncatula* possessed a distinct peach color. Also contrasting with *L. excavata* was the fact that the eggs of *Pelina* usually were placed below the alga-agar surface and frequently were out of contact with ambient air. Another difference was the papillose nature of the non-striated chorion (Fig. 13). The incubation period was 3-4 days ($n = 18$). Interestingly, newly hatched larvae tended to remain buried in the agar just below the algal mat rather than crawling over the algal surface. This tendency persisted throughout larval life, although older larvae occasionally were seen moving across the surface of algae. Supporting the laboratory observations was the fact that larvae were rarely seen on the surface of field-collected colonies of the blue-green algal genus *Cylindrospermum*. Instead, they were buried in the algal growth with only the posterior spiracles in contact with the ambient air. The habit of feeding below the surface of the algal growth is in distinct contrast to the behavior of species of *Hyadina* and *Lytogaster* which feed on the surface (Foote, 1977).

The results of larval feeding tests utilizing unialgal cultures are summarized in Table 1. Larvae completed development only on species of the blue-green genera *Anabaena*, *Cylindrospermum*, *Lyngbya*, and *Oscillatoria*. Interestingly, not all genera of Cyanophyceae supported larval growth, and development was nil or greatly reduced in cultures of *Gloeocapsa*, *Nostoc*, *Phormidium*, and *Synechococcus*. Even among the blue-green species that allowed for larval development, there were apparent differences in nutritional suitability. For example, within the genus *Anabaena* high success rates were obtained on cultures of *A. variabilis* and an undetermined species (100% and 80%, respectively), whereas only 20% of the larvae reached the adult stage on *A. flos-aquae*. A strong indication of the trophic restriction of *P. truncatula* to blue-green algae is that no adults were obtained from larvae placed in cultures of any other group of algae. In fact, attempted culture on most of the non-cyanophyte algal species resulted in death of the larvae as first instars. Only cultures of *Chlamydomonas* sp., *Cosmarium botrytis*, *Botrydiopsis alpina*, *Botrydium becherianum*, and *Navicula pelliculosa* permitted some larval development. Of these five species, only *C.* sp., *B. alpina*, and *B. becherianum* supported growth to the third instar, and no larvae formed pupae.

Table 1. Results of larval feeding tests for *Pelina truncatula* using different algal monocultures.

Alga	n	Percent Reaching Different Life Stages			
		2L	3L	P	A
Cyanophyceae					
<i>Anabaena flos-aquae</i>	30	90	83	43	20
<i>Anabaena variabilis</i>	20	100	100	100	100
<i>Anabaena</i> sp.	10	100	80	80	80
<i>Cylindrospermum</i> sp.	10	100	100	100	100
<i>Gloeocapsa alpicola</i>	10	10	0	0	0
<i>Gloeocapsa</i> sp.	10	100	90	0	0
<i>Lyngbya spiralis</i>	5	100	40	40	40
<i>Nostoc commune</i>	10	0	0	0	0
<i>Oscillatoria tenuis</i>	20	30	30	30	30
<i>Oscillatoria</i> sp.	10	50	50	40	10
<i>Phormidium</i> sp.	20	0	0	0	0
<i>Synechococcus leopoliensis</i>	10	30	0	0	0
Chlorophyceae					
<i>Chlamydomonas eugametos</i>	10	30	0	0	0
<i>Chlamydomonas</i> sp.	10	100	60	0	0
<i>Chlorella vulgaris</i>	10	0	0	0	0
<i>Cosmarium botrytis</i>	10	10	0	0	0
<i>Scenedesmus quadricauda</i>	10	0	0	0	0
<i>Vaucheria</i> sp.	10	0	0	0	0
Xanthophyceae					
<i>Botrydiopsis alpina</i>	10	40	40	0	0
<i>Botrydium becherianum</i>	10	60	10	0	0
Bacillariophyceae					
<i>Navicula pelliculosa</i>	10	80	0	0	0

As Table 2 indicates, the time required to complete larval and pupal development varied among the blue-green algal species that were nutritionally suitable. Thus, the combined larval-pupal period among larvae that fed on species of *Anabaena* and *Cylindrospermum* ranged between 16 and 21 days, whereas this period was extended to nearly 30 days in cultures of *Oscillatoria* sp. Nearly all of the slowed development occurred in the larval period which doubled from an average of 11.2 days to 21.5 days. Growth was fastest in *Anabaena* sp. which gave a combined larval-pupal period of ca. 16 days.

Similar results were obtained in nature. No immature stages were found in colonies of any alga except those of *Cylindrospermum* spp. Surprisingly, no larvae were taken in growths of certain of the blue-green genera that supported larval development in the laboratory rearings, suggesting that the genus *Cylindrospermum* is the primary, if not the sole, host in nature. Lar-

Table 2. Developmental times in days for *Pelina truncatula* feeding on different algal monocultures.

Alga	Larval Period			Pupal Period			Combined Period		
	n	\bar{x}	s	n	\bar{x}	s	n	\bar{x}	s
<i>Anabaena flos-aquae</i>	13	12.23	2.17	6	8.17	0.75	6	18.67	0.82
<i>Anabaena variabilis</i>	20	10.95	1.00	20	7.85	0.49	20	18.80	0.89
<i>Anabaena</i> sp.	8	8.63	0.92	8	7.25	0.46	8	15.88	0.99
<i>Cylindrospermum</i> sp.	10	12.90	1.10	10	7.70	0.48	10	20.60	0.97
<i>Lyngbya</i> sp.	2	13.00	0.00	2	7.00	0.00	2	20.00	0.00
<i>Oscillatoria tenuis</i>	6	10.67	0.52	6	7.33	0.52	6	18.00	0.89
<i>Oscillatoria</i> sp.	4	21.50	1.00	1	8.00	—	1	29.00	—

vae of two other hyadinine genera, *Hyadina* and *Lytogaster*, were also found in colonies of *Cylindrospermum*. However, only rarely did larvae of *Pelina* co-occur with species of these other genera in the same algal colony. In general, *Pelina* larvae were taken from colonies growing in somewhat wetter habitats, whereas larvae of *Hyadina* and *Lytogaster* were usually associated with soil-inhabiting patches of *Cylindrospermum*. Thus, at least ten larvae of *P. truncatula* but none of the other two genera of Hyadinini were discovered in a floating mat of mixed algae occurring in a shallow pool of a small stream in southern Arizona. Further, only *Pelina* larvae were found in a submerged colony of *Cylindrospermum* in a stand of cattail (*Typha latifolia* L.) growing along the shores of Flathead Lake in Montana. However, segregation into different habitats was not absolute, as *Pelina* larvae were occasionally discovered in soil-inhabiting *Cylindrospermum*. Thus, four larvae of *L. excavata* and five of *P. truncatula* were found in two petri dish samples (2.84 cm²/dish) of *Cylindrospermum* that was growing on moist, sewage-laden soil bordering the drainage ditch of a small package sewage treatment plant near Kent, Ohio, on June 3, 1972.

Larvae moved about slowly when feeding on a suitable blue-green algal colony (e.g. *Cylindrospermum*) but became more active and soon abandoned a nutritionally unfavorable alga (e.g. *Chlorella*). During feeding the larvae moved the anterior end of the body back and forth as they crawled across or through the algal substrate. Trichomes of blue-green algae were ingested whole or were torn away from the algal matrix by the ripping action of the mouthhooks working in conjunction with the comblike structures located around the oral opening (Fig. 5). These structures raked across the algal surface, shredding the matrix, and pulling entire trichomes or fragments of trichomes into the oral cavity. The floor of the pharyngeal sclerite has nine low, relatively flat-topped ridges (Fig. 14), but it is doubtful if these structures can serve as filtering devices. In this respect, *Pelina* larvae resemble those of *L. excavata* (Foote, 1981). During feeding a steady stream

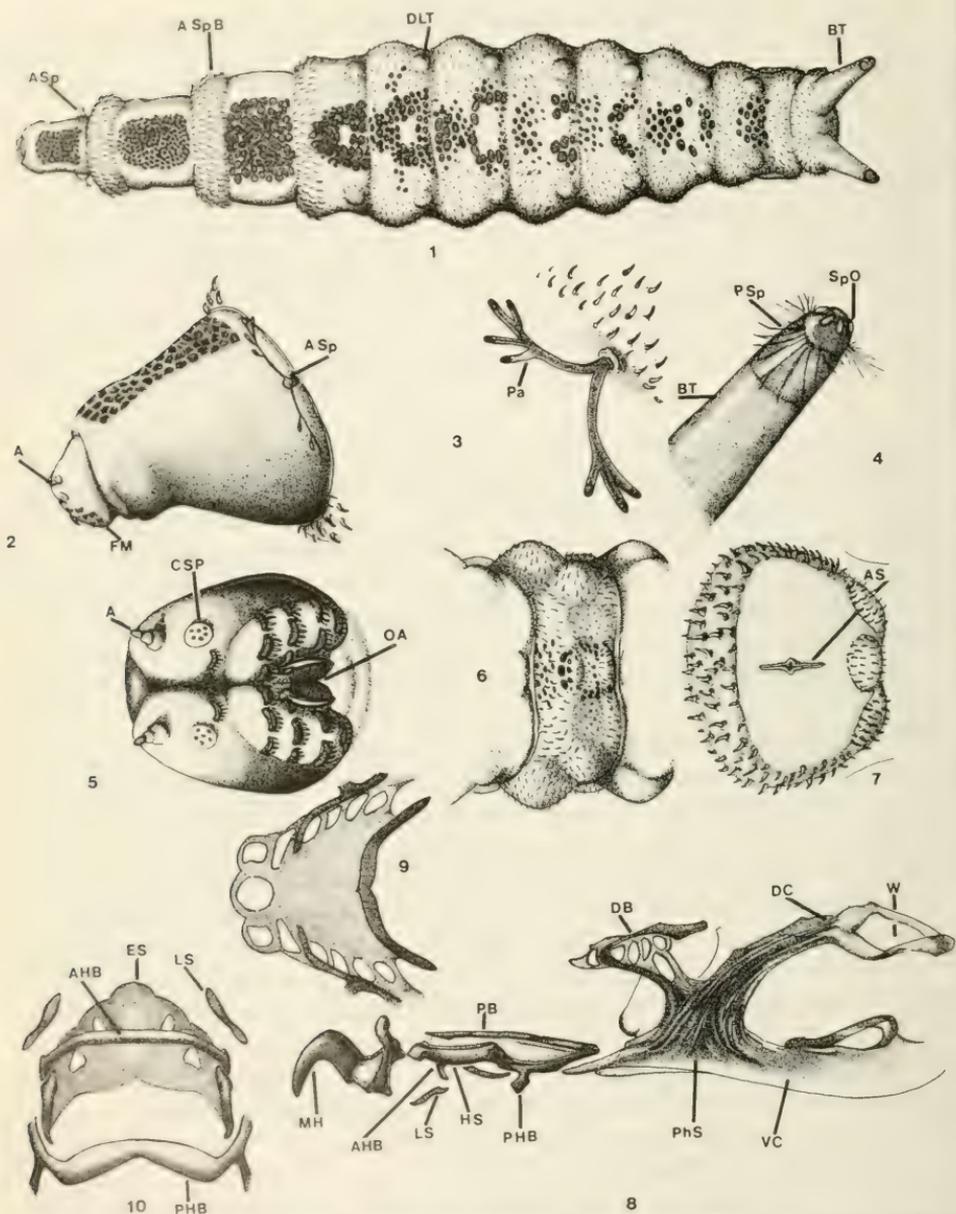
Table 3. Life cycle data for *Pelina truncatula* in northeastern Ohio. Rearings maintained at 22°C, with *Cylindrospermum* sp. serving as adult and larval food.

Flight period	Mid-May to late October
Adult longevity	21+ days
Premating period	4 days
Preoviposition period	6 days
Incubation period	3-4 days
Larval period	11-14 days
Pupal period	7-9 days
Length of life cycle	28-33 days
Fecundity	170±
Number of generations/yr	5-6

of algal material entered the oral opening and progressed steadily down the alimentary canal. Although the mouth parts moved fairly rapidly, the "flickering" movement typical of such filter-feeding ephydrid larvae as *S. stagnalis* (Zack and Foote, 1978) was not noticeable. Larvae frequently were buried in the agar substrate except for the posterior spiracles which usually retained contact with the surface. Buried larvae fed by bending up the anterior third of the body until the facial mask came into contact with the algal mat.

Several larvae usually fed together within each algal colony, and no obvious aggressive behavior between individuals was noted. Five larvae were found together in a 7.5 cm² patch of *Cylindrospermum* growing on moist soil in northeastern Ohio, and over 10 mature larvae and 15 puparia were collected within a 144 cm² area of a floating algal mat in south central Arizona. The larval period lasted 11-14 days and averaged 12.9 days under laboratory conditions when *Cylindrospermum* sp. served as the larval food (n = 10). Pupation usually occurred within the algal colony, although a few puparia were found on the sides of the petri dishes above the algal surface. All field-collected puparia were taken from *Cylindrospermum* colonies. In all cases, the posterior spiracles were in contact with ambient air, even though most of the puparium was buried in the algal mass. The pupal period lasted 7-9 days and averaged 7.7 days (n = 10).

Assuming a preoviposition period of 6.0 days, an incubation period of 3.5 days, a larval period of 12.9 days, and a pupal period of 7.7 days, the life cycle can be completed in approximately 30 days. With a warm season lasting approximately 150 days in the latitude of northern Ohio (mid-May to mid-October), five generations a year could be produced in the northern states (Table 3). The discovery of larvae and puparia during November and early April in southern Arizona suggests a continuous cycling of generations in that area of the country.



Figs. 1-10. *Pelina truncatula*, third-instar larva. 1, Dorsal habitus. 2, Lateral view of anterior end. 3, Anterior spiracle. 4, Posterior spiracle. 5, Facial mask. 6, Dorsal view of segment 9. 7, Perianal pad. 8, Lateral view of cephalopharyngeal skeleton. 9, Dorsal bridge of pharyngeal sclerite. 10, Ventral view of hypostomal sclerite. Abbreviations: A = antenna; AHB = anterior hypostomal bridge; AS = anal slit; ASp = anterior spiracle; ASpB = anterior spinule band; BT = breathing tube; CSP = circular sensory plate; DB = dorsal bridge; DC = dorsal cornu; DLT = dorsolateral tubercle; ES = epistomal sclerite; FM = facial mask; HS = hy-

DESCRIPTIONS OF IMMATURE STAGES

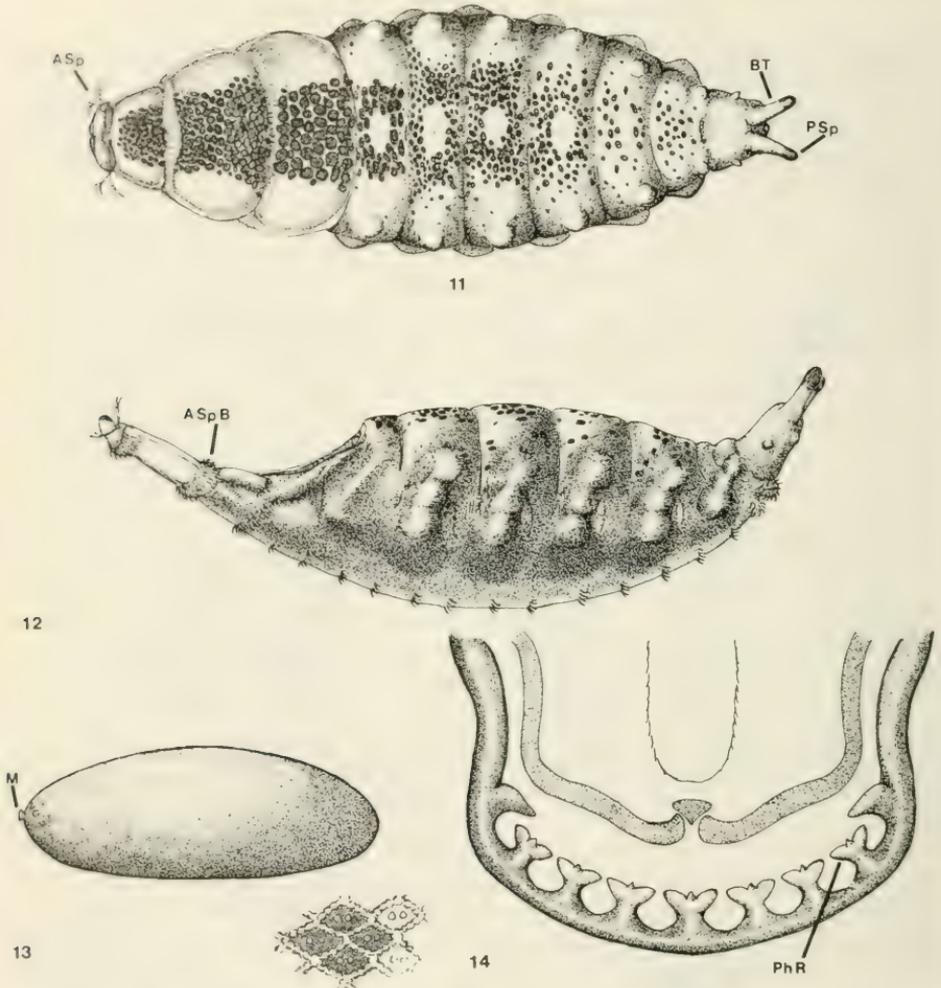
Egg (Fig. 13).—Length 0.45–0.52 mm, \bar{x} = 0.50; width 0.18–0.22 mm, \bar{x} = 0.20 (n = 10). Elongate-ovoid, slightly flattened ventrally. Pinkish in color when living, white when preserved. Chorion appearing papillose, with reticulated pattern; micropylar end not upturned, bearing small tubercle apically; opposite end rounded and not upturned.

Mature third-instar larva (Fig. 1).—Length 4.0–5.5 mm, \bar{x} = 4.6; width 0.8–1.1 mm, \bar{x} = 1.0 (n = 10). Somewhat flattened dorsoventrally; anterior end tapering, posterior end blunt and bearing apically 2 diverging breathing tubes; margins of body segments smooth, without noticeable lateral indentations; single row of low tubercles dorsolaterally on segments 5–11. Integument dorsally with conspicuous black scales; scales particularly noticeable on segments 2–5, less so on remaining segments; anterior borders of segments 3–5 with rows of dark bristles, bristle rows distinctly less conspicuous on remaining segments.

Segment 1 (pseudocephalic) (Fig. 5) frequently invaginated into segment 2, bearing antennae apically, circular sensory plates apicoventrally, and facial mask around oral aperture ventrally; antennae appearing 3-segmented; circular sensory plates with complete rims, each plate bearing 5–6 peglike structures; facial mask (Fig. 5) with conspicuous rows of comblike structures bordering oral aperture, 1 row anterior to aperture, others lateral to opening, each structure composed of narrow piece anteriorly and several narrow teeth posteriorly. Segment 2 (prothoracic) (Fig. 2) with numerous black scales dorsally, bearing bifurcate anterior spiracles near posterolateral border; each spiracle (Fig. 3) with 2 strongly diverging branches, dorsal branch bearing 4–5 elongate papillae apically, ventral branch with 3 apical papillae, base of spiracle arising from slightly pigmented ringlike structure. Segments 3–11 similar except in dorsal patterns formed by darkened tegumentary scales (Fig. 6); dorsolateral tubercles best developed on segments 5–11; venter of each segment with creeping welts bearing blackened bristles apically.

Segment 12 (caudal) bearing perianal pad ventrally and spiracular breathing tubes apicolaterally; perianal pad (Fig. 7) semicircular, bearing anal slit medially, pad bordered by several rows of spinules, post-anal spinule pad well-developed. Breathing tubes (Fig. 4) elongate, approximately 3× as long as wide, tapering distally; each tube capped by spiracular plate, plates with 4 radiating spiracular openings and 4 groups of branching hairlike processes.

←
postomal sclerite; LS = ligulate sclerite; MH = mouthhooks; OA = oral aperture; Pa = papilla; PB = parastomal bar; PhS = pharyngeal sclerite; PHB = posterior hypostomal bridge; PSp = posterior spiracle; SpO = spiracular opening; VC = ventral cornu; W = window.



Figs. 11-14. *Pelina truncatula*, immature stages. 11, Dorsal view of puparium. 12, Lateral view of puparium. 13, Egg. 14, Pharyngeal ridges of mature larva. Abbreviations: M = micropylar end; PhR = pharyngeal ridge; other abbreviations as in Figs. 1-10.

Cephalopharyngeal skeleton (Fig. 8) length 0.44-0.46 mm, \bar{x} = 0.45 (n = 10). Mouthhooks paired, not connected dorsally; hook part narrow and sicklelike, without accessory teeth; basal part broader, with small window ventrally and narrow projection posterodorsally. Hypostomal sclerite (Fig. 10) composed of lateral rods connected by 2 narrow, arched hypostomal bridges, anterior bridge evenly curved, posterior bridge indented medioposteriorly. Epistomal sclerite (Fig. 10) broad, with 4-6 small windows laterally. Parastomal bars (Fig. 8) narrow, seemingly not connected posteriorly

to pharyngeal sclerite, extending anteriorly above hypostomal sclerite, anterior ends not expanded or connected. Pharyngeal sclerite (Fig. 8) largely pigmented; dorsal cornua rather broad, connected anteriorly by dorsal bridge, each cornu with large, irregular window posteriorly; dorsal bridge (Fig. 9) broad, with numerous windows laterally; ventral cornua broad, each with narrow window posterodorsally; floor of pharyngeal sclerite with 9 rather broad ridges (Fig. 14), lateral ridges incomplete, middle 7 ridges bearing lateral lamellae apically.

Puparium (Figs. 11, 12).—Length 4.0–4.6 mm, \bar{x} = 4.2; width 0.9–1.2 mm, \bar{x} = 1.0 (n = 10). Swollen dorsoventrally at midlength, anterior and posterior ends tapering and distinctly upturned; anterior end somewhat invaginated and bearing branched anterior spiracles apicolaterally; posterior end bearing 2 somewhat diverging breathing tubes apically. Dorsum of more anterior segments bearing numerous, densely clustered black scales, scales increasingly scattered on more posterior segments. Perianal pad somewhat invaginated; ventral creeping welts noticeable as bands of blackened bristles.

DISCUSSION

The discovery that at least nine species of four genera (*Axysta*, *Hyadina*, *Lytogaster*, *Pelina*) of the ephydrid tribe Hyadinini have larvae that feed on blue-green algae suggests strongly that this tribe is trophically unified by its preference for this group of microorganisms. In contrast, species of the three other North American genera currently assigned to the Hyadinini have distinctly different larval feeding habits. Thus, larvae of *Brachydeutera* appear to feed on decomposing plant remains in shallow pools (Williams, 1939), those of *Ochthera* are predacious (Simpson, 1975), and *Gastrops* larvae have been found in the eggs of frogs (Bokerman, 1957). Perhaps these three genera at least should be removed from the Hyadinini.

The immature stages of *L. excavata* and *P. truncatula*, two species commonly found in colonies of *Cylindrospermum*, are quite distinctive and can be separated by use of the key given below.

KEY TO IMMATURE STAGES OF *LYTOGASTER EXCAVATA* AND *PELINA TRUNCATULA*

Egg

1. Ends of egg upturned, chorion striated; living embryo white *L. excavata* Loew
- Ends of egg not upturned, chorion papillose; living embryo peach colored *P. truncatula* (Sturtevant and Wheeler)

Mature Larva, Puparium

1. Dorsum without conspicuous black scales; branches of anterior spiracles with sessile papillae *L. excavata* Loew

- Dorsum with conspicuous black scales; branches of anterior spiracles with papillae on elongate finger-like stalks
 *P. truncatula* (Sturtevant and Wheeler)

The utilization of blue-green algae by ephydrid larvae may have considerable practical as well as ecological significance, as many species of this group of algae are capable of fixing nitrogen in aquatic and terrestrial habitats (Balandreau et al., 1975; Granhall, 1975; Maque, 1977). Because some ephydrid larvae feed exclusively on cyanophytes and are occasionally quite abundant, they may have an unsuspected impact on the amount of nitrogen fixed by blue-green algal colonies. The presence of numerous larvae of hyadinine species within colonies of soil-inhabiting blue-green algae can result in fairly rapid destruction of the algal growths. As many as 47 larvae of *L. excavata* have been found in one petri dish sample (2.84 cm²) of *Cylindrospermum* sp. growing on moist soil in southern Arizona. Larvae of *Hyadina*, *Lytogaster*, and *Pelina* readily abandon a *Cylindrospermum* colony once it has been largely consumed and move to adjacent colonies. Thus, their cumulative effect on soil-inhabiting blue-greens could be considerable.

At least four species of Ephydridae have larvae that feed on blue-green algae occurring as floating algal mats in shallow-water habitats (Foote, 1977). Larvae of *Setacera pacifica* (Cresson) occasionally became so abundant in floating colonies of *Anabaena* sp. in alkaline ponds in northwestern Montana that the mats quickly became riddled. As a result, the mats were easily disrupted and dispersed by wave action. It is of more than passing interest in this connection that the bacterium responsible for Legionnaire's disease has been reported to be associated with floating mats of such blue-green algae as *Fischerella* sp., *Phormidium* sp., and *Oscillatoria* sp. (Tison et al., 1980).

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THE IDENTITY OF NEARCTIC *CEROCEPHALA* WESTWOOD
(HYMENOPTERA: PTEROMALIDAE)

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Abstract.—The name *Cerocephala rufa* (of American authors) has been incorrectly applied to a Nearctic species that is actually the Palearctic species *C. eccoptogastris* Masi. The Nearctic species *C. dubarae* Wallace is synonymized with *C. rufa* (Walker). Both *rufa* and *eccoptogastris* are now recognized as Holarctic. A key is given for both species, their geographic distribution is summarized, and known hosts are listed. *Cerocephala eccoptogastris* is associated with Scolytidae and *C. rufa* with Anobiidae. Both may be primary parasites or they may be secondarily associated with Braconidae.

Cerocephala Westwood is one of five Nearctic genera currently placed in the Cerocephalinae (Burks, 1979). All members of this subfamily parasitize woodboring beetles and/or possibly their parasites. Keys to world genera of the subfamily were given by Gahan (1946) and Hedqvist (1969). *Cerocephala* was first reported in the Nearctic by Wallace (1959) who described the species *dubarae* as a parasite of the Eastern Death Watch Beetle (*Hadrobregmus carinatus* (Say): Anobiidae). Burks (1979) later added the Palearctic species *C. rufa* (Walker) to the Nearctic faunal list. This was cited as a secondary parasite of *Dendrosoter* sp. and *Spathius* sp. (Braconidae) through Scolytidae. The purpose of this paper is to clarify the nomenclature of the two Nearctic species of this genus, both of which have been misidentified. In addition a key and illustrations are given to aid in identification, and a lectotype is chosen for the Holarctic species *C. eccoptogastris* Masi.

Cerocephala eccoptogastris Masi

Figs. 1-4

Cerocephala eccoptogastris Masi, 1921: 189-193.

Cerocephala sp. indet.: Graham, 1969: 59, 61.

Cerocephala rufa: Burks, 1979: 781 (misidentification)

Cerocephala eccoptogastris is the correct name for the taxon that has been called *C. rufa* in the New World. Burks (1979) reported *C. rufa* for the first time from the Nearctic. I subsequently identified this species as *rufo* until Marcus Graham suggested in a letter to A. Hajek that the species was not *rufo* but might be *C. eccoptogastris* or an undescribed species. Study of six female and two male syntype specimens of Masi's species convinced me that they are identical to the Nearctic species being called *C. rufa*. Graham (1969: 59, 61) mentioned the possibility that an indeterminate species known to him from material in the British Museum (Natural History) might also be *eccoptogastris*. Boucek (*in litt.*) has confirmed this as the correct name.

Identification.—In addition to characters mentioned in the key at the end of this paper, female *eccoptogastris* may be separated from female *rufo* by the following character: In *eccoptogastris* the lower facial process (Fig. 1, lfp) projects farther forward than the upper facial process (ufp) so that both may be seen in dorsal view (Fig. 2), whereas in *rufo* the upper process projects farther forward than the lower which is not visible from above (Fig. 6). In male *rufo* the processes are about equally weakly developed so that from above the appearance is of only one process (Fig. 8) as in the female. Both can be seen from above for male *eccoptogastris* (Fig. 4).

Type-material.—Described from 7 ♀ and 4 ♂. I take this opportunity to designate as LECTOTYPE the female marked with a black dot inside a black ring. This is the lowermost of 2 card-mounted specimens on a single pin bearing the data: "Bengasi, 111-1916, Zanon, cotype." Specimens in the Museo Civico di Storia Naturale "G. Doria," Genova.

Distribution.—In the Nearctic, *eccoptogastris* has been reported from Ohio, Michigan, and Colorado (Burks, 1979, as *rufo*). I have confirmed these records based on specimens in the U.S. National Museum and add the new state record of California. The Palearctic distribution is Libya (Bengasi), Egypt, and Spain (Hedqvist, 1969), to which is added "Macedonia," Greece, and France (based upon my determination of USNM material), Turkey and Palestine (Graham, 1969: 61, indeterminate species), and Israel (Boucek, *in litt.*).

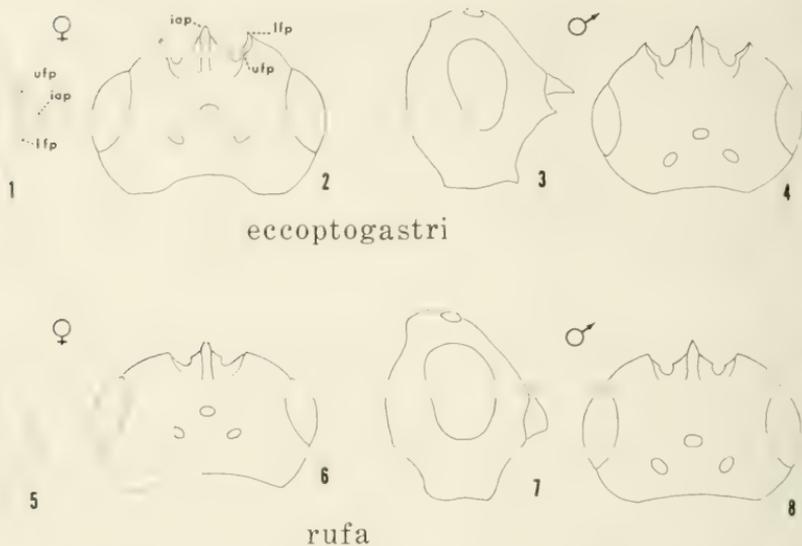
Hosts.—Nearctic hosts for this species include *Scolytus multistriatus* (Marsham) (Scolytidae) and *Dendrosoter* and *Spathius* spp. (Braconidae). Palearctic records include *Scolytus ?rugulosus* (Ratzeburg) and *S. koenigi* Schevyrew (Hedqvist, 1969). *Cerocephala eccoptogastris* apparently may act as both a primary and secondary parasite through Scolytidae.

Cerocephala rufa (Walker)

Figs. 5-8

Epimacrus rufus Walker, 1833: 369-370.

Cerocephala dubarae Wallace, 1959: 84-86. NEW SYNONYMY.



Figs. 1-8. Heads of *Cerocephala* species. 1, 3, 5, 7. Lateral view. 2, 4, 6, 8. Dorsal view. (ufp = upper facial process; lfp = lower facial process; iap = interantennal projection.)

Wallace (1959) compared his new species *dubarae* with Gahan's published concept (1946) of *Cerocephala cornigera* Westwood. According to Graham (1969: 60) the specimen in the Hope Museum which formed the basis of Gahan's concept of *cornigera* is actually a male of *rufa*. Gahan's published description of *cornigera* (1946: 358), however, was not based so much on the Hope specimen of *rufa* as on notes on the type of *Sciatheras trichotus* Ratzeburg, a synonym of *cornigera*. Thus Gahan's description of *cornigera* is probably a combination of both *rufa* and *cornigera*. Confounding the problem even further, however, is that Gahan's illustrations (1946: Pl. 47, fig. 4, 4a and Pl. 48, fig. 3) are almost certainly of *eccoptogastris*. This is based on the following two factors: The drawings were done by A. Cushman in Washington, and because Gahan refers only to "notes" he had taken, it is not likely that he borrowed any of the specimens he had seen in Europe: Gahan (1946: 359) determined two specimens from Hyeres, France as *cornigera* and stated that these were the only specimens of this species in the U.S. National Museum. These specimens, determined by Gahan as *cornigera* and presumably the only specimens available for illustration by Cushman, are actually *eccoptogastris* based on comparison with the type material of Masi. The basic problem, then, is that Gahan's concept of *cornigera* was based on notes and illustrations that involved at least two pos-

sible misidentifications (namely *cornigera* for *rufa* and *eccoptogastris*). Wallace (1959) compared his new species *dubarae* against Gahan's illustrations of *cornigera* (i.e., actually *eccoptogastris*). I have seen two female and one male paratypes of *dubarae* as well as the type of *rufa* and can find no basis for separation. A further basis for combining these names is that both are associated with Anobiidae, whereas *eccoptogastris* and *cornigera* appear to be associated with Scolytidae.

Identification.—See key and identification section for *eccoptogastris*.

Type-material.—*Epimacrus rufus* Walker, described from 1 ♀ (see Graham, 1969: 60) in the G. T. Rudd collection, Yorkshire Museum, York, England. *Cerocephala dubarae* Wallace, described from 5 ♀ and 2 ♂, the holotype, allotype and 1 ♀ paratype in the Carnegie Museum, Pittsburgh, Pennsylvania; 2 ♀ paratypes and 1 ♂ paratype in the U.S. National Museum, Washington, D.C.; 1 ♀ paratype, Canadian National Collection, Ottawa, Canada.

Distribution.—In the Nearctic, *rufa* is known only from Pennsylvania. In the Palearctic it is known from Britain, Czechoslovakia, and Sweden (Graham, 1969; Hedqvist, 1969).

Hosts.—In the Nearctic, this species is known from *Hadrobregmus carinatus* (Anobiidae). In the Palearctic, *rufa* has been reared from *Anobium pertinax* Fabricius and *A. punctatum* (DeGeer) (Anobiidae), possibly as a secondary through the braconid *Spathius exarator* (Linnaeus) (Graham, 1969).

KEY TO NEARCTIC *CEROCEPHALA*

- In profile (Figs. 1, 3), lower facial process (lfp) produced as a denticle, carinae laterad of clypeus distinct causing ventral anterior corner of head to appear denticulate, interantennal projection acute *eccoptogastris* Masi
- In profile (Figs. 5, 7), lower facial process obscure or rounded, clypeus without carinae laterad and head rounded at ventral anterior corner, interantennal projection obtuse *rufa* (Walker)

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REEVALUATION OF PLEISTOCENE SCARAB BEETLES
FROM RANCHO LA BREA, CALIFORNIA
(COLEOPTERA: SCARABAEIDAE)

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Abstract.—Late Pleistocene Scarabaeidae described from the Rancho La Brea asphalt deposits, Los Angeles, California are reviewed. *Canthon praticola* LeConte (= *C. praticola vetustus* Pierce, n. syn.) and *C. simplex* LeConte (= *C. simplex antiquus* Pierce, n. syn.) still occur in southwestern North America. *Copris pristinus* Pierce and *Onthophagus everestae* Pierce are apparently extinct, perhaps due to terminal Pleistocene extinctions of large mammals. *Paleocopris* Pierce is a new synonym of *Phanaeus* MacLeay. *Phanaeus labreae* (Pierce), n. comb., and *Serica kanakoffi* Pierce cannot be placed at species level due to the nature of the holotypes.

This is one of a series of papers (Miller and Peck, 1979; Doyen and Miller, 1980) reevaluating the fossil insects described from the Rancho La Brea asphalt deposits, Los Angeles County, California. The Scarabaeidae of this deposit were described by Pierce (1946b, c); one species was reviewed by Matthews and Halffter (1968). We have reevaluated Pierce's type-specimens, as well as some of the more recently excavated representatives of this family. The bulk of the new material from Rancho La Brea, as well as that from the McKittrick and Carpinteria asphalt deposits, must await future study. As discussed by Miller and Peck (1979), Pierce was prone to extreme taxonomic splitting, and most of his Pleistocene taxa are synonyms of extant species. Subspecific names are inappropriate because the fossils do not represent geographic races.

Locality, age, and ecological data for Rancho La Brea were discussed by Pierce (1946a) and Miller and Peck (1979), and will later be treated in greater detail by Miller. The scarabs came from Pits A, 13, 16, and 81. These excavations all included a Late Pleistocene biota, but assignment of exact ages is impossible in most cases because most of the Pierce specimens are without stratigraphic data. All specimens are deposited in the Natural His-

tory Museum of Los Angeles County Invertebrate Paleontology collection (LACMIP).

TAXONOMY

Canthon (Boreocanthon) praticola LeConte

Canthon praticola LeConte, 1859: 10.

Canthon praticola vetustus Pierce, 1946b: 122. NEW SYNONYMY.

Boreocanthon praticola vetustus of Halffter, 1959: 176.

The holotype elytron (LACMIP 2592 = C117a) and paratype elytron (LACMIP 2593 = C118a), both from Pit 81, of *Canthon praticola vetustus* are apparently *C. praticola*, but there is no justification for a subspecific name. *Canthon praticola* does not presently occur in California; it is distributed from British Columbia and Alberta in Canada to Wyoming, Colorado, Kansas, Oklahoma, Texas, and Arizona in the United States and Sonora and possibly Chihuahua in Mexico (Halffter, 1959). *Boreocanthon* was given generic status by Halffter (1958), but was later lowered to subgeneric status (Halffter and Martinez, 1977).

Canthon (Boreocanthon) simplex LeConte

Canthon simplex LeConte, 1857: 41.

Canthon simplex antiquus Pierce, 1946b: 120–122, figs. 1–3. NEW SYNONYMY.

Boreocanthon simplex antiquus of Halffter, 1959: 176.

The holotype prothorax with legs (LACMIP 2594 = C114d) and paratype elytra (LACMIP 2595–2597 = C114a–c), all from Pit A, of *Canthon simplex antiquus* are apparently *C. simplex*, but a subspecific name is unjustified. *Canthon simplex* presently occurs in Arizona, California, and the Pacific Northwest.

Copris pristinus Pierce

Copris pristinus Pierce, 1946b: 124–130, figs. 4–9, 18–19.

Copris pristinus of Matthews, 1961: 35, 67, 69; Halffter, 1959: 176, 1964: 22; Matthews and Halffter, 1968: 160–161, figs. 7–8.

Examination of paratypes of *Copris pristinus* by Matthews and Halffter (1968) revealed that *C. pristinus* is not a member of the *armatus* complex as previously thought (Matthews, 1961; Halffter, 1959, 1964). They concluded that *C. pristinus* is "an extinct species which in most essentials fits well within the *rebouchei* complex, as defined by Matthews (1961), but which shows some less important features of the *armatus* complex." The *rebouchei* complex includes three extant species, one of which, *C. lecontei* Matthews, extends today to southern Arizona. Thus, since the Pleistocene, *Copris* has apparently retreated from California. The holotype head (LACMIP 2850 = C49p) and 29 paratypes (LACMIP 2853–2878, 4329–4333) are from Pit A; 6 paratypes (LACMIP 2851, 2879–2883, 4328) are from Pit 16

dump; and 3 paratypes (LACMIP 2884–2886) are from the inside of a *Felis atrox* (Leidy) skull (LACM HC 183) from depth 12.5 feet (3.8 m) in Pit 13. The ages of the specimens from Pits A and 16 are uncertain, but probably Late Pleistocene. A Late Pleistocene age for the Pit 13 specimens may be assumed because of their association with the extinct *F. atrox*, although such data must be used with care (Harington, 1980).

Onthophagus everestae Pierce

Fig. 1

Onthophagus everestae Pierce, 1946b: 131, figs. 15–17.

The holotype head (LACMIP 3057 = C115a) from Pit 81 is unlike any described species of *Onthophagus* in North or Central America and must be considered a valid and extinct species. Its closest relatives appear to be *Onthophagus corrosus* Bates (known from Mexico) and *Onthophagus cuevensis* Howden (known from San Luis Potosi and Tamaulipas in Mexico; Howden, 1973), but *O. everestae* is quite different from these and is readily distinguished by the well-developed carina (Fig. 1). The paratype leg (LACMIP 3058 = C115b), also from Pit 81, is a species of *Canthon* in the *imitator* group, similar to *Canthon obliquum* Horn of Baja California.

Phanaeus labreae (Pierce), NEW COMBINATION

Fig. 2

Paleocopriss labreae Pierce, 1946b: 130, figs. 10–14.

Paleocopriss labreae of Halffter, 1959: 176; Matthews, 1961: 35.

The holotype head (LACMIP 3059 = C116a), from Pit 81, of *Paleocopriss labreae* is a very large but very minor male referable to the genus *Phanaeus*, which makes *Paleocopriss* a new junior synonym of *Phanaeus* (NEW SYNONYMY). The structure of the lateral clypeal carina of the head (Fig. 2) is characteristic of the *videx* group of Edmonds (1972), but we have not attempted specific identification due to the broken and distorted condition of the holotype. The paratype legs, all from Pit 81, belong to other genera: LACMIP 3062 (=C116d) and 3063 (=C116e) are *Copriss*, 3060 (=C116b) may be *Deltochilum*, and 3061 (=C116c) is probably *Onthophagus* (the last two lack characters for generic placement).

Serica kanakoffi Pierce

Serica kanakoffi Pierce, 1946c: 132, figs. 1–2.

The unique holotype (LACMIP 3071 = C107a) is a head from Pit 81. *Serica* is a taxonomically very difficult genus in which species are superficially similar. Positive identifications must usually be based on characters of the male genitalia (Dawson, 1919). In view of the nature of the genus, it is impossible to place this taxon adequately. It is probable, however, that *S. kanakoffi* is really one of the many extant California species.



Figs. 1, 2. Holotype heads. 1, *Onthophagus everestae* (scanning electron microscope photograph by L. E. C. Ling, Carleton University). 2, *Phanaeus labrae* (photograph by V. E. Krantz, Smithsonian Institution).

DISCUSSION

Of the six scarab species reported by Pierce (1946b, c) from Rancho La Brea, two are extant species, and two are extinct species. The other two cannot be placed to species, but present evidence does not give us reason to consider them extinct. The extinct species differ from all described

species, but it is possible that they might eventually be rediscovered in Mexico. Congeners of the two extinct species are associated with mammal dung.

The modern California scarab fauna includes (in San Diego County) only one rare *Onthophagus*, *O. cartwrighti* Howden (1973). Species closely related to *O. cartwrighti* occur in pack rat nests in Arizona, but *O. cartwrighti* belongs to a different species group than does *O. everestae*, and there is no reason to suspect that their habits would be similar. All the other members of the genera *Onthophagus*, *Copris*, and *Phanaeus* now occur from central Arizona eastward or along the Sierra Madre to the south and feed on the dung of various mammals. In the Late Pleistocene a diverse and abundant large mammal fauna existed at Rancho La Brea (Marcus, 1960; Stock, 1956). This fauna underwent a very late Pleistocene extinction, probably due to climatic change (drying and warming with increased seasonality), and perhaps some influence from human hunting (Johnson, 1977; Axelrod, 1967; Martin and Neuner, 1978). The modern ranges of *Onthophagus*, *Copris*, and *Phanaeus* corroborate increasing aridity in post-Pleistocene California. It is probable that the resultant reduction of dung availability, as well as direct effects of the changing climate caused the demise of these scarabs. However, even if the large mammal fauna had survived into the Holocene, the scarabaeine fauna might not have survived the present seasonal dry periods, since their successful reproduction requires adequate moisture.

At Rancho La Brea, the only other insect species included in contemporary studies that is not known to be extant is the tenebrionid beetle *Coni-ontis remnans* Pierce (Doyen and Miller, 1980). It is probable, however, that this species still occurs in California and has been overlooked in museum collections of this large and taxonomically difficult genus. Studies of other deposits in North America (Ashworth, 1979; Matthews, 1977) and Europe (Coope, 1978) indicate that almost all Pleistocene insects represent extant species.

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INSECT ASSOCIATES OF SPURGES, MAINLY
EUPHORBIA MACULATA L., IN EASTERN UNITED STATES

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Abstract.—The insect fauna associated with mats of a prostrate spurge, *Euphorbia maculata* L., was studied in Pennsylvania and North Carolina during 1979-80. All species observed (except pollinators and foragers at nectariferous glands) are listed, and notes on feeding habits, phenology, and previously recorded associations with *Euphorbia* are given for the more common species. A sap-feeding guild, including several specialists on Euphorbiaceae, dominated the fauna. Coreid, rhopalid, and mirid bugs fed exclusively on flowers and fruits; several lygaeids fed on fallen seeds. A few species are recorded from *E. dentata* Michx. and *E. preslii* Guss. in Pennsylvania, *E. blodgettii* Engelm. ex Hitchc. in Florida, and *E. maculata* in New York, West Virginia, and Georgia. Mats of *E. maculata* generally harbored a more diverse fauna than the erect *Euphorbia* spp.

The genus *Euphorbia* L., containing an estimated 1600 species of herbs, shrubs, and trees in subtropical and temperate regions, is not only the largest genus of the spurge family Euphorbiaceae but one of the most broadly interpreted of modern plant genera (Richardson, 1968). Interest in these plants is keen owing to their poisonous properties (Kingsbury, 1964), ornamental uses, and importance as agricultural weeds (Krochmal, 1952). Several introduced spurges have adversely affected North American agriculture; cypress spurge, *Euphorbia cyparissias* L., and especially leafy spurge, *E. esula* L., have had the greatest impact. The latter species, a noxious perennial first introduced to the United States in the early 19th century (Britton, 1921), has infested some 2.5 million acres of cultivated land in the western states (Noble et al., 1979).

Biological control workers have surveyed the arthropod fauna of *Euphorbia* in Europe (Schröder, 1970) and have imported and released lepidopteran species (Sesiidae, Sphingidae) in an attempt to reduce infestations of *E. esula* (Carl and Zwölfer, 1965; Harris, 1970; New, 1971; Forwood and McCarty, 1980). Several species of Coleoptera are under evaluation for

potential release (Harris, 1979). Although entomologists logically have focused on Old World insects restricted to *Euphorbia*, a better understanding of arthropod communities associated with native and naturalized spurge is desirable. Selleck (1959) and Maw (unpublished, cited in Best et al., 1980) have recorded the fauna, largely species attracted to nectar and pollen, associated with the introduced *E. esula* in Saskatchewan. The literature treating native *Euphorbia*-insect relationships consists of observations on visitors to mats of the western *E. albomarginata* Torrey and Gray (Krombein, 1961), pollination studies on this and two other western spurge (Ehrenfeld, 1979), and casual references to individual species, e.g., Cockerell (1911).

The principal native host observed in my study was *E. maculata* L., a usually prostrate annual often referred to as *E. supina* Raf.; for a history of the taxonomic confusion and correct nomenclature, see Wheeler (1939, 1960), Croizat (1962), and Burch (1966). This small-leaved, hispid-villous plant, generally distributed throughout eastern United States and southern Canada, ranges west to North Dakota and Texas; it is thought to have been introduced to Oregon, California, and Arizona (Wheeler, 1941). *Euphorbia maculata* belongs to the subgenus *Chamaesyce* whose species are less important as agricultural pests than those of the subgenus *Esula*, which contains cypress and leafy spurge (Wheeler, 1941). It is an occasional weed in home lawns and becomes a major pest only in localized areas, e.g., western New York's onion-growing region (Dunn, 1979).

I made limited observations on the insect associates of toothed spurge, *E. dentata* Michx.; on an erect plant, here called *E. preslii* Guss.; and on the prostrate *E. blodgettii* Engelm. ex Hitchc. The correct name for *preslii* has been in question, and the names *hypericifolia* L., *nutans* Lag., and *maculata* L. (sensu Wheeler, 1939) have been used (Burch, 1966; Richardson, 1968).

STUDY SITES AND METHODS

The main study sites in Pennsylvania were railroad yards at Enola (Cumberland Co.) and Harrisburg (Dauphin Co.), and railroad tracks at Hershey (Dauphin Co.) where mats of *E. maculata* were growing in ballast material. A fourth site was a small garden near Matthews (Mecklenburg Co.), North Carolina. The prostrate growth habit of *E. maculata* made direct observation and a "scratch and search" technique (Slater and Baranowski, 1978) efficient means of studying the associated fauna. Insects were hand picked from the plants or from beneath mats. Live specimens of common species were observed in the laboratory to determine feeding sites and possible host injury. Because *E. maculata* is a relatively late-season annual, appearing about 1 June in the Harrisburg area, I did not begin sampling until mats were established. During September–November 1979 and July–October

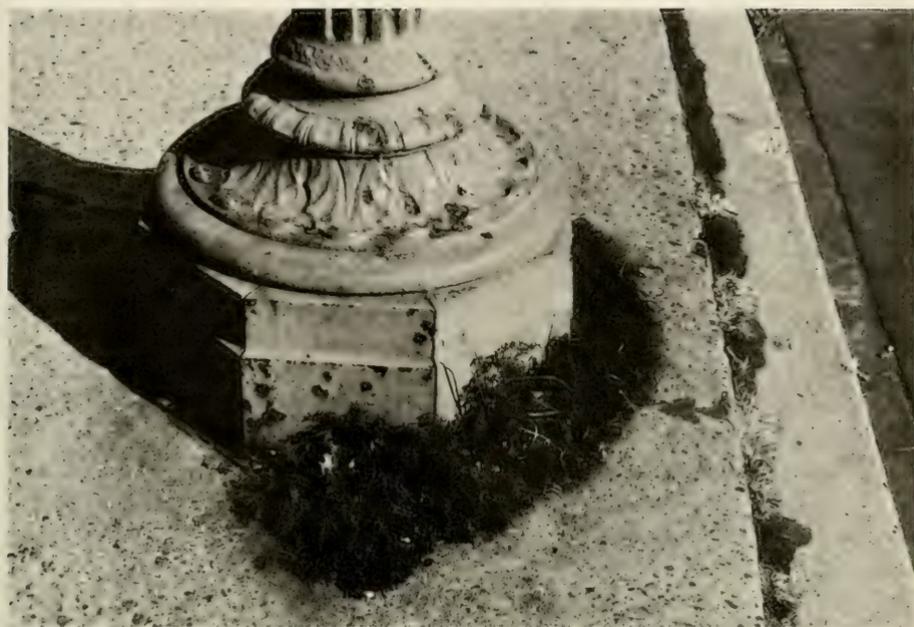


Fig. 1. Mat of *Euphorbia maculata* growing along a city sidewalk.

1980, I made 15 collections at the four main sites (Hershey—5 samples, Enola—3, and Harrisburg, Pa.—2; Matthews, N.C.—5).

I made ten supplemental observations on *E. maculata* growing at the edge or in cracks of sidewalks and paving (Fig. 1) in the Harrisburg area and took five samples from *E. preslii* and one from *E. dentata*. Single collections were made from *E. maculata* at Ithaca, N.Y.; Grafton, W. Va.; Monroe, N.C.; and Atlanta, Ga. Collections from mats of *E. blodgettii* were made in Dade Co. and Big Pine Key (Monroe Co.), Fla. Voucher specimens have been deposited in the insect collection of the Bureau of Plant Industry, Pa. Dep. Agric., Harrisburg.

RESULTS

In Table 1 relative abundance, stages collected, feeding habits, and collection sites are given for the insect community associated with mats of *E. maculata* and the species collected from *E. blodgettii*, *E. dentata*, and *E. preslii*. Habits and seasonality are provided for the more common species; for these, or related species, previously recorded associations with *Euphorbia* are cited.

HEMIPTERA-HETEROPTERA

Thyreocoridae.—Little biological data are available for members of the taxonomically difficult genus *Galgupha*, negro bugs belonging to a group

one hemipterist has labeled "small, miserable black insects" (Leston, 1961). In the railroad yards at Harrisburg the uniformly black adults of *G. aterrima* McAtee and Malloch were found beneath mats of *E. maculata* where they were difficult to distinguish from cinders of ballast material near the tracks. Nymphs occurred during September on the inflorescences and developing capsules, and in the laboratory they fed exclusively on these reproductive structures. I found that *G. atra* Amyot and Serville had similar habits in North Carolina, and I collected this species on *E. maculata* at Atlanta, Ga.

Thyreocorids were among the most abundant hemipterans associated with *Euphorbia* plants in Arizona (Ehrenfeld, 1979). Hoffman (1975) noted that *Galgupha* spp. occurring in the eastern U.S. are more often encountered on the ground or under cover than in sweeping vegetation. It seems likely that careful study will show that *Galgupha* spp. consistently are associated with reproductive structures of prostrate spurge.

Coreidae.—*Chariesterus antennator* (F.), belonging to a New World genus found mainly in subtropical and tropical regions, is restricted to the Euphorbiaceae. Related species of *Chariesterus* are intimately tied to this plant family; they serve as intermediate vectors of dermatitis-transmitting flagellate protozoans living in the latex of *Euphorbia* spp. (Strong, 1924).

Although no detailed life history study exists for *C. antennator*, this specialist herbivore has been collected on *E. corollata* L. (Hussey, 1922) and *E. preslii* (= *nutans*) (Osborn, 1904a). In Missouri, Sullivan (personal communication) observed nymphs on fruiting plants of *E. dentata* and *E. preslii* and mating pairs on *E. corollata*. I found this characteristic *Euphorbia* associate only in small numbers on *E. preslii* in Pennsylvania. This coreid becomes more common in the southeastern states (Slater and Baranowski, 1978), and in the Florida Keys I observed a large population breeding on the prostrate *E. blodgettii*.

Rhopalidae.—*Liorhyssus hyalinus* (F.), known from *E. preslii* (Osborn, 1904a), also feeds on plants of unrelated families (Southwood and Leston, 1959). This rhopalid was, however, a characteristic *Euphorbia* associate in Pennsylvania where two and possibly three generations developed on *E. maculata* from July through October. Eggs were placed in clusters of 25–30 on lower leaf surfaces; nymphs fed only on the flowers and developing fruits. As noted by Osborn (1904b), nymphs blend in well with the color of the host plant. Adults were present on mats of *E. maculata* until late October in Pennsylvania and were collected on this plant in Georgia during early December.

Lygaeidae.—This largely seed-feeding family contributed nine species to the *Euphorbia*-insect community; at least six species occurred consistently among fallen seeds under mats of *E. maculata*. The orsilline *Nysius niger* Baker (= *ericae* (Schilling) of American authors (Ashlock, 1977)) developed

the largest populations. Milliken (1918) noted that this lygaeid placed some of its eggs in the clustered parts of *E. serpyllifolia* Pers. Other *Nysius* spp., e.g., *N. coenosulus* Stål in Hawaii (Zimmerman, 1948), have been recorded from *Euphorbia*, and *N. euphorbiae* Horvath transmits a protozoan from the latex of one plant to another (Lafont, 1910).

Adults and nymphs of the myodochines, *Neopamera bilobata* (Say) and *Ptochiomera nodosa* Say, also occurred in large numbers, especially on mats growing under harsh conditions such as cracks in sidewalks, parking lots, and other paved areas. Sweet (1960) noted that these species were typical of ruderal sites having sparse vegetation. Watson (1917) observed that the strawberry pest *Pseudopachybrachius vinctus* (Say) (cited as *Pamera vincta*) is "very abundant" on its possible native host, wild spurge; his observations may, in fact, refer also to *N. bilobata* (Sweet, 1960). *Ligyrocoris diffusus* Uhler and *Myodochus serripes* Olivier were common but were more apt to be associated with mats growing in less harsh environments like gardens or edges of lawns. Although these orsilline and myodochine lygaeids might use prostrate spurges only as hiding places, their consistent collection under mats, often in assemblages of three or four species, coupled with my observations of seed feeding in the laboratory, suggest that seeds of *E. maculata* may be among their preferred foods. It is significant that M. H. Sweet, who has provided the most detailed information on seed-feeding habits in the Lygaeidae (Sweet, 1964), also has noted the presence of lygaeids under prostrate species of *Euphorbia* (personal communication).

The geocorine lygaeids found under *E. maculata*, mainly *Geocoris uliginosus* Say, may prey on other lygaeids inhabiting the litter layer. Sweet (1964) observed *uliginosus* feeding on *Ptochiomera nodosa*, and Crocker and Whitcomb (1980) reported *G. bullatus* (Say) preying on *Neopamera bilobata* (cited as *Pachybrachius bilobatus*); I found both prey lygaeids commonly under spurges. Geocorines also feed on plant material, including seeds (Sweet, 1960; Tamaki and Weeks, 1972), and may feed on fallen seeds of prostrate euphorbias.

Miridae.—*Semium hirtum* Reuter, first associated with spurges by Heidemann (1901), belongs to a genus known only from *Euphorbia* (Kelton, 1973). This specialist appears restricted to the prostrate spurges where it feeds on developing inflorescences. Osborn (1904b) noted that the appearance of this mirid in Ohio coincided with the development of blossoms on its host (a weedy *Euphorbia* common on the Ohio State University campus, probably *E. maculata*). The pinkish-rose nymphs and adults of contrasting rosy red, black, and white are well camouflaged on their hosts. In Pennsylvania nymphs were found from July to early November; the recurrence of early instars in September indicates the beginning of a possible second generation. In North Carolina adults were present until late November.

Table 1. Arthropod fauna associated with *Euphorbia maculata* and *E. preslii*.^a

	Relative Freq. on		Stages	Feeding Sites, Habits	Collection Sites
	<i>E. m.</i>	<i>E. p.</i>			
HEMIPTERA-HETEROPTERA					
Cydnidae					
<i>Melanaethus pensylvanicus</i> (Signoret)	R	—	N,A	R?	2
Thyreocoridae					
<i>Galgupha aterrima</i> Malloch	C	R	N,A	F	1,2
<i>Galgupha atra</i> Amyot and Serville	M	—	A	F	4,5
Pentatomidae					
<i>Thyanta</i> sp.	R	—	N	F	2
Coreidae					
<i>Chariesterus antennator</i> (F.)	C	—	N,A	F	2,6 ^b
Rhopalidae					
<i>Liorhyssus hyalinus</i> (F.)	C	R	E,N,A	F	2,5
<i>Niesthrea sidae</i> F.	R	—	A	F	6 ^b
Lygaeidae					
<i>Atrazonotus umbrosus</i> Distant	M	—	A	S?	2,4
<i>Geocoris bullatus</i> (Say)	R	—	A	Pr,S?	6
<i>Geocoris uliginosus</i> (Say)	C	—	N,A	Pr,S?	2,4,5,6 ^b
<i>Ligyrocoris diffusus</i> Uhler	C	—	N,A	S	1,2
<i>Lygaeus kalmii</i> Stål	M	—	N,A	F	2,3
<i>Myodocha serripes</i> Olivier	C	—	N,A	S	1,2,4
<i>Nysius niger</i> Baker	C	—	N,A	S	2,6 ^b
<i>Neopamera bilobata</i> (Say)	C	—	N,A	S	4,5,6 ^b
<i>Ptochiomera nodosa</i> Say	C	—	N,A	S	2,4,6 ^b
Nabidae					
<i>Pagasa fusca</i> Stein	R	—	A	Pr	2
<i>Reduviolus americanoferus</i> (Carayon)	R	—	N,A	Pr	2
Miridae					
<i>Semium hirtum</i> Reuter	C	—	N,A	F	2,3,4,6 ^b
<i>Spanagonicus albofasciatus</i> Reuter	M	—	N,A	F,L?	2,4
HEMIPTERA-HOMOPTERA					
Aleyrodidae					
<i>Trialeurodes abutilonea</i> (Haldeman)	M	M	P,A	L	2
<i>T. vaporariorum</i> Westwood	R	—	P,A	L	2
Aphididae					
<i>Aphis craccivora</i> Koch	M	M	N,A	L	2
Cicadellidae					
<i>Xerophloea viridis</i> (F.)	M	—	N,A	L?	4
COLEOPTERA					

Table 1. Continued.

	Relative Freq. on		Stages	Feeding Sites, Habits	Collection Sites
	<i>E. m.</i>	<i>E. p.</i>			
Chrysomelidae					
<i>Glyptina spuria</i> LeConte	C	R	A	R?, L	2,4,6 ^b
LEPIDOPTERA					
Yponomeutidae					
<i>Atteva punctella</i> Cramer	—	R ^c	P	L	2

^a Relative frequency: C, consistently collected at most sites, usually >5 specimens; M, moderate abundance, 2–5 sites; R, rare, <2 sites; —, not collected. Stages collected: E, eggs; L, larvae; N, nymphs; P, pupae; A, adults. Feeding sites and habits: F, flowers, fruits; L, leaves, stems; Pr, predacious; R, roots; S, seeds (fallen). Collection sites: 1, N.Y.; 2, Pa.; 3, W. Va.; 4, N.C.; 5, Ga.; 6, Fla.

^b Host plant is *Euphorbia blodgettii*.

^c Host plant is *Euphorbia dentata*.

COLEOPTERA

Chrysomelidae.—The only coleopteran species I consistently collected from spurges was *Glyptina spuria* LeConte, a little-studied alticine chrysomelid. I found adults of this flea beetle on or under prostrate spurges from Pennsylvania to Florida. In the laboratory adults fed on stems and fruit, pausing occasionally to clean milky sap or latex from their mouthparts. Balsbaugh and Hays (1972), in reporting *G. spuria* from roadside vegetation, noted that specific hosts were unknown; *G. cyanipennis* Crotch, however, feeds on *E. cyathophora* in Florida (Schwarz, 1890). Although I did not find larvae of *G. spuria*, they most likely are root feeders on euphorbias. Larvae of several species of *Aphthona*, a genus closely related to *Glyptina* and tied to plants of the Euphorbiaceae (Blake, 1964), feed on *Euphorbia* roots (Harris, 1979).

DISCUSSION

Plants of the genus *Euphorbia*, probably owing to the presence of toxic alkaloids, at times have been mentioned as unattractive to insects: "Ordinarily not even grasshoppers will eat these plants" (Wheeler, 1941). But as biological control workers have discovered, spurges harbor a diverse arthropod fauna (Harris, 1979) that includes numerous pollinators (Bakke, 1936; Selleck, 1959; Best et al., 1980). Apparently, however, all parts of spurge plants may be attacked, and several specialist insects appear to have co-evolved with their *Euphorbia* hosts.

Dominant in the present study were members of a sap-feeding guild, es-

pecially species of Hemiptera-Heteroptera. In England, Butler (1918) observed that spurges serve as hosts for several heteropterans. I found that the coreid *Chariesterus antennator* and the mirid *Semium hirtum* were specialist herbivores restricted to the inflorescences and developing fruits, thus occupying a niche used by the so-called spurge bugs of the mainly Old World family Stenocephalidae (Scudder, 1957). The rhopalid *Liorhysus hyalinus*, although not restricted to spurge, was a characteristic member of the *Euphorbia* community. In general, a more diverse heteropteran fauna developed on prostrate spurges. Mats of *E. maculata*, in addition to harboring larger populations of coreids, mirids, and rhopalids, provided an abundant source of fallen seeds and a presumably favorable microhabitat for various seed-feeding Lygaeidae.

The Hemiptera-Homoptera contributed few species to the *Euphorbia*-insect community and seldom were found in large numbers. I made only two collections of the whiteflies *Trialeurodes abutilonea* Haldeman and *T. vaporariorum* (Westwood), although both are known to occur on *Euphorbia* spp. (Russell, 1963). Cowpea aphid, *Aphis craccivora* Koch, was most common on *E. preslii*. This apparently is the first *Euphorbia* host record for this polyphagous aphid.

Chewing arthropods were scarce: only the chrysomelid *Glyptina spuria* was encountered at several localities. The ailanthus webworm, *Atteva punctella* (Cramer), was the only lepidopteran found in the study. On *E. dentata* I found pupae on a webbed and heavily damaged plant growing near the webworm's main host, the tree of heaven, *Ailanthus altissima* Swingle (Simaroubaceae). *Atteva* spp. are thought to be restricted to simaroubaceous plants (Duckworth, 1967), and for the ailanthus webworm I am aware of just one additional host, *Simarouba glauca* DC (Bawa and Opler, 1978).

In addition to the various species found breeding on *Euphorbia* there was a diverse group of insect visitors. I observed (but did not identify) ants foraging at the nectariferous glands associated with flowers (cyathia) and Diptera and Hymenoptera visiting flowers. Nymphs of the mirid *Spananonicus albofasciatus* Reuter and the leafhopper *Xerophloea viridis* (F.) occurred under *E. maculata* but may have been breeding on nearby grasses. In North Carolina, however, the abundance of *X. viridis* nymphs under isolated mats suggested that this leafhopper feeds partly on spurges.

I found a disproportionately greater number of species associated with the prostrate *E. maculata* than with the erect *E. preslii*. Species richness of any *Euphorbia*-insect association appears influenced by growth habit of the host plants. Ehrenfeld (1979) found that mats of *E. albomarginata* attracted three times the number of pollinating species compared to the two erect *Euphorbia* spp. Parasitic insects are among the known flower visitors, e.g., the tachinid fly *Winthemia quadripustulata* (F.) on *E. nutans* (Allen, 1925). Topham and Beardsley (1975) regarded *Euphorbia* flowers as such

an important nectar source for parasites that they recommended maintaining spurges along margins of cultivated fields.

The insect community I found associated with *E. maculata* was dominated by sucking insects associated with inflorescences and fruits. Several of these sap feeders are restricted to spurges, whereas other, mainly little-studied, species were collected consistently from these plants. Considerable overlap was apparent between the Pennsylvania and North Carolina, and even Florida, spurge-insect communities. Few polyphagous or generalist species were present. Native spurges, although far from depauperate, harbored few chewing insects that might help limit populations of introduced, weedy spurges. Even so, the relatively specialized fauna should interest students of animal-plant coevolution.

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THE TAXONOMIC STATUS OF *ENCARSIA*, *PROSPALTELLA*,
AND *TRICHAPORUS* AND A DESCRIPTION OF
PRIMAPROSPALTELLA, NEW GENUS
(HYMENOPTERA: CHALCIDOIDEA: APHELINIDAE)

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Abstract.—The status of the genera *Encarsia* Foerster, 1878, *Prospaltella* Ashmead, 1904, and *Trichaporus* Foerster, 1856 is clarified. A characterization of *Encarsia* is given. The type-species of *Prospaltella* is *Coccophagus aurantii* Howard, 1894 not *Prospalta murtfeldtae* Howard, 1894. *Prospaltella* is a synonym of *Encarsia* as per Viggiani and Mazzone, 1979. *Primaprospaltella* n. gen. is described with the type-species *Prospalta murtfeldtae* Howard, 1894.

Trichaporus Foerster, 1856 and *Trichaporus* Ashmead, 1900 are objective synonyms, with the type-species *Euderus columbianus* Ashmead, 1888. These genera are properly placed in the Eulophidae, not the Aphelinidae, where they are both senior objective synonyms of *Galeopsomyia* Girault, 1916. Due to the confusion and disruption the proper placement of these genera would cause, the authors are requesting in a separate appeal to the ICZN that the generic names *Trichaporus* Foerster, 1856 and *Trichaporus* Ashmead, 1900 be permanently suppressed and placed on the Official List of Rejected and Invalid Generic Names in Zoology.

For some time there has been confusion regarding the proper placement of species in the genera *Prospaltella*, *Encarsia*, and *Trichaporus* as well as whether one genus or another is synonymous with one or both of the others. Various viewpoints have been put forward and the matter reviewed by numerous authors including Nowicki (1929), Mercet (1930a, 1930b), Dozier (1933: 91-92), DeSantis (1948), Flanders (1953), Boucek (1963: 273), Nikol'skaya and Trjapitzin (1965), Ferriere (1965), Nikol'skaya and Jasnosh (1966), and Viggiani and Mazzone (1979). However, there still remains a need for clarification.

This need became evident over the past several years during studies of aphelinid parasites of whitefly and diaspidid scale insects. On various oc-

casions we studied museum material and found that obviously congeneric very closely related species, sometimes even conspecific material, had been referred to different genera. This led to a study of all the original specific and/or generic descriptions, the type-species of the genera involved, additional species assigned to these genera, to certain related genera, and pertinent literature.

STATUS OF *PROSPALTELLA*
Prospaltella Ashmead, 1904

Type-species.—*Coccophagus aurantii* Howard, 1894, type by designation under the plenary powers.

This genus was made a junior synonym of *Encarsia* Foerster, 1878 (Vigiani and Mazzone, 1979).

Howard (1894: 6) described *Prospalta* in the Aphelininae. The name *Prospalta* was preoccupied by Walker (1857: 1114) in the Lepidoptera. Ashmead (1904a) supplied the replacement name *Prospaltella* for *Prospalta* Howard.

Prospaltella has been repeatedly listed in catalogs as being monotypic (Peck, 1951: 437; Peck, 1963: 275; Gordh, 1979: 907), but it is not. Howard (1894) follows his original description of this genus with the description of the new species *Prospalta murtfeldtii*. Following this description he adds "To this genus may also be referred *Coccophagus aurantii* How. described in *Insect Life* (Vol. VI, p. 231)." Thus this genus is not monotypic as it has two species (*P. murtfeldtii* and *P. aurantii*) originally ascribed to it. Neither of these species was designated as the type-species by Howard.

Prospaltella murtfeldtii was named for a Miss Mary M. Murtfeldt, hence Peck (1951: 437), acting in accordance with the then current Rules of Zoological Nomenclature, changed the spelling of the name to *P. murtfeldtae*. This was a justified emendation and is the spelling in use today.

Since Howard (1894) designated no type-species in his original description, both *P. murtfeldtae* and *P. aurantii* were available for subsequent designation as type-species. Ashmead (1904b: 345, 386) lists *P. murtfeldti* (sic) as the type-species. This was the first designation of a type-species and set *P. murtfeldtae* as type by subsequent designation. Howard (1907), apparently overlooking this, listed *Prospalta aurantii* (Howard) as the type. However, Rust (1913) pointed out that Ashmead's (1904b) previous designation of *P. murtfeldtae* as the type must hold. Rust stated that this is unfortunate because *P. murtfeldtae* is rather less typical of the genus, as now known, than is *P. aurantii*. Thus, over the years, the generic concept of *Prospaltella* that became used in the literature was that of *P. aurantii* and not *P. murtfeldtae*. For this reason Nikol'skaya and Trjapitzin (1965) appealed to the International Commission of Zoological Nomenclature to use its plenary powers to set aside all previous designations of type-species for the genus *Prospaltella* and designate *Coccophagus aurantii* as the type-

species. In Opinion 845 (ICZN, 1968) the Commission approved this appeal and designated *Coccophagus aurantii* Howard, 1894 as type-species, by designation under the plenary powers, for the genus *Prospaltella* Ashmead. Unfortunately, this designation was overlooked in the recently published "Catalog of Hymenoptera in America North of Mexico" (Gordh, 1979) where *P. murtfeldtae* (as *P. murtfeldiae*) not *P. aurantii* was given as the type-species.

Nikol'skaya and Trjapitzin (1965) stated that *P. murtfeldtae* should belong to the genus *Coccophagoides* Girault, 1915. Our examination of *P. murtfeldtae* immediately revealed that it not only differed from *Coccophagoides* but also differed from *P. aurantii* and most other species now placed under *Prospaltella* in many characters that are sufficiently significant as to require placement of *P. murtfeldtae* in a different genus. Having compared type material and other specimens of *P. murtfeldtae* with a slide bearing parts of the holotype of *Coccophagoides abnormicornis* Girault, with several other *Coccophagoides* spp., with *Encarsia tricolor* Foerster, and with many other species of *Encarsia*, we are erecting a new genus to contain this species.

Primaprospaltella DeBach and LaSalle, NEW GENUS

Type-species.—*Prospalta murtfeldtae* Howard, 1894.

This genus is characterized as follows:

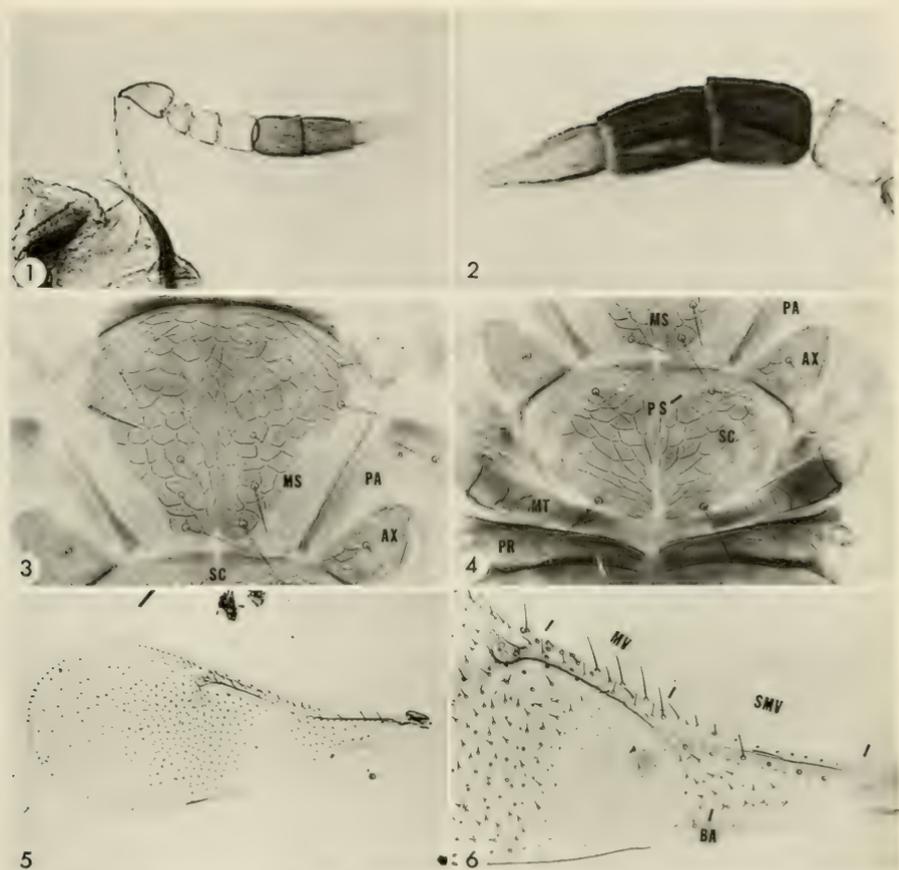
Female.—Mandible with one tooth and a broad truncation. Maxillary palpus 2-segmented, labial palpus 1-segmented.

Antenna (Fig. 1) 8-segmented (1133), the 3-segmented club noticeably differentiated from the funicle. Funicle segments 1 and 2 of about equal length, but funicle segment 2 wider. Funicle segments 1 and 2 wider than long, funicle 3 about as long as wide. First club segment the widest flagellar segment, the next segments narrower, the ultimate club segment narrow, lengthened, cone-shaped. This gives the club a strongly tapered appearance (Fig. 2).

Pronotum composed of 2 sclerites. Mesoscutum trapezoid, broader at broadest point than long, bearing 14–18 setae (Fig. 3). Scutellum broader than long, with 4 setae and 2 placoid sensilla (Fig. 4). Propodeum longer medially than the metanotum (up to twice as long) (Fig. 4). Parapsis with 3 setae, axilla with 1. All tarsi 5-segmented. Ovipositor exerted just past tip of abdomen.

Forewing (Figs. 5, 6) uniformly setose without speculum or other bare areas. Submarginal vein distinctly longer than marginal vein, with no break in vein before junction with marginal vein. Stigmal vein with 2–3 setae. Disc densely setose. Basal area of forewing (area beneath the bullae on the submarginal vein) with 15–30 setae.

Male.—Resembles female in general except for usual sexual differences.



Figs. 1-6. *Primaprospaltella murtfeldtae*, female. 1, Antenna. 2, Club. 3, Mesoscutum. 4, Scutellum, metanotum, propodeum. 5, Forewing. 6, Forewing, basal half. Abbreviations: AX = axilla; BA = basal area; MS = mesoscutum; MT = metanotum; MV = marginal vein; PA = parapsis; PR = propodeum; PS = placoid sensilla; SC = scutellum; SMV = submarginal vein.

Antennae (Fig. 7) 8-segmented (1133). Club not as noticeably differentiated as in female. Apical segment tapered, 1st club segment not distinctly wider than rest of flagellum.

Included species:

Primaprospaltella murtfeldtae (Howard), NEW COMBINATION, (type-species). *Prospalta murtfeldtii* Howard, 1894, U.S. Dep. Agric., Insect Life 7(1): 6-7.

Primaprospaltella maculata (Howard), NEW COMBINATION. *Prospalta maculata* Howard, 1907, U.S. Dep. Agric., Bur. Ent., Tech. Ser. 12(4): 79-80.

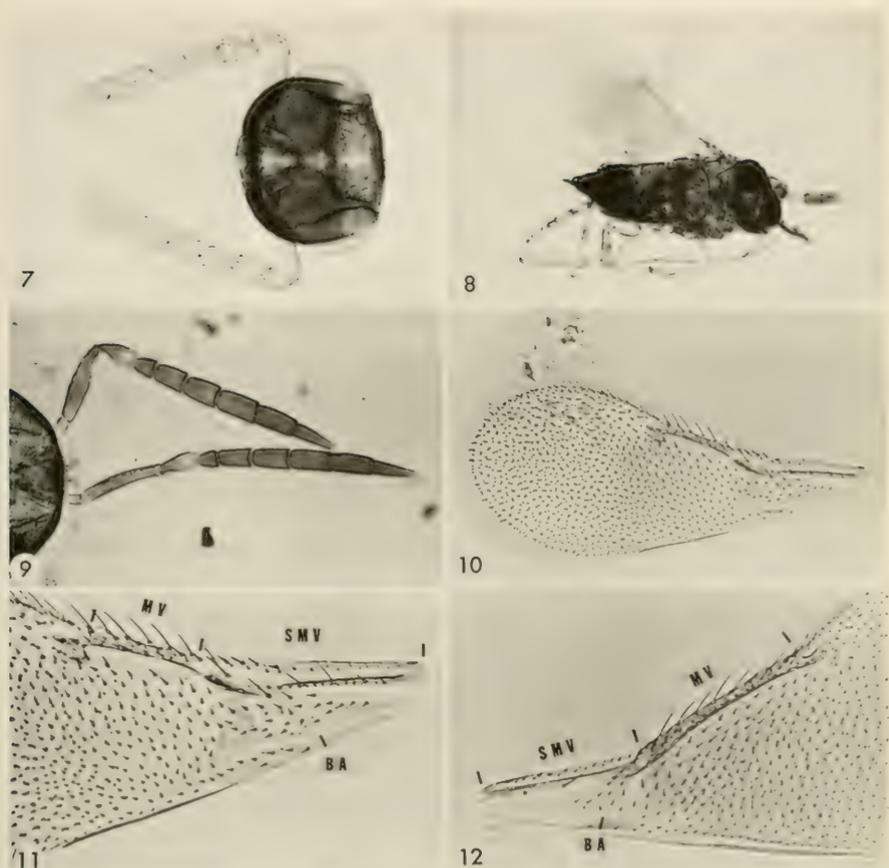
Discussion.—*Primaprospaltella* belongs to the Prospaltellinae (sensu Nikol'skaya and Jasnosh, 1966; Jasnosh, 1976). As previously stated, *Primaprospaltella murtfeldtae* has been thought by authors to belong to the genus *Coccophagoides* Girault as well as to what is now considered *Encarsia*. The first two genera are more similar, and are distinguished from all other genera in this subfamily by having two-segmented maxillary palpi (instead of one-segmented), having the submarginal vein distinctly longer than the marginal vein (as opposed to of about equal lengths or the marginal vein longer), and in having a relatively more setose basal area, i.e., that area beneath the bullae on the submarginal vein (see Figs. 6, 11, 12). In *Coccophagoides* there are 8–20+ setae (Figs. 10, 11), in *Primaprospaltella* there are 14–30+ setae (Figs. 5, 6), in *Encarsia* there are 0–12 setae, usually less than 6 (Figs. 12, 13, 15, 17).

Primaprospaltella can be separated from *Coccophagoides* by several characters. Doutt (1966) gives an historical review of the genus *Coccophagoides* and mentions for the first time the presence of a hypogynium in this genus. The hypogynium is a modification of the apical sternite of the abdomen into a plow-shaped structure. This same type of structure is seen in *Aphelinus* Dalman, but *Coccophagoides* is the only genus in the Prospaltellinae where it is found.

Also, all *Coccophagoides* we have examined have six setae on the scutellum while *Primaprospaltella* has four. We find that the number of scutellar setae is quite constant throughout genera in this subfamily, and thus is a good generic character. In fact, *Coccophagoides* is the only genus placed in the Prospaltellinae with six instead of four setae on the scutellum.

There are some subjective characters that can be used to distinguish these genera. The antennae have been thought by authors to be similar in these groups, but we consider them to be quite dissimilar (see Figs. 1, 2, 9). In *Coccophagoides* (antenna, Fig. 9) the antenna is rather long and narrow. The first funicle segment is distinctly shorter (usually less than half the length) than the second funicle segment. The second and third funicle segments are both distinctly longer than wide, and the third funicle segment and the first club segment are of approximately the same width. In *Primaprospaltella* (Figs. 1, 2) the antenna is short and stout. The three funicle segments are all subquadrate, the first segment being narrower but usually little if any shorter than the second. The second and third segments are at most only slightly longer than wide, and the first club segment is clearly the widest flagellar segment, being noticeably wider than the third funicle segment.

In *Coccophagoides* there is sometimes a break or narrowing in the submarginal vein just before it joins the marginal vein that is not present in *Primaprospaltella*.



Figs. 7-8. *Primaprospaltella murtfeldtae*. 7. Head and antennae, male. 8. Lectotype female. Figs. 9-11. *Coccophagoides comperci*, female. 9. Antennae. 10. Forewing. 11. Forewing, basal half. Fig. 12. *Encarsia tricolor*, female forewing, basal half. Abbreviations: BA = basal area; MV = marginal vein; SMV = submarginal vein.

Primaprospaltella can be distinguished from *Encarsia* by the distinctly dissimilar antennae, by having more than 14 setae in the basal area of the wing, having 2 segmented maxillary palpi and 1 segmented labial palpi (palpal formula 2-1), and in having the submarginal vein distinctly longer than the marginal vein.

Characters used to separate these three genera are given in Table 1.

Both species included in *Primaprospaltella* have distinct maculations. The legs are banded and there are light and dark patterns on the thorax. We are not certain whether this will prove to be a valid generic character.

We now include only *Primaprospaltella murtfeldtae* and *P. maculata* in

Table 1. Characters used to differentiate *Coccophagoides*, *Primaprospaltella*, and *Encarsia*

<i>Coccophagoides</i>	<i>Primaprospaltella</i>	<i>Encarsia</i>
Palpal formula 2-1	Palpal formula 2-1	Palpal formula 1-1
Marginal vein distinctly shorter than submarginal	Marginal vein distinctly shorter than submarginal	Marginal vein of about equal length or longer than submarginal
8-20+, usually more than 10, setae in basal area of forewing	More than 14, usually 20-30, in basal area of forewing	0-12, usually less than 6, setae in basal area of forewing
Hypogynium present	Hypogynium absent	Hypogynium absent
6 setae on scutellum (and 2 placoid sensilla)	4 setae on scutellum (and 2 placoid sensilla)	4 setae on scutellum (and 2 placoid sensilla)

this genus. Both are primary parasites of Diaspididae. However, a complete study of all the species presently included in *Encarsia*, *Coccophagoides*, and related groups will probably reveal additional members of this genus. Dozier (1928: 37) refers to a small group of species that may fall in this genus. However, we have not examined these and we do not feel that we can place them accurately solely on their descriptions.

Howard (1894) described *Prospalta murtfeldtae* from "five balsam-mounted specimens reared by Miss Mary E. Murtfeldt, at Kirkwood, Mo., from *Aspidiotus uvae*." We have examined these cotypes and designate one the LECTOTYPE. This is the top right specimen on the slide, which we have clearly marked. A photograph of the lectotype is given in Fig. 8. This slide is deposited in the U.S. National Museum, type number 2708.

ENCARSIA CHARACTERIZATION

Viggiani and Mazzone (1979), considering *P. aurantii* not generically distinct from *Encarsia* Foerster, 1878, synonymized *Prospaltella* with *Encarsia*. We agree with this synonymy and consider that almost all of the species currently placed in *Prospaltella* belong in *Encarsia*. The only current exceptions are *Prospaltella murtfeldtae* (Howard) and *P. maculata* (Howard) which we have placed in the new genus *Primaprospaltella*. *Encarsia* thus contains numerous parasites of both Aleurodidae and Diaspididae.

The major characteristics of *Encarsia* remain those of the type, *Encarsia tricolor* Foerster, 1878, although there is considerable variation among the many species now included in *Encarsia*, so that at some future time it may be desirable to erect new genera (see DeBach and Rose, 1981). Our concept of *Encarsia* follows.

Encarsia Foerster, 1878

Type-species.—*Encarsia tricolor* Foerster, 1878, type by original designation.

Encarsia is placed in the subfamily Prospaltellinae (Nikol'skaya and Jasnosh, 1966; Jasnosh, 1976).

The genus *Encarsia* was described by Foerster in 1878. With the generic description he described one species, *E. tricolor*, which he designated as the type-species. He stated that he described this species from a single male specimen. Nowicki (1929: 159) stated that he examined this specimen which was kept in the Berlin Museum and that is a female not a male.

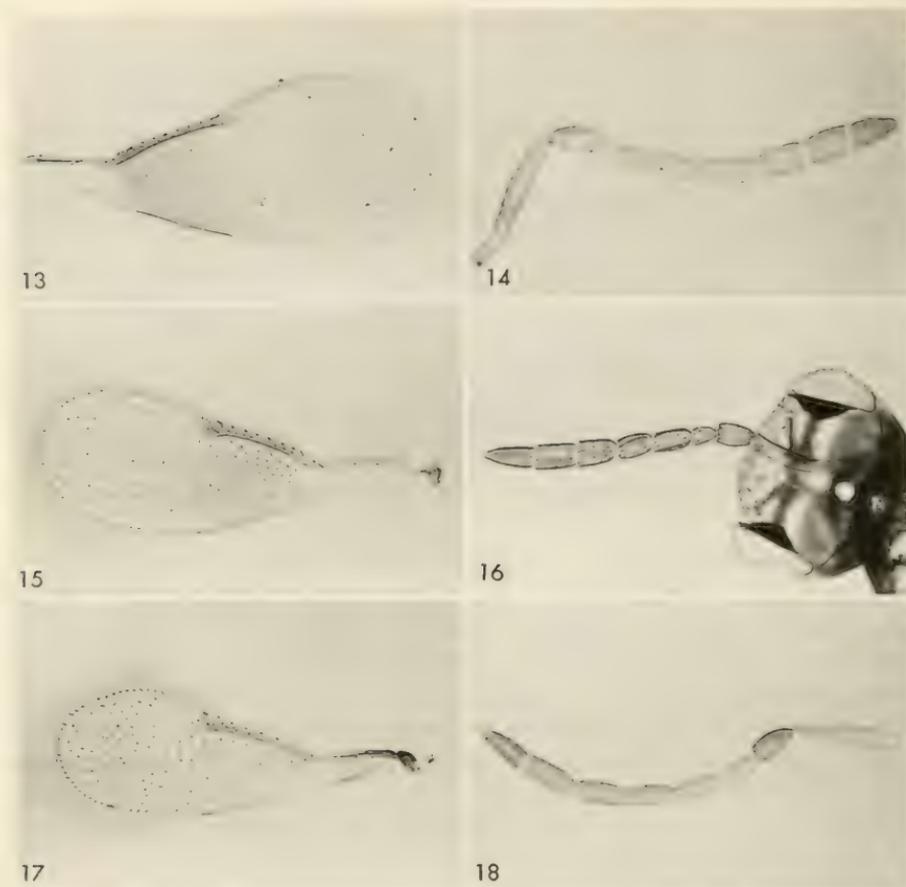
We have not examined this type-specimen, but we have examined another female from Foerster's collection in Naturhistorisches Museum in Vienna. Nowicki mentioned this same specimen (1929: 160) and stated that it agreed fully with the type, "stimmt vollkommen mit der Type überein."

Our concept of the principal characteristics of *Encarsia*, sensu lato, are as follows:

Female.—Antenna (Figs. 14, 16, 18) 8-segmented (1133 or 1142), with club sometimes scarcely differentiated from funicle, making it difficult in these cases to ascertain whether the club is 2 or 3 segmented. First funicle segment can range in size from subquadrate and about $\frac{1}{2}$ length of 2nd funicle segment up to equal in length to 2nd funicle segment. Funicle segment 2 through to the last flagellar segment longer than wide. Scape cylindrical, not or only slightly produced or flattened. Maxillary palpus 1-segmented, labial palpus 1-segmented.

Pronotum consisting of 2 distinct sclerites. Mesoscutum bearing from very few setae to many (4, perhaps fewer, to as many as 16; 8–10 in *E. tricolor*). Scutellum broader than long and bearing 2 placoid sensilla and 4 setae. Parapsis with 1–3 setae, axillae with 1–3 setae. Tarsal formula 5-5-5 or 5-4-5.

Forewing (Figs. 12, 13, 15, 17) with marginal vein about equal to or longer than submarginal vein. Postmarginal vein extremely short or absent, stigmal vein short, the latter bearing one or more setae. Forewing quite variable in shape and setation. Setation on disc sparse to moderate. No speculum present. Less than 12 (usually less than 6) setae in basal area of wing (that area beneath bullae on submarginal vein). *Encarsia tricolor* is one of the more setose species having moderately dense setation on the wing disc and 8–12 setae in the basal area (Figs. 12, 13). Wing shape varies from fairly broad (in *E. tricolor* the length is only about $2.25\times$ the width) with a fairly short marginal fringe (about $\frac{1}{4}$ the width of the disc), to rather narrow (up to nearly $3\times$ as long as wide) with a fringe nearly or slightly exceeding $\frac{1}{2}$ width of disc (Fig. 17). Posterior margin of the wing generally smoothly rounded. In some forms a small rounded asetose area is found on the disc adjacent to the stigmal vein.



Figs. 13-14. *Encarsia tricolor*. Figs. 15-16. *E. perniciosi*. Figs. 17-18. *E. formosa*. 13, 15, 17, Forewing of female. 14, 16, 18, Female antenna.

Abdomen structure normal. Ovipositor not or only slightly exerted. Seventh sternum not extending past about $\frac{3}{4}$ length of abdomen.

Discussion.—As mentioned previously, Viggiani and Mazzone (1979) synonymized *Prospaltella* with *Encarsia*. They also synonymized *Trichaporus* and *Aspidiotiphagus* with *Encarsia*. We have reviewed the status of *Prospaltella* and *Trichaporus* in this paper, and in a companion paper, DeBach and Rose (1981), discuss *Aspidiotiphagus*.

The synonymization of *Prospaltella* with *Encarsia* makes a very large genus with considerable variation between species. Viggiani and Mazzone do not characterize the genus *Encarsia*, per se, but they indicate the extent of variation they consider to exist by defining 14 species-groups. While we do not agree with them in certain cases regarding the species placed in a

particular group, or even with the validity of certain groups, we consider this work to constitute a strong contribution in the right direction.

The genus *Encarsia* includes parasites mainly of Aleurodidae and Diaspididae, although the males of some species may be hyperparasitic, sometimes even on the females of their own species (adelphoparasitism), and in a few cases males are known to develop in the eggs of Lepidoptera (Flanders, 1959; Nikol'skaya and Jasnosh, 1966). Many species are thelytokous.

STATUS OF *TRICHAPORUS*

Whether or not to assign a particular species to *Encarsia* or *Trichaporus* and whether one is a synonym of the other has been a continuing source of taxonomic confusion. Various authors treat them as distinct genera (Peck et al., 1964; Trjapitzin and Jasnosh, 1978) whereas others have considered one to be a synonym of the other; for example, Dozier (1933) synonymized species of *Encarsia* under *Trichaporus* and Viggiani and Mazzone (1979) synonymized *Trichaporus* under *Encarsia*. Our analysis and conclusions follow.

Trichaporus Foerster, 1856

Type species.—*Euderus columbianus* Ashmead, 1888.

Throughout the following discussion the genus spellings *Trichaporus* and *Trichoporus* are variously used depending upon the usage by the authors being discussed.

Foerster (1856: 84) described the genus *Trichaporus* in the Tetrastichoidea, but included no species. The genus was subsequently mentioned (Taschenberg, 1866: 109; Kirchner, 1867: 186; Dalla Torre, 1898: 27, 159), but still without included species. Ashmead (1900: 561) in "Insects of New Jersey" listed the genus *Trichoporus* Forst. Under it he placed "*T. columbianus* Ashm. Lives in Cecidomyid galls, widely distributed (Ashm.)."

Even though he does not specifically state it in this article, this species is undoubtedly *Euderus columbianus* Ashmead, 1888. Ashmead only described two nearctic eulophids with the specific name *columbianus*. Of these two, only *Euderus columbianus* is associated with cecidomyiids, which it parasitizes. Ashmead (1904b: 374) further links *Euderus* and *Trichaporus* when he lists "*Euderus* Thomson nec Haliday (= *Trichoporus* Forster)."

In a later edition of "Insects of New Jersey," Crawford (1910: 641) listed *Trichoporus* under the genus *Euderus* stating, "*E. columbianus* Ashm. (*Trichoporus*) lives in Cecidomyiid galls and is widely distributed (Ashm.)." Crawford worked at the U.S. National Museum after Ashmead and presumably had access to his material. Girault (1912) published a note in two parts on *Trichaporus*. Although he states that he cannot connect them directly, he also assumes that Ashmead's *T. columbianus* is *Euderus columbianus*.

It seems certain, then, that the first nominal species placed in the genus *Trichaporus* was *Euderus columbianus* Ashmead.

Ashmead (1904b) placed four more species in *Trichaporus*. Girault (1912) designated one of these four, *T. melleus* Ashmead, 1904, as the type-species. He mentions *T. columbianus*, but he felt that *T. columbianus* couldn't be the type-species because it possessed characteristics different than those used in Ashmead's (1904b) characterization of the genus.

Kurdjumov (1913: 2) mentions *Trichaporus* in a paper published in Russian on the Tetrastichini. This paper was translated into French by Nowicki (1927)¹. Kurdjumov went to Foerster's collection in Vienna to study his material. There were six species labeled as belonging to the genus *Trichaporus*. Two were eulophids, and four were aphelinids. Of these six only one, *Euderus arithmeticus*, was ever described by Foerster (although see previous footnote). The remainder were represented only by Foerster's manuscript names. Kurdjumov chose the first species placed in the collection under *Trichaporus* to be the type-species. This was one of the eulophids, *T. solutus* (manuscript name). He considered this species as belonging to the genus *Astichus* and accordingly synonymized *Trichaporus* with *Astichus*.

Gahan and Fagan (1923: 147) considered *T. melleus* from Girault's (1912) designation, not *T. solutus*, to be the type-species. They point out that "inasmuch as the Ashmead species were the first to be included in the genus, one of these must be made the type." They overlook the fact that *E. columbianus* was the first included species as it had been placed in the genus four years earlier than *T. melleus*.

Nowicki (1929) considered that Ashmead (1904b) misunderstood Foerster's original concept of the genus. He stated that Ashmead's species differed from Foerster's original description by two very important characters. Foerster described *Trichaporus* as having 8-segmented antennae and a scutellum without scutellar grooves. All of Ashmead's (1904b) species have 9 or 10-segmented antennae and grooves on the scutellum. Ashmead was aware of these characters for he used them in his key. Nowicki thus felt that none of these species was suitable for the type-species. However, Nowicki (1929) does not mention *T. columbianus* of Ashmead (1900).

Nowicki also did not accept *T. solutus* as type. He felt that Foerster's generic diagnosis didn't correspond to either of the eulophids in his (Foerster's) collection. Nowicki thus reasoned that these eulophids must have

¹ There seems to be a slight discrepancy between Kurdjumov's original Russian paper and Nowicki's French translation concerning what name Foerster actually applied to one of the species in his collection. Kurdjumov reads "a ♂ *T. arithmeticus* Forst., which is a synonym of *Euderus arithmeticus*" Nowicki's translation reads "a ♂ *Euderus arithmeticus*

been placed accidentally in with *Trichaporus* through a mistake during rearrangement of the collection. Nowicki recognized the four aphelinids placed under *Trichaporus* as belonging to four different genera. He chose one of these, *T. aleyrodis* (manuscript name), as the type-species and placed the genus in the Aphelinidae. Since this was not a nominal species, it was not available as a type-species. He suggested that the Ashmead (1904b) species that had been placed in *Trichaporus* not *Trichaporus* could remain in the separate genus *Trichoporus* Ashmead, 1904, with *T. melleus* as the type-species and be placed in the Tetrastichini.

Mercet (1930a) treated *Trichaporus* and gave "Genotipo: *Trichaporus aleyrodis* Forster, in litt." after Nowicki. He felt, however, that this designation was "muy discutible." He pointed out that while Nowicki thought that neither *T. melleus* nor *T. solutus* was suitable as the type-species, *T. aleyrodis* didn't fit Foerster's original description either because *T. aleyrodis* is pentamerous. Foerster described *Trichaporus* as being tetramerous.

Mercet felt that the whole matter had become such a puzzle that the problem should be referred to the Commission of Nomenclature of the Zoological Congress for them to assign a definitive type-species for *Trichaporus*. In this same paper Mercet described *Trichaporus aleyrodis* (as *Trychaporus aleyrodis*). This misspelling is obviously a lapsus as he spells *Trichaporus* correctly throughout the rest of his paper. This species thus became *Trichaporus aleyrodis* Mercet, 1930.

Dozier (1933) synonymized *Encarsia* with *Trichaporus*, accepting *T. aleyrodis* as the type-species. He states that Nowicki "has shown that *Trichaporus* Forst. is distinct from *Trichoporus* Ashm." and agrees that *Trichoporus* Ashm. should be a separate genus with *T. solutus* as the type-species.

Boucek (1963: 273) also stated that *Trichoporus* Ashmead has nothing to do with *Trichaporus* Foerster. He felt that Nowicki fixed *T. aleyrodis* as the type-species of *Trichaporus* which belongs in the Aphelinidae, and that *Trichoporus* Ashmead belongs in the Tetrastichinae.

Viggiani and Mazzone (1979) list "*Trichaporus* (Foerster), Novicky, 1929" as a synonym of *Encarsia*. They give the type-species as "*Trichaporus aleyrodis* (Foerster), Novicky."

The only thing that appears clear up to this point is that there has been deep and continuing confusion about this problem. Ashmead continually used the spelling *Trichoporus* even though he clearly attributed this genus to Foerster. It is obvious that he was referring to the same taxon and the difference in spelling is an emendation. It seems logical to assume that he was just correcting Foerster's use of an "a" as the connecting vowel. The proper spelling of the word formed from these two Greek roots is *Trichoporus* (personal communication by Dr. A. Bandy, Professor of Classics, Literatures and Languages, University of California, Riverside).

It was not uncommon for early workers to correct such mistakes as a matter of routine upon discovering them. Even though grammatically correct, this change constitutes an unjustified emendation and this name becomes *Trichoporus* Ashmead, 1900, not 1904 as previous authors have stated. As an emendation it automatically becomes an objective junior synonym of *Trichoporus* Foerster, 1856.

The fact that these two genera are objective synonyms clarifies matters. As objective synonyms they must represent the same taxon and share the same type-species; thus one of them cannot be placed in the Aphelinidae while the other is placed in the Tetrastichinae.

Once it is understood that *Trichoporus* Ashmead is an objective junior synonym of *Trichoporus* Foerster, it is easy to determine the correct type-species. The International Code of Zoological Nomenclature (1961) states in Article 69: "If no nominal species were included at the time the genus was established, the nominal species-group taxa that were first subsequently and expressly referred to it are to be treated as the only originally included species." And further: "If only one nominal species was first subsequently referred to a genus, it is ipso facto the type-species, by subsequent monotypy."

The code thus makes it quite clear that the type-species of *Trichoporus* Foerster is *Euderus columbianus*, type by subsequent monotypy. The code does not consider how well the first subsequently referred nominal species fit the original generic concept. The fact that they are the first, whether placed accurately or not, make them the only species available to be designated as the type-species. Actually, and apparently quite coincidentally, *T. columbianus*, of all the species ever placed in the genus, seems to best fit Foerster's (1856) original genus description as it has four-segmented tarsi, eight-segmented antennae, and a scutellum without grooves.

Euderus columbianus is now considered a synonym of *Galeopsomyia haemon* (Walker) (Burks, 1975: 144). *Euderus columbianus* was chosen by Girault (1916) as the type-species of his new genus *Galeopsomyia*. *Galeopsomyia* is thus an objective junior synonym of *Trichoporus*.

The genus *Trichoporus*, since Ashmead's placement of *E. columbianus* in it, has never been used in its proper sense. It has since been assigned three different type-species by three different authors (*T. melleus*, *T. solutus*, *T. aleyrodus*). All of these type-species assignments were incorrect and two of three were not available for consideration as type-species when assigned.

Proper placement of this genus now would disrupt taxonomy within the Eulophidae by creating a senior objective synonym to *Galeopsomyia*, a genus name which has been in use for 65 years.

To request a change of type-species to any of the previously used type-species would also be disruptive. In the case of making *T. melleus* Ashmead

the type-species, *Trichaporus* would become a senior synonym of *Exurus* Philippi, 1873. *Trichaporus solutus* is a nomen nudum and not available for designation as type-species. If *T. aleyrodis* Mercet were designated as the type-species, the genus *Trichaporus* would become a senior synonym of *Encarsia* Foerster, 1878. Any of these changes would cause confusion and promote instability within these groups.

For these reasons we are requesting in a separate paper to the International Commission of Zoological Nomenclature that the names *Trichaporus* Foerster, 1856 and *Trichaporus* Ashmead, 1900, which have never been properly placed or used in connection with correct type-species, and because their use has caused long-lasting confusion to workers in the field, be placed on the list of permanently rejected names. The aphelinid species currently residing in *Trichaporus* should be placed in the genus *Encarsia* (as per Viggiani and Mazzone, 1979).

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A NEW GENUS AND SPECIES OF APHELINIDAE
WITH SOME SYNONYMIES, A REDIAGNOSIS OF
ASPIDIOTIPHAGUS AND A KEY TO PENTAMEROUS
AND HETEROMEROUS PROSPALTELLINAE
(HYMENOPTERA: CHALCIDOIDEA: APHELINIDAE)

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Abstract.—*Aleurodiphilus americanus*, n. gen., n. sp., is described. The systematic position of *Aleurodiphilus* in the subfamily Prospaltellinae is discussed and a key given for separation of the genera *Aleurodiphilus*, *Aspidiotiphagus* Howard, 1894, *Coccophagoides* Girault, 1915, *Encarsia* Foerster, 1878, and *Primaprospaltella* DeBach and LaSalle, 1981. Two additional species, *basicinctus* (Gahan) and *pergandiellus* (Howard), are placed under *Aleurodiphilus*. All *Aleurodiphilus* species are primary parasites of whiteflies (except for hyperparasitic males). Known distribution of the genus includes North, Central, and South America and the Caribbean.

The taxonomic standing and relationship of *Aspidiotiphagus* to *Aleurodiphilus* and *Encarsia* is discussed. Recognition characters for *Aspidiotiphagus* are given. All *Aspidiotiphagus* species are primary parasites of diaspidid scales. Known distribution of *Aspidiotiphagus* is worldwide.

A companion paper by DeBach and LaSalle (1981) helps clarify the *Encarsia-Prospaltella-Trichaporus* problem but does not resolve it entirely in our minds because for several years it has been our opinion that there is still another closely related but distinct and generally unrecognized natural group of species of whitefly parasites that have variously been placed under *Encarsia*, *Prospaltella*, or *Trichaporus*. Hayat (1976) recognized that such a group exists, and he included several *Encarsia* species in it but without giving it any formal designation. Viggiani and Mazzone (1979) suggested a *pergandiella* group of *Encarsia* for such forms but included only *E. pergandiella* Howard.

The existence of the natural group described here became evident to us over the past several years during our study of thousands of specimens of so-called *Encarsia* spp. or *Prospaltella* spp., plus a few *Trichaporus* spp.,

reared from the woolly whitefly, *Aleurothrixus floccosus* (Maskell) (Homoptera: Aleyrodidae), collected throughout the Americas, as well as from other whitefly species from various countries and from species descriptions in the literature. We consider that this rather uniform, generally easily distinguishable group of whitefly parasites deserves generic status as much as, or more so than, some closely related well-established genera.

Accordingly, we propose the new genus *Aleurodiphilus* for these rather distinctive species of parasites that, as far as is known, are limited to whiteflies as hosts. This genus appears to resemble *Aspidiotiphagus* most closely but is also very closely related to *Encarsia* as defined by DeBach and LaSalle (1981) and to *Prospaltella* of authors as generally understood before Viggiani and Mazzone (1979) and DeBach and LaSalle (1981). We continue to recognize *Aspidiotiphagus* as valid and do not accept the synonymy of that genus under *Encarsia* as proposed by Viggiani and Mazzone (1979). Reasons for this and recognition characters for *Aspidiotiphagus* are given later.

We recognize that we are dealing with groups that are very closely related and that species exist that currently are difficult to assign. As Hayat (1976) states "It is interesting to note that in the shape, discal setation and longish marginal fringe the aforementioned species [i.e. *Encarsia acaudaleyrodis* Hayat, *E. pergandiella* Howard, *E. parvella* Silvestri, *E. nipponica* Silvestri, and probably also *P. citrofila* Silvestri: authors' addition] resemble some of the species presently in *Aspidiotiphagus* How. (*A. latipennis* Comp.) and also *Prospaltella* Ashm. (*P. nupta* Silv., *P. inserens* Silv., *P. explorata* Silv. and *P. diaspidicola* Silv.), but they differ in the conformation of antennal segments." We agree with Hayat (1976) that *Aspidiotiphagus* and certain *Encarsia* are similar but that they also have significant differences. Additionally, we think it useful to establish the new genus *Aleurodiphilus* in spite of the apparent similarity between certain species of *Aleurodiphilus*, *Aspidiotiphagus*, and *Encarsia*. We, of course, are using *Encarsia* herein as proposed by DeBach and LaSalle (1981) which therefore includes most *Prospaltella* of authors.

Aleurodiphilus DeBach and Rose, NEW GENUS

Based upon study of a number of species and hundreds of specimens, females of this genus generally can be readily recognized as follows: Rather narrow forewing (usually more than $3\times$ as long as wide) usually smoothly and gently curved along posterior margin, presence of a round or oval aseptose clear area below stigmal vein extending about to mid-disc (similar to *Aspidiotiphagus*), longest posterior marginal fringe of forewing $\frac{1}{2}$ to $\frac{3}{4}$ width of disc, longest anterior marginal fringe of forewing $\frac{1}{3}$ to nearly $\frac{1}{2}$ width of disc, setation of forewing sparse (usually less than 100 setae in disc

distad of a line drawn between stigmal vein and distal end of frenal fold and less than 50 setae basad of this line), 1 seta in hyaline area of wing base and a noticeably distinct row of setae beneath alary fringe that is paired, with rare exceptions, from origin between stigma and margin to apex and past for from $\frac{1}{3}$ distance to completely to distal end of frenal fold. This row of setae set off from discal setae by a linear area free of setae extending around disc. No setae on the dorsal stigmal vein. Hindwing semi-pedunculate. Female antenna 8-segmented, elongate (longer than abdomen), nearly as long as thorax and abdomen combined, from very little to moderate differentiation between funicle and club segments, the 2 club segments broadly joined and usually less than $\frac{2}{3}$ as long as preceding 4 funicle segments combined. All tarsi 5-segmented. Mesoscutum usually with 4–6 setae but with as many as 12 depending on species; reticulate sculpture. Parapsis with 2 setae, axilla with 1. Scutellum with 4 setae and 2 placoid sensilla. Ovipositor short (subequal to hindtibia). Color yellowish to completely fuscous with different degrees and patterns of dusky melanization in integument depending upon species. Melanization pattern, if any, appears very constant for each species and is a good specific diagnostic character. Forewing hyaline except on dark species which have fuscous wing base. Length about 1 mm or less. Parasites of whiteflies.

Male generally dusky, otherwise similar to female except for usual sex differences in antenna and genitalia. Males frequently, perhaps obligatorily, hyperparasitic.

Type-species.—*Aleurodiphilus americanus*, n. sp.

Aleurodiphilus americanus DeBach and Rose, NEW SPECIES

Figs. 1–18

This widespread American biparental parasite of *Aleurothrixus floccosus* (Maskell) can be recognized by possession of the characters given for the genus: by the female's predominantly pale yellow color—having only some faint infuscation evident in some cleared specimens on the mesothoracic and metathoracic sternal areas (Fig. 1) and on the antenna, especially the ultimate segment (Fig. 2); by the pale setae on head, thorax, and abdomen which are essentially invisible at 120 \times under binocular microscope; by the common presence of males which are predominantly dusky except for partial areas of the head and mesoscutum and the entire scutellum; and by the following:

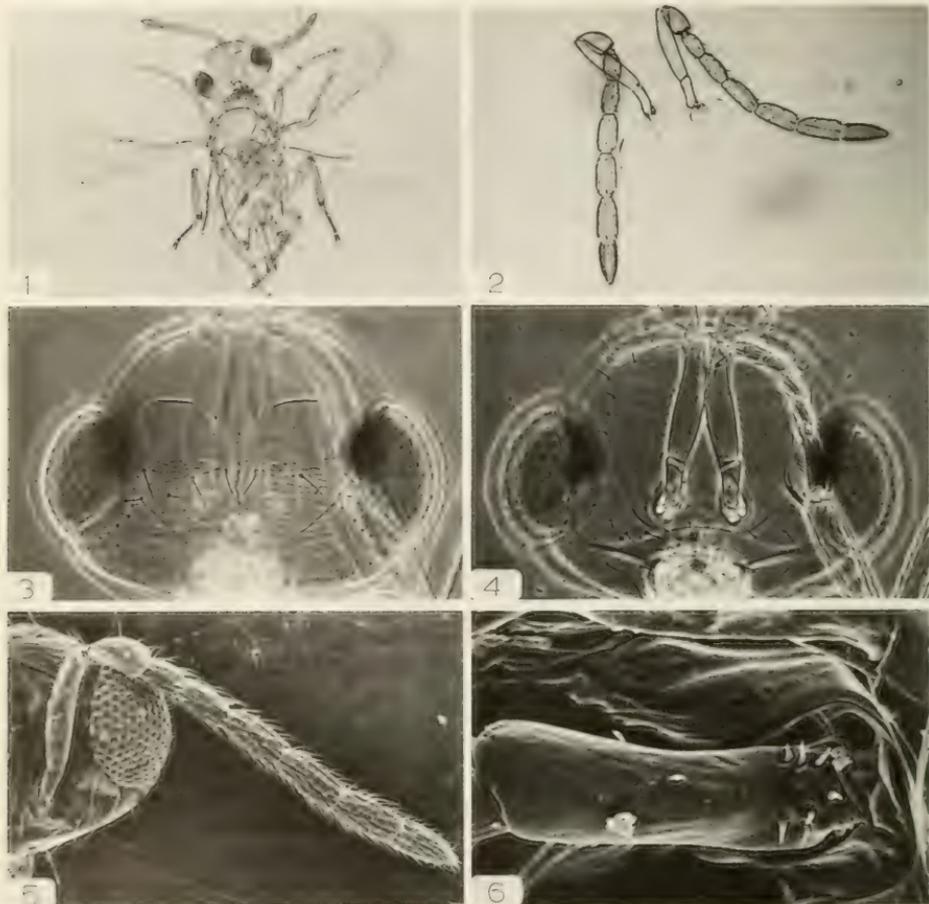
Female.—Head wider than thorax or abdomen, faintly setose (Fig. 1). Under 450 \times phase contrast magnification 20 large setae evident on fronto-vertex; occiput with 20–22 setae (10–11 pairs) ranging in a band between compound eyes and extending behind compound eyes (Fig. 3); face asetose centrally but with 4 setae between antennal bases and 3–4 setae laterally on

each side bordering compound eyes and adjacent to frontovertex (Fig. 4); about 10 setae scattered in a band extending between compound eyes just above mouthparts (Fig. 4); compound eyes very finely setose; triangular suture around ocelli inconspicuously evident; 5 large setae present within ocellar triangle. Mandible well developed, tridentate. Maxillary and labial palpi 1-segmented. Antenna with numerous coarse setae (Fig. 5).

Antenna relatively long and slender, about $0.7\times$ as long as thorax and abdomen together (Figs. 1, 2, 5). Relative proportions of antennal segments (i.e., radicle; scape; pedicel; funicle 1, 2, 3, 4; club 1, 2) as follows: length, 1.0:2.7:1.2:0.9:1.2:1.4:1.5:1.5:1.6; width, 1.0:1.5:1.8:1.5:1.6:1.8:1.9:1.9:1.8. The radicle bears 7 small round specialized sensilla on the basal portion, each with a minute seta (Fig. 6). Each funicle segment usually bears a pair of basiconic sensilla distad; each club segment bears one. Tip of club usually with 3 elongate, finger-like sensilla. Flagellar segments bear longitudinal sensilla (rhinarium) usually according to the formula: 0, 1, 2, 2, 2. The 2 club segments broadly joined; tip of club more or less pyriform (Fig. 7).

Mesoscutum with 4 setae. Scutellum with 4 setae and 2 placoid sensilla. Parapsis with 2 setae, axilla with 1 (Figs. 8, 9). Sculpture on head and thorax very faintly evident only under $450\times$ phase contrast magnification. Vertex without evident sculpture; face very faintly sculptured. Thoracic sculpture reticulate (Fig. 8). Endophragma short, extending to anterior portion of abdominal segment 4. Metanotum long and narrow, about $12.5\times$ as long as wide. Propodeum very narrowly constricted in center. Second abdominal tergum (the tergum immediately posteriad of the propodeum) appears 2-lobed with fine reticulate sculpture laterad (Figs. 8, 10).

Forewing (Fig. 11) narrow, hyaline, no infuscation, about $3\times$ as long as wide; large roundish glabrous area around stigma extending to about mid-disc; marginal vein about $1\frac{1}{3}\times$ as long as submarginal; stigmal vein short, bearing no setae on dorsal surface, closely appressed to margin; longest posterior marginal fringe hairs about $\frac{1}{2}$ width of disc; 2 setae near base of submarginal vein, 10–12 bullae on submarginal vein; usually 6 setae on anterior edge of marginal vein; a single seta in hyaline area of wing base below bullae (Fig. 12); about 5 minute nearly invisible setae occur along or on the submarginal vein in the basal $\frac{1}{2}$ of costal cell (Figs. 11, 12); approximately 100 setae in discal area distad of a line drawn between stigma and distal end of frenal fold and about 50 setae basad of that line; a distinct line of setae encircling wing beneath marginal fringe and rather clearly separate from discal setae proper by a clear streak, the line of setae extends from between stigma and margin around wing to just past proximal end of frenal fold, line of setae double from stigmal area to well past apex, single thereafter (Figs. 11, 13). Hindwing long and narrow, semi-pedunculate, about $8\times$



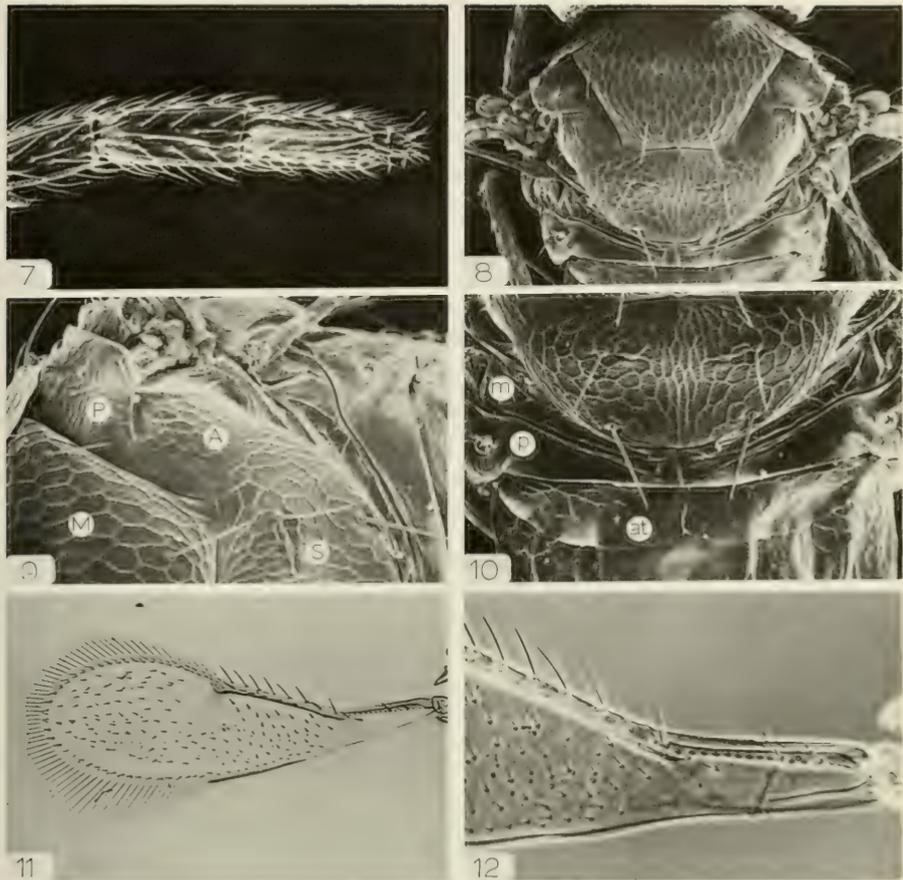
Figs. 1-6. *Aleurodiphilus americanus*, female. 1, Holotype. 2, Antennae. 3, Occiput. 4, Ventral aspect of head. 5, Antenna (SEM). 6, Radical (SEM).

as long as wide, longest fringe hairs about $1.8\times$ width of disc, setation sparse, usually about 35-50 setae on blade (not including fringe and vein setae) (Fig. 14).

Each tarsus 5-segmented, foretarsus noticeably longer than foretibia, mid- and hindtarsi noticeably shorter than corresponding tibiae; first tarsal segment not distinctly elongate on any leg (Figs. 15, 16, 17).

Abdomen dorsally with a pair of prominent setae (phase contrast, $450\times$) laterally on segments, 4, 5, and 6; a medial and lateral pair on segment 7, a central pair and a smaller pair, one located near each posterior abdominal spiracle on segment 8 and, on syntergum, 2 pairs near apex (Fig. 16).

Ovipositor short, subequal to middle tibia and only $1.2\times$ as long as the

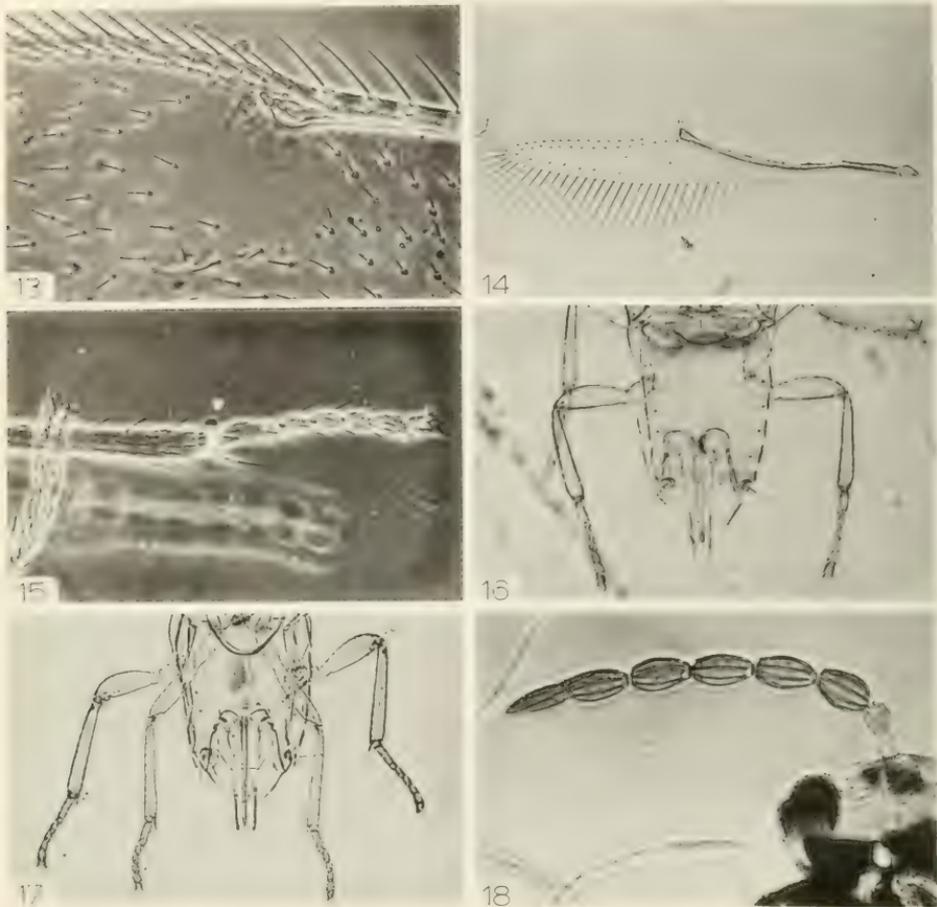


Figs. 7-12. *Aleurodiphilus americanus*, female. 7, Antenaral club (SEM). 8, Dorsal aspect of thorax (SEM). 9, Dorsal aspect of thorax (SEM). 10, Dorsal aspect of thorax and abdomen (SEM). 11, Forewing. 12, Forewing base. Abbreviations: A = axilla; at = second abdominal tergum; M = mesoscutum; m = metanotum; P = parapsis; p = propodeum; S = scutellum.

longest cercal seta; broadly separated from endophragma by 0.5 to 0.8 of its own length (Fig. 17).

Length 0.74-0.96 mm.

Male.—Resembles female in general morphology except for usual sexual differences. Color very different from female, integument markedly diffused with black. Posterior margin of head, small areas on the face, anterior 1/3 of mesoscutum, axillae, propodeum, and abdomen black. Flagellum and marginal vein noticeably dusky. Antenna 8-segmented, about as long as thorax and abdomen together, segments stouter than in female but much less con-



Figs. 13-18. *Aleurodiphilus americanus*. 13. Chaetotaxy and glabrous area of forewing, female. 14. Hindwing, female. 15. Middle tibia and tarsus, female. 16. Dorsal abdomen and hindlegs, female. 17. Ventral abdomen, ovipositor, mid- and hindlegs, female. 18. Antenna, male.

spicuously setose. Pedicel short, about $\frac{1}{2}$ length of any flagellar segment. All 6 flagellar segments bearing numerous longitudinal sensilla, flagellar segments 1-5 appear slightly swollen, ultimate segment noticeably narrower, tapering to a point (Fig. 18). Last 2 segments broadly joined but not fused as in males of *Encarsia tricolor* Foerster and *E. acaudaleyrodia* Hayat.

Length, 0.65-0.81 mm.

Specimens.—Described from the type-series (25 ♀ and 24 ♂ specimens on 6 slides, reared by P. DeBach and M. Rose, from *Aleurothrixus floccosus* (Mask.) on citrus, Santiago (Manzanillo) Colima, Mexico, Jan. 21, 1975.

Additional material from same host on same host plant: Acapulco, Guerrero, Mexico, January 27, 1975, 54♀:14♂ on 6 slides; Cuernavaca, Morelos, Mexico, January 29, 1975, 7♀:7♂ on 2 slides; Oaxaca, Oaxaca, Mexico, January 30-31, 1975, 13♀:8♂ on 2 slides; Veracruz, Veracruz, Mexico, February 3, 1975, 2♀ on 1 slide, near Ciudad Valles, S. L. Potosi, Mexico, 2♀:2♂ on 2 slides; Playa Azul, Guerrero, Mexico, January 25, 1975, 1♀ (the preceding all reared by P. DeBach and M. Rose); near La Paz, Baja California Sur, Mexico, May, 1967, 4♀ on 3 slides, P. DeBach; Culiacan, Sinaloa, Mexico, May 23-24, 1967, 6♀:1♂ on 2 slides, P. DeBach; Mazatlan, Sinaloa, Mexico, May 25, 1967, 3♀:14♂ on 2 slides, P. DeBach; same locality and collector, July 10, 1969, 1♂; Culiacan, Sinaloa, Mexico, July 23, 1970, 1♀:2♂, A. Sanchez Borja; Culiacan, Sinaloa, Mexico, September 23, 1970, 5♀, E. Rios; Rio de Janeiro, Brazil, March 22, 1970, 3♀, P. DeBach; Jacare Paqua, Brazil, May 9, 1971, 4♀ on 2 slides, T. Figueiredo; Queda Hereque, El Salvador, March 8, 1970, 5♀:3♂, J. Quezada.

Type-series in the collection of the Division of Biological Control, University of California, Riverside. Holotype female is at upper center on slide bearing 8 females, the rest are paratypes. The ♂ allotype is the upper center on slide bearing 12♂, the rest are paratypes.

One slide each bearing ♀♂ paratypes of *A. americanus* to be deposited in the U.S. National Museum of Natural History, Washington, D.C.; the British Museum (Natural History), London; the Zoological Institute, Soviet Academy of Science, Leningrad; The Mexican National Museum, Mexico City; and in the collection of the Hebrew University Faculty of Agriculture, Rehovot, Israel. All type-material is from Santiago (Manzanillo), Colima, Mexico.

Notes.—The sex ratio is 2.3♀:1.0♂ based on 300 specimens from Mexico. No pupal cast skin is evident in the whitefly mummy from which *A. americanus* has emerged. There are about four irregularly oval, pale brown meconia evident within the mummy around the sides. The slight amount of ventral pigmentation (see p. 662) evident on most females from Mexico is very uniform for a given area but is imperceptible, for example, in the Brazilian material. We do not consider this to be sufficient grounds for species separation but crossing tests would be helpful in this case. Sibling species may occur as commonly in this genus as in *Aphytis* (see DeBach, 1969). Males have been dissected in incidental checking as hyperparasites on *Amitus spiniferus* Hempel but no thorough studies have been made. *Aleurodiphilus americanus* was introduced from Mexico and colonized in southern California for biological control of woolly whitefly on several occasions between 1967 and 1971 but no recovery was made.

In addition to the new species of woolly whitefly parasite, *Aleurodiphilus americanus*, we find that a previously known species of woolly whitefly parasite, *Encarsia basicincta* Gahan, belongs to *Aleurodiphilus* hence is

designated *Aleurodiphilus basicinctus* (Gahan), NEW COMBINATION. Also, from an examination of the types of *Encarsia pergandiella* Howard, it is evident that this species belongs to *Aleurodiphilus* hence is designated *Aleurodiphilus pergandiellus* (Howard), NEW COMBINATION.

Also, we have in our collection at UCR at least eight new species from whitefly in California and Mexico that clearly fall into *Aleurodiphilus*. These await description. Specimens in our collection from Shikoku, Japan and New Delhi, India, as well as *Encarsia acaudaleyrodia* Hayat, may also prove to belong to *Aleurodiphilus* when sufficiently studied. Finally, it appears possible (although unlikely) from the descriptions that *Encarsia nipponica* Silvestri and *Encarsia parvella* Silvestri may belong under *Aleurodiphilus*.

Aleurodiphilus americanus appears to be very closely related to the previously mentioned parasite of *Aleurothrixus floccosus*, *A. basicinctus* (Gahan), and to *A. pergandiellus* (Howard) which parasitizes *Aleuroplatus* and *Trialeurodes* spp. It differs from *A. basicinctus* (Fig. 19) mainly in the absence of any appreciable melanization pattern in the integument, especially dorsally, and in being arrhenotokous (biparental) whereas *A. basicinctus* evidently is thelytokous (uniparental) based on Gahan's 8 female and no male cotypes from Puerto Rico and our reared collection of 103 *A. basicinctus* females to only 2 males from Florida.

Aleurodiphilus americanus differs from *A. pergandiellus* in having relatively shorter, more compact, female antennae. Those of *A. pergandiellus* (Fig. 20) are about equal to the combined length of the thorax and abdomen; those of *A. americanus* (Figs. 1, 2, 5) are about 0.7 times as long as the thorax and abdomen together. Also those of *A. pergandiellus* are finely setose whereas those of *A. americanus* are more coarsely setose (phase contrast microscope). There are rhinaria on all funicular segments except the first in *A. americanus* whereas there are no rhinaria on funicular segments 1 and 2 in *A. pergandiellus*. The first middle tarsal segment is long and slender in *A. pergandiellus* (Fig. 21), noticeably less so in *A. americanus* (Fig. 15). Comparisons with *A. americanus* were based on Gahan's (1927) description of 8 female cotypes of *A. basicinctus* and on Howard's (1907) description of *A. pergandiellus* and his types (USNM, labeled No. 9321) [the "seven female specimens"—Howard op. cit.—were actually 5 female *A. pergandiellus*, 1 *Eretmocerus* sp. and 1 adult whitefly—authors] as well as a slide bearing 4 females collected and determined as *E. pergandiella* by H. L. Dozier. This material was reared from *Trialeurodes* on perennial verbena, Wilmington, Delaware, November 26, 1927.

Aleurodiphilus is most readily distinguished from *Encarsia* (including *Prospaltella*; the latter as generally used by authors previous to Viggiani and Mazzone (1979) and DeBach and LaSalle (1981)) by the rather large asetose clear area beneath the stigma of the forewing as well as by other



Fig. 19. *Aleurodiphilus basicinctus*, female. Figs. 20, 21. *A. pergandiellus*. USNM type no. 9321, female. 20, Antenna. 21, Middle tibia and tarsus.

comparative characters that follow. We consider the large asetose area beneath the stigma of the forewing to constitute a major generic criterion. There is little or no variation in this character intraspecifically and it is common to species of *Aleurodiphilus* over a wide geographic range.

Certain Asian whitefly parasites in our collection from India, Pakistan, and Japan and the figures and descriptions given in Hayat (1976) and Silvestri (1927, 1930) have a similar asetose area in the forewing as well as 5 segmented tarsi and antennae generally as described for *Aleurodiphilus* but differ somewhat in chaetotaxy of the wing, mesoscutum and/or parapsis. There are also minor differences in the general habitus of the antennae and wings. Further study will be required to determine whether these Asian forms belong to *Aleurodiphilus*, *Encarsia*, or perhaps to a new genus.

Aspidiotiphagus also possesses a similar asetose area in the forewing and the *cubensis* group of *Encarsia* possesses a smaller one (DeBach and Rose, unpublished) but these three genera can be distinguished by other characteristics (see following key).

A similar comparative situation exists between other aphelinid genera. *Aphelinus* and *Aphytis*, for example, both have similar forewings characterized by an asetose area (the speculum) but are distinguished by other characters. It is of interest that originally nearly all *Aphytis* spp. were included under *Aphelinus* as *Aleurodiphilus* has been under *Encarsia*. Other

aphelinid genera rather easily recognized by their forewing setal pattern and/or asetose areas include *Ablerus*, *Azotus*, and *Eretmocerus* among others.

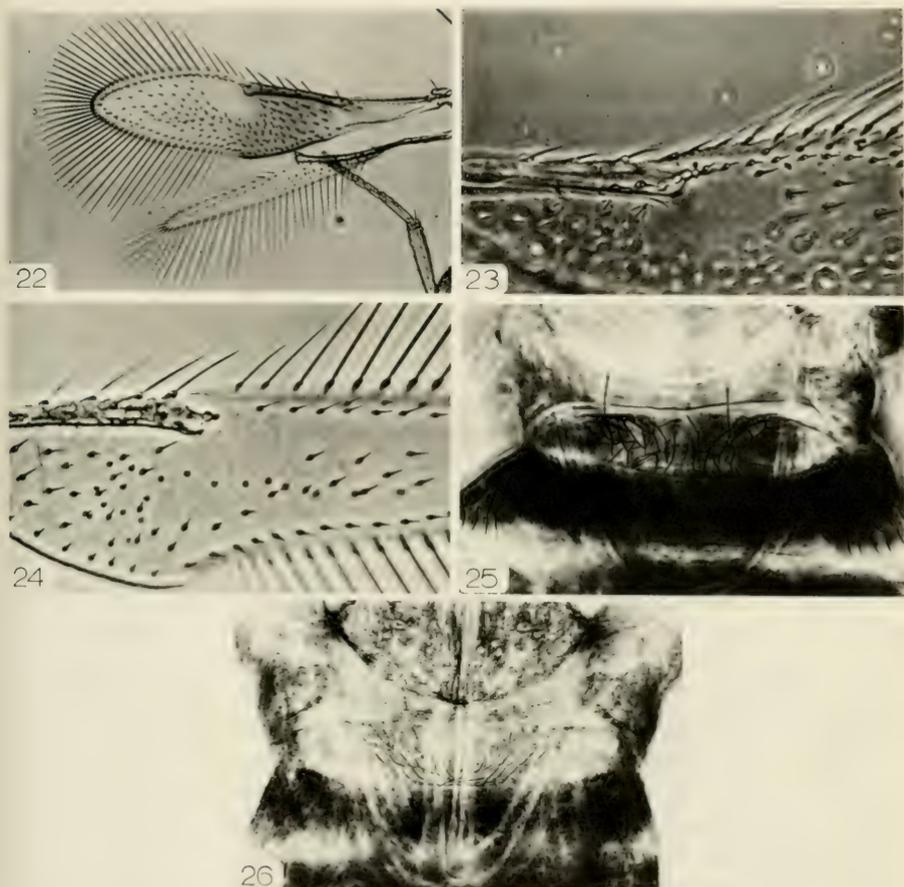
Aleurodiphilus is most easily confused with *Aspidiotiphagus*, in fact, as mentioned, there appear to be very similar forms. Species of *Aspidiotiphagus* generally have more narrow forewings than *Aleurodiphilus* spp. with the posterior margin inflexed (angled) forward at the junction of the disc with the frenal fold (Fig. 22). *Aspidiotiphagus* spp. have fewer setae in the disc (Fig. 22) with the double row of setae (see p. 662) on the inside anterior margin of the forewing originating 1-4 setae distad of the terminus of the stigmal vein (Fig. 23) or with a distinct gap between the terminus of the stigma and the origin of the double row of setae (Fig. 24). This double row of setae does not continuously extend beyond the apex in *Aspidiotiphagus* spp. whereas in all species of *Aleurodiphilus* we examined this double row of setae extends beyond the apex for from $\frac{1}{3}$ to the entire distance to the distal end of the frenal fold. The apex of the forewing is generally more oblately curved in *Aleurodiphilus* spp. than *Aspidiotiphagus* spp. (Figs. 11, 22).

In *Aspidiotiphagus* the greatest length of the posterior marginal setae of the forewing is generally as long as or longer than the width of the disc (Fig. 22) (occasionally only three-fourths as long) whereas in *Aleurodiphilus* it usually ranges only between one-half to three-fourths the width of the disc. The greatest length of the anterior fringe hairs of the forewing in *Aspidiotiphagus* ranges from one-half to more than the width of the disc, whereas in *Aleurodiphilus* it only ranges from one-third to one-half the width of the disc, essentially no overlap in this criterion.

Aspidiotiphagus generally has a 3-segmented club fairly well differentiated from the remainder of the flagellum whereas *Aleurodiphilus* has a largely undifferentiated flagellum, the 2-segmented club is mainly distinguished by the last 2 segments being broadly joined (although this character is often difficult to evaluate in either genus). *Aspidiotiphagus* with 3-segmented clubs generally bear rhinaria only on club segments except for *A. silwoodensis* Alam and *A. cyanophylli* Alam, which are figured (Alam, 1956) with rhinaria on all funicle segments; *Aleurodiphilus* has rhinaria on the club and all funicle segments except 1 and on 2 or 3 depending on species.

All *Aspidiotiphagus* we examined (p. 671) bear distinctive sculpture medially on the second abdominal tergum (the tergum immediately posteriad of the propodeum) (Figs. 25, 26), whereas no equivalent sculpture is evident on any *Aleurodiphilus* species examined (see following rediagnosis of *Aspidiotiphagus* for further detail on the preceding characters).

All known species of *Aspidiotiphagus* are parasites of Diaspididae; all known species of *Aleurodiphilus* are parasites of Aleyrodidae (except the hyperparasitic males, which, as far as we know, parasitize primary parasites within aleyrodids).



Figs. 22-26. *Aspidiotiphagus* spp., females. 22, *A.* sp. ex diaspidid scale from Cyprus, forewing and hindwing. 23, *A.* sp. ex *Aonidiella orientalis* from Saudi Arabia, glabrous area of forewing with double row of setae under margin beginning 3 setae distad of stigmal vein. 24, *A. lounsburyi* (determined H. Compere), glabrous area of forewing with double row of setae under margin beginning after an asetose gap distad of stigmal vein. 25, *A. citrinus* (determined H. Compere), second abdominal tergum. 26, *A. latipennis* (paratype), second abdominal tergum.

Aleurodiphilus, as already mentioned, might also be confused with certain *Encarsia* species we place in the *cubensis* group of *Encarsia* (DeBach and Rose, unpublished). The *cubensis* group has a small glabrous area in the forewing beneath the stigma but is easily distinguished from *Aleurodiphilus* species by having 4-segmented middle tarsi and a 3-segmented club whereas *Aleurodiphilus* has 5-segmented tarsi on all legs and a 2-segmented club. Our *cubensis* group appears to be a natural one and is not the equivalent of Viggiani and Mazzone's (1979) *formosa* group although, along with dissim-

ilar species, they include *E. cubensis* Gahan and *E. quaintancei* Howard in the latter.

The geographical distribution of *Aleurodiphilus* is broad and may turn out to be much greater when additional collections and studies have been made. We have determined from our collections, other museum specimens, and from the taxonomic literature, that species occur in North, Central, and South America and the Caribbean. Our literature survey has not revealed the presence of species in Europe.

REDIAGNOSIS OF *ASPIDIOTIPHAGUS* HOWARD

Coccophagus citrinus Craw, 1891.

Encarsia citrinus Riley and Howard, 1891.

Aspidiotiphagus citrinus Howard, 1894.

Prospaltoides howardi Brèthes, 1914.

Aspidiotiphagus shoeversi Smits van Burgst, 1915.

There is some confusion regarding the type of *Coccophagus citrinus* Craw, the type-species of *Aspidiotiphagus*. When Craw (1891a, b) described *C. citrinus*, reared from *Aonidiella citrina* (Coquillett) (= *Aspidiotus citrinus*) first collected in the San Gabriel Valley in California in 1889, it was placed under *Coccophagus* apparently following Howard's suggestion. Riley and Howard (1891) then placed it as *Encarsia citrinus* (see Compere, 1936, for further detail). This generic designation was later changed by Howard (1894) who erected the new genus *Aspidiotiphagus* for *citrinus* and redescribed this species from 14 female specimens reared from *A. citrina* (Coq.) (= *Aspidiotus aurantii* Maskell, var. *citrinus*) also collected in San Gabriel, California by Coquillett in 1889.

Elsewhere, Brèthes (1914) erected *Prospaltoides* for his new species *howardi* reared from *Pseudaulacaspis* (= *Diaspis*) *pentagona* (Targioni-Tozzetti) in Argentina which he subsequently (Brèthes, 1916) synonymized with *Aspidiotiphagus citrinus*. Mercet (1930) also synonymized *Aspidiotiphagus schoeversi* Smits van Burgst with *A. citrinus*. DeSantis (1948) examined the "type" of "*Prospaltoides howardi* Brèthes" and stated that only two species of *Aspidiotiphagus*, *A. citrinus* and *A. lounsburyi* (Berlese and Paoli), are present in Argentina, seemingly confirming Brèthes' (1916) synonymy.

Howard did not designate any of the specimens collected by Coquillett in California in 1889 as a holotype when he erected *Aspidiotiphagus* in 1894. Craw's original specimens, also collected in 1889, are apparently lost. There are no specimens from Craw deposited at the U.S. National Museum nor were we able to locate specimens in the collections of the California Academy of Sciences, the University of California, the Los Angeles Natural History Museum, or the California State Department of Food and Agriculture.

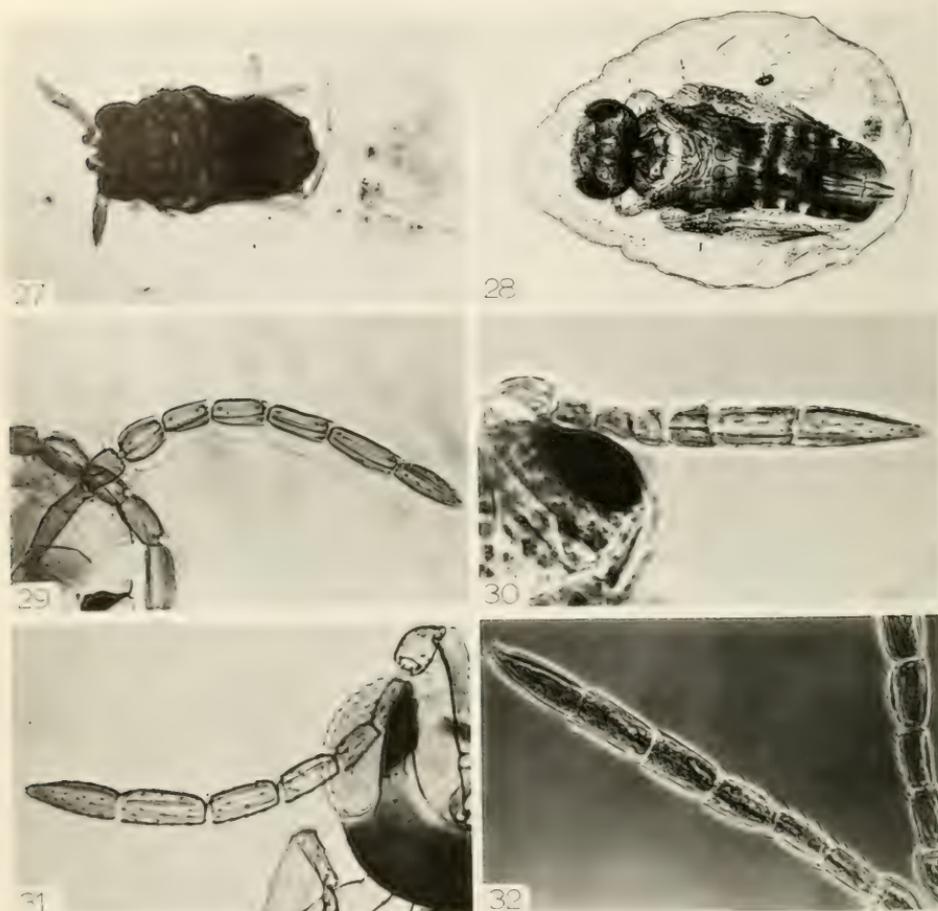
We examined 12 female specimens on three unnumbered slides from the USNM labeled; "*Coccophagus citrinus* Craw from *Aspidiotus aurantii*, Jan. 18, 1889, San Gabriel, Cal." (1 slide), "*Aspidiotiphagus citrinus* Craw bred from *Aspidiotus aurantii* San Gabriel, Cal. Jan. 24, 1889" (1 slide), and "*Aspidiotiphagus citrinus* from *Aspidiotus aurantii* March 13, 1889 San Gabriel, Cal." (1 slide). The data on the USNM slides corresponds with Howard's (1895) statement regarding *Aspidiotiphagus citrinus*, "Redescribed from fourteen female specimens reared January 18 and 24, February 2 and March 13, 1889 by Mr. D. W. Coquillett from *Aspidiotus aurantii*, var. *citrinus*, from San Gabriel, Cal." The last two slides dated January 24 and March 13, 1889 also bear the notation, "Part of original material which formed basis of Howard description in Ins. Life VI, p. 230." Specimens noted by Howard (1895) collected on February 2, 1889 by the same collector on the same host in the same locale were not among the USNM collection we examined.

We have designated a NEOTYPE on the USNM slide dated March 13, 1889 (Fig. 27). The USNM specimens of *Aspidiotiphagus citrinus* are difficult, at best, to study as fine detail is often obscured. However, the characters as given by Howard (1894) can generally be observed and fit the generic description of *Aspidiotiphagus* to follow.

In order to compare *Aspidiotiphagus* with *Aleurodiphilus*, *Encarsia*, and other genera, we have studied, along with the USNM material, the collections of H. Compere, P. DeBach, M. Rose, and others held in the Division of Biological Control, University of California, Riverside. More than 1000 specimens of *Aspidiotiphagus*, including paratypes (*A. flavus*, *A. latipennis*) designated by Compere (1936) and numerous specimens identified by Compere and others, collected from 21 scale insect genera comprising 54 known species and 8 unknown species of Diaspididae from 37 countries throughout the world were examined.

To our knowledge only one species of *Aspidiotiphagus* is recorded from a non-diaspine scale host: *Aspidiotiphagus aleyrodidis* Ashmead (1904), reared from an aleyrodid on sugar-cane in Manila, Philippines. We examined 3 of Ashmead's syntypes (USNM Cat. No. 7354, E. Grissell, personal communication) and found that these point-mounted specimens definitely were not *Aspidiotiphagus* but possibly belong to *Encarsia*. Cleared slide mounts would be necessary for accurate identification.

Thus, all known species of *Aspidiotiphagus* are parasites of diaspidid scales. DeSantis' (1979) very extensive host list for *A. citrinus* and *A. lounsburyi* tends to confirm this. Our host records, rearings and dissections all indicate that *Aspidiotiphagus* are primary, solitary, internal parasites which develop in immature (second-instar) scale bodies (Fig. 28). It is possible that most, if not all, *Aspidiotiphagus* spp. are thelytokous. Males are non-existent or extremely rare in all species studied that had sufficient specimens available to be meaningful. Male *Aspidiotiphagus* spp. we have examined



Figs. 27-32. *Aspidiotiphagus* spp. 27, *A. citrinus*, USNM neotype female. 28, *A. sp.* female inside second-instar *Hemiberlesia lataniae* from California. 29, *A. sp.* near *lounsburvi*, male antenna. 30, *A. lounsburvi* (determined H. Compere), female antenna. 31, *A. sp.* ex *Parlatoria blanchardi* from Israel, female antenna. 32, *A. latipennis* (paratype), female antenna.

greatly resemble the female, the immediately obvious differences being the antennae (Fig. 29) and genitalia.

The current taxonomic status of *Aspidiotiphagus* exemplifies dichotomy of thought. We, as stated earlier, favor retention of *Aspidiotiphagus* as a valid genus as did Hayat (1976). Conversely, Viggiani and Mazzone (1979) place *Aspidiotiphagus* under their proposed *citrina* group of *Encarsia* whereas Alam (1956) divides *Aspidiotiphagus* into two proposed subgenera: *Aspidiotiphagus* Howard subgen. n., type-species *A. citrinus* (Craw) based on "Hairs of marginal fringe of forewing clearly longer than maximum width of disc" and *Paraspidiotiphagus* subgen. n., type-species *A. flavus* Com-

pere based on "Hairs of marginal fringe of forewings not longer than maximum width of disc." Apparently Alam's decisions were made based on descriptions from the literature as well as on the description of his two new species, *Aspidiotiphagus silwoodensis* Alam and *A. cyanophylli* Alam.

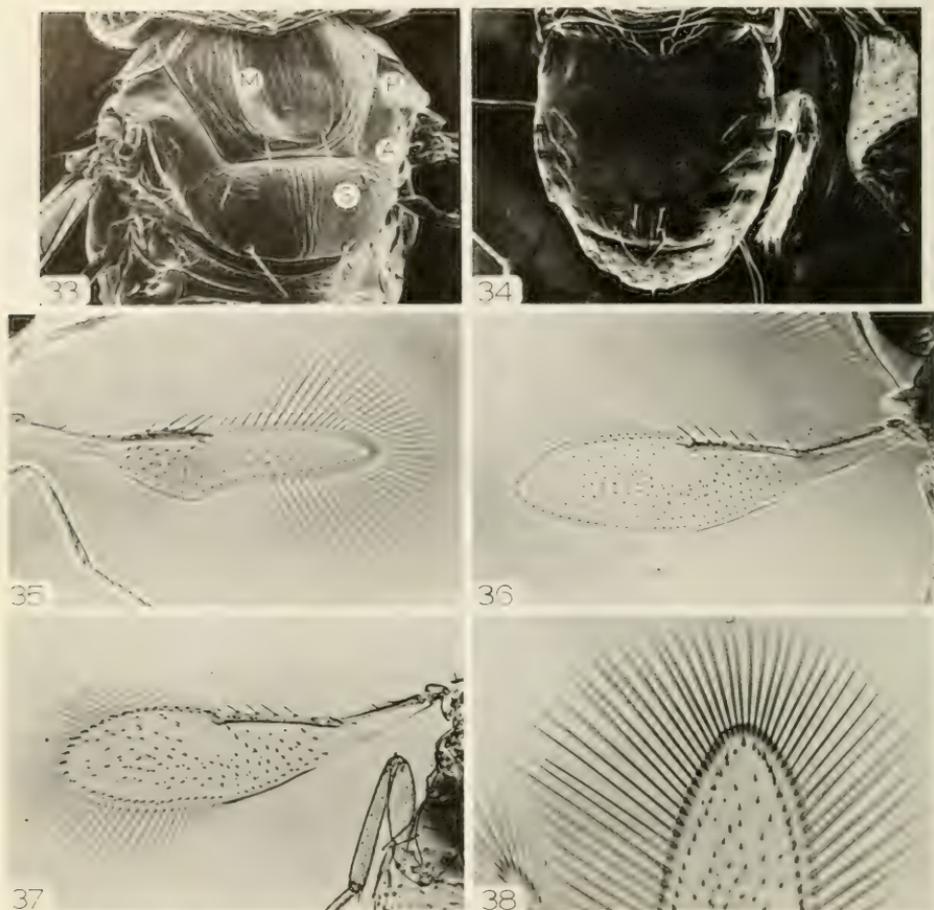
Compere (1936) noted "In this paper two forms [*A. flavus*, *A. latipennis*: authors' addition] are described in which the width of the forewings is greater than the length of the longest marginal fringe." Whether the relative length of the alary fringe of the forewing of various *Aspidiotiphagus* spp. will prove sufficient to support Alam's proposal of subgenera is problematical. We do not now intend to make this determination.

From our examination of the numerous specimens of *Aspidiotiphagus* already mentioned we have found several morphological characteristics which separate this genus from *Aleurodiphilus* and *Encarsia* (see pp. 666, 667) as well as from *Coccophagoides* and *Primaprospaltella*. These characters are given below and in the following key. We also consider that the number of species of *Aspidiotiphagus* is apparently greater than have been described, particularly the fuscous, thelytokous species that are near *citrinus* and which are numerically abundant worldwide.

All *Aspidiotiphagus* we examined are adequately described in habitus by Craw (1891a, b), Howard (1894), Brèthes (1914), Mercet (1930), Compere (1936) and DeSantis (1948). Howard's (1894) generic description states, "club long, distinctly three jointed." However, *A. fuscus* Compere (1936, Fig. 8) differs in having the 4 ultimate segments enlarged with the 5 ultimate antennal segments bearing rhinaria. We have observed similar antennae in other, undescribed *Aspidiotiphagus*. *Aspidiotiphagus* would be more fittingly characterized as generally having a 3-segmented club, ranging in appearance from first club segment reduced as in *A. lounsburyi* (Fig. 30), with rhinaria only on the club segments (except *A. silwoodensis* Alam and *A. cyanophylli* Alam), to antennae with 4 ultimate segments enlarged with rhinaria on the 4 ultimate antennal segments and occasionally on 5 ultimate antennal segments (Figs. 31, 32).

All species of *Aspidiotiphagus* we examined bear 1 seta on the parapsis and axilla, 2-6 setae on mesoscutum, 4 setae on scutellum (Compere's (1936) record of 6 setae on scutellum of *flavus* is apparently incorrect) (Fig. 33) and, in most specimens, 4 dorsal setae on abdominal terga 7 and 8 and on the syntergum. The dorsal surface of the posterior abdominal terga usually is stippled, often most conspicuously on the syntergum (Fig. 34). All tarsi are pentamerous.

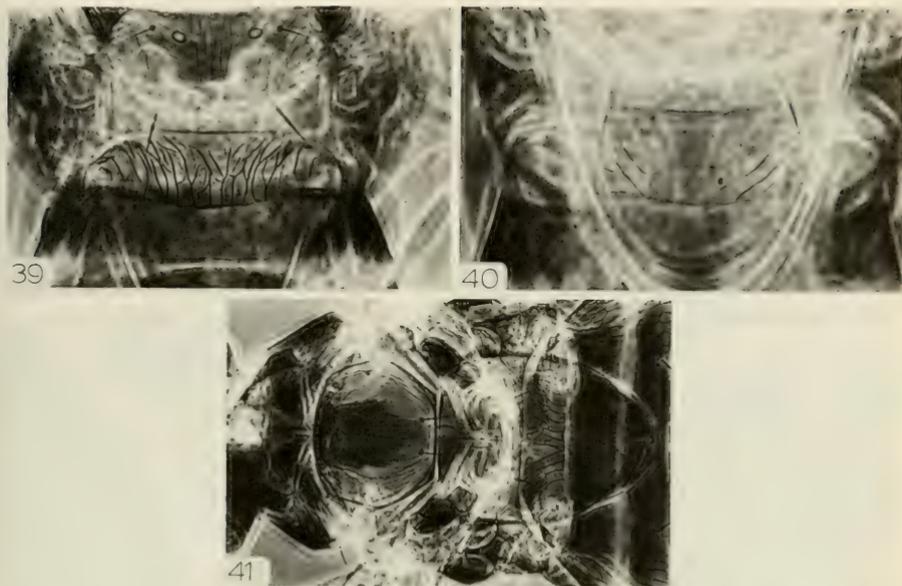
The inflexed wing, with a glabrous area surrounding the stigmal vein, has been characterized above and ranges in degree of inflection from *lounsburyi* (Fig. 35) to *flavus* (Fig. 36) with the other described species and undescribed specimens of *Aspidiotiphagus* grading between these species. *Aspidiotiphagus flavus* Compere (Fig. 36) has the least inflexed wing of those species



Figs. 33-36, 38. *Aspidiotiphagus* spp., females. 33. *A.* sp. ex *Hemiberlesia lataniae* from California, dorsum of thorax. 34. *A.* sp. as Fig. 33, dorsum of abdomen. 35. *A. lounsburyi* (determined H. Compere), forewing. 36. *A. flavus* (paratype), forewing. 37. *Aleurodiphilus basicinctus* female. 38. *Aspidiotiphagus* sp. ex diaspidid scale from Cyprus, apex of forewing. Abbreviations: A = axilla; M = mesoscutum; P = parapsis; S = scutellum.

described by Compere (1936) and is somewhat similar in general habitus to *Aleurodiphilus basicinctus* (Gahan), which has the most extremely inflected wing in our collection of *Aleurodiphilus* (Fig. 37) and is somewhat more inflected than the forewing of *Aleurodiphilus americanus* (Fig. 11). The apical margin in *Aleurodiphilus* spp. is generally more oblatly rounded than in *Aspidiotiphagus* spp. (Figs. 11, 22, 35, 36, 37, 38).

In all specimens of *Aspidiotiphagus* examined the forewing between the submarginal and marginal veins and the frenal fold is fuscous (least conspicuous in *A. flavus* paratypes) and bears one seta in the wing base with



Figs. 39–41. *Aspidiotiphagus* spp., females. 39, *A.* sp. ex diaspidid scale from Australia, second abdominal tergum. 40, *A.* sp. ex *Aonidiella orientalis* from Saudi Arabia, second abdominal tergum. 41, *A.* sp. ex diaspidid scale from the Dominican Republic, second abdominal tergum, dorsum of thorax and anterior abdomen, endophragma.

no setae on the dorsal surface of the stigmal vein (Fig. 22). The double row of setae (see p. 669) on the forewing begins at variable distances from the terminus of the stigmal vein, often after an asetose "gap" (Figs. 23 and 24), and does not extend beyond the apex of the forewing but rather becomes a single row, often with large spaces between setae, at the apex. Thereafter a double row may again commence for a short distance (Fig. 38).

A striking and possibly unique character to distinguish *Aspidiotiphagus* is the characteristic medial sculpture on the second abdominal tergum (see p. 669). In all specimens examined this character is evident and is readily observed at low (100 \times) to high (400 \times) magnifications under the phase contrast microscope, even on damaged specimens. Compere's (1936) Figure 9, page 298, of "*Aspidiotiphagus fuscus* n. sp. Female" and Figure 10, page 300, of "*Aspidiotiphagus flavus* n. sp. Female" suggests this structure but he didn't use it as a character.

This normally longitudinally elongate reticulate sculpture is located medially (Figs. 24, 26) but can encompass nearly the width of the second abdominal tergum (Fig. 39). The type and degree of sculpture ranges in appearance (phase contrast microscope) from delicately light (Fig. 40) to bold and distinct (Fig. 41). Sculpture-type is reasonably constant within



Figs. 42-45. *Aspidiotiphagus* spp., females. 42, *A. sp. ex Hemiberlesia lataniae* from California, thorax and abdomen to show second abdominal tergum, lateral aspect (SEM). 43, Same specimen as Fig. 42, scutellum, metanotum, propodeum, and second abdominal tergum, dorsal aspect (SEM). 44, 45, *A. sp. ex Aonidiella aurantii* from People's Republic of China, as Figs. 42, 43 (SEM). 46, *Encarsia diaspidicola*, USNM cotype no. 41387, female, thorax and abdomen, dorsal view.

conspecific series and could eventually prove useful in species determination. Examination of this structure with a Joel JSM 35C scanning electron microscope showed the sculpture to consist of reticulations formed by sharply raised, longitudinal ridges with smaller longitudinal ridges within the reticulations (Figs. 42, 43, 44, 45).

No such sculpture is evident on any of the *Aleurodiphilus* spp. in our collection. Only *Encarsia diaspidicola* (Silvestri) (= *P. diaspidicola* Silvestri) (Silvestri, 1930) shows any close semblance of such sculpture of all the

hundreds of specimens of *Encarsia* we have examined. However, on *E. diaspidicola*, USNM cotypes, No. 41387, the sculpture of the second abdominal tergum is neither longitudinally elongate nor medially placed (Fig. 46).

Craw (1891a, b) pointed out that *Aspidiotiphagus citrinus* from *Aonidiella citrina* Coquillett failed to reproduce on *Aonidiella aurantii* (Maskell). Compere (1936) later states, "attempts to propagate *Aspidiotiphagus citrinus* upon red scale, *Chrysomphalus aurantii* (Maskell) [*Aonidiella aurantii* (Mask.): authors' addition], have corroborated Craw's contention that this coccid is not a host of the parasite in question."

Such host specificity by a primary thelytokous parasite between two such closely allied hosts (*A. citrina* and *A. aurantii*) that were sympatric and often found on the same host plant in southern California (DeBach et al., 1978) strongly indicates that the actual host range is very narrow, particularly when backed by laboratory tests as is the case presented here. Such oligophagous and possibly monophagous host selection is a good species indicator under biosystematic criteria.

We have observed numerous small differences in the habitus, pigmentation, antennae, chaetotaxy, wing form and sculpture (both generally and on the second abdominal tergum) on numerous specimens of *Aspidiotiphagus* reared from different species of diaspid scales worldwide, including many specimens called *A. citrinus* by various authors. These differences are reasonably constant in series of specimens from a given host species, locale and collection date, hence more than one species may be represented. However, as has been demonstrated with thelytokous species, sibling species, and "forms" of *Aphytis* (DeBach, 1969; Rössler and DeBach, 1972a, b, 1973; Rosen and DeBach, 1979) determination of specific status in such cases requires considerable biological, ecological and behavioral study. For *Aspidiotiphagus* this remains in the future.

KEY TO PENTAMEROUS AND HETEROMEROUS PROSPALTELLINAE

1. Six setae on scutellum; hypogynium present *Coccophagoides*
- Four setae on scutellum; hypogynium absent 2
2. Maxillary palpus 2-segmented; submarginal vein distinctly longer than marginal vein; more than 10 setae in basal area of forewing below bullae; flagellar segments highly differentiated, flagellum rather short and stout; distinctive 3-segmented club *Primaprospaltella*
- Maxillary palpus 1-segmented; propodeum narrowly constricted medially, shorter medially than metanotum; submarginal vein subequal to marginal vein; less than 10 setae in basal area of forewing below bullae; flagellar segments little differentiated, flagellum gen-

- erally long and narrow; club variable, undifferentiated to 4 ultimate segments enlarged 3
3. Wing without glabrous area beneath stigma *Encarsia*
 - Wing with glabrous oval or circular area beneath stigma 4
4. Midtarsus tetramerous, others pentamerous; forewing not narrow, about 2.5× as long as wide; *cubensis* group *Encarsia*
 - Each tarsus pentamerous; forewing narrow, usually more than 3× as long as wide 5
5. Second abdominal tergum distinctly sculptured medially; antennal club generally 3-segmented, can appear 4-segmented; 1 seta on parapsis; longest forewing anterior-fringe setae ½ to 1-plus times as wide as disc; longest forewing posterior-fringe setae ¾ to 1-plus times as wide as disc; forewing usually distinctly inflexed posteriorly (Figs. 22-45) *Aspidiotiphagus*
 - Second abdominal tergum without sculpture medially; antennal club 2-segmented; 2 setae on parapsis; longest forewing anterior-fringe setae ⅓ to ½ width of disc; longest forewing posterior-fringe setae ½ to ¾ width of disc; forewing more or less smoothly curved along posterior margin (Figs. 1-18) *Aleurodiphilus*

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DESCRIPTION OF THE IMMATURE STAGES OF
DIORYCTRIA TAEDAE SCHABER AND WOOD, WITH NOTES ON
ITS BIOLOGY AND THAT OF *D. DISCLUSA* HEINRICH
(LEPIDOPTERA: PYRALIDAE)

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Abstract.—Adult emergence in Maryland and Delaware of a pine cone-worm, *Dioryctria taedae* Schaber and Wood, indicates two broods per year, one in late August and the other in early October. Observations on the biology of the coneworms feeding on loblolly pine, *Pinus taeda* L., are recorded with brief descriptions of the immature stages. Measurements of the head capsule, body length, and labrum indicate five larval instars. Ten species of Hymenoptera and five of Diptera have been recovered as parasites from the last two larval instars and pupae. Comparative notes on *D. disclusa* Heinrich are also given.

The loblolly pine (*Pinus taeda* L.) industry in Maryland holds a significant place in the economy of the state, and the forests are maintained by planting.

Landowners purchase seedlings grown in state forest nurseries from the Maryland Department of Forestry. Seeds are in great demand and must be obtained by collecting cones from the crowns of trees that are cut for lumber each fall. However, the seed supply at the State Forest Tree Nursery in Harmans, Maryland, is extremely limited having been reduced by seed insects to the point where plantings may have to be curtailed.

Because pine coneworms are considered among the most destructive pests of pine cones, various insect surveys were initiated. In Virginia, Knight (1952) and Schroeder (unpublished data) reported that *Dioryctria amatella* (Hulst) destroyed 27% and 45% of the total seed, respectively. *Dioryctria amatella* and *D. disclusa* Heinrich were found to be primary pests of loblolly pine in Mississippi (Neel and Sartor, 1969). *Dioryctria amatella* accounted for 86% of all insects identified attacking mature loblolly pine cones in Georgia (Dohany and Heikkinen, 1968). A study of slash pine cones (*Pinus elliotii* Engelm.) in Florida showed that, although the number infested by *Dioryctria* spp. and *Laspeyresia anaranjada* Miller were about the same, the coneworms were estimated to destroy nine times as many

seeds as the seedworm, *L. anaranjada*, or nearly 25% of the total potential seed yield (Merkel, 1961).

A pine coneworm was discovered infesting second year cones of loblolly pine in Maryland in the early 1960's and was identified at that time as "*D. zimmermani* (Grote)" (Coop. Econ. Insect Rep., 1964).

Subsequently, Schaber and Wood (1971) showed this identification to be incorrect. Because of different morphological characteristics and biological feeding habits exhibited by this species from previously published descriptions, this insect was described as *D. taedae*.

This paper provides detailed descriptions of the egg, larva, and pupa with notes on the biology of the various life stages not included by Schaber and Wood (1971).

METHODS AND PROCEDURES

The collection of cones was concentrated in Sommerset, St. Mary's, Wicomico, and Worcester counties, Maryland; in Sussex Co., Delaware; and in King and Queen County, Virginia, during the study period, 1967-1970. These counties were selected because continuous logging was in progress for the duration of this study. Although this is not a random design for the collection of the pine cones, it proved less costly than to hire a professional climber. Additionally, even if a climber were in the 18-24 m high trees, he would be unable to see the tips of the branches and, therefore, would be unable to tell if the cones or terminals were infested. Since the forestry practices of the State of Maryland prevent the private cutting of trees, the only successful method that remained was to follow the logging crews from area to area.

Only cones, tips, and leaders that showed signs of damage were collected. Cones were dipped in melted paraffin to delay spoilage and desiccation when used as larval food. Most of the larvae were fed the artificial medium of the fall armyworm (Burton, 1967) modified as suggested by E. O. Thomas (personal communication). These modifications included the following: (1) Addition of inositol, (2) substitution of bacitracin for streptomycin, (3) 3.5 ml of 37% formaldehyde instead of 15 ml of 10% formalin, (4) 14 g of methyl-p-hydroxybenzoate and 14 g of sorbic acid instead of the 8.8 g and 11.8 g, respectively, in 100 ml of 95% ethyl alcohol, (5) no kanamycin sulfate, and (6) in the vitamin mixture, vitamin B₁₂ not triturated in mannitol but added directly into the solution.

The larvae, after hatching or collection from the field, were placed in individual 2 oz plastic containers half filled with artificial medium. The larvae were transferred to fresh stock every two weeks because of desiccation of the medium with first- and second-instar larvae and because of the appetite of the later instar larvae. These containers served as pupation chambers as well.

Table 1. Mean measurements of the larval instars of *Diorcctria taedae*. All values in mm.

Instar	N	Head Length	Head Width	Body Length	Labrum Width
1	2	0.20	0.30	2.00	0.10
2	4	0.45	0.57	5.30 ± 1.5	0.20
3	3	0.82	1.16	8.40 ± 0.9	0.30
4	14	1.22	1.68	13.5 ± 1.3	0.50
5	12	1.50	2.10	18.3 ± 2.8	0.65

The rearing chamber was set for 16 hours of light and 8 hours of darkness. The day temperature was 29°C and the night, 18°C. Moisture was added to the growth chamber by placing a 2500 ml beaker of water with a wick formed of wire mesh 15 cm high wrapped with cheesecloth.

Adults were placed in small vials for sex determination and then transferred to breeding cages. These cages were 30 cm cubes and each contained two small vials of 10% sugar water as a food source. After three or four days, the females were removed and placed in individual egg-laying cages. The egg-laying cages were made of two round plastic dishes 95 mm in diameter with the open ends taped together, containing 10 mm of artificial medium as a base. A 0.3 cm, slightly curved mesh screen was placed on top of the medium and covered with cheesecloth. Again, small vials containing sugar water were added. After oviposition had been completed, the female moths were preserved, mounted, and labeled. The young larvae that hatched were placed in individual rearing containers as previously described.

DESCRIPTION OF LIFE STAGES

Egg.—Eggs elliptic-oval; average width, 0.55 mm; average length, 1.05 mm. Creamy white when deposited. Embryo clearly visible before hatching. Color gradually changes from white to yellow, to reddish orange, and then to a dull reddish brown before hatching. Surface of egg with rugose appearance due to network of ridges running irregularly over entire surface.

Larva (Table 1).—First-instar average length 2.00 mm upon hatching. Striped and light brown. Compound eyes with small area of very heavy pigmentation, disappearing toward end of first-instar. Second-instar displays same coloration patterns as first-instar. Third-instar uniform in color and may vary from reddish brown to almost black. Fourth-instar generally darker in color than earlier instars. Fifth-instar body color usually black green to purplish overlaid with some pinacula. From each pinaculum, arises a single seta (Fig. 1). Ventrally, body usually buff to reddish brown. Head varies in color from light to dark reddish brown with some maculations. Six lateral ocelli lighter in color than head capsule. Thoracic shield reddish brown and

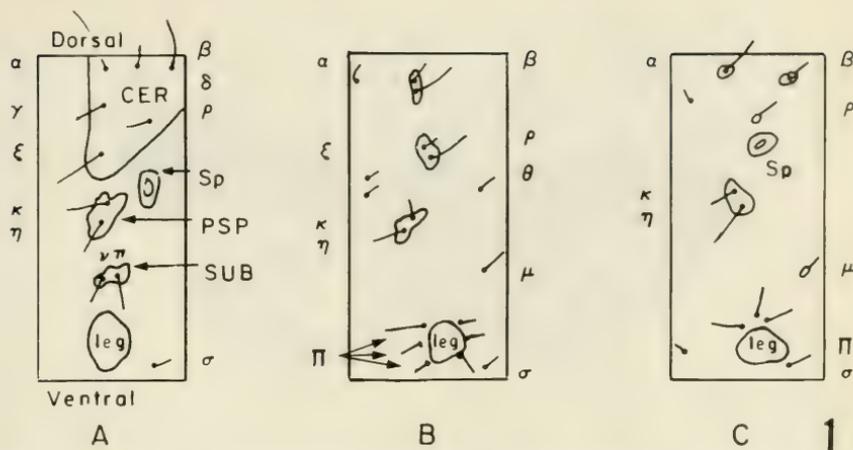


Fig. 1. Schematic of the setal arrangement of the fifth-instar larva of *Dioryctria taedae*. A. Prothorax. B. Metathorax. C. 4th abdominal segment. (Setal terminology follows that of Peterson, 1962.)

Abbreviations

- CER — cervical shield
- Sp — spiracle
- α — alpha
- β — beta
- γ — gamma
- δ — delta
- ϵ — epsilon
- ρ — rho
- σ — sigma

- PSP — prespiracular setae
- SUB — subventral group
- κ — kappa } PSP
- η — eta }
- μ — mu }
- ν — nu } Π
- π — pi }
- τ — tau }

light brown to yellow anteriorly, with yellow mesal line. Three pairs of thoracic legs with simple claws and 4 pairs of prolegs. Anal shield yellowish brown with 6 setae and sclerotized pigmented pits, when viewed microscopically, black. Integument coarsely granulose with large apodemal spots and tubercles on either side. Head of fifth-instar averages 1.5 mm wide and 2.1 mm long. Labrum (Fig. 2) averages 0.65 mm in width, emargination quite deep. Epipharynx (Fig. 2) with many light-colored stout spines. Labrum with 6 toothlike projections and 12 setae. Spinneret relatively stout, about 3.5 \times as long as wide. Mandibles dark brown to black, and quadradentate. Proleg crochets arranged in circle. Microspines on venter of each segment distinct: perianal region with medium sized, lightly pigmented spines.

Pupa.—Pupa cylindrical, smooth, narrow, varying in length from 14.3 to 15.9 mm (mean 15.3 mm). Mean length of abdominal segments 10.5 mm. Head forming a blunt point, with a pronounced clypeal protuberance. In-

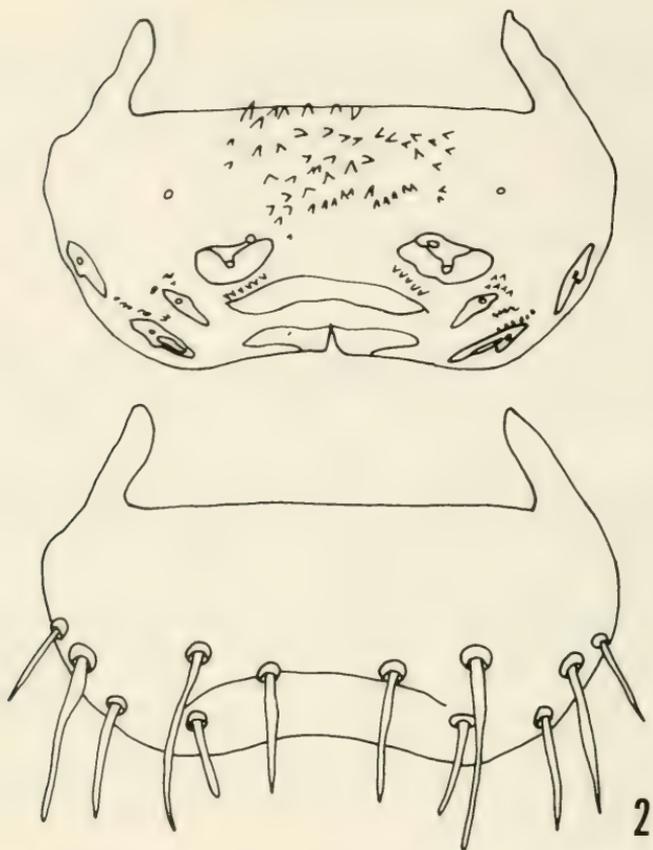


Fig. 2. Fifth-instar larva of *Dioryctria taedae*. Top, epipharynx; bottom, labrum.

tegument smooth, but pro- and mesothorax are wrinkled. Dorsum of metathorax punctate. Dorsal $\frac{2}{3}$ of abdominal segments heavily punctate, punctures extending ventrally to midway on segments. Dorsocaudal gibba elongate, black, and elevated, about 3.5 to 4 \times as long as wide. Dorsum of segment 10, caudad of gibba, darker than dorsum of other segments; sometimes containing an extra pair of setae. Of 90 pupal cases examined, 24 exhibited an extra pair of setae; of these 18 were females and 6 were males. Cremaster expands slightly laterally and contains 6 slender spines with small apical hooks.

Adult.—The complete description and notes on how to distinguish adults from 2 closely related species (*D. amatella* and *D. zimmermani*) have been published (Schaber and Wood, 1971). However, to further aid field identification, the 3 species have been included here for comparison (Fig. 3).



A



B



3

C

Fig. 3. Adults. A, *Dioryctria taedae*. B, *D. amatella*. C, *D. zimmermani* (western specimen).

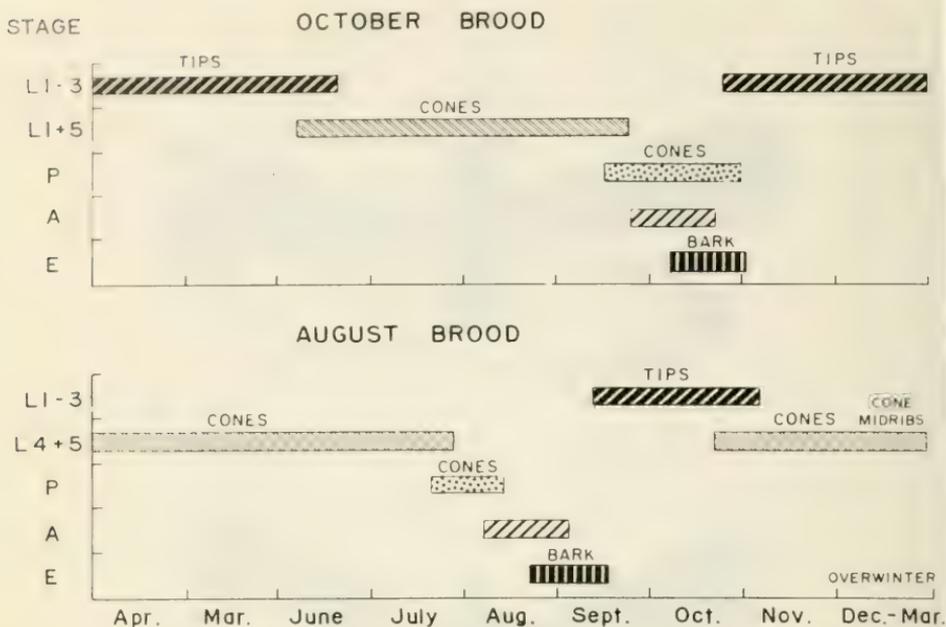


Fig. 4. Life history of *Dioryctria taedae* in Maryland.

LARVAL ACTIVITY AND DEVELOPMENT

Field-collected larvae of *D. taedae* were taken from flower clusters, second year cones, terminals, or leaders of loblolly pine, rarely from first year cones. Larvae in the first-, second-, and third-instars were taken from terminals and leaders; however, fourth- and fifth-instar larvae were rarely found there. In most cases, fourth- and fifth-instar larvae were taken from second year cones.

Larvae from the October adults infest terminals and, the next spring, they attack developing second year cones. A larva may feed on one or more cones before it completes development. Some larvae of this October brood continue activity, pupate, and emerge with the adults of the October brood, thus there is interbreeding between the two broods of this species (Fig. 4).

Larvae in the field overwinter either as first-/second-instars or as later instars. The young instar larvae (October brood) tunnel into the terminal and spin a hibernaculum very soon after hatching. The older larvae (August brood) eat out the midrib of the second year pine cones and line it with silk. In the spring, they emerge and infest terminals and developing second year cones and emerge as adults in late July to early August.

PUPAL DEVELOPMENT

The duration of the pupal stage varied from 14 to 33 days. Based on data taken during the summers of 1967 and 1968, there are two pupation periods, in late July to early August and in early September, averaging 18.3 and 23.0 days, respectively (Fig. 4). Duration of the latter period varied from 16 to 26 days. Only one specimen of all larvae, either reared in the laboratory or from the field, pupated between August 16 and September 14.

Of the total number of pupations observed, 53% occurred during the first pupation period of late July to early August and 45% pupated during the second pupation period.

ADULT BEHAVIOR

Dioryctria taedae exhibits a bimodal life cycle (Fig. 4). Adults emerge in the latter part of August and in the early part of October. *Dioryctria* spp. were observed emerging during these same two periods in Florida (Ebel, 1965) and Georgia (Franklin and Coulson, 1968).

In the fall of 1967, two moths were observed in the grass and low underbrush at the base of a large loblolly pine tree at Willards, Maryland. They were making short abrupt flights of 1 to 2 m, 0.5 to 1 m above the ground, alighting on the vegetation. Extended or high flights, or both, were never attempted in the field or in the laboratory.

Before flight begins, the moths wave their antennae and make fibrillate movements with their wings. Flight begins with an abrupt spring and concurrent fast wing beating, and ends with an abrupt landing, legs clutching the surface with no further movement.

When adults were placed in vials for sex determination, females crawled very little. The males, however, were constantly crawling and attempting to fly.

In June 1965, in Georgia, Dr. Gene Wood (personal communication) noted that several *Dioryctria* specimens were attracted to a black light trap and that the first insect of the evening was a *Dioryctria* sp.

In the laboratory, the female moth, when placed in an egg-laying cage, probed with her abdomen under and into cracks in the artificial medium and around roughened areas of the 0.3 cm mesh screen and cheesecloth. Most eggs were laid on the underside of the screen. Eclosion took place seven to eight days after deposition.

HOSTS AND DAMAGE

Loblolly pine is preferred to pond pine as host for *D. taedae* in Maryland and Delaware. Attacks on pond pine occurred only at the periphery of heavily infested stands of loblolly pine. It infested only loblolly pine cones

in Virginia and North Carolina (Neunzig et al., 1964a, b) but in Georgia, *D. taedae* (reported as *D. zimmermani*) attacked shortleaf pine, *P. echinata* Mill. (Franklin and Coulson, 1968).

Attacks by the larvae of *D. taedae* were noticed only on older trees, whereas *D. zimmermani* attacked trees of nursery stock age in Illinois and other northeastern states (Rennels, 1960; Schuder, 1960). No damage of nursery stock was caused by *D. taedae*.

PARASITES AND NATURAL CONTROL

A species of *Xanthophyto* is the most abundant dipterous parasite found in Maryland and Delaware parasitizing *D. taedae*.

The small parasite, *Hyssopus rhyacioniae* Gahan, is the most prevalent of the Hymenoptera. It produces many offspring from one dead host larva. Small black ants were also noticed within the dead larval skins and tunnels of *D. taedae*; similarly, Schuder (1960) noted small black ants feeding on larvae of *D. zimmermani* in Indiana.

The parasites of *D. taedae* noted were:

Hymenoptera.—Braconidae: *Macrocentrus dioryctriae* Muesebeck; *Meteorus tetralophae* Muesebeck; *Bracon* sp.; *Apanteles aristoteliae* Viereck. Eulophidae: *Hyssopus rhyacioniae* Gahan. Ichneumonidae: *Charops annulipes* Ashmead; *Lissonota* spp. (two species); *Exeristes comstockii* (Cresson); *Campoplex* sp.

Diptera.—Tachinidae: *Xanthophyto* sp.; *Phrynofrontina* sp.; *Phrynofrontina discalis* (Coquillett). Cecidomyiidae: Unidentified species.

OTHER SPECIES FOUND IN ASSOCIATION WITH *D. TAEDAE*

Only seven specimens of *D. disclusa* were captured within the study area during 1967 and 1968. Larvae of this species were found infesting second year cones of loblolly pine. The larvae pupated in mid-May and emerged in June.

The pupal case from the first abdominal segment to the end of the cremaster averaged 9.5 mm in length and darkens with age to become a dark reddish brown. The average period of pupation was 16 days.

Because no adults were captured or emerged later than the middle of June during four years (1965–1968) of intensive collecting, there is probably only one generation per year in Maryland. In Mississippi, adult moths emerged during a similar two week period extending from the third week in May to the first week in June. No moths emerged after this time, even though collection of damaged cones was carried out until October (Neel and Sartor, 1969). Due to its low relative abundance, *D. disclusa* is apparently not a major factor in pine seed reduction.

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THE GENUS *CHIONANTHOBIUS* PIERCE (COLEOPTERA:
CURCULIONIDAE): A NEW SPECIES FROM CUBA
AND A KEY TO SPECIES

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Abstract.—A new species of Lignyodini (Curculionidae: Tychiinae), *Chionanthobius darlingtoni*, from Cuba is described and illustrated. The new species closely resembles *C. autumnalis* Clark from Texas. It is the third species of *Chionanthobius* and the first from outside the United States. A key is provided for the identification of all three species.

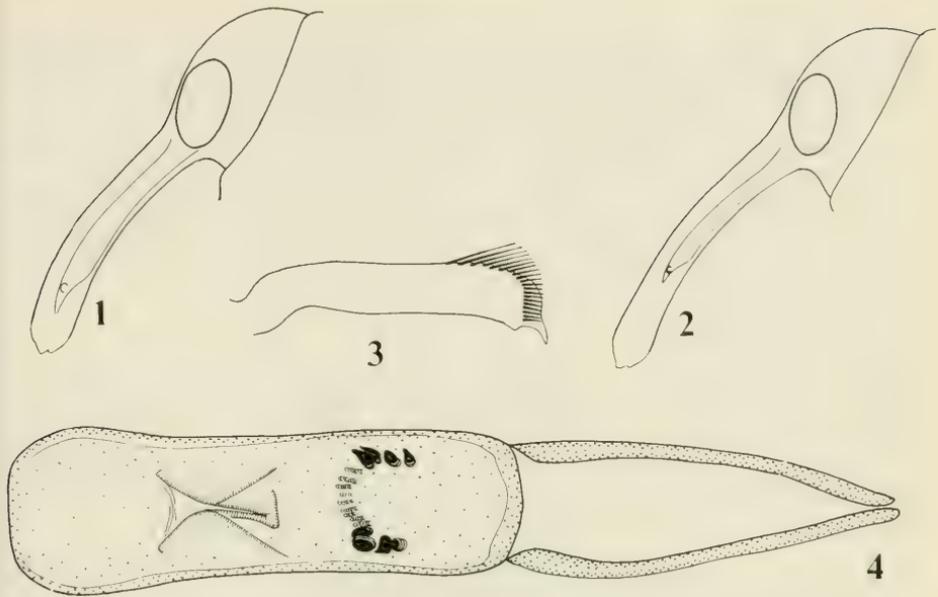
The genus *Chionanthobius* was erected by Pierce (1912) for a species now known from the states of Maryland, Georgia, and Florida, *C. schwarzi* Pierce. Clark and Anderson (1981) redefined *Chionanthobius* to accommodate a second species, *C. autumnalis* Clark from Texas. More recently, specimens of a third, previously undescribed species of *Chionanthobius* have become available. The purpose of this paper is to name and describe this species. The species is of special interest because it is from Cuba, making it the first known member of the genus from outside the United States. It is represented by four specimens found among unsorted curculionids at the Museum of Comparative Zoology, Harvard University, Cambridge, Massachusetts (MCZ) by Charles W. O'Brien. Thanks are extended to C. W. O'Brien and to Margaret Thayer of the MCZ for making them available for study.

Chionanthobius darlingtoni Clark, NEW SPECIES

Figs. 1-4

Type material.—*Holotype*: ♀, labeled "CUBA: Havana/X-13-1926 P. J./Darlington, Jr." (MCZ). *Allotype*: ♀, with same label data as for holotype (MCZ). *Paratypes*: With same label data as for holotype (1 ♂, MCZ); "Havana/X-13-26 Cuba/Darlington" (1 ♂, MCZ).

Male holotype.—*Length*: 3.94 mm. *Width*: 1.86 mm. *Head*: Eyes separated by distance ca. 0.11 × eye width. *Rostrum* (Fig. 1): Slender; in profile, dorsal margin slightly, nearly evenly curved from base to apex; in dorsal



Figs. 1-4. *Chionanthobius darlingtoni*. 1, Head and rostrum, male. 2, Head and rostrum, female. 3, Left metatibia, male. 4, Male genitalia, dorsal view.

view, tapered slightly from base to antennal insertions, slightly widened at insertions, distal portion slightly constricted medially; lateral and dorsolateral sulci well-defined proximally, represented by rows of increasingly shallow punctures distally; with small, aeneous scales proximally and in scrobe, minute setae proximad of antennal insertions. *Prothorax*: Strongly constricted subapically; dorsum with dense vestiture of intermixed pallid, whitish scales, and slightly broader, pallid fulvous, recumbent scales; pleuron with long, dense, imbricated, whitish scales below, with transverse vitta of fulvous scales medially, and with scales like those on dorsum above. *Elytra*: In dorsal view, humeri prominent, sides convergent from humeri to apices, posterior tubercles prominent; odd interspaces slightly raised; scales on interspaces uniformly recumbent; pallid whitish scales, fulvous scales, and fuscous scales present, darker scales present in small subbasal patches on interspaces 2-5, in broad, diffuse, zigzag-shaped posteromedian transverse band and a similar, broader, more distinct subapical band. *Legs*: Femora stout, unarmed, with vestiture of narrow, intermixed pallid whitish and fulvous, acuminate, recumbent scales; metatibia (Fig. 3) with long, curved, acute apical uncus, and small praemucro. *Genitalia* (Fig. 4): Median lobe expanded apically; endophallus with short rows of laminate spines connected by transverse row of smaller spines.

Female allotype.—*Length*: 3.56 mm. *Width*: 1.87 mm. Otherwise as described for male, except rostrum (Fig. 2) longer, more slender, less deeply sulcate and punctate, with more sparse vestiture, and smaller tibial unci.

Discussion.—*Chionanthobius darlingtoni* is known only from the type-series from Cuba. It resembles *C. autumnalis* of Texas more closely than it does the type-species of *Chionanthobius*, *C. schwarzi*. It is distinguished from *C. autumnalis* in having the rostral sulci deeper, the dorsal and ventral margins of the scrobe carinate, and in having the vestiture of the pronotum and the elytra much more pallid, with dark scales absent from the prothorax, and mostly limited to the diffuse posteromedian and subapical transverse bands on the elytra. The male genitalia (Fig. 4) differ from those of *C. autumnalis* by the distinctly enlarged apical portion of the median lobe but have similar endophallic armature. The female genitalia of the two species do not appear to differ significantly.

The only intraspecific variation noted among the specimens in the type-series is in the development and extent of the elytral bands of dark scales which are more distinct in some than in others.

The host of *C. darlingtoni* is unknown. Known host plants of species of *Chionanthobius* are all members of the family Oleaceae: *Chionanthobius virginica* L. and *Osmanthus americanus* (L.) Benth. and Hook. f. ex Gray are hosts of *C. schwarzi*, and *Forestiera ligustrina* (Michx.) Poir. is host of *C. autumnalis* (Clark and Anderson, 1981). Plants in the genera *Chionanthus* and *Osmanthus* occur in North America and in the Far East, whereas the genus *Forestiera* has species in North, Central, and South America and in the West Indies (Elias, 1980). It seems likely that the Cuban *C. darlingtoni* will be found to have a *Forestiera* host because of its relationship to *C. autumnalis* and its geographic range. The new *Chionanthobius* is named in honor of its collector, P. J. Darlington of Harvard, noted Coleopterist, Zoogeographer, and Evolutionist.

KEY TO SPECIES OF *CHIONANTHOBIOUS*

- 1. Femora toothed; striae scales not or very slightly broader than scales on interspaces, their color matching that of scales on adjacent interspaces; pronotum with fulvoferruginous scales only *schwarzi* Pierce
- Femora unarmed; striae scales distinctly broader than scales on interspaces, fulvous, contrasting with white or fuscous scales on adjacent interspaces; pronotum with pallid whitish scales only, or with darker scales limited to lateromedian vittae 2
- 2. Dorsal and ventral scrobal margins ecarinate; pronotum with lateromedian vittae of fulvous to fulvoferruginous scales ... *autumnalis* Clark
- Dorsal and ventral scrobal margins carinate; pronotum with pallid whitish scales only *darlingtoni*, new species

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NOTES ON NEW SPECIES OF EPILAMPRINE COCKROACHES
FROM COSTA RICA AND PANAMA
(BLATTARIA: BLABERIDAE)

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Abstract.—Four new species of *Epilampra* are described, *E. involucris* and *E. belli* from Costa Rica, and *E. unistilata* and *E. rothi* from Costa Rica and Panama. The first three, along with *E. carinulata* (Saussure), are designated as the *Carinulata* Group of *Epilampra*.

Several undescribed species of cockroaches have been encountered in Costa Rica and Panama in recent years. In this paper four new species are described, and some biological notes given in order to facilitate future studies. Roth (1969; 1970a, b; 1973), in a continuing study of the male genitalia of Blattaria, drew significant taxonomic inferences. We follow his methods for dissection and preparation of the genitalia and his system (as derived from McKittrick, 1964) for naming the parts. Roth (1970b) in his study of the genus *Epilampra* Burmeister, 1838, discussed the close affinities of *Audreia* Shelford, 1910, to *Epilampra* and the ambiguities encountered by other specialists (Hebard, 1920; Rehn and Hebard, 1927) resulting from Shelford's characterization of *Audreia*. Consequently, Roth transferred all the *Audreia* species which he examined, except the type-species, *A. carinulata* (Saussure), 1895, into either Subgroup A of his *Burmeisteri* Group or his monotypic *Heusseriana* Group of *Epilampra* or to the genus *Poeciloderrhis* Stal, 1874. Roth based his conclusions chiefly on the morphology of the male genitalia, noting that the primary character used by Shelford, the reduced subquadrate tegmina in both sexes, is not true of all *Audreia*. For example, *A. exploratrix* Gurney has lateral lobate tegmina, while *A. bromeliadarum* Caudell and *A. cicatricosa* (Rehn) are apterous. Three of the species described here share characters of the male genitalia and lack of a left style with *A. carinulata*, yet the nymphal color patterns, where known, are typical of *Epilampra*. We consider them to comprise a new species group within the genus *Epilampra*.

The holotype and allotype of all four species described here are deposited in the Ohio State University Entomology Museum. Paratypes are divided about equally between the Snow Entomological Museum, University of Kansas, and the F. W. Fisk collection.

Carinulata Group, NEW DESIGNATION

Adults usually shining reddish brown; tegmina usually short, subquadrate in both sexes (but may be full length); subgenital plate of male asymmetric, single right style; hooked phallomere, R2, stout, lacks subapical incision, sheath proximal to base of R2 lacks row of slender setae noted for most *Epilampra*; sclerotization of left phallomere, L2d, diagnostic for the group and species within it; nymph tan or gray, numerous dark punctations as typical for *Epilampra*. Appearance of R2 in this group very similar to R2 in *Poeciloderrhis* (as defined by Roth, 1970a), but no *Carinulata* Group species shows abdominal tergal glands as noted for male *Poeciloderrhis*.

KEY TO SPECIES OF THE *CARINULATA* GROUP

1. Adult fully winged in both sexes *unistilata*, new species
- Adult with tiny wing rudiments and short subquadrate tegmina in both sexes 2
2. Smaller, length of male under 14 mm, of female under 18 mm *carinulata* (Saussure)
- Larger, length of male 16–23 mm, of female 22–28 mm 3
3. Male with flattened sclerotization of left phallomere, L2d, L-shaped and blunt-tipped (Fig. 1A); female with lateroposterior angles of abdominal tergum 7 acute; supra-anal plate with very shallow (0.15 mm deep) median notch *involutris*, new species
- Male with flattened sclerotization of left phallomere, L2d, hammer-head-shaped (Fig. 1D); female with lateroposterior angles of abdominal terga 3–7 acute, spinelike; supra-anal plate lacks median notch *belli*, new species

Epilampra involutris Fisk and Schal, NEW SPECIES

Figs. 1A, 1B, 1C

Male holotype.—Measurements in Table 1. Head broad and flat, interocular distance nearly $\frac{1}{2}$ width of head, distance between white ocellar spots $\frac{1}{3}$ width of head; maxillary palpus pale, distal (5th) segment covered with gray microtrichiae giving it a velvety appearance; segment 5 longer than 4, slightly shorter than 3; mouthparts lighter colored than reddish brown of head and body; antenna brown, shorter than body. Pronotum convex, semi-circular in outline, lateroposterior angles rounded, right and left posterior margins straight, meeting at obtuse (160°) angle; pronotum covering most

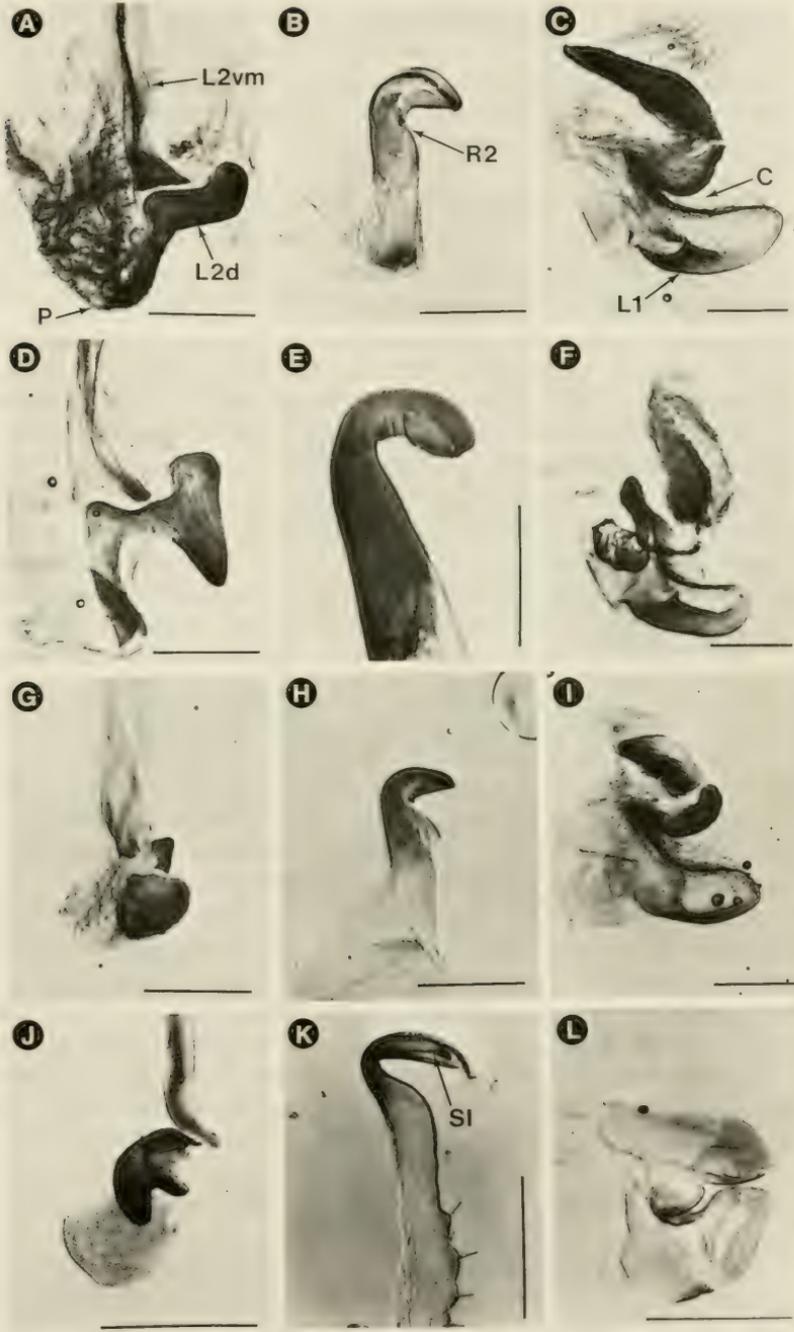
of head: tegmina truncated, $1\frac{1}{3}\times$ as long as pronotum, their lateroposterior angles broadly rounded, posterior margins nearly straight, exposing 7 abdominal terga but covering tiny wing rudiments; tegmina smooth, venation feebly indicated by lines of shallow punctations between scarcely elevated veins.

Abdominal terga, except tergum 7, bear acute spines at lateroposterior angles, smooth except for up to 18 low longitudinal ridges (cicatrices) on distal $\frac{1}{4}$ of each tergum; tergal glands or specializations not evident; supra-anal plate extends beyond subgenital plate, broadly rounded posteriorly with shallow (0.2 mm deep) median notch; plate reddish brown proximally, distal $\frac{1}{2}$ nearly transparent with scattered small raised black spots, each surrounded by a setal socket; cercus light brown, flattened, stout, apparently 10-segmented; terminal segment finger-shaped, black-tipped. Genitalia (Figs. 1A, B, C) similar to those of *carinulata* (Roth, 1970b, figs. 347–352); hooked right phallomere (R2) small, stout, blunt-tipped except for minute distal spine; subapical incision lacking. R2 of holotype has apparent split on outer circumference of hook, but split lacking in dissected paratypes. Flat sclerotization of left phallomere (L2d) blunt-tipped and L-shaped as in *carinulata*, but membranous prepuce readily visible due to thick covering of microtrichiae; phallomere L1 with deep, well defined cleft, setal brush lacking.

Abdominal sterna smooth, transverse except posterior margin of sternum 7 with sharp lateral emarginations at base of each cercus, the remainder broadly concave; subgenital plate with anterior margin broadly convex, posterior margin convex laterally, broadly emarginate centrally with simple (0.5 mm) right style, left style absent. Legs and ventral body surface brown, less reddish than dorsal surface; ventro-anterior margin of front femur with 4 large spines separated by row of minute setae from 2 apical spines; ventro-anterior margins of mid- and hindfemora with 4 spines plus apical spine, of hindfemur with 4 spines only; mid- and hindfemora with dorso-apical (genicular) spine. Tibiae fully spined; tarsi with obvious pulvilli on 4 proximal tarsomeres, large arolium and simple symmetrical claws on 5th tarsomere.

Female allotype.—External form and color similar to those of male except as follows: Tegmina with posterior margins broadly rounded, merging imperceptibly with lateroposterior angles; tergum 7 with lateroposterior an-

Fig. 1. Male genitalia of *Epilampra* spp. A, B, C, *E. involucris*. D, E, F, *E. belli*. G, H, I, *E. unistilata*. J, K, L, *E. rothi*. A, D, G, J, Ventromedial sclerite of left phallomere (L2vm), dorsal sclerite of L2 (L2d), prepuce (P). B, E, H, K, Hooked sclerite of right phallomere (R2), subapical incision (SI). C, F, I, L, First sclerite of left phallomere (L1), cleft (C). Scale bars = 0.5 mm. Fig. J from Roth (1970b, fig. 281).



gies acute; supra-anal plate uniform reddish brown, lacking color pattern noted for type, plate more transverse, not extending beyond subgenital plate; median notch shallow (0.15 mm deep). Subgenital plate fused with sternum 7 (as in all female blaberid cockroaches), its anterior margin slightly convex, posterior margin semicircular with sinuate outline. Genitalia not studied.

Male nymph (subimago).—Head broad, interocular distance nearly $\frac{1}{2}$ head width, interocellar distance $0.35 \times$ head width; front of head brown with scattered dark punctations, mouthparts lighter colored, maxillary palpus as in adult. Antenna brown; pronotum convex, semicircular in outline, posterior margin transverse, lateroposterior angles broadly rounded and extending posteriorly; meso- and metanota exposed; transverse wing pads seen as broadly rounded lateroposterior angles; color of entire notum light gray, heavily marked with black punctations and dark brown spots, spots concentrated centrally along posterior margins of terga. Abdominal terga bear acute spines at lateroposterior angles and raised cicatrices as described for adult; each cicatrix marked by dark brown spot; other spots on terga apparently formed by clusters of scattered dark punctations. Overall coloration shows "salt and pepper" effect characteristic of *Epilampra*. Supra-anal plate semicircular with broadly rounded lateroposterior margins reflexed and median notch at posterior end; coloration gray with numerous punctations; tan, black-tipped cerci stout, weakly segmented. Abdominal sterna light brown with dark punctations; subgenital plate with right style present, left absent (earlier instars have symmetrical paired styles).

Types.—Holotype δ , allotype f , 6 δ and 3 f paratypes and 2 δ nymphs all from COSTA RICA, Heredia Prov., Finca La Selva near Puerto Viejo, collected by C. Schal during 1979 and 1980; other male and female paratypes from same locality collected by F. W. Fisk in March 1974.

Remarks.—*Epilampra involucris* may be separated from other species in the *Carinulata* Group by means of the key. Based on external morphology alone it is difficult to separate from *E. belli*, but the male genitalia are distinct. Also, based on present knowledge, the species are allopatric; *involucris* is found in the Caribbean lowlands of north central Costa Rica while *belli* occurs in the Pacific highlands in southern Costa Rica near the Panama border. *Epilampra involucris* is commonly found in both primary and secondary (older than 20 years) forests in the Caribbean lowlands. The males rest in leaf litter by day but climb onto vegetation at dusk, rarely climbing higher than 50 cm above the ground. Females and nymphs are found in the leaf litter, though occasionally late instar nymphs and females climb as well. The courtship sequence is somewhat similar to that of *Gromphadorhina portentosa* (Schaum) (Barth, 1968). Following contact with a female the male arches his abdomen down and then up in a sweeping motion until he contacts the female's genitalia. The more common sequence noted

Table 1. Measurements of adult *Epilampra involucris* in mm.

	Holotype ♂	6 Paratype ♂ (Range)	Allotype ♀	3 Paratype ♀ (Range)
Total length	19.0	16.6–22.6	25.6	25.4–28.2
Pronotum, length	5.3	5.0–5.5	7.0	5.5–6.9
Pronotum, width	7.5	7.7–8.5	10.2	9.1–10.2
Tegmen, length	6.3	5.9–6.9	7.9	5.9–9.0
Tegmina, width	9.0	8.7–10.2	12.2	10.9–12.4
Abdomen, length	11.9	11.8–14.0	14.5	12.4–14.6
Hindtibia, length	7.2	6.6–8.5	9.2	8.3–9.8

in Blattaria, namely, mounting of the male by the female, does not occur in this species. Copulation takes place in the usual opposed position and lasts 20 to 30 minutes. As in other blaberid cockroaches the oothecae are not deposited externally but are held in the genital pouch until the young are hatched. Dissection of six oothecae disclosed 50 ± 2.53 (mean \pm standard deviation) developing embryos in each.

The name *involucris* refers to the flightless condition which this species shares with most members of the *Carinulata* Group.

Epilampra belli Fisk and Schal, NEW SPECIES

Figs. 1D, 1E, 1F

Male holotype.—Measurements in Table 2. Head broad and flat; interocular distance just over $\frac{1}{2}$ head width, interocellar distance $\frac{1}{3}$ head width; dark reddish brown color of body and head extends to clypeus; clypeus and mouthparts buff; expanded distal segment of clypeus velvety gray; antenna brown. Pronotum and tegmina as in *involucris*; both species show suffused sprinkling of darker spots around margins of pronotum and tegmina comparable to black punctations of other *Epilampra*. Lateroposterior angles of abdominal terga 2–4 about 90° , of terga 5 and 6 acute, spinelike, of tergum 7 rounded. Terga smooth except for cicatrices along distal margins; tergal specializations absent. Supra-anal plate extends beyond subgenital plate, broadly rounded posteriorly with very shallow notch; exposed portion of plate mostly transparent with scattered setae; cercus light brown, apical segment slender, black-tipped. Abdominal sterna and subgenital plate as in *involucris* (right style present, left absent). Genitalia (Figs. 1D, E, F) similar to those of *involucris* except as follows: R2 lacks any split on its outer circumference, L1 more sclerotized, L2d with free sclerotized portion shaped like hammerhead, proximal extension truncate, apical extension blunt-tipped; additionally, a sclerotized portion extends into membranous prepuce; prepuce nearly transparent, lacking microtrichiae. Legs differ from

Table 2. Measurements of *Epilampra belli* in mm.

	Holotype ♂	2 Paratype ♂ (Range)	Allotype ♀	3 Paratype ♀ (Range)
Total length	1	18.6–19.0	22.2	22.4–26.5
Pronotum, length	5.2	5.1–5.8	6.0	6.3–8.0
Pronotum, width	7.2	7.1–7.3	8.4	9.1–10.0
Tegmen, length	6.3	5.9–6.1	7.7	7.9–9.8
Tegmina, width	8.8	8.9–9.1	10.9	10.9–12.4
Abdomen, length	1	9.5–10.1	15.8	14.5–17.1
Hindtibia, length	6.5	6.6–6.8	8.2	7.5–9.5

¹ Tip of abdomen removed for dissection of genitalia.

those of *involutris* only in 3 (rather than 4) large spines on ventroposterior margin of hindfemur and smaller tarsal arolia.

Female allotype.—External features similar to holotype except as noted: Posterior margins of tegmina broadly rounded, merging with lateroposterior angles; abdominal terga 3–7 with lateroposterior angles acute, spinelike; supra-anal plate uniform dark reddish brown, posterior margin without median notch; subgenital plate with anterior margin slightly convex, posterior margin semicircular.

Types.—Holotype ♂ and allotype ♀ from COSTA RICA, Puntarenas Prov., Finca Las Cruces near San Vito, collected by W. J. Bell Jan. 27, 1980; 1 ♂ paratype collected by M. Koszarab Feb. 12, 1970 at same locality; 1 ♂, 3 ♀ paratypes collected by F. W. Fisk Feb. 4–6, 1974 from same locality.

Remarks.—*Epilampra belli* is closest to *E. involutris* but can be separated from it as noted in the key and remarks under *involutris*. Very little is known of its biology except that it favors very moist habitats. The species is named after Dr. William J. Bell who collected the type specimens.

Epilampra unistilata Fisk and Schal, NEW SPECIES

Figs. 1G, 1H, 1I, 2B

Male holotype.—Measurements in Table 3. Head flat; interocular and interocellar distances nearly equal, about ¹/₄ head width; vertex tan; nearly black interocellar band present; face and mouthparts mostly buff; maxillary palpus with 5th (distal) segment covered with gray microtrichiae, segments 3 and 4 subequal in length, shorter than 5; antenna brown; pronotum exposing vertex of head and dorsal areas of compound eyes; pronotum vaulted, anterior and lateral margins forming a semicircle; lateroposterior angles broadly rounded, right and left posterior margins straight, meeting at 120° angle; base color mottled red brown, interrupted by poorly defined pale median line. Tegmina fully developed, extending beyond tips of cerci; dis-

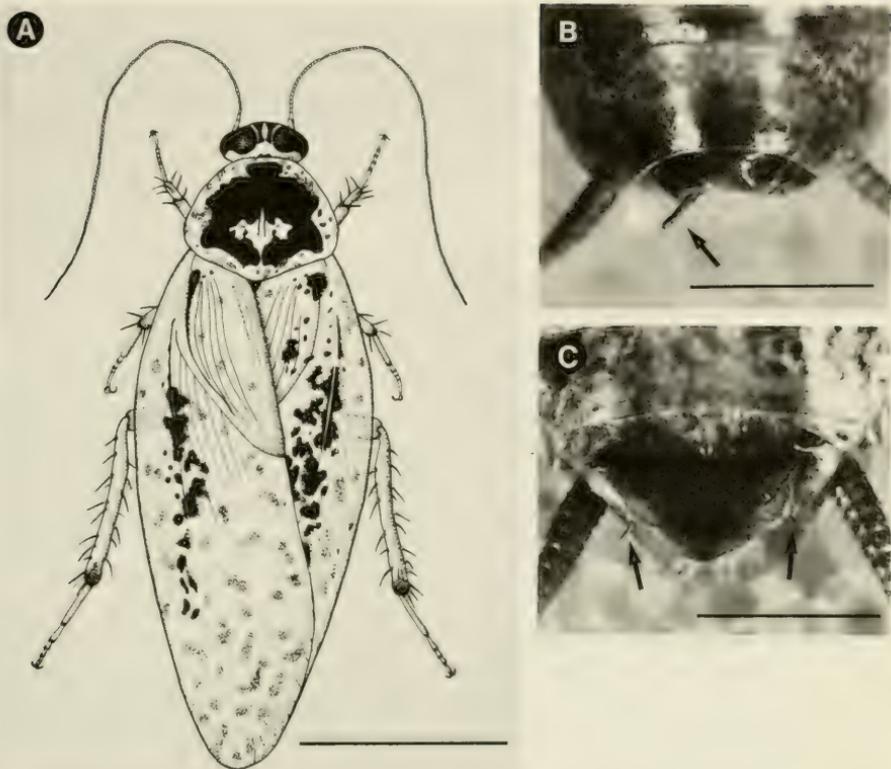


Fig. 2. A, Male *Epilampra rothi*, habitus of dark form; scale bar = 6.2 mm. B, C, Ventral aspect of distal part of abdomen. B, *E. unistilata*. C, *E. rothi*. Scale bars for B and C = 2.0 mm.

coidal sectors (M + Cu veins) oblique; wings and tegmina transparent, tinted with reddish brown, but tegmina also with darker brown mottling. Light brown abdominal terga have lateroposterior angles broadly rounded, cicatrices barely visible, tergal specializations lacking; supra-anal plate semicircular, rounded posterior margin with oblique median emargination; cercus slender, nearly 7× longer than wide.

Genitalia (Figs. 1G, H, I) characteristic for Group; R2 small and stout with blunt tip, no subapical incision or slender setae on sheath; L1 with a deep open cleft; L2d with flattened sclerotized portion ovate distally, proximal portion (adjacent to L2vm) with deep U-shaped emargination. Subgenital plate (Fig. 2B) convex anteriorly and posteriorly, posterior margin with ample median emargination, single style arising from right edge of emargination. Abdominal sterna light reddish brown with scattered darker tiny

Table 3. Measurements of *Epilampra unistilata* in mm.

	Holotype ♂	8 Paratype ♂ (Range)	Allotype ♀	3 Paratype ♀ (Range)
Total length	20.2	20.8–22.4	23.0	24.4–24.8
Pronotum, length	4.0	4.0–4.3	4.4	4.8–5.0
Pronotum, width	4.9	5.1–5.6	6.6	6.7–7.2
Fegmen, length	16.7	17.7–19.7	19.4	20.0–20.8
Tegmina, width	9.1	9.1–10.5	10.5	9.3–10.3
Abdomen, length	9.3	9.1–10.4	10.7	—
Hindtibia, length	6.7	6.5–6.8	7.3	7.4–7.7

spots, no spots on legs and ventral thorax; ventro-anterior margin of front femur with 3 large spines separated by row of widely spaced minute setae from 2 apical spines; ventro-anterior margins of mid- and hindfemora also ventroposterior margins of front and midfemora all with 3 large spines plus apical spine, ventroposterior margin of hindfemur as above but lacks apical spine; in addition, mid- and hindfemora bear genicular spine. Tibiae fully spined; tarsi with obvious pulvilli on 4 proximal tarsomeres; arolium present; claws simple, symmetrical.

Female allotype.—Similar to male in external form and color except as follows: Interocellar band not so dark; supra-anal plate with large posterior median emargination; cerci less slender, about 4× longer than wide; subgenital plate with posterior semicircular margin entire; ventro-anterior margin of front femur with 4 large spines (rather than 3); ventroposterior margin of hindfemur with 4 spines plus genicular spine.

Types.—Holotype and allotype collected in copulo by C. Schal May 4, 1979 in COSTA RICA, Heredia Prov., Finca La Selva near Puerto Viejo; 5 ♂ and 3 ♀ paratypes collected by C. Schal in 1979, same locality; 3 ♂ paratypes collected in light traps by H. Wolda July 10 and Oct. 13, 1977 in PANAMA, Chiriqui Prov., Fortuna; 5 ♂ paratypes collected in light traps by H. Wolda Feb. 17 and May 10, 1980 in PANAMA, Bocas del Toro Prov., Corriente Grande, on Rio Changuinola.

Remarks.—*Epilampra unistilata* is the only member of the *Carinulata* Group to have fully developed, functional wings and tegmina. It is placed in the group because of the single right style (from which the name is derived; Latin *Stilus*) and the morphology of the male genitalia which are most similar to those of *carinulata*.

Variations among the paratypes are noted in the intensity of coloration and the spination of the legs, that is, the ventro-anterior margin of the front femur has 4 (sometimes 3) spines separated by a row of fine setae from the 2 (sometimes 1) apical spines; the ventroposterior margin of the midfemur usually has 4 plus a distal spine; and the hindfemur usually has 4 large spines but no distal spine.

Epilampra unistilata occurs in the lower understory of lowland rain forests. Males are active starting around sunset. They usually climb to from 0.5 to 1.5 m above ground level. As noted above, they have been taken in light traps. Females are rarely seen and usually occur lower in the vegetation. Courtship was not observed, but copulation is in the typical opposed position. The ootheca of one female was found to contain 36 developing embryos.

Epilampra rothi Fisk and Schal, NEW SPECIES

Figs. 1J, 1K, 1L, 2A, 2C

Male holotype (light form).—Measurements in Table 4. Head flat, with interocular and interocellar distances equal, $\frac{1}{4}$ as wide as head; vertex pale cinnamon, interocular space suffused with dark brown, darkest adjacent to inner margins of eyes and ocellar spots; central brown mark just below ocelli and separated from interocular band by pale tan area, the mark connected dorsolaterally with pair of commalike spots, their "heads" directly beneath but not touching ocelli; pair of median brown spots on clypeus below central mark; remainder of head pale except gray-brown segments 4 and 5 of maxillary palpus; antenna brown. Vaulted pronotum covering most of head; ground color of pronotum and tegmina cinnamon, disc with diffuse pattern of darker areas; wide borders of pronotum and costal margins of tegmina pale with scattered darker spots; tegmina and wings translucent. Abdominal terga tan, lateroposterior angles rounded, no cicatrices or tergal specializations; supra-anal plate semicircular with median emargination not evident in holotype (but present in some paratypes); cercus slender, about 5× longer than wide; genitalia as in Figs. 1J, K, L; R2 with obvious sub-apical incision and row of slender spines proximal to base; L1 with short open cleft, setal brush lacking but a few widely scattered microtrichiae at that site; L2d shaped like mitten with thumb extended at near right angle; prepuce clearly defined by its scalelike covering. Legs and ventral surfaces of thorax and abdomen tan with a few darker spots, abdominal sterna increasingly darker towards posterior; reddish brown subgenital plate (Fig. 2C) convex anteriorly, trigonal posteriorly with nearly straight lateroposterior margins meeting at midline as a blunted right angle, simple style located at center of each lateroposterior margin; right style somewhat larger. Ventro-anterior margin of front femur with 5 large spines separated by row of close-set, short setae from 2 apical spines; ventro-anterior margins of mid- and hindfemora with 3 large spines plus apical spine; ventroposterior margin of front femur with 2 spines plus apical spine, of midfemur with 4 spines plus apical spine, of hindfemur with 4 spines only; tibiae fully spined; tarsi with pulvilli on 4 proximal tarsomeres and arolium on 5th tarsomere between simple, symmetrical claws.

Male paratype (dark form).—Differs from holotype in color as follows

Table 4. Measurements of *Epilampra rothi* in mm.

	Light Form (Costa Rica)				Dark Form (Panama)	
	Holotype Male	8 Paratype ♂ (Range)	Allotype Female	5 Paratype ♀ (Range)	24 Paratype ♂ (Range)	3 Paratype ♀ (Range)
Total length	20.0	19.4-20.2	20.8	19.4-22.3	18.2-20.6	20.7-21.3
Pronotum, length	4.2	3.7-4.1	4.3	4.1-4.7	3.9-4.4	3.7-4.7
Pronotum, width	5.1	4.7-5.7	5.7	5.4-6.6	4.7-5.0	5.0-5.9
Tegmen, length	16.8	16.6-17.3	17.0	16.0-19.4	16.0-18.3	16.1-17.9
Tegmina, width	8.2	7.5-9.4	9.0	8.4-9.9	7.7-9.3	9.1-10.0
Abdomen, length	10.8	10.4-11.0	11.1	11.5-13.8	10.3-11.1	9.9-12.4
Hindtibia, length	6.3	5.4-6.5	6.0	6.0-6.6	5.1-6.4	5.2-6.6

(Fig. 2A): Ground color of whole body buff, contrasting with numerous dark brown markings; vertex of head pale with dark stripes just dorsal and ventral to it, the 2 ventral stripes filling most of the interocular plus interocellar space (stripes fused on the midline in some paratypes); below stripes, but separate, is central dark mark with its dorsolateral commalike extensions; this mark fused with clypeal spots noted in holotype, resulting in very dark central mark with well defined margins which, along with small lateral spots and black mandibles, comprises characteristic facial pattern; maxillary palpus with light and dark bands on all segments. Dark disc of pronotum contrasts sharply with pale but spotted borders; very dark marks irregular (but consistent) in shape; obvious central pale area within disc enclosing 2 pairs of small black dots; tegmina with numerous dark brown spots, some fused into mottled dark areas especially along radial vein; venter of thorax and abdomen plus legs marked with numerous nearly black spots; some larger marks on coxae and femora and dark bands on tibiae and tarsi; subgenital plate and 2 adjacent sterna reddish brown except for narrow pale latero-posterior borders.

Female allotype (light form).—Similar to male holotype except as follows: General coloration more intense, dark markings on face as in dark form except the 2 clypeal spots not fused with central face mark; disc of pronotum and most of tegmina cinnamon, but wide borders of pronotum and costal margins of tegmina pale with numerous dark spots; abdominal terga shading to dark reddish brown towards supra-anal plate; plate dark with narrow pale borders and short median stripe extending anteriorly from posterior margin about $\frac{1}{4}$ length of plate; posterior margin with oblique median emargination; legs and venter of thorax and abdomen colored as in dark form males; subgenital plate semicircular in outline.

Female paratypes.—Other Costa Rican females less intensively colored than allotype, correspond more to cinnamon colored light-form males, while Panamanian females correspond to dark form males; that is, they have 2

clypeal spots fused with central facial mark, dark pronotal disc with central pale area and no cinnamon color on dorsum.

Types.—Holotype and allotype taken in copulo by C. Schal Feb. 23, 1980, COSTA RICA, Heredia Prov., Finca La Selva near Puerto Viejo; 6 ♂ and 3 ♀ paratypes collected by C. Schal in 1979 and 1980, same location; 2 ♀ paratypes collected by M. Kosztarab and A. Young in light trap, Jan. 10, 1970, same location; 2 ♂ and 2 ♀ paratypes taken by H. Wolda in light traps, May 1978, May and June 1979, PANAMA, Chiriqui Prov., Fortuna; 24 ♂ and 3 ♀ paratypes taken by H. Wolda in light trap between Jan. 13 and May 10, 1980, PANAMA, Bocas del Toro Prov., Corriente Grande on Rio Changuinola.

Remarks.—*Epilampra rothi* appears to represent the "n. sp. D" of Dr. Louis M. Roth (1970b) for whom we have named the species. As pointed out by Roth it is closest to but distinct from *Epilampra azteca* Saussure and falls in Subgroup C of the *Burmeisteri* Group of *Epilampra*. It exhibits considerable range in coloration. The dark form (from Panama) with striking dark markings against a pale background (Fig. 2A) most closely resembles *azteca* and has been mistakenly identified as *azteca* in the past (Roth, 1970b), while the light form (from Costa Rica and the adjacent Chiriqui Province of Panama) with suffused chestnut brown markings on a cinnamon brown background appears quite different. Both populations agree in external morphology and male genitalia, and we are treating them as one species. As noted in the descriptions some individuals show color patterns between the dark and light extremes.

Epilampra rothi is probably the most common species of its size in the lower understory of the Costa Rican lowland rain forest, but it is apparently more restricted in its Panamanian distribution. Males are common on leaves starting about sunset usually 0.5 to 1.5 m above ground. Females are relatively scarce and occur lower in the vegetation, while nymphs are common in the leaf litter. Copulation is in the opposed position. Courtship was not observed. C. Schal collected 3 males of this species in north central Nicaragua along the Rio Bocay.

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A NEW SPECIES OF *RHAGOLETOTRYPETA* (DIPTERA: TEPHRITIDAE)
FROM TEXAS, WITH A KEY TO THE KNOWN SPECIES

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Abstract.—A species previously identified with the Mexican species *Rhagoletotrypeta annulata* Aczél is shown on the basis of additional material reared from berries of *Celtis laevigata* Willd. (Ulmaceae) to be a new species, here described as *R. uniformis* including the larva, the first described in the genus. A key to the known species of *Rhagoletotrypeta* is also given.

Specimens of a tephritid fly reared from berries of the sugarberry or Mississippi hackberry (*Celtis laevigata* Willd.; family Ulmaceae) by D. R. Johnston were sent to me for determination. The specimens were found to be the same as earlier specimens collected by Mr. Johnston in the same locality and reported by R. H. Foote (1966) as *Rhagoletotrypeta annulata* Aczél. However, comparison of this additional material with authentic specimens of *R. annulata* revealed that the Texas specimens exhibited characters sufficiently distinct from those of *R. annulata* for it to be considered a distinct species. It is therefore so described here.

The six species of *Rhagoletotrypeta* now known may be distinguished as in the following key. I agree with Foote (1966) that the genus *Serpentographa* is congeneric with *Rhagoletotrypeta*, although it forms a monotypical group within that genus comprised by the type-species *R. argentinensis* (Aczél). Two other subgroups may be distinguished, one including the other two Argentinian species (*R. pastranai* and *R. xanthogastra*) and the other including the three North American species (*R. annulata*, *R. rohweri*, and *R. uniformis*, n. sp.).

KEY TO SPECIES OF THE GENUS *RHAGOLETOTRYPETA* ACZÉL

- 1(2). Medial crossband of wing (passing through *tp*) turned basad anteriorly, meeting costa well basad of *tp*; ovipositor with 2

- ventral notches close to tip and without lateral notches (Argentina) *R. argentinensis* (Aczél)
- 2(1). Medial band of wing more or less straight and oblique, meeting costa opposite to or apical of *tp*; ovipositor in known females with lateral notches and teeth or simply aculeate.
- 3(6). Mesoscutum with crescentic or J-shaped sublateral whitish marks and with mesal whitish stripe not extending anterior to transverse suture; scutellum broadly blackish basally as far as bases of lateral bristles; 4th and sometimes 5th abdominal terga with 4 black basal spots; ovipositor with 2 pairs of lateral teeth (Argentina).
- 4(5). Lateral whitish marks of mesoscutum largely on transverse sulcus, crescentic and extending but little posterad; mesoscutum without patches of whitish tomentum; humerus with central whitish spot *R. xanthogastra* Aczél
- 5(4). Lateral whitish marks of mesoscutum extending from transverse sulcus to postalar bristles; mesoscutum with pair of median fusiform patches of whitish tomentum in anterior $\frac{1}{2}$; humerus largely whitish *R. pastranai* Aczél
- 6(3). Mesoscutum with whitish marks only on humeri and meson, mesal stripe extending anterior to transverse sulcus; abdominal terga wholly yellowish or with varying extent of dark basal annulation, which may be interrupted mesally; ovipositor simply aculeate (female of *R. annulata* not known) (North America).
- 7(8). Dark bands of wing broad, apicomarginal band meeting medial band so broadly as to fill entire width of cells R_1 and R_{2+3} ; mesoscutum with 4 longitudinal stripes of gray tomentum, a pair on each side of mesal whitish stripe (northern USA)
 *R. rohweri* Foote
- 8(7). Dark bands of wing narrower, apicomarginal band not or only slightly invading cell R_{2+3} , where meeting medial band; mesoscutum with grayish tomentum covering 1 pair of narrow stripes on whole lateral $\frac{1}{3}$ of mesoscutum (south of range of *R. rohweri*).
- 9(10). Oblique dark pterostigmatal band of wing (from pterostigma to *tp*) of nearly uniform width; apicomarginal band at widest point about as wide as medial band in cell R_5 ; mesoscutum with pair of rather narrow gray tomentose stripes in intra-alar position (USA: Texas) *R. uniformis*, new species
- 10(9). Pterostigmatal band much broader in posterior than in anterior $\frac{1}{2}$; apicomarginal band very narrow, at broadest point much

narrower than medial band in cell R_5 ; mesoscutum lightly tomentose in lateral $\frac{1}{3}$ (Mexico: Tamazunchale, San Luis Potosi)

..... *R. annulata* Aczél

No data on the Argentinian species and *R. rohweri* have come to hand since those given in the original descriptions:

R. argentinensis (Aczél), 1951: 308 (*Serpentinographa*).

R. pastranai Aczél, 1954: 146.

R. xanthogastra Aczél, 1951: 315 (♀); 1954: 150 (♂).

R. rohweri Foote, 1966: 804.

Rhagoletotrypeta annulata Aczél

Fig. 1

Rhagoletotrypeta annulata Aczél, 1954: 142, fig. 13–15; pl. 2, B.

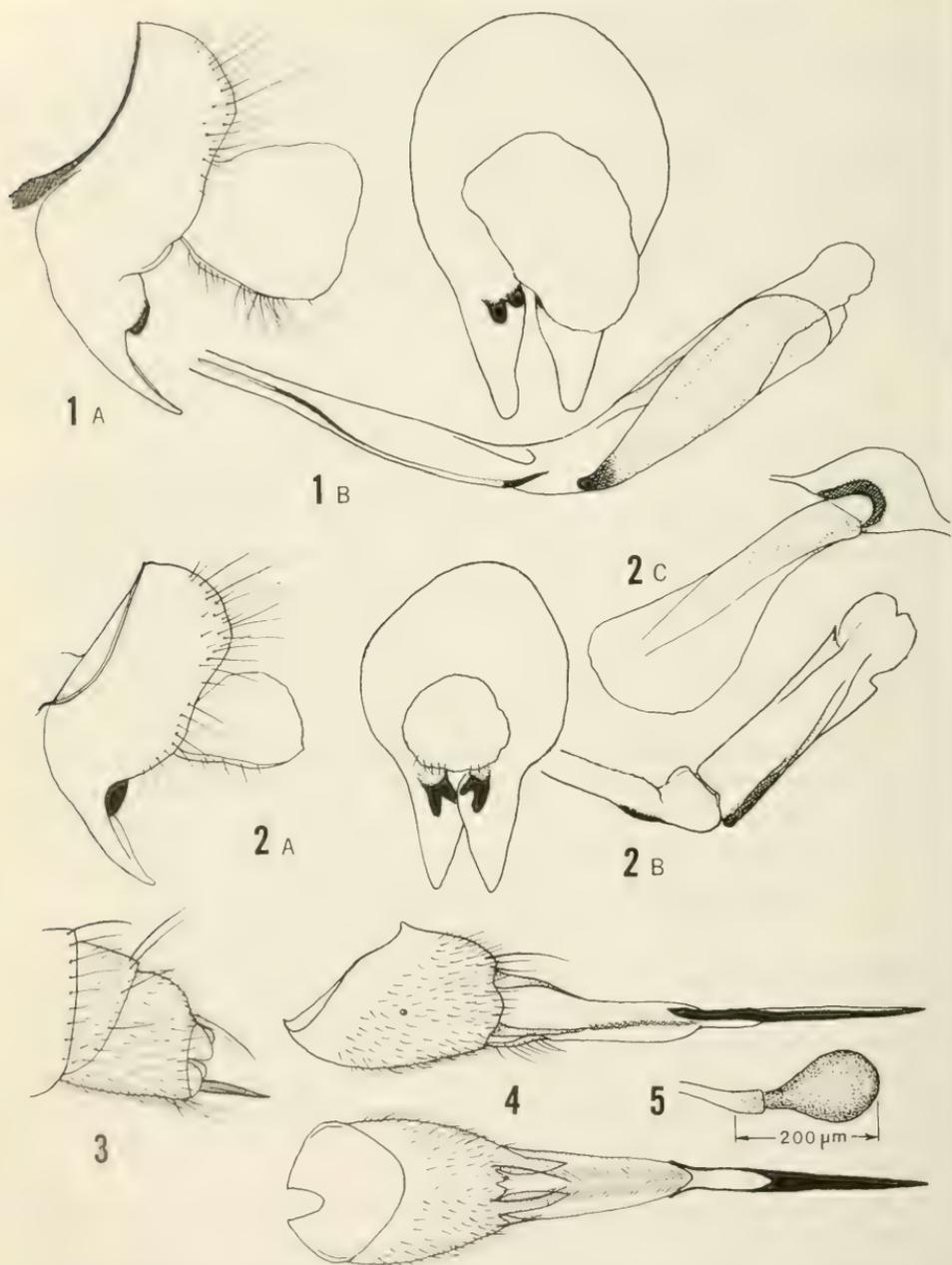
The only known specimens of this species, the male holotype and one male paratype, both in the U.S. National Museum, have been examined, including a preparation of the postabdomen of the paratype. Besides the characters cited in the key, the following distinctions from the new species described below were found: Femora blackish, yellowish only close to apex; abdominal terga distinctly annulate, second tergum (apical half of basal syntergum) blackish in basal half or a little more, yellowish apically; bands on remaining preabdominal terga complete but narrowed mesally (as in Aczél's Fig. 18); mesoscutum thinly gray tomentose in lateral third; male postabdomen as in Fig. 1, the cerci very large, the lobes of the epandrium more strongly projecting posteriorly than in *R. uniformis*, and the aedeagus 4.2 times as long as height of epandrium.

Rhagoletotrypeta uniformis Steyskal, NEW SPECIES

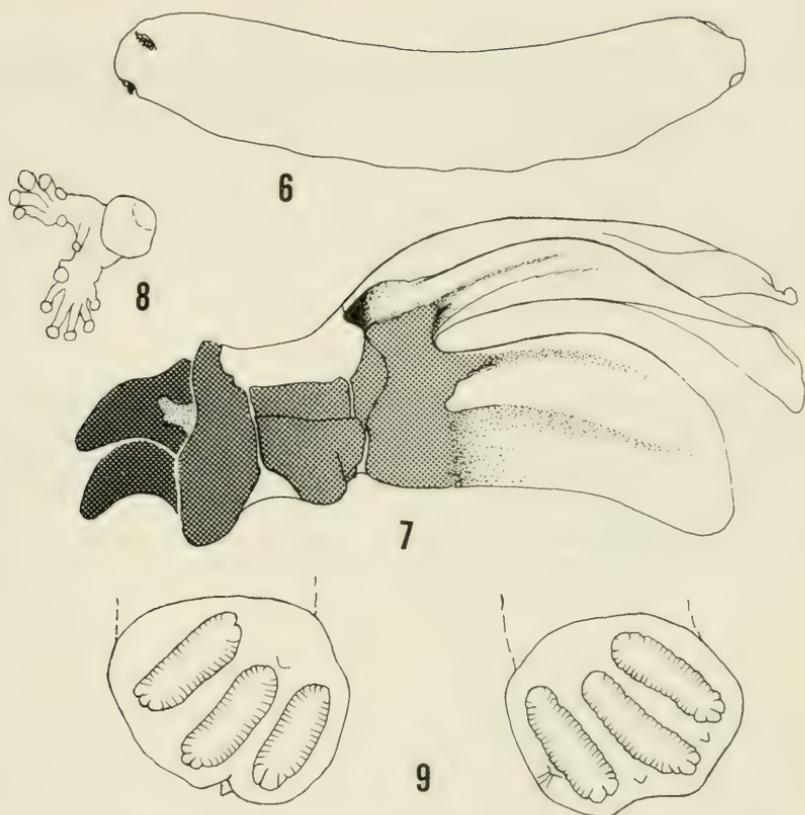
Figs. 2–9

Differs from *R. annulata* Aczél in having yellowish femora with no more than faint infuscation; abdominal terga varying from wholly yellowish to distinctly banded, the basal syntergum blackish in basal half and wholly yellowish in apical half, with no more than faint indications of pair of infuscated areas, remaining terga usually with blackish bands interrupted mesally, always so on 5th tergum; wing pattern as shown by Foote (1966: Fig. 7, as *R. annulata*).

Male.—Postabdomen as in Fig. 2, length of cerci about equal to that of body of epandrium; lobes of epandrium projecting less than in *R. annulata*, with strong denticles (prensisetae) well anterior to posterior profile of epandrium; aedeagus 3.5× as long as greatest height of epandrium (anterior margin to tip of lobes); aedeagal apodeme hardly capitate, unilaterally expanded toward tip.



Figs. 1-5. Terminalia. 1, *Rhagoletotrypeta annulata*. 2-5, *R. uniformis*. 1A, Male, lateral and posterior views. 1B, Apical part of aedeagus, lateral view. 2A, Male, lateral and posterior views. 2B, Apical part of aedeagus, lateral view. 2C, Sperm pump. 3, Same, female, lateral view, retracted. 4, Same, lateral and ventral views, extended. 5, Same, spermatheca.



Figs. 6-9. Larva of *Rhagoletotrypeta uniformis*. 6, Whole larva in profile. 7, Cephalopharyngeal skeleton. 8, Anterior spiracle. 9, Posterior spiracles.

Female.—Postabdomen in lateral view, retracted as in Fig. 3, extended as in Fig. 4, simply aculeate, tip beyond end of oviduct $1.5\times$ as long as basal portion; spermathecae 2, as in Fig. 5, dark brown with paler brown collar.

Larva (mature).—Whitish, mouthhooks and heavily sclerotized parts of cephalopharyngeal skeleton blackish, posterior spiracles and anal plates brownish; surface smooth, with creeping spicules minute and sparse: shape as in Fig. 6, length 6.3 to 7.4 mm, blunt at both ends; cephalopharyngeal skeleton as in Fig. 7, mouthhooks bluntly pointed, without accessory teeth; posterior spiracles as in Fig. 8, sunray hairs seen under high magnification at only one point on mesal side of right spiracle; anterior spiracle as in Fig. 9, with about 13 "buds" on fairly long stems; anal plates together forming circle.

Puparium.—Tawny, 4.0 mm long.

Types.—Holotype, ♂; allotype; and 2 ♂ and 11 ♀ paratypes, San Antonio, Texas, late May 1973 with 5 larvae (skin of one prepared as microslide) and several puparia (D. R. Johnston); also one pair of paratypes, 1 August 1956, and 1 ♂, 13 June 1970, same locality and collector. The 1973 series was collected from berries of *Celtis laevigata* collected in the fall of 1972. Adults emerged in jars sometime late in May; the exact dates are unrecorded, but a couple of adults were still alive on 10 June 1973. The other paratypes were caught outdoors, one on a screen door and another in the airline jetway at the San Antonio airport.

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THE GENUS *UROPLATA*, TYPE-SPECIES AND AUTHORSHIP
(COLEOPTERA: CHRYSOMELIDAE)

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Abstract.—The name *Uroplata* was validated in the Dejean Catalogue by citation of four species that were previously described. Authorship of *Uroplata* belongs to Chevrolat; errors in the literature have resulted in four other persons being attributed with authorship of the genus. *Uroplata mucronata* (Olivier) is designated as the type-species. Most of the 88 species in the genus occur in South America; one species has been introduced into Hawaii and Australia to aid in control of lantana.

I have received a request from a correspondent for the type-species of *Uroplata*. This appears to be a simple matter, but it is not. Uhmman, in his monumental catalogue of the world Hispinae (1957: 122), gave the author of *Uroplata* as "Chevrolat, 1837," and the type-species as *Uroplata vicina* Guérin-Méneville (1844: 274). My examination of "Chevrolat, 1837" (Dejean, 1837a: 365) has shown that four of the species listed were validated previous to publication of the Dejean catalogue. Therefore, *Uroplata* was validated by Dejean (1837a) because that citation constituted an indication within the meaning of Article 12 of the *International Code of Zoological Nomenclature* (International Commission on Zoological Nomenclature, 1964) and because the circumstances fulfilled the requirements of Article 16a(v) which defines an indication as ". . . the citation, in combination with a new genus-group name, of one or more available specific names; . . ."

In the Dejean catalogue (1837a: 365) there were 49 species names (most were *nomina nuda*) listed under *Uroplata* Chevrolat, with nine of them presented as synonyms. The four species names that were validated previous to the catalogue were *hastata* Fabricius (1801: 62), now in *Stethispa*; *mucronata* Olivier (1808: 765), now in *Uroplata*; *quadrata* Fabricius (1801: 65), now in *Baliosus*; and *inaequalis* Weber (1801: 65), now in *Anoplitis*. According to Article 69a of the *International Code of Zoological Nomenclature*, one of the originally included nominal species must be the type-

species. Since *Uroplata vicina* Guérin-Ménéville does not fulfill that requirement, I hereby designate *U. mucronata* (Olivier) as type-species of *Uroplata*. This action will cause no change in the currently accepted zoological application of *Uroplata*.

No less than five different workers have been, at one time or another, credited with authorship of *Uroplata*. Agassiz (1846: 168) attributed authorship to "Chevrolat, 1834." In the other great catalogues of zoological names, Scudder (1882: 333) also gave "Chevrolat, 1834" as author, but Neave (1940: 620) indicated that in the "Dejean 1835" citation *Uroplata* was a *nomen nudum*, and gave authorship to Guérin-Ménéville (1844: 274). Besides Uhmman (1957), another who gave Chevrolat as author was Chapuis (1875: 319). Guérin-Ménéville was again given as author by Baly (1885-86: 92). Weise (1911a: 46) gave Baly (1864: 335) as author of *Uroplata*, as did also Weise (1910: 146), Weise (1911b: 32), Blatchley (1924: 44), Blackwelder (1946: 729), Monros and Viana (1947: 279), and Uhmman (1947: 119). Maulik (1930: 48) and Uhmman (1937: 451) gave the author as Chapuis, 1875. Finally, Arnett (1968: 941) gave "Dejean, 1835," as author.

The confusion in the literature concerning the date of publication of *Uroplata* in the Dejean catalogue was caused by the issuance of the catalogue in parts. The correct date is 1837.

The publication by Dejean of *Uroplata* and its list of species appeared twice in the same year in the Dejean catalogue, and in identical versions. One was in the second edition (not so designated on the title page; 1837a: 365) and the other in the third edition (so designated on the title page; 1837b: 389). The dates of publication of the various parts of the Dejean catalogue, along with other important data, are discussed in an article by Barber and Bridwell (1940). They noted that Dejean, in the introduction to his third edition of the catalogue, gave responsibility to Chevrolat for genera proposed out of the old genera *Hispa*, *Cassida*, *Galeruca*, *Altica*, *Chrysomela*, *Colaspis*, *Eumolpus*, *Clytra*, *Cryptocephalus*, etc., and cited him as author in the catalogue. Barber and Bridwell therefore accepted Chevrolat as author of many Chrysomelidae genera in the Dejean catalogue, and I attribute authorship of *Uroplata* to Chevrolat on this basis.

The genus *Uroplata* in 1970 contained 88 species, all of which are native to the Americas, with most occurring in South America. These beetles are leafminers, and their most frequent hosts are plants of the genera *Lantana*, *Lippia*, *Verbena*, *Vernonia*, and *Pithecoctenium*. These are most often shrubs, herbs, or vines. The beetles also feed on plants of at least 19 other genera. One Brazilian species, *U. girardi* Pic, was released on Kauai, Hawaii, in 1965 to aid in control of *Lantana camara* L. cv. *Aculeata*; this beetle has also been established in Australia.

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BIOLOGY OF *MICRODON FUSCIPENNIS* (DIPTERA: SYRPHIDAE)
WITH INTERPRETATIONS OF THE REPRODUCTIVE STRATEGIES
OF *MICRODON* SPECIES FOUND NORTH OF MEXICO

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Abstract.—Two hundred and ninety six adults, larvae, and pupae of *Microdon fuscipennis* were collected and/or reared from nests of the dolichoderine ant, *Iridomyrmex pruinosus* (Roger). Observations are made on the distribution of *M. fuscipennis* in the ant nests, sex ratio (1:1), adult emergence, mating, number of eggs laid (\bar{x} = 63), larval emergence from the egg, and predation (third-instar fly larvae frequently eat ant larvae). Reproductive strategies for the genus *Microdon* are: 1) specialist strategy—one host species; and 2) generalist strategy—multiple host species. The species of *Microdon* found north of Mexico and their ant-associations are listed and used to predict the reproductive strategy of each fly species.

Microdons are unusual syrphid flies. The larvae and pupae are dome-shaped and develop in ant nests. The larvae exhibit slow, sluglike movements, a characteristic which originally caused them to be described as mollusks or coccids (Wheeler, 1908). As adults, microdons do not show typical syrphid behavior. They do not hover or visit flowers as most syrphids but spend their adult lives close to the ant colonies from which they emerged.

More than 350 species of *Microdon* are known from all zoogeographic regions. The diversity, greatest in the tropics (especially the Neotropics, 174 species), tapers off rapidly towards the poles. The northern- and southernmost records for microdons in the New World are *Microdon albicomatus* Novak from the Yukon (62°41'N) and *Microdon violaceus* (Macquart) from Chile (37°47'S). Microdons are considered primitive because they represent the first offshoot on the branch which includes all other syrphids (Thompson, 1969, 1972). The phylogenetic position and biologic distinctiveness of microdons clearly support the recognition of the group as a separate family (Thompson, 1969, 1972). For pragmatic reasons, however, microdons are left as an aberrant subfamily of the Syrphidae.

Early reviews on microdons (Wheeler, 1901, 1908; Donisthorpe, 1927)

were primarily descriptive, speculating on behavioral interactions between the larvae and their hosts. Andries (1912) first provided quantitative data on the life cycle of microdons as well as detailed descriptions of larvae, pupae, and adults. Greene (1955) added information on a number of *Microdon*-ant associations and described larval and pupal forms. More recently, Jordan (1968), and van Pelt and van Pelt (1972) contributed additional biological data (see Table 3). Akre et al. (1973) determined the sex ratio, size measurements, number of eggs laid per female, and the number of larvae and pupae per colony for two color morphs of *M. xanthopilis* Townsend (reported as *cothurnatus*), forming a sound basis for future comparative work on other *Microdon* species.

The biology of microdons is not uniform. Akre et al. (1973) described only one generation per year. *Microdon fuscipennis* (Macquart) has at least two. Akre et al. (1973) also stated that microdons overwinter as third larval instars, yet these data indicate that this is not true for *fuscipennis*.

Other unresolved questions exist. Are the microdon eggs laid in the ant nest or do the larvae move there? Do the microdon larvae eat the ant larvae and pupae?

These questions are discussed with respect to *M. fuscipennis* which develops in the nests of the dolichoderine ant, *Iridomyrmex pruinosus* (Roger). Two alternative behavioral strategies for *Microdon* flies are described. Table 2 lists the species of *Microdon* found in America north of Mexico and their known hosts and predicts their reproductive strategy.

MATERIALS AND METHODS

Collection.—*Microdon fuscipennis* was collected primarily during the spring and summer near Athens, Georgia, from nests of *Iridomyrmex pruinosus*. Ant nests were excavated with a pen knife. *Microdon fuscipennis* larvae and pupae were placed in plastic pop-top vials for transport. Entire ant colonies were also transported back to the laboratory.

Laboratory rearing.—The fly larvae were reared in plastic ant nests, exposed to natural daylight, and stocked with ant colonies dug in the field. The ants were maintained on honey and mealworms. Water was supplied by means of cotton plugs inside the nests. After the microdon larvae were observed eating the young ant larvae, additional ant larvae were added weekly to the colonies.

As the microdon larvae grew and pupated, the pupae were removed and placed in vials. A wooden stick was placed in each vial allowing the teneral adults an elevated surface from which they could expand their wings. All live material was kept at 27°C.

As the adults emerged, the pupal cases were removed from the rearing vials and placed in capsules. When an adult died, it was pinned along with the pupal case.

Table 1. Quantitative data on *Microdon fuscipennis*.

	Mean	Standard Deviation	n
Number of <i>M. fuscipennis</i> larvae, pupae per <i>I. pruinosus</i> colony	3.45	3.75	84
Number of eggs laid per female	63.5	18.9	15
Sex ratio	1:1		

Groups of approximately 30 eggs were hatched in 3 cm × 3 cm vials, fitted with a secure top and a 0.5 cm charcoal-plaster (1:2) bottom for humidity control. Water was occasionally added. No fungal inhibitor was added. Although some containers supported rich fungal growth, egg mortality was low.

RESULTS AND DISCUSSION

Field data.—Innumerable ant colonies of many different species were excavated. *Microdon fuscipennis* was found only in those of *I. pruinosus*.

Eighty-four *I. pruinosus* (Table 1) colonies containing microdon larvae and pupae were excavated. Over 20 additional nests contained only empty pupal cases. From the 84 colonies, 149 larvae, 141 pupae, and 6 adults were removed (296 total), giving an average of 3.5 microdons per colony. The largest number of microdons per colony was 24 (11 larvae, 12 pupae, and 1 adult). Between April and September, second and third larval instars and pupae could always be found in ant colonies. First-instars were also found from April to September, although very infrequently, perhaps because of their diminutive size and cryptic appearance. This suggests that *M. fuscipennis* reproduces all summer long. In contrast, *M. xanthopilis* has one generation per year (Akre et al., 1973). Premarked *Iridomyrmex* nests excavated in the winter revealed both second and third larval instars as well as pupae.

Laboratory data.—Reared adults had close to a 1:1 sex ratio, true also for *M. xanthopilis* (Akre et al., 1973).

Mating behavior.—Virgin females readily mated when placed with one male in the same vial. Although some females were unreceptive to a male, replacement with a second or third male eventually resulted in copulation. If mating resulted, it usually occurred within five minutes.

Soon after exposure to the female, the male would attempt to mount. Although no preliminary courtship was noted, *M. fuscipennis* adults emitted a "buzzing" sound when handled or first exposed to another individual. This phenomenon, common to many syrphid flies (Thompson, *in litt.*), was assumed to be defensive but may also be part of courtship. Frequently

several mounting attempts were made before copulation was successful. Mating position was similar to that described by Akre et al. (1973) for *M. xanthopilis*. The male prothoracic legs held the female's abdomen and the metathoracic legs were positioned on the tip of the female's abdomen. Frequently females were observed to stroke the male legs during copulation with her metathoracic legs. Copulation lasted from a few minutes to two hours. Both males and females readily mated more than once.

Oviposition.—Although a female mated soon after emerging from the pupal case, it usually took 24 hours before she oviposited. Females released eggs in batches of 4–5 in the rearing vials. If a small flat stone were placed in the mating vials, the female probed it with her ovipositor and then deposited the eggs beneath. Fifteen mated *M. fuscipennis* females deposited 925 eggs, averaging 63 eggs, with a maximum of 83 laid by one female (Table 1). Females reared from larvae laid as many eggs as those reared from pupae collected in the field. Eggs were usually laid within 48 hours and the female died within one day thereafter. *Microdon eggeri* Mik (Andries, 1912) and *M. xanthopilis* laid approximately 150 eggs per female (Akre et al., 1973). No field observations were made on oviposition of *M. fuscipennis*.

Eggs.—*Microdon fuscipennis* eggs were white, measured 0.7 mm × 1.5 mm, and had a distinctive sculpturing. Akre et al. (1973) found the eggs of *M. xanthopilis* to be much smaller (0.3 mm × 0.7 mm).

First larval instar.—First-instar larvae emerged through an elongated slit at the end of the egg between 7:00 and 9:00 AM. They were extremely mobile and demonstrated positive phototropism by moving toward the light in the rearing vial. Akre et al. (1973) observed similar behavior in *M. xanthopilis* and concluded that this mobility reflected a dispersal stage. This may be true, but it must also be noted that the problem of desiccation is paramount for the first-instar since the surface to volume ratio is highest for them. Rapid movement into an ant nest would increase survival where the ground temperature (i.e. *M. fuscipennis*) is over 38°C. If the eggs are deposited and hatch outside the ant nest, rapid movement would be imperative for survival. When first-instars are found in the field, they are in the depths of the colony. These areas have few ants, are the moistest part of the colony during dry periods, and have fairly constant temperature during the summer. Thus, this factor may have an important role in the survival of the first-instars in their natural environment.

First-instars placed in ant nests had mortality rates of 90% or more. *Iridomyrmex* workers easily turned over the first-instar larvae and carried them out of the colony to the refuse piles where they desiccated and dried. If the colony had a surplus of food, the searching activities of the ants were diminished and the first-instars were not found as frequently. Second- and third-instars did not appear to be killed as frequently.

In artificial nests, the first-instar larva usually restricted its movements to

the moist cotton plug. The plug originally was clear of fungal growth but quickly became contaminated. First-instars did best in nests which had contained ants for a number of weeks prior to the introduction of the fly larvae, and which also had fungus-covered cotton plugs. First-instars were never observed eating ant larvae although they frequently moved among the young ant brood.

Second and third larval instars.—Second- and third-instars were primarily found near the young ant brood and appeared to be less dependent on moisture than first-instars. In field colonies, these larvae are found just below the surface where the ants move the brood to take advantage of the optimum ground temperature. Fly larvae developed more quickly in the field than in the laboratory because of the higher ambient temperatures and a more plentiful food supply.

In laboratory colonies, second- and third-instar larvae consumed half-grown ant larvae or smaller ones but never pupae. Frequently the ants would pull the larvae away from the microdon. Successful microdons moved up and over the ant larvae piercing the larval skin and emptying the body contents, then discarding the empty shell. A worker would promptly pick up the larval remains and carry it to the refuse pile. Frequently, third-instars were observed consuming 8–10 larvae in a 30 minute period. I have also observed *M. globosus* (Fabricius) feeding on ant larvae. Similarly van Pelt and van Pelt (1972) reported that *M. baliopterus* Loew consumed larvae of the myrmicine ant, *Monomorium*.

Third larval instars prior to pupation occasionally released a clear brown fluid. Whether this fluid originated from the oral or rectal openings was not determined. The ants seemed to be attracted to the fluid and would consume it immediately. What the ants did with this fluid afterwards was not determined. Fluid release was also observed in *M. globosus*.

First larval instars, source of food.—In contrast to second- and third-instars, first larval instars were never observed eating ant larvae. First-instars frequently moved among the young ant larvae and would probe them with their mouthparts but never appeared to puncture the larval skin.

The first-instar fly larvae may obtain some form of nourishment from the ant larvae. Some myrmecologists (G. and J. Wheeler, personal communication) believe that the brood of the colony represents the digestive organ of the colony. Ant larvae are fed masticated proteinaceous materials; these materials are broken down and digested by the ant larvae and by trophallaxis fed back to the adult workers. The probing by the first-instar larvae may cause the ant larvae to release a liquid food which the fly larvae consume. No data presently exist to support this hypothesis.

Pupae.—Pupae were primarily found close to the surface (2 cm or less) in the larger galleries of the nest. Frequently groups of 3–4 pupae (emerged and yet to emerge) were found together. In the process of excavating col-

Table 2. Behavioral strategies of North American *Microdon*.

	STRATEGY I Example: <i>M. fuscipennis</i>	STRATEGY II Example: <i>M. xanthophilis</i>
1. Characteristics of the ant host		
a. Host	one host species	multiple host species
b. Size of the host	small species	large species
c. Brood production	throughout the summer	one generation per summer
d. Number of queens per colony	multiple queens	one or multiple queens
2. Number of generations of flies	multiple generations	one generation
3. Rate of development of the fly larvae	fast	slow
4. Food source	ant larvae	unknown
5. Reproduction	fewer eggs (ex. 62); larger in size	many eggs (ex. 150); smaller in size
6. Distribution	restricted to a single host	widespread, not restricted to a single host

onies with no larvae, empty pupal cases were found from the previous year. These were packed with soil and if the soil was moist, showed various degrees of deterioration.

Adult emergence.—Adult emergence from the pupal case took less than 60 seconds and usually occurred between 7:00 and 9:00 AM. The teneral adults crawled to the highest object in the rearing vial and remained motionless for 1–2 hours. Expansion of the wings rarely took more than 5–10 minutes. During the first 1–2 hours after emergence the adult flies released a fecal droplet.

Reproductive strategies of Nearctic microdons.—A compilation¹ of known information on microdon flies indicates two different reproductive strategies. *Microdon fuscipennis* and *M. xanthophilis*, two species for which we have relatively complete biological data, illustrate these different strategies (Table 2).

Microdon fuscipennis exemplifies the first strategy. Adults lay fewer eggs and seem to specialize on one host ant. This host is small, widely distributed, with populous colonies, multiple queens and a large quantity of brood. These host colonies support on the average 3.5 microdons (i.e. *M. fuscipennis*). Due to a long period of brood production, the microdon is able to

¹ These tables should be cited as: Duffield, R. M. and F. C. Thompson. 1981. Behavioral strategies and ant associations of the *Microdon* species found north of Mexico. Tables 2 & 3 in Duffield . . . etc.

Table 3. *Microdon*-ant associations for North American species north of Mexico. Subfamilies of ants are Formicinae (F), Dolichoderinae (D), and Myrmicinae (M).

Species of <i>Microdon</i>	Host Ant and Subfamily	Reproductive Strategy	Reference
<i>M. abditus</i> Thompson		1	
<i>M. abstrusus</i> Thompson	<i>Formica exsectoides</i> Forel (F)	2	this study
<i>M. adventitius</i> Thompson		1	
<i>M. albicomatus</i> Novak	<i>Formica obscuripes</i> Forel (F) <i>Formica fusca</i> L. (F)	2	Akre (<i>in litt.</i>) this study
<i>M. aurulentus</i> (Fabricius)		2	
<i>M. baliopterus</i> Loew	<i>Monomorium minimum</i> (Buckley) (M)	1	van Pelt and van Pelt, 1972
<i>M. coarctatus</i> Loew	<i>Aphaenogaster fulva</i> Roger (M) <i>Monomorium minimum</i> (Buckley) (M)	1	Greene, 1955 Greene, 1923a
<i>M. cothurnatus</i> Bigot	<i>Formica obscuripes</i> Forel (F) <i>Formica haemorrhoidalis</i> Emery (F) <i>Camponotus pennsylvanicus</i> (DeGeer) (F) ? <i>Camponotus vicinus</i> Mayr (F) <i>Camponotus novaeboracensis</i> (Fitch) (F) <i>Formica subnuda</i> Emery (F)	2	Cockerell and Andrews, 1916 Knab, 1917 this study Cole, 1923 this study this study
<i>M. craigheadii</i> Walton		1	
<i>M. diversipilosus</i> Curran		1	
<i>M. fulgens</i> Wiedemann	<i>Polyergus lucidus</i> Mayr (F); slave— <i>Formica schaufussi</i> Mayr (F) <i>Camponotus abdominalis</i> (Buckley) (F)	2	 this study
<i>M. fuscipennis</i> (Macquart)	<i>Iridomyrmex pruinosus</i> (Roger) (D)	1	this study
<i>M. globosus</i> (Fabricius)	<i>Tapinoma sessile</i> (Say) (D)	1	Greene, 1955; this study
<i>M. laetoides</i> Curran		1	
<i>M. laetus</i> Loew		1	
<i>M. lanceolatus</i> Curran	<i>Formica argentea</i> Wheeler (F)	2	Cockerell and Andrews, 1916
<i>M. manitobensis</i> Curran		2	
<i>M. marmoratus</i> Bigot		1	

Table 3. Continued

Species of <i>Microdon</i>	Host Ant and Subfamily	Reproductive Strategy	Reference
<i>M. megalogaster</i> Snow	<i>Formica subsericea</i> Say (F)	2	Greene, 1923b; this study
<i>M. newcomeri</i> Mann		2	
<i>M. ocellaris</i> Curran	<i>Formica schaufussi</i> Mayr (F)	2	this study
<i>M. painteri</i> Hull	<i>Monomorium minimum</i> (Buckley) (M)	1	this study
<i>M. piperi</i> Knab	<i>Camponotus vicinus</i> Mayr (F)	2	Cole, 1923
	<i>Camponotus</i> sp. (F)		this study
	<i>Camponotus herculeanus</i> (L.) (F)		this study
<i>M. ruficrus</i> Williston	<i>Lasius</i> sp. (F)	2	this study
	<i>Lasius alienus</i> (Foerster) (F)		this study
<i>M. rufipes</i> (Macquart)	<i>Pheidole dentata</i> Mayr (M)	1	this study
<i>M. scutifer</i> Knab		1	
<i>M. tristis</i> Loew	<i>Camponotus pennsylvanicus</i> (DeGeer) (F)	2	Greene, 1955
	<i>Camponotus novaeboracensis</i> (Fitch) (F)		this study
<i>M. viridis</i> Townsend		1	
<i>M. xanthopilis</i> Townsend	<i>Formica obscuripes</i> Forel (F)	2	Akre et al., 1973

produce more than one generation a year. Fly larvae consume ant larvae and are able to grow and develop quickly. The distribution of species exhibiting this strategy depends on the distribution of the host ant. This strategy is common to those species in the south.

A second strategy is reflected by *M. xanthopilis*. The adults are larger, lay more eggs, and specialize on closely related ant species. The host is usually large with populous colonies which can support one hundred or more microdon larvae. Fly development is slow, with only one generation a year. The larval food source is unknown, but probably is not the ant larvae.

Notes on other *Microdon* species.—Table 3 lists the species of *Microdon* found in America north of Mexico. Host records are included. The species taxonomy is that of Thompson (1981), who jointly developed these tables¹. Details on the new host associations will be found in Thompson (1981). The microdon species were assigned a reproductive strategy on the basis of the available information and our concepts of their phylogenetic relationships. For example, *Microdon albicomatus* Novak is assigned to strategy 2 as its host is a species of *Formica*. *Microdon abditus* Thompson is assigned to

strategy I as this species is closely related to *globosus* Fabricius, a strategy I species.

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REVISIONARY NOTES ON NEARCTIC *MICRODON*
FLIES (DIPTERA: SYRPHIDAE)

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Abstract.—A key to the adults and puparia of the species of *Microdon* Meigen found in America north of Mexico is given. For each species a short synonymy and summary of distribution and ant host records (new records for 11 species) are given. Lectotypes are designated for *M. aurulentus* Fabricius, *M. globosus* Fabricius, and *M. manitobensis* Curran. New synonyms are given for *M. globosus* (= *albipilis* Curran, = *conflictus* Curran, = *pseudoglobosus* Curran, and = *hutchingsi* Curran), *M. lanceolatus* Adams (= *modestus* Knab, = *senilis* Knab, and = *similis* Jones), *M. ruficrus* Williston (= *basicornis* Curran and = *champlaini* Curran), and *M. tristis* Loew (= *robusta* Telford). Three new species are described: *M. abditus* Thompson (New Hampshire, type-locality; eastern North America), *M. abstrusus* Thompson (Maryland, type-locality; Pennsylvania and West Virginia), and *M. adventitius* Thompson (Georgia).

Microdons have maggots that look like molluscan slugs and live with ants. The adults are typical flies. Interest in microdon biology has increased recently (Greene, 1955; van Pelt and van Pelt, 1972; Akre et al., 1973; Duffield, 1981), prompting a review of their taxonomy. My work has been done in conjunction with that of Duffield (1981), whose paper serves as a general introduction to mine.

Most of the north temperate species of *Microdon* are similar to one another, and their taxonomy has been considered difficult. Williston (1887), Johnson (1916), Knab (1917), and Curran (1925) have struggled with the taxonomy of Nearctic microdons, each successively contributing more to its resolution. Their works have been restricted to adults and have tended to divide intraspecific variation more finely and thus to recognize more species. I depart from this trend and recognize fewer species. Immatures and adults have been studied together, with the result that adults have been discovered to display more intraspecific variation than previously assumed possible. Akre et al. (1973) show that two distinct color morphs of *cothur-*

natus Bigot exist. This has led to a reevaluation of *lanceolatus* Adams, the color morphs of which were considered distinct species. Long series of adults reared by Duffield (1981) show that some adult characters vary. Altogether this study recognizes 30 species, 10 new synonyms, one new status, and 3 misidentifications.

Adult microdons are difficult to identify to species. Some new adult characters are used, such as pleural hair and wing microtrichia patterns, but the key to adults is still not perfect. This key distinguishes adults of most species and most adults of the other species. Characters that will discriminate adults of all species have not been found. Immatures differ distinctly between species. Associated material is readily identified, because species with similar adults usually have quite different immatures. Immatures are easily collected, and puparia are easily reared. Adults usually stay near their host ant nests, so when adults are collected, especially in numbers, the immatures may be nearby. Puparia are frequently found near the surface or openings of the ant colonies. Puparial exuviae should be glued to a card, and the card should be pinned and labeled in the same way as for adult specimens. Live puparia should be reared (see Duffield, 1981: 717). Larvae are usually found deep in the colony and should be fixed and then preserved in alcohol. Puparia are distinguished from larvae by the presence of anterior respiratory horns.

Genus *Microdon* Meigen

Microdon Meigen, 1803: 275. Type-species, *Musca mutabilis* Linnaeus (as *Mulio mutabilis* Fabricius; mono.).

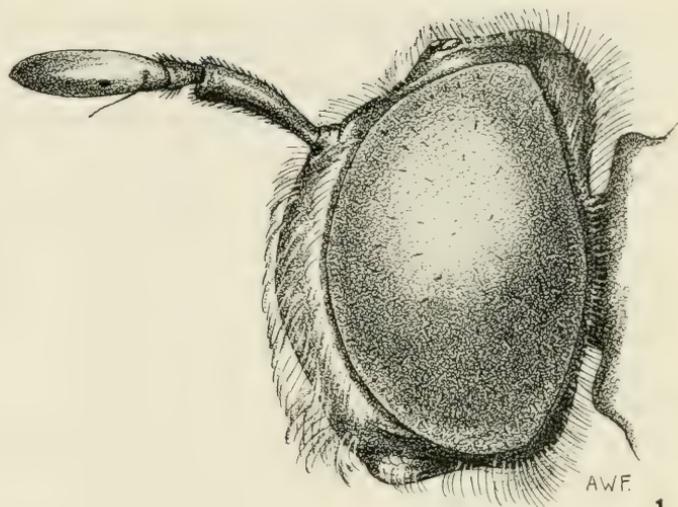
Microdon subg. *Serichlamys* Curran, 1925: 50. Type-species, *Aphritis rufipes* Macquart (mono.).

The taxonomy of the genus follows that of Curran (1925) except that the subgenus *Serichlamys* Curran is considered a synonym of the typic subgenus (Wirth et al., 1965: 597). The taxonomic placement of the genus is reviewed by Thompson (1969, 1972).

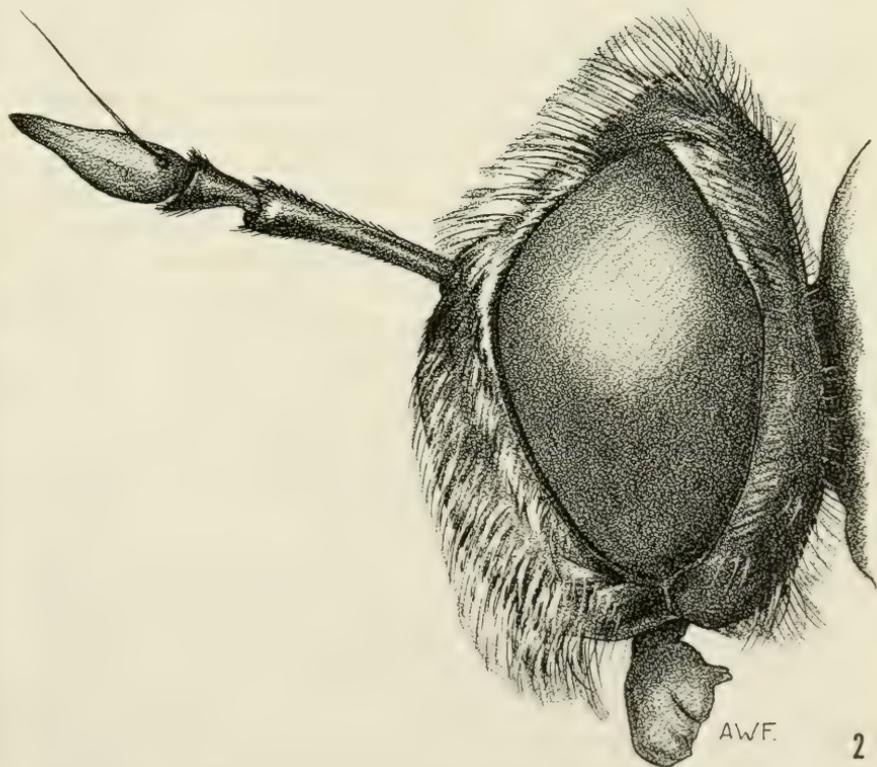
KEY TO THE ADULTS OF SPECIES OF *MICRODON* MEIGEN FOUND NORTH OF MEXICO¹

1. Abdomen narrow, narrower than thorax, parallel-sided, subcylindrical; 2nd tergum with sides arcuate, with strong basomedial depression and 2 sublateral depressions, subequal in length to 3rd tergum (Fig. 41); antenna short, shorter than face (Fig. 11); propleuron bare (sg. *Omegasyrphus*) 11

¹ In the keys a few supplemental characters are given in parentheses to further diagnose the species. The alternative for these characters are found in the couplets that follow the ones with the parenthetical material.



1



2

Figs. 1-2. Heads, lateral view. 1, *Microdon laetoides*. 2, *M. lanceolatus*.

- Abdomen usually broad, broader than thorax, without parallel sides; 2nd tergum never with 3 distinct depressions and not subequal to 3rd tergum; if with narrow abdomen (*laetus* Loew and *craigheadi* Walton), then either antenna longer than face or propleuron haired 2
- 2. Apical crossvein strongly angulate on anterior $\frac{1}{3}$ and with an external spur at point of angulation; abdomen triangular, with 2nd tergum very short and rectangular basolaterally (Fig. 40); body metallic green (sg. *Chymophila*) *fulgens* Wiedemann
- Apical crossvein evenly curved, without a sharp angulation nor with an external spur; abdomen more elongate, with 2nd tergum longer (sg. *Microdon*) 3
- 3. Eye distinctly haired; bright metallic green, blue or purple flies; body hair sparse, extensively white, not obscuring ground color (scutellum with small apicomedial spines) 9
- Eye usually bare (*rufipes* Macquart with eye haired); brownish orange to black flies, not with bright metallic ground colors, rarely with metallic golden or silvery hair obscuring ground color 4
- 4. Propleuron usually haired; if not, then either sternopleuron with anteroventral hair patch or scutellum with spines 14
- Propleuron bare; sternopleuron without anteroventral hair patch; scutellum without spines (Fig. 15), although it may be emarginate 5
- 5. Arista thick, short, less than $\frac{1}{2}$ as long as 3rd antennal segment (Fig. 21) (δ hindtarsus not swollen; scutellum convex; alula microtrichose; 3rd antennal segment more than $2\times$ as long as 1st (Fig. 7)) *fuscipennis* (Macquart)
- Arista thin, longer, more than $\frac{1}{2}$ as long as 3rd segment 6
- 6. Alula bare medially; scutellum not strongly emarginate 8
- Alula microtrichose 7
- 7. Widespread, but not Californian: δ 3rd antennal segment usually having long pubescence, with pubescence as long or longer than arisal width; δ hindtarsus frequently greatly swollen; scutellum usually deeply emarginate apically; 3rd antennal segment usually not much thicker basally than apically (Fig. 5) . . . *globosus* (Fabricius)
- Californian: δ 3rd antennal segment having very short pubescence, with pubescence shorter than arisal width; δ hindtarsus not greatly swollen; scutellum only slightly emarginate apically; 3rd antennal segment frequently large basally and gradually narrowed apically (Fig. 3) *marmoratus* Bigot
- 8. Third antennal segment long, about $3\times$ as long as 1st (Fig. 4); δ front broad; δ hindtarsus not swollen *adventitius* Thompson

- Third antennal segment short, shorter than 1st (Fig. 12); ♂ front narrow; ♂ hindtarsus swollen *abditus* Thompson
- 9. Tibiae more extensively dark, only pale narrowly on base and apex: fore- and midtibiae reddish brown; hindtibia metallic bluish green: ♀ 3rd antennal segment with elongate sensory pit (Fig. 9); 2nd basal cell bare. (Larger flies, longer than 8 mm) .. *craigheadii* Walton
 - Tibiae orange except for narrow dark medial scars; ♀ 3rd antennal segment with a small oval sensory pit (Figs. 1, 10); 2nd basal cell microtrichose on most of apical $\frac{2}{3}$ 10
- 10. Front entirely and vertex extensively white-haired, only ocellar triangle black-haired; abdomen entirely white-haired; front smooth; larger flies, longer than 8 mm *laetoides* Curran
 - Front and vertex black-haired; abdomen partially black-haired; front rugose; smaller flies, shorter than 8 mm *laetus* Loew
- 11. Wing with black maculae broadly connected anteriorly *pallipennis* Curran
 - Wing with black maculae isolated 12
- 12. Abdomen metallic blue *coarctatus* Loew
 - Abdomen not metallic blue 13
- 13. Abdomen almost entirely piceous red *painteri* Hull
 - Abdomen largely metallic blackish green *baliopterus* Loew
- 14. First abdominal sternum bare and reduced or absent 15
 - First abdominal sternum haired and well developed 17
- 15. Legs brown to black; mesonotum orange laterally; scutellum orange; eye bare *scutifer* Knab
 - Legs extensively orange, only coxae, trochanters and basal $\frac{1}{3}$ of femora dark; mesonotum and scutellum dark 16
- 16. Abdomen entirely golden-yellow-haired; hindbasitarsus yellow-haired; fore- and midtarsi all pale orange; eye bare *diversipilosus* Curran
 - Abdomen with large basolateral patches of black hair on terga; apical sterna with black hair medially; hindbasitarsus black-haired above; fore- and midtarsi with brown apical tarsomeres; eye haired *rufipes* Macquart
- 17. Third antennal segment short, conical, shorter than arista (Fig. 2). (Scutellum without distinct spines or tubercles (Fig. 14); sternopleuron with anteroventral hair patch) *lanceolatus* Adams
 - Third antennal segment long, not conical, longer than arista 18
- 18. Entirely black-haired, metallic purplish black. (Scutellar spines minute and obscured by hair; sternopleuron with anteroventral hair patch) *newcomeri* Mann
 - Partially yellow or pale-haired 19

19.	Abdomen black-haired beyond 2nd segment; legs usually entirely black-haired. (Sternopleuron usually with anteroventral hair patch; scutellar spines minute or absent (Fig. 20))	<i>megalogaster</i> Snow	20
	Abdomen and legs more extensively pale-haired		20
20.	Third antennal segment elongate, longer than 1st segment, with apex thin and flared (Fig. 6); sternopleuron usually with anteroventral hair patch; scutellar spines large, haired (Fig. 19); trochanters and ventral surface of basal $\frac{1}{4}$ of femora pale orange	<i>tristis</i> Loew	
	- Third antennal segment shorter, usually shorter than 1st segment; if not, other characters different		21
21.	Sternopleuron without anteroventral hair patch		27
	- Sternopleuron with anteroventral hair patch. (Legs usually dark, black to dark reddish brown)		22
22.	Front and vertex extensively black-haired, with only a few marginal yellow hairs; abdomen black-haired beyond 3rd segment; metallic bluish green	<i>piperi</i> Knab	
	- Front, abdomen, or both, more extensively pale haired; not metallic bluish green		23
23.	Femora entirely pale-haired		25
	- Femora usually extensively black-haired dorsoapically, almost always with some black hair at least on hindfemur		24
24.	Second basal cell frequently bare basoposteriorly; scutellum frequently bright golden-haired; larger and more robust flies	<i>manitobensis</i> Curran	
	- Second basal cell frequently microtrichose; scutellum white-haired; smaller and more slender flies	<i>albicomatus</i> Novak	
25.	Scutellum with distinct spines (Fig. 18); tibial hair dense and long	<i>ocellaris</i> Curran	
	- Scutellum usually without spines, rarely with small spines (Fig. 16); tibial hair sparse and short		26
26.	Femora pale ventrally; eastern North America	<i>abstrusus</i> Thompson	
	- Femora black; Pacific Northwest	<i>xanthopilis</i> Townsend	
27.	Thorax and abdomen extensively metallic golden-haired; wing completely microtrichose. (Scutellar spines large, haired; tibiae pale orange on basal $\frac{1}{2}$)	<i>aurulentus</i> (Fabricius)	
	- Thorax and abdomen pale yellow-haired to white-haired; wing usually partially bare		28
28.	Scutellar spines large, haired (Fig. 17); legs entirely black	<i>ruficrus</i> Williston	
	- Scutellar spines minute or absent, bare; tibiae pale orange on basal $\frac{1}{2}$		29

29. Second basal cell bare basoposteriorly; tibiae pale orange on basal $\frac{1}{2}$, frequently base and venter of femora also orange; basicosta yellow-haired *cothurnatus* Bigot
 – Second basal cell microtrichose; legs black; basicosta partially black-haired *albicomatus* Novak

KEY TO THE PUPARIA OF SPECIES OF *MICRODON*
 FOUND NORTH OF MEXICO

1. Dorsal surface smooth (Figs. 22, 23, 26, 28) 11
 – Dorsal surface reticulate or rugose (Figs. 24, 25, 27) 2
 2. Dorsal surface irregularly reticulate, with reticulations and hairs forming large patches, smooth between patches (Fig. 25); posterior spiracular tubercle cylindrical, ending in a medial cone, with spiracular openings lateral; anterior spiracular tubercle long, about $2\times$ as long as broad. (Marginal fringe broad) *rufipes* (Macquart)
 – Dorsal surface uniformly reticulate (Fig. 27); posterior spiracular tubercle not as above, with spiracular opening apical; anterior spiracular tubercle shorter, less than $2\times$ as long as broad 3
 3. Marginal band thin, with only a ventral fringe (Fig. 38); posterior spiracular openings forming two semicircular groups 5
 – Marginal band thick, with both a dorsal and ventral fringe (Figs. 37, 39); posterior spiracular openings divided into 4 groups 4
 4. Anterior spiracular tubercle long, about $1\frac{1}{2}\times$ as long as broad, with pores not protuberant; posterior spiracular tubercle without apical medial carina *ruficrus* Williston
 – Anterior spiracular tubercle shorter, only about as long as broad, with pores protuberant; posterior spiracular tubercle (Fig. 29) with apicomedial carina between spiracular openings .. *fulgens* Wiedemann
 5. Marginal fringe penicillate, that is, with tufts of longer hairs alternating with shorter hairs (Fig. 36) *abstrusus* Thompson
 – Marginal fringe of uniform width, all hairs of the same length 6
 6. Posterior spiracular tubercle with median carina separating spiracular openings *tristis* Loew
 – Posterior spiracular tubercle without carina 7
 7. Dorsal surface indistinctly reticulate (Fig. 22). (Anterior spiracular tubercle about as long as broad) *ocellaris* Curran
 – Dorsal surface distinctly reticulate 8
 8. Anterior spiracular tubercle smooth laterally 9
 – Anterior spiracular tubercle rugose laterally 10
 9. Posterior spiracular tubercle triangular in posterior view; anterior spiracular tubercle short, broader than long *cothurnatus* Bigot

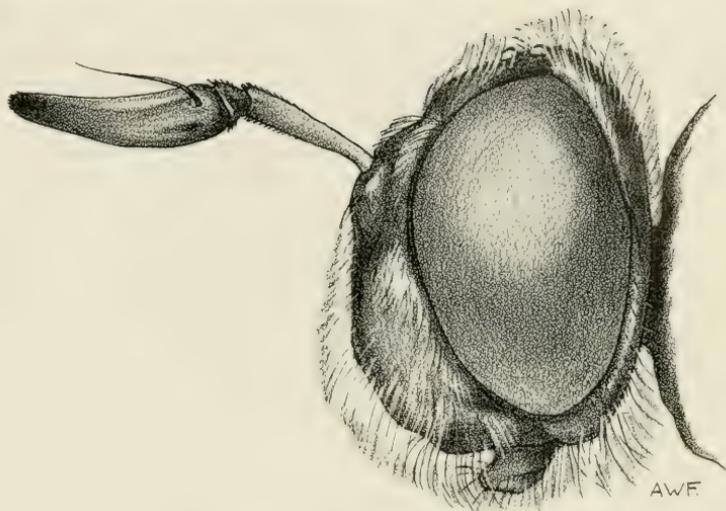
- Posterior spiracular tubercle semicircular in posterior view; anterior spiracular tubercle long, longer than broad . . . *xanthopilis* Townsend
- 10. Anterior spiracular tubercle long, twice as long as broad; dorsolateral surface without tubercles in middle of many reticulate areas *albicomatus* Novak
- Anterior spiracular tubercle short, only about as long as broad; dorsolateral surface with 1-4 tubercles in middle of many reticulate areas *piperi* Knab
- 11. Posterior spiracular tubercle conical (Fig. 30); dorsal surface with peculiar lateral knoblike processes (Fig. 35) *Microdon (Omegasyrphus)* spp.
- Posterior spiracular tubercle elongate, usually expanded apically; dorsal surface without knoblike processes 12
- 12. Submarginal fringe present (a thick-haired band dorsad to marginal fringe); marginal band thin 13
- Submarginal fringe absent; marginal band thick 15
- 13. Posterior spiracular tubercle short, broader than long *ocellaris* Curran
- Posterior spiracular tubercle long, longer than broad 14
- 14. Posterior spiracular tubercle concave posteriorly, with spiracular openings broadly separated and rugose, i.e., edges of openings slightly protruding to give the surface a rugose appearance (Fig. 33); marginal band broad, much broader than apical fringe (Fig. 38, a, b) *megalogaster* Snow
- Posterior spiracular tubercle only slightly concave posteriorly, with openings not broadly separated, with surface smooth; marginal band very narrow, apical fringe much broader than band *manitobensis* Curran
- 15. Marginal band thin; posterior spiracular tubercle not flared apically *lanceolatus* Adams
- Marginal band thick; posterior spiracular tubercle flared apically . . 16
- 16. Anterior spiracular tubercle short, less than 2× as long as broad; posterior spiracular tubercle smooth laterally, reticulate medially (Fig. 34) *globosus* (Fabricius)
- Anterior spiracular tubercle long, more than 2× as long as broad; posterior spiracular tubercle reticulate all around base *fuscipennis* (Macquart)

Subgenus *Microdon* Meigen

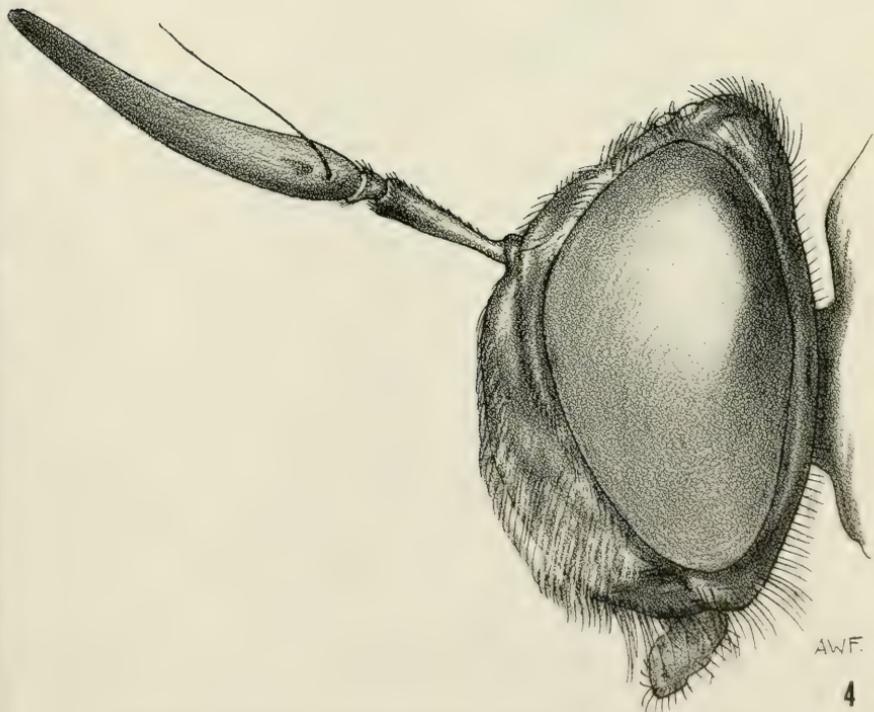
Microdon abditus Thompson, NEW SPECIES

Figs. 12, 23

globosus of Curran, 1925: 53 (descr., MG*, distr., syn. notes).



3



4

Figs. 3-4. Heads, lateral view. 3, *Microdon marmoratus*. 4, *M. adventitius*.

As there has never been any question as to the identity of this species since Williston (1887) first separated it from *globosus* Fabricius (as *fuscipennis*), I merely provide reference to the most recent description of it. This species is named *abditus* from the Latin meaning concealed, referring to the fact that this species was "concealed" under various incorrect names.

Material examined.—Holotype ♂, paratype ♀, NEW HAMPSHIRE, Coos County, 1st Connecticut Lake, 28 June 1976, L. V. Knutson, swept from grasses and sedges along the shore of the lake, deposited in U.S. National Museum. Paratypes: CANADA. QUEBEC: Joliette, 15 August, Aldrich, 1 ♂ (USNM); Covey Hill, 16–29 June 1927, W. J. Brown, 16 ♂ ♀ (CNC, USNM); Covey Hill, 23 June 1924, G. S. Walley (1 ♂ CNC); Wakefield, 24 June 1946, G. S. Walley, 18 ♂ ♀ (CNC, USNM); St. Martin, June, 1 ♂ (CNC); Beechgrove, 29 July 1962, J. R. Vockeroth, 1 ♂ (CNC); St. Ann's, 14 June 1940, D. J. McDonald, 1 ♂ (CNC); Abbotsford, 16 July 1937, G. Shewell, 1 ♂ (CNC); Brome, 8 June 1936, W. J. Brown, 1 ♂ (CNC); Farm Point, 10 July 1959, S. D. Hicks, 1 ♂ (CNC); Montreal Island, 1 ♂ 1 ♀ (MCZ). ONTARIO: Alfred, 17 June 1976, H. J. Teskey, 4 ♂ (CNC, USNM); Apple Hill, 1 July 1932, G. H. Hammond, 1 ♀ (CNC); Bridge End, 23 June 1940, D. J. McDonald, 1 ♂ (CNC); Britannia, 5 June 1948, S. D. Hicks, 3 ♂ (CNC); "Kilworth," 15 June 1934, 1 ♂ (CNC). U.S.A. CONNECTICUT: "Austan," 3 June 1918, H. C. Fall, 1 ♀ (MCZ); Lyme, 16 June 1918, S. W. Fisher, 3 ♂ 1 ♀ (USNM), 2 June 1918, Champlain, 1 ♂ (USNM), 3 June 1918, Champlain, 3 ♂ (USNM), 27 June 1918, Champlain, 1 ♂ (USNM), Williston, 1 ♂ (USNM); North Guilford, 12 June 1941, N. Turner, 1 ♀ (CNC). ILLINOIS: 3 miles south of Norris City, 27 May 1961, G. P. Waldbauer, 1 ♀ (Waldbauer Coll.). MAINE: Hollis, 12 June 1918, J. H. Emerton, 1 ♀ (MCZ); Saco, 27 June 1940, Wm. Nutting, 1 ♀ (MCZ). MASSACHUSETTS: Andover, June 1869, 1 ♂ (USNM); Beverly, 20 June 1868, 1 ♀ (USNM); Sherborn, 12 June 1915, C. A. Frost, 1 ♀ (USNM); Framingham, June, C. W. Johnson, 1 ♀ (MCZ); Wellesley, A. P. Morse, 1 ♀ (MCZ). MICHIGAN: Wexford County, 11 June 1949, R. R. Dreisbach, 2 ♀ (MCZ, USNM). NEW YORK: Fort Montgomery, 17–19 June 1919, F. M. Schoot, 2 ♂ (MCZ, USNM), 24 June 1917, F. M. Schott, 2 ♀ (MCZ, USNM); Keene Valley, 7 July 1917, H. Notman, 1 ♂ (USNM); Lake Champlain, Corlear Bay, July 1939, R. C. Shannon, 1 ♀ (USNM). NEW JERSEY: Middlesex County, 11 June, C. W. Johnson, 1 ♂ (MCZ); Morriston, 24 June 1926, 1 ♂ (USNM); Ramsey, 12–13 June 1916, J. Bequaert, 3 ♂ (MCZ, USNM); Westville, 10 September 1911, A. L. Melander, 1 ♀ (USNM); "Gt. Piece Mdw.," 30 May 1919, J. Bequaert, 1 ♂ (USNM). NEW HAMPSHIRE: Noxon Camp, 2000 ft, 5 July 1931, J. M. Aldrich, 1 ♀ (USNM). NORTH CAROLINA: Jackson County, 9 miles southeast of Cashiers, 24 May 1977, D. W. Webb, 3 ♂ (Maier & INHS). PENNSYLVANIA: Lancaster County, .6 miles southwest of Blainsport, 22 June 1978, C. Shiffer,

1 ♂ (Shiffer Collection), 21 June 1978, C. Shiffer, 1 ♀ (Shiffer Collection). WEST VIRGINIA: Pocahontas County, Rt. 28, circa 10 miles south of Frost, 9 June 1979, A. G. Wheeler, Jr., 1 ♂ 1 ♀ (USNM).

Microdon abstrusus Thompson, NEW SPECIES

Fig. 36

ruficrus of Greene, 1955: 9 (L* descr. (L P)).

Adult male.—*Head*: Brownish black, pale yellow-haired; face shiny except narrowly pale pollinose laterally, broad, $\frac{1}{2}$ of head width at its broadest; cheek pale pollinose; front and vertex shiny, about $\frac{1}{4}$ head width at its narrowest; ocellar triangle broad, ratio of longitudinal axis (from anterior ocellus to base) to latitudinal axis (between posterior ocelli) about 0.4; eye bare; occiput pale pollinose. Antenna black haired; 3rd antennal segment blunt apically; ratio—2.5:1.0:2.8.

Thorax: Brownish black, with slight greenish-blue iridescence, pale yellow-haired, extensively shiny; propleuron pollinose, haired above front coxa; sternopleuron with anteroventral hair patch; scutellum convex apically, without spines; squama and halter pale yellow. *Wing*: Hyaline, microtrichose; epaulet black-haired; basicosta yellow-haired. *Legs*: Brownish black except orange ventrally on femora and tibiae, pale yellow-haired.

Abdomen: Brownish black, with slight greenish blue iridescence, pale yellow-haired except black-haired narrowly basomedially on 3rd and 4th terga.

Female.—Same as male except for normal sexual dimorphism.

Larva and puparium described by Greene (1955: 9 as *ruficrus*). The specific name, *abstrusus*, is from the Latin meaning hidden.

Ant host.—*Formica exsectoides* Forel.

Material examined.—Holotype ♂ and associated puparium, MARYLAND, Prince Georges County, Beltsville, 19 May 1979, R. M. Duffield and F. C. Thompson, from *Formica exsectoides* colony, deposited in U.S. National Museum. Paratypes: 19 ♂, 10 ♀, 9 puparia, all from same locality, but some collected 15 April 1978 and May 1980 (USNM). PENNSYLVANIA, Centre County, Colyer Lake, Potter Turnpike, 25 May 1977, F. D. Fee, 2 ♂ (Fee coll.). WEST VIRGINIA, Hardy County, 2 miles northwest of Mathias, 25 April 1980, R. D. Gordon, 3 larvae (USNM).

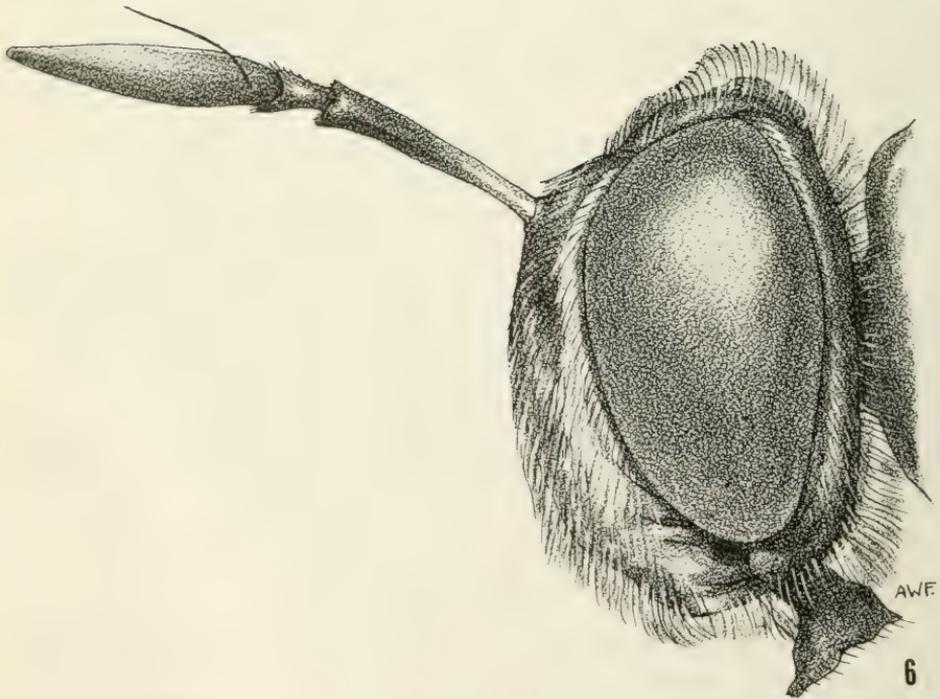
Microdon adventitius Thompson, NEW SPECIES

Figs. 4, 15

Adult male.—*Head*: Face orange, yellow haired, with sides slightly convergent dorsally, medially convex, dorsolaterally depressed; cheek brown, yellow-haired; front broad, about $\frac{1}{3}$ head width, parallel-sided, orange except brownish ventrolaterally, yellow-haired; vertex yellow, yellow-haired;



5



6

Figs. 5-6. Heads, lateral view. 5, *Microdon globosus*. 6, *M. tristis*.

ocellar triangle small, equilateral, yellow except ocelli bordered with black; occiput brown on ventral $\frac{2}{3}$, yellow dorsally, yellow-haired; eye brown, bare. Antenna brownish orange on first 2 segments, brownish black on 3rd, arista yellow; 3rd segment curved, with small sensory pit on base near aristal insertion; antennal ratio—4:1:13; arista long, about $\frac{2}{3}$ as long as 3rd segment, somewhat thick, about $\frac{1}{8}$ as thick as basal width of 3rd segment.

Thorax: Humerus orange, yellow-haired; propleuron bare; mesonotum brownish black except orange laterally, yellow-haired; scutellum orange, convex apically, without spines, yellow-haired; pleuron orange except darker brown on pectus, yellow-haired; sternopleuron without anterior hair patch. *Wing:* Brownish except darker brown anterior margin and apical crossveins, microtrichose except bare on base of 2nd basal cell and medially on alula. *Legs:* Orange except femoral scars brownish black dorsally, yellow-haired.

Abdomen: Brownish orange, generally yellow-haired, black haired narrowly and subapically on 2nd, on basal $\frac{2}{3}$ of 3rd, and basal $\frac{1}{2}$ of 4th terga, intermixed on 4th sternum; 1st sternum well developed.

Female.—Same as male except for normal sexual dimorphism.

Microdon adventitius is similar to and the sister-species of the species pair, *remotus* Knab (Cuba) and *fuscipennis* Williston (SE USA). These species are the sister group to the *globosus* complex (*abditus* Thompson + *globosus* Fabricius + *marmoratus* Bigot). The partially bare alula and the longer and less thickened arista separate *adventitius* from its immediate sisters, and the greatly elongate third antennal segment separates it from all its relatives. The specific name, *adventitius*, is from the Latin meaning extraordinary.

Material examined.—Holotype ♂ and paratype ♂, GEORGIA, Clarke County, Athens, 4 May 1976, J. F. MacDonald, deposited in U.S. National Museum. *Paratypes:* Georgia, Clarke County, Athens, R. Duffield, 1 ♂, 2 ♀ (USNM); Clarke County, Whitehall Forest, 8–11 March 1979, H. D. Pratt, 1 ♂ (Pratt Coll.).

Microdon albicomatus Novak

Microdon albicomatus Novak in Novak et al., 1977: 664 ♂ ♀ P* Idaho, Latah Co., 7 miles northeast of Harvard (HT ♂ WSU)².

² The format used for each specific name is: Name Author Date: Page of original description Stage(s) described Type-locality (Kind of Type Stage of Type Location of Type). Author Date: Page of subsequent reference(s) (notes on contents of reference). Abbreviation used in the synonymy are (except for those used for the location of the type are given in the acknowledgements): A = Adult or Adult structures; E = Egg; HT = Holotype; IS = Immature Stages; L = Larva; LT = Lectotype; MG = Male genitalia; P = Puparium; ST = Syntypes; T = Type(s); and * = illustrated or examined.

Microdon albicomatus was described from Idaho, but it is wide-ranging. I have seen specimens from northernmost Yukon south to Washington and Idaho, and east to New Brunswick. *Microdon albicomatus* and *ocellaris* adults are very similar. They differ as follows: *albicomatus* usually has some black hair on the femora, whereas in *ocellaris* it is entirely pale-haired; *albicomatus* has only a few hairs on the propleuron, whereas *ocellaris* has numerous hairs there; and *albicomatus* has the 2nd basal cell almost completely microtrichose, whereas in *ocellaris* it is extensively bare on the posterobasal half.

Ant hosts.—*Formica obscuripes* Forel and *F. fusca* Linnaeus. New Host Record: OREGON, Tillamook, 26 March 1919, A. C. Burrill, in a log, *Formica fusca* Linnaeus, 3 larvae (USNM).

Material examined.—55. Canada: Alberta, British Columbia, Manitoba, New Brunswick, Northwest Territories, Quebec, Saskatchewan, Yukon. U.S.A.: Colorado, Idaho, New Hampshire, Oregon, Washington, Wyoming.

Microdon aurulentus (Fabricius)

Mulio aurulentus Fabricius, 1805: 185 ? "Carolina" (LT ♀ MNHN here design.). Macquart, 1842: 72 (12) (redescr. based on type); Curran, 1925: 80 (A* redescr., Penn., Va.).

Fabricius described *aurulentus* from material in the Bosc Collection. Macquart later redescribed this material. The material now consists of a single female (#1139) in box 34 of the Macquart Collection and is labeled "M. aurulentus/ n in Carolina Bosc," "No. 1082/ Aphritis/ aurulentus." This specimen is undoubtedly a syntype and probably the holotype, but I do not accept the assumption of holotype status for single remaining original specimens (for discussion of this point see Crosskey, 1974: 272 (pro) and Vane-Wright, 1975: 26–28 (con)). Thus, I have designated this single female as LECTOTYPE and have so labeled it.

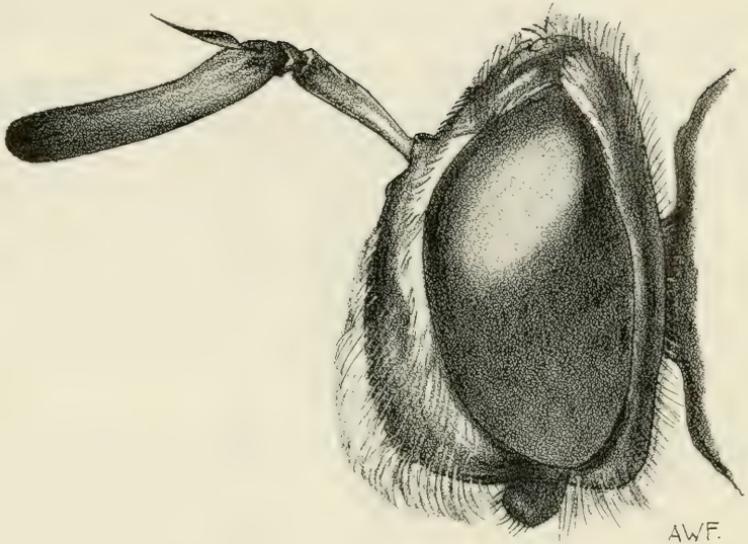
Material examined.—8. U.S.A.: Alabama, Georgia, Virginia.

Microdon cothurnatus Bigot

Figs. 24, 32

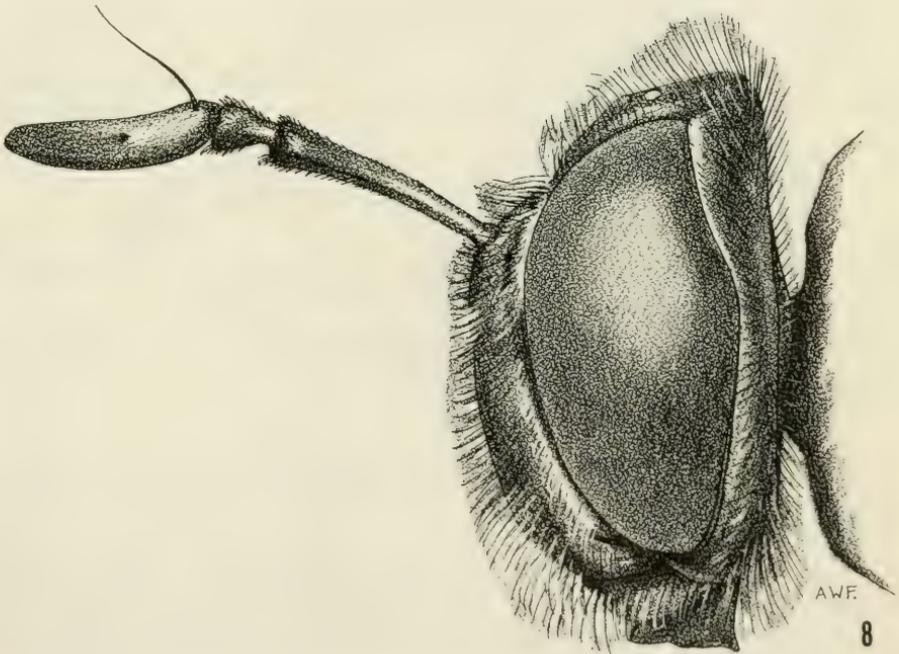
Microdon cothurnatum Bigot, 1883: 320 ♂ "Amer. septent. (Washingt. Territ.)" (HT ♂ BMNH). Johnson, 1916: 75 (diff. *tristis* Loew, distr. recs.); Knab, 1917: 134 (descr. note (A, L), distr. recs.); Cockerell, 1917: 15 (Colo., descr. note (P)); Curran, 1925: 65 (redescr., recognized 2 forms and 1 var.); Greene, 1955: 13 (descr. L*, P*).

Microdon tristis var. *cockerelli* Jones, 1922: 17 ♂ ♀ P Colorado, Boulder (STs ♂ P USNM). Cockerell and Andrews, 1916: 55 (Colo., descr. ♂ ♀



AWF.

7



AWF.

8

Figs. 7-8. Heads, lateral view. 7, *Microdon fuscipennis*. 8, *M. manitobensis*.

Pf: Novak et al., 1977: 664 (descr. A P*; Idaho). Syn. Curran, 1925: 65. NEW STATUS.

I have examined the holotype of *cothurnatus* Bigot and the syntypes of *cockerelli* Jones and find them to represent the same species. All authors until Novak et al. (1977) correctly interpreted the name *cothurnatus*; but the limits of their concept were varied, and some described forms or races of the species. In the most recent of these treatments, Curran (1925: 65-67) divided *cothurnatus* into a western form called "typical," an eastern form, and a variety (*similis* Jones). This led Novak to apply incorrectly the name *cothurnatus* to Curran's western form, which is here called *xanthopilis* Townsend, and to use the subspecific name *cockerelli* for the true *cothurnatus* Bigot.

Ant hosts.—*Camponotus* spp. and *Formica* spp. New Host Records: MASSACHUSETTS, Bedford, 15 May 1926, P. J. Darlington, under bark of pine stump, *Camponotus novaeboracensis* (Fitch), 1 puparium (USNM). NEW HAMPSHIRE, Coos County, Pittsburg, Connecticut Lakes, Rt. 3, 19 June 1973, B. J. & F. C. Thompson, *Formica subnuda* Emery, 30 ♀ ♂ puparia (USNM); Coos County, Carroll, 28 June 1977, J. F. Burger & W. J. Morse, *Camponotus pennsylvanicus* (DeGeer) colony in a decomposing log, 10 ♂ ♀ puparia (USNM, UNH).

Material examined.—168. Canada: Alberta, British Columbia, Manitoba, New Brunswick, Newfoundland, Nova Scotia, Ontario, Quebec, Saskatchewan. U.S.A.: Colorado, Connecticut, Idaho, Maine, Massachusetts, Michigan, New Hampshire, New Jersey, New York, Oregon, Pennsylvania, Wisconsin.

Microdon craigheadii Walton

Fig. 9

Microdon craigheadii Walton, 1912: 463 ♂ ♀ Pennsylvania, Carlisle Junction (HT ♂ USNM). Curran, 1925: 83 (A* MG* descr.).

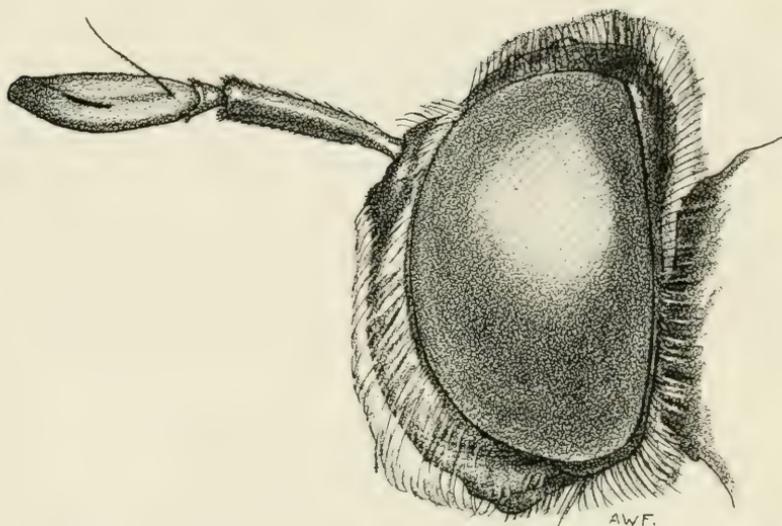
Material examined.—25. U.S.A.: Georgia, Maryland, New Jersey, Pennsylvania, Tennessee, Texas, West Virginia.

Microdon diversipilosus Curran

Microdon diversipilosus Curran, 1925: 76 ♂ Kansas, Clark County, 1962 ft (HT ♂ UKaL).

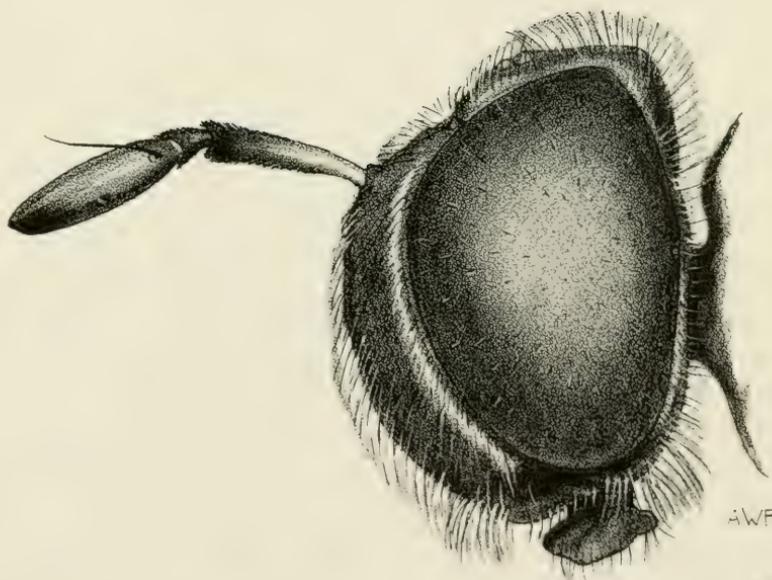
Wirth et al. (1965: 598) list *diversipilosus* Curran from a number of states in addition to the type-locality. I have not verified these additional records because the type is the only specimen I have seen. The genitalia of the type are missing.

Material examined.—1. U.S.A.: Kansas.



AWF.

9



AWF.

10

Figs. 9-10. Heads, lateral view. 9, *Microdon craigheadii*. 10, *M. laetus*.

Microdon fuscipennis (Macquart)

Figs. 7, 21

Ceratophya fuscipennis Macquart, 1834: 488 ? Pennsylvania, Philadelphia (T ? UMO). Curran, 1925: 77 (A* descr.).

Microdon agapenor Walker, 1849: 539 ♀ Georgia (STs ♀ BMNH).

Microdon pachystylum Williston, 1887: 8 ♂ Georgia (HT ♂ USNM). Syn. Curran, 1925: 77.

The biology of this species is covered in detail by Duffield (1981).

Ant hosts.—*Iridomyrmex pruinosus* (Roger).

Material examined.—123. U.S.A.: Alabama, Georgia, Florida, Kansas, Louisiana, Mississippi, New Mexico, North Carolina, South Carolina, Texas.

Microdon globosus (Fabricius)

Figs. 5, 34

Mulio globosus Fabricius, 1805: 185 ? "Carolina." (LT ♀ MNHN here design.). Macquart, 1842: 73 (13) (A*, redescr. of type); Greene, 1955: 5 (descr. L*).

Dimeraspis podagra Newman, 1838: 373 ? Illinois, Wanborough (HT ♂ BMNH). Syn. Walker, 1849: 540.

Microdon albipilis Curran, 1925: 54 ♂* Manitoba (HT ♂ CNC). N. SYN.

Microdon conflictus Curran, 1925: 58 A* MG* Virginia, Great Falls (HT ♂ CNC). Johnson, 1927: 45 (note on type). N. SYN.

Microdon pseudoglobosus Curran, 1925: 57 A* ♂ MG* New Jersey, Lucaston (HT ♂ UKaL). Johnson, 1927: 45 (note on type). N. SYN.

Microdon hutchingsi Curran, 1927: 89 ♀ Quebec, Aylmer, Queens Park (HT ♀ CNC). N. SYN.

fuscipennis of: Williston, 1887: 4 (descr.), and various earlier authors.

I, like Williston (1887), recognize only two species of globose *Microdon* species, *abditus* Thompson and *globosus* Fabricius. The species *globosus* may represent a complex. The antennal ratio and the size of the male hind tarsus vary geographically. The names *globosus*, *podagra*, *conflictus* and *pseudoglobosus* clearly apply to the southeastern populations, in which the third antennal segment is subequal to the 1st and the hindbasitarsis of the male is greatly swollen. Northward and westward, the third antennal segment becomes longer and the male hindbasitarsis less swollen. The names *albipilis* and *hutchingsi* apply to these populations. *Microdon marmoratus* Bigot is also part of the *globosus* complex. I am not certain that my interpretation is correct; but I leave it as it is because a colleague has expressed an interest in revising this complex.

The name of this species has been greatly confused, because no author

since Macquart (1842) has checked the types. Curran (1925) attempted to settle the confusion, which he stated was due "chiefly to carelessness." Unfortunately he fixed the name *globosus* to the wrong species. Fabricius described *globosus* from material in the Bosc Collection. Macquart (1842) redescribed this material. Williston (1887) recognized two "globose" *Microdon* species, one of which he called *fuscipennis* Macquart and the other *globosus* Fabricius. Snow (1895: 249 and Snow in Aldrich, 1905: 346) apparently believed (*teste* Curran, 1925: 54) that Williston inverted the names of these two species and, therefore, corrected that error. Curran (1925) correctly removed the name *fuscipennis*, a synonym of *pachystylum* Williston, from the confusion. Curran, then, accepted Williston's interpretation of *globosus* and described *pseudoglobosus* and *conflictus* for "*fuscipennis*" of Williston.

The material on which Macquart based his redescription is still present in his collection (#1138, box 34) and has been re-examined. Although neither specimen has a "Bosc" label, I accepted them as Bosc material because Macquart identified them as such. Both, therefore, could be considered syntypes, but I believe only one is. One is a specimen of *fuscipennis* Macquart, and the other is *globosus* Fabricius. Macquart in his redescription differentiated between these specimens on the basis of the shape of the abdomen, one he described as "*presque disciforme*" and the other as "*ovulaire*." I consider that the Fabrician description of the abdomen as "*magis globosum*" applies only to the *globosus* specimen, which I here designate as lectotype to eliminate any further confusion.

The type of *Dimeraspis podagra* Newman is in the British Museum (Natural History) and is the same as *globosus* as was noted by Walker (1849). Austen has labeled this specimen with a query, but I see no reason for not accepting it as the type because it does agree with the original description.

Ant hosts.—*Tapinoma sessile* (Say). New Host Records: GEORGIA, Union County, Hightower Gap, 7 May 1977, R. M. Duffield, *Tapinoma sessile* (Say), larvae, puparia, 5 ♂ 4 ♀ (USNM).

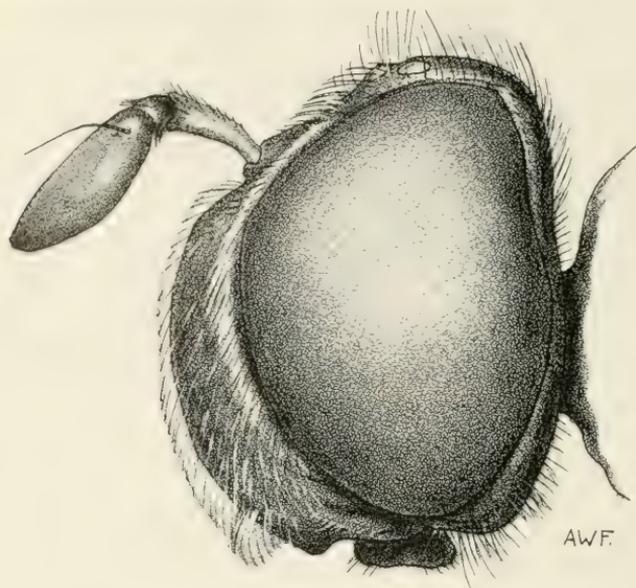
Material examined.—188. Canada: Alberta, British Columbia, Manitoba, New Brunswick, Ontario, Quebec, Saskatchewan. U.S.A.: Colorado, Connecticut, District of Columbia, Florida, Georgia, Kansas, Illinois, Maryland, Massachusetts, Michigan, New Jersey, New York, North Carolina, Pennsylvania, South Carolina, Texas, West Virginia, Wisconsin, Vermont, Virginia.

Microdon laetoides Curran

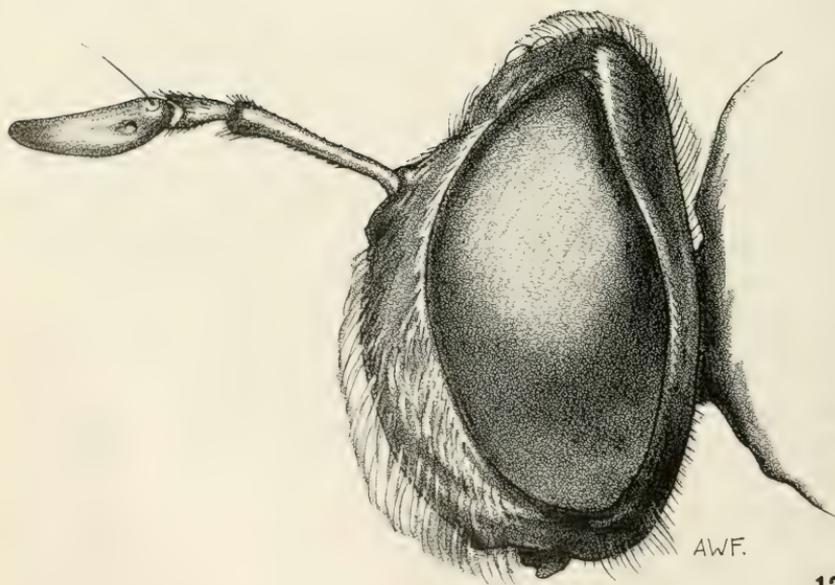
Fig. 1

Microdon laetoides Curran, 1935: 3 ♀ Arizona, Globe (HT ♀ AMNH).

Material examined.—2. U.S.A.: Arizona.



11



12

Figs. 11-12. Heads, lateral view. 11, *Microdon painteri*. 12, *M. abditus*.

Microdon laetus Loew

Fig. 10

Microdon laetus Loew, 1864: 74 ♂ ♀ Cuba (STs lost MCZ).*Microdon scitulus* Williston, 1887: 10 ♂ Florida (HT ♂ USNM). Curran, 1925: 84 (descr.). Syn. Wirth et al., 1965: 598.

In my review of the West Indian syrphid fauna (Thompson, 1981), I questioned the synonymy of *laetus* with *scitulus*. I have now re-examined the mainland populations (*scitulus*) and feel that the synonymy is reasonable.

Material examined.—67. U.S.A.: Alabama, Florida, Kansas, Louisiana, Maryland, Mississippi, Missouri. Cuba, Jamaica.

Microdon lanceolatus Adams

Figs. 2, 14

Microdon lanceolatus Adams, 1903: 222 ♂ Kansas, Clark County, Englewood (HT ♂ UKaL). Curran, 1925: 70 (A* descr.); Greene, 1955: 4 (descr. P*).*Microdon coloradensis* Cockerell and Andrews, 1916: 53 ♂* Colorado, Boulder, foot of Flagstaff Hill (HT ♂ USNM). Cockerell, 1917: 15 (Colo., descr. notes (A, P)); Knab, 1917: 138 (N. Mex., descr. note); Jones, 1922: 17, 44 (Colo.). Syn. Curran, 1925: 60.*Microdon modestus* Knab, 1917: 139 ♂ ♀ Nevada, Elko (HT ♂ USNM). Curran, 1925: 67 (cit.). N. SYN.*Microdon senilis* Knab, 1917: 139 ♀ California, Claremont (HT ♀ USNM). Curran, 1925: 62 (cit.). N. SYN.*Microdon similis* Jones, 1917: 219 ♀ Colorado, Poudre Canon (LT ♀ USNM here design.). Jones, 1922: 17, 41, 44 (A*, Colo.); Knab, 1917: 135 (?=*cothurnatus* Bigot); Curran, 1925: 67 (descr. as var. of *cothurnatus* Bigot). N. SYN.

The hair color is variable in *lanceolatus*, ranging from entirely yellow through yellow and black to entirely black. I have seen six different color morphs: All black hair (*modestus* allotype); all black hair except yellow and black hair on face (*senilis* holotype), yellow hair on head and thorax and yellow and black hair on abdomen (*lanceolatus* holotype); yellow hair on head and thorax and black hair on abdomen (*similis* lectotype); black hair on head, yellow hair on thorax, and yellow and black hair on abdomen (*modestus* holotype); and yellow and black hair on head, yellow hair on thorax, and yellow and black hair on abdomen (unnamed). These morphs are not discrete; intermediate forms with various amounts of yellow and black hair exist. No geographical, altitudinal or clinal pattern is apparent in the hair color variation. All these morphs are readily recognized as *lanceolatus* by the very short and conical third antennal segment.

Microdon similis Jones was described from two females. Both syntypes were found in his collection, and the one bearing his determination label is here designated as lectotype and is so labeled. Both syntypes are specimens of *lanceolatus* Adams, the typical color morph.

Ant host.—*Formica argentea* Wheeler.

Material examined.—22. Canada: Alberta, British Columbia. U.S.A.: California, Colorado, Montana, Nevada, New Mexico, Utah, Washington, Wyoming.

Microdon manitobensis Curran

Figs. 8, 13, 31

Microdon manitobensis Curran, 1924: 227 ♂ ♀ Saskatchewan, "Elmboro" (LT ♂ CNC here design.). Johnson, 1927: 45 (note on types); Curran, 1925: 62 (A* descr.); Greene, 1955: 4 (descr. L* P); Novak et al., 1977: 663 (key ref. (A, P*)).

Curran did not clearly designate a holotype for *manitobensis*, but he did label a specimen as holotype. This specimen is now in the Canadian National Collection and is designated LECTOTYPE.

Material examined.—79. Canada: Alberta, British Columbia, Manitoba, Nova Scotia, Ontario, Quebec, Saskatchewan. U.S.A.: Colorado, Maine, New Hampshire, New Mexico, New York, Washington.

Microdon marmoratus Bigot

Fig. 3

Microdon marmoratum Bigot, 1883: 320 ♂ ♀ California (STs UMO). Curran, 1925: 56 (A* descr.); Greene, 1955: 5 (descr. L* P).

Microdon marmoratus is very closely related to the northwestern populations of *globosus* (*q.v.*). I doubt the specific status of *marmoratus* and consider it only a distinctive population of *globosus*. The characters given in the key are those from Curran (1925: 49) and a colleague, but I find that they do not consistently separate *globosus* (in sense of the non-Californian populations) from *marmoratus* (the Californian populations). Gary Coovert of Dayton Museum of Natural History, Ohio, has expressed an interest in resolving this complex, so the problem is left as is.

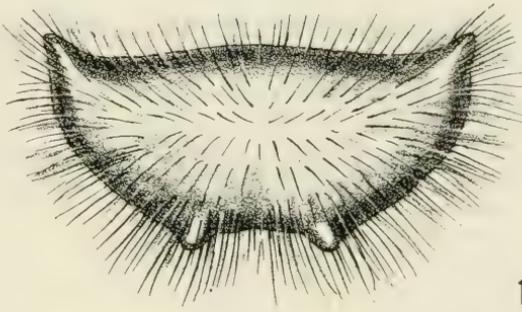
Material examined.—39. U.S.A.: California, Oregon.

Microdon megalogaster Snow

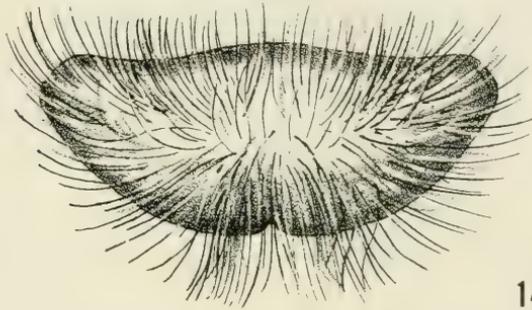
Figs. 20, 26, 33, 38

Microdon megalogaster Snow, 1892: 34 ♂ ♀ Illinois (Snow, 1895: 249, Hunter, 1897: 123) (HT ♂ UKaL). Jones, 1922: 17, 44 (Colo.); Greene, 1923b: 140 (descr. L, P*; Va.), 1955: 12 (descr. L, P*); Curran, 1925: 60 (descr.).

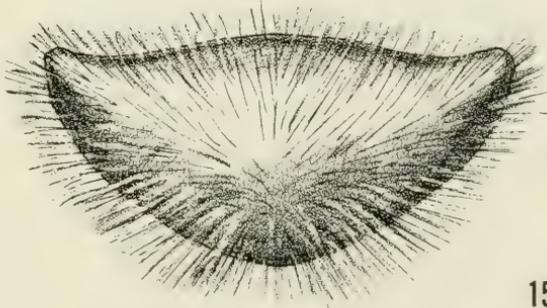
Microdon bombiformis Townsend, 1895a: 33 ♀ Virginia, Dixie Landing (near Washington, D.C.) (HT ♀ UKaL). Syn. Hunter, 1897: 123.



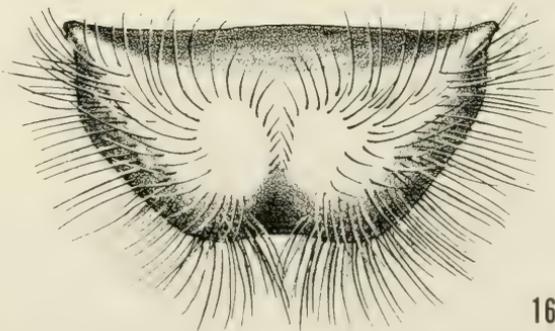
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14



15



16

Figs. 13–16. Scutella, dorsal view. 13, *Microdon manitobensis*. 14, *M. lanceolatus*. 15, *M. adventitius*. 16, *M. xanthopilis*.

Ant hosts.—*Formica subsericea* Say and *F. fusca* Linnaeus. New Host Records: GEORGIA, Union County, Hightower Gap, 7 May 1977, R. M. Duffield & D. Freeman, *Formica subsericea* Say, larvae, puparia (USNM).

Material examined.—79. Canada: Ontario, Quebec. U.S.A.: Connecticut, District of Columbia, Georgia, Illinois, Maryland, Massachusetts, Minnesota, New York, North Carolina, Pennsylvania, Tennessee, Virginia.

Microdon newcomeri Mann

Microdon newcomeri Mann 1924: 94 ♂ California, Portola (HT ♂ USNM).

Material examined.—3. U.S.A.: California.

Microdon ocellaris Curran

Figs. 18, 22

Microdon ocellaris Curran, 1924: 227 ♀ Pennsylvania, Linglestown (LT ♀ USNM) (Curran, 1925: 82). Johnson, 1927: 45 (note on type); Curran, 1925: 82 (descr., type design., distr.).

Ant host.—*Formica schaufussi* Mayr. New Ant Host Record: MASSACHUSETTS, Blue Hill, 6 May 1911, *Formica schaufussi* Mayr, 2 puparia (USNM).

Material examined.—39. U.S.A.: Alabama, Colorado, Connecticut, Georgia, Michigan, New Jersey, New York, Pennsylvania, Tennessee.

Microdon piperi Knab

Microdon piperi Knab, 1917: 136 ♂ ♀ Washington, Seattle (HT ♂ and associated puparium USNM). Curran, 1925: 78 (A* descr.); Greene 1955: 15 (descr. (L*,P*)); Novak et al., 1977: 663 (key ref. (A. P*)).

Ant host.—*Camponotus* species. New Ant Host Records: BRITISH COLUMBIA, Lavington, 8 May 1953, J. Grant, *Camponotus* sp., 4 ♂ ♀ puparia (USNM, CNC). WASHINGTON, Columbia County, 23 March 1939 & 26 May 1941, S. H. Lyman, *Camponotus herculeanus* (Linnaeus), 10 ♀ puparia (USNM).

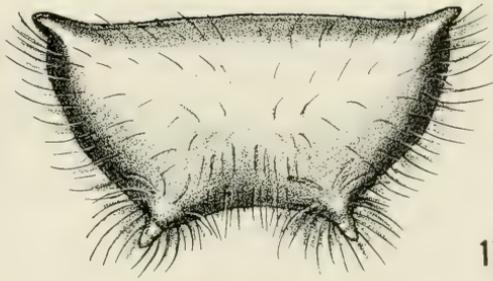
Material examined.—112. Canada: Alberta, British Columbia. U.S.A.: California, Colorado, Idaho, Montana, New Mexico, Oregon, Washington, Wyoming.

Microdon ruficrus Williston

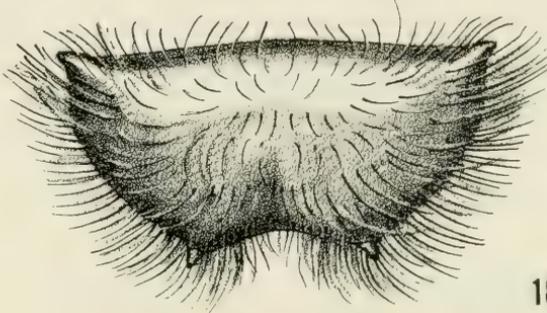
Figs. 17, 37, 39

Microdon tristis var. *ruficrus* Williston, 1887: 7 ♂ Connecticut (HT ♂ USNM). Knab, 1917: 135 (elevated to sp. status, descr., distr.); Curran, 1925: 68 (A* descr.).

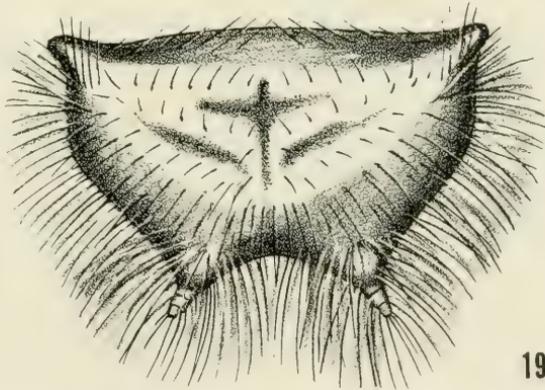
Microdon basicornis Curran, 1925: 79 ♂* New Brunswick, "Barber D." (HT ♂ CNC). N. SYN.



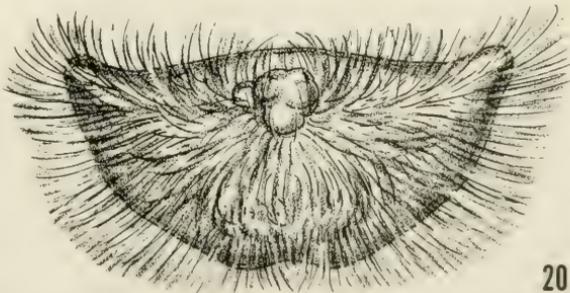
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18



19



20

Figs. 17-20. Scutella, dorsal view. 17, *Microdon ruficrus*. 18, *M. ocellaris*. 19, *M. tristis*. 20, *M. megalogaster*.

Microdon champlaini Curran, 1925: 71 A* ♂ ♀ Pennsylvania, Linglestown (HT ♂ USNM). Greene, 1955: 10 (descr. (L*, P*)). N. SYN.

Curran (1925) separated *ruficrus*, *basicornis*, and *champlaini* on the basis of slight differences in the size and condition of the scutellar spines, the color of antennae, and the color of hair of the front. I consider these differences trivial. I have seen reared specimens that vary in these characters but are associated with identical puparia.

Ant host.—*Lasius* spp. New Host Records: GEORGIA, Union County, Hightower Gap, 11 April 1976, R. M. Duffield, *Lasius* sp., 1 ♂ puparium (USNM). ONTARIO, Ottawa, 14 December 1953, E. C. Becker, *Lasius alienus* (Foerster), eggs, larvae, puparia, ♂ ♀ (CNC).

Material examined.—106. Canada: New Brunswick, Nova Scotia, Ontario, Quebec. U.S.A.: Connecticut, District of Columbia, Georgia, Illinois, Maine, Maryland, Massachusetts, New Hampshire, New Jersey, New York, North Carolina, Pennsylvania, Virginia, Wisconsin.

Microdon rufipes (Macquart)

Aphritis rufipes Macquart, 1842: 71 (11) ♀ Pennsylvania, Philadelphia (T ♀ UMO?). Knab, 1917: 140 (distr. recs., syn.); Curran, 1925: 50 (transl. orig. descr.).

Microdon limbus Williston, 1887: 8 ♀ Florida (HT ♀ USNM). Syn. Knab, 1917: 140.

Ant host.—*Pheidole dentata* Mayr. New Host Records: GEORGIA, Laura Walker State Park, 6 June 1976, R. M. Duffield, *Pheidole dentata* Mayr, 1 ♀ puparium (USNM).

Material examined.—31. U.S.A.: Florida, Georgia, Maryland, Texas, Virginia.

Microdon scutifer Knab

Microdon scutifer Knab, 1917: 141 ♂ Texas, Willis (HT ♂ USNM). Curran 1925: 75 (descr.).

Material examined.—4. U.S.A.: Alabama, Texas.

Microdon tristis Loew

Figs. 6, 19

Microdon tristis Loew, 1864: 73 ♀ Virginia (T ♀ MCZ lost). Wheeler, 1908: 204 (L* biol.); Johnson, 1916: 75 (diff. *cothurnatus* Bigot, distr. recs.); Knab, 1917: 135 (descr., distr. recs.); Jones, 1922: 17, 44 (A*, Colo.); Curran, 1925: 72 (A* descr., distr. rec.); Greene, 1955: 14 (L* P* descr. (L P)).

Microdon robusta Telford, 1939: 14 A* L* Minnesota, Ramsey Co., Battle Creek Park (HT ♀ UMSP). Greene, 1955: 11 (L* P* descr., distr. recs.). N. SYN.

The holotype of *robusta* is a specimen of *tristis*. Telford (1939) said his species was "very similar to *tristis*" but was "distinguished from it by the evenly rounded scutellum, rugose notum, and somewhat darker legs." Telford described *robusta* from two reared females, which are in teneral condition. The shape of the scutellum is greatly distorted, having not been inflated, but spines are distinctly present. The rugose condition of the notum is also due to the teneral condition of the types, and the leg color is well within the range of *tristis*. Telford's statement that "The larvae of the two are also decidedly distinct" is peculiar, because the larva of *tristis* was not known at that time. When requesting the loan of the *robusta* types, I was told that the immature material was now lost.

Ant host.—*Camponotus pennsylvanicus* (DeGeer) and *C. novaehboracensis* (Fitch). New Ant Host Record: CONNECTICUT, Middlesex County, 3.5 miles east of Killingworth, 4 June 1978, C. T. Maier, *Camponotus novaehboracensis* (Fitch), 1 puparium.

Material examined.—148. Canada: British Columbia, Manitoba, New Brunswick, Nova Scotia, Ontario, Quebec. U.S.A.: Connecticut, Illinois, Iowa, Kansas, Maine, Massachusetts, Michigan, Minnesota, Missouri, New Hampshire, New York, Pennsylvania, Rhode Island, Vermont.

Microdon viridis Townsend

Microdon viridis Townsend, 1895b: 610 ♀ Mexico, Baja California, San Jose del Cabo (HT ♀ CAS). Curran, 1925: 83 (key ref., cit., distr. note).

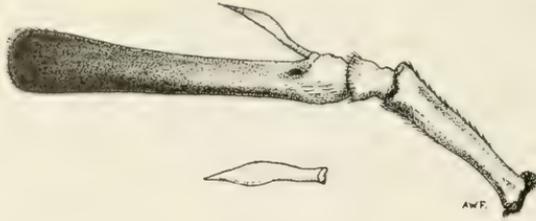
The holotype of *viridis* was destroyed in the 1906 San Francisco earthquake (Arnaud, 1979: 9). The original description indicates that *viridis* is similar to *laetus* and *laetoides* but can be distinguished from them by the "decidedly incrassate" hindbasitarsis. This species should be deleted from the fauna of America north of Mexico. I have seen no material that agrees with the original description. The eastern records of this species undoubtedly refer to either *laetus* or *craigheadii*, and the West Coast records may refer to *laetoides*.

Microdon xanthopilis Townsend

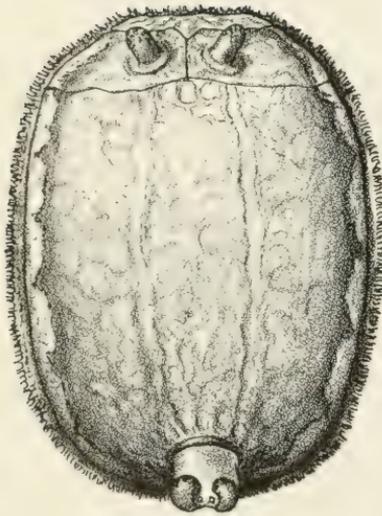
Fig. 16

Microdon xanthopilis Townsend, 1859b: 611 ♂ ♀ California (LT ♂ UKaL here designated). Curran, 1925: 64 (key ref., descr. based on syntype). *cothurnatus* of Akre et al., 1973: 327 (E* L* P* A* biol., behavior); Novak et al., 1977: 664 (P* key ref.).

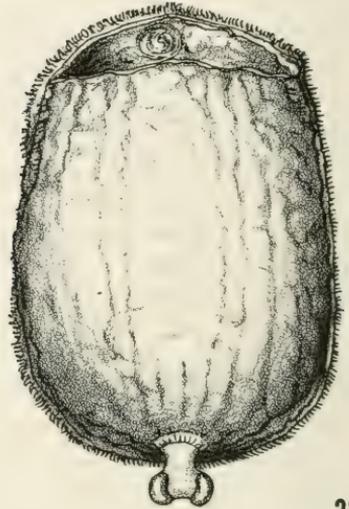
Microdon xanthopilis was described from two specimens. One was returned to the California Academy of Sciences and was destroyed in the 1906 earthquake (Arnaud, 1979: 9). The other was retained by Townsend and was later sold to the Snow Entomological Museum. This latter specimen was redescribed by Curran, is here designated lectotype, and has been so



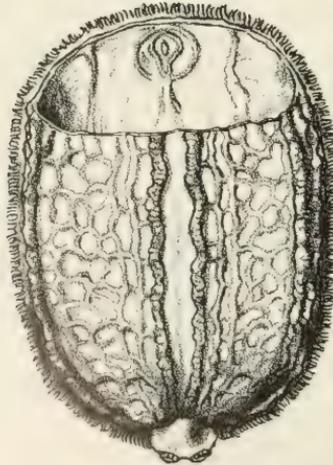
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24

Figs. 21-24. 21. Antenna, lateral view, with dorsal view of arista. 22-24, Puparia, dorsal view. 21, *Microdon fuscipennis*. 22, *M. ocellaris*. 23, *M. abditus*. 24, *M. cothurnatus*.

labeled. The lectotype is the species called *cothurnatus* by Akre et al. (1973).

Material examined.—37. Canada: Alberta, British Columbia. U.S.A.: California, Montana, Washington.

Subgenus *Chymophila* Macquart

Chymophila Macquart, 1834: 485. Type-species, *splendens* Macquart (mono.)

Microdon subg. *Eumicrodon* Curran, 1925: 50. Type-species, *Microdon fulgens* Wiedemann (Orig. design. (p. 46)).

Microdon fulgens Wiedemann

Figs. 27, 29, 40

Microdon fulgens Wiedemann, 1830: 82 ♀ "Neugeorgien" (T ♀ ZMHu) Knab, 1917: 140 (descr. notes, distr. recs.); Curran, 1925: 50 A* (descr., distr. recs.).

Chymophila splendens Macquart, 1834: 486 ? Pennsylvania, Philadelphia (HT ? UMO).

Ant hosts.—*Camponotus abdominalis* (Fabricius); *Formica schaufusi* Mayr and *Polyergus lucidus* Mayr. New Host Records. FLORIDA, Pine Key, February 1976, R. M. Duffield, *Camponotus abdominalis* (Fabricius); Dade County, Everglades National Park, 28 March 1978, R. M. Duffield, *C. abdominalis* (Fabricius), 1 ♀ puparium (USNM). GEORGIA, Clarke County, Athens, August 1975, R. M. Duffield, *Formica schaufusi* Mayr and *Polyergus lucidus* Mayr, 2 larvae, 2 puparia (USNM).

Material examined.—33. U.S.A.: Arkansas, Florida, Georgia.

Subgenus *Omegasyrphus* Giglio-Tos

Omegasyrphus Giglio-Tos, 1891: 4. Type-species, *Microdon coarctatus* Loew (sub. mon., Giglio-Tos, 1892: 3).

Currently four species of the subgenus *Omegasyrphus* are recognized. The differences between these species, given by Curran (1925: 50), are accepted here. However, I have not found them satisfactory nor do I understand the species limits in this subgenus. I would recognize only two species: *pallipennis* Curran of limited range and variation; and *coarctatus* Loew of wide range and variation, including all other names. Because Coovert has expressed an interest in revising *Microdon*, I leave this problem unresolved.

Microdon baliopterus Loew

Fig. 41

Microdon baliopterus Loew, 1872: 86 ♂ ♀ Texas (STs ♂ ♀ MCZ lost). Curran, 1925: 87 (A* MG* descr., distr. recs.); van Pelt & van Pelt, 1972: 977 (L*, biol., descr. (IS), Tex.).

Ant host.—*Monomorium minimum* (Buckley).

Material examined.—40. U.S.A.: Arizona, California, Colorado, Georgia, Kansas, Nebraska, Nevada, New Mexico, South Dakota, Texas, Utah, Wyoming.

Microdon coarctatus Loew

Figs. 28, 30, 35

Microdon coarctatus Loew, 1864: 74 ♂ ♀ District of Columbia (ST ♂ ♀ MCZ lost). Greene, 1923a: 82 (L* descr. (L P), host rec., Va & Tex.), 1955: 6 (L* P* descr. (L P), host rec., Va., Tex.); Curran, 1925: 86 (A*, descr., La.).

Ant host.—*Monomorium minimum* (Buckley), *Aphaenogaster fulva* (Roger).

Material examined.—10. U.S.A.: Louisiana, Montana, North Carolina, Texas, Virginia.

Microdon painteri Hull

Fig. 11

Microdon painteri Hull, 1922: 370 ♂ ♀ Mississippi, Greenville (HT ♂ CNC). Curran, 1925: 88 (A* MG* descr.).

Ant host.—*Monomorium minimum* (Buckley). New Host Records: GEORGIA, Clarke County, Bogart, 26 July & 12 August 1972, A. Lavallee, *Monomorium minimum* (Buckley), 9 ♂ (USNM).

Material examined.—11. U.S.A.: Arkansas, Georgia, North Carolina.

Microdon pallipennis Curran

Microdon pallipennis Curran, 1925: 89 A* MG* Colorado, Garden of the Gods and Texas, Austin (STs ♂ ♀ UKaL).

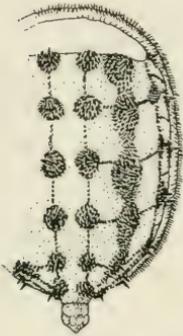
Material examined.—5. U.S.A.: Texas.

ACKNOWLEDGMENTS

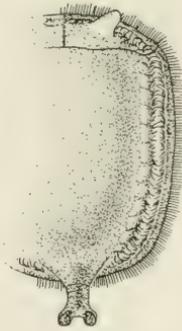
I thank Paul H. Arnaud, Jr., California Academy of Sciences, San Francisco (CAS); John F. Burger, University of New Hampshire, Durham

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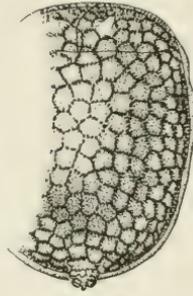
Figs. 25–41. 25–28, Puparia, dorsal view. 29–34, Hind spiracular processes: c = caudal view; d = dorsal view; l = lateral view. 35, Abdominal process, dorsal view. 36–39, Marginal fringe, dorsal view except 37 is lateral view. 40–41, Abdomens, dorsal view. 25, *Microdon rufipes*. 26, 33, 38, *M. megalogaster*. 27, 29, 40, *M. fulgens*. 28, 30, 35, *M. coarctatus*. 31, *M. manitobensis*. 32, *M. cothurnatus*. 34, *M. globosus*. 36, *M. abstrusus*. 37, 39, *M. ruficrus*. 41, *M. baliopterus*.



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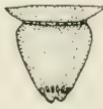
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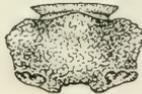
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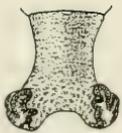
32 d



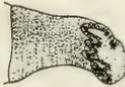
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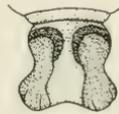
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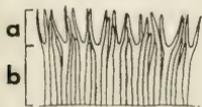
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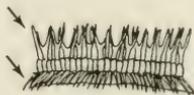
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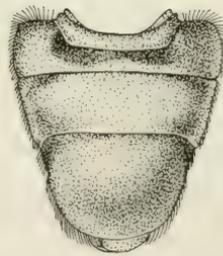
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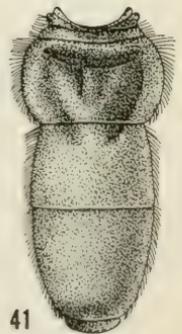


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LfL



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(UNH); George W. Byers, Snow Entomological Museum, University of Kansas, Lawrence (UKaL); Frank D. Fee, State College, Pennsylvania (Personal Collection); Loïc Matile, Muséum National d'Histoire Naturelle, Paris (MNHN); Philip J. Clausen, University of Minnesota, St. Paul (UMSP); Howard E. Evans, Colorado State University, Fort Collins (CSUFC); J. W. Ismay, Hope Department of Entomology, Oxford University (UMO); K. G. V. Smith, British Museum (Natural History), London (BMNH); Margaret K. Thayer, Museum of Comparative Zoology, Harvard University, Cambridge (MCZ); Roger D. Akre, Washington State University, Pullman (WSU); G. P. Waldbauer, University of Illinois, Urbana (Personal Collection); Chris T. Maier, Connecticut Agricultural Experimental Station, New Haven (Personal Collection); Harry D. Pratt, Atlanta, Georgia (Personal Collection); H. Schumann, Zoologisches Museum, Museum für Naturkunde, Humboldt-Universität, Berlin (ZMHu); Clark N. Shiffer, State College, Pennsylvania (Personal Collection); Donald Webb, Illinois State Natural History Survey Division, Champaign (INHS); Pedro Wygodzinsky, American Museum of Natural History, New York (AMNH); J. R. Vockeroth, Agricultural Canada, Ottawa (CNC), for the permission to study and/or the loan of material in their care. I also thank D. R. Whitehead, Raymond Gagné, and Paul Marsh of the Systematic Entomology Laboratory, USDA, Washington, D.C.; Wayne N. Mathis of the Smithsonian Institution (USNM), Washington, D.C.; and Chris T. Maier, New Haven, for their critical review of this manuscript.

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SEXING *PHLOEOTRIBUS LIMINARIS* ADULTS
(COLEOPTERA: SCOLYTIDAE)

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Abstract.—Morphological differences on the front of the head and on the propygidium and pygidium can be used to determine the sex of adults of the peach bark beetle, *Phloeotribus liminaris* (Harris). The propygidium is an excellent diagnostic character, and the differences between sexes are easily distinguished by inexperienced observers.

Defects in black cherry, *Prunus serotina* Ehrh., caused by the peach bark beetle, *Phloeotribus liminaris* (Harris), are a serious problem because they reduce the quality of cherry. In conducting biological and behavioral studies on this insect, it was essential to distinguish the sexes. However, the characters that identify the sexes of this species or of any other species of the genus had not been illustrated.

Two morphological characters often used to determine the sex of species of the family Scolytidae are the size and shape of the pygidium (eighth tergum) and the shape of the front of the head along with the presence or absence of hairs. Swaine (1918) and Chamberlin (1939) briefly described the front of the head of *P. liminaris* under the name *Phthorophloeus liminaris* (Harris). Bright (1976) also described the front of the head. Our paper describes morphological differences of the propygidium (seventh tergum), pygidium (eighth tergum), and shape of the front of the head for adult male and female peach bark beetles, *P. liminaris* (Fig. 1).

MATERIALS AND METHODS

One hundred adult peach bark beetles were collected at random from infested black cherry, *P. serotina*, in Pocahontas County, West Virginia. The insects were grouped by sex using Chamberlin's (1939) description of the front of the head. The propygidium and pygidium were examined for

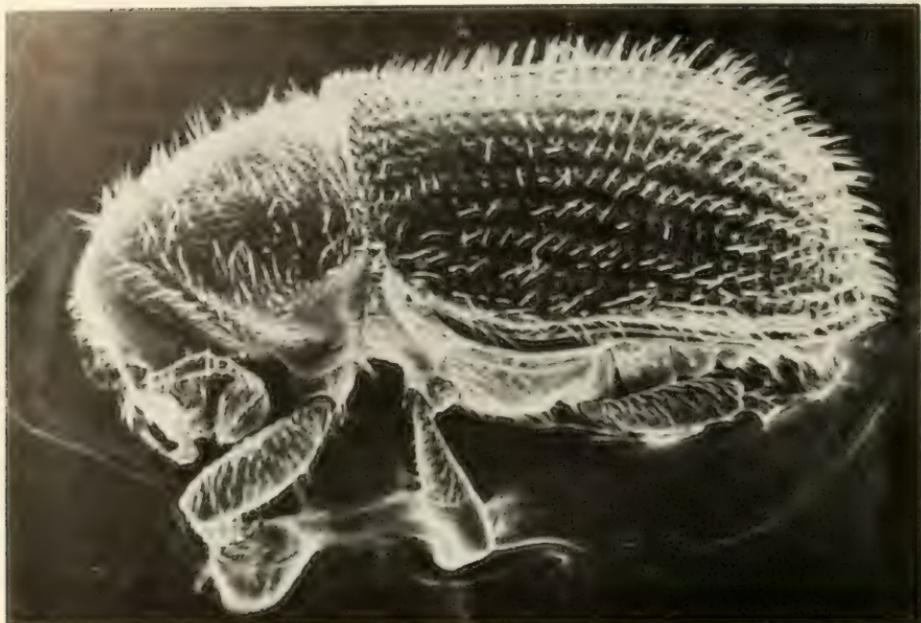


Fig. 1. Adult peach bark beetle, *Phloeotribus liminaris*.

morphological differences, and the front of the head was reexamined for additional sex characters.

A stereoscopic microscope at 50–100 \times magnification was used to make all determinations. The external morphological sex characters were photographed using a Hitachi S-500¹ scanning electron microscope at 130 \times magnification. After microscopic examination for sexual differences, the sex of the examined beetles was determined by dissecting the genitalia.

RESULTS AND DISCUSSION

We found morphological differences that distinguish the sexes on the front of the head and on the propygidium and pygidium (Fig. 2).

The front of the head of the male is distinctly concave in the middle above a divided transverse carina as described by Chamberlin (1939). A frontal bump is also present just above the concave area (Fig. 2A). The front of the head of the female is flat to slightly convex (Fig. 2B).

The propygidium in the female is about twice as long as that in the male

¹ The use of trade, firm, or corporation names in this publication is for the information and convenience of the reader. Such use does not constitute an official endorsement or approval by the U.S. Department of Agriculture or the Forest Service of any product or service to the exclusion of others that may be suitable.

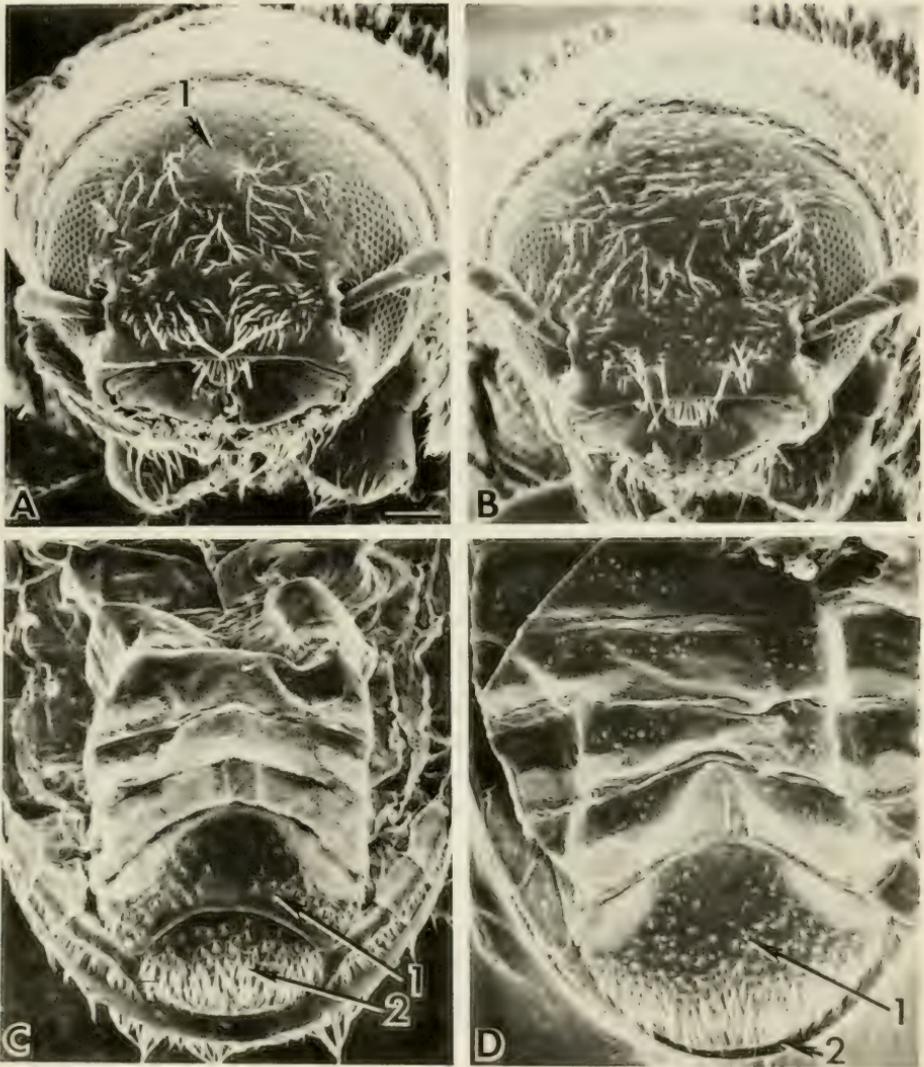


Fig. 2. Male and female adult peach bark beetle, *Phloeotribus liminaris*. A. Front of head of δ showing frontal hump (1). B. Front of head of $\bar{\nu}$. C. Abdomen showing propygidium (1) and pygidium (2) of δ . D. Abdomen showing propygidium (1) and pygidium (2) of $\bar{\nu}$. Bar—50 μm .

and shaped differently (Fig. 2D). The posterior end of the female propygidium is rotund and covered with bristles, and the posterior end of the male propygidium is orbiculate and contains few bristles.

The pygidium in the male is square, contains numerous bristles, and is

more visible than that in the female (Fig. 2C). The pygidium in the female is only .045-.050 mm long, contains no bristles, and is usually retracted under the propygidium (Fig. 2D). The propygidium in the female appears as the last abdominal tergum and the pygidium in the male is visible and is the last tergum.

With practice and use of a stereoscopic microscope at 50 \times magnification, the sex characters on the front of the head can be used to determine the sex of both living and dead specimens. The characters of the propygidium and pygidium are usually not useful in living insects unless immobilized because the tip of the abdomen is usually concealed beneath the elytra. However, when working with dead specimens and using a stereoscopic microscope at 50 \times magnification, the characters of the propygidium and pygidium can be used to determine sex. The seventh tergum of each sex is an excellent diagnostic character that can be accurately, quickly, and easily distinguished by inexperienced observers.

ACKNOWLEDGMENT

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STUDIES ON THE LEAF-MINING SAWFLIES OF THE TRIBE
FENUSINI IN ASIA (HYMENOPTERA: TENTHREDINIDAE)

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Abstract.—The following new taxa are proposed in the Fenusini: *Anafenus* **shinoharai**, n. sp. from Japan; *Birmella* **taiwanensis**, n. sp. from Taiwan; *Metallus* **nepalensis**, n. sp. from Nepal; *M. satoi*, n. sp. from Korea; and *Okutanius* **lobatus**, n. gen., n. sp. from Korea. Each represents new records for the respective genera from each country. Notes on hosts and new localities for other Fenusini are also given.

The Fenusini, all leaf miners in the larval stage, are very small, dark-colored, and are not commonly collected. Because of the scarcity of specimens, the fauna of Asia is not well known. I examined some specimens from Asia, and present information here on new hosts and records, and describe five new species and one new genus. These data represent additions to my treatment of the world genera of Fenusini (Smith, 1976), and the genera discussed here may be identified by using the key to genera in the same paper. The species from Japan are not treated in full; Togashi (1980) gave a key to genera of Fenusini for Japan, but accumulation of the material available in collections in Japan is necessary for a revision of the Fenusini for that country, and some genera are currently being studied by Japanese workers.

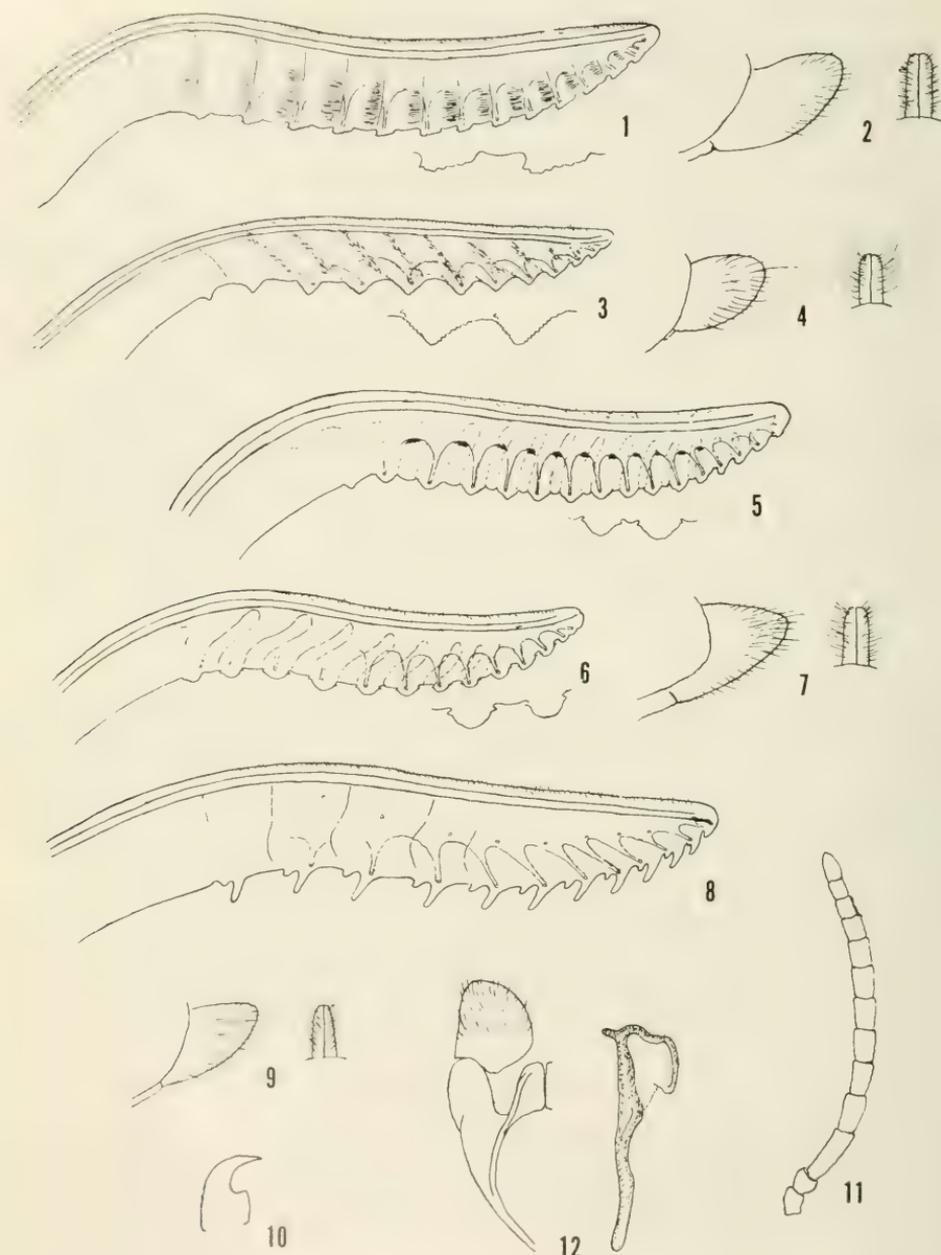
Anafenus Benson

Two species have been described; *javana* (Enslin) from Indonesia (Java) and *impropria* (Malaise) from Sedanka (near Vladivostok), USSR. The following species represents the first record of this genus from Japan: the host is the first recorded for the genus.

Anafenus shinoharai Smith, NEW SPECIES

Figs. 1, 2

Female.—Length, 3.2–3.7 mm. Black with palpi, extreme apex of each femur, all tibiae, and all tarsi white; labrum whitish to brown; abdominal



Figs. 1-2, *Anafenusia shinoharai*. 1, Lancet. 2, Sheath. Figs. 3-4, *Birmella taiwanensis*. 3, Lancet. 4, Sheath. Fig. 5, *Metallus nepalensis*, lancet. Figs. 6-7, *M. satoi*. 6, Lancet. 7, Sheath. Figs. 8-11, *Okutanius lobatus*. 8, Lancet. 9, Sheath. 10, Tarsal claw. 11, Antenna. Fig. 12, *Birmella taiwanensis*, male genitalia, capsule, ventral; valve, lateral. Sheaths shown in lateral view on left and dorsal view on right.

terga brownish, paler than black thorax. Wing subhyaline, little darker at base; veins dark brown, stigma paler brown. Antenna $1\frac{1}{4}\times$ head width; 9-segmented; 1st and 2nd segments each longer than broad; 3rd segment $1\frac{1}{2}\times$ length of 4th segment; segments 4–9 gradually decreasing in length and each only slightly longer than broad. Clypeus truncate; malar space narrow, less than $\frac{1}{2}$ diameter of an ocellus; postocellar area convex, slightly elevated above surrounding area on head, $1\frac{1}{3}\times$ broader than long; distance between eyes below greater than eye length; no genal carina. Prepectus absent. Tarsal claw simple; hindbasitarsus equal to length of following 3 segments combined; foretarsus equal in length to foretibia. Forewing with radial cell closed; vein 2A + 3A straight; 1st cubital crossvein indicated but faint, therefore wing with 4 cubital cells. Hindwing with radial cell open; anal cell present. Sheath (Fig. 2) slender, rounded at apex in lateral view. Lancet (Fig. 1) with serrulae low, each with 5–6 coarse posterior subbasal teeth.

Male.—Unknown.

Holotype.—Female, "larva coll. Hirao, Nagano, 10-VII-1932, K. Sato," "bred with *Ulmus* sp. (leaf miner)," "Emerg. Yokohama, 30-III-33," "166." In the National Science Museum (Natural History), Tokyo.

Paratype.—Same data as for holotype (1♀). Deposited with holotype.

Remarks.—The following separates *shinoharai* from *impropria*: Vein M of forewing arcuately curved (nearly straight in *impropria*); hindtibia and tarsi white (brownish at apices in *impropria*); subcosta brown, a little paler toward stigma (yellow in *impropria*); malar space indicated (linear in *impropria*); and sheath broader and more rounded (narrower in *impropria*). *Anafenusa javana* has black legs, and 10-segmented antennae, neither of which agree with *shinoharai*.

The species is named for Mr. Akihiko Shinohara, a student of sawflies at the University of Osaka Prefecture.

Birmella Malaise

The following species represents the first record of *Birmella* outside of Burma and the first record of a member of the *Fenusini* from Taiwan.

Birmella taiwanensis Smith, NEW SPECIES

Figs. 3, 4, 12

Female.—Length, 3.3 mm. Black with following pale orange: 1st and 2nd antennal segments; palpi; tegula; basal 4 terga and sterna; and legs except for blackish apical tarsal segments. Wings subhyaline; veins and stigma black. Antennal length $1\frac{1}{3}\times$ head width; 10-segmented; 1st and 2nd segments each longer than broad, cylindrical; 3rd segment $1\frac{1}{3}\times$ length of 4th segment; segments 4–10 gradually decreasing in length; apical 4 segments

each $1\frac{1}{2}\times$ or more longer than broad. Clypeus truncate; malar space linear; postocellar area $1\frac{1}{3}\times$ broader than long; supraclypeal furrow deep and sharply separating clypeus and supraclypeal area; distance between eyes below shorter than eye length; no genal carina. Prepectus absent. Tarsal claw simple; foretarsus $1\frac{1}{2}\times$ length of foretibia; hindbasitarsus equal to length of 3 following tarsal segments combined; 4th tarsal segment produced below 5th segment. Basal plates emarginated behind, leaving large membranous area. Forewing with radial cell closed; vein 2A + 3A curved upward and meeting 1A. Hindwing with radial cell open; anal cell absent. Sheath (Fig. 4) short and rounded in lateral view. Lancet (Fig. 3) with rather deep, pointed serrulae, each with 7-10 fine anterior and 7-10 fine posterior subbasal teeth.

Male.—Length, 2.4-2.8 mm. Similar in structure and color to female except tegula black; basal terga more brownish than orange; and hindtarsus mostly blackish. Genitalia in Fig. 12.

Holotype.—Female, "Arisan, Taiwan, May 27, 1929, coll. K. Sato," "Taiwan 57, 393." In the National Science Museum (Natural History), Tokyo. Arisan (Alishan in Chinese) is a mountain (ca. 2400 m) in Chiai Pref., west of Mt. Yushan, the highest mountain in Taiwan.

Paratypes.—Labeled "Baibara, Formosa, IV-25-1929, coll. K. Sato" (3♂). Deposited with holotype. Baibara is north of Puli, Nantou Pref., in central Taiwan.

Remarks.—The following key will separate *taiwanensis* from the two known species of *Birmella* from Burma:

1. Malar space as long as diameter of an ocellus in female, more than $\frac{1}{2}$ as long in male (black with legs and palpi yellowish; clypeus truncate; supraclypeal furrow deep) *truncata* Malaise
- Malar space linear 2
2. Black with legs and palpi yellow; clypeus with shallow, angular emargination; supraclypeal furrow shallow, indistinct .. *genalis* Malaise
- Black with 1st and 2nd antennal segments, palpi, tegula in female, basal 4 terga and sterna, and legs pale orange; clypeus truncate; supraclypeal furrow deep, distinct *taiwanensis*, new species

Fenusa Leach

Fenusa dohrnii (Tischbein).—This species was recorded from Japan by Togashi (1963), Okutani (1967) on *Alnus japonica* Steud., and Togashi (1972) on *Alnus fauriei* Kev. It is a leaf miner of *Alnus* throughout the Holarctic Region. I have seen specimens from Hokkaido on *Alnus japonica*; Yokohama, Kanagawa-ken, 10-V-1933, K. Sato; and Shikotan, Kuriles.

Fenusa pusilla (Lepelletier).—Records for Japan were given by Togashi

(1960) on *Betula*, Inoue (1963) on *Betula platyphylla* Sukatchev var. *japonica* (Miq.) Hara in Hokkaido with life history notes, Okutani (1967) on *Betula platyphylla* var. *japonica*, *B. verrucosa* Ehrh., and *B. populifolia* Marsh., and Togashi (1976) on *Betula ermanii* Cham. This Holarctic species is a serious pest of birch in North America.

Fenusa ulmi Sundevall.—I saw one specimen from "Sounkyo, Hokkaido, VI-19-1938, coll. K. Sato." This is the first record of this elm leaf miner from Japan; it is also found in Europe and is adventive in North America.

Messa Leach

Messa nana (Klug).—A specimen at Hokkaido University is from Hokkaido and bears a host label "*Betula platyphylla* var. *japonica*." This is the first record of this species from Japan; it occurs in Europe, and it has been introduced into the northeastern United States and eastern Canada where it is also a leaf miner of *Betula*.

Metallus Forbes

Takeuchi (1952), Togashi (1963, 1978), and Okutani (1967) recorded *Metallus albipes* (Cameron) from Japan, and Okutani (1970) recorded *M. pumilus* (Klug) from Japan. Both are European species. Okutani (1967, 1970) recorded the hosts of both species as *Rubus crataegifolius* Bunge. The only other described species from Asia is *M. compressicornis* (Malaise) from Burma. The following species from Korea and Nepal are new.

Metallus satoi Smith, NEW SPECIES

Figs. 6, 7

Female.—Length, 4.0 mm. Black with palpi, extreme apex of each femur, and all tibiae and all tarsi white. Wings subhyaline; veins brown, costa and stigma paler brown. Antennal length $1\frac{1}{2} \times$ head width; 9-segmented: 1st and 2nd segments each broader than long; 3rd segment $1\frac{1}{3} \times$ length of 4th segment; segments 4–9 gradually decreasing in length and each about $2 \times$ longer than broad. Clypeus truncate; malar space linear; postocellar area $1\frac{2}{3} \times$ broader than long; distance between eyes below greater than eye length; no genal carina. Prepectus absent. Tarsal claw with one tooth and broad, acute basal lobe; hindbasitarsus equal to length of 3 following segments combined; foretarsus slightly longer than foretibia. Forewing with radial cell closed; vein 2A + 3A straight; 1st cubital crossvein very faint, thus appearing to have 3 cubital cells. Hindwing with radial cell closed, though veins faint at apex; anal cell present. Sheath (Fig. 7) rounded at apex in lateral view. Lancet (Fig. 6) with serrulae rounded, far apart, each broader than long and with small subbasal tooth at base on anterior and posterior sides.

Male.—Unknown.

Holotype.—Female. "Shakuoji, Korea, VII-22-1931, coll. K. Sato." In the National Science Museum (Natural History), Tokyo. Shakuoji, Korea, may be Seogwang-sa, a temple in a mountainous area, about 39°N, southwest of Weonsan in Hamgyeongnam-Do near the border of Gangweon-Do (A. Shinohara, personal communication).

Remarks.—The coloration of *satoi* is identical to that of *pumilus* (Klug) from Europe; however, the following separates *satoi* from *pumilus* and other species of *Metallus*: lancet serrulae low, rounded, broader than long (serrulae long, as long as broad in *pumilus*, *geei* (Brischke), and *albipes*; more pointed than rounded at their apices, and no posterior subbasal tooth near the base *geei*), and far apart (close together in *nepalensis*, Fig. 5); sheath narrower in lateral view (more broadly rounded in the three European species); clypeus truncate (very shallow V-shaped emargination in some other species); third antennal segment longer than fourth segment (subequal in length in all other species); malar space linear (short but distinct in other species); and femora black (white in *geei* and *albipes*).

The species is named after the collector.

Metallus nepalensis Smith, NEW SPECIES

Fig. 5

Female.—Length, 3.6 mm. Black with 1st and 2nd antennal segments and palpi white; legs white with basal $\frac{2}{3}$ of forecoxa, extreme bases of mid- and hindcoxae, and basal $\frac{2}{3}$ of forefemur black. Wings subhyaline; veins and stigma dark brown to black. Antennal length $2\times$ head width; 9-segmented; 1st and 2nd segments each broader than long; segments 3–5 subequal in length; segments 6–9 gradually decreasing in length and each slightly more than $2\times$ longer than broad. Clypeus very shallowly, circularly concave on anterior margin; malar space very narrow to linear; postocellar area $2\times$ broader than long; distance between eyes below greater than eye length; no genal carina. Prepectus absent. Tarsal claw with long tooth and broad, acute basal lobe; hindbasitarsus equal in length to following 3 segments combined; foretarsus longer than foretibia. Forewing with radial cell closed; vein $2A + 3A$ straight; 1st cubital crossvein absent, therefore with 3 cubital cells. Hindwing with radial cell closed; anal cell present. Sheath (as in Fig. 7) slender, in lateral view rounded at apex. Lancet (Fig. 5) with serrulae low, close together, rounded, each broader than long, and with small indistinct subbasal tooth near base on anterior and posterior sides.

Male.—Unknown.

Holotype.—Female. "Nepal, Kmd., Godav ari, 6000', 14-17-VII-1967, Mal. Tr., Can. Exp." In the Canadian National Collection, Ottawa.

Remarks.—The following separates *nepalensis* from *compressicornis* from Burma: basal antennal segments white; mid- and hindfemora white; presence of three cubital cells in the forewing, and the circularly concave

anterior margin of the clypeus. The lancet serrulae are broader than long and close together (far apart and as long or longer than broad in *pumilus*, *geei*, and *albipes*; similar in *satoi* but far apart). The white mid- and hindfemora separate *nepalensis* from *pumilus* and *satoi*; the black forefemora and concave anterior margin of the clypeus separate *nepalensis* from *albipes* and *geei*, and, in addition, the apical antennal segments which are more than two times longer than broad separate *nepalensis* from *geei* which has those segments about one and one-half times broader than long.

Okutanius Smith, NEW GENUS

Type-species.—*Okutanius lobatus* Smith, new species.

Antenna 13-segmented; 1st and 2nd segments each as broad or broader than long; 3rd segment longer than 4th segment; segments 4–13 subequal in length (Fig. 11). Prepectus present, separated from mesepisternum by furrow. No genal carina. Tarsal claw simple with small basal lobe (Fig. 10). Forewing with radial cell closed; vein 2A + 3A straight; 1st cubital crossvein faint, therefore with 4 cubital cells. Hindwing with radial cell open; without anal cell.

Remarks.—The presence of a prepectus and a basal lobe on the tarsal claws takes *Okutanius* to the couplet separating *Parna* and *Nefusa* in my key to genera (Smith, 1976). *Parna*, however, has a genal carina, a closed radial cell in the hindwing, and an anal cell in the hindwing; both *Nefusa* and *Parna* have 9-segmented antennae with the second segment longer than broad, a broad, acute basal lobe on the tarsal claws, and an anal cell in the hindwing.

The genus is named for Professor Teiichi Okutani, Kobe University, Kobe, Japan; genus gender, masculine.

Okutanius lobatus Smith, NEW SPECIES

Figs. 8–11

Female.—Length, 4.0 mm. Black with 1st and 2nd antennal segments and labrum brown; palpi whitish; legs yellowish white with basal $\frac{1}{2}$ of each coxa black; basal 6 terga brownish, paler than black thorax. Wings subhyaline; veins brown, stigma paler brown. Clypeus truncate; malar space linear; postocellar area $2 \times$ broader than long; distance between eyes below greater than eye length. Antenna with 1st segment as broad as long; 2nd segment broader than long; 3rd segment $1\frac{1}{2} \times$ length of 4th segment; 4th segment longer than broad; segments 5–13 subequal in length and slightly longer than or about as long as broad. Hindbasitarsus equal to length of following 3 segments combined; foretarsus slightly longer than foretibia. Head and body smooth and shining. Sheath (Fig. 9) rounded in lateral view. Lancet (Fig. 8) with long, narrow lobelike serrulae alternating with short lobelike serrulae about $\frac{1}{2}$ or less the length of long ones.

Male.—Unknown.

Holotype.—Female. "Suigen, Chosen, Sept. 5, 1928, coll. K. Sato." "373." In the National Science Museum (Natural History), Tokyo. The type-locality is now known as Suweon, Korea.

Remarks.—The generic and specific characters noted including the unusual lancet (Fig. 8) should distinguish *lobatus*. The name is derived from the serrulae of the lancet.

Parna Benson

Parna kamijoi Togashi.—Togashi (1980) recently recorded this genus from Japan. Several specimens from Sapporo with the host label "*Tilia maximowiziana*," the same host Togashi reported, are at Hokkaido University. Another specimen at the National Science Museum, Tokyo, is from Sapporo, I-VI-1930, S. Fujii. *Parna tenella* (Klug), the only other species in the genus, occurs in Europe and Japan and is also a leaf miner of *Tilia*.

Profenus MacGillivray

I have seen several species from Hokkaido and Honshu. The genus is currently being revised by I. Togashi, Ishikawa Prefecture College of Agriculture. Togashi (1960, 1963) has recorded *Profenus thomsoni* (Konow), a leaf miner of *Betula*, in Japan.

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A KEY TO TROPICAL SPECIES OF *TRICORYNUS*, WITH
TAXONOMIC CHANGES (COLEOPTERA: ANOBIIDAE)

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Abstract.—Results of a study of the described Neotropical species of *Tricorynus* include four new synonyms, three changes in status, and 23 new combinations. New synonyms are: *T. herbarius* (Gorham) (= *Catorama maroniensis* Pic, n. syn.); *T. rubriventris* (Pic) (= *Catorama robustior* Pic, n. syn.); *T. wagneri* (Pic) (= *Catorama major* Pic, n. syn.); and *T. subglaber* (Pic) (= *T. depressus* White, n. syn.). *Tricorynus distinctus* (Pic), *T. subglaber* (Pic), and *T. longesulcatus* (Pic) represent changes of status. A key is given to the 30 described species, and a list is given of those species in the key with their synonyms. Lists of label data on type-specimens and of the 13 species and a subspecies of uncertain status are given and many are discussed. Most of the types of species described by Maurice Pic were studied.

The quality of the taxonomic work of Maurice Pic in the Coleoptera hinders study of faunas in which he described numerous species. Most of his publications consist of very brief, hastily composed descriptions that give but vague impressions of the beetles he had before him. Rarely can his names be assigned on the basis of these descriptions alone, and his notes that compare the new species with others are equally inadequate. Seldom are keys to species provided in his papers; illustrations are never included. This situation results in considerable mystery as to the correct assignment of Pic's names.

In 1977, I visited the Muséum National d'Histoire Naturelle in Paris, saw the types of most Pic species of Anobiidae, and borrowed a number of them; examination of these specimens has allowed assignment of many Pic names. My intent has been to revise certain tropical American genera of Anobiidae. Revisions of *Protheca* and *Stichtoptychus* (White, 1979a, 1980) have been published and a revision of *Cryptorama* is in preparation. Due to a change in direction of my research plans, I can attain only part of my goal of revising the *Tricorynus* by presenting a key to species.

The following key includes the Pic species whose types I have seen or which can be assigned on the basis of specimens identified by Pic. Also included are other species whose names can be assigned with certainty. Most species that have been treated in the three studies of *Tricorynus* faunas (i.e., White, 1965b, 1967, 1974) are not part of this work, because those have already been keyed and described. This excludes species occurring north of Guatemala and a single Chilean species.

Also included herein is a list of names of species that apparently belong in *Tricorynus* but which cannot be assigned with confidence because the descriptions are inadequate and no reliably identified specimens are available. Correct assignment of these names is a task for the future. I do, however, discuss the situation for most of these names.

Tropical species known to have been misplaced in *Catorama* (= *Tricorynus*) by Pic have been dealt with and placed in their correct genus in other publications (White, 1979a, 1979b, and 1980).

The literature contains no thorough morphological descriptions for most of the Pic species that are keyed in this paper. For that reason, a series of characters are included in most couplets to increase the likelihood that the species can be identified correctly.

The species here cited in combination with *Tricorynus* represent new combinations with the exception of the following: *distinctipennis* (Pic), *herbarius* (Gorham), *lepesmei* White, *neltumae* (Fisher), *robusticollis* (Pic), *tabaci* (Guérin), and *zeae* Waterhouse.

TAXONOMIC NOTES

Tricorynus herbarius (Gorham)

Cathorama herbarium Gorham, 1883: 207.

Catorama maroniensis Pic, 1927a: 8. NEW SYNONYM.

Close comparison of the type of *maroniensis* with a lengthy series of *herbarius* showed no reliable external differences to distinguish them, so the above change is necessary.

I erred (White, 1979b: 212) in listing *Catorama minasensis* Pic (1927a: 8) as a synonym of *T. herbarius*. The mistake resulted from examination of two specimens on one pin determined by Pic as *minasensis* and which bear (almost certainly in error) a red museum type label; these specimens are identical with *herbarius*. In error I accepted the Pic 1927a reference to *minasensis* as its original description, because there Pic neither referred to an earlier description nor made it clear that he was transferring *minasensis* (described by Pic, 1904b: 37) from *Eupactus* to *Catorama*. A discussion of the status of *minasensis* and the type-specimen will appear in a future paper on *Calymmaderus*.

Tricorynus rubriventris (Pic)*Cathorama rubriventris* Pic, 1904c: 57.*Catorama robustior* Pic, 1923: 5. NEW SYNONYM.

I have compared the lectotype of *C. robustior* (see below) with the holotype of *C. rubriventris* and found them to be the same species.

There is reason to question the accuracy of the locality Pic gave in the original description for *robustior*, for there are no collection data on the specimen, and it is clearly the same species as the type of *rubriventris*, which was collected in Mexico. In the original description of *robustior*, Pic gave the locality of collection as "Guyane Fr."; however, Pic (1927a: 8) gave the locality for *robustior* as "Colombie."

Though the head of the type of *rubriventris* is missing (evidently eaten by a dermestid), there is no doubt that it is the same species as *robustior*.

The pin bearing Pic's handwritten type label has four different specimens mounted on two cards. I select as the LECTOTYPE of *robustior* a specimen on the upper card and have written an "L" beneath it.

Tricorynus wagneri (Pic)*Catorama wagneri* Pic, 1927b: 186.*Catorama major* Pic, 1928a: 4. NEW SYNONYM.

While examining the Pic collection in Paris I found that a USNM specimen I had brought along agreed closely with the type of *T. wagneri*. Later I found another USNM specimen that agreed closely with the type of *T. major*. I have found no differences at the species level between these specimens that were compared with the respective types, so I here synonymize the two names.

Tricorynus subglaber (Pic), NEW STATUS*Cathorama rubriventris subglaber* Pic, 1904c: 57.*Tricorynus depressus* White, 1967: 8. NEW SYNONYM.

Though *subglaber* was described as a variety of *C. rubriventris*, the types of the two are sufficiently distinct as to leave no doubt that they are different species. I have compared the holotype of *subglaber* with specimens of *depressus* and found that they are the same species. The mere eleven words that validated *subglaber* did not allow it to be recognized.

Tricorynus distinctus (Pic), NEW STATUS*Catorama cribrata distincta* Pic, 1905a: 92.

Comparison of Pic's types of *C. cribrata* and *C. distincta* showed that they are clearly two distinct species.

Tricorynus longesulcatus (Pic), NEW STATUS*Catorama argentina longesulcata* Pic, 1928b: 50.

The differences between the type of *C. argentina longesulcata* Pic and a specimen that I compared with the type of *C. argentina* and which agreed very closely with it convince me that the two should be treated as distinct species.

KEY TO TROPICAL SPECIES OF *TRICORYNUS*

1. Elytron with no strongly impressed lateral grooves at apical $\frac{1}{2}$ 2
- Elytron with 1 or 2 distinctly impressed lateral grooves at apical $\frac{1}{2}$ 6
- 2(1). Head before each eye with a black, very coarsely punctate depression; Caribbean and Central America *tabaci* (Guérin)
- Head not as above 3
- 3(2). Elytron apically at side with a moderately distinct stria formed of large punctures; side of pronotum distinctly inflated; body $2\times$ as long as wide; reddish brown throughout; pubescence tan; length 4.2 mm; Argentina *robusticollis* (Pic)
- Not as above 4
- 4(3). Metasternum depressed anteriorly and with a distinct, longitudinal carina; large elytral punctures more or less clearly aligned into rows; pronotum at side bulging above anterior margin; eyes separated by about $1.8\times$ vertical diameter of an eye; length about 3.4-3.6 mm; Argentina *wagneri* (Pic)
- Metasternal and other characters not exactly as above 5
- 5(4). Elytral punctures obviously dual, dense, and aligned into longitudinal bands; middle tibia not grooved; eyes separated by about $1.5\times$ vertical diameter of an eye; large punctures at side of pronotum separated by much less than diameter of a puncture; length 3.6 mm; Mexico *rubriventris* (Pic)
- Elytral punctures not dual, small and sparse, not aligned; middle tibia grooved; eyes separated by about $2.0\times$ vertical diameter of an eye; large punctures at side of pronotum separated by about diameter of a puncture; length 3.7 mm; French Guiana *guyanensis* (Pic)
- 6(1). Elytron apically at side with but 1 distinctly impressed groove, or with lower groove much stronger than a 2nd, upper groove 7
- Elytron apically at side with 2 impressed grooves, about equally deep 11

- 7(6). Head just above eye level with a deep, arcuate, transverse groove; pronotum produced above anterior angle; pubescence with a golden reflection; elytron at apex with a fine, impressed groove, above it with a stria of aligned punctures; length 3.7 mm; Brasil *fulvopilosus* (Pic)
 - Not as above 8
- 8(7). Elytral apex at side with a 2nd upper groove or stria that is shorter and weaker than lower groove; length 2.2-3.0 mm 9
 - Elytral apex at side with but 1 groove; length 1.7-1.9 mm 10
- 9(8). Elytral apex at side with a 2nd, upper groove; metasternum carinate at middle; large elytral punctures separated on an average by a little over diameter of a puncture; eyes separated by about 1.7× vertical diameter of an eye; pronotum at side bulging; length 3 mm; Brasil *distinctus* (Pic)
 - Elytral apex at side with an upper stria formed of punctures; metasternum not carinate; large elytral punctures separated by 2-3× diameter of a puncture; pronotum at side not bulging; eyes separated by about 2.4× vertical diameter of an eye; length 2.2 mm; Peru *baeri* (Pic)
- 10(8). Eyes large, strongly bulging, separated by about 1.5× vertical diameter of an eye; Guadeloupe *lepesmei* White
 - Eyes smaller, weakly bulging, separated by nearly 2.0× vertical diameter of an eye; Brasil *unisulcatus* (Pic)
- 11(6). Anterior tibia with a single distinct groove; pronotum bulging above anterior margin; eyes separated by 1.6-1.8× vertical diameter of an eye; length 2.7-3.4 mm; Caribbean
 *neltumae* (Fisher)
 - Anterior tibia with 2 distinct grooves; other characters not as above 12
- 12(11). Metasternum distinctly, longitudinally carinate at middle; eyes separated by about 1.7× vertical diameter of an eye; pronotum bulging above anterior margin; body about 1.9× as long as wide; metasternum rounded front to back; length 2.7 mm; Brasil and Argentina *rudepunctatus* (Pic)
 - Metasternum not carinate; other characters not as above 13
- 13(12). Lateral elytral striae distinct at apex but not indicated at level of metasternum 14
 - Lateral elytral striae distinct at apex and weakly to clearly indicated at level of metasternum by shallow grooves or aligned punctures 20
- 14(13). Elytral apices distinctly produced, outline of elytral apex when see from above as a broad "W"; eyes separated by 1.7× ver-

- tical diameter of an eye; pronotum at side inflated; length 2.3 mm; Argentina *caudatus* (Pic)
- Elytral apices evenly rounded; otherwise not as above 15
- 15(14). Pronotum at side with large punctures only, separated on an average by more than diameter of a puncture, small punctures absent; head with large punctures only; eyes separated by $1.5\times$ vertical diameter of an eye; length 2.6 mm; Brasil *subplicatus* (Pic)
- Pronotum at side not as above; head not as above; eyes separated by $1.6-2.0\times$ vertical diameter of an eye; Caribbean, Brasil, and Argentina 16
- 16(15). Abdominal sutures impressed and segments convex front to back; punctation at side of pronotum obscurely dual; length about 1.7 mm; Argentina *brevesulcatus* (Pic)
- Abdominal sutures not impressed, segments nearly flat front to back; punctation at side of pronotum clearly to obscurely dual; length 2.0-2.4 mm; Brasil and Caribbean 17
- 17(16). Mesosternal hooklike process produced posteriorly over metasternum; pronotum at side distinctly bulging; body red brown throughout; length 2 mm; Puerto Rico *insulicola* (Fisher)
- Mesosternal hooklike process not produced; otherwise not as above 18
- 18(17). Eyes larger, clearly bulging, separated by about $1.6\times$ vertical diameter of an eye; punctation at side of pronotum obscurely dual, larger punctures but slightly larger than small punctures and less dense; length 2.0-2.5 mm; Guadeloupe *pierrei* (Lepesme)
- Eyes smaller, weakly bulging, separated by about $2\times$ vertical diameter of an eye; punctation at side of pronotum clearly dual, large punctures much larger than small punctures and denser .. 19
- 19(18). Body primarily dark brown but with elytral apex, head, and abdomen more or less red brown; length about 2.4 mm; Brasil *reitteri* (Pic)
- Body primarily red brown but with metasternum a little darker than remainder; length about 2.0 mm; Guadeloupe *minutissimus* (Pic)
- 20(13). Punctures of head clearly dual, of small, dotlike punctures and larger, rimmed punctures 21
- Punctures of head of 1 size, irregular in size, or obscurely dual 23
- 21(20). Elytra and abdomen reddish brown, remainder of body clearly darker; punctation of metasternum obscurely dual throughout; eyes separated by about $1.9\times$ diameter of an eye; 2.9 mm; Argentina *argentinus* (Pic)

-	Not exactly as above	22
22(21).	Punctures at side of pronotum above anterior margin so dense that they are largely confluent; Brasil	<i>brasiliensis</i> (Pic)
-	Punctures at side of pronotum above anterior margin not running together; Argentina	<i>sparsepunctatus approximatus</i> (Pic)
23(20).	Punctures at side of pronotum dual, distinctly impressed and clearly of 2 sizes	24
-	Punctures at side of pronotum obscurely dual, weakly impressed and not clearly of 2 sizes	28
24(23).	Length about 4.0 mm; dark brown nearly throughout; apex of 5th abdominal segment narrowly produced; Brasil ..	<i>convexus</i> (Pic)
-	Length about 2.4-3.5 mm; red brown nearly throughout; apex of 5th abdominal segment not produced	25
25(24).	Elytra with large punctures on disk showing no tendency to alignment in bands; eyes separated by 1.6-1.8× vertical diameter of an eye; length 2.8 mm	26
-	Elytra with large punctures on disk showing weak to distinct tendency to alignment in bands; eyes separated by 1.8-2.4× vertical diameter of an eye; length 2.3-3.5 mm; various localities	27
26(25).	Eyes separated by 1.6× vertical diameter of an eye; Brasil	<i>cribratus</i> (Pic)
-	Eyes separated by 1.8× vertical diameter of an eye; Peru	<i>distinctipennis</i> (Pic)
27(25).	Large punctures of elytral disk clearly forming bands or rows; large punctures of metasternum smaller, sparser laterally, not quite attaining side; metasternum behind anterior margin on each side of middle with a narrow, elongated fovea; length 2.7-3.5 mm; South America, Central America, and Caribbean	<i>herbarius</i> (Gorham)
-	Large punctures of elytral disk with a weak tendency to form bands; large punctures of metasternum abruptly stopping laterally and broadly absent from side; metasternum behind anterior margin on each side with 2 foveae, 1 nearly round, the other elongated; length 2.3 mm; Argentina	<i>curtus</i> (Pic)
28(23).	Dorsum primarily dark brown but nearly black at base of elytra and with elytral suture red brown; eyes separated by about 1.8× vertical diameter of an eye; ventral surface red brown; length about 2.7 mm; Argentina	<i>subrutiliceps</i> (Pic)
-	Body red brown throughout; otherwise not as above	29
29(28).	Elytra with large punctures on disk showing a weak tendency to alignment in series; eyes separated by about 1.8× vertical diameter of an eye; 2.4 mm long; Argentina ..	<i>longesulcatus</i> (Pic)

- Elytra with large punctures on disk showing no tendency to alignment in series; eyes separated by about $1.4\times$ vertical diameter of an eye; 2.8 mm long; Argentina *rufus* (Pic)

LIST OF SPECIES IN KEY, WITH SYNONYMY

- | | |
|--|---|
| <i>argentinus</i> (Pic), 1904c: 57. | <i>longesulcatus</i> (Pic), 1928b: 50. |
| <i>baeri</i> (Pic), 1904a: 19. | <i>minutissimus</i> (Pic), 1904d: 104. |
| <i>brasilienis</i> (Pic), 1902: 68. | <i>neltumae</i> (Fisher), 1942: 37. |
| <i>brevesulcatus</i> (Pic), 1927b: 187. | <i>pierrei</i> (Lepesme), 1947: 227. |
| <i>caudatus</i> (Pic), 1928b: 49. | <i>reitteri</i> (Pic), 1927a: 9. |
| <i>convexus</i> (Pic), 1902: 68. | <i>robusticollis</i> (Pic), 1922: 4. |
| <i>cribratus</i> (Pic), 1905a: 92. | <i>rubriventris</i> (Pic), 1904c: 57. |
| <i>curtus</i> (Pic), 1927a: 7. | <i>robustior</i> (Pic), 1923: 5. |
| <i>distinctus</i> (Pic), 1905a: 92. | <i>rudepunctatus</i> (Pic), 1904c: 57. |
| <i>distinctipennis</i> (Pic), 1904a: 19; | <i>rufus</i> (Pic), 1927a: 7. |
| White, 1973: 847. | <i>sparsepunctatus approximatus</i> |
| <i>fulvopilosus</i> (Pic), 1927a: 8. | (Pic), 1928a: 4. |
| <i>guyanensis</i> (Pic), 1923: 5. | <i>subplicatus</i> (Pic), 1927a: 9. |
| <i>herbarius</i> (Gorham), 1883: 207. | <i>subrutiliceps</i> (Pic), 1905b: 136. |
| <i>latipennis</i> (Pic), 1927a: 9. | <i>tabaci</i> (Guérin), 1850: 437. |
| <i>claveri</i> (Pic), 1923: 5. | <i>impressifrons</i> (Fall), 1905: 234. |
| <i>maroniensis</i> (Pic), 1927a: 8. | <i>puncticeps</i> (Gorham), 1886: 348. |
| <i>goudoti</i> (Pic), 1927a: 8. | <i>unisulcatus</i> (Pic), 1927b: 187. |
| <i>venezuelensis</i> (Pic), 1927a: 9. | <i>wagneri</i> (Pic), 1927b: 186. |
| <i>insulicolus</i> (Fisher), 1936: 240. | <i>major</i> (Pic), 1928a: 4. |
| <i>lepesmei</i> White, 1965a: 115. | |
| <i>estriatus</i> (Lepesme), 1947: 228. | |

LABEL DATA

Most data listed below are from types, but in the case of two Pic species, the data are from specimens identified by Pic but which do not bear type labels. Because of the apparent carelessness of Pic's work, the latter specimens may not represent the same species as his types (which could not be found). The species *baeri* and *major* have been worked into the key on the basis of these non-types.

I have noted discrepancies between published data and data on type-specimens.

The data refer to taxa that are either in the section on taxonomic notes or in the above key to species.

T. argentinus (Pic).—“S. Arg.; TYPE: Le Nat. no. 108, 1904, p. 57; *Cathorama argentina* Pic.” In the original description Pic gave “Buenos-Ayres (ex Baer).”

T. baeri (Pic).—“Sud-Peru, Hac. Huayuri, 28. 3. 1936.: [upside down label

- that conflicts with the previous one]; Gestr. von Tonus; 804; [a folded up label]; *Cathorama baeri* Pic [an undecipherable word]." The specimen bearing these data is not the type; the species was described in 1904, so the type could not have been collected in 1936.
- T. brasiliensis* (Pic).—"Jatahy, Prov. Goyas, Brésil; Le Nat. No. 361, 1902, p. 68; type; TYPE detriat; *Cathorama brasiliensis* Pic."
- T. brevesulcatus* (Pic).—"Decembre; Rep. Argent.; type; TYPE; *brevesulcata* Pic."
- T. caudatus* (Pic).—"Corumba, Matt Grosso; type; TYPE; *C. caudata* n. sp." Pic, 1928b: 49, gave the data as "Sierras de Córdoba: Alta gracia, 13.II.1927 (*C. Bruch*).—Brésil: Corumba."
- T. convexus* (Pic).—"Serra da Bernada (Pernambuco), Duhant 5. 6. 1894; TYPE; *Catorama convexa* Pic." In the original description Pic gave the data as "Serra de Bernada (Pernanbuco)."
- T. cribratus* (Pic).—"Tijuca (Brasil); Le Nat. No. 435, 1905, p. 92; type; TYPE; *cribrata* Pic."
- T. curtus* (Pic).—"B. Ayres; Rep. Argentina, Prov. Buenos Aires, 190, *C. Bruch*; type; TYPE; *curta* n. sp."
- T. distinctipennis* (Pic).—"Pérou, Prov. Otuzco, Choouisongo 2100, G. A. Baer. 3-1900; Type; TYPE; *Eupactus distinctipennis* Pic."
- T. distinctus* (Pic).—"S. Antonio da Barra, Pr. de Bahia, Gounelle 11-12.88; Le Nat. No. 435, 1905, p. 92; type; TYPE; v. *distincta* Pic."
- T. estriatus* (Lepesme) = *lepesmei* White.—"Museum Paris, Guadeloupe, Leo Dufau 1913; 1180, Anobieii; [undecipherable label]; TYPE; *Catorama estriatum mihi*, type, P. Lepesme det."
- T. fulvopilosus* (Pic).—"Jatahy, GOYAZ; TYPE; *fulvopilosa* n. sp."
- T. guyanensis* (Pic).—"Septembré; Guyane Françse, Nouveau Chantier, Collection le Moul; *C. guyanensis* n. sp."
- T. insulicola* (Fisher).—"Scirpus validus, Kiz Rd. No. 36, Ponce P.R., Coll. 21 Aug. '33, R. G. Oakley; San Juan #4506; Type No. 57595 U.S.N.M." There was an error by Fisher in transmitting the type data, because the original description gave "collected on "hucar" on beach, Tallaboa road near Ponce, P.R., August 21, 1933, by R. C. Oakley (I No. 4506)."
- T. longesulcatus* (Pic).—"Rio Salado, R. argent.; type; TYPE; *argentina longesulcata* Pic." In the original description Pic gave the collection data as: Santiago del Estero: Rio Salado (*Wagner*, in coll. Pic).
- T. major* (Pic).—"Cordoba Argentina, Dep. de Calamuchita, El Sauce, XII-1938; Manuel J. Viana; *major* Pic." This specimen clearly cannot be the type, for the species was described in 1928.
- T. maroniensis* (Pic).—"Juin; Guyane Française, St-Jean du Maroni; Coll. Le Moul; TYPE; *maroniensis* n. sp."

- T. minutissimus* (Pic).—“Tijuca (Rio), Bresil, E. Gounelle, 12, 1884; Le Nat. No. 412, 1904, p. 103; type; TYPE; Cathorama minutissima Pic.”
- T. neltumae* (Fisher).—“P.R. Acc. No. 812-40, Guanica, P.R., 12-5-40; L.F. Martorell Collectors [sic]; From seed pods of *Neltuma juliflora*; Type No. 64849 U.S.N.M.; Catorama neltumae Fisher.” In the original description the type number is given as 55676. The USNM type catalog has the data for *neltumae* entered under both the numbers 55676 and 64849. The second number is not needed, so the first number should be accepted as the correct one.
- T. pierrei* (Lepesme).—“Guadeloupe, Vitrac; TYPE; Catorama Pierrei mihi, TYPE, P. Lepesme det.” The original description gives the locality as “Trois-Rivieres.”
- T. reitteri* (Pic).—“Blumenau, S.O. Brasilien, (Reitter); Reitteri n. sp.” These data are all this specimen bears, so because it is not clearly labeled as type, I have added a LECTOTYPE label to it, and so designate it.
- T. robusticollis* (Pic).—“Republ. Argentina, Chaco de Santiago, Del Estero [sic], Rio Salado; type; TYPE; robusticollis n. sp.”
- T. robustior* (Pic).—“Type; C. robustior n. sp.” In the original description the locality of collection is given as “Guyane Fr.,” but there is no such label on the pin holding the specimens. Pic, 1928a: 4, gave the locality of collection for *robustior* as “R. Argentina.”
- T. rubriventris* (Pic).—“Mexique; type; Le Natur, No. 408, 1904, p. 57; TYPE.”
- T. rudepunctatus* (Pic).—“Bresil, Jatahy; type; Le Natur. No. 408, 1904, p. 57; TYPE; Cathorama rudepunctata Pic.”
- T. rufus* (Pic).—“Mon—[undecipherable]; n. sp.—[undecipherable]; type; TYPE Catorama rufa Pic.” The crudely scribbled labels on the pin are difficult to impossible to read. In the original description Pic gave the locality of collection as “Rep. Argentine.”
- T. sparsepunctatus approximatus* (Pic).—“Janvier; Republ. Argentine, Chaco de Santiago Del Estero. Rio Salado; Collection Wagner; TYPE; sparsepunctata v. approximata Pic.”
- T. subglaber* (Pic).—“1960; Mexique; type; Cathorama v. subglaber Pic; TYPE.”
- T. subplicatus* (Pic).—“S. Antonio, Bresil; type; TYPE; subplicata n. sp.”
- T. subruticeps* (Pic).—“Gov. Chubut, (Bruch); type; TYPE; Cathorama subruticeps Pic.” In the original description Pic gave the data as “Gov. Chubut (coll. Bruch et Pic).” The spelling published was *subruticeps*.
- T. unisulcatus* (Pic).—“Bresil, (Gounelle); type; TYPE; unisulcata n. sp.”
- T. wagneri* (Pic).—“Rep. Argentina, Choco de Santiago del Setera Rio Dulce [sic]; TYPE; wagneri n. sp.”

SPECIES OF UNCERTAIN STATUS

- gossypii* (Brèthes), 1924: 67. *robustior caucaensis* (Pic), 1927a: 8.
goyosensis (Pic), 1905a: 92. *sallei* (Guérin), 1851: cxv.
humeralis (Kirsch), 1874: 401. *sparsepunctatus* (Pic), 1928a: 4.
instriatus (Pic), 1923: 5. *s. rudectepunctatus* (Pic), 1928a: 4.
instriatipennis (Pic), 1923: 6. *substriatus* (Pic), 1905b: 136.
minutus (Pic), 1923: 5. *thecaoides* (Pic), 1904d: 103.
peruvianus (Kirsch), 1874: 401. *zeae* Waterhouse, 1849: lxxviii.

The above names cannot be assigned because their descriptions do not adequately characterize them, and no readily identifiable types or specimens are available. The situation in regard to most of these species and subspecies deserves detailed comments.

The type of *goyosensis* (Pic) is evidently lost. My examination of Pic's box of *Catorama* types showed that five types were missing from their cards and were likely among the loose beetles in the bottom of the box. Clues found (bits of glue on specimens that fit with glue on cards; specimens with areas denuded of pubescence that matched glue impressions on cards, etc.) allowed four of these types to be returned to their proper cards. However, I was not able to find the type of *goyosensis*. The metasternum and legs of the type were on the card, but the remainder of the beetle was not among the beetles and debris on the bottom of the box. The spelling *goyosensis* is given in the original description; however, Pic, 1912: 69, and Blackwelder, 1945: 405, give the spelling *goyasensis*.

Though I thoroughly searched Pic's very badly crowded box of *Catorama* and closely examined the debris in the bottom of the box, I did not find the types of his other 8 species and subspecies listed above.

Pic, 1923: 5, after the description of *Catorama instriata* n. sp., presented the following: "Le *C. minuta* mihi, du Chili, est plus petit, nettement rétréci en arrière, peu pubescent." It would appear that Pic here intended to refer to a species he previously described; however, there is no evidence of a previous reference to the name *minuta*, and it is doubtful that there is such a reference. It would seem that we have only these few words by which to recognize "*minuta*."

Pic, 1923: 6, after the description of *Catorama guyanensis* n. sp., gave the following: "Le *C. instriatipennis* mihi, du Brésil, très voisin du précédent, est un peu plus pubescent et a, sur les élytres, quelques points plus gros sur un fond finement et assez densément ponctué." As with *minuta* (above) Pic probably intended this to be a reference to a previously described species; however, there is no evidence to indicate that this name had actually been validated previously. We thus have a second species name validated through carelessness and which can likely never be assigned.

Species that Pic placed in *Catorama* which do not appear in the lists

above have been dealt with in other publications (White, 1979a, 1979b, 1980).

The description of *Catorama humeralis* Kirsch mentions parallel, impressed lines at the side of the elytra behind the middle. This makes it likely that the species is actually a member of *Tricorynus*. However, the description of *C. peruviana* Kirsch states that the elytral disk is striate, and this indicates that the species is probably a member of *Stichtoptychus*.

Lepesme, 1947: 226–228, treated, in addition to the two species listed above, two other species in *Catorama*. I have seen the type of *C. dufaudi* Pic, 1911: 183, and have transferred this species to *Stichtoptychus* (White, 1980). The other species that Lepesme treated was *sallie* Guérin, which is not recognizable from Lepesme's notes or from the description that Guérin offered for it.

It is likely that *T. zaeae* Waterhouse is a senior synonym of *T. tabaci* Guérin. I compared a specimen of *tabaci* with the description of *zaeae* and found it to agree closely. The body length Waterhouse gave for his specimens (number not given) of *zaeae* ($1\frac{3}{4}$ to 2 lines = 3.69 to 4.23 mm) compares well with the length for 37 specimens of *tabaci*, namely 3.4–4.6 mm. However, a troubling aspect of the description of *zaeae*, and one which raises some doubts as to whether *zaeae* is identical with *tabaci*, is the lack of reference to black, very coarsely punctate depressions on the head. These are prominent features of *tabaci* and should not have been overlooked if the species were the same as *tabaci*. In fact, *tabaci* is the most readily recognized species of the entire genus due to these punctate depressions. *Tricorynus zaeae* was recorded by Waterhouse as feeding on corn; *tabaci* is known to feed on a variety of materials, including garlic, divi-divi seeds, dry herbs, ramie dry stem, popcorn, dried pepper, and *Crataegus meriana*.

During work on the revision of *Tricorynus* (White, 1965b), I wrote to the British Museum of Natural History in an attempt to locate the type of *T. zaeae*. E. B. Britton attempted without success to locate the type-series and stated that if the specimens exist they should be in the British Museum; since they were not found, there is slight chance that they can now be located.

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A NEW *ATAENIUS* FROM SOCORRO ISLAND, MEXICO
(COLEOPTERA: SCARABAEIDAE: APHODIINAE)

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Abstract.—A new species of aphodiine scarab beetle, *Aphodius hoguei*, from Socorro Island, Mexico, is described, illustrated with line drawings and scanning electron micrographs, and compared with and distinguished from its closest relative.

The insect fauna of the eastern Pacific oceanic islands is still very poorly known in spite of the numerous zoological surveys made there during the last two centuries. Although many of the larger insects have been described from these islands, many of the smaller forms remain undescribed. Therefore, we were pleased to examine a series of a small aphodiine scarab beetle collected from Socorro Island by Charles L. Hogue and Arthur V. Evans when they participated in the Steele Expedition to the Islas Revillagigedo, Mexico, in 1977. These beetles were found to represent a new species of *Ataenius* and this species is described below.

Ataenius hoguei Cartwright and Spangler, NEW SPECIES
Figs. 1-5

Holotype male.—Length 4.5 mm, width 2.0 mm. Convex, elongate; black; anterior angles of pronotum and legs reddish brown (Fig. 1).

Head moderately convex, sides weakly arcuate to rather sharply angled genae; clypeal margin finely reflexed, rounded each side of shallow median emargination (Fig. 2). Surface of head anterior to greatest convexity of the clypeus with close, very fine rugulae. Disc of head minutely punctate; punctures gradually more noticeable across the occipital area where they are still very fine and separated by 3 or 4× their diameter; with a deep fovea in front of and adjacent to each eye.

Pronotum 1.4 mm long, 2.0 mm wide; sides and base weakly arcuate, finely margined; short setae, separated by about their length, along entire lateral and posterior margin. Surface with scattered, moderate punctures; punctures slightly more numerous on anterior angles and diagonally poste-



Fig. 1. *Ataenius hoguei*, habitus, 20 \times .

riorly toward middle of base; punctures gradually finer from middle to anterior margin.

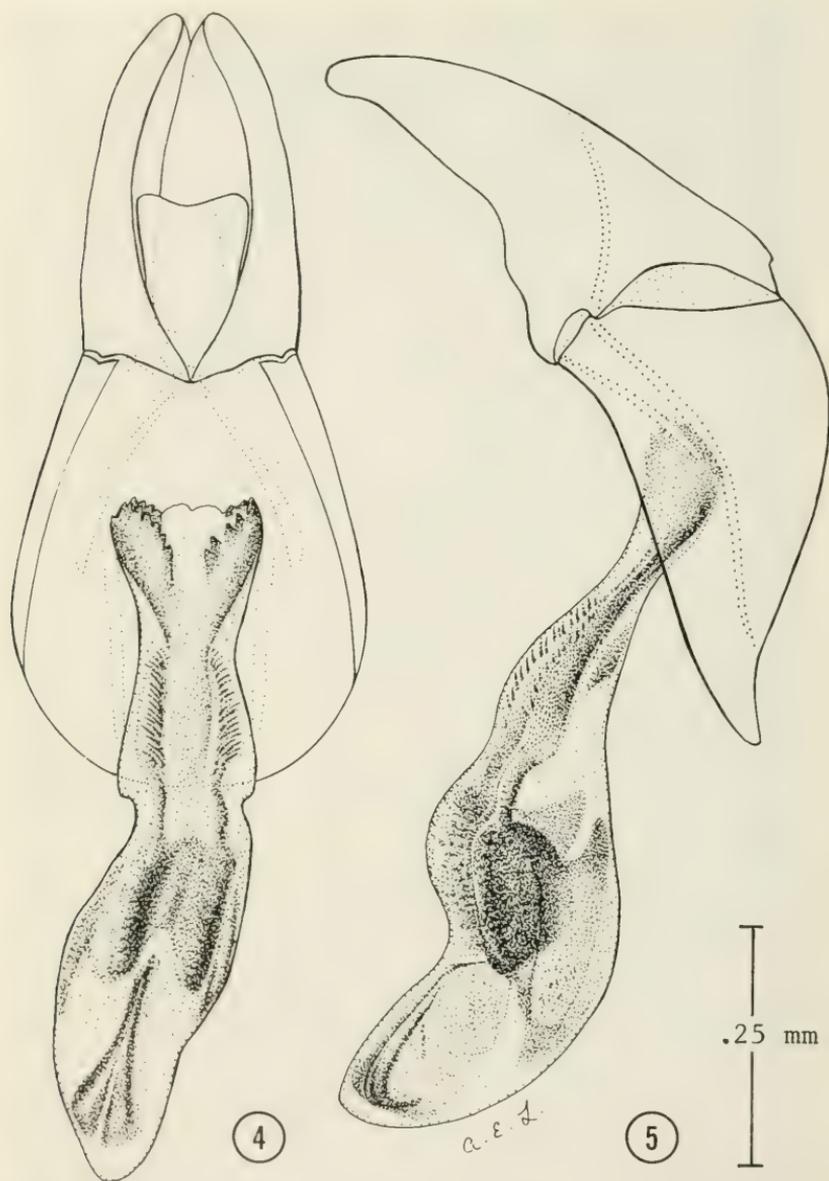
Elytra 3.0 mm long, 2.0 mm wide; humeri dentate; sides parallel; striae moderately deep and coarsely punctate; intervals very finely alutaceous, weakly convex, and appearing crenate because of strial punctures; intervals more strongly convex laterally and apically; humeral umbones almost smooth.

Metasternum shagreened; carinate between middle coxae; longitudinally grooved on midline, deeper anteriorly (Fig. 3); discal area flattened, punctate anteriorly, posterior $\frac{1}{3}$ finely closely punctate.

Profemur shining and smooth, with perimarginal groove. Protibial spur of male hooked inward at tip. Mesofemur and metafemur shining and smooth, with 1 or 2 moderately coarse punctures at apices; ventrally with fine marginal line on apical $\frac{1}{2}$. Metacoxae each with a large deep pit just anterior to juncture with femur. Metatibia with fringe of 6 fine short apical setae, a very short fine accessory spine, and an intervening seta next to terminal



Figs. 2, 3. *Ataenius hoguei*, 2, Head and protibia, 50 \times . 3, Metasternum, 75 \times .



Figs. 4, 5. *Atanius hoguei*, male genitalia. 4, Ventral view. 5, Lateral view.

spurs: long spur subequal to 1st tarsal segment in length and about $\frac{1}{3}$ the length of entire tarsus.

Abdominal segments slightly convex; with very fine, scattered punctures at middle; punctures becoming larger and more noticeable laterally; anterior

marginal fluting about equal on anterior segments, slightly wider and deeper on terminal segment. Pygidium eroded over basal $\frac{1}{2}$, leaving a wide convex shining apical lip.

Male genitalia as illustrated (Figs. 4, 5).

Allotype.—Length 4.9 mm, width 2.1 mm. Female differs from male in having a more distinct basal band of moderately fine close punctures, separated by 1 diameter or less, across the head; a normally straight anterior tibial spur; and slightly more noticeable alutaceous sculpture.

Type-data.—Holotype δ : MEXICO: Socorro Island, Revillagigedo Arch., 5 June 1977, Steele Exped. 1977, Station 1, sea level, C. Hogue and A. Evans; deposited in Natural History Museum of Los Angeles County, California. Allotype same data as for holotype. Paratypes (11 δ , 9 ♀), same data as holotype: 1 δ and 1 ♀ in British Museum (Natural History), London; 1 δ and 1 ♀ in the California Academy of Sciences, San Francisco; 2 δ in the Museum of Comparative Zoology, Harvard University; 2 δ and 2 ♀ in the Natural History Museum of Los Angeles County; 4 δ and 4 ♀ in the National Museum of Natural History, Smithsonian Institution; and 1 δ and 1 ♀ in the H. F. Howden collection.

Etymology.—We take pleasure in naming this species for Dr. Charles L. Hogue, the first named of the collectors.

Comparative notes.—*Ataenius hoguei* resembles *Ataenius wenzeli* Horn and will key to that species in the revision of the species of the United States and Canada by Cartwright (1974); however, in *A. hoguei* the elytra are generally less alutaceous, the intervals not as flat, the occipital band of punctures across the head are finer and less numerous (especially in the male), the apical fringe of the posterior tibia is shorter and finer, the accessory spine very short and fine, and the puncture or pit at the base of the posterior coxa is very coarse and noticeable.

Habitat.—Unknown; specimens were collected near the shore at Bahía Vargas Lozano where they were attracted to a 15-watt ultraviolet light at night.

ACKNOWLEDGMENTS

We thank Mary-Jacque Mann, Smithsonian Institution scanning electron microscopist, for taking the micrographs; Charles L. Hogue and Scott Miller for making the specimens and background information available to us; and Anne Lacy, biological illustrator, for preparing the pen and ink drawings for this article.

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**EDOVUM PUTTLERI, N. G., N. SP. (HYMENOPTERA:
EULOPHIDAE), AN EGG PARASITE OF THE
COLORADO POTATO BEETLE
(CHRYSOMELIDAE)**

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Abstract.—*Edovum puttleri*, new genus, new species, is described and illustrated from material reared from eggs of *Leptinotarsa undecimlineata* (Stål) from Colombia, South America. This egg parasite has been successfully reared on eggs of the Colorado potato beetle (*L. decemlineata* (Say)) in the laboratory.

In February and March of 1980, Ben Puttler (USDA, ARS, Biological Control of Insects Research Unit, Columbia, Mo.) made a search in Colombia, South America, for potential natural enemies to use against the Colorado potato beetle, *Leptinotarsa decemlineata* (Say). An egg parasite of the related species *L. undecimlineata* (Stål) had been found and referred to in the literature as *Emersonopsis* species (Puttler, personal communication). Puttler rediscovered this parasite in Colombia and submitted it to me for identification. Superficially this wasp resembled species of the genus *Emersonopsis* (host unknown), but biologically it behaved like species of *Emersonella*, a group of egg parasites of Chrysomelidae. After considerable study, however, I still could not definitely place the specimen to genus, so I sent it to Zdenek Bouček (British Museum Natural History) for his opinion. He suggested that this eulophid wasp belonged to an undescribed genus. After additional comparison with about 40 entedontine genera in the collection of the U.S. National Museum and after personal discussion with Bouček, I am describing the material as a new genus and species. The name is needed at this time because of studies being conducted on the potential use of this parasite as a biological control agent for the Colorado potato beetle. Additionally, some thoracic characters are discussed which may help define future work in the entedontine eulophids.

EULOPHIDAE: ENTEDONTINAE
Edovum Grissell, NEW GENUS

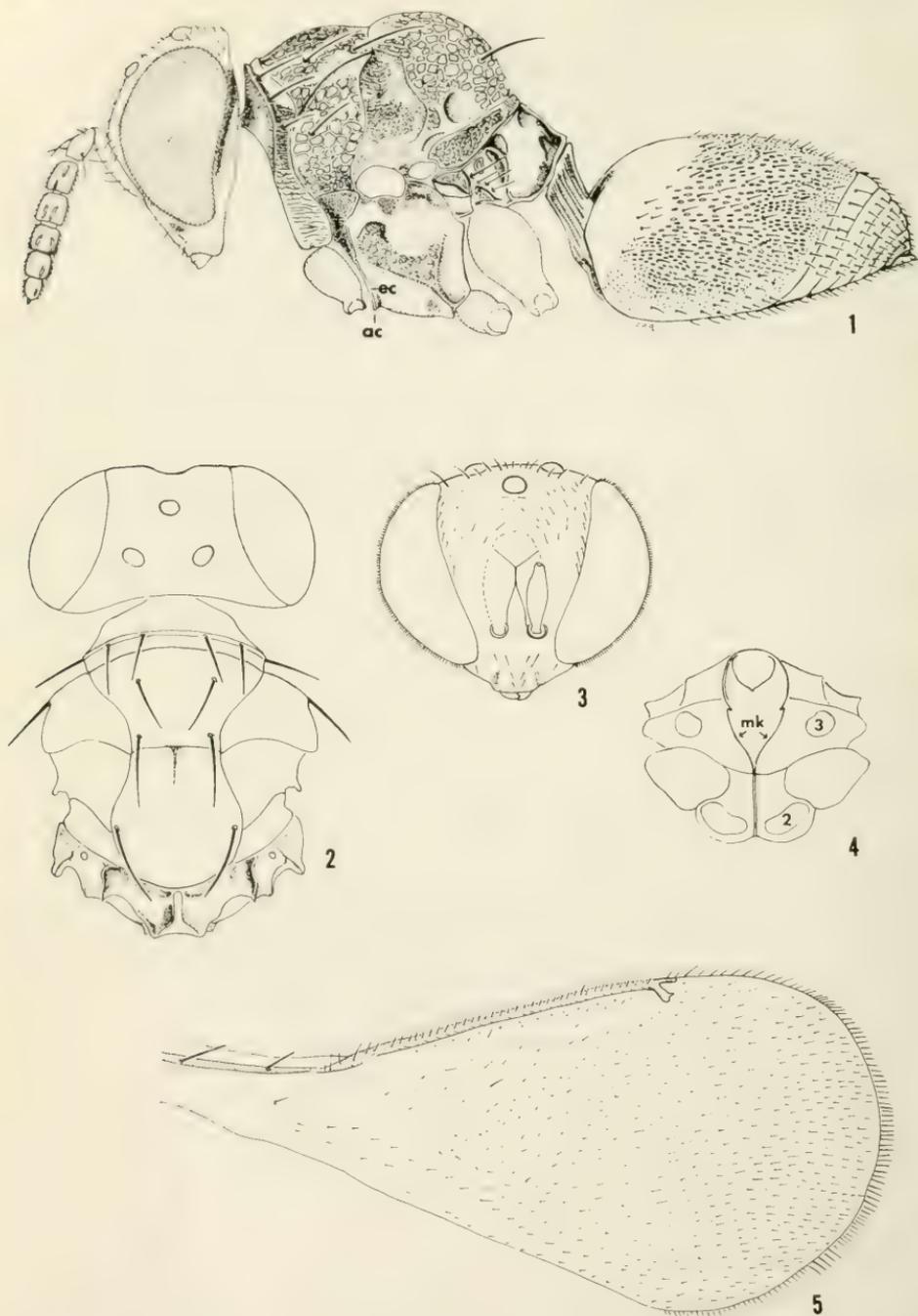
Type-species.—*Edovum puttleri*, new species.

Female.—Body heavily sclerotized, not collapsing when dry. Head without occipital carina, occiput meeting vertex at angle medially but not sharply defined, ocelli in nearly right triangle (Fig. 2), postocellus with posterolateral depression, face (Fig. 3) with eyes converging ventrally, toruli laterally closer to eye than to each other (1:2) and several diameters above lower margin of eye, scrobal grooves arising at inner margins of toruli meeting in upper $\frac{1}{3}$ of scrobal basin at frontal groove which is V-shaped, mandible with 2 subequal denticles, antenna (Fig. 6) with 3 flagellomeres, club 2-segmented with apical spine, anellus inconspicuous, eyes densely setose. Pronotum carinate along anterior margin with 6 bristles arising from transverse groove; scutum with 1 pair of bristles submedially and 1 pair on hindmargin, sidelobe with lateral bristle, scutellum with 2 posterolateral bristles (Fig. 2), notaulus distinct for entire distance but posterior $\frac{1}{3}$ at inner margin of less sculptured flattened area (thus easily overlooked in some views), slight median groove extending $\frac{1}{3}$ length from base to apex of scutellum, thorax with distinct epicnemial (laterally) and acetabular (ventrally) carinae outlining forecoxal depressions, axillae not produced forward, metasternum (Fig. 4) with Y-shaped keel separating hindcoxae and merging with foramen of propodeum, propodeum (Fig. 2) with flattened median carina subtended by longitudinal depressions and laterally produced into projection in front of hindcoxa; wing (Fig. 5) with costal cell $\frac{1}{2}$ as wide as submarginal seta, submarginal vein with 2 setae, marginal vein nearly $2\times$ length of submarginal, postmarginal and stigmal veins subequal and reduced, apical wing fringe about length of stigmal vein; tibial spur formula 1:1:1, midtibial spur longest. Abdominal petiole elongate with ventral length at least $2\times$ as long as minimum diameter (in side view) and longitudinally carinate, abdomen in side view (Fig. 1) ventrally flat, dorsally arched, first tergum $\frac{3}{4}$ length of abdomen, nearly carapace-like, second tergum $2\times$ length of tergum 3, terga 3-7 subequal, ovipositor not protruding.

Male.—Differing from female by the following characters: Antenna (Fig. 7) with 4 flagellomeres, 1-segmented club, scape slightly expanded apicoventrally, last sternum rounded apically with slight circular depression medially.

Etymology.—*Edovum* from *edo*, L.—eat, plus *ovum*, L.—egg. Gender neuter.

Discussion.—*Edovum* belongs in the Entedontinae as defined by Peck et al. (1964). Within the subfamily this genus is distinguished from all other genera by the presence of an epicnemial carina connected ventrally with the acetabular carina (Fig. 1). Essentially this forms a mesosternal (forecoxal)



Figs. 1-5. *Edovum putleri*. 1. Habitus (ac = acetabular carina; ec = epicnemial carina). 2. Head and thorax, dorsal view. 3. Head, frontal view. 4. Thorax, ventral view (mk = metasternal keel; 3 = hindcoxal cavity; 2 = midcoxal cavity). 5. Forewing, dorsal view (setae on undersurface indicated by dots).



Figs. 6-7. *Edovum puttleri*, antenna. 6, ♀. 7, ♂ (setae not shown, similar to female).

depression that separates the forecoxae from the midcoxae. The mesosternum is distinctly angulate between the pairs of coxae. In other genera, there is at most a slight groove corresponding to the epicnemial carina, there is no acetabular carina, and the mesosternum slopes evenly from fore- to mid-coxa without the formation of a forecoxal depression. The terms epicnemial carina and acetabular carina are used in the sense of Richards (1977) and define diagnostic structures that have seldom been referred to in the Chalcidoidea.

Another character apparently unique to *Edovum* is the presence between the hindcoxae of a forked metasternal keel (Fig. 4, mk), which is continuous with the propodeal foramen (including nucha). In other entedontines, either there are no structures between the coxae or there are weak carinae that approach the foramen but do not join with it.

The above characters are enough to distinguish *Edovum* as structurally unique. A combination of other characters that make it even more distinct are the following: Eyes converging strongly below, V-shaped frontal groove joined by scrobal grooves, curved (not angled) vertex, notauli deeply impressed for entire length, scutellum with a basal median groove, propodeum

medially not projecting as a neck beyond the hindcoxae, and first abdominal tergum covering about three-fourths length of abdomen.

Placement of *Edovum* in relation to other genera is rather problematical. Until the Entedontinae are revised, however, I suggest that the thoracic structure of *Edovum* is sufficiently distinct to isolate it taxonomically from all other genera.

Edovum puttleri Grissell, NEW SPECIES

Holotype female.—Body length 1.6 mm. Black except ivory colored are: Scape, legs beyond coxae, wing veins; antenna past scape brown. Ratio ocellular length : postocellus : postocellar length as 5:4:9, ratio upper to lower interocular distances to eye height as 26:14:31, scrobal basin confined to middle $\frac{1}{3}$ of face, clypeus slightly swollen with free edge weakly upturned, in side view malar distance $\frac{1}{6}$ eye height (5:32), scape reaching midway to median ocellus, length less than eye width (13:15), ratio scape : pedicel : F1 : F1 : F3 : club as 13:6:6:6:5:11 (Fig. 6); occiput shagreened to finely reticulate with sculpture extending over vertex and reticulations becoming somewhat larger on face above toruli, postocellar depression aciculate, polished are: Supraclypeal area including interantennal triangle, clypeus, dorsal area of scrobes above frontal groove; face and vertex with sparse setae. Dorsomedian strip behind pronotal groove polished, groove and dorsolateral corners shagreened changing to longitudinal reticulation laterally, thorax dorsally (except axillae) with conspicuous reticulation that becomes effaced in posterior $\frac{1}{3}$ of notaulus (i.e., notaular depression), basal $\frac{1}{4}$ of scutellum with sculpture less developed than apex, axillae with aciculate to reticulate sculpture, side of thorax polished except following areas shagreened: Prepectus, mesosternal depression, mesopleural depression (somewhat hour-glass shaped), metasternum; the following areas lightly aciculate: Lower posterior area of mesopleuron, inner aspects of coxae (otherwise highly polished); propodeum (Fig. 1, 2) with median carina flattened, slightly elevated in profile, polished, area on either side depressed, upper $\frac{1}{3}$ shallow transverse polished pit, lower $\frac{2}{3}$ with shagreened longitudinal pit that continues around nucha, median areas highly polished with deep dorsolateral fovea, areas set off laterally by shagreened, longitudinal sulcus; spiracle on flattened polished plane with 6 setae laterally, otherwise lateral area of propodeum shagreened on upper and lower parts, polished between; wing (Fig. 5) ratio of submarginal : marginal : stigmal : postmarginal veins as 27:48:3:3, costal cell without setae, basal $\frac{1}{3}$ of wing without setae on underside and above sparsely setose, 1 seta in area below submarginal vein. Abdominal terga 1–7 in ratio of 45:5:3:3:3:3:2 (longest dorsal view of each tergum), tergum 1 basally depressed, anterior $\frac{1}{3}$ polished and asetose, posterior $\frac{2}{3}$ with elongate pits (medially ca. own long diameter apart) interspersed with setae, remaining terga alutaceous with transverse setal row.

Allotype male.—Body length 1.4 mm. Very similar to female except in following characters: Ratio scape : pedicel : F1 : F2 : F3 : F4 : club as 15:6:6:5:5:5:6 (Fig. 7); scutellum polished or with effaced sculpture in basal $\frac{1}{2}$; abdominal terga 1–7 in ratio of 42:2:2:4:4:4:2 basal $\frac{1}{2}$ of tergum 2 polished.

Holotype.—♀, USNM type no. 100070, South America, Colombia, Medellin, 27-II to 3-III-1980, B. Puttler, ex *Leptinotarsa undecimlineata* on *Solanum saponaceum* Duy.

Allotype and paratypes.—Allotype ♂, 21 ♀ and 5 ♂ paratypes with same data as for holotype; 15 ♂ paratypes, F₁ generation of above, reared in United States, Missouri, Columbia, III-1980, ex *Leptinotarsa decemlineata* (Say). Material in USNM except 4 ♀, 4 ♂ paratypes in British Museum (Natural History), and 3 ♀, 3 ♂ paratypes in Museo de La Plata, La Plata, Argentina.

Other material examined.—25 specimens, South America, Colombia, Palmira (Valle), 19-25-II-1980, B. Puttler, same host as for holotype. Material at USDA, Biological Control of Insects Research Unit, Columbia, Missouri.

Hosts.—Occurring naturally in eggs of *Leptinotarsa undecimlineata*, but successfully cultured in the laboratory in eggs of the Colorado potato beetle, *L. decemlineata*.

Variation.—Size range is minimal in this species with females ranging from 1.3 to 1.6 mm and males from 1.2 to 1.5 mm. The 50 or 60 specimens examined are remarkably constant in coloration and morphology except for the abdomen. Abdominal tergum 1 remains unmodified after death, but terga 2–7, being relatively shorter and slightly telescopic, tend to vary in relation to each other and to tergum 1. In females tergum 1 is at least three-quarters the length of the abdomen and sometimes as much as nine-tenths. In males tergum 1 is usually about three-quarters but in a few specimens only about one-half the length of the abdomen. In these few specimens, the second tergum is extended four or five times the normal length with terga 3–7 remaining relatively unchanged. For comparative purposes the length of tergum 1 should be given in relation to some fixed structure such as the propodeum rather than to the remainder of the abdomen. There may be 1 to 3 setae basally on the wing beneath the submarginal vein.

Etymology.—Named in recognition of Ben Puttler and his work in biological control.

ACKNOWLEDGMENTS

I thank Ben Puttler for his cooperation in providing specimens and for reviewing this manuscript. I thank Zdenek Bouček (Commonwealth Institute of Entomology, British Museum (Natural History)) for providing both the initial direction to this study and a review of the findings. I also thank Michael Schauff (Systematic Entomology Laboratory, USDA) for making

slides needed in this study and Helen Proctor for the final typing of the manuscript.

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NOTICE OF A NEW PUBLICATION

The Flower Flies of the West Indies (Diptera: Syrphidae). By F. Christian Thompson, Systematic Entomology Laboratory, HBIII, Agricultural Research Service, U.S. Department of Agriculture, Washington, D.C. Memoirs of the Entomological Society of Washington, Number 9, 200 pp. Cost, \$10.00.

A taxonomic analysis of the flower flies of the West Indies is presented and includes keys and illustrations for 27 genera and 129 species. Complete bibliographies and synonymies are given for each species, and extensive discussions are provided for many. The economic importance, distribution, and taxonomy of these flies are discussed. Twenty new species and one new subgenus are described, and 46 new synonymies are proposed.

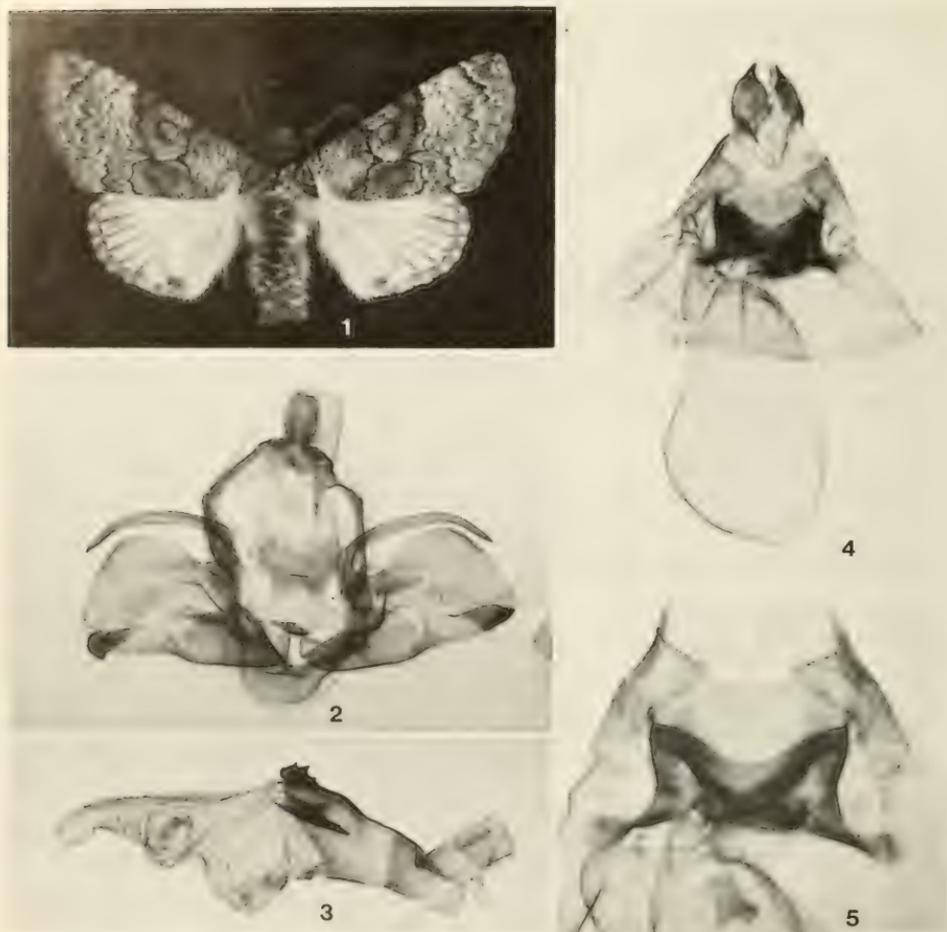
This publication can be ordered from the Custodian, Entomological Society of Washington, % Department of Entomology, Smithsonian Institution, Washington, D.C. 20560.

NOTE

Charadra ingenua Smith in West Texas
(Lepidoptera: Noctuidae: Pantheinae)

The moth discussed and figured was originally thought to be an undescribed species, but comparison with a series of *Charadra ingenua* Smith (1906, J. N.Y. Entomol. Soc. 14: 10) from the Flagstaff area of northern Arizona indicated at most a geographical race of *ingenua*. This somewhat distinctive appearing population is known from Big Bend National Park, Brewster County, the Davis Mountains, Jeff Davis County, and the Guadalupe Mountains, Culberson County, Texas. It is very common in Green Gulch, Big Bend National Park, and it will probably also prove common in neighboring Chihuahua and Coahuila, Mexico. *Charadra ingenua* was described from two males and two females from Glenwood Springs and Durango, Colorado; the type male was the only specimen from Durango; it was in the J. B. Smith Collection, now in the American Museum of Natural History in New York City, and it was figured by Hampson (1913, Catalogue of the Lepidoptera Phalaenae in the British Museum 13: pl. 234, fig. 14). The west Texas population differs in being more uniform in color and having less contrast in the pattern; the tendency is for individuals to have more gray scaling and less white. However, two male specimens from McKittrick Canyon in the Guadalupe Mountains are very similar to specimens in the series from Walnut Canyon, Arizona, whereas the female collected at the same time has the pale areas grayer. There are no evident, constant structural differences in the genitalia of either sex between the populations.

There are before us 98 specimens from west Texas, 86 from Big Bend National Park, mostly collected in Green Gulch, 9 from Fort Davis, and 3 from McKittrick Canyon, Guadalupe Mountains; from Arizona there are 105 specimens, 103 from Walnut Canyon, near Walnut Canyon National Monument, and 2 from West Fork [Oak Creek Canyon], near the upper end of the Wilderness Area.



Figs. 1-5. *Charadra ingenua*. 1, Adult from Fort Davis, Jeff Davis Co., Texas, 11 July 1969, A. and M. E. Blanchard; in A. Blanchard Collection. A specimen with almost no white scaling. 2, Male genitalia, aedeagus removed (genitalia slide AB 3717). 3, Aedeagus (genitalia slide AB 3717). 4, Female genitalia (genitalia slide AB 3713). 5, Lamella antivaginalis (genitalia slide AB 3718). Photographs by A. Blanchard.

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NOTE

Mallophaga from Three Species of Scoters (Anatidae)

During a survey of the helminth parasites of three species of scoters (Black, *Melanitta nigra* (L.); White-winged, *M. deglandi* (Bonaparte); Surf, *M. perspicillata* (L.)), taken in British Columbia in 1974 and Labrador in 1978, Mallophaga were routinely collected from each host during necropsy. Eighty-two animals (17 Black, 17 White-winged, 48 Surf scoters), all more than one year old, were examined to obtain quantitative data on their feather-lice fauna. Specimens were fixed and stored in 70% alcohol and later mounted in Rubin's solution (Rubin, 1951. *Stain Technol.* 26: 257-260), or stained with carbol fuchsin and mounted in Canada Balsam. Lapage (1961. *Parasitology* 51: 1-109; reprinted 1962. *Wildl. Dis.* (26), 3 microcards (109 pp.)) listed the Mallophaga that had been recovered from scoters, while Emerson (1972. *Checklist of the Mallophaga of North America (North of Mexico)*. Part IV, Bird host list. Desert Test Center, Dugway, Utah. 216 pp.) gathered together North American records. The classification of the Mallophaga listed herein follows that of Emerson (1972. *Checklist of the Mallophaga of North America (North of Mexico)* Part I. Suborder Ischnocera, 200 pp.; Part II. Suborder Amblycera, 118 pp. Dugway Proving Ground, Dugway, Utah).

Four genera and six species of Mallophaga were recovered during this study (Black scoters, 3 genera [5 species]; White-winged scoters, 3 genera [4 species]; Surf scoters 4 genera [6 species]). Sixteen (94%) of the Black, 16 (94%) of the White-winged, and 34 (71%) of the Surf scoters were infested. No differences were noted in the burdens (prevalence and intensity of infestation) of scoters from the two sample areas, and years.

The philopterids found were of two morphological types, depending on their preferred position on the host. Short, round-bodied types, not greatly dorsoventrally flattened and with a large head, were located mostly on the head and neck (Clay, 1957. 1st Symposium on Host Specificity among Parasites of Vertebrates. Paul Attinger S.A., Neuchatel. 120-158), e.g. *Anatocetus* spp., while severely dorsoventrally flattened, elongate forms were recovered mostly from the wings and back, e.g. *Anaticola* sp. The amblycerans (*Holomenopon* spp. and *Trinoton* sp.) were found mainly on the breast and wings of the host (see Bourgeois and Threlfall, 1979. *Can. J. Zool.* 57: 1355-1357; Fitzpatrick and Threlfall, 1977. *Can. J. Zool.* 55: 1205-1209).

The following annotated list shows, for each mallophagan, the number (%) of each host infested, the number of parasites recovered (male, M:

female, F; nymph, N; total, T), mean number per infested bird, and range of numbers. Male *Anatoecus dentatus* and *A. icterodes* are separated from the *Anatoecus* nymphs and females. At the present time it is impossible to distinguish between the nymphs of the two species, and also the females. Indeed the taxonomic status of these species needs some clarification (Emerson, 1972, Part 1). Several mixed infections were noted (Blacks 4, White-winged 3, Surfs 2) and the absence of a male of one species, or males of both species, does not necessarily mean that all the females present are of one species. *Anatoecus* spp. were found to infest 13 (81%) of the Black scoters, 10 (59%) of the White-winged scoters and 28 (58%) of the Surf scoters.

ISCHNOCERA PHILOPTERIDAE

Anaticola crassicornis (Scopoli): *M. nigra*, 17(100), 33M, 39F, 93N, 165T, 10, 1-22; *M. deglandi*, 7(41), 52M, 43F, 129N, 224T, 32, 1-91; *M. perspicillata*, 28(58), 24M, 44F, 64N, 132T, 5, 1-22.

Anatoecus dentatus (Scopoli): *M. nigra*, 4(24), 9M, 9T, 2, 1-5; *M. deglandi*, 4(24), 15M, 15T, 4, 1-8; *M. perspicillata* 4(8), 5M, 5T, 1, 1-2.

Anatoecus icterodes (Nitzsch): *M. nigra*, 7(41), 16M, 16T, 2, 1-4; *M. deglandi*, 4(24), 9M, 9T, 2, 1-4; *M. perspicillata*, 11(23), 17M, 17T, 2, 1-3.

Anatoecus spp.: *M. nigra*, 9(53), 32F, 32N, 64T, 7, 1-9F, 4-16N; *M. deglandi*, 5(29), 16F, 5N, 21T, 4, 1-5F, 1N; *M. perspicillata*, 20(42), 39F, 3N, 42T, 2, 1-7F, 1N.

AMBLYCERA MENOPONIDAE

Holomenopon leucoxanthum (Burmeister): *M. nigra*, 4(24), 7M, 7F, 14T, 4, 2-7; *M. perspicillata*, 5(10), 1M, 7F, 8T, 2, 1-3.

Holomenopon loomisii (Kellogg): *M. nigra*, 5(29), 4M, 11F, 15T, 3, 1-6; *M. deglandi*, 4(24), 1F, 1N, 6T, 2, 1-2; *M. perspicillata*, 3(6), 5F, 5T, 2, 1-2.

Holomenopon spp.: *M. nigra*, 7(41), 22N, 22T, 3, 1-7; *M. perspicillata*, 4(8), 6N, 6T, 2, 1-2.

Trinoton querquedulae (Linnaeus): *M. perspicillata*, 1(2), 1N, 1T, 1, 1.

The occurrence of *A. icterodes* and *H. loomisii* on the Black scoter, and *A. dentatus*, *A. icterodes*, *H. leucoxanthum* and *H. loomisii* on the Surf scoter constitute new host records.

The only other species of ectoparasite found was *Freyana anatina* (Koch) (Freyanidae), an astigmatid mite, which occurred on 6 (36%) of the Black scoters and 6 (13%) of the Surf scoters.

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NOTE

Predation on a Mouse by the Chinese Mantid
Tenodera aridifolia sinensis Saussure
(Dictyoptera: Mantoidea)

Observations of predation upon vertebrates by individual insects are uncommon, and most cases are of aquatic beetles (Coleoptera, Dytiscidae), water bugs (Hemiptera, Belostomatidae), and nymphal dragonflies (Odonata) preying upon tadpoles, frogs, and fish (Imms, A. D. 1960. A General Text Book of Entomology). Although Imms also mentions attacks by South American mantids feeding on birds, lizards, and frogs, most reports of mantids feeding on vertebrates are Australian records. Morse (1922, *Emu* 22: 74) described an attack by a mantid on a nestling bird, upon which it fed, and Nash (1962, *Victorian Nat.* 79: 11) described the attack and predation by the mantid, *Archimantis latistylus* (Serville), upon a golden bell frog, *Litoria aurea* (Lesson). Ridpath (1977, *J. Aust. Entomol. Soc.* 19: 153-154) documented several (and apparently regular) attacks by the large mantid, *Heirodula weneri* (Giglio-Tos) on the green tree frog, *Litoria caerulea* (White). He also observed on two separate occasions the capture of a small bird, the brown honeycreeper, *Lichmera indistincta* (Vig. and Horsf.).

The Chinese mantid, *Tenodera aridifolia sinensis* Saussure, is one of the largest of mantids (73-103 mm) and probably powerful enough to subdue and feed upon small vertebrates. The only published account of this species feeding on a captured vertebrate, however, describes the feeding on a captured *Trionyx* soft-shelled turtle (Johnson, M. D. 1976, *J. Kans. Entomol. Soc.* 49: 164). Though demonstrating the mantid's ability to subdue heavy vertebrates, this observation was unnatural in that both the turtle and mantid were enclosed in a small terrarium-aquarium.

We document here the capture and feeding by the Chinese mantid on a mouse. The description is substantiated with Polaroid® color photographs now on file in the Systematic Entomology Laboratory, USDA, National Museum of Natural History, and which are unfortunately not of reproducible quality for publication.

The observation occurred in the afternoon in the garden of JH in early August, 1980. A small whitefooted deer mouse (probably a juvenile, body length 80-90 mm, weight 10-15 g), *Peromyscus leucopus* (Rafinesque), was observed running along the periphery of the garden. It had gone behind a thicket of zinnias, when distress sounds from the mouse were heard. One zinnia bush was noticeably in motion, alerting JH, who observed the mouse immobilized by the grasp of the mantid's forelegs behind the mouse's head. The mantid was hanging upside down by its mid- and hindlegs from the

plant, and the mouse was elevated above the ground so that its hindlegs were unable to touch ground. The forelegs of the mouse, though free, remained at the mouse's side.

The mantid began at once to feed on the living mouse, commencing at the nose, and systematically working towards the back of the head, eating hair, bones, and other tissue along the way. The nasal bones of the skull were exposed within five minutes of feeding, with considerable bleeding at the wound site. After ten minutes the mantid had fed to the area of the brain, the mouse shuddered and appeared dead from that moment. The mantid fed to the hindquarters ($t = 45$ min). Bones, hairs, and all other parts were consumed at least to this point, when observations were discontinued.

Although it is unlikely that mice or other vertebrates are a regular part of this mantid's diet, it is nevertheless possible for large mantids to supplement opportunistically their diets with small vertebrates.

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83(4), 1981, pp. 802-803

NOTE

Acleris maccana (Lepidoptera: Tortricidae): Distribution Notes and a New Record for Virginia

The tortricine moth, *Acleris maccana* (Treitschke) (also referred to as *Peronea fishiana* Fernald in North America), was described from Germany and has its primary distribution in Europe. It is not known whether the North American populations were introduced at some time in the past century or whether they have been on the North American continent much longer. Until recently, the collection records in the Nearctic were mainly from southern Canada, with intrusions into the United States in New England and Washington. In June 1976, I collected one male at the base of Mt. Rogers in western Virginia. This represents a considerable extension of the North American distribution of *A. maccana* into the southern Appalachian



Fig. 1. Distribution of *Acleris maccana* in North America.

Mountains. Inasmuch as most collection records are for September or October in North America, it is possible that the moth has escaped notice by most collectors. Collection records from the literature and the Smithsonian Institution collection are plotted on the map (Fig. 1) and are as follows: CANADA: *Quebec*: Norway Bay [Ottawa R., near Hull]; Meach Lake [near Hull]; St. Godefroi [Gaspé Penin.]; Montreal; Aylmer. *Ontario*: Biscotasing; Ottawa. *Manitoba*: Winnipeg; Cartwright; Aweme. *Alberta*: Edmonton. *British Columbia*: Kaslo; Vancouver; Vavenby. UNITED STATES: *Maine*: Old Town; Orono. *Massachusetts*: Winchenden. *Virginia*: Grindstone Cpgd., Mt. Rogers, Smyth Co. *Washington*: Tacoma. The larval host in Europe is *Vaccinium* (Ericaceae).

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NOTE

First Record of the Red Pine Scale, *Matsucoccus resinosa*
(Homoptera: Margarodidae) from Pennsylvania

An extensive infestation of an undescribed scale insect was found on red pine, *Pinus resinosa* Ait., in Connecticut in 1946. Bean and Godwin described this scale as *Matsucoccus resinosa* in 1955 (For. Sci. 1: 164-176). Through extensive surveys, by 1976 this scale also was found in New Jersey and New York (Anderson, J. F. et al. 1976. Conn. Agric. Exp. Stn. Bull. 765: 1-6). The red pine scale is thought to be an introduced species, possibly of Eurasian origin, imported on pines planted on the grounds of the 1937 New York World Fair, although this has not been proven (Doane, C. C. 1959. Conn. Agric. Exp. Stn. Circ. 207: 1-7).

In November, 1980, I received a sample of Japanese red pine, *Pinus densiflora* Sieb. and Zucc., a known host of *M. resinosa*, from the Morris Arboretum in Philadelphia, submitted by Ann F. Rhoads, plant pathologist at the Arboretum. Dr. Rhoads indicated that the tree was in a state of decline and that scale feeding was the suspected cause. Examination of the sample revealed first instar Coccoidea, the overwintering form of the red pine scale. Since these could not be positively identified, I made additional collections in spring, 1981. Stages found during the spring compared exactly with the descriptions of the various stages of *M. resinosa* presented by Bean and Godwin (1955). On May 21, 1981, I collected adults and positively identified them as *Matsucoccus resinosa*, the red pine scale. At this time both sexes were active on 5-year and older growth, and some females had begun to oviposit. Ovisacs and male cocoons were abundant on the undersides of infested limbs.

This collection, representing the first record of *M. resinosa* in Pennsylvania, is the only known infestation in the state. Arboretum records show that the infested tree was part of a plant breeding experiment conducted in 1958; further details of the history of that particular plant are not known. How this isolated infestation became established remains a mystery.

Slide mounted voucher specimens have been deposited in the U.S. National Museum, Beltsville, Maryland. Morris Arboretum personnel are attempting to eradicate the scale population.

I am grateful to Ann F. Rhoads, plant pathologist, Morris Arboretum, Philadelphia, for bringing the infestation to my attention and for her interest and cooperation.

James F. Stimmel, *Bureau of Plant Industry, Pennsylvania Department of Agriculture, Harrisburg, Pennsylvania 17110.*

BOOK REVIEW

The Cockroach Combat Manual. By Austin M. Frishman, Arthur P. Schwartz, and Robert Powell. William Morrow and Co., Inc., 105 Madison Ave., New York, N.Y. 10016. 192 pp., illus. 1980. Cost: \$4.95.

This unusual little paperback book is a blend of practical, useful information and several dozen entertaining sketches presented essentially as cartoons. The first author, Dr. Austin Frishman, teaches pest control at the State University of New York, Farmingdale, Long Island. He was trained in pest control at Purdue University, and is closely affiliated with the pest control industry. Arthur Schwartz is a writer who also serves as a literary agent and publishers' marketing consultant. The clever sketches were drawn by Robert Powell. Emphasis has been placed on the habits of domestic cockroaches, how to prevent indoor infestations from becoming established, and what to expect from a pest control operator if one is consulted. Included are concise data on diseases sometimes carried by cockroaches. Dr. Frishman himself has done research along these lines. The chief insecticides in wide use are discussed. A list of selected pest control firms, arranged geographically, appears at the back of the book. By perusing this book, almost anyone can absorb fundamental information about pest cockroaches, in addition to enjoying some interesting and pertinent data on non-pest members of the group. No references to literature are included, and I think that some would have been a useful addition to this book.

Ashley B. Gurney, *Cooperating Scientist, Systematic Entomology Laboratory, IBIII, Agric. Res., Sci. and Educ. Admin., USDA, c/c National Museum of Natural History, Washington, D.C. 20560.*

BOOK REVIEW

Taxonomists' Glossary of Mosquito Anatomy. By R. E. Harbach and K. L. Knight. Plexus Publishing Co., Marlton, N.J. xi + 415 pp. 1980. Cost: \$24.95.

This is a compilation and extension of 16 separate parts by K. L. Knight, R. E. Harbach, and J. L. Laffoon, published from 1970 to 1978 in

Mosquito Systematics (and M. S. Newsletter). It will certainly stand as one of the most important and useful works on insect anatomy to appear in recent years. The references to usage of terms and the bibliography pertinent there to are laudable features of the work. The illustrations, both from drawings and scanning electron microscope photographs, are excellent and the figure numbers are conspicuously placed in the upper right-hand corner of the pages. The importance of anatomy and its nomenclature becomes quite evident in this work, and it will have a powerful stabilizing and coordinating influence.

Especially because the publisher hopes for further editions of the work and requests notice of possible improvements and corrections (p. 414), there are a considerable number of comments that should be made.

It comes as a surprise that there is an index (65 pages) to an alphabetic glossary such as this, rather than interpolation of cross-references. The book will be used for reference by many who will not take the trouble to peruse it sufficiently to find that there is such a thing as an index in it. If one looks for 'oesophagus,' for example, which is the more usual spelling of the word, he will find it only in the index or as a synonym under 'esophagus.' Because the book is divided into 5 sections (adult, egg, larva, pupa, vestiture), convenient for serial publication but inconvenient in a comprehensive work, he will even have some difficulty finding which section of the book he is in, because there are no running heads. Although setae are referred to in more than one section, their general treatment is in the section on vestiture. Recommended terms are in bold capitals, distinguishing them from other terms in bold lower case letters. A third category could well have been in a third distinctive face for cross-references. This arrangement, furthermore, has apparently left no place for certain general terms, such as meron, phragma, tagma, etc.; 'apodeme' is found in the adult section, although apodemes occur also in larvae. It is to be hoped that in another edition the glossary will consist in only one alphabetical list, including cross-references.

No indication is given of the language of terms that are other than English. It would be a distinct improvement to indicate that a term is Latin, French, German, Spanish, etc. Many anatomical terms are really Latin, especially in European usage, but with various degrees of adoption into English; 'abdomen,' for example, is originally Latin, but the plural for entomologists as well as for other English-speaking people is always 'abdomens' rather than 'abdomina,' but the plural of 'palpus' is always 'palpi.' It would be a distinct improvement to cite the language of such terms and to give their plurals when those forms are different from the usual English plurals in -s or -es. The plural of 'halter' has been cited as 'halteres,' but no such information is given for 'calypter.' Many workers need the advice that one can say 'halteres' and 'calypters' in English, while the Latin forms, often used in technical writing, are 'halteres' and 'calypteres.'

The work would also benefit greatly from a recategorization of entries. 'Accessory gland duct' and 'accessory gland duct base' are treated as separate entries, but there is no entry for 'accessory gland.' This is apparently a result of the use of numerous multiple noun-modifier phrases in the book. Under 'accessory gland duct base,' the term 'base of accessory gland duct' is even cited as a synonym. It would be more logical and time- and space-saving to have one entry for 'accessory gland,' the term most people would look for, with references to its duct, base, etc., included therein. The grammatical or stylistic choice of prepositional phrase vs. noun-modifier phrase is better left to the user. In Fig. 27, the caption for 'accessory gland' is spelled out, while its duct is labeled 'AGD' and its base is labeled 'ABDB.' The term 'acrostichal seta' appears in the adult section and various setae are referred to in other sections, but the general definition for 'seta' is in the short section on vestiture. There is some evidence that 'seta' is used rather loosely, inasmuch as it is used for papilla of other authors (see 'cibarial seta,' p. 8) and spine is cited on p. 31 as a synonym of seta. The index refers to 'sensillum' only under 'abdominal puncture,' although sensilla of various kinds, including perhaps the 'cibarial setae,' are not setae and all structures in the cuticle are not vestiture.

It is recognized in the book that the English prefixes fore-, mid-, and hind- are not separate words; therefore 'foreleg, midleg, hindleg' rather than 'front leg, middle leg, and hind or hinder leg.'

The following are a few miscellaneous items of comment arranged by page number:

p. 6—'basolateral seta' would be better as 'basilateral seta,' as in the preceding term 'basisternum'; 'calypter' should have the lower and upper calypters referred to under it, with no need to look elsewhere for 'lower' and 'upper.'

p. 7—'cephaliger' is hybrid Greek and Latin; better Greek 'cephalophore' or Latin 'capitiger'; 'cercus index,' etc.—the adjectival form 'cercal' is used in several terms; it would be better in 'cercal index, cercal length, cercal width,' etc., although it would be still better to give points of measurement under 'cercus.'

p. 9—'Clypeo-Palatum' is germanized only in having 2 capital letters.

p. 10—The use of 'ommatidium' is general in referring to a single unit of the compound eye and includes the part called 'corneal facet.' There is no reason for rejecting 'ommatidium.'

p. 10, etc.—'suture' as used in 'coronal suture,' etc., does not refer to a true suture (something 'sewed together,' a meeting of two distinct sclerites) but is better referred to as a 'sulcus' in these instances and for other cases where an impression indicates internal ridges which are usually secondary strengthening structures. Under 'coxal cavity,' a term with much broader application, 'acetabulum,' is cited as a synonym, but does not appear in the

index. In the term 'coxale Borste,' the word 'coxale' has the -e ending because it is a German feminine adjective and has nothing to do with a 'coxale,' a term used by Snodgrass and in this book in the terms 'precoxale' and 'postcoxale' as designations for sclerites.

p. 15—The term 'postabdomen' is missing from the entry on genitalia and no reference to Hennig's great 1974 work is made in the bibliography. The term 'genitalia' is preferred over 'terminalia' for the same reason others have given for the opposite preference.

p. 18—'Insula' is Latin and 'ilot' is French for 'island.'

p. 19—Under 'labellar mesial sclerite' the term preferred over 'mesal' in Webster's 3rd International Dictionary is more usually in insect anatomy replaced by 'mesal,' because it is derived from the Greek *meson* and the -i- is superfluous.

p. 19, 20—It is contrary to regular English syntax to place 'basal, mesal (mesial),' etc. in intermediary position in such terms as 'labellar basal sclerite, labellar mesal sclerite, labial basal seta,' and many others. It should not be necessary to have separate entries for these lateral, mesal, basal, upper, lower, etc., entities; their number and position can be accounted for in entries on 'labial seta, labellar sclerite,' etc., which are what most users of the book will look for them under.

p. 22—'lower meskatepisternal scale,' etc.; the prefix in 'meskatepisternal' and similar words is 'meso-,' dropping the -o- only before another vowel, forming 'mesokatepisternal,' etc. It is one of the vagaries of anatomical nomenclature that Greek terms are inconsistently transcribed; *meson*, *meron*, *pleuron*, etc., are transcribed literally, but *sternum* (not *sternon*) and *notum* (*noton*) are latinized. If the Greek elements in these terms are considered to be latinized, then the classical Latin transcription of Greek *k* to Latin *c* should obtain, as in *catastrophē*, *cataclysm*, *coelum*, etc., giving 'mesocatepisternum.'

p. 30—The opisthophallus may be what Hennig has called the epiphallus in higher Diptera, and the prosophallus may be equal to hypandrium; the matter should be investigated.

p. 49—The 'transnotal suture' is what has usually been called 'transverse suture' in the higher Diptera; it is not really a suture, but a sulcus.

p. 132—I would never look for 'dorsal apotome' under 'dorsal,' but under 'apotome' and I would not find it.

p. 138—The term 'egg-buster' is crassly colloquial.

p. 139—For 'exoparartis,' as well as 'parartis' (p. 155), 'postartis' (p. 156), 'postcoila' (p. 157), there should be general entries under 'artis' and 'coila.' There is no classical word 'artis,' which may be intended for the Latin 'artus,' a joint. The 'coila' is apparently free Greek 'koilos' or 'koloma,' a hollow, better transcribed as 'coela,' although there is no such

word in Greek. The whole subject of the terminology of mandibular articulations needs additional study.

p. 144—The terms 'laciniarastrum, laciniastipes' are germanic compounds and hardly suitable in anatomical terminology; 'laciniar rastrum, laciniar stipes' as English terms or 'rastrum laciniae, stipes laciniae' as Latin would be more acceptable.

p. 147—Certainly 'lobe' is used for parts of many other structures.

p. 308—One misses any treatment of surface sculpturing, such as was treated by Harris, R. A. 1979. A glossary of surface sculpturing. Occas. Pap. Entomol. (Dep. Food and Agric., State of Calif.) 28 (31 pp.).

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BOOK REVIEW

The Plant Bugs of the Prairie Provinces of Canada. By Leonard A. Kelton. Biosystematics Research Institute Publ. 1703, Agriculture Canada, Ottawa. 314 illus., 408 pp. 1980. Cost: \$9.95, Canada: \$11.95, United States (paperback).

The Plant Bugs of the Prairie Provinces is the eighth in a series of useful handbooks treating the insects of Canada. Dr. Kelton's volume brings to us for the first time a summary of the mirid fauna of north central North America. Not since Knight's *Taxonomic Review: Miridae of the Nevada Test Site and the Western United States* (1968. Brigham Young Univ. Sci. Bull. 9(3), 282 pp.) has anyone attempted such a comprehensive regional study of this large and diverse family. Kelton's work treats 314 species, including 27 Holarctic species. All are brought together in keys, and numerous species are figured for the first time. Each genus is briefly described, and a diagnosis, host plants (including many new records), and a summary of distribution are furnished for each species. Original descriptions, all combinations, and, when pertinent, general treatments and revisions of genera are cited, allowing the reader easy access to additional information on

species of interest. Equally valuable are the glossary of terminology used in the text and the appendix listing common and scientific names of plants.

As can be expected in any work of this scope, errors occur. A sheet of errata is furnished with the volume. In addition to these, and inconsistent with the format, is the omission of the synonym *Brooksella* Kelton under *Brooksetta* (p. 222). *Brooksetta*, a replacement name proposed by Kelton (1979. Can. Entomol. 111: 1423), is used in the original reference given in the bibliography rather than *Brooksella* (Kelton, 1979c). Two references listed in the text also were omitted from the terminal bibliography: Henry, T. J. 1977. *Review of Reuteria Puton 1975, with Descriptions of Two New Species (Hemiptera: Miridae)*. Entomol. News 87:61-74; and Henry, T. J. and A. G. Wheeler, Jr. 1974. *Sthenarus dissimilis and Orthops rubricatus: Conifer Feeding Mirids New to North America (Hemiptera: Miridae)*. Proc. Entomol. Soc. Wash. 76: 217-224. Perhaps the general introduction and biology sections could have been more thorough; however, workers interested in additional information may refer to Knight's (1941. *The Plant Bugs, or Miridae, of Illinois*. Ill. Nat. Hist. Surv. Bull. 22. 234 pp.; and 1968) regional works for more extensive discussions. A reference citing mirids as vectors of plant viruses would have been an important addition on page 12 because it has been suggested that mirids are inefficient virus vectors and that, in some cases, their saliva even may inhibit viral growth (Carter, W. 1973. *Insect Relations to Plant Disease*. 2nd ed. John Wiley and Sons, New York. 759 pp.). An update, since this volume went into press, is the synonymy of *Capsus simulans* (Stål) on page 82 under *Capsus cinctus* Kolenati (Vinokurov, N. N. 1977. Entomol. Obozr. 56: 103-115).

Dr. Kelton modestly offers this volume primarily to economic entomologists and field personnel, but the scope of the work goes well beyond that of an introductory guide and will prove indispensable to practicing taxonomists and specialists studying Miridae. *Plant Bugs of the Prairie Provinces* is one of the most comprehensive treatises of the North American Miridae and certainly the most updated treatment. It is a must for anyone studying this family.

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SOCIETY MEETINGS

873rd Regular Meeting—December 11, 1980

The 873rd Regular Meeting of the Entomological Society of Washington was called to order by President T. J. Spilman at 8:00 PM on December 11, 1980 in the Naturalist Center of the National Museum of Natural History. Twenty-eight members and 11 guests attended. Minutes of the previous meeting were read and approved.

Annual reports were given by Mignon Davis, Corresponding Secretary, Joyce Utmar, Membership Chairman, and F. Christian Thompson, Treasurer.

Membership Chairman Joyce Utmar read for the first time the names of the following new applicants:

Kevin N. Barber, Department of Environmental Biology, University of Guelph, Guelph, Ontario, Canada.

Donald G. Cochran, Department of Entomology, VPI & SU, Blacksburg, Virginia.

Terry J. Jacobs, Rm. 511, Box 310, Graver Inn, Fargo, North Dakota.

Steven G. Kniser, Department of Entomology, VPI & SU, Blacksburg, Virginia.

The speaker for the evening was Dr. Richard Duffield, Dept. of Zoology, Howard University, whose talk was entitled "Chemistry and function of exocrine secretions of selected arthropods." The talk included examples of exocrine secretions of wasps, ants, bees, and harvestmen.

NOTES AND EXHIBITIONS

William E. Bickley circulated a new book, *Taxonomists' Glossary of Mosquito Anatomy*, by Ralph E. Harbach and Kenneth L. Knight, published by Plexus Publishing, Inc., Marlton, N.J. Joyce Utmar showed a blown glass tumbler featuring black arthropod designs. It was made by Friar Jerry Hovanec, a potter and glass blower of Capuchin College, Washington, D.C. who called it a "tick tumbler." Mr. Ed Saugstad had a note on termite damage to styrofoam.

Sylvia Churgin, a librarian at the National Museum of Natural History, announced she is on temporary duty at the Smithsonian Tropical Research Institution and described some of the activities at that institution. Helen Sollers-Riedel gave an update on her cat's flea problem.

President T. J. Spilman read special letters of appreciation to Dr. Donald Anderson for assistance as projectionist for the Society and to Helen Sol-

lers-Riedel for her efforts as Hospitality Chairman. President Spilman thanked all officers for doing a fine job and passed the gavel on to President-Elect Jack E. Lipes, who adjourned the meeting at 10:00 PM for holiday punch and cookies.

David A. Nickle, *Recording Secretary*

874th Regular Meeting—January 8, 1981

The 874th Regular Meeting of the Entomological Society of Washington was called to order by President Jack E. Lipes at 8:00 PM on January 8, 1981, in the Naturalist Center of the National Museum of Natural History. Forty members and 14 guests attended. Minutes of the previous meeting were read and approved.

Membership Chairman Joyce Utmar read for the first time the names of the following new applicants:

- Christine M. Garcia, University of Maryland, College Park, Maryland.
- David Voegtlin, Illinois State Natural History Survey, 607 E. Peabody St., Champaign, Illinois.
- John A. Wojtowicz, Department of Zoology, University of Tennessee, Knoxville, Tennessee.

The speaker for the evening was Mr. T. J. Spilman, whose talk was entitled "Beetles of Medical Importance." He spoke on beetles that cause allergy, adult beetles found alive in humans (adult coleopteriasis, formerly scarabeiasis), larval beetles found alive in humans (larval coleopteriasis, formerly canthariasis), and vesicating beetles. The talk was well received by the audience.

NOTES AND EXHIBITIONS

Joyce Utmar displayed a stick pin portraying a wasp with a flylike insect perched on its wing. She considered it to be a representation of either ectoparasitism or phoresy.

Dr. F. C. Thompson passed around *Flies of the Nearctic Region*, Vol. 1, Parts 1 and 2, edited by G. C. D. Griffiths, published by E. Schweizerbart'sche Verlagsbuchhandlung, Stuttgart, 1981.

Joyce Utmar displayed several insect-related newsletters and noted their addresses. These included *Frass*, *Coccidologist's Newsletter*, *Chrysomela*, *Curculio*, *Scarabaeus*, *Ceratopogonidae Information Exchange*, *Ichnews*, *Polistine Information Exchange*, *Proctos*, and *Sphecos*.

Dr. Margaret Collins displayed two large live larvae of palm weevils she recently collected in Guyana and which are used occasionally as food in Guyana.

Guests were introduced, and the meeting was adjourned at 10:00 PM, after which cookies and punch were served.

David A. Nickle, *Recording Secretary*

875th Regular Meeting—February 5, 1981

The 875th Regular Meeting of the Entomological Society of Washington was called to order by President Jack E. Lipes at 8:00 PM in the Insect Zoo of the National Museum of Natural History. Twenty-five members and 14 guests attended. The minutes of the previous meeting were read and approved. No new members were reported for the month.

The speaker for the evening was Miss Kay Weisberg of the Insect Zoo, whose talk, entitled "Biology of Fungus Ants," was accompanied by color slides and a movie showing swarming behavior of fungus ants of Louisiana.

NOTES AND EXHIBITIONS

Mignon Davis displayed a new book of 3 volumes, *The Collembola of North America North of the Rio Grande*, by Kenneth Christiansen and Peter Bollinger.

John Heppner announced the joint meetings of the IVth Congress of Latin American Entomology, the VIth Congress of Venezuelan Entomology, the IIIrd Triennial Meeting of the Pan American Acridological Society, and the 1st Symposium of the Neotropical Lepidoptera Society. This is to be held in Maracay, Venezuela, July 5–10, 1981.

President Lipes read a letter of appreciation to Dr. Frederick W. Poos for his generous donation to the Society, which placed the donation into the Special Publication Fund.

Tom Wallenmaier displayed a tray consisting of a piece of plexiglass with a 6 × 6 grid of depressions drilled into one side of the square. He uses it for microlepidoptera genitalia preparations, which are used routinely at APHIS ports of entry to make rapid comparisons with unknown material intercepted at quarantine facilities.

Guests were introduced, and the meeting was adjourned at 9:30 PM for cookies and drinks.

David A. Nickle, *Recording Secretary*

876th Regular Meeting—March 5, 1981

The 876th Regular Meeting of the Entomological Society of Washington was called to order by President Jack E. Lipes at 8:00 PM in the Naturalist Center of the National Museum of Natural History. Twenty seven members

and 7 guests attended. The minutes of the previous meeting were read and approved.

Membership Chairman Joyce Utmar read the names of the following applicants for membership:

Ltc. Ralph R. Carestia, 13107 Oval Lane, Bowie, Maryland.
Scott T. Clark, 1012 Sunset Circle West, Yale, Oklahoma.

President Lipes announced that the Executive Committee had approved publication of Memoir No. 9, "The Flower Flies of the West Indies (Diptera: Syrphidae)" by F. C. Thompson. An announcement was made also concerning the Annual Joint Banquet of the Entomological Society of Washington and Plant Pest Society of Washington (formerly the Insecticide Society of Washington). It will be held at Ft. McNair Officers' Club on June 4, 1981. The guest speaker will be Mr. Kjell Sandved, photographer for the National Museum of Natural History.

The speaker for the evening was Dr. Thomas E. Wallenmaier of the USDA Animal and Plant Health Inspection Service, Plant Protection and Quarantine. His talk was entitled "A Survey of All Insects Taken at Plant Quarantine, with Their Common Means of Entry." After outlining means of entry by insects into this country and the duties of port identifiers, inspectors, and other PPQ personnel, he showed lists of insect families taken at plant quarantine. A question and answer session followed the talk.

NOTES AND EXHIBITIONS

William E. Bickley exhibited the book, *Fleas*, edited by R. Traub and H. Starcke, and published by A. A. Balkema, Salem, New Hampshire. This book consists of 37 articles from the Proceedings of the International Conference on Fleas, Ashton Wold, Peterborough, U.K., June 21-25, 1977.

Visitors were introduced, and the meeting was adjourned at 9:27 PM, after which refreshments were served.

Joyce Utmar, *Recording Secretary pro tem*

877th Regular Meeting—April 2, 1981

The 877th Regular Meeting of the Entomological Society of Washington was called to order by President-Elect Margaret Collins at 8:00 PM on April 2, 1981 in the Naturalist Center of the National Museum of Natural History. Twenty-seven members and 13 guests attended. Minutes of the previous meeting were read and approved. No new members were reported for the month.

The speaker for the evening was Dr. Michael G. Emsley of the Department of Biology, George Mason University, whose talk was entitled, "In-

sects of the Rain Forest." The talk was highlighted with excellent Kodachrome slides showing unusual color forms and adaptations frequently encountered in studies of rain forest insects.

NOTES AND EXHIBITIONS

Mr. George Steyskal displayed *A Manual of Nearctic Diptera*, vol. 1, Monograph No. 27, 1981, published by Biosystematics Research Institute, Ottawa, Canada.

Mr. T. J. Spilman showed the new book, Simon and Schuster's *Guide to Insects* by Ross H. Arnett, Jr. and Richard L. Jacques, Jr. It is an easy-to-use field guide to 350 North American species, with more than 1000 color illustrations and information on morphology, behavior, habitat, and ecological significance.

Visitors were introduced, and the meeting was adjourned at 9:30 PM for refreshments.

David A. Nickle, *Recording Secretary*

878th Regular Meeting—May 7, 1981

The 878th Regular Meeting of the Entomological Society of Washington was called to order by President Jack E. Lipes at 8:00 PM on May 7, 1981 in the Naturalist Center of the National Museum of Natural History. Seventeen members and 10 guests attended. The minutes of the previous meeting were read and approved.

Membership Chairman Joyce Utmar read the names of the following applicants:

Robert E. Orth, Department of Entomology, Division of Biological Control, University of California, Riverside, California.

David W. Ribble, 197 Poplar Ave., Campbell, California.

President-Elect Margaret Collins noted that announcements for the annual banquet have been mailed and other arrangements have been completed. The mistress of ceremonies will be Dr. Manya B. Stoetzel.

The speaker for the evening, introduced by Eugene Gerberg, was Mr. Ronald A. Moser of the Department of Transportation, whose talk was entitled "Entomology and the Fly Fisherman." He gave a brief historical review of fly fishing, showed examples of "naturals" or realistic flies and impressionistic imitations. In addition to many slides, he showed materials used in fly tying and many examples of dry and wet flies, emergers, nymphs, and streamers which he had prepared. After the talk, he demonstrated how to hand tie a fly.

NOTES AND EXHIBITIONS

Ed Saugstad showed a specimen of *Aedes vexans*, caught in a light trap, in pseudocopulation with a fly of a different family. Jack Lipes exhibited a live coccinellid, *Anatis quindecimpunctata*. Theodore Bissell showed a postcard featuring a tropical cerambycid beetle sent from Poland by Manya Stoetzel and signed by 24 other people.

The meeting was adjourned at 9:15 PM, after which refreshments were served.

Joyce A. Utmar, *Recording Secretary pro tem*

879th Regular Meeting—June 4, 1981

The Entomological Society of Washington and Plant Pest Society of Washington Joint Annual Banquet was held on June 4, 1981, at the Fort McNair Officers' Club, Washington, D.C. Dr. Dale Parrish was host, Drs. Margaret Collins and Dora Hayes were banquet chairmen, and Dr. Manya Stoetzel was Mistress of Ceremonies. After the open bar social hour and dinner, Mr. Kjell Sandved, photographer for the National Museum of Natural History, presented an innovative movie presentation, "From the Tropics to Antarctica."

The banquet was attended by 113 persons. After the presentation by Mr. Sandved, Dr. Stoetzel conducted the drawing of several door prizes.

David A. Nickle, *Recording Secretary*

PUBLICATIONS FOR SALE BY THE
ENTOMOLOGICAL SOCIETY OF WASHINGTON

MISCELLANEOUS PUBLICATIONS

Cynipid Galls of the Eastern United States, by Lewis H. Weld	\$ 5.00
Cynipid Galls of the Southwest, by Lewis H. Weld	3.00
Both papers on cynipid galls	6.00
Identification of Alaskan Black Fly Larvae, by Kathryn M. Sommerman	1.00
Unusual Scalp Dermatitis in Humans Caused by the Mite <i>Dermatophagoides</i> , by Jay R. Traver	1.00
A Short History of the Entomological Society of Washington, by Ashley B. Gurney	1.00
Pictorial Key to Species of the Genus <i>Anastrepha</i> (Diptera: Tephritidae), by George C. Steyskal	1.50
Taxonomic Studies on Fruit Flies of the Genus <i>Urophora</i> (Diptera: Tephriti- dae), by George C. Steyskal	2.00

MEMOIRS OF THE ENTOMOLOGICAL SOCIETY OF WASHINGTON

No. 1. The North American Bees of the Genus <i>Osmia</i> , by Grace Sandhouse, 1939	\$15.00
No. 2. A Classification of Larvae and Adults of the Genus <i>Phyllophaga</i> , by Adam G. Boying, 1942	(out of print)
No. 3. The Nearctic Leafhoppers, a Generic Classification and Check List, by Paul Wilson Oman, 1949	15.00
No. 4. A Manual of the Chiggers, by G. W. Wharton and H. S. Fuller, 1952	15.00
No. 5. A Classification of the Siphonaptera of South America, by Phyllis T. Johnson, 1957	15.00
No. 6. The Female Tabanidae of Japan, Korea and Manchuria, by Wallace P. Murdoch and Hiroshi Takahashi, 1969	15.00
No. 7. Ant Larvae: Review and Synthesis, by George C. Wheeler and Jeanette Wheeler, 1976	11.00
No. 8. The North American Predaceous Midges of the Genus <i>Palpomyia</i> Mei- gen (Diptera: Ceratopogonidae), by W. L. Grogan, Jr. and W. W. Wirth, 1979	12.00
No. 9. The Flower Flies of the West Indies (Diptera: Syrphidae), by F. Christian Thompson, 1981	10.00

Back issues of the Proceedings of the Entomological Society of Washington are available at \$18.00 per volume to non-members and \$9 per volume to members of the Society.

Prices quoted are U.S. currency. Postage extra except on prepaid orders. Dealers are allowed a discount of 10 per cent on all items, including annual subscriptions, that are paid in advance. All orders should be placed with the Custodian, Entomological Society of Washington, % Department of Entomology, Smithsonian Institution, Washington, D.C. 20560.

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