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THE ONION PLANT BUG GENUS *LABOPIDICOLA* (HEMIPTERA: MIRIDAE): ECONOMIC IMPLICATIONS, TAXONOMIC REVIEW, AND DESCRIPTION OF A NEW SPECIES

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Abstract.—The onion plant bug genus *Labopidicola* Kelton is reviewed, and *L.* ***cepula*** from Texas is described as new. New distribution records and known records for all species are given, and a summary of the economic literature and speculation on pest potential are presented. Figures of male genitalia of all species and the adult male of *L. idahoensis* and a key to the species are provided to facilitate recognition.

Until recently all species of *Labopidicola* Kelton were placed in *Labopidea* Uhler, a larger western genus. Knight (1923) described the first species, *allii,* from Missouri where it was common on wild garlic. He later recognized *ainsliei* from Iowa and *planifrons* from South Dakota (Knight, 1928) but gave no host data. Johnston (1930) described *geminatus* from a long series collected on *Allium canadense* L. in Texas, and Knight (1968) added the 5th species of this genus, *idahoensis,* again without a host association. Kelton (1979) in his revision of the genus *Labopidea* discovered that the above species were not congeneric with Uhler's type-species, *chloriza* Uhler; hence, he erected *Labopidicola* to accommodate them and made *idahoensis* the type of the genus. Tate (1940) first associated *ainsliei* with *Allium* spp., and, more recently, Kelton (1979) reported this host relationship for *idahoensis* and *planifrons*.

In this paper I summarize the economic literature, speculate on the pest potential of the species in the genus, redescribe the known taxa, describe one new species, figure the adult male of *idahoensis* and male genitalia of all species, provide new state records for three species and known distributions for all species, and give the first comprehensive key to separate species of the genus.

The following abbreviations used are for institutions cited in this paper: AMNH, American Museum of Natural History, New York; ORSU, Oregon State University, Corvallis; PDA, Pennsylvania Department of Agriculture, Harrisburg; PSU, Pennsylvania State University, University Park; TAM, Texas A&M University, College Station; USNM, National Museum of Natural History, Washington, D.C.

Economic Implications

All species in this genus are restricted to feeding on onion and garlic, *Allium* spp. There are numerous records of at least two species damaging cultivated onions. The most frequently mentioned species, *L. allii*, has been given the common name "onion plant bug" because it often becomes a serious pest (Froeschner, 1949). Glenn (1923) provided the first life history study in his paper on "The onion capsid, *Orthotylus translucens* Tucker" (later recognized as *L. allii* by Henry and Wheeler, 1979). Glenn observed this species as early as 1915 and noted that onion tops often were killed, and that the mirids were sometimes so abundant that they covered the ground as one walked through the fields.

Stiles (1937) recorded *L. allii* as a new pest for Oklahoma, and Smith and Kelly (1937, 1938) and Bryson (1937a, 1937b, 1939) reported *allii* damaging onions throughout Kansas. From 1934 to 1936 *allii* became "exceedingly abundant" in Missouri, and many plantings of Bermuda onions were destroyed (Knight, 1941). Drake (1933, 1936, 1937a, 1937b, 1940), Haseman (1941), and Smith et al. (1946) provided numerous other records of *L. allii* causing injury. Populations as high as 15–20 bugs per plant in over 200 acres of onions have been observed in Texas (U.S. Dep. Agric., 1955). The light to medium damage reported in several Texas counties (U.S. Dep. Agric., 1957) apparently is the most recent record of onion plant bugs as pests. Damage to Moraine locust (a cultivar of honeylocust, *Gleditsia triacanthos* L.) by *L. ainsliei* in North Carolina (U.S. Dep. Agric., 1959, 1960b) should be attributed to *Diaphnocoris chlorionis* (Say), a species restricted to honeylocust (Wheeler and Henry, 1976). The reports of *Labopidea* spp. on sugar beets in Utah (Knowlton, 1933) and winter wheat in Montana (U.S. Dep. Agric., 1960a) have not been examined but probably represent misidentifications (or true *Labopidea* spp.) or accidental host records.

Other than Westcott's (1973) listing of *L. allii* as a pest on onions and my new Pennsylvania record (Henry, 1977a), I am not aware of any recent interest in these mirids as pests or of any additional reports of damage. It is not clear why onion plant bugs apparently no longer reach damaging levels. It may be that current cultivation practices and the use of more modern pesticides or, possibly, the introduction of resistant varieties have helped eliminate much of the threat to cultivated onions. Early remedies like whale oil soap mixed with water (Glenn, 1923) and 2% sulphur mixed with derris or diatomaceous earth (Drake, 1938) were said to give some control, but it may be that simple cultural methods actually have minimized the importance of onion bugs. Glenn (1923) noted that where fields were burned over or plowed under, few mirids survived to the following year, and Knight (1941), after establishing that *L. allii* overwintered as eggs deposited in stems, suggested that eliminating old stems and destroying nearby wild *Allium* spp. would control onion plant bugs.

It is likely that these early season, univoltine species are unable to reinfest onions successfully as many populations consist of a high proportion of brachypterous females; this loss of flight would prevent easy migration of large numbers of bugs from wild *Allium* spp. back into cultivated fields.

While the onion bugs have not attracted much attention in recent years, the potential exists for members of this genus to reach damaging numbers in commercial plantings and home gardens. If large reservoir patches of wild *Allium* spp. are present and if poor sanitation practices are followed, onion plant bugs could again become a major concern in the United States.

Labopidicola Kelton

Labopidicola Kelton, 1979: 757. Type-species: *Labopidea idahoensis* Knight.

Diagnosis.—Generally small to medium-sized mirids, length 3.30–4.70 mm in macropterous male and female, 2.75–3.20 mm in brachypterous female; body coloration yellow to bluish green, pubescence erect, suberect, and recumbent silvery and brown to fuscous setae (darker setae often becoming bristle-like), intermixed with recumbent sericeous setae, especially on head and pronotum. Head broad, distance across eyes wider than anterior margin of pronotum; vertex wide, nearly 3× the dorsal width of an eye, base with a distinct carina reaching across to posterior angles of each eye; rostrum short, stout, not reaching beyond apices of procoxae or middle of sternum; pronotum trapeziform, posterior angles strongly rounded, basal margin straight to weakly concave, middle of anterior margin often weakly sinuate, calli distinct, weakly concave, area just posterior sunken or depressed; mesoscutum broadly exposed, scutellum equilateral; hemelytra uniformly opaque green; membrane translucent to opaque, usually fumate or tinged with brown, totally brachypterous forms without hemelytral membrane common (brachyptery has not been observed in males); venter and legs uniformly greenish to testaceous. Male genitalia: Left paramere C-shaped with left side often slender and curved in toward base; right paramere generally globose with a slender spine or arm extending anteriorly when viewed *in situ*; aedeagus with 2–3 spiculi, ductus seminis thickened, tapering apically, secondary gonopore usually subapical, middle of basal margin of genital segment with a group of 2 or 3 irregularly shaped processes that are hidden when parameres are in position.

Remarks.—*Labopidicola* are recognized by the overall green color, the broad vertex with a distinct transverse basal carina, the short, thickened rostrum (Fig. 7) that does not reach beyond the middle of the sternum, the two types of setae on the dorsum, and the male genitalia.

Labopidicola keys to *Labopidea* in Knight's (1941: 81; 1968: 93) general faunal studies and my (Henry, 1977b: 606) key to the green Orthotylinae of the eastern United States, but species of *Labopidicola* can be distinguished from *Labopidea* by the more distinct basal carina on the vertex, the tylus or clypeus clearly visible from above, the shorter, stouter rostrum, and the lack of fuscous markings on the head, calli, and antennae. Kelton (1980) provided a key to separate *Labopidicola* from other genera in the Canadian Prairie Provinces.

KEY TO SPECIES OF *LABOPIDICOLA*[1]

1. Hemelytra clothed with pale and/or silvery and erect, brown to fuscous setae (setae may become bristle-like) 2
– Hemelytra clothed with only pale or silvery setae, at most, a few darker setae scattered on basal areas of coria and clavi 4
2. Small species, length in macropterous male less than 3.80 mm; dorsum clothed with both long, erect, rather fine, pale and brown to fuscous setae; length of 4th antennal segment much greater than length of 1st antennal segment; male genitalia (Fig. 4); Tex. .... *geminatus* (Johnston)
– Larger species, length in macropterous male averaging 4.00 mm or more; dorsum clothed with numerous, rather short, dark, bristle-like setae; length of 4th antennal segment subequal to length of 1st segment 3
3. Length of 2nd antennal segment greater than basal width of pronotum by more than the dorsal width of 2 eyes; male genitalia (Fig. 5); Ida., Col.; B.C., Alta., Sask., Man. .... *idahoensis* (Knight)
– Length of 2nd antennal segment greater than basal width of pronotum by less than the dorsal width of 1 eye; male genitalia (Fig. 3); Tex. .... *cepula*, new species
4. Dorsum clothed only with short, recumbent pale setae; male genitalia (Fig. 1); Ill., Ia., Mich., Pa., Tenn. .... *ainsliei* (Knight)
– Dorsum clothed with short, recumbent, or suberect, and long erect pubescence 5
5. Length of 3rd antennal segment almost equal to basal width of pronotum in male; length of pronotum and width of vertex subequal; male genitalia (Fig. 2); Utah east to Pa. and N.C. ...... *allii* (Knight)

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[1] This key works best with well-preserved, unrubbed males. In specimens having the dorsal pubescence clearly disturbed, only male genitalia will accurately separate species; brachypterous females are best identified by their association with males.

Length of 3rd antennal segment clearly less than basal width of pronotum in male; length of pronotum less than width of vertex; male genitalia (Fig. 6); Ia., S.D.; Man., Sask. .... *planifrons* (Knight)

Labopidicola ainsliei (Knight)

Fig. 1

Labopidea ainsliei Knight, 1928: 235; Knight, 1941: 105; Froeschner, 1949: 171; Carvalho, 1958: 81.
Labopidicola ainsliei: Kelton, 1979: 757.

Diagnosis.—Male length 3.60 mm (range of 5 specimens 3.56–3.76 mm, $\bar{x}$ = 3.63 mm), width 1.20 mm. General color yellow to yellowish green; dorsum only with short, recumbent, pale, simple setae, sparsely intermixed with silvery sericeous pubescence. *Head:* Width 0.86 mm, vertex 0.50 mm. *Rostrum:* Length 0.62 mm, reaching apices of procoxae. *Antenna:* Uniformly yellowish or testaceous, segments III and IV more brownish; I, length 0.32 mm; II, 1.12 mm; III, 0.80 mm; IV, 0.54 mm. *Pronotum:* Length 0.42 mm, basal width 0.92 mm. *Hemelytron:* Uniformly yellowish to yellowish green, with short, recumbent simple setae, intermixed with a few silvery sericeous setae; membrane translucent, shaded with brown. Venter and legs yellowish or pale yellowish green. *Male genitalia:* Fig. 1.

Macropterous female.—Length 3.32–3.52 mm ($\bar{x}$ = 3.42 mm for 2 specimens). All specimens available are very teneral and not measurable beyond lengths. Very similar to male in color and general form.

Brachypterous female.—Length 2.76 mm, with apices of hemelytra reaching apex of abdomen, width 1.20 mm. *Head:* Width 0.86 mm, vertex 0.50 mm. *Rostrum:* Length 0.70 mm, reaching apices of procoxae. *Antenna:* I, Length 0.30 mm; II, 1.06 mm; III, 0.90 mm; IV, 0.42 mm. *Pronotum:* Length 0.40 mm, basal width 0.90 mm.

Specimens examined.—IOWA: Holotype ♂, Sioux City, June 25, 1925, C. N. Ainslie coll. (USNM); 5 ♂, 1 macropterous ♀, Ames, June 8–10, 1929, H. H. Knight and H. M. Harris colls., on onion (USNM); 3 ♂, 2 macropterous ♀, Ames, June 1, 1933–34, on wild onion (TAM). MICHIGAN: 2 ♂, 2 macropterous ♀, 2 brachypterous ♀, May 1942, E. I. McDaniel coll., on chives (USNM). PENNSYLVANIA: 1 ♂, Howard, June 18, 1978, V. Haas coll., from light trap (PSU). TENNESSEE: 2 ♂, Hamilton Co., May 10, 1942, Turner coll., in light trap at edge of peach orchard (USNM).

Remarks.—*Labopidicola ainsliei* is best recognized by the short, recumbent, pale setae on the hemelytra and by the male genitalia. The right paramere (Fig. 1d) has the apex rather broadened; the left paramere is strongly C-shaped.

This species, previously known only from Illinois and Iowa (Knight, 1941), is now recorded from Michigan, Pennsylvania, and Tennessee.

Labopidicola allii (Knight)

Fig. 2

Orthotylus translucens Glenn (*nec* Tucker), 1923: 79.
Labopidea allii Knight, 1923: 31; Knight, 1941: 105; Froeschner, 1949: 171; Carvalho, 1958: 81; Henry, 1977a: 417.
Labopidicola allii Kelton, 1979: 757.

Diagnosis.—Male, length 3.67 mm (range of 15 specimens 3.60–4.32 mm, $\bar{x}$ = 3.76 mm), width 1.36 mm. General color green to bluish green, thickly clothed with erect and semierect simple setae, intermixed with silvery, sericeous pubescence, especially on head and pronotum. *Head:* Width 0.78 mm, vertex 0.48 mm, thickly clothed with silvery sericeous setae, especially along margins of eyes, median line, and on tylus. *Rostrum:* Length 0.70 mm, reaching apices of procoxae. *Antenna:* Green to testaceous, segment II testaceous, tinged with green, III and IV brownish; I, length, 0.38 mm; II, 1.16 mm; III, 1.04 mm; IV, 0.46 mm. *Pronotum:* Length 0.48 mm, basal width 1.00 mm, with scattered sericeous setae, lateral and anterior margins and median line with distinct rows of silvery sericeous setae. *Hemelytron:* Uniformly green, thickly clothed with erect and semierect pale setae, intermixed with a few scattered sericeous setae; membrane translucent brown, veins green. Venter green; legs green with apical halves of tibiae and all of metafemur becoming more testaceous. *Male genitalia:* Fig. 2.

Macropterous female.—Length 4.28 mm (range of 15 specimens 4.08–4.64 mm, $\bar{x}$ = 4.32 mm), width 1.48 mm. *Head:* Width 0.92 mm, vertex 0.56 mm. *Rostrum:* Length 0.84 mm, reaching apices of procoxae. *Antenna:* I, Length 0.38 mm; II, 1.20 mm; III, 0.94 mm; IV, 0.36 mm. *Pronotum:* Length 0.50 mm, basal width 1.18 mm.

Brachypterous female.—Length 3.25 mm (range of 5 specimens 2.84–3.40 mm, $\bar{x}$ = 3.08 mm), length to apex of wings 2.92 mm (range of 5 specimens 2.60–3.14 mm, $\bar{x}$ = 2.80 mm), wings reaching anterior margin of 8th abdominal tergum. *Head:* Width 0.94 mm, vertex 0.60 mm. *Rostrum:* Length 0.78 mm. *Antenna:* I, Length 0.32 mm; II, 1.02 mm; III, 0.92 mm; IV, 0.50 mm. *Pronotum:* Length 0.40 mm, basal width 0.96 mm.

Specimens examined.—ARKANSAS: 1 macropterous ♀, Washington Co., May 29, 1964, C. E. McCou coll. (USNM). ILLINOIS: 1 ♂, 1 macropterous ♀, Olney, June 1915, on onion (USNM); 1 ♂, Urbana, 1923, P. A. Glenn coll. (USNM). INDIANA: 2 macropterous ♀, 1 brachypterous

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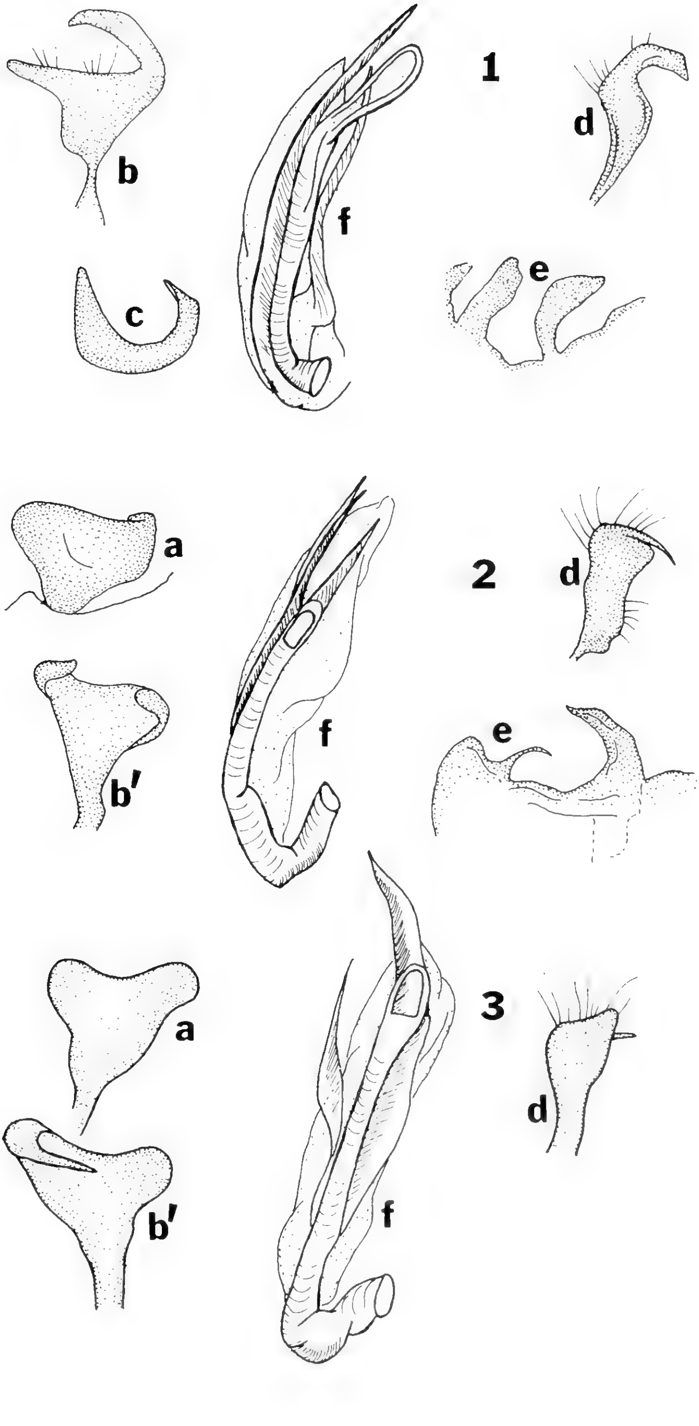
Figs. 1–3. Male genitalia. 1, *Labopidicola ainsliei*. 2, *L. allii*. 3, *L. cepula*. a. Left paramere, lateral aspect *in situ*. b, Left paramere, lateral aspect. b′, Left paramere, inside lateral aspect. c, Left paramere, dorsal aspect. d, Right paramere, lateral aspect. e, Ventral process. f, Aedeagus.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♀, Posey Co., June 6, 1931, on onions (USNM). IOWA: 2 macropterous ♀, Ames, June 8–10, 1929, H. H. Knight coll. (USNM); 1 ♂, 3 macropterous ♀, Ames, May 8, 1933–34, on onions (TAM); 1 ♂, 6 macropterous ♀, Bloomfield, May 5, 1936, F. Andre coll. (USNM); 1 ♂, 1 macropterous ♀, Bloomfield, June 15, 1937, F. Andre coll. (USNM); 2 macropterous ♀, 2 brachypterous ♀, Little Rock, July 2, 1897 (USNM); 1 ♂, Pleasant Valley, May 16, 1930, on onions (USNM); 1 brachypterous ♀, 6 mi. NW Ledyard, July 7, 1928, G. D. Hendrickson coll. (USNM). KANSAS: 1 ♂, 3 macropterous ♀, Manhattan, May 6, 1936, R. H. Painter coll. (USNM). KENTUCKY: 1 ♂, 1 macropterous ♀, Lexington, May 10, 1938, L. H. Townsend coll., on onions (TAM). MICHIGAN: 1 brachypterous ♀, Rochester, May 28, 1942 (USNM). MISSOURI: 2 macropterous ♀ (including holotype), 6 5th-instar nymphs, Jackson, Apr. 1921, A. C. Burrill coll., on wild garlic (USNM). NORTH CAROLINA: 2 brachypterous ♀, Union Co., Monroe, May 25, 1980, A. G. Wheeler, Jr. coll., on *Allium vineale* L. (PDA). OKLAHOMA: 3 ♂, 3 macropterous ♀, Chickasha, Apr. 1928, M. W. Shakleford coll. (USNM). PENNSYLVANIA: 2 ♂, 13 macropterous ♀, Dauphin Co., Clark's Valley, May 19, 1977, T. J. Henry coll., on *Allium* sp. (PDA, USNM); 1 ♂, Howard, Centre Co., June 1978, V. Haas coll., at light (PSU). UTAH: 2 ♂, Promontory, May 25, 1952, G. F. Knowlton coll. (USNM). VIRGINIA: 7 ♂, 3 ♀, King George Co., Rt. 206 just E of Stafford Co. line, May 8, 1981, A. G. Wheeler, Jr. coll., on *Allium* sp. WEST VIRGINIA: 4 ♂, 9 macropterous ♀, Grant Co., Shale Barrens, Rt. 28, 1.2 mi. W Petersburg, May 29, 1978, T. J. Henry and A. G. Wheeler, Jr. colls., on *Allium* sp. (PDA, USNM).

Remarks.—*Labopidicola allii* is best separated from other *Labopidicola* species by the thickly pubescent dorsum that lacks darker setae and by the left paramere that is broadened laterally forming a mitten-shaped pattern.

Labopidicola allii is the most common and widespread member of the genus. This species, previously known from Illinois, Indiana, Iowa, Kansas, Missouri, Oklahoma (Kelton, 1979), and Pennsylvania (Henry, 1977a), is now recorded from Arkansas, Kentucky, Michigan, Utah, Virginia, and West Virginia.

***Labopidicola cepula* Henry, New Species**

Fig. 3

Diagnosis.—Holotype male, length 4.36 mm (length of male paratype 4.28 mm), width ca. 1.36 mm (wings slightly spread). General color yellow green; pronotum, scutellum, and hemelytra with erect and semierect dark bristle-like setae, intermixed with recumbent, silvery sericeous setae. *Head:* Width 0.82 mm, vertex 0.50 mm. *Rostrum:* Length 0.78 mm, reaching middle of sternum. *Antenna:* Testaceous; I, length 0.42 mm; II, 1.18 mm; III, 0.98 mm; IV, 0.42 mm. *Pronotum:* Length 0.46 mm, basal width 1.12 mm. *Hem-*

elytron: Uniformly yellowish green; membrane translucent brown. Venter and legs yellowish to yellowish green. *Male genitalia:* Fig. 3.

Allotype.—Macropterous female: Length 4.08 mm (range of 6 specimens 3.88–4.12 mm, $\bar{x}$ = 4.02 mm), width 1.56 mm. *Head:* Width 0.88 mm, vertex, 0.58 mm. *Rostrum:* Length 0.84 mm. *Antenna:* I, Length 0.36 mm; II, 1.20 mm; III, 0.90 mm; IV, 0.42 mm. *Pronotum:* Length 0.48 mm, basal width 1.14 mm.

Brachypterous female.—Length 3.56 mm (range of 3 specimens 3.56–3.68 mm, $\bar{x}$ = 3.61 mm), wing tips reaching 9th abdominal tergum, width 1.48 mm. *Head:* Width 0.88 mm, vertex 0.56 mm. *Rostrum:* Length 0.82 mm. *Antenna:* I, Length 0.42 mm; II, 1.16 mm; III, 0.90 mm; IV, 0.46 mm. *Pronotum:* Length 0.46 mm, basal width 1.06 mm.

Type-material.—Holotype ♂, Bastrop Co., Texas, Bastrop State Park, May 8, 1966, J. C. Schaffner coll., taken on *Allium* sp. (USNM type no. 76881). Allotype female, same data as holotype (USNM). Paratypes: 1 ♂, 5 macropterous ♀, 4 brachypterous ♀, same data as holotype (TAM, USNM).

Remarks.—*Labopidicola cepula* resembles *allii* in male genitalia, but is most similar to *idahoensis* in dorsal pubescence. It is interesting that a male and female of *geminatus* were also collected at Bastrop Co., Texas, Bastrop State Park (May 8, 1966 and May 5, 1968 by Dr. Schaffner).

Etymology.—The specific name *cepula* is from the Latin feminine diminutive for onion.

***Labopidicola geminatus* (Johnston)**

Fig. 4

Labopidea geminata Johnston, 1930: 298; Carvalho, 1958: 82.
Labopidicola geminata: Kelton, 1979: 758.

Diagnosis.—Male, length 3.52 mm (range of 9 specimens 3.12–3.76 mm, $\bar{x}$ = 3.52 mm), width 1.16 mm. General color yellowish to pale green; dorsum with numerous scattered silvery setae, intermixed with erect, brown to fuscous setae. *Head:* Width 0.74 mm, vertex 0.40 mm, thickly clothed with silvery sericeous setae, with distinct rows forming along inside margins of eyes and on median line, vertex scattered with a few long, erect darker setae. *Rostrum:* Length 0.60 mm, reaching apices of procoxae. *Antenna:* Segment I green, II testaceous, III and IV brown; I, length 0.28 mm; II, 1.00 mm; III, 0.78 mm; IV, 0.42 mm. *Pronotum:* Length 0.42 mm, basal width 0.94 mm, thickly clothed with silvery, sericeous setae, especially along median line and on anterior margin, intermixed with erect darker setae; scutellum and mesoscutum with scattered silvery setae and a single row of these setae along median line. *Hemelytron:* Green with erect pale and brown to fuscous setae, intermixed with recumbent silvery setae; membrane fumate. Venter yellowish green; legs testaceous to yellowish green. *Male genitalia:* Fig. 4.

Macropterous female.—Length 3.76 mm (range of 6 specimens 3.44–3.84 mm, $\bar{x}$ = 3.64 mm), width 1.36 mm. *Head:* Width 0.80 mm; vertex 0.52 mm. *Rostrum:* Length 0.70 mm, reaching just beyond apices of procoxae or to middle of mesosternum. *Antenna:* I, Length 0.32 mm; II, 0.88 mm; III, 0.72 mm; IV, 0.44 mm. *Pronotum:* Length 0.42 mm, basal width 1.02 mm.

Brachypterous female.—Length 3.08 mm (range of 5 specimens 3.04–3.28 mm, $\bar{x}$ = 3.08 mm), length to apices of wings 2.44 mm (range 2.44–2.68 mm, $\bar{x}$ = 2.56 mm), apices of wings reaching anterior margin of 7th abdominal tergum. *Head:* Width 0.80 mm, vertex 0.52 mm. *Rostrum:* Length 0.72 mm. *Antenna:* I, Length 0.30 mm; II, 0.94 mm; III, 0.80 mm; IV, 0.44 mm. *Pronotum:* Length 0.36 mm, basal width 0.90 mm.

Specimens examined.—TEXAS: 3 ♂, Bosque Co., 2 miles W Iredell, Apr. 24, 1970, J. C. Schaffner coll. (TAM); 1 ♂, 4 brachypterous ♀, Brazos Co., Minter Springs, Apr. 12, 1970, V. V. Board coll. (TAM); 3 ♂, Brazos Co., College Station, Apr. 6, 1964, H. R. Burke coll., at light (TAM); 2 ♂, Brazos Co., College Station, Apr. 15, 1978, T. J. Henry, J. C. Schaffner, R. T. Schuh colls., taken on *Allium* sp. (USNM); 8 ♂, Burnett Co., Inks Lake St. Park, Apr. 25–28, 1965–1968, J. C. Schaffner coll. (TAM); 7 ♂, 6 macropterous ♀, Dimmit Co., Jan. 31, 1946, H. T. Hibbs coll. (TAM, USNM); 18 ♂, 4 macropterous ♀, 8 brachypterous ♀, Gonzales Co., Palmetto State Park, Mar. 26–May 4, 1964–70, V. V. Board, H. R. Burke, J. C. Schaffner colls. (TAM, USNM); 1 ♂, 1 macropterous ♀, 3 brachypterous ♀ (paratypes), Grimes Co., Huntsville, Apr. 4, 1928, H. G. Johnston coll. (USNM); 1 ♂, Hunt Co., Apr. 23, 1954, C. F. Garner coll. (USNM).

Remarks.—*Labopidicola geminatus* was described as the "southern twin" of *planifrons,* but actually is closer to *idahoensis* based on the presence of darkened setae on the dorsum. It differs from *idahoensis* in the longer dorsal pubescence and proportionately shorter second antennal segment, and by the male genitalia.

The name *geminata* is here amended to the masculine *geminatus*. According to George Steyskal, Cooperating Scientist of the Systematic Entomology Laboratory, USDA, because Kelton (1979) did not provide the meaning of *Labopidicola,* and because words ending in *-icola* form nouns of common gender, this genus must be considered masculine.

Labopidicola idahoensis **(Knight)**

Figs. 5, 7, 8

Labopidea idahoensis Knight, 1968: 97.
Labopidicola idahoensis: Kelton, 1979: 757; Kelton, 1980: 245.

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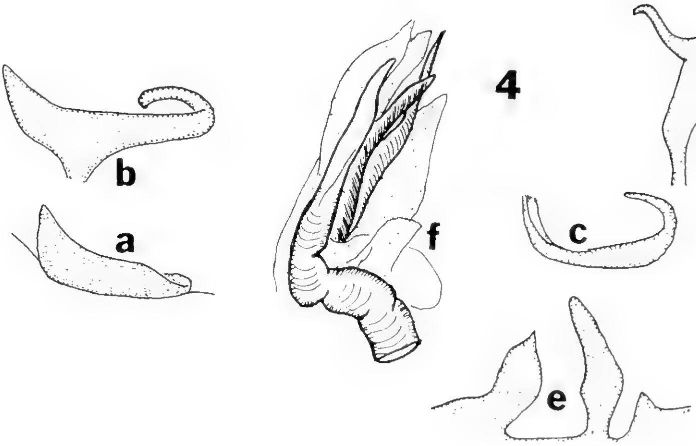

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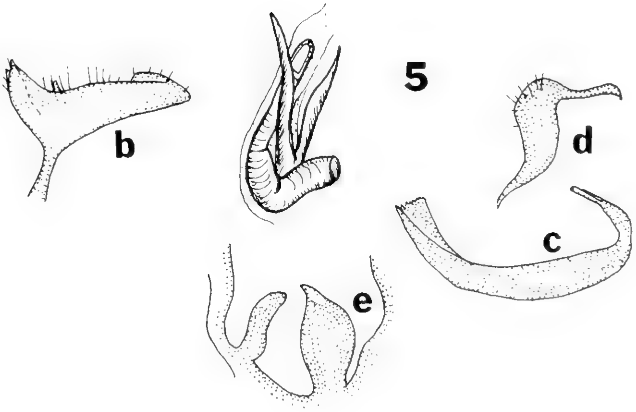

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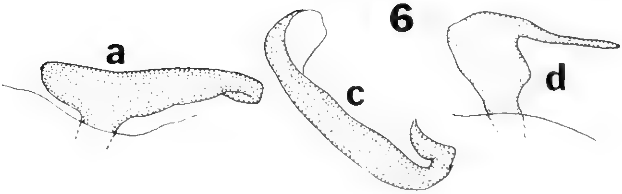


Figs. 4–6. Male genitalia. 4, *Labopidicola geminatus*. 5, *L. idahoensis*. 6, *L. planifrons*. a, Left paramere, lateral aspect *in situ*. b, Left paramere, lateral aspect. c, Left paramere, dorsal aspect. d, Right paramere, lateral aspect. e, Ventral process. f, Aedeagus.

Diagnosis.—Male, length 4.02 mm (range of 15 specimens 3.80–4.28 mm, $\bar{x}$ = 4.05 mm), width 1.28 mm. General color yellowish green; dorsum with scattered silvery, sericeous setae and rather short, bristle-like fuscous setae. *Head:* Width 0.86 mm, vertex 0.52 mm. *Rostrum:* Length 0.76 mm, reaching just past apices of procoxae to middle of mesosternum. *Antenna:* Greenish yellow, segments III and IV becoming brown; I, length 0.44 mm; II, 1.38 mm; III, 0.88 mm; IV, 0.48 mm. *Pronotum:* Length 0.46 mm, basal width 1.00 mm, with recumbent, silvery, sericeous setae, thickly intermixed with fuscous bristle-like setae. *Hemelytron:* Yellowish green with numerous, short, fuscous bristle-like setae intermixed with a few simple pale setae; membrane smoky translucent to fumate. Venter and legs yellowish green. *Male genitalia:* Fig. 5.

Macropterous female.—Not examined.

Brachypterous female.—Length 3.96 mm (range for 15 specimens 3.36–4.00 mm, $\bar{x}$ = 3.76 mm), length to apices of wings 2.96 mm (range for 15 specimens 2.76–3.20 mm, $\bar{x}$ = 2.98 mm), width 1.32 mm. *Head:* Width 0.94 mm, vertex 0.60 mm. *Rostrum:* Length 0.80 mm, reaching just beyond procoxae to middle of mesosternum. *Antenna:* I, Length 0.44 mm; II, 1.32 mm; III, 0.96 mm; IV, 0.46 mm. *Pronotum:* Length 0.42 mm, basal width 0.96 mm.

Specimens examined.—IDAHO: holotype ♂, 1 brachypterous ♀, Genesse, alt. 2700′, May 5, 1937, V. E. Nygren coll. (USNM). OREGON: 27 ♂, 32 brachypterous ♀, Clatsop Co., Saddle Mt. State Park, June 14, 1979, R. T. Schuh coll., on *Allium* sp. (AMNH, USNM). UTAH: 2 brachypterous ♀, Cache Jct., June 11, 1903, no coll. data (USNM); 1 brachypterous ♀, Ogden, June 9, 1927, G. F. Knowlton coll. (USNM).

Remarks.—*Labopidicola idahoensis* is most similar to *geminatus* in appearance but can be separated from it by the shorter, more thickly set, dark, bristle-like setae found on the dorsum (Fig. 6) and other characters given in the key.

Labopidicola idahoensis, previously known from Idaho (Knight, 1968) and Colorado, British Columbia, Alberta, Saskatchewan, and Manitoba (Kelton, 1979), is now recorded from Oregon and Utah.

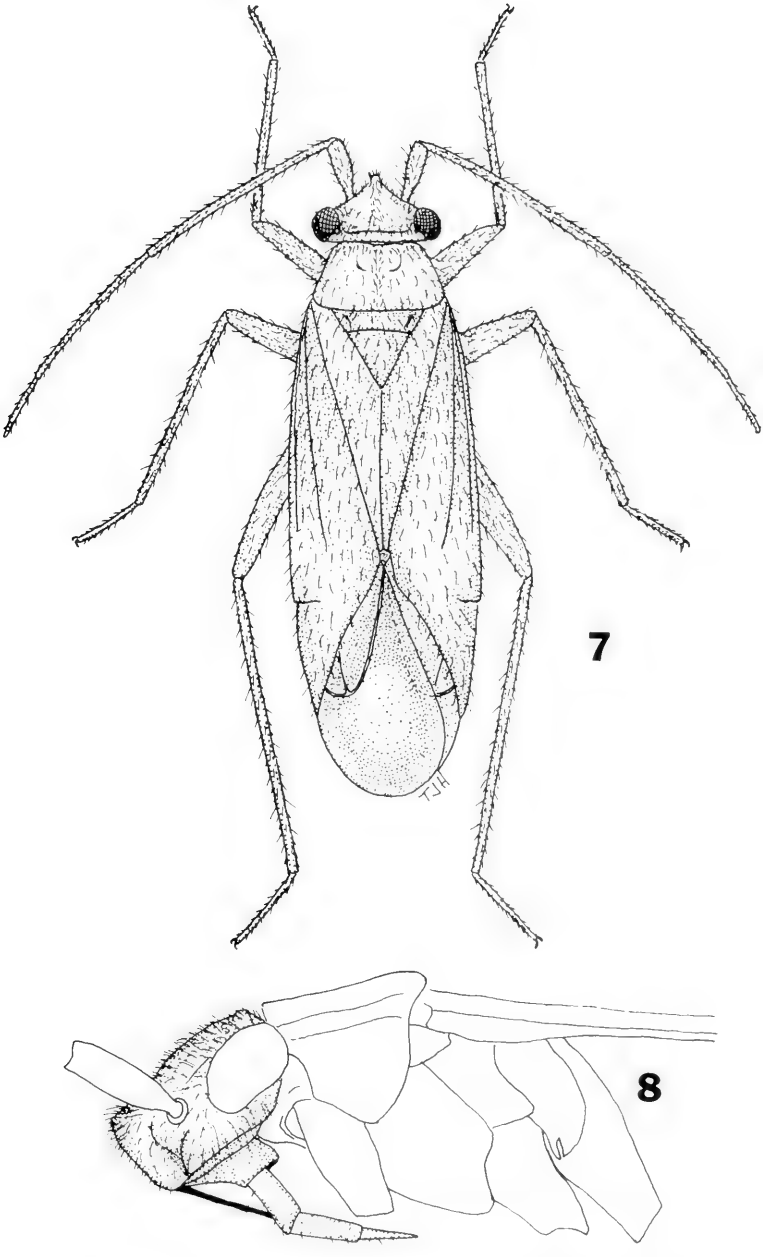
Labopidicola planifrons (Knight)

Fig. 6

Labopidea planifrons Knight, 1928: 234; Knight, 1941: 105; Carvalho, 1958: 82.

Labopidicola planifrons: Kelton, 1979: 754; Kelton, 1980: 246.

Diagnosis.—Male, length 4.04 mm, width ca. 1.36 mm. General color pale greenish, posterior ½ of pronotum, hemelytral margins, setal punctures and legs tinged with blue green, dorsum clothed with erect and suberect, silvery,



Figs. 7, 8. *Labopidicola idahoensis*. 7, Dorsal habitus of adult male. 8, Lateral aspect of head and pronotum.

simple setae, sparsely intermixed with silvery sericeous pubescence. *Head:* Width 0.84 mm, vertex 0.52 mm. *Rostrum:* Length 0.70 mm, reaching just beyond procoxae to middle of sternum. *Antenna:* Segment I greenish, II and III testaceous; I, length 0.36 mm; II, 1.00 mm; III, 0.88 mm; IV, broken. *Pronotum:* Length 0.44 mm, basal width 1.02 mm. *Hemelytron:* Uniformly pale green, tinged along margins and on setal punctures with blue green; membrane translucent brownish. Venter and legs pale greenish. *Male genitalia:* Fig. 6.

Remarks.—I have examined only the holotype of *planifrons*. It is nearest to *allii* in general color and pubescence but can be separated by the characters given in the key. This is the only species with a strongly recurved hook on the right arm of the left paramere (Fig. 6c).

Labopidicola planifrons was described from South Dakota and later reported from Iowa, Manitoba, and Saskatchewan (Kelton, 1979).

ACKNOWLEDGMENTS

I thank the following people and their institutions for kindly lending specimens: K. C. Kim (PSU), J. C. Schaffner (TAM), R. T. Schuh (AMNH), M. A. Schwartz (ORSU), and A. G. Wheeler, Jr. (PDA). I also thank George Steyskal (SEL) for his expert interpretation of the gender for *Labopidicola*.

LITERATURE CITED

Bryson, H. R. 1937a. A plant bug (*Labopidea allii* Knight). U.S. Dep. Agric. Insect Pest Surv. Bull. 17: 186.

———. 1937b. A plant bug (*Labopidea allii* Knight). U.S. Dep. Agric. Insect Pest Surv. Bull. 17: 245.

———. 1939. Onion plant bug (*Labopidea allii* Knight). U.S. Dep. Agric. Insect Pest Surv. Bull. 19: 151.

Carvalho, J. C. M. 1958. Catalogue of the Miridae of the world. Part III. Subfamily Orthotylinae. Arq. Mus. Nac., Rio de J. 47: 1–161.

Drake, C. J. 1933. Biology and control of onion insects. Report of agriculture research for the year ending June 30, 1933. Agric. Exp. Stn., Iowa State Coll. Agric. Mech. Arts 1933: 71–72.

———. 1936. A mirid (*Labopidea allii* Knight). U.S. Dept. Agric. Insect Pest Surv. Bull. 16: 193.

———. 1937a. A plant bug (*Labopidea allii* Knight). U.S. Dep. Agric. Insect Pest Surv. Bull. 17: 186.

———. 1937b. Biology and control of onion insects. Report of agriculture research for the year ending June 30, 1937. Part I. Agric. Exp. Stn., Iowa State Coll. Agric. Mech. Arts 1937: 141–142.

———. 1938. Biology and control of onion insects. Report on agriculture research for the year ending June 30, 1938. Part I. Agric. Exp. Stn., Iowa State Coll. Agric. Mech. Arts 1938: 135.

———. 1940. Biology and control of onion insects particularly as vectors in yellow dwarf disease. Report on agriculture research for year ending June 30, 1940. Part II. Agric. Exp. Stn., Iowa State Coll. Agric. Mech. Arts 1940: 151.

Froeschner, R. C. 1949. Contribution to a synopsis of the Hemiptera of Missouri. Pt. IV. Am. Midl. Nat. 42: 123–188.

Glenn, P. A. 1923. The onion capsid, *Orthotylus translucens* Tucker. J. Econ. Entomol. 16: 79–81.

Haseman, L. 1941. A mirid (*Labopidea allii* Knight). U.S. Dep. Agric. Insect Pest Surv. Bull. 21: 190.

Henry, T. J. 1977a. A mirid (*Labopidea allii*). U.S. Dep. Agric. Coop. Plant Pest Rep. 2(24): 417.

———. 1977b. *Orthotylus nassatus*, a European plant bug new to North America (Heteroptera: Miridae). U.S. Dep. Agric. Coop. Plant Pest Rep. 2(31): 605–608.

Henry, T. J. and A. G. Wheeler, Jr. 1979. *Orthotylus translucens*: Taxonomic status and correction of published misidentifications (Hemiptera: Miridae). Proc. Entomol. Soc. Wash. 81: 60–63.

Johnston, H. G. 1930. Four new species of Miridae from Texas (Hemiptera). Bull. Brooklyn Entomol. Soc. 25: 295–300.

Kelton, L. A. 1979. *Labopidea* Uhler in North America with descriptions of a new species and new genus (Heteroptera: Miridae). Can. Entomol. 111: 753–758.

———. 1980. The plant bugs of the prairie provinces of Canada. Heteroptera: Miridae. Biosyst. Res. Inst., Ottawa. 408 pp.

Knight, H. H. 1923. A new species of *Labopidea* on garlic (Heteroptera-Miridae). Bull. Brooklyn Entomol. Soc. 18: 31.

———. 1928. New species of *Labopidea* and *Macrotyloides* (Hemiptera, Miridae). Can. Entomol. 60: 233–236.

———. 1941. The plant bugs, or Miridae of Illinois. Ill. Nat. Hist. Surv. Bull. 22, 234 pp.

———. 1968. Taxonomic review: Miridae of the Nevada Test Site and the western United States. Brigham Young Univ. Sci. Bull. 9(3): 282 pp.

Knowlton, G. F. 1933. Notes on Utah Heteroptera. Entomol. News 44: 261–264.

Smith, R. C., G. A. Dean, and E. G. Kelly. 1946. The fifteenth or 1945 annual insect population summary of Kansas. J. Kans. Entomol. Soc. 19: 37–52.

Smith, R. C. and E. G. Kelly. 1937. The sixth annual insect population summary of Kansas covering the year 1936. J. Kans. Entomol. Soc. 10: 113–132.

———. 1938. The seventh annual insect population summary of Kansas, covering the year 1937. J. Kans. Entomol. Soc. 11: 54–76.

Stiles, C. F. 1937. A plant bug (*Labopidea allii* Knight). U.S. Dep. Agric. Insect Pest Surv. Bull. 17: 186.

Tate, H. D. 1940. Insect vectors of yellow dwarf, a virus disease of onion. Iowa State Coll. J. Sci. 14: 267–294.

U.S. Dep. Agric. 1955. A mirid (*Labopidea allii*). U.S. Dep. Agric. Coop. Econ. Insect Rep. 5(16): 341.

———. 1957. A mirid (*Labopidea allii*). U.S. Dep. Agric. Coop. Econ. Insect Rep. 8(13): 234.

———. 1959. A mirid (*Labopidea ainsliei*). U.S. Dep. Agric. Coop. Econ. Insect Rep. 9(25): 551.

———. 1960a. A mirid (*Labopidea* sp.). U.S. Dep. Agric. Coop. Econ. Insect Rep. 10(31): 701.

———. 1960b. A mirid (*Labopidea ainsliei*). U.S. Dep. Agric. Coop. Econ. Insect Rep. 10(42): 987.

Westcott, C. 1973. The gardener's bug book. 4th ed. Doubleday and Co., Inc. 689 pp.

Wheeler, A. G., Jr. and T. J. Henry. 1976. Biology of the honeylocust plant bug, *Diaphnocoris chlorionis*, and other mirids associated with ornamental honeylocust. Ann. Entomol. Soc. Am. 69: 1095–1104.

PROC. ENTOMOL. SOC. WASH.
84(1), 1982, pp. 16–22

SIX *TRICHOGRAMMA* (HYMENOPTERA: TRICHOGRAMMATIDAE) SPECIES ASSOCIATED WITH A MARYLAND CORNFIELD, WITH DESCRIPTION OF A NEW SPECIES[1,2,3]

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Abstract.—Trichogramma species occurring along the edge of a 3 ha stand of field corn in the Beltsville Agricultural Research Center, Beltsville, Maryland, were surveyed during the 1980 season by maintenance of *Heliothis virescens* (F.) egg cloths in ten locations. A total of 1931 eggs from 79 egg cloths was parasitized by *Trichogramma* spp. Six species of *Trichogramma* were collected. These species were, in descending order of abundance, *T. minutum* Riley, *T. pretiosum* Riley, *T. exiguum* Pinto and Platner, *T. parkeri* Nagarkatti and ***T. marylandense***, n. sp., and *T. retorridum* (Girault). *Trichogramma marylandense* is described and illustrated.

Trichogramma wasps have been mass reared and released against insect pests for over 70 years (see Ridgway et al., 1981, for a review). Some recent examples of successful biological control of pests with *Trichogramma* are reported by Oatman and Platner (1978) on tomato, Parker (1971) on cabbage, and Ables et al. (1979) on cotton. However, in spite of recent advances in *Trichogramma* taxonomy (Nagarkatti and Nagaraja, 1971; Pinto et al., 1978), which have made possible the accurate identification of most of the known North American species, little effort has been made to determine the endemic species of *Trichogramma* in agricultural areas. Surveys of *Trichogramma* species are now needed to obtain information on their distribution,

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[1] Scientific Article No. A2970. Contribution No. 6030 of the Md. Agric. Exp. Stn., College Park.

[2] From a dissertation to be submitted to the Graduate School, University of Maryland, by the author in partial fulfillment of the requirements for the Ph.D. degree in Entomology.

[3] Mention of a commercial product in this paper does not constitute an endorsement of this product by the USDA.

biology, and ecology so that their potential for use as biological control agents can be evaluated.

During 1980 and 1981 I surveyed the species of *Trichogramma* occurring in and around a field of corn at the Beltsville Agricultural Research Center, Beltsville, Maryland. My objectives were to determine what species were present and to obtain information on their relative abundance.

MATERIALS AND METHODS

In 1980 I surveyed the *Trichogramma* species by placing ten strips of cloth (except on sampling dates 1 and 2 when only two cloths were used), each containing ca. 100 naturally oviposited *Heliothis virescens* (F.) eggs, in ten locations around the perimeter of a 3 ha stand of field corn. Four of the locations were adjacent to a 0.2 ha plot of sweet corn (variety NK199) within the larger field. The phenology of the corn was as follows: The field corn was planted 27 May, tasseled 21 July, was in silk from 29 July to 8 August, and was machine harvested 22 September; the sweet corn plot contained staggered plantings so that all stages of growth were continuously present. Sweet corn was planted on 30 May and every week thereafter. The first planting tasseled on 10 July and was in silk from 18 to 28 July. The sweet corn was not harvested.

Egg cloths were maintained in the sample area from 7 May to 7 November 1980. The cloths were attached to a 5 cm wire ringed with Tanglefoot® to limit access to egg predators and then suspended from stakes or branches at a height of ca. 1 m. The egg cloths were replaced every 3–5 days and held in the laboratory for emergence of parasitoids. Prior to use all *H. virescens* eggs were killed by exposure to ca. 30 krad of gamma radiation. Identifications were made in collaboration with Carll Goodpasture, formerly of the Beneficial Insect Introduction Laboratory, IIBIII, ARS, USDA.

In 1981 a 0.2 ha plot of soybeans replaced the 0.2 ha sweet corn plot. The 3 ha field was again planted to field corn. I continued the survey by concentrating 45 egg cloths in and around the soybean plot.

The description of the *Trichogramma* species (except color characters) is based on 15th-generation adults from a culture started in 1980 and 6th-generation adults from a culture started in 1981. Both cultures were maintained at 20–25°C. The adults were preserved on glass slides in Hoyer's medium. The terminology used is that of Pinto et al. (1978). Quantitative data listed in the description are those of the holotype (male) or allotype followed (in brackets) by the mean, standard error, and range of that same character measured on 30 additional specimens. (All characters are not from the same 30 specimens since all characters are not clearly visible on all specimens.) Description of color is based on freshly killed 15th-generation adults from the 1980 culture. Since rearing temperature has been shown to affect color (Kwangtung Collaborative Research Group of Biological Control of Rice Pests, 1974), these insects were reared for at least two generations at 27°C, 70–80% RH, and constant light.

Results and Discussion

A total of 1931 eggs on 79 egg cloths was parasitized by *Trichogramma* in 1980. Dates of parasitization ranged from 12 May (first sample) to 21 October. Six species of *Trichogramma* were reared from these eggs. These species were, in descending order of abundance, *T. minutum* Riley (36), *T. pretiosum* (Riley) (31), *T. exiguum* Pinto and Platner (16), *T. parkeri* Nagarkatti (3) and *T. marylandense,* n. sp. (3), and *T. retorridum* (Girault) (1). Figure 1 shows the number of cloths with eggs parasitized by each species on each sampling date. Unfortunately, parasitism of eggs on a single cloth by more than one female cannot be detected unless the females are of different species, since their progeny are otherwise indistinguishable. *Trichogramma minutum, T. pretiosum,* and *T. exiguum* were collected much more frequently than were the other three species and were collected throughout the entire season, whereas the latter three species were collected only briefly early in the season. The one exception was the collection of *T. marylandense* in September, when parasitism was at a marked peak. Different eggs on the same cloth were parasitized by two different species of *Trichogramma* on 11 occasions (*T. minutum*/*T. pretiosum,* 5; *T. minutum*/*T. exiguum,* 4; *T. pretiosum*/*T. exiguum,* 1; *T. pretiosum*/*T. marylandense,* 1). On two occasions individuals of two species emerged from the same egg (*T. minutum* ♂ and *T. exiguum* ♂; *T. minutum* ♀ and *T. pretiosum* ♀).

The 1981 survey is not yet completed, however specimens of *T. marylandense* collected in 1981 are included in the material examined for the description. *Trichogramma marylandense* was collected on 13 July, 20 July, and 17 August 1981, and sampling is continuing.

One of the objectives of the 1980 study was to determine the relative abundance of the *Trichogramma* species in the survey area. However, the number of females of each species sampled may not reflect their abundance. Differences in host acceptability and microhabitat preference could affect sample size. The discovery of six sympatric *Trichogramma* species all attacking the same host (in this case an artificially provided host) should serve to emphasize the need for basic ecological studies of *Trichogramma* species. An understanding of such specific characteristics as habitat and host preference is essential to biological control programs involving species of this genus.

Trichogramma marylandense Thorpe, New Species

Figs. 2–4

Type-data.—Holotype adult ♂ on slide with two other specimens under separate coverslips; holotype nearest right margin of slide with right label

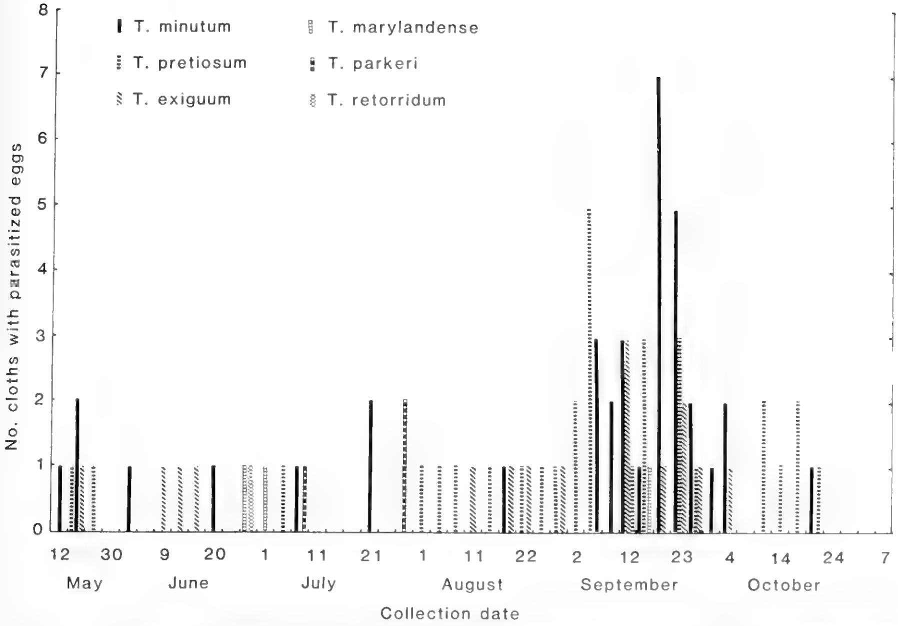
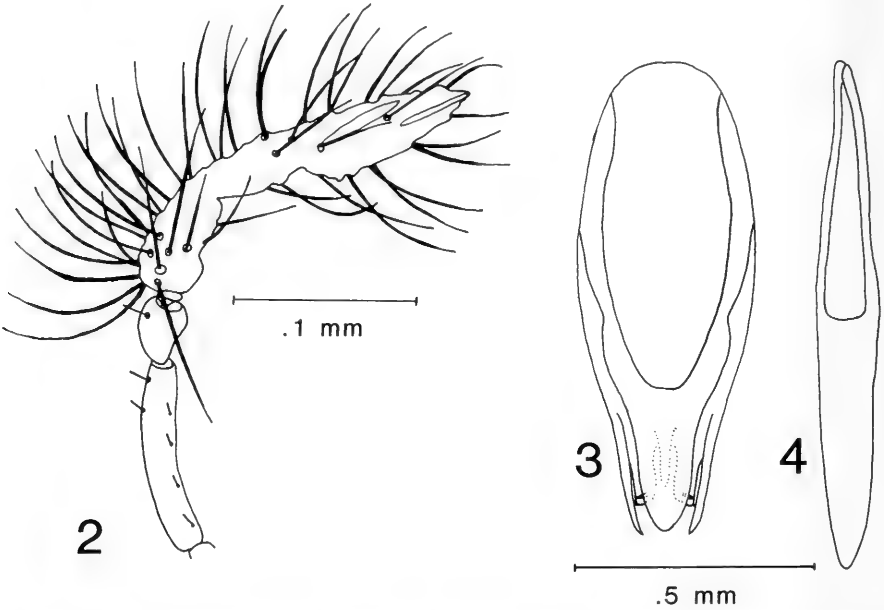


Fig. 1. Number of cloths with *Heliothis virescens* eggs parasitized by *Trichogramma* spp. on each collection date, Beltsville, Maryland, 1980.

"*Trichogramma marylandense* Thorpe, Beltsville, Md. 12-4/1, mounted 31 XII 80, F15 lab culture, ex. *Heliothis virescens* egg cloth, coll. 26 VI 80, K. Thorpe, Hoyers." Allotype adult ♀ on slide with two other specimens under separate coverslips, same label; allotype center specimen. There are 145 paratypes (80 ♂, 65 ♀), 94 of which (50 ♂, 44 ♀) are on 32 slides all with same data as holotype. Remaining 51 paratypes (30 ♂, 21 ♀) are on 17 slides with right label "*Trichogramma marylandense* Thorpe, Beltsville, Md. 20-3-2, mounted 1 IX 81, F6 lab culture, ex. *Heliothis virescens* egg cloth, coll. 13 VII 81, K. Thorpe, Hoyers." Holotype (USNM type no. 100087) and allotype are deposited in the collection of the National Museum of Natural History, Washington, D.C.

Holotype male.—Eye and ocelli red; antenna and head yellow; thorax yellow with black pronotum and mesoscutum; legs yellow except meso- and metacoxae, metafemur, and 3rd tarsal segments black; wings clear with smokey patch extending from base to even with distal end of stigma; 1st abdominal segment yellow, remaining segments black.

Antenna (Fig. 2) with flagellum (excluding annellus) relatively long and curved, 0.16× as wide as long (0.032 mm × 0.199 mm) [0.17 ± 0.002; 0.15–0.19], 1.21× as long as metatibia (0.165 mm) [1.20 ± 0.005; 1.15–1.27], with 2 distinct constrictions, flagellar setae moderately long, tapering gradually



Figs. 2–4. *Trichogramma marylandense*, holotype male. 2, Antenna. 3, Genital capsule. 4, Aedeagus.

from base, 46 in number [46.6 ± 1.63; 41–55], longest 2.46× as long (0.078 mm) as maximum width of flagellum [2.37 ± 0.03; 2.07–2.75].

Forewing with vein tracts well defined, area between 4th and 5th vein tracts with 34 setae [28.5 ± 0.81; 22–38], longest seta on postapical wing margin 0.12× as long as maximum wing width (0.032 mm and 0.267 mm) [0.13 ± 0.003; 0.10–0.18). Hindwing with posterior vein tract extending ⅓ to ½× the distance of middle tract; anterior tract of 1–4 setae extending less than ⅓ distance of middle tract.

Mesoscutellum with anterior setae 0.25× as long as posterior setae (0.010 mm and 0.039 mm) [0.28 ± 0.012; 0.19–0.50].

Genital capsule (Fig. 3) 0.37× as wide as long (0.036 mm × 0.099 mm) [0.37 ± 0.003; 0.33–0.39]; dorsal expansion of gonobase (DEG) shallowly constricted at base, sides concave, width at base (0.023 mm) 0.64× the width of genital capsule [0.71 ± 0.016; 0.53–0.93]; DEG (0.102 mm long) extending 1.02× the length of genital capsule [0.97 ± 0.006; 0.92–1.03]; chelate structures (CS) (0.095 mm long) extending 0.95 the length of genital capsule [0.91 ± 0.008; 0.82–0.97]; median ventral projection (MVP) (0.090 mm long) long and slender, sharply pointed apically, extending 0.90× the length of genital capsule [0.89 ± 0.004; 0.83–0.92]; aedeagus (Fig. 4) (0.112 mm long) 0.68× as long as metatibia [0.66 ± 0.006; 0.58–0.73], 1.12× as long as genital capsule [1.12 ± 0.004; 1.08–1.16]; apodemes (0.053 mm long) comprising 0.48× length of aedeagus [0.50 ± 0.009; 0.43–0.61].

Allotype female.—Color as in male except antenna and head yellow shaded with black; mesoscutum yellow.

Forewing area between 4th and 5th vein tracts with 29 setae [28.2 ± 0.78; 19–37]; longest seta on postapical wing margin 0.12× as long as maximum wing width (0.032 mm and 0.267 mm) [0.13 ± 0.002; 0.11–0.16].

Ovipositor 0.88× as long as metatibia (0.153 mm and 0.175 mm) [0.88 ± 0.008; 0.80–0.97].

Remarks.—Males of *T. marylandense* differ from males of most known North American species of *Trichogramma* by having a DEG that is greater than 0.90× the length of the genital capsule. The only other North American species similar to *T. marylandense* in this respect are *T. brevicapillum* Pinto and Platner, *T. fasciatum* (Perkins), *T. julianoi* Platner and Oatman, *T. maltbyi* Nagaraja and Nagarkatti, and *T. retorridum* (Girault). The flagellar setae of *T. brevicapillum* males are much shorter and stouter than those of *T. marylandense* (1.17× longer than the flagellar width in *T. brevicapillum* (Pinto et al., 1978) compared to 2.37× longer in *T. marylandense*). The DEG of *T. marylandense* males is narrower at its apex than the distance across the gonostyli, which distinguishes it from *T. fasciatum* males in which the DEG is broader at its apex than the distance across the gonostyli (Pinto et al., 1978). The genital capsule of *T. julianoi* is very similar to that of *T. marylandense* but can be distinguished by the length of the apodemes of the aedeagus (0.80× the length of the aedeagus (Platner and Oatman, 1981) compared to 0.50× the length of the aedeagus in *T. marylandense*). *Trichogramma maltbyi* males differ from *T. marylandense* males by having the DEG narrower at its base (ca. ½ genital capsule width in *T. maltbyi* (Nagaraja and Nagarkatti, 1973) compared with 0.71 in *T. marylandense*) and by having longer antennal setae (nearly 4× the flagellar width (Nagaraja and Nagarkatti, 1973) compared with 2.37× in *T. marylandense*). *Trichogramma retorridum* males can be separated from *T. marylandense* males by their very short, suboval flagellum (0.43× as wide as long (Pinto et al., 1978) compared to 0.17× as wide as long in *T. marylandense*). The male genital capsule of *T. marylandense* is very similar to that of the Indian species *T. achaeae* Nagaraja and Nagarkatti (1969). However, the latter species has a minute and inconspicuous MVP, whereas the MVP in *T. marylandense* is long and slender and attains 0.89× the length of the genital capsule. Also, in *T. achaeae* the aedeagus and apodemes together attain less than the length of the genital capsule while in *T. marylandense* they attain 1.12× its length.

Hosts and distribution.—Original specimens of *T. marylandense* were reared from *Heliothis virescens* eggs artifically placed on the edge of a corn field in Beltsville, Maryland on 23 June, 26 June, and 12 September 1980, and from eggs placed in and near a soybean field at the same location on 13 July, 20 July, and 17 August 1981. At present these are the only known collections of this species. Natural hosts are unknown.

ACKNOWLEDGMENTS

I thank Eric Grissell, Systematic Entomology Laboratory, IIBIII, USDA, and Akey C. F. Hung and David L. Vincent, Beneficial Insect Introduction Laboratory, IIBIII, USDA, for their critical review of the manuscript.

LITERATURE CITED

Ables, J. R., S. L. Jones, R. K. Morrison, V. S. House, D. L. Bull, L. F. Bouse, and J. B. Carlton. 1979. New developments in the use of *Trichogramma* to control lepidopteran pests of cotton. Proc. Beltwide Cotton Prod. Res. Conf. 3 pp.

Kwangtung Collaborative Research Group of Biological Control of Rice Pests, Kwangtung Province. 1974. The control of rice leaf roller, *Cnaphalocrocis medinalis* Guenee by trichogrammatid egg parasites. (In Chinese with English summary.) Acta Entomol. Sinica 7(3): 269–280.

Nagaraja, H. and S. Nagarkatti. 1969. Three new species of *Trichogramma* from India. Entomophaga 14(4): 393–400.

———. 1973. A key to some new world species of *Trichogramma* (Hymenoptera: Trichogrammatidae), with descriptions of four new species. Proc. Entomol. Soc. Wash. 75(3): 288–297.

Nagarkatti, S. and H. Nagaraja. 1971. Redescriptions of some known species of *Trichogramma* (Hymenoptera: Trichogrammatidae) showing the importance of the male genitalia as a diagnostic character. Bull. Entomol. Res. 61: 13–31.

Oatman, E. R. and G. R. Platner. 1978. Effect of mass releases of *Trichogramma pretiosum* against lepidopterous pests on processing tomatoes in Southern California, with notes on host egg population trends. J. Econ. Entomol. 71(6): 896–900.

Parker, F. D. 1971. Management of pest populations by manipulating densities of both hosts and parasites through periodic releases, pp. 365–376. *In* Huffaker, C. B., ed., Biological Control. Plenum Press, N.Y. 511 pp.

Pinto, J. D., G. R. Platner, and E. R. Oatman. 1978. Clarification of the identity of several common species of North American *Trichogramma* (Hymenoptera: Trichogrammatidae). Ann. Entomol. Soc. Am. 71(2): 169–180.

Platner, G. R. and E. R. Oatman. 1981. Description of a new species of *Trichogramma* (Hymenoptera: Trichogrammatidae) from New York. Proc. Entomol. Soc. Wash. 83(1): 164–167.

Ridgway, R. L., F. R. Ables, C. Goodpasture, and A. W. Hartstack. 1981. *Trichogramma* and its utilization for crop protection in the U.S.A., pp. 41–48. *In* Coulson, J. R., ed., Proceedings of the Joint American-Soviet Conference on the Use of Beneficial Organisms in the Control of Crop Pests. Entomol. Soc. Amer., College Park, Md. 62 pp.

PROC. ENTOMOL. SOC. WASH.
84(1), 1982, pp. 23–37

FIVE NEW SPECIES OF *PHERBELLIA* ROBINEAU-DESVOIDY, SUBGENUS *OXYTAENIA* SACK, FROM NORTH AMERICA (DIPTERA: SCIOMYZIDAE)

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Abstract.—*Pherbellia* **borea**, *P.* **californica**, *P.* **marthae**, *P.* **paludum**, and *P.* **ursilacus** are described as new species from North America. Illustrations and photographs of the copulatory apparatus and geographic distribution are given for the new species as well as for *P. bryanti* Steyskal and *P. propages* Steyskal. All are members of the *P. propages* group.

The genus *Pherbellia* Robineau-Desvoidy is known from all the zoogeographic realms of the world. Within the family Sciomyzidae *Pherbellia* constitutes by far the largest genus. Prior to this study there were 32 described species of *Pherbellia* from North America north of Mexico. Some of the species which occur in the Nearctic also occur in the Neotropic and Palaearctic regions.

It seems advisable to recognize *Pherbellia* as a single genus as did Steyskal (1961, 1966) until a more comprehensive taxonomic study can be made. The genus has been broken into several subgenera. This paper is concerned only with North American members of the subgenus *Oxytaenia* Sack.

The type-species of the subgenus *Oxytaenia* is *Pherbellia brunnipes* (Meigen). It was recorded by Melander (1920) and Steyskal (1965) as Holarctic, being found in Wyoming and Idaho, USA, as well as Europe. However, Steyskal (1966) stated in regard to *P. brunnipes* ". . . my examination of European material shows a species different from any I have seen from this continent, including material from the Melander collection. Of the American species, it is most closely related to *P. bryanti* and *P. propages* . . . ." Close examination of illustrations by El'berg (1965) and Rozkošný (1966) showing European terminalia further confirms that *P. brunnipes* is Palaearctic. On the basis of external characters, close scrutiny of a female specimen from Melander's collection from Wyoming labeled *P. brunnipes* reveals it to be *P. prefixa* Steyskal.

Presently from North America there are nine species referred to the subgenus *Oxytaenia*, which is now comprised of *Pherbellia beatricis, P. bryanti, P. prefixa, P. propages* plus the five new species which are herein described. All are quite small, rather inconspicuous, dull colored flies.

The new species are separated from *Pherbellia propages* and *P. bryanti*. These new species along with *P. propages* and *P. bryanti* are here referred to as the *P. propages* group. The male postabdomen of *Pherbellia bryanti, P. propages,* and the new species provides the most definitive means of separation. For identification the postabdomen must first be severed from the specimen and placed in a 10% solution of potassium hydroxide until the viscera and muscular tissues have been dissolved. The postabdomen is then flushed with distilled water and examined under the microscope in a droplet of glycerine. Staining the prepared section with acid fuchsin will further intensify subtle membranous structures, thereby facilitating determinations.

The postabdomen of North American *Oxytaenia* may still be typified as stated by Steyskal (1966): "surstyli of anterior and posterior pairs close together, the posterior pair broad basally, usually with a narrow apical point more or less directed posteriad, the anterior pair small and lying backward against the posterior pair; hypandrium with anterior margin transverse, lateral processes consisting of broad anterior lamina, and more or less blade-like posterior sclerite bearing variously developed apical prongs; phallapodeme deeply cleft, Y-shaped, arms bearing clamshell-like pregonite; aedeagus broad; postgonites massive, black, usually with small but deep apical emargination giving them the appearance of a crab's claw; ejaculatory apodeme narrow-headed, relatively small and short, but with large vesicle (seminal pump), the vas deferens short and of small diameter."

The *Pherbellia propages* group is here considered to be monophyletic. The adults show scarcely any external differences. However, dissection of the male terminalia reveals distinct differences in the aedeagi and the posterior process of the hypandria. Lesser differences are seen in the posterior and anterior surstylus as well as the ejaculatory apodeme and seminal pump. Some species are allopatric such as *P. californica* and *P. ursilacus* as shown on the locality map (Fig. 34). Four of the species are sympatric at Aklavik, Northwest Territories (Figs. 33, 34).

The holotypes of both *Pherbellia propages* and *P. bryanti* have been examined and are as illustrated in this paper. Examination of paratypes of the above species reveals that several species of the *P. propages* group are represented. Therefore, the locality maps as they appear in this paper indicate the known distribution for *P. propages* and *P. bryanti,* sensu stricto.

The groundwork and stimulus for this study was provided by Steyskal (1966). In his description of *Pherbellia propages* he observed and illustrated differences in the posterior process of the hypandrium. He felt that the differences might represent subspecies, however he made no mention at that time of aedeagal differences.

Members of the *Pherbellia propages* group share the following characters: Frons with median stripe less than ⅔ as long as distance from ocellus to frontal margin; anterior fronto-orbital bristle much shorter than posterior fronto-orbital bristle; arista with short, fine, closely set hairs; mesopleuron entirely bare; pteropleuron with all bristles of nearly equal length; sternopleuron usually with 2 very strong bristles and several weak bristles along the upper surface; wing not patterned, at most with anterior margin and crossvein clouded; wing length of males, 2.3–3.4 mm; first vein not surpassing level of *ta*, either ending short of it or at the same level; halter pale yellowish or whitish.

All possess a mesoscutal pattern of intradorsocentral and sublateral brown stripes. The degree of distinctness seems dependent on the condition of the insect at the time of capture. In general old battered specimens tend to loose their distinct stripes. All specimens I have seen in the *Pherbellia ursilacus* series show this character indistinctly.

Pherbellia californica Orth, New Species

Figs. 1, 2, 6, 17–20, 34

Holotype male.—Height of head ⅔ width. Medifacies yellowish to whitish pruinose, facial grooves subshiny, parafacies and cheeks pruinose yellowish to whitish respectively. Frons yellowish, slightly narrowed anteriorly. Midfrontal stripe extending ½ distance from anterior ocellus to anterior margin of frons. Ocellar triangle and orbital plates with greyish pruinosity. Orbital plates tapered anteriorly, extending beyond midfrontal stripe. Orbito-antennal spot lacking; narrow strip of whitish pruinosity along upper orbital margin. Two pairs of fronto-orbital bristles, anterior pair ½ as long; ocellars, postocellars, and inner and outer verticals well developed. Occiput greyish pruinose. Short black setae on lower ⅔ of cheeks and parafacies on anterior ½ of frons, between ocellar and postocellar bristles, along outer parts of orbital plates, and in midcervial patch. Lateral occipital margins with stronger setae and bristles. Antennae testaceous, segment 3 elongate oval. Arista blackish with short hairs. Palpi yellowish, labium and labella yellowish brown.

Thorax dorsally grey, pruinose, with indistinct brownish longitudinal stripes.

Mesopleuron grey, pruinose throughout, posterior ⅓ brownish. Remainder of thoracic surfaces greyish pruinose with some tendency toward brown or brownish yellow. Mesopleuron bare; pteropleuron with a cluster of bristles of nearly equal size. Sternopleuron with fine short setae over most of surface, 2 well developed bristles dorsally and well developed bristles ventrally. Prosternum bare.

Coxae yellowish white, pruinose. Forefemur and tibia dark brownish infumated, tarsal segments light brown infumated. Mid- and hindlegs entirely testaceous.

Wing length 3.4 mm. Membrane greyish-yellow hyaline; costal margin

Fig. 1. *Pherbellia californica*, paratype male. Point-mounted. Photo by M. E. Badgley, University of California, Riverside.

and wing veins testaceous; crossveins brownish, slightly infuscated. No stump veins; anterior cross vein slightly oblique, first vein not surpassing the level of anterior cross vein; anal vein reaching wing margin. Halter, squama, and squamal ciliae yellowish.

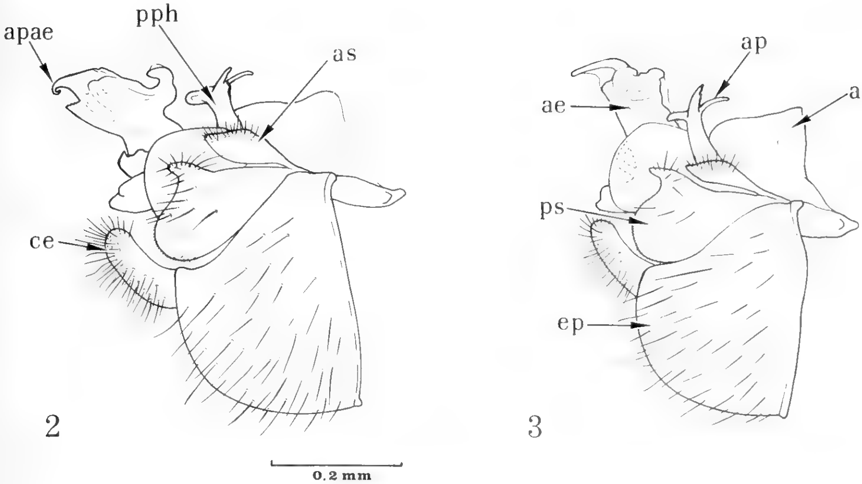
Abdominal segments testaceous, slightly infumated dorsally; andrium testaceous; terminalia as in Fig. 2. Copulatory apparatus as in Figs. 6, 17–20.

Allotype female.—Similar to holotype except for reproductive structures. Wing length 3.3 mm.

Holotype.—♂, California, Mendocino Co., 2 mi N of Willits, 24 April 1967, elevation 1330 feet. T. W. Fisher–R. E. Orth, field notes accession no. AS-578. National Museum of Natural History.

Allotype.—♀, same data as holotype. Deposited with holotype.

Paratypes.—Same locality and collector data as holotype. 12 June 1966, AS-482 (8 ♀, 26 ♂); 24 May 1967, AS-578 (13 ♀, 36 ♂); 23 April 1968, AS-669 (3 ♀, 3 ♂); 24 April 1968, AS-671 (2 ♂). At Agriculture Canada, California Academy of Sciences, Cornell University, University of California at Riverside, and the National Museum of Natural History.



Figs. 2, 3. 2, *Pherbellia californica*, paratype male; 2 mi N of Willits, Mendocino Co., California, 24 May 1967, T. W. Fisher–R. E. Orth; terminalia, sinistral view, inverted; apae = apical process of aedeagus; as = anterior surstylus; ce = cerci; pph = posterior process of hypandrium. 3, *P. borea*, paratype male; Hay River, N.W.T., 10 Sept. 1932, O. Bryant, lot no. 352; terminalia, sinistral view, inverted; ae = aedeagus; alh = anterior lamina of hypandrium; ap = apical prong; ep = epandrium; ps = posterior surstylus.

Other specimens.—In addition to the above I have seen material from the following localities: *California:* Humboldt Co., 2 mi S of Orick; Marin Co., 2 mi NW of Bolinas; .5 mi S of Tomales; Mendocino Co., 7 mi N of Hopland; Ukiah; Plumas Co., 1 mi E of Chester; .5 mi S of Crescent Mills; Rock Creek at Hwy. 36; Shasta Co., 5.25 mi NW of Anderson; Siskiyou Co., 3.5 mi S of Fort Jones, Scott Valley. *Oregon:* Benton Co., Parker Creek, Mary's Peak; Hood River Co., .5 mi S of Sherwood Campground, Mt. Hood National Forest; Marion Co., Breitenbush; Wasco Co., Hwy. 26, 1 mi S of Hwy. 216 Jct. *Washington:* Lewis Co., Adna.

Variation.—Wing length 2.6–3.4 mm in males, 2.8–4.0 mm in females.

Discussion.—This species is known only from California, Oregon and Washington. It overlaps no other species in the *Pherbellia propages* group. It is the only species in the group which shows considerable variation in the aedeagus. In specimens collected in the general proximity of the type-locality the apical process of the aedeagus bends back on its self while in more northern specimens it is opened out more (see Figs. 17, 18). Deviation of the aedeagus and subtle differences in the posterior process of the hypandrium in material from localities away from the type-locality may represent a subspecies.

Pherbellia borea Orth, New Species

Figs. 3, 4, 11–13, 33

Holotype male.—Similar to *Pherbellia californica* except as follows. Mid- and hindfemora infuscated, brown, hindfemur darker than midfemur; tibiae and tarsi brown, slightly infumated. Abdominal segments brownish grey. Terminalia as in Fig. 3. Copulatory apparatus as in Figs. 4, 11–13. Wing length 2.9 mm.

Female.—Not known.

Holotype.—♂, Northwest Territories, Aklavik, 25 July 1931, O. Bryant, lot no. 300. National Museum of Natural History.

Paratypes.—*Northwest Territories:* Aklavik, 5 August 1930, lot no. 110, 18 Sept. 1930, lot no. 153, 10 Aug. 1931, lot 289, O. Bryant (3 ♂); Hay River, 10 Sept. 1932, lot no. 352, O. Bryant (1 ♂); Hyndman, 68°5′N, 131°03′W, 30 July 1969, 1 Aug. 1969, G. E. Shewell (3 ♂, 2 ♂) respectively. Wing length 2.6–3.0 mm. At Agriculture Canada, California Academy of Sciences, University of California at Riverside, and the National Museum of Natural History.

Discussion.—Distribution of this species is the most northern of the *Pherbellia propages* group. The southern-most collection site is Hay River, Northwest Territories approximately 61° north latitude. This species name is from the Latin adjective borea—northern.

Pherbellia marthae Orth, New Species

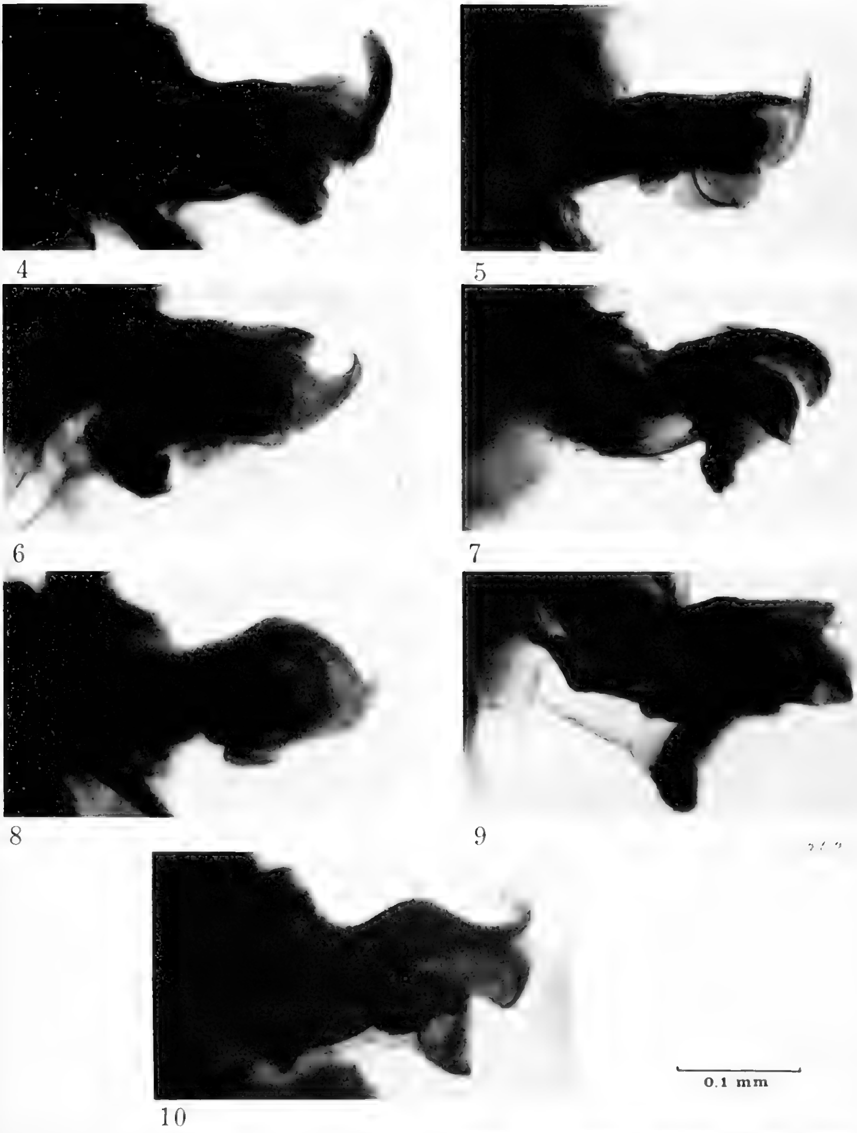
Figs. 7, 21–23, 33

Holotype male.—Similar to *Pherbellia californica* except as follows. Mid- and hindlegs brown, slightly infuscated, hindfemur darker than midfemur. Abdominal segments brownish grey. Copulatory apparatus as in Figs. 7, 21–23. Wing length 3.2 mm.

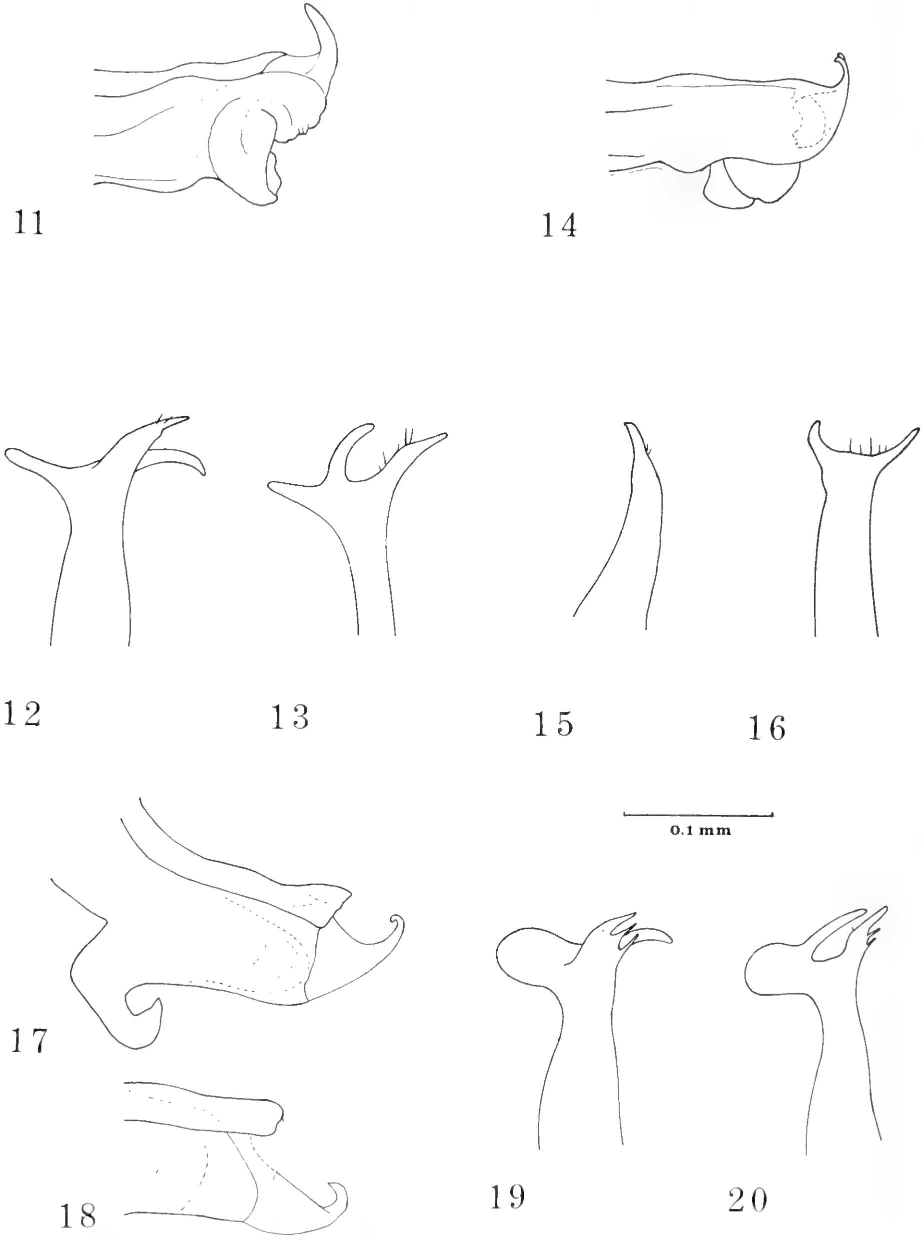
Female.—Not known.

Holotype.—♂, Churchill, Manitoba, 2–9 Aug. 1937, D. G. Denning. National Museum of Natural History.

Paratypes.—*Alberta:* Cascade Trail, Banff, 10 July 1968, elevation 5000 feet, H. J. Teskey (1 ♂); Cooking Lake, 20 June 1937, 25 July 1937, F. O. Morrison (2 ♂); 1.5 mi W of Lacombe, 23 May 1962, C. O. Berg (2 ♂); Slave Lake, 6 June 1966, G. E. Shewell (1 ♂). *British Columbia:* Ketchum Lake, 58°22′N, 131°45′W, 26 Aug. 1960, W. W. Moss (1 ♂); Spectacle Lake, Oliver, 10 June 1959, L. A. Kelton (1 ♂). *Manitoba:* Churchill, 2–9 Aug. 1937, D. G. Denning (1 ♂); Herchmer, 10 Aug. 1937, D. G. Denning (1 ♂); The Pas, 28 May 1930, O. Bryant, lot no. 6 (1 ♂); Treesbank, 17 Oct. 1915, J. M. Aldrich (1 ♂). *Northwest Territories:* Aklavik, 18 June 1931, 22 June 1931, 24 June 1931, O. Bryant, lot nos. 234, 238, 241 (1 ♂, 1 ♂, 1 ♂); Fort Franklin, Great Bear Lake, 22 June 1969, G. E. Shewell (3 ♂); Lac Maunoir, N shore, 15 July 1969, 17 July 1969, G. E. Shewell (1 ♂, 11 ♂)



Figs. 4–10. Aedeagi, sinistral profiles. 4, *Pherbellia borea*, paratype male; Aklavik, N.W.T., 18 Sept. 1930, O. Bryant, lot no. 153. 5, *P. bryanti*; Yellowstone National Park, Gibbon Falls, Wyoming, 27 July 1956, A. L. Melander. 6, *P. californica*, paratype male; 2 mi N of Willits, Mendocino Co., California, 24 May 1967, T. W. Fisher–R. E. Orth. 7, *P. marthae*, paratype male; Churchill, Manitoba, 2–7 Aug. 1937, D. G. Denning. 8, *P. paludum*, paratype male; Gander, Newfoundland, 17 June 1961, C. P. Alexander. 9, *P. propages*; Long Lake, Burleigh Co., North Dakota, 4 June 1968, W. W. Wirth. 10, *P. ursilacus*, paratype male; Bear Lake, Bear Lake Co., Idaho, 19 July 1959, B. A. Foote.



Figs. 11–20. 11–13, *Pherbellia borea*, paratype male; Aklavik, N.W.T., 18 Sept. 1930, O. Bryant, lot no. 153. 14–16, *P. bryanti*; Yellowstone National Park, Gibbon Falls, Wyoming, 27 July 1956, A. L. Melander. 17–20, *P. californica*; 17, 19, 20, Paratype male, 2 mi N of Willits, Mendocino Co., California, 24 May 1967, T. W. Fisher–R. E. Orth; 18, Adna, Wash-

respectively; Norman Wells, 25 June 1969, G. E. Shewell (3 ♂). *Saskatchewan:* Cantyre, 53°23′N, 101°50′W, 12 Sept. 1959, J. R. Vockeroth (4 ♂); Quill Lake, 20 May 1968, H. J. Teskey (1 ♂); Uranium City, 18, 19, 21 June 1962, J. G. Chillcott (1 ♂, 1 ♂, 1 ♂); Yorkton, 16 Sept. 1959, J. R. Vockeroth (1 ♂). *Yukon:* 58 mi E of Dawson, Gravel Lake, 12 Aug. 1962, P. J. Skitsko (1 ♂); La Force Lake, 9 July 1960, J. E. H. Martin (1 ♂); Takhini Hot Springs, 16 Aug. 1962, R. E. Leech (1 ♂). *Alaska:* Fairbanks, 7 June 1948, R. Sailer (2 ♂); Goldstream River Valley, 8½ mi N of Fairbanks, 29 July 1971, B. A. Foote (1 ♂); Wonder Lake, McKinley National Park, 25 July 1965, D. Chant (1 ♂). *Montana:* 2 mi E of Babb, 22 July 1967, B. A. Foote (2 ♂); 7 mi W of Eureka, 15 July 1965, B. A. Foote (1 ♂). *North Dakota:* McHenry Co., 4 mi N of Upham, 5 June 1969, W. W. Wirth (1 ♂); Mountrail Co., Powers Lake, 8 June 1969, W. W. Wirth (2 ♂). Wing length 2.3–3.2 mm. At Agriculture Canada, Cornell University, University of California at Riverside, and the National Museum of Natural History.

Discussion.—This species was the most common of the *P. propages* group found in collections. It, along with three other species of the group, has been collected at Aklavik, Northwest Territories. It is a northwestern and mid-continent species. This species is named for my wife, Martha.

Pherbellia paludum Orth, New Species

Figs. 8, 24–26, 33

Holotype male.—Similar to *Pherbellia californica* except as follows. Mid- and hindfemora and tibiae infumated, brown, hindfemur darker than midfemur; mid- and hindtarsi light brownish. Abdominal segments brownish grey. Copulatory apparatus as in Figs. 8, 24–26. Wing length 2.65 mm.

Female.—Not known.

Holotype.—♂, Newfoundland, Woody Point Rd., 10 June 1961, C. P. Alexander. National Museum of Natural History.

Paratypes.—*Alberta:* 40 mi W of Edmonton (Wabamun Lake), 23 May 1962, C. O. Berg (1 ♂); 1.5 mi W of Lacombe, 23 May 1962, C. O. Berg (1 ♂). *Newfoundland:* Gander, 17 June 1961, C. P. Alexander (1 ♂); Woody Point Rd., 10 June 1961, C. P. Alexander (1 ♂). *Northwest Territories:* Aklavik, 5 Aug. 1930, lot no. 110, O. Bryant (2 ♂); Aklavik, 18 July 1932, lot no. 305, O. Bryant (1 ♂). *Ontario:* Midland, 12 May 1959, J. G. Chillcott (1 ♂); 5 mi S of Severn Falls, 4 May 1959, J. G. Chillcott (2 ♂). *Alaska:* Fort Richardson, Eagle River Flats, 25 May 1948, E. Lepage (1 ♂); Matan-

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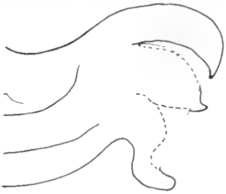
ington, 10 July 1917, A. L. Melander. 11, 14, 17, 18, Aedeagus sinistral profile. 12, 15, 19, Posterior process of hypandrium, side view. 13, 16, 20, Posterior process of hypandrium, posterior oblique view.



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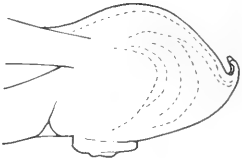

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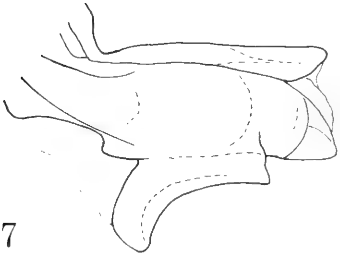

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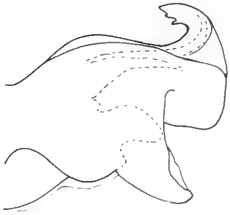

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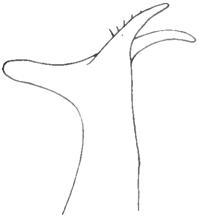

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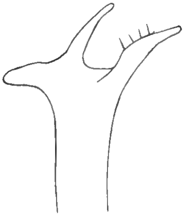

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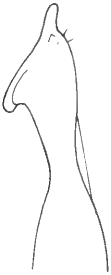

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Figs. 21–32. 21–23, *Pherbellia marthae*, paratype male; Churchill, Manitoba, 2–7 Aug. 1937, D. G. Denning. 24–26, *P. paludum*, paratype male; Gander, Newfoundland, 17 June 1961, C. P. Alexander. 27–29, *P. propages*; Long Lake, Burleigh Co., North Dakota, 4 June uska, 14 Aug. 1952, C. O. Berg (1 ♂). *Idaho:* Benewah Co., 1 mi N of Plummer, 26 May 1959, B. A. Foote (1 ♂). *Michigan:* Midland Co., 19 May 1939, R. R. Dreisbach (1 ♂); Osecola, 1 June 1947, R. R. Dreisbach (1 ♂). *Wyoming:* Biscuit Basin, Yellowstone National Park, 2 Aug. 1934, A. L. Melander (1 ♂). At Agriculture Canada, California Academy of Sciences, Cornell University, University of California at Riverside, and the National Museum of Natural History.

Discussion.—*Pherbellia paludum* has the most widespread distribution of any species of the *P. propages* group. However in collections it is relatively rare. This species is known transcontinentally north of 44°N latitude. This species name is the genitive pleural of the Latin palus, meaning "of marshes."

Pherbellia ursilacus Orth, New Species

Figs. 10, 30–32, 34

Holotype male.—Similar to *Pherbellia californica* except as follows. This specimen, along with the paratypes, shows a tendency toward being greasy. Coloration tends toward yellowish brown in most areas. Thorax dorsally cinereous, with only faint longitudinal darker stripes. Copulatory apparatus as in Figs. 10, 30–32. Wing length 3.2 mm.

Female.—Not known.

Holotype.—♂, Bear Lake, Bear Lake Co., Idaho, 19 July 1959, B. A. Foote. National Museum of Natural History.

Paratypes.—Same data as holotype (18 ♂). Wing length 2.5–3.2 mm. At Cornell University, University of California at Riverside, and the National Museum of Natural History.

Discussion.—This species is known only from Bear Lake, Idaho. The type-locality is described by Foote (1961). The collecting site was a marshy area approximately four miles west of the town of Mud Lake. It is a flood plain area poorly drained, with many extensive marshes bordering the Bear River north of the lake. The collection locality was at the edge of one of these marshes. Foote states "The marsh is completely unshaded and supports a rich stand of hydrophilic vegetation composed primarily of numerous species of sedges (mostly *Carex* spp.) and rushes. At the time of collection in mid-July the water depth was less than one foot, and extensive areas lacked standing water, although the soil was water-logged. Aquatic snails are abundant and include such common genera as *Lymnaea*, *Physa*, *Heli-*

←

1969, W. W. Wirth. 30–32, *P. ursilacus*, paratype male; Bear Lake, Bear Lake Co., Idaho, 19 July 1959, B. A. Foote. 21, 24, 27, 30, Aedeagus, sinistral profile. 22, 25, 28, 31, Posterior process of hypandrium, side view. 23, 26, 29, 32, Posterior process of hypandrium, posterior oblique view.

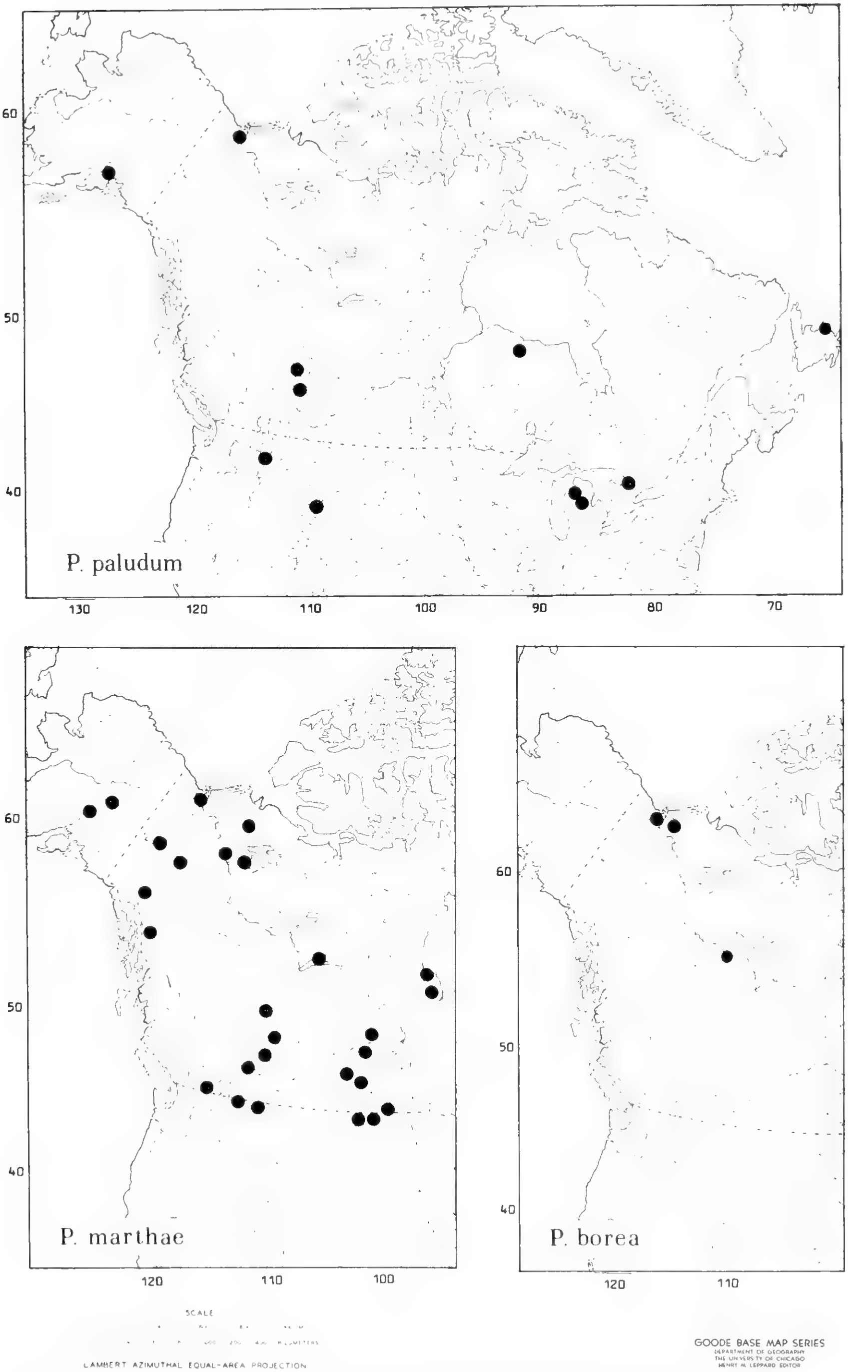

Fig. 33. Collection sites for *Pherbellia borea*, *P. marthae*, and *P. paludum*.

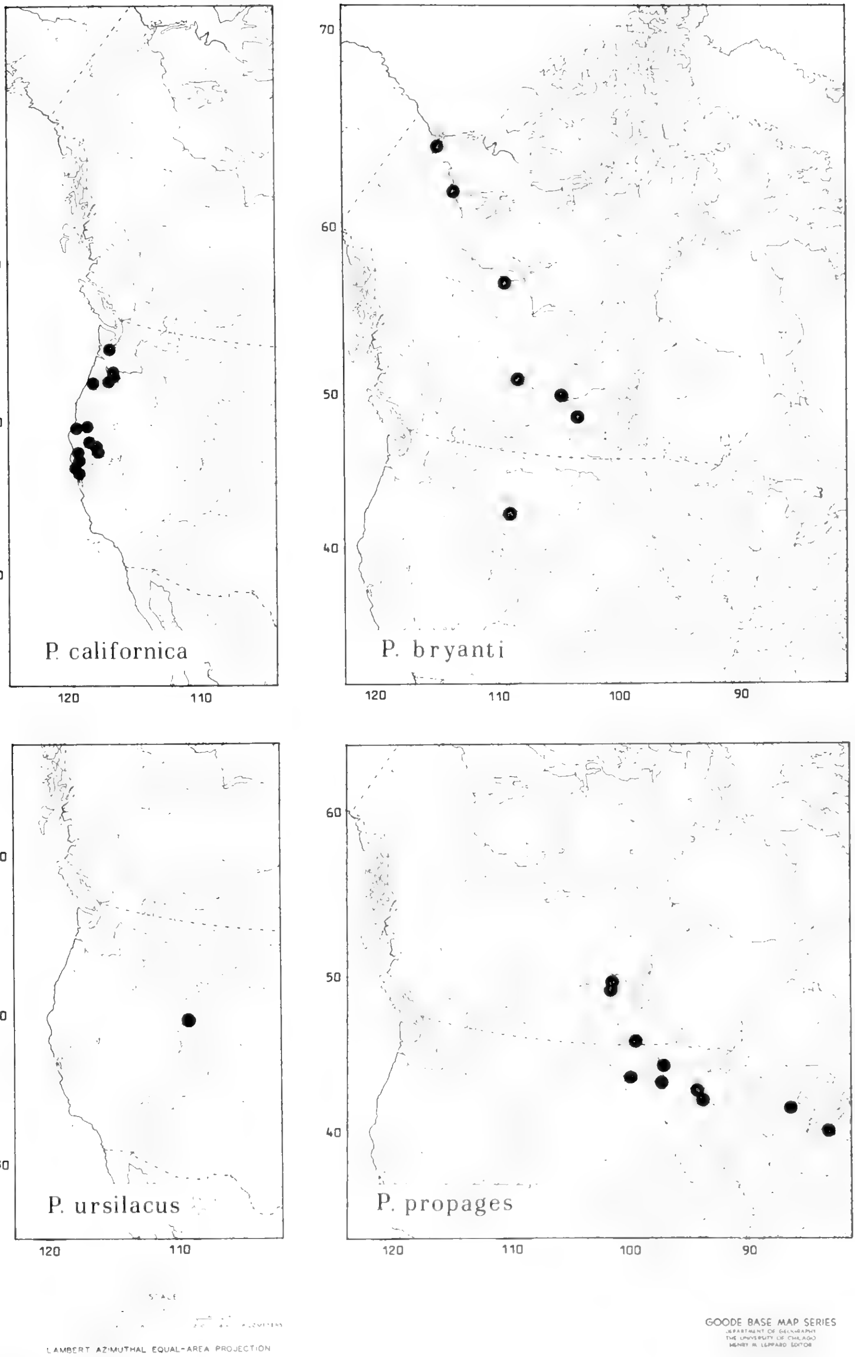

Fig. 34. Collection sites for *Pherbellia bryanti*, *P. californica*, *P. propages*, and *P. ursilacus*.

soma, and *Gyraulis*. Many snails are stranded on the wet soil as the water level recedes during the summer months. A very interesting group of sciomyzid species was taken including some forms not collected elsewhere in the state (e.g., *Pherbellia obtusa* and *Sepedon anchista*)." Under distribution Foote (1961) reports "*Pherbellia obtusa* (Fallén).—Recorded from Bear Lake on July 19 [1959] when approximately 60 adults were taken during a two-hour search of the marsh." It has since been determined that *P. obscura* is Palaearctic. According to Bratt et al. (1969) *P. argyra*, a holarctic species, has been until recently misidentified as *P. obtusa*. I have seen specimens from Cornell University which are *P. argyra* and bear the exact above data. With the above information it appears that Foote's *P. obtusa* was comprised of both *P. argyra* and *P. ursilacus*.

This species most closely resembles *Pherbellia marthae*. This species name is the latinization of the type-locality; Ursa—bear + lacus—lake; it is either a noun in apposition or in the genitive case, both of which have the same form.

Pherbellia bryanti **Steyskal**

Figs. 5, 14–16, 34

The holotype male was examined and agrees well with Figs. 5, 14–16. Collection data for the holotype: Aklavik, Northwest Territories, 20 Aug. 1930, O. Bryant, National Museum of Natural History Type no. 67875. Wing length 2.9 mm.

Other specimens.—In addition to the holotype I have seen specimens from the following localities (Fig. 34): *Alberta:* Soda Lake. *Northwest Territories:* Aklavik; Good Hope; Hay River. *Saskatchewan:* Parkside; Quill Lake. *Wyoming:* Gibbon Falls, Yellowstone National Park.

Discussion.—This species is known from Aklavik, Northwest Territories to Yellowstone National Park, Wyoming. Collection data has its distribution restricted to a narrow band just east of the continental divide.

Pherbellia propages **Steyskal**

Figs. 9, 27–29, 34

The holotype male was examined and agrees well with Figs. 9, 27–29. Collection data for holotype: Aweme, Manitoba, 9 Oct. 1915, N. Criddle, National Museum of Natural History Type no. 67877. Wing length 2.7 mm.

Other specimens.—In addition to the holotype I have seen specimens from the following localities (Fig. 34): *Saskatchewan:* Hudson Bay; Cantyre. *Michigan:* Midland Co. *Minnesota:* Anoka Co., Cedar Creek Bog; Norman Co.; Ramsey Co., University Farm, St. Paul. *North Dakota:* Burleigh Co., Long Lake; Leonard.

Discussion.—Collection data reveal this species to be more or less restricted to north central United States and south central Canada. Its known distribution overlaps in part with *P. marthae* and *P. paludum*.

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LITERATURE CITED

Bratt, A. D., L. V. Knutson, B. A. Foote, and C. O. Berg. 1969. Biology of *Pherbellia* (Diptera: Sciomyzidae). Cornell Univ. Exp. Stn. Mem. 404, 247 pp.

El'berg, K. Y. 1965. New Palaeartic genera and species of flies of the family Sciomyzidae (Diptera, Acalyptrata). Entomol. Obozr. 44(1): 189–198.

Foote, B. A. 1961. The marsh flies of Idaho and adjoining areas (Diptera, Sciomyzidae). Am. Midl. Nat. 65(1): 144–167.

Melander, A. L. 1920. Review of the Nearctic Tetanoceridae. Ann. Entomol. Soc. Am. 13: 305–332, 1 plate.

Rozkošný, R. 1966. Českǫslovenské druhy malakofágní čeledi Sciomyzidae (Diptera). Folia Přírodovédecké Fak. J. E. Purkyně, Biologia 15: 1–111.

Steyskal, G. C. 1961. The North American Sciomyzidae related to *Pherbellia fuscipes* (Macquart). Pap. Mich. Acad. Sci. Arts Lett. 46: 405–415.

———. 1965. Sciomyzidae, pp. 685–695. *In* Stone et al., A Catalog of the Diptera of America North of Mexico. U.S. Dep. Agric., Agric. Handb. 276, 1696 pp.

———. 1966. The Nearctic species of *Pherbellia* Robineau-Desvoidy, subgenus *Oxytaenia* Sack (Diptera, Sciomyzidae). Pap. Mich. Acad. Sci. Arts Lett. 51: 31–38.

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SYNOPSIS OF THE GLYPHIPTERIGIDAE (LEPIDOPTERA: COPROMORPHOIDEA) OF THE WORLD

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Abstract.—A brief history and review of the current taxonomic status of the family Glyphipterigidae is discussed for the world fauna. Included are a world checklist of genera and species, notes on type-localities (including a map and table of faunal distributions) for all 326 species, a terminal bibliography to original descriptions of taxa, and an index to species. *Carmentina* Meyrick is transferred from Yponomeutidae to Glyphipterigidae.

In preparing a revision of the North American Glyphipterigidae, as well as a world catalog of genera formerly associated with the family (Heppner, *in press* b), the following list of included species was completed. The Glyphipterigidae sensu Meyrick (1914c) involved one of the most mixed conglomerations of unrelated genera ever assembled as one family in the Lepidoptera in the last 100 years. Representatives of 24 families as divergent and unrelated as Incurvariidae and Zygaenidae were included in Glyphipterigidae by Meyrick, primarily on the basis of various similar characters and on similar superficial appearance, especially the iridescently colored markings of the forewings of many of these moths. These common "facies" undoubtedly are the result of convergent evolution among unrelated taxa as a response to behavioral patterns for diurnal flight activity, which is the normal activity of the majority of species among these unrelated moths.

The Glyphipterigidae are characterized by adult characters of a tineoid abdominal articulation, naked haustellum, head smooth-scaled, labial palpus upcurved and usually with ultimate segment longest, maxillary palpus 2–4 segmented, ocellus present and large, forewings having a pterostigma and usually with a developed chorda, and male genitalia without a socius, uncus, or gnathos. The larvae are mostly borers; setal patterns include 2 L-group prothoracic setae; prolegs are vestigial; and spiracles are often projected on conelike protrusions. The pupa is unspined and the spiracles are on projections like in the larva. Some species, notably in *Ussara*, produce a netlike pupal case; most other genera pupate in the larval host branch or stem.

As was pointed out in an earlier paper (Heppner, 1977), the main body of the Glyphipterigidae sensu Meyrick, comprises four major distinct families: Glyphipterigidae sensu stricto (Copromorphoidea), Immidae (Immoidea), Brachodidae (Sesioidea), and Choreutidae (Sesioidea). Another larger group of genera are now placed in Tortricidae as the tribe Hilarographini (Chlidanotinae). These five groups comprise in total over 1200 species. The remaining genera and species not now in these families are distributed among another 20 families: Incurvariidae, Tineidae, Psychidae, Gracillariidae, Oecophoridae, Elachistidae, Agonoxenidae, Gelechiidae, Copromorphidae, Epermeniidae, Plutellidae, Yponomeutidae, Douglasiidae, Acrolepiidae, Heliodinidae, Pyralidae, Zygaenidae, Limacodidae, Geometridae, and Noctuidae (Heppner, *in press* b).

All genera previously associated with Glyphipterigidae are listed and assigned to appropriate families in a catalog of these generic names (Heppner, *in press* b). A checklist of Immidae has been completed (Heppner, *in press* a). Checklists of Brachodidae and Choreutidae are available in a review of the Sesioidea (Heppner and Duckworth, 1981). The Hilarographini (Tortricidae) will be reviewed in a future paper.

The following checklist of the genera and species remainng in Glyphipterigidae is presented here to complete the synopses of the majority of the species formerly assigned to this family sensu lato. The synopsis of genera below gives an overview of the family and the generic distribution of the 326 species remaining in Glyphipterigidae. Table 1 shows these species as they are distributed among the various faunal regions as based upon their type-localities. The map (Fig. 1) illustrates the world distribution of the type-localities of Glyphipterigidae species (most species are known only from the type-locality). The surprising aspect seen on the map is the lack of described species of Glyphipterigidae from such areas as New Guinea, Sumatra, the Philippines, and temperate South America (Chile and Argentina), areas which should have some species, indeed in most cases large faunas, for this family. Future collections from such areas undoubtedly will greatly increase the current size of the family; this can be partially substantiated merely with the North American fauna, where the present total of 15 species rises to 38 in the revision shortly to be in press. Such areas as Japan, New Zealand, western Europe, and parts of Australia, as well as North America, probably are now fairly well known for Glyphipterigidae.

The world checklist has the type-species noted for each genus, the page of original description following the year of publication of each name, with the general type-locality for each species noted at the right margin. Localities in brackets are of subsequent determination. Letters after Australia refer to New South Wales (NSW), Queensland (Q), South Australia (SA), Tasmania (T), Victoria (V), and Western Australia (WA). Other abbreviations are: ab. = aberration; emend. = emendation; ICZN = International

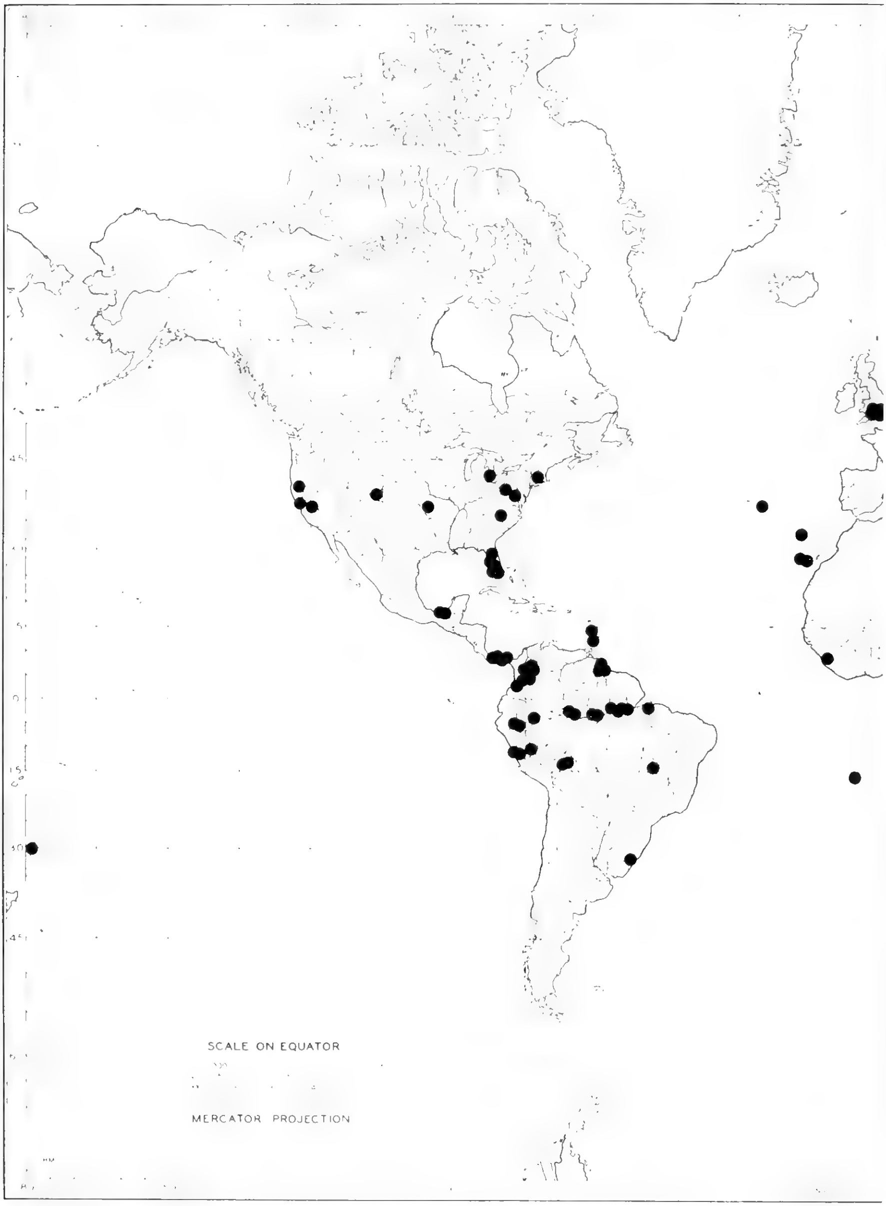
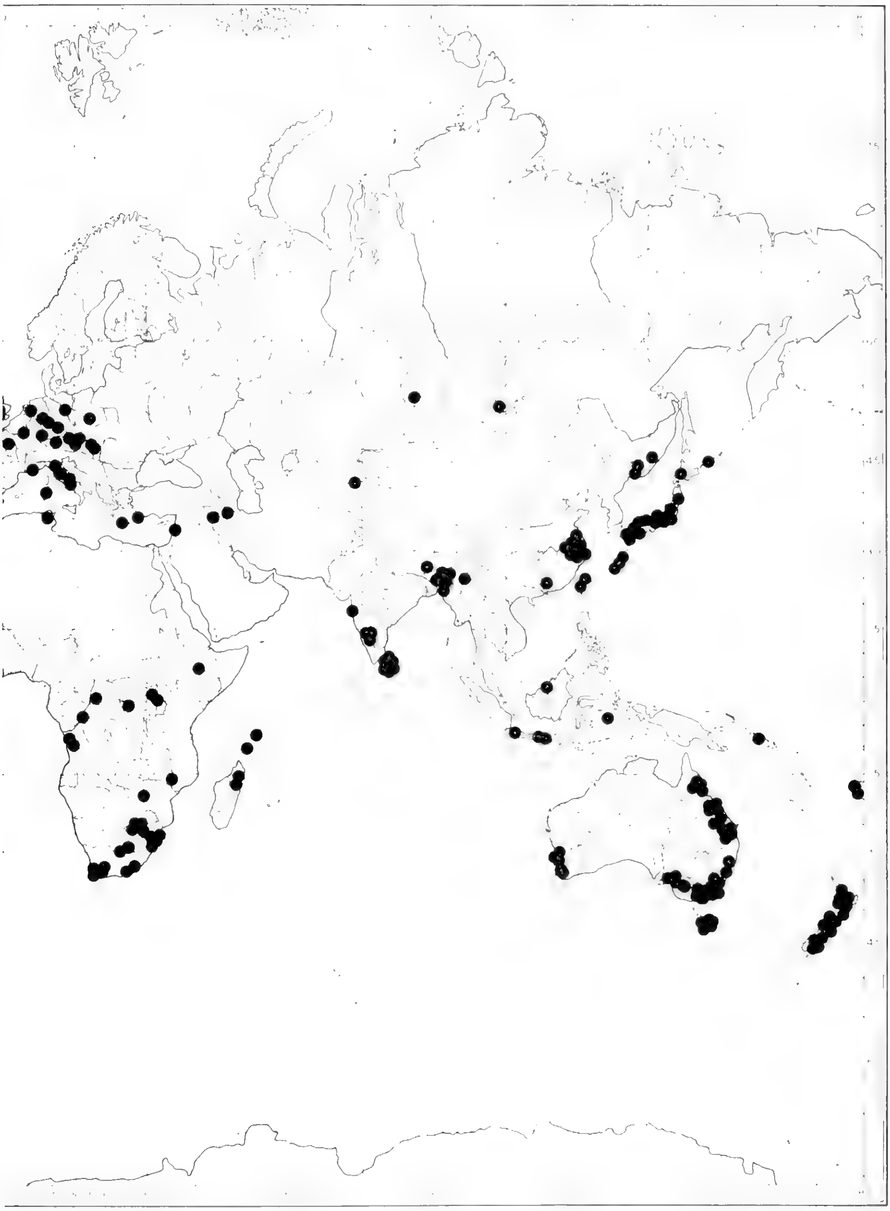


Fig. 1. Distribution map of the family Glyphipterigidae by type-locality of species in the



world (western and eastern hemispheres).

Table 1. Faunal distribution of Glyphipterigidae species. N = Nearctic; NL = Neotropical; P = Palearctic; E = Ethiopian; O = Oriental; A = Australian; OC = Oceana.

Genus	N	NL	P	E	O	A	OC	Total
Chrysocentris				7	1			8
Irinympha				1				1
Ernolytis							1	1
Carmentina			1		3	2		6
Cotaena		2						2
Myrsila		1						1
Lepidotarphius					1			1
Tetracmanthes				1				1
Phalerarcha		2						2
Cronicombra		6						6
Taeniostolella		2						2
Machlotica		2						2
Abrenthia	1							1
Neomachlotica	1	3						4
Trapeziophora		1						1
Ussara		9		2	2			13
Electrographa					1			1
Rhabdocrates		1						1
Apistomorpha						1		1
Phryganostola						6		6
Pantosperma						1		1
Circica						2		2
Glyphipterix	7	41	59	20	40	85	1	253
Diploschizia	6	3						9
Faunal totals	15	73	60	31	48	97	2	326

Commission on Zoological Nomenclature; missp. = misspelling; nom. nud. = *nomen nudum*; nom. dub. = *nomen dubium*; nom. oblit. = *nomen oblitum*; preocc. = preoccupied; var. = variety.

Generic Synopsis of Glyphipterigidae

Genus	Number of species
Chrysocentris Meyrick, 1914	8
Irinympha Meyrick, 1932	1
Ernolytis Meyrick, 1922	1
Carmentina Meyrick, 1930	6
Cotaena Walker, [1865]	2
Myrsila Boisduval, [1875]	1
Lepidotarphius Pryer, 1877	1
Tetracmanthes Meyrick, 1925	1
Phalerarcha Meyrick, 1913	2

Cronicombra Meyrick, 1920	6
Taeniostolella Fletcher, 1940	2
Machlotica Meyrick, 1909	2
Abrenthia Busck, 1915	1
Neomachlotica Heppner, 1981	4
Trapeziophora Walsingham, 1892	1
Ussara Walker, 1864	13
Electrographa Meyrick, 1912	1
Rhabdocrates Meyrick, 1931	1
Apistomorpha Meyrick, 1881	1
Phryganostola Meyrick, 1881	6
Pantosperma Meyrick, 1888	1
Circica Meyrick, 1888	2
Glyphipterix Hübner, [1825]	253
Diploschizia Heppner, 1981	9

Glyphipterigidae (Copromorphoidea)

Chrysocentris Meyrick, 1914b: 284 (Type-species: *C. clavaria* Meyrick, 1914).

chalcotypa (Bradley, 1965: 105) (*Glyphipterix*). **New combination.** Zaire

chrysozona (Meyrick, 1921b: 112) (*Glyphipteryx* [sic]). **New combination.** South Africa

clavaria Meyrick, 1914b: 284. Malawi

ditiorana (Walker, 1863: 348) (*Sciaphila*). Malaysia (Sarawak)

eupepla Meyrick, 1930b: 7. Madagascar

infuscata Ghesquière, 1940: 32. Zaire

phaeometalla Meyrick, 1937: 125. Zaire

urania Meyrick, 1920b: 297. South Africa

Irinympha Meyrick, 1932a: 274 (Type-species: *I. aglaograpta* Meyrick, 1932).

aglaograpta Meyrick, 1932a: 275. Uganda

Ernolytis Meyrick, 1922: 488 (Type-species: *E. chlorospora* Meyrick, 1922).

chlorospora Meyrick, 1922: 488. Fiji

Carmentina Meyrick, 1930a: 597 (Type-species: *C. iridesma* Meyrick, 1930).

Metapodistis Meyrick, 1933: 372 (Type-species: *M. chrysosema* Meyrick, 1933). **New synonymy.**

chrysosema (Meyrick, 1933: 372). **New combination.** Solomon Is.

iridesma Meyrick, 1930a: 598. Solomon Is.

molybdora (Meyrick, 1912: 57) (*Glyphipteryx* [sic]). **New combination.** Sri Lanka

molybdotoma (Diakonoff and Arita, 1979: 93). **New combination.** Japan

perculta (Diakonoff, 1979: 300). **New combination.** Taiwan

polychrysa (Meyrick, 1934b: 523). **New combination.** Indonesia (Java)

Cotaena Walker, [1865]: 21 (Type-species: *C. mediana* Walker, [1865]).
mediana Walker, [1865]: 21. Brazil (Pará)
plenella (Busck, 1914: 61) (*Glyphipteryx* [sic]). Panama

Myrsila Boisduval, [1875]: 433 (Type-species: *M. auripennis* Boisduval, [1875]).
auripennis Boisduval, [1875]: 433. Brazil (Pará)

Lepidotarphius Pryer, 1877: 235 (Type-species: *L. splendens* Pryer, 1877 [= *Glyphipteryx* [sic] *perornatella* Walker, 1864]).
  Desmidoloma Erschoff, 1892: 671 (Type-species: *Staintonia fulgens* Erschoff, 1877 [=*Glyphipteryx* [sic] *perornatella* Walker, 1864]).
perornatella (Walker, 1864: 840) (*Glyphipteryx* [sic]). China
  splendens Pryer, 1877: 235.
  fulgens (Erschoff, 1877: 347) (*Staintonia*).

Tetracmanthes Meyrick, 1925: 136 (Type-species: *T. astrocosma* Meyrick, 1925).
astrocosma Meyrick, 1925: 136. South Africa

Phalerarcha Meyrick, 1913a: 100 (Type-species: *P. chrysorma* Meyrick, 1913).
chrysorma Meyrick, 1913a: 101. Guyana
eumitrella (Busck, 1914: 60) (*Ussara*). **New combination**. Panama

Cronicombra Meyrick, 1920a: 327 (Type-species: *C. granulata* Meyrick, 1920).
deltodes (Walsingham, 1914: 301) (*Glyphipteryx* [sic]). **New combination**. Mexico (Tabasco)
essedaria Meyrick, 1926a: 306. Peru
granulata Meyrick, 1920a: 327. Brazil (Pará)
lamella (Busck, 1914: 59) (*Porpe*). Panama
palpella (Walsingham, 1914: 300) (*Glyphipteryx* [sic]). **New combination**. Mexico (Tabasco)
phaeobathra (Meyrick, 1932a: 276). (*Ussara*). **New combination**. Brazil (Goiás)
porphyrospila (Meyrick, 1926a: 306) (*Machlotica*). **New combination**. Peru

Taeniostolella Fletcher, 1940: 109 (Type-species: *Taeniostola celophora* Meyrick, 1920) [replacement name].
  Taeniostola Meyrick, 1920a: 326 (Type-species: *T. celophora* Meyrick, 1920) [preocc.].
  celophora (Meyrick, 1920a: 327) (*Taeniostola*). Brazil (Pará)
  litura (Felder and Rogenhofer, 1875: 14) (*Oecophora*). **New combination**. Brazil (''Amazonas'')

Machlotica Meyrick, 1909b: 36 (Type-species: *M. chrysodeta* Meyrick, 1909).

Maclotica [sic] Busck, 1915: 87, missp.
chrysodeta Meyrick, 1909b: 37. Bolivia
eurymolybda Meyrick, 1926a: 306. Peru

Abrenthia Busck, 1915: 87 (Type-species: *A. cuprea* Busck, 1915).
cuprea Busck, 1915: 87. USA (Pennsylvania)

Neomachlotica Heppner, 1981b: 479 (Type-species: *N. spiraea* Heppner, 1981).
actinota (Walsingham, 1914: 301) (*Glyphipteryx* [sic]). Mexico (Tabasco)
atractias (Meyrick, 1909b: 38) (*Machlotica*). Bolivia
nebras (Meyrick, 1909b: 37) (*Machlotica*). Bolivia
spiraea Heppner, 1981b: 481. USA (Florida)

Trapeziophora Walsingham, 1892: 529 (Type-species: *T. gemmula* Walsingham, 1892).
gemmula Walsingham, 1892: 530. St. Vincent

Ussara Walker, 1864: 800 (Type-species: *U. decoratella* Walker, 1864).
Setiostoma Felder and Rogenhofer, 1875: 18 (pl. 138, f. 1) (Type-species: *S. flaviceps* Felder and Rogenhofer, 1875) [not *Setiostoma* Zeller, 1875 (Oecophoridae: Stenomatinae)]. **New synonymy**.
Usara [sic] Busck, [1934]: 182, missp.
ancobathra Meyrick, 1932a: 275. Brazil (Amazonas)
ancyristis Meyrick, 1920a: 334. Brazil (Pará)
arquata Meyrick, 1926a: 307. Colombia
chalcodesma Meyrick, 1913a: 67. Guyana
chrysangela Meyrick, 1922: 488. Peru
decoratella Walker, 1864: 801. Brazil (Amazonas)
eurythmiella Busck, 1914: 59. Panama
flaviceps (Felder and Rogenhofer, 1875: 18) (*Setiostoma*). Brazil (Amazonas)
hilarodes (Meyrick, 1909c: 430) (*Glyphipteryx* [sic]). **New combination**. India (Assam)
iochrysa Meyrick, 1921a: 184. Indonesia (Java)
olyranta Meyrick, 1931: 184. Brazil (Rio Grande do Sul)
polyastra Meyrick, 1937: 126. South Africa
semicoronis Meyrick, 1932b: 115. Ethiopia

Electrographa Meyrick, 1912: 63 (Type-species: *E. thiolychna* Meyrick, 1912).
thiolychna Meyrick, 1912: 63. Burma

Rhabdocrates Meyrick, 1931: 183 (Type-species: *R. sporomantis* Meyrick, 1931).
sporomantis Meyrick, 1931: 184. Peru

Apistomorpha Meyrick, 1881: 247 (Type-species: *A. argyrosema* Meyrick, 1881).
argyrosema Meyrick, 1881: 247. Australia (NSW)

Phryganostola Meyrick, 1881: 248 (Type-species: *P. drosophaes* Meyrick, 1881).
achlyoessa Meyrick, 1881: 252. New Zealand
achlyoëssa Meyrick, 1881: 252, incorrect spelling.
acyloessa [sic] (Ferro et al., 1977: 9) (*Glyphipteryx* [sic]), missp.
ataracta Meyrick, 1888: 88. New Zealand
drosophaes Meyrick, 1881: 249. Australia (NSW)
euthybelemna Meyrick, 1881: 250. Australia
macrantha Lower, 1905: 113. Australia (V)
oxymachaera Meyrick, 1881: 251. New Zealand

Pantosperma Meyrick, 1888: 89 (Type-species: *P. holochalca* Meyrick, 1888).
holochalcum Meyrick, 1888: 89. New Zealand

Circica Meyrick, 1888: 88 (Type-species: *C. cionophora* Meyrick, 1888).
cionophora Meyrick, 1888: 88. New Zealand
xestobela Meyrick, 1888: 89. New Zealand

Glyphipterix Hübner, [1825]: 421 (Type-species: *G. linneella* Hübner, [1825] [=*Tinea bergstraesserella* Fabricius, 1781]) [ICZN ruling pending: case 2115 (Diakonoff and Heppner, 1977)].
Heribeia Stephens, 1829: 49 (Type-species: *Tinea forsterella* Fabricius, 1787).
Aechmia Treitschke, 1833: 69 (Type-species: *Phalaena* (*Tortrix*) *fyeslella* [sic] Fabricius, 1794 [=*Phalaena thrasonella* Scopoli, 1763]).
Aecimia [sic] Boisduval, 1836: 138, missp.
Glyphipteryx Zeller, 1839: 203, emend. [not *Glyphipteryx* Curtis, 1827 (Agonoxenidae)].
Glyphiteryx [sic] Fischer von Röslerstamm, 1841: 233, missp.
Anacampsoides Bruand, 1850: 32 (Type-species: *Heribeia simpliciella* Stephens, 1834) [nom. oblit.].
Glyphopteryx Herrich-Schäffer, 1854: 92, emend.
Glyphiptoryx [sic] Mann and Rogenhofer, 1878: 500, missp.
Glyphptieryx [sic] Turati, 1879: 203, missp.
Glyphipterys [sic] Christoph, 1882: 38, missp.
Glyphyteryx [sic] Hampson, 1918: 387, missp.
Glyphteryx [sic] Watt, 1920: 439, missp.
acinacella Meyrick, 1883: 193 (*Glyphipteryx* [sic]). Australia (V)
acronoma Meyrick, 1888: 86 (*Glyphipteryx* [sic]). New Zealand

acrothecta Meyrick, 1881: 244 (*Glyphipteryx* [sic]).	New Zealand
actinobola Meyrick, 1881: 241 (*Glyphipteryx* [sic]).	Australia (NSW)
aechmiella (Duponchel, 1838: 533) (*Elachista*).	France
oechmiella [sic] (Duponchel, 1838: pl. 308, f. 7) (*Elachista*), missp.	
aerifera Meyrick, 1912: 57 (*Glyphipteryx* [sic]).	New Zealand
albimaculella Heinemann, [1876]: 397 (*Glyphipteryx* [sic]).	Germany
alpha Moriuti and Saito, 1964: 61.	Japan
altiorella Bauer, 1923: 167 (*Glyphipteryx* [sic]).	Austria
amblycerella Meyrick, 1883: 189 (*Glyphipteryx* [sic]).	Australia (V)
ametris Diakonoff, 1979: 307.	Taiwan
amphipeda Meyrick, 1920b: 295 (*Glyphipteryx* [sic]).	South Africa
amseli Diakonoff, 1978: 45.	China (Chekiang)
anaclastis Meyrick, 1907a: 130 (*Glyphipteryx* [sic]).	Australia
angulosella (O. Costa, 1834a: 4) (*Oecophora*).	Italy
pernicipennella (O. Costa, [1836]: [301]) (*Elachista* (*Ornix*)).	
antidoxa Meyrick, 1909c: 435 (*Glyphipteryx* [sic]).	Sri Lanka
archimedica Meyrick, 1921b: 113 (*Glyphipteryx* [sic]).	Zimbabwe
argophracta Meyrick, 1926b: 338 (*Glyphipteryx* [sic]).	South Africa
argyrelata Turner, 1932: 192 (*Glyphipteryx* [sic]).	Australia (Q)
argyroguttella Ragonot, 1885: lvi (*Glyphipteryx* [sic]).	Italy
ab. *paurographella* Ragonot, 1885: lvi (*Glyphipteryx* [sic]).	
argyromis Meyrick, 1907c: 985 (*Glyphipteryx* [sic]).	Sri Lanka
argyrotoxa Turner, 1913: 214 (*Glyphipteryx* [sic]).	Australia (Q)
asterias (Meyrick, 1907d: 154) (*Anticrates*).	India (Assam)
asteriella Meyrick, 1881: 235 (*Glyphipteryx* [sic]).	Australia (NSW)
asteronota Meyrick, 1881: 240 (*Glyphipteryx* [sic]).	New Zealand
astrapaea Meyrick, 1881: 245 (*Glyphipteryx* [sic]).	New Zealand
atelura Meyrick, 1920a: 331 (*Glyphipteryx* [sic]).	Guyana
aulogramma Meyrick, 1907a: 121 (*Glyphipteryx* [sic]).	New Zealand
autopetes Meyrick, 1907a: 118 (*Glyphipteryx* [sic]).	Australia (WA)
bactrias Meyrick, 1911a: 67 (*Glyphipteryx* [sic]).	New Zealand
basifasciata Issiki, 1930: 427 (*Glyphipteryx* [sic]).	Japan
jezonica Matsumura, 1931: 1079 (*Glyphipteryx* [sic]).	
bergstraesserella (Fabricius, 1781: 302) (*Tinea*).	Germany
bergstraessella [sic] (Fabricius, 1794: 321) (*Tinea*), missp.	
lineella (Hübner, 1796: pl. 65, f. 436) (*Tinea*).	
lineana (Hübner, [1796–99]: pl. 14, f. 84) (*Tortrix*).	
linneana [sic] Hübner, [1825]: 421, missp.	
linneella [sic] Hübner, [1825]: 421, missp.	
treitschkeana (Frölich, 1828: 76) (*Tortrix*).	
bergstraesella [sic] Bruand, 1850: 48 (*Glyphipteryx* [sic]), missp.	
pietruskii Nowicki, 1864: 22 (*Glyphipteryx* [sic]).	

ab. *arcuatella* Klemensiewicz, 1907: 19 (*Glyphipteryx* [sic]).	
bergsträsserella [sic] Amsel, 1950: 26 (*Glyphipteryx* [sic]), missp.	
beta Moriuti and Saito, 1964: 61.	Japan
japonicella Matsumura, 1931: 1079 (*Glyphipteryx* [sic]), not Zeller, 1877.	
bicornis Meyrick, 1909c: 432 (*Glyphipteryx* [sic]).	India (Assam)
bifasciata Walsingham, 1881: 321 (*Glyphipteryx* [sic]).	USA (California)
bifasciella Amsel, 1959: 61 (*Glyphipteryx* [sic]).	Iraq
bohemani (Zeller, 1852: 116) (*Aechmia*).	South Africa
brachyaula Meyrick, 1907a: 127 (*Glyphipteryx* [sic]).	Australia (Q)
brachydelta Meyrick, 1916: 418 (*Glyphipteryx* [sic]).	New Zealand
californiae Walsingham, 1881: 320 (*Glyphipteryx* [sic]).	USA (California)
calliactis Meyrick, 1914a: 112 (*Glyphipteryx* [sic]).	New Zealand
callicrossa Meyrick, 1907a: 119 (*Glyphipteryx* [sic]).	Australia (WA)
callidelta Meyrick, 1922: 492 (*Glyphipteryx* [sic]).	Peru
calliscopa Lower, 1905: 112 (*Glyphipteryx* [sic]).	Australia (V)
callithea Meyrick, 1921b: 113 (*Glyphipteryx* [sic]).	South Africa
canachodes Meyrick, 1909c: 434 (*Glyphipteryx* [sic]).	India (Madras)
carenota Meyrick, 1909c: 431 (*Glyphipteryx* [sic]).	India (Assam)
caudatella Walsingham, 1897: 119 (*Glyphipteryx* [sic]).	Grenada
cestrota Meyrick, 1915b: 221 (*Glyphipteryx* [sic]).	Peru
chalcodaedala Turner, 1913: 215 (*Glyphipteryx* [sic]).	Australia (Q)
chalcostrepta Meyrick, 1907a: 128 (*Glyphipteryx* [sic]).	Australia (T)
chionosoma Diakonoff, 1978: 54.	China (Kiangsu)
chrysallacta Meyrick, 1922: 491 (*Glyphipteryx* [sic]).	Peru
chrysoplanetis Meyrick, 1881: 238 (*Glyphipteryx* [sic]).	Australia
circumscriptella Chambers, 1881: 291 (*Glyphipteryx* [sic]).	USA (Massachusetts)
circumscripta [sic] Dyar, 1900: 84 (*Glyphipteryx* [sic]) missp.	
clearcha Meyrick, 1921a: 185 (*Glyphipteryx* [sic]).	Indonesia (Java)
climacaspis Meyrick, 1920b: 296 (*Glyphipteryx* [sic]).	South Africa
codonias Meyrick, 1909a: 15 (*Glyphipteryx* [sic]).	New Zealand
colorata Meyrick, 1913a: 103 (*Glyphipteryx* [sic]).	Guyana
columnaris Meyrick, 1913a: 69 (*Glyphipteryx* [sic]).	Guyana
cometophora Meyrick, 1881: 231 (*Glyphipteryx* [sic]).	Australia
compastis Meyrick, 1923b: 618 (*Glyphipteryx* [sic]).	India (Assam)
conjunctella (O. Costa, 1834a: 5) (*Oecophora*).	Italy
colluripennella (O. Costa, 1834b: 77) (*Ornix*), nom. nud.	
colluripennella (O. Costa, [1836]: [301]) (*Elachista* (*Ornix*)).	
conosema Meyrick, 1913a: 69 (*Glyphipteryx* [sic]).	Guyana
cornigerella Zeller, 1877: 403 (*Glyphipteryx* [sic]).	Colombia
crassilunella Rebel, 1916: 157 (*Glyphipteryx* [sic]).	Greece (Crete)
crinita Meyrick, 1913a: 102 (*Glyphipteryx* [sic]).	Guyana

crotalotis Meyrick, 1909c: 432 (*Glyphipteryx* [sic]).	India (Assam)
cultrata Meyrick, 1912: 56 (*Glyphipteryx* [sic]).	India (Assam)
cyanophracta Meyrick, 1883: 186 (*Glyphipteryx* [sic]).	Australia (NSW)
cyanochalca Meyrick, 1883: 185 (*Glyphipteryx* [sic]).	Australia (NSW)
lyelliana Lower, 1893: 182 (*Glyphipteryx* [sic]).	
danilevskii Diakonoff, 1978: 49.	USSR (Kazakh SSR)
decachrysa Meyrick, 1918a: 36 (*Glyphipteryx* [sic]).	South Africa
deliciosa Diakonoff, 1978: 55.	China (Chekiang)
delta Moriuti and Saito, 1964: 62.	Japan
deuterastis Meyrick, 1907a: 121 (*Glyphipteryx* [sic]).	Australia (WA)
diaphora Walsingham, 1910: 258 (*Glyphipteryx* [sic]).	Madeira Is.
dichalina Meyrick, 1911b: 290 (*Glyphipteryx* [sic]).	Seychelles Is.
dichorda Meyrick, 1911a: 76 (*Glyphipteryx* [sic]).	New Zealand
diplotoxa Meyrick, 1920b: 296 (*Glyphipteryx* [sic]).	South Africa
dolichophyes Diakonoff, 1978: 50.	China (Kiangsu)
xyridota Meyrick, 1935: 87 (*Glyphipteryx* [sic]), not Meyrick, 1918.	
enclitica Meyrick, 1909c: 430 (*Glyphipteryx* [sic]).	India (Mysore)
epastra Meyrick, 1922: 490 (*Glyphipteryx* [sic]).	Peru
equitella (Scopoli, 1763: 254) (*Phalaena*).	[Austria]
majorella (Heydenreich, 1851: 87) (*Aechmia*), nom. nud.	
majorella Mann, 1854: 590 (*Glyphipteryx* [sic]), nom. nud.	
var. *majorella* (Herrich-Schäffer, 1854: 93) (*Aechmia*).	
maiorella [sic] Prohaska, 1905: 19 (*Glyphipteryx* [sic]), missp.	
erastis Meyrick, 1911a: 76 (*Glyphipteryx* [sic]).	New Zealand
erebanassa Meyrick, 1934a: 41 (*Glyphipteryx* [sic]).	China (Kwangtung)
euastera Meyrick, 1881: 236 (*Glyphipteryx* [sic]).	New Zealand
euleucotoma Diakonoff and Arita, 1976: 208.	Japan
expurgata Meyrick, 1922: 493 (*Glyphipteryx* [sic]).	Peru
falcigera Meyrick, 1913a: 102 (*Glyphipteryx* [sic]).	Guyana
forsterella (Fabricius, 1781: 509) (*Tinea*).	Germany
humerella (Hübner, [1800–05]: pl. 42, f. 292) (*Tinea*), not Denis and Schiffermüller, 1775 [Gelechiidae].	
lucasella (Duponchel, 1838: 440) (*Aechmia*).	
oculatella (Zeller, 1850: 157) (*Aechmia*).	
oculatella Mann, 1854: 591 (*Glyphipteryx* [sic]), nom. nud.	
form *nivicaput* Diakonoff, 1979: 311, invalid [ICZN, Art. 15].	
fortunatella Walsingham, 1908: 989 (*Glyphipteryx* [sic]).	Canary Is.
funditrix Diakonoff and Arita, 1976: 211.	Japan
fuscoviridella (Haworth, 1828: 569) (*Tinea*).	[England]
albicostella (Duponchel, 1838: 397) (*Adela*).	
aereinitidella (Millière, 1854: 60) (*Cephalispheira*).	
gamma Moriuti and Saito, 1964: 62.	Japan
gaudialis Diakonoff and Arita, 1976: 198.	Japan

gemmatella (Walker, 1864: 1022) (*Gelechia*).	Sierra Leone
gemmipunctella (Walker, 1869: 86) (*Gelechia*).	Australia (V)
atristriella Zeller, 1877: 398 (*Glyphipteryx* [sic]).	
chrysolithella Meyrick, 1881: 229 (*Glyphipteryx* [sic]).	
gemmula Diakonoff and Arita, 1976: 194.	Japan
gianelliella Ragonot, 1885: lvi (*Glyphipteryx* [sic]).	Italy
gonoteles Meyrick, 1907a: 119 (*Glyphipteryx* [sic]).	Australia
grapholithoides Walsingham, 1891: 116 (*Glyphipteryx* [sic]).	South Africa
gypsonota Turner, 1927: 158 (*Glyphipteryx* [sic]).	Australia (T)
halimophila Lower, 1893: 183 (*Glyphipteryx* [sic]).	Australia (SA)
haplographa Turner, 1927: 157 (*Glyphipteryx* [sic]).	Australia (T)
harpogramma Turner, 1913: 214 (*Glyphipteryx* [sic]).	Australia
haworthana (Stephens, 1834: 262) (*Heribeia*).	[England]
haworthella (Stephens, 1829: 49) (*Heribeia*), nom. nud.	
zonella (Zetterstedt, [1839]: 1009) (*Oecophora*).	
howarthana [sic] Jordan, 1886: 154 (*Glyphipteryx* [sic]), missp.	
hemipempta Meyrick, 1909c: 429 (*Glyphipteryx* [sic]).	Sri Lanka
heptaglyphella Le Marchand, 1925: 314 (*Glyphipteryx* [sic]).	France
holodesma Meyrick, 1883: 190 (*Glyphipteryx* [sic]).	Australia (T)
hologramma Meyrick, 1920a: 333 (*Glyphipteryx* [sic]).	Brazil (Pará)
hyperlampra Turner, 1913: 216 (*Glyphipteryx* [sic]).	Australia (Q)
idiomorpha Meyrick, 1917: 10 (*Glyphipteryx* [sic]).	South Africa
imparfasciata Arita, 1979: 77.	Japan (Ryukyu Is.)
indomita Meyrick, 1922: 491 (*Glyphipteryx* [sic]).	Brazil (Amazonas)
invicta Meyrick, 1920a: 334 (*Glyphipteryx* [sic]).	Brazil (Pará)
iinvicta [sic] Clarke, 1969: 68, missp.	
iocheaera Meyrick, 1881: 243 (*Glyphipteryx* [sic]).	New Zealand
ioclista Meyrick, 1913a: 70 (*Glyphipteryx* [sic]).	Guyana
iometalla Meyrick, 1881: 232 (*Glyphipteryx* [sic]).	Australia (Q)
isoclista Meyrick, 1925: 136 (*Glyphipteryx* [sic]).	Fiji
isozela Meyrick, 1907a: 124 (*Glyphipteryx* [sic]).	Australia
japonicella Zeller, 1877: 400 (*Glyphipteryx* [sic]).	Japan
lamprocoma Meyrick, 1907a: 127 (*Glyphipteryx* [sic]).	Australia (SA)
lamprosema Turner, 1926: 144 (*Glyphipteryx* [sic]).	Australia (NSW)
leptocona Meyrick, 1922: 493 (*Glyphipteryx* [sic]).	Peru
leptosema Meyrick, 1888: 87 (*Glyphipteryx* [sic]).	New Zealand
leucargyra Turner, 1927: 157 (*Glyphipteryx* [sic]).	Australia (T)
leucocerastes Meyrick, 1881: 239 (*Glyphipteryx* [sic]).	Australia (NSW)
leucophragma Meyrick, 1923a: 564 (*Glyphipteryx* [sic]).	Angola
leucoplaca Turner, 1913: 217 (*Glyphipteryx* [sic]).	Australia
longistriatella Rebel, 1940: 37 (*Glyphipteryx* [sic]).	Azores Is.
loricatella (Treitschke, 1833: 70) (*Aechmia*).	Hungary

loricutella [sic] Desmarest, [1857]: 282 (*Glyphipteryx* [sic]), missp.	
luteocapitella Caradja, 1926: 41 (*Glyphipteryx* [sic]).	USSR (Kemerovo ASSR)
luteomaculata Arita, 1979: 79.	Japan (Ryukyu Is.)
lycnophora Turner, 1913: 213 (*Glyphipteryx* [sic]).	Australia (Q)
macraula Meyrick, 1907a: 120 (*Glyphipteryx* [sic]).	Australia (T)
macrodrachma Diakonoff, 1979: 305.	China (Chekiang)
madagascariensis Viette, 1951: 340 (*Glyphipteryx* [sic]).	Madagascar
magnatella Erschoff, 1877: 346 (*Glyphipteryx* [sic]).	USSR (Irkutsk)
maritima Diakonoff, 1979: 303.	USSR (Maritime)
marmaropa Turner, 1913: 218 (*Glyphipteryx* [sic]).	Australia
maschalis Meyrick, 1909c: 433 (*Glyphipteryx* [sic]).	Sri Lanka
medianella Turati, 1930: 211 (*Glyphipteryx* [sic]).	Greece (Rhodes)
medica Meyrick, 1911b: 291 (*Glyphipteryx* [sic]).	Seychelles Is.
melania Diakonoff and Arita, 1976: 213.	Japan
mesaula Meyrick, 1907a: 121 (*Glyphipteryx* [sic]).	Australia (SA)
metasticta Meyrick, 1907a: 120 (*Glyphipteryx* [sic]).	New Zealand
meteora Meyrick, 1881: 237 (*Glyphipteryx* [sic]).	Australia (NSW)
chalceres Turner, 1913: 215 (*Glyphipteryx* [sic]).	
metron Diakonoff, 1948: 206 (*Glyphipteryx* [sic]).	Indonesia (Buru)
metronoma Meyrick, 1907a: 123 (*Glyphipteryx* [sic]).	Australia (V)
minorella Snellen, 1882: 753 (*Glyphipteryx* [sic]).	Netherlands
equitella of authors, not Scopoli, 1763.	
molybdastra Meyrick, 1923a: 564 (*Glyphipteryx* [sic]).	Angola
monodonta Diakonoff, 1948: 206 (*Glyphipteryx* [sic]).	Indonesia (Buru)
montisella Chambers, 1875: 292 (*Glyphipteryx* [sic]).	USA (Colorado)
montinella [sic] Chambers, 1877: 14 (*Glyphipteryx* [sic]), missp.	
montella Meyrick, 1913b: 44 (*Glyphipteryx* [sic]), emend.	
morangella Felder and Rogenhofer, 1875: 10 (*Glyphipteryx* [sic]).	New Zealand
nattani Gozmany, 1954: 277 (*Glyphipteryx* [sic]).	Hungary
necopina Philpott, 1927: 88 (*Glyphipteryx* [sic]).	New Zealand
neochorda Meyrick, 1922: 493 (*Glyphipteryx* [sic]).	Peru
nephoptera Meyrick, 1888: 87 (*Glyphipteryx* [sic]).	New Zealand
nicaeella Möschler, 1866: 146 (*Glyphipteryx* [sic]).	France
nigromarginata Issiki, 1930: 426 (*Glyphipteryx* [sic]).	Japan
suzukii Matsumura, 1931: 1079 (*Glyphipteryx* [sic]).	
nugella Felder and Rogenhofer, 1875: 10 (*Glyphipteryx* [sic]).	Colombia
octatoma Diakonoff, 1978: 48.	China (Chekiang)
octonaria Philpott, 1924: 210 (*Glyphipteryx* [sic]).	New Zealand
okui Diakonoff and Arita, 1976: 206.	Japan
oligastra Meyrick, 1926a: 308 (*Glyphipteryx* [sic]).	Colombia
orthodeta Meyrick, 1922: 490 (*Glyphipteryx* [sic]).	Brazil (Amazonas)

ortholeuca Meyrick, 1921b: 113 (*Glyphipteryx* [sic]).	South Africa
orthomacha Meyrick, 1920a: 331 (*Glyphipteryx* [sic]).	Australia (Q)
orymagdis Meyrick, 1909c: 435 (*Glyphipteryx* [sic]).	Sri Lanka
oxycopis Meyrick, 1918b: 195 (*Glyphipteryx* [sic]).	India (Assam)
oxydonta Diakonoff, 1978: 57.	China (Chekiang)
oxyglypta (Meyrick, 1929: 519) (*Acrolepia*). **New combination**.	Panama
oxytricha Meyrick, 1928: 424 (*Glyphipteryx* [sic]).	South Africa
palaeomorpha Meyrick, 1881: 242 (*Glyphipteryx* [sic]).	Australia (Q)
paradisea Walsingham, 1897: 119 (*Glyphipteryx* [sic]).	Grenada
parazona Meyrick, 1907a: 125 (*Glyphipteryx* [sic]).	Australia (V)
perfracta Meyrick, 1922: 493 (*Glyphipteryx* [sic]).	Peru
perimetalla Lower, 1905: 112 (*Glyphipteryx* [sic]).	Australia (V)
persica Diakonoff, 1979: 309.	Iran
pertenuis Diakonoff, 1979: 306.	Tunisia
pharetropis Meyrick, 1907a: 125 (*Glyphipteryx* [sic]).	Australia (V)
phosphora Meyrick, 1907a: 126 (*Glyphipteryx* [sic]).	Australia (SA)
plagiographa Bradley, 1965: 106.	Uganda
platydisema Lower, 1893: 183 (*Glyphipteryx* [sic]).	Australia (V)
platyochra Meyrick, 1920a: 333 (*Glyphipteryx* [sic]).	Brazil (Pará)
polychroa Lower, 1897: 23 (*Glyphipteryx* [sic]).	Australia (V)
polyzela Meyrick, 1920a: 331 (*Glyphipteryx* [sic]).	Australia (Q)
protomacra Meyrick, 1907a: 117 (*Glyphipteryx* [sic]).	Australia (WA)
pseudostoma Meyrick, 1922: 492 (*Glyphipteryx* [sic]).	Guyana
psychopa Meyrick, 1909c: 433 (*Glyphipteryx* [sic]).	Sri Lanka
pygmaeella Rebel, 1896: 132 (*Glyphipteryx* [sic]).	Canary Is.
pyristacta Turner, 1913: 213 (*Glyphipteryx* [sic]).	Australia (Q)
pyrogastra Meyrick, 1909c: 429 (*Glyphipteryx* [sic]).	India (Assam)
pyrophora Turner, 1913: 217 (*Glyphipteryx* [sic]).	Australia (NSW)
quadragintapunctata Dyar, 1900: 84 (*Glyphipteryx* [sic]).	USA (Kansas)
refractella Zeller, 1877: 402 (*Glyphipteryx* [sic]).	Colombia
regula Diakonoff and Arita, 1976: 202.	USSR (Kuril Is.)
repletana (Walker, 1864: 1037) (*Ussara*).	Brazil (Amazonas)
rhanteria Turner, 1913: 216 (*Glyphipteryx* [sic]).	Australia (Q)
rhinoceropa Meyrick, 1935: 86 (*Glyphipteryx* [sic]).	China (Chekiang)
rhodanis Meyrick, 1909c: 434 (*Glyphipteryx* [sic]).	India (Assam)
rugata Meyrick, 1915a: 203 (*Glyphipteryx* [sic]).	New Zealand
sabella Newman, 1856: 299 (*Glyphipteryx* [sic]).	Australia (V)
saurodonta Meyrick, 1913a: 68 (*Glyphipteryx* [sic]).	Canada (Ontario)
schoenicolella Boyd, 1859: 144 (*Glyphipteryx* [sic]).	England
schultzella Amsel, 1949: 88 (*Glyphipteryx* [sic]).	Germany
scintilla C. Clarke, 1926: 420 (*Glyphipteryx* [sic]).	New Zealand
sclerodes Meyrick, 1909c: 432 (*Glyphipteryx* [sic]).	Sri Lanka

scolias Meyrick, 1910: 73 (*Glyphipteryx* [sic]).	New Zealand (Kermadec Is.)
semiflavana Issiki, 1930: 426 (*Glyphipteryx* [sic]).	Japan
semifravana [sic] Kodama, 1961: 45 (*Glyphipteryx* [sic]), missp.	
semilunaris Wollaston, 1879: 436 (*Glyphipteryx* [sic]).	St. Helena
semisparsa Meyrick, 1918b: 195 (*Glyphipteryx* [sic]).	India (Madras)
seppella (Fabricius, 1776: 296) (*Tinea*).	England
septemstrigella Zeller, 1877: 405 (*Glyphipteryx* [sic]).	Colombia
sexguttella Toll, 1936: 404 (*Glyphipteryx* [sic]).	Poland
similis Philpott, 1928: 369 (*Glyphipteryx* [sic]).	New Zealand
simplicella Christoph, 1882: 38 (*Glyphipteryx* [sic]).	USSR (Maritime)
simpliciella (Stephens, 1834: 263) (*Heribeia*).	[England]
cramerella of authors, not Fabricius, 1777 [Gracillariidae].	
cognatella (Stephens, 1834: 261) (*Heribeia*).	
variella Zeller, 1839: 203 (*Glyphipteryx* [sic]), not Fabricius, 1794 [Incurvariidae].	
fischeriella (Zeller, 1839: 204) (*Aechmia*).	
roeslerstammella (Fischer von Röslerstamm, 1841: 242) (*Aechmia*).	
desiderella (Fischer von Röslerstamm, 1841: 242) (*Aechmia*).	
desideratella [sic] (Duponchel, 1842: 322) (*Aechmia*), missp.	
speculans Meyrick, 1922: 490 (*Glyphipteryx* [sic]).	Brazil (Amazonas)
speculiferella Christoph, 1882: 37 (*Glyphipteryx* [sic]).	USSR (Maritime)
stasichlora Meyrick, 1931: 184 (*Glyphipteryx* [sic]).	Peru
stelucha Meyrick, 1909d: 375 (*Glyphipteryx* [sic]).	South Africa
stilata Meyrick, 1912: 57 (*Glyphipteryx* [sic]).	Sri Lanka
struvei Amsel, 1938: 113 (*Glyphipteryx* [sic]).	Germany
sulcosa Diakonoff, 1978: 58.	Italy (Sardinia)
synarma Meyrick, 1909c: 431 (*Glyphipteryx* [sic]).	India (Assam)
syndecta Meyrick, 1915b: 221 (*Glyphipteryx* [sic]).	Peru
synorista Meyrick, 1922: 492 (*Glyphipteryx* [sic]).	Brazil (Amazonas)
talhouki Diakonoff, 1978: 61.	Lebanon
tetrachrysa Meyrick, 1907b: 749 (*Glyphipteryx* [sic]).	Sri Lanka
tetrasema Meyrick, 1883: 191 (*Glyphipteryx* [sic]).	Australia (T)
thrasonella (Scopoli, 1763: 253) (*Phalaena*).	[Austria]
fueslella (Fabricius, 1787: 250) (*Tinea*).	
fyeslella (Fabricius, 1794: 318) (*Tinea*).	
ahornerella (Hübner, 1796: pl. 26, f. 178) (*Tinea*).	
seppella (Hübner, 1796: pl. 32, f. 223) (*Tinea*), not Fabricius, 1776.	
aillyella (Hübner, 1796: pl. 64, f. 431) (*Tinea*).	
triguttella (Donovan, 1804: pl. 382, f. 1) (*Phalaena*).	
fueslii (Haworth, 1828: 531) (*Gracillaria*), emend.	
equitella (Treitschke, 1833: 71) (*Aechmia*), not Scopoli, 1763.	

poeyella (Duponchel, 1838: 438) (*Aechmia*).	
fuselella [sic] (Zeller, 1839: 203), (*Tinea*) missp. [in synonymy].	
fiesiella [sic] (Westwood, 1840: 112) (*Aechmia*), missp.	
cladiella Stainton, 1859: 364 (*Glyphipteryx* [sic]).	
var. *albardella* Snellen, 1882: 752 (*Glyphipteryx* [sic]).	
var. *eyndhoveniella* Snellen, 1882: 752 (*Glyphipteryx* [sic]).	
ab. *nitens* Bankes, 1907: 204 (*Glyphipteryx* [sic]).	
thravonella [sic] Meyrick, 1914c: 28 (*Glyphipteryx* [sic]), missp.	
transversella (Walker, 1864: 849) (*Argyresthia*).	New Zealand
trigonaspis Meyrick, 1907a: 131 (*Glyphipteryx* [sic]).	Australia (WA)
trigonodes Arita, 1979: 79.	Japan (Ryukyu Is.)
tripedila Meyrick, 1912: 58 (*Glyphipteryx* [sic]).	India (Assam)
''triplaca'' Turner; Meyrick, 1913b: 44 (*Glyphipteryx* [sic]), nom. nud., nom. dub.	Australia (Q)
tripselia Meyrick, 1907a: 129 (*Glyphipteryx* [sic]).	Australia (V)
triselena Meyrick, 1881: 234 (*Glyphipteryx* [sic]).	New Zealand
tungella Felder and Rogenhofer, 1875: 10 (*Glyphipteryx* [sic]).	New Zealand
umbilici Hering, 1927: 431 (*Glyphipteryx* [sic]).	Canary Is.
uncta Meyrick, 1913a: 101 (*Glyphipteryx* [sic]).	Guyana
unguifera Meyrick, 1922: 489 (*Glyphipteryx* [sic]).	Peru
unifasciata Walsingham, 1881: 322 (*Glyphipteryx* [sic]).	USA (California)
variata Meyrick, 1913a: 104 (*Glyphipteryx* [sic]).	Guyana
versicolor Meyrick, 1913a: 103 (*Glyphipteryx* [sic]).	Guyana
voluptella Felder and Rogenhofer, 1875: 10 (*Glyphipteryx* [sic]).	Brazil (Amazonas)
xanthoplecta Meyrick, 1922: 491 (*Glyphipteryx* [sic]).	Peru
xyridota Meyrick, 1918b: 194 (*Glyphipteryx* [sic]).	India (Assam)
zalodisca Meyrick, 1920a: 332 (*Glyphipteryx* [sic]).	Brazil (Pará)
zelota Meyrick, 1888: 86 (*Glyphipteryx* [sic]).	New Zealand
zermattensis Amsel, 1932: 20 (*Glyphipteryx* [sic]).	Germany

Diploschizia Heppner, 1981a: 311 (Type-species: *Glyphipteryx* [sic] *impigritella* Clemens, 1863).

glaucophanes (Meyrick, 1922: 489) (*Glyphipteryx* [sic])	Brazil (Amazonas)
habecki Heppner, 1981a: 317	USA (Florida)
impigritella (Clemens, 1863: 9) (*Glyphipteryx* [sic]).	USA (Pennsylvania)
exoptatella (Chambers, 1875: 234) (*Glyphipteryx* [sic]).	
kimballi Heppner, 1981a: 325.	USA (Florida)
lanista (Meyrick, 1918b: 195) (*Glyphipteryx* [sic]).	USA (N. Carolina)
minimella Heppner, 1981a: 315.	USA (Florida)
regia Heppner, 1981a: 320.	USA (Florida)

tetratoma (Meyrick, 1913a: 68) (*Glyphipteryx* [sic]).	Guyana
urophora (Walsingham, 1914: 300) (*Glyphipteryx* [sic]).	Guatemala

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LITERATURE CITED

Amsel, H. G. 1932. Neue mitteleuropäische Kleinschmetterlinge und Bemerkungen über *Melasina lugubris* Hb. und *M. ciliaris* O. (Lep.). Dtsch. Entomol. Z. 46: 18–24, 1 pl.

———. 1938. Neue oder seltene Kleinschmetterlinge aus dem nordwestdeutschen Faunengebiet, nebst Bemerkungen über die Rassenbildung bei *Gelechia ericetella* Hb. in Mittel- und Südeuropa (Lepidoptera: Gelechiidae, Glyphipterygidae). Abh. Naturwiss. Ver. Bremen 30: 108–114.

———. 1949. Eine neue deutsche *Glyphipteryx*-Art (Lep. Glyphipterygidae). Entomon 1: 88–89.

———. 1950. Kleinschmetterlinge aus dem badischen Schwarzwald. Beitr. Naturkd. Forsch. Südwestdtschl. 9: 26–28.

———. 1959. Irakische Kleinschmetterlinge, II. Bull. Soc. Entomol. Egypte 43: 41–83.

Arita, Y. 1979. Three new *Glyphipterix* species from Ishigaki Island, the Ryukyu Islands (Lepidoptera: Glyphipterigidae). Tyo to Ga 30: 77–82.

Bankes, E. R. 1907. *Glyphipteryx thrasonella*, Scop., ab. *nitens*, n. ab. Entomol. Mon. Mag. 43: 204.

Bauer, E. 1923. Eine neue *Glyphipteryx* (Microlep.) aus den Alpen. Entomol. Mitt. 12: 167–168.

Boisduval, J. B. A. D. de. 1836. Histoire naturelle des insectes. Spécies général des Lépidoptères. Vol. 1. Roret, Paris. 690 pp.

———. [1875]. Sphingides, Sesiides, Castniides. *In* Boisduval, J. B. A. D. de and A. Guenée, Histoire naturelle de insectes. Spécies général des Lépidoptères Héterocères. Vol. 1. Roret, Paris. 568 pp.

Boyd, T. 1859. Notes on an entomological tour in Cornwall. Entomol. Weekly Intelligencer 1858: 142–144.

Bradley, J. D. 1965. Microlepidoptera. *In* Ruwenzori Expedition 1952. Vol. II, no. 12. Br. Mus. (Nat. Hist.), London. Pp. 81–148.

Bruand, C. T. 1850. Catalogue systematique et synonymique des Lépidoptères de Département du Doubs. Tineides. Mém. Soc. Emul. Doubs 3(3): 23–68.

Busck, A. 1914. New genera and species of microlepidoptera from Panama. Proc. U.S. Natl. Mus. 47: 1–67.

———. 1915. Descriptions of new North American microlepidoptera. Proc. Entomol. Soc. Wash. 17: 79–94.

———. [1934]. Microlepidoptera of Cuba. Entomol. Am. 13: 151–202, pls. 30–36.

Caradja, A. von. 1926. Ueber einige bei Sutschansk gesammelte Pyraliden und sonstige Kleinfalter. Dtsch. Entomol. Z. Iris 40: 36–43.

Chambers, V. T. 1875. Teneina [sic] of Colorado. Cincinnati Q. J. Sci. 2: 289–305.

———. 1877. Tineina. Can. Entomol. 9: 13–15.

———. 1881. New species of Tineina. J. Cincinnati Soc. Nat. Hist. 3: 289–296.

Christoph, H. 1882. Neue Lepidopteren des Amur-Gebietes. Bull. Soc. Imp. Natr. Moscou 57: 5–47.

Clarke, C. E. 1926. New species of Lepidoptera. Trans. N. Z. Inst. 56: 417–421.

Clarke, J. F. G. 1969. Catalogue of the type specimens of Microlepidoptera in the British Museum (Natural History) described by Edward Meyrick. Vol. VI: Glyphipterigidae, Gelechiidae (A–C). Br. Mus. (Nat. Hist.), London. 537 pp., 267 pls.

Clemens, B. 1863. American micro-lepidoptera. Proc. Entomol. Soc. Phil. 2: 4–14.

Costa, O. G. 1834a. Specie nuove di Lepidotteri del Regno di Napoli. I. Naples. 8 pp., 1 pl.

———. 1834b. Cenni zoologici ossia descrizione sommaria delle specie nuove di animali discoperti in diverse contrade del Regno nell anno 1834. Annuario Zool. (Naples) 1834: 1–90.

———. [1836]. *Asopia*. *In* Fauna del Regno di Napoli ossia enumerazione di tutti gli animali che abitano le diverse regioni di questo regno e le acque che le bagnano contenente la descrizione de nuovi o poco esattamente conosciuti. Lepidotteri. Torchi, Naples. Pp. [196–197; and 301].

Desmarest, E. [1857]. Papillons nocturnes. *In* Chenu, J. C., Encyclopédie d'histoire naturelle ou traité complet de cette science d'apres les travaux des naturalists les plus éminents de tous les pays et de toutes les époques. Vol. 10. Havard, Paris. 321 pp., 39 pls.

Diakonoff, A. 1948. Fauna Buruana. Microlepidoptera II. Treubia 19: 197–219.

———. 1978. Descriptions of new genera and species of the so-called Glyphipterygidae sensu Meyrick, 1913 (Lepidoptera). Zool. Verh. (Leiden) 160: 1–63.

———. 1979. Descriptions of new taxa of the so-called Glyphipterigidae auctorum (Lepidoptera). Zool. Meded. (Leiden) 54: 291–312.

Diakonoff, A. and Y. Arita. 1976. New and old species of Glyphipterigidae and a new species of Acrolepiidae from Japan and the Far East (Lepidoptera). Zool. Meded. (Leiden) 50: 179–219.

———. 1979. Three new species of the so-called Glyphipterigidae auctorum from Japan (Lepidoptera). Zool. Meded. (Leiden) 54: 87–100.

Diakonoff, A. and J. B. Heppner. 1977. Proposed use of the plenary powers to designate a type-species for the nominal genus *Glyphipterix* Hübner, [1825] (Lepidoptera, Glyphipterygidae). Z. N. (S.) 2115. Bull. Zool. Nomencl. 34: 81–84.

Donovan, E. 1792–1813. The natural history of British insects; explaining them in their several states, with the periods of their transformations, their food, oeconomy and c. Together with the history of such minute insects as require investigation by the microscope. London. 16 vols.

Duponchel, P. A. J. 1838. Nocturnes. *In* Godart, J. B., ed., Histoire naturelle des Lépidoptères ou Papillons de France. Vol. 11. Méquignon-Marvis, Paris. 720 pp., pls. 287–314.

———. 1842. Nocturnes. Suppl. *In* Godart, J. B., ed., Histoire naturelle des Lépidoptères ou Papillons de France. Suppl. Méquignon-Marvis, Paris. 555 pp., pls. 51–90.

Dyar, H. G. 1900. Notes on some North American Yponomeutidae. Can. Entomol. 32: 37–41, 84–86.

Erschoff, N. 1877. Diagnosen neuer Lepidopteren aus den verschiedenen Provinzen des russischen Reiches. Hor. Entomol. Soc. Ross. 12: 336–348.

———. 1892. Verzeichniss von Schmetterlinge aus Central-Siberien. Mem. Lepid. Romonoff 6: 670–672, pl. 16.

Fabricius, J. C. 1776. Genera insectorum eorumque characteres naturales secundum numerum, figuram, situm et proportionem omnium partium oris asiecta mantissa specierum nuper detectrum. Kiel. 310 pp.

———. 1781. Species insectorum exhibentes eorum differentias specificas, synonyma auctorum, loca natalia, metamorphosin adiectis observationibus, descriptionibus. Bohn, Hamburg and Cologne. 2 vols., 510 pp.

———. 1787. Mantissa insectorum sistens species nuper detectas adiectis synonymis, observationibus, descriptionibus, emendationibus. Proft, Hafniae. 382 pp.

———. 1794. Entomologia systematica emendata et aucta. Secundum classes, ordines, genera, species adjectis synonymis, locis, observationibus, descriptionibus. Proft, Hafniae. Vol. 3, part 2, 349 pp.

Felder, R. and A. F. Rogenhofer. 1875. Zweite Abtheilung: Lepidoptera. Atlas. *In* Felder, C., R. Felder, and A. F. Rogenhofer, Reise der österreichischen Fregatte Novara um die Erde in den Jahren 1857, 1858, 1859 unter den Behilfen des Commodore B. von Wüllerstorf-Urbair. Zoologischer Theil. [part]. Vienna. 20 pp., pls. 108–140.

Ferro, D. N., A. D. Lowe, R. G. Ordish, K. G. Somerfield, and J. C. Watt. 1977. Standard names for common insects of New Zealand. Bull. Entomol. Soc. N. Z. 4: 1–42.

Fischer von Röslerstamm, J. A. 1834–1843. Abbildungen zur Berichtigung und Ergänzung der Schmetterlingkunde, besonders der Microlepidopterologie als Supplement zu Treitschke's und Hübner's europaeischen Schmetterlingen, mit erläuterndem Text. Leipzig. 308 pp., 100 pls.

Fletcher, T. B. 1940. New generic names for microlepidoptera. Entomol. Rec. J. Var. 52: 17–19, 109.

Frölich, G. F. von. 1828. Enumeratio tortricum, L., regno Württembergico indigenarum. Tubingen. 102 pp.

Ghesquière, J. 1940–42. Catalogue raisonnés de la faune entomologique du Congo Belge. Lépidoptères, microlépidoptères. Ann. Mus. Congo Belge (Turvuren), Zool. (3) 7: 1–240, 6 pls.

Gozmany, L. 1954. Studies on microlepidoptera. Ann. Hist.-Nat. Mus. Natl. Hung. 5: 273–285.

Hampson, G. F. 1918. Some small families of the Lepidoptera which are not included in the key to the families in the catalogue of Lepidoptera Phalaenae, a list of families and subfamilies of the Lepidoptera with their types, and a key to the families. Novit. Zool. 25: 366–394.

Haworth, A. H. 1803–1828. Lepidoptera Britannica. J. Murray, London. 609 pp. [4 parts].

Heinemann, H. von and M. F. Wocke. [1876]. Die Schmetterlinge Deutschlands und der Schweiz. Zweite Abtheilung. Kleinschmetterlinge. Band II: Die Motten und Federmotten. Heft II. Schwetschke, Braunschweig. Pp. 389–825.

Heppner, J. B. 1977. The status of the Glyphipterigidae and a reassessment of relationships in yponomeutoid families and ditrysian superfamilies. J. Lepid. Soc. 31: 124–134.

———. 1981a. Revision of the new genus *Diploschizia* (Lepidoptera: Glyphipterigidae) for North America. Fla. Entomol. 64: 309–336.

———. 1981b. *Neomachlotica*, a new genus of Glyphipterigidae (Lepidoptera). Proc. Entomol. Soc. Wash. 83: 479–488.

———. *In press* a. Review of the family Immidae (Immoidea) with a world checklist. J. Lepid. Soc.

———. *In press* b. A world catalog of genera associated with the Glyphipterigidae auctorum (Lepidoptera: Copromorphoidea). J. N. Y. Entomol. Soc.

Heppner, J. B. and W. D. Duckworth. 1981. Classification of the superfamily Sesioidea (Lepidoptera: Ditrysia). Smithson. Contrib. Zool. 314: 1–144.

Hering, M. 1927. Die Minenfauna der Canarischen Inseln. Zool. Jahrb. Abt. Syst. Ökol. Geogr. Tiere 53: 405–486.

Herrich-Schäffer, G. A. W. 1847–1855. Die Schaben und Federmotten. *In* Systematische Bearbeitung der Schmetterlinge von Europa, zugleich als Text, Revision und Supplement zu Jakob Hübner's Sammlung europäischer Schmetterlinge. Vol. 5. G. J. Manz, Regensburg. 394 + 52 pp., 132 pls.

Heydenreich, G. H. 1851. Lepidopterorum europaeorum catalogus methodicus. Systematisches Verzeichniss der europaeischen Schmetterlinge. J. Klinkhardt, Leipzig. 130 pp.

Hübner, J. 1796–[1838]. Sammlung europäischer Schmetterlinge. Augsburg. 9 pts.

———. 1816–[1825]. Verzeichniss bekannter Schmettlinge [sic]. Augsburg. 431 pp.

Issiki, S. T. 1930. New Japanese and Formosan microlepidoptera. Ann. Mag. Nat. Hist. (10) 6: 422–431.

Jordan, K. 1886. Die Schmetterlingsfauna nordwest-Deutschlands, insbesondere die lepidopterologischen Verhältnisse der Umgebung von Göttingen. Zool. Jahrb. Zeitsch. Syst. Geogr. Biol. Thiere, Suppl. 1: 1–164.

Klemensiewicz, S. 1907. O nowych i malo znanych gatunkach motyli fauny galicyjskiej. Sprawozd. Komis. Fizyograf. PAU (Warsaw) 40: 3–31.

Kodama, T. 1961. The larvae of Glyphipterygidae (Lepidoptera) in Japan (I). Osaka Fac. Agric., Entomol. Lab. 6: 35–45.

Le Marchand, S. 1925. *Glyphipteryx heptaglyphella,* n. sp. Amat. Papill. 2: 314–316.

Lower, O. B. 1893. New Australian Lepidoptera. Trans. R. Soc. S. Aust. 17: 146–185.

———. 1897. Descriptions of new species of Australian Lepidoptera, with notes on synonymy. Proc. Linn. Soc. N.S.W. 22: 10–32.

———. 1905. New Australian Lepidoptera No. 22. Trans. R. Soc. S. Aust. 29: 103–115.

Mann, J. 1854. Aufzählung der Schmetterlinge, gesammelt auf einer Reise im Auftrag des k. k. zoologischen Museums nach Oberkrain und dem Küstenlande, in den Monaten Mai und Juni 1854, als Beitrag zur Fauna des österreichischen Kaiserstaates. Verh. Zool.-Bot. Ver. Wien 4: 545–596.

Mann, J. and A. F. Rogenhofer. 1878. Zur Lepidopteren-Fauna des Dolomiten-Gebietes. Verh. Zool.-Bot. Ges. Wien 27: 491–500.

Matsumura, S. 1931. 6000 illustrated insects of Japan-Empire. Tokyo. 1496 + 191 pp.

Meyrick, E. 1881. Descriptions of Australian micro-lepidoptera. IV: Tineina. Proc. Linn. Soc. N.S.W. 5: 204–271.

———. 1883. Descriptions of Australian micro-lepidoptera. VII: Revisional. Proc. Linn. Soc. N.S.W. 7: 148–202.

———. 1888. Descriptions of New Zealand Tineina. Trans. N. Z. Inst. 20: 77–106.

———. 1907a. Descriptions of Australasian micro-lepidoptera. XIX. Plutellidae. Proc. Linn. Soc. N.S.W. 32: 47–150.

———. 1907b. Descriptions of Indian micro-lepidoptera. III. J. Bombay Nat. Hist. Soc. 17: 730–754.

———. 1907c. Descriptions of Indian micro-lepidoptera. IV. J. Bombay Nat. Hist. Soc. 17: 976–994.

———. 1907d. Descriptions of Indian micro-lepidoptera. V. J. Bombay Nat. Hist. Soc. 18: 137–160.

———. 1909a. Notes and descriptions of New Zealand Lepidoptera. Trans. N. Z. Inst. 41: 5–16.

———. 1909b. Descriptions of micro-lepidoptera from Bolivia and Peru. Trans. Entomol. Soc. Lond. 1909: 13–43.

———. 1909c. Descriptions of Indian micro-lepidoptera. IX. J. Bombay Nat. Hist. Soc. 19: 410–437.

———. 1909d. New South African microlepidoptera. Ann. South Afr. Mus. 5: 349–379.

———. 1910. Lepidoptera from the Kermadec Islands. Trans. N. Z. Inst. 42: 67–73.

———. 1911a. Notes and descriptions of New Zealand Lepidoptera. Trans. N. Z. Inst. 43: 58–78.

———. 1911b. Tortricina and Tineina. *In* Reports of the Percy Sladen Trust Expedition to the Indian Ocean in 1905, under the leadership of My. J. Stanley Gardiner, M. A. Vol. 3. Trans. Linn. Soc. Lond. Zool. (2) 14: 263–307.

———. 1912. Glyphipterygidae. Exotic Microlepid. 1: 35–63.

———. 1913a. Glyphipterygidae. Exotic Microlepid. 1: 67–70, 98–104.

———. 1913b. Carposinidae, Heliodinidae, Glyphipterygidae. *In* Wagner, H., ed., Lepidopterorum catalogus. Part 13. W. Junk, Berlin. 53 pp.

———. 1914a. Descriptions of New Zealand Lepidoptera. Trans. N. Z. Inst. 46: 101–118.

———. 1914b. Glyphipterygidae. Exotic Microlepid. 1: 283–284.

———. 1914c. Lepidoptera Heterocera. Fam. Glyphipterygidae. *In* Wytsman, P., ed., Genera insectorum. Fasc. 164. Brussels. 39 pp., 2 pls.

———. 1915a. Descriptions of New Zealand Lepidoptera. Trans. N. Z. Inst. 47: 201–204.

———. 1915b. Descriptions of South American micro-lepidoptera. Trans. Entomol. Soc. Lond. 1915: 201–256.

———. 1916. Descriptions of New Zealand Lepidoptera. Trans. N. Z. Inst. 48: 414–419.

———. 1917. Descriptions of South African micro-lepidoptera. Ann. South Afr. Mus. 17: 1–21.

———. 1918a. Descriptions of South African micro-lepidoptera. Ann. Transvaal Mus. 6: 7–59.

———. 1918b. Glyphipterygidae. Exotic Microlepid. 2: 191–196.

———. 1920a. Glyphipterygidae. Exotic Microlepid. 2: 325–338.

———. 1920b. Descriptions of South African micro-lepidoptera. Ann. South Afr. Mus. 17: 273–318.

———. 1921a. New microlepidoptera. Zool. Meded. (Leiden) 6: 145–202.

———. 1921b. Descriptions of South African micro-lepidoptera. Ann. Transvaal Mus. 8: 49–148.

———. 1922. Glyphipterygidae. Exotic Microlepid. 2: 481–493.

———. 1923a. Voyage du Comte Jacques de Rohan-Charot dans l'Angola. Description d'éspeces nouvelles de microlépidoptères. Bull. Mus. Natl. Hist. Nat. (Paris) 29: 563–566.

———. 1923b. Glyphipterygidae. Exotic Microlepid. 2: 616–619.

———. 1925. Glyphipterygidae. Exotic Microlepid. 3: 132–136.

———. 1926a. Glyphipterygidae. Exotic Microlepid. 3: 301–308.

———. 1926b. New South African micro-lepidoptera. Ann. South Afr. Mus. 23: 325–351.

———. 1928. Glyphipterygidae. Exotic Microlepid. 3: 420–424.

———. 1929. The micro-lepidoptera of the "St. George" Expedition. Trans. Entomol. Soc. Lond. 76: 489–521.

———. 1930a. Hyponomeutidae [sic]. Exotic Microlepid. 3: 591–598.

———. 1930b. Glyphipterygidae. Exotic Microlepid. 4: 1–7.

———. 1931. Glyphipterygidae. Exotic Microlepid. 4: 180–185.

———. 1932a. Glyphipterygidae. Exotic Microlepid. 4: 273–276.

———. 1932b. Entomological expedition to Abyssinia, 1926–7. Microlepidoptera. Trans. Entomol. Soc. Lond. 80: 107–120.

———. 1933. Glyphipterygidae. Exotic Microlepid. 4: 370–372.

———. 1934a. Pterophoridae-Tortricidae-Tineidae. *In* Caradja, A. von and E. Meyrick, Materialien zu einer Microlepidopteren-Fauna Kwangtungs. Dtsch. Entomol. Z. Iris 48: 28–43.

———. 1934b. Glyphipterygidae. Exotic Microlepid. 4: 523–524.

———. 1935. List of microlepidoptera of Chekiang, Kiangsu and Hunan. *In* Caradja, A. von and E. Meyrick, Materialien zu einer Microlepidopteren Fauna der chinesischen Provincen Kiangsu, Chekiang und Hunan. Friedländer, Berlin. Pp. 44–96.

———. 1937. Glyphipterygidae. Exotic Microlepid. 5: 123–126.

Millière, P. 1854. Description de nouvelles éspeces de microlépidoptères. Ann. Soc. Entomol. Fr. (3) 2: 59–68.

Moriuti, S. and T. Saito. 1964. *Glyphipterix semiflavana* Issiki and the allied new species from Japan (Lepidoptera: Glyphipterigidae). Entomol. Rev. Japan 16: 60–63, pl. 9–10.

Möschler, H. B. 1866. Aufzählung der in Andalusien 1865 von Herrn Graf v. Hoffmannsegg gesammelten Schmetterlinge. Berlin. Entomol. Z. 10: 136–146.

Newman, E. 1856. Characters of a few Australian Lepidoptera, collected by Mr. Thomas R. Oxley. Trans. Entomol. Soc. Lond. 1855: 281–300.

Nowicki, M. S. 1864. Microlepidopterorum species novae. Jagellon Univ., Krakow. 31 pp., 1 pl.

Philpott, A. 1924. Notes and descriptions of New Zealand Lepidoptera. Trans. N. Z. Inst. 55: 207–214.

———. 1927. Notes and descriptions of New Zealand Lepidoptera. Trans. N. Z. Inst. 58: 80–90.

———. 1928. Notes and descriptions of New Zealand Lepidoptera. Trans. N. Z. Inst. 58: 359–370.

Prohaska, K. 1905. Beitrag zur Microlepidopteren-Fauna von Steirmark und Kärnten. Jahresber. K. K. Ersten Staats-Gymnas. (Graz) 1905: 1–29.

Pryer, W. B. 1877. Descriptions of new species of Lepidoptera from North China. Cist. Entomol. 2: 231–235, pl. 4.

Ragonot, E. L. 1885. [Contribution]. Bull. Soc. Entomol. Fr. 1885: lvi.

Rebel, H. 1896. Dritter Beitrag zur Lepidopteren-fauna der Canaren. Ann. Naturhist. Hofmus. (Vienna) 11: 102–148, pl. 3.

———. 1916. Die Lepidopterenfauna Kretas. Ann. Naturhist. Hofmus. (Vienna) 30: 66–172, pl. 4.

———. 1940. Die Lepidopterenfauna des Azorischen Archipels. Mit 1. Anhang: eine Lepidopteren-Ausbeute von Madeira. Comm. Biol. 8: 1–59, pls. 1–2.

Scopoli, J. A. 1763. Entomologia Carniolica exhibens insecta Carnioliae indigena et distributa in ordines, genera, species, varietates. Methodo Linnaeana. Vienna. 419 pp., 43 pls. [1972 reprint: Akademische Verlag, Graz].

Snellen, P. C. T. 1882. De Vlinders van Nederland. Microlepidoptera. Brill, Leiden. 2 vols., 1196 pp., 14 pls.

Stainton, H. T. 1859. A manual of British butterflies and moths. Vol. II. (Comprising the slender-bodied and small moths). Van Voorst, London. 480 pp.

Stephens, J. F. 1829. The nomenclature of British insects; being a compendious list of such species as are contained in the systematic catalogue of British insects, and forming a guide to their classification, and c. and c. Baldwin and Cradock, London. 68 pp. [June 1, 1829].

———. 1831–1835. Illustrations of British entomology; or, a synopsis of indigenous insects: containing their generic and specific distinctions; with an account of their metamorphoses, times of appearance, localities, food, and economy, as far as practicable. Haustellata. Vol. IV. London. 436 pp., pls. 33–40.

Toll, S. 1936. Untersuchung der Genitalien bei *Pyrausta purpuralis* L. und *P. ostrinalis* Hb., nebst Beschreibung 11 neuer Microlepidopteren-Arten. Ann. Mus. Zool. Polonici 11: 403–413, pls. 47–49.

Treitschke, F. 1833. Schaben. Geitschen. *In* Ochsenheimer, F., Die Schmetterlinge von Europa. Vol. 9, pt. 2. Fleischer, Leipzig. 294 pp.
Turati, E. 1879. Contribuzione alla fauna Lepidotterologica Lombarda. Boll. Soc. Entomol. Ital. 11: 153–208, pls. 7–8.
———. 1930. Lepidotteri di Rodi. Mem. Soc. Entomol. Ital. 9: 196–214.
Turner, A. J. 1913. Studies in Australian micro-lepidoptera. Proc. Linn. Soc. N.S.W. 38: 174–228.
———. 1926. Studies in Australian Lepidoptera. Trans. R. Soc. S. Aust. 50: 120–155.
———. 1927. New and little-known Tasmanian Lepidoptera. Pap. R. Soc. Tasmania 1926: 119–164.
———. 1932. New Australian Lepidoptera. Trans. R. Soc. S. Aust. 56: 175–196.
Viette, P. 1951. Quelques microlépidoptères de Madagascar. Mém. Inst. Sci. Madagascar (Ser. A) 5: 337–346.
Walker, F. 1863. Tortricites & Tineites. *In* List of the specimens of lepidopterous insects in the collection of the British Museum. Part 28. Br. Mus., London. Pp. 288–561.
———. 1864. Tineites. *In* ibid. Pt. 29–30. Br. Mus., London. Pp. 563–1096.
———. [1865]. Supplement. *In* ibid. Pt. 31. Br. Mus., London. 321 pp.
———. 1869. Characters of undescribed Lepidoptera Heterocera. E. W. Janson, London. 112 pp.
Walsingham, T. de G. 1881. On some North American Tineidae. Proc. Zool. Soc. Lond. 1881: 301–325, pls. 35–36.
———. 1891. African micro-lepidoptera. Trans. Entomol. Soc. Lond. 1891: 63–132, pls. 3–7.
———. 1892. On the micro-lepidoptera of the West Indies. Proc. Zool. Soc. Lond. 1891: 492–549.
———. 1897. Revision of the West-Indian micro-lepidoptera, with descriptions of new species. Proc. Zool. Soc. Lond. 1897: 54–183.
———. 1908. Microlepidoptera of Tenerife. Proc. Zool. Soc. Lond. 1907: 911–1034, pls. 51–53.
———. 1910. Madeiran Tineina (Lepidoptera). Entomol. Mon. Mag. 46: 257–259.
———. 1914. Hemerophilidae. *In* Tineina, Pterophorina, Orneodina and Pyralidina and Hepialina (part). *In* Godman, F. D. and O. Salvin, Biologia Centrali-Americana. Insecta. Lepidoptera-Heterocera. Vol. 4. London. Pp. 300–319, pl. 9.
Watt, M. N. 1920. The leaf-mining insects of New Zealand. Trans. N. Z. Inst. 52: 439–466, pl. 30.
Westwood, J. O. [1838]–1840. Synopsis of the genera of British insects. London. 158 pp.
Wollaston, T. V. 1879. Notes on the Lepidoptera of St. Helena, with descriptions of new species. Ann. Mag. Nat. Hist. (5) 3: 219–233, 329–343, 415–441.
Zeller, P. C. 1839. Versuch einer naturgemässen Eintheilung der Schaben. Isis v. Oken 32: 167–220.
———. 1850. Verzeichniss der von Herrn Jos. Mann beobachteten toscanischen Microlepidoptera. Entomol. Z. (Stettin) 11: 59–64, 134–136, 139–162, 195–212.
———. 1852. Lepidoptera Microptera, quae J. A. Wahlberg in Caffrorum terra collegit. Glogau. 120 pp. [reissued in [1854]: Kongl. Svenska Vetensk. Akad. Handl. 1852: 1–120].
———. 1877. Exotische Microlepidoptera. Hor. Soc. Entomol. Ross. 13: 3–493, 6 pls.
Zetterstedt, J. W. [1839]–1840. Insecta Lapponica. Voss., Lipsiae. 1140 pp.

Alphabetical List of Species

achlyoessa Meyrick, Phryganostola
achlyoëssa Meyrick, Phryganostola
acinacella Meyrick, Glyphipterix
acronoma Meyrick, Glyphipterix
acrothecta Meyrick, Glyphipterix
actinobola Meyrick, Glyphipterix

actinota (Walsingham), Neomachlotica
acyloessa [sic] (Ferro et al.), Phryganostola achlyoessa
aechmiella (Duponchel), Glyphipterix
aereinitidella (Millière), Glyphipterix
aerifera Meyrick, Glyphipterix
aglaograpta Meyrick, Irinympha
ahornerella (Hübner), Glyphipteryx thrasonella
aillyella (Hübner), Glyphipterix thrasonella
albardella Snellen, Glyphipterix thrasonella
albicostella (Duponchel), Glyphipterix fuscoviridella
albimaculella Heinemann, Glyphipterix
alpha Moriuti and Saito, Glyphipterix
altiorella Bauer, Glyphipterix
amblycerella Meyrick, Glyphipterix
ametris Diakonoff, Glyphipterix
amphipeda Meyrick, Glyphipterix
amseli Diakonoff, Glyphipterix
anaclastis Meyrick, Glyphipterix
ancobathra Meyrick, Ussara
ancyristis Meyrick, Ussara
angulosella (Costa), Glyphipterix
antidoxa Meyrick, Glyphipterix
archimedica Meyrick, Glyphipterix
arcuatella Klemensiewicz, Glyphipterix bergstraesserella
argophracta Meyrick, Glyphipterix
argyrelata Turner, Glyphipterix
argyroguttella Ragonot, Glyphipterix
argyromis Meyrick, Glyphipterix
argyrosema Meyrick, Apistomorpha
argyrotoxa Turner, Glyphipterix
arquata Meyrick, Ussara
asterias (Meyrick), Glyphipterix
asteriella Meyrick, Glyphipterix
asteronota Meyrick, Glyphipterix
astrapaea Meyrick, Glyphipterix
astrocosma Meyrick, Tetracmanthes
ataracta Meyrick, Phryganostola
atelura Meyrick, Glyphipterix
atractias (Meyrick), Neomachlotica
atristriella Zeller, Glyphipterix gemmipunctella
aulogramma Meyrick, Glyphipterix
auripennis Boisduval, Myrsila
autopetes Meyrick, Glyphipterix
bactrias Meyrick, Glyphipterix
basifasciata Issiki, Glyphipterix
bergstraesella [sic] Bruand, Glyphipterix bergstraesserella
bergstraessella [sic] (Fabricius), Glyphipterix bergstraesserella
bergstraesserella (Fabricius), Glyphipterix
bergsträsserella [sic] Amsel, Glyphipterix bergstraesserella
beta Moriuti and Saito, Glyphipterix
bicornis Meyrick, Glyphipterix
bifasciata Walsingham, Glyphipterix
bifasciella Amsel, Glyphipterix
bohemani (Zeller), Glyphipterix
brachyaula Meyrick, Glyphipterix
brachydelta Meyrick, Glyphipterix
californiae Walsingham, Glyphipterix
calliactis Meyrick, Glyphipterix
callicrossa Meyrick, Glyphipterix
callidelta Meyrick, Glyphipterix
calliscopa Lower, Glyphipterix
callithea Meyrick, Glyphipterix
canachodes Meyrick, Glyphipterix
carenota Meyrick, Glyphipterix
caudatella Walsingham, Glyphipterix
celophora (Meyrick), Taeniostolella
cestrota Meyrick, Glyphipterix
chalcodaedala Turner, Glyphipterix
chalceres Turner, Glyphipterix meteora
chalcodesma Meyrick, Ussara
chalcostrepta Meyrick, Glyphipterix
chalcotypa (Bradley), Chrysocentris
chionosoma Diakonoff, Glyphipterix
chlorospora Meyrick, Ernolytis
chrysallacta Meyrick, Glyphipterix
chrysangela Meyrick, Ussara
chrysodeta Meyrick, Machlotica
chrysolithella Meyrick, Glyphipterix gemmipunctella
chrysoplanetis Meyrick, Glyphipterix
chrysorma Meyrick, Phalerarcha
chrysosema (Meyrick), Carmentina
chrysozona (Meyrick), Chrysocentris
cionophora Meyrick, Circica
circumscripta [sic] Dyar, Glyphipterix circumscriptella
circumscriptella Chambers, Glyphipterix
cladiella Stainton, Glyphipterix thrasonella
clavaria Meyrick, Chrysocentris
clearcha Meyrick, Glyphipterix
climacaspis Meyrick, Glyphipterix
codonias Meyrick, Glyphipterix
cognatella (Stephens), Glyphipterix simpliciella
colluripennella (Costa), Glyphipterix simpliciella

colorata Meyrick, Glyphipterix
columnaris Meyrick, Glyphipterix
cometophora Meyrick, Glyphipterix
compastis Meyrick, Glyphipterix
conjunctella (Costa), Glyphipterix
conosema Meyrick, Glyphipterix
cornigerella Zeller, Glyphipterix
cramerella (of authors), Glyphipterix simpliciella
crassilunella Rebel, Glyphipterix
crinita Meyrick, Glyphipterix
crotalotis Meyrick, Glyphipterix
cultrata Meyrick, Glyphipterix
cuprea Busck, Abrenthia
cyanophracta Meyrick, Glyphipterix
cyanochalca Meyrick, Glyphipterix
danilevskii Diakonoff, Glyphipterix
decachrysa Meyrick, Glyphipterix
decoratella Walker, Ussara
deliciosa Diakonoff, Glyphipterix
delta Moriuti and Saito, Glyphipterix
deltodes (Walsingham), Cronicombra
desideratella [sic] (Duponchel), Glyphipterix simpliciella
desiderella (Röslerstamm), Glyphipterix simpliciella
deuterastis Meyrick, Glyphipterix
diaphora Walsingham, Glyphipterix
dichalina Meyrick, Glyphipterix
dichorda Meyrick, Glyphipterix
diplotoxa Meyrick, Glyphipterix
ditiorana (Walker), Chrysocentris
dolichophyes Diakonoff, Glyphipterix
drosophaes Meyrick, Phryganostola
enclitica Meyrick, Glyphipterix
epastra Meyrick, Glyphipterix
equitella (of authors), Glyphipterix minorella
equitella (Scopoli), Glyphipterix
equitella (Treitschke), Glyphipterix thrasonella
erastis Meyrick, Glyphipterix
erebanassa Meyrick, Glyphipterix
essedaria Meyrick, Cronicombra
euastera Meyrick, Glyphipterix
euleucotoma Diakonoff and Arita, Glyphipterix
eumitrella (Busck), Phalerarcha
eupepla Meyrick, Chrysocentris
eurymolybda Meyrick, Machlotica
eurythmiella Busck, Ussara
euthybelemna Meyrick, Phryganostola
exoptatella (Chambers), Diploschizia impigritella
expurgata Meyrick, Glyphipterix
eyndhoveniella Snellen, Glyphipterix thrasonella
falcigera Meyrick, Glyphipterix
fiesiella (Westwood), Glyphipterix thrasonella
fischeriella (Zeller), Glyphipterix simpliciella
flaviceps (Felder and Rogenhofer), Ussara
forsterella (Fabricius), Glyphipterix
fortunatella Walsingham, Glyphipterix
fueslella (Fabricius), Glyphipterix thrasonella
fueslii (Haworth), Glyphipterix thrasonella
fulgens (Erschoff), Lepidotarphius perornatella
funditrix Diakonoff and Arita, Glyphipterix
fuscoviridella (Haworth), Glyphipterix
fuselella [sic] (Zeller), Glyphipterix thrasonella
fyeslella (Fabricius), Glyphipterix (ibid.)
gamma Moriuti and Saito, Glyphipterix
gaudialis Diakonoff and Arita, Glyphipterix
gemmatella (Walker), Glyphipterix
gemmipunctella (Walker), Glyphipterix
gemmula Diakonoff and Arita, Glyphipterix
gemmula Walsingham, Trapeziophora
gianelliella Ragonot, Glyphipterix
glaucophanes (Meyrick), Diploschizia
gonoteles Meyrick, Glyphipterix
granulata Meyrick, Cronicombra
grapholithoides Walsingham, Glyphipterix
gypsonota Turner, Glyphipterix
habecki Heppner, Diploschizia
halimophila Lower, Glyphipterix
haplographa Turner, Glyphipterix
harpogramma Turner, Glyphipterix
haworthana (Stephens), Glyphipterix
haworthella (Stephens), Glyphipterix haworthana
hemipempta Meyrick, Glyphipterix
heptaglyphella Le Marchand, Glyphipterix
hilarodes (Meyrick), Ussara
holochalca Meyrick, Pantosperma
holodesma Meyrick, Glyphipterix
hologramma Meyrick, Glyphipterix
howarthana [sic] Jordan, Glyphipterix haworthana
humerella (Hübner), Glyphipterix forsterella

hyperlampra Turner, Glyphipterix
idiomorpha Meyrick, Glyphipterix
iinvicta [sic] Clarke, Glyphipterix invicta
imparfasciata Arita, Glyphipterix
impigritella (Clemens), Diploschizia
indomita Meyrick, Glyphipterix
infuscata Ghesquière, Chrysocentris
invicta Meyrick, Glyphipterix
iocheaera Meyrick, Glyphipterix
iochrysa Meyrick, Ussara
ioclista Meyrick, Glyphipterix
iometalla Meyrick, Glyphipterix
iridesma Meyrick, Carmentina
isoclista Meyrick, Glyphipterix
isozela Meyrick, Glyphipterix
japonicella Matsumura, Glyphipterix beta
japonicella Zeller, Glyphipterix
jezonica Matsumura, Glyphipterix basifasciata
kimballi Heppner, Diploschizia
lamella (Busck), Cronicombra
lamprocoma Meyrick, Glyphipterix
lamprosema Turner, Glyphipterix
lanista (Meyrick), Diploschizia
leptocona Meyrick, Glyphipterix
leptosema Meyrick, Glyphipterix
leucargyra Turner, Glyphipterix
leucocerastes Meyrick, Glyphipterix
leucophragma Meyrick, Glyphipterix
leucoplaca Turner, Glyphipterix
lineana (Hübner), Glyphipterix bergstraesserella
lineella Hübner, Glyphipterix (ibid.)
linneana [sic] Hübner, Glyphipterix (ibid.)
linneella Hübner, Glyphipterix (ibid.)
litura (Felder and Rogenhofer), Taeniostolella
longistriatella Rebel, Glyphipterix
loricatella (Treitschke), Glyphipterix
loricutella [sic] Desmarest, Glyphipterix loricatella
lucasella (Duponchel), Glyphipterix forsterella
luteocapitella Caradja, Glyphipterix
luteomaculata Arita, Glyphipterix
lycnophora Turner, Glyphipterix
lyelliana Lower, Glyphipterix cyanochalca
macrantha Lower, Phryganostola
macraula Meyrick, Glyphipterix
macrodrachma Diakonoff, Glyphipterix
madagascariensis Viette, Glyphipterix
magnatella Erschoff, Glyphipterix
maiorella [sic] Prohaska, Glyphipterix equitella
majorella (Herrich-Schäffer), Glyphipterix equitella
majorella (Heydenreich), Glyphipterix equitella
majorella Mann, Glyphipterix equitella
maritima Diakonoff, Glyphipterix
marmaropa Turner, Glyphipterix
maschalis Meyrick, Glyphipterix
mediana Walker, Cotaena
medianella Turati, Glyphipterix
medica Meyrick, Glyphipterix
melania Diakonoff and Arita, Glyphipterix
mesaula Meyrick, Glyphipterix
metasticta Meyrick, Glyphipterix
meteora Meyrick, Glyphipterix
metron Diakonoff, Glyphipterix
metronoma Meyrick, Glyphipterix
minimella Heppner, Diploschizia
minorella Snellen, Glyphipterix
molybdastra Meyrick, Glyphipterix
molybdora (Meyrick), Carmentina
molybdotoma (Diakonoff and Arita), Carmentina
monodonta Diakonoff, Glyphipterix
montella Meyrick, Glyphipterix montisella
montinella [sic] Chambers, Glyphipterix montisella
montisella Chambers, Glyphipterix
morangella Felder and Rogenhofer, Glyphipterix
nattani Gozmany, Glyphipterix
nebras (Meyrick), Neomachlotica
necopina Philpott, Glyphipterix
neochorda Meyrick, Glyphipterix
nephoptera Meyrick, Glyphipterix
nicaeella Möschler, Glyphipterix
nigromarginata Issiki, Glyphipterix
nitens Bankes, Glyphipterix thrasonella
nivicaput Diakonoff, Glyphipterix forsterella
nugella Felder and Rogenhofer, Glyphipterix
octatoma Diakonoff, Glyphipterix
octonaria Philpott, Glyphipterix
oculatella Mann, Glyphipterix forsterella
oculatella (Zeller), Glyphipterix forsterella
okui Diakonoff and Arita, Glyphipterix
oligastra Meyrick, Glyphipterix
olyranta Meyrick, Ussara
orthodeta Meyrick, Glyphipterix

ortholeuca Meyrick, Glyphipterix
orthomacha Meyrick, Glyphipterix
orymagdis Meyrick, Glyphipterix
oxycopis Meyrick, Glyphipterix
oxydonta Diakonoff, Glyphipterix
oxyglypta (Meyrick), Glyphipterix
oxymachaera Meyrick, Phryganostola
oxytricha Meyrick, Glyphipterix
palaeomorpha Meyrick, Glyphipterix
palpella (Walsingham), Cronicombra
paradisea Walsingham, Glyphipterix
parazona Meyrick, Glyphipterix
paurographella Ragonot, Glyphipterix argyroguttella
perculta (Diakonoff), Carmentina
perfracta Meyrick, Glyphipterix
perimetalla Lower, Glyphipterix
pernicipennella (Costa), Glyphipterix angulosella
perornatella (Walker), Lepidotarphius
persica Diakonoff, Glyphipterix
pertenuis Diakonoff, Glyphipterix
phaeobathra (Meyrick), Cronicombra
phaeometalla Meyrick, Chrysocentris
pharetropis Meyrick, Glyphipterix
phosphora Meyrick, Glyphipterix
pietruskii Nowicki, Glyphipterix bergstraesserella
plagiographa Bradley, Glyphipterix
platydisema Lower, Glyphipterix
platyochra Meyrick, Glyphipterix
plenella (Busck), Cotaena
poeyella (Duponchel), Glyphipterix thrasonella
polyastra Meyrick, Ussara
polychroa Lower, Glyphipterix
polychrysa (Meyrick), Carmentina
polyzela Meyrick, Glyphipterix
porphyrospila (Meyrick), Cronicombra
protomacra Meyrick, Glyphipterix
pseudostoma Meyrick, Glyphipterix
psychopa Meyrick, Glyphipterix
pygmaeella Rebel, Glyphipterix
pyristacta Turner, Glyphipterix
pyrogastra Meyrick, Glyphipterix
pyrophora Turner, Glyphipterix
quadragintapunctata Dyar, Glyphipterix
refractella Zeller, Glyphipterix
regia Heppner, Diploschizia
regula Diakonoff and Arita, Glyphipterix
repletana (Walker), Glyphipterix
rhanteria Turner, Glyphipterix
rhinoceropa Meyrick, Glyphipterix
rhodanis Meyrick, Glyphipterix
roeslerstammella (Fischer v. Röslerstamm), Glyphipterix simpliciella
rugata Meyrick, Glyphipterix
sabella Newman, Glyphipterix
saurodonta Meyrick, Glyphipterix
schoenicolella Boyd, Glyphipterix
schultzella Amsel, Glyphipterix
scintilla Clarke, Glyphipterix
sclerodes Meyrick, Glyphipterix
scolias Meyrick, Glyphipterix
semicoronis Meyrick, Ussara
semiflavana Issiki, Glyphipterix
semifravana [sic] Kodama, Glyphipterix semiflavana
semilunaris Wollaston, Glyphipterix
semisparsa Meyrick, Glyphipterix
seppella (Fabricius), Glyphipterix
seppella (Hübner), Glyphipterix thrasonella
septemstrigella Zeller, Glyphipterix
sexguttella Toll, Glyphipterix
similis Philpott, Glyphipterix
simplicella Christoph, Glyphipterix
simpliciella (Stephens), Glyphipterix
speculans Meyrick, Glyphipterix
speculiferella Christoph, Glyphipterix
spiraea Heppner, Neomachlotica
splendens Pryer, Lepidotarphius perornatella
sporomantis Meyrick, Rhabdocrates
stasichlora Meyrick, Glyphipterix
stelucha Meyrick, Glyphipterix
stilata Meyrick, Glyphipterix
struvei Amsel, Glyphipterix
sulcosa Diakonoff, Glyphipterix
suzukii Matsumura, Glyphipterix nigromarginata
synarma Meyrick, Glyphipterix
syndecta Meyrick, Glyphipterix
synorista Meyrick, Glyphipterix
talhouki Diakonoff, Glyphipterix
tetrachrysa Meyrick, Glyphipterix
tetrasema Meyrick, Glyphipterix
tetratoma (Meyrick), Diploschizia
thiolychna Meyrick, Electrographa
thrasonella (Scopoli), Glyphipterix
thravonella [sic] Meyrick, Glyphipterix thrasonella
transversella (Walker), Glyphipterix

treitschkeana (Frölich), Glyphipterix bergstraesserella
trigonaspis Meyrick, Glyphipterix
trigonodes Arita, Glyphipterix
triguttella (Donovan), Glyphipterix thrasonella
tripedila Meyrick, Glyphipterix
triplaca Meyrick, Glyphipterix "triplaca"
tripselia Meyrick, Glyphipterix
triselena Meyrick, Glyphipterix
tungella Felder and Rogenhofer, Glyphipterix
umbilici Hering, Glyphipterix
uncta Meyrick, Glyphipterix
unguifera Meyrick, Glyphipterix
unifasciata Walsingham, Glyphipterix
urania Meyrick, Chrysocentris
urophora (Walsingham), Diploschizia
variata Meyrick, Glyphipterix
variella Zeller, Glyphipterix simpliciella
versicolor Meyrick, Glyphipterix
voluptella Felder and Rogenhofer, Glyphipterix
xanthoplecta Meyrick, Glyphipterix
xestobela Meyrick, Circica
xyridota Meyrick, Glyphipterix
xyridota Meyrick, Glyphipterix dolichophyes
zalodisca Meyrick, Glyphipterix
zelota Meyrick, Glyphipterix
zermattensis Amsel, Glyphipterix
zonella (Zetterstedt), Glyphipterix haworthana

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AN ADDITIONAL STUDY ON THE NESTING BEHAVIORS OF SPECIES OF *MISCOPHUS* (HYMENOPTERA: SPHECIDAE)

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Abstract.—Additional observations made on nesting females of *Miscophus* (*Miscophus*) *americanus* Fox, *M.* (*Nitelopterus*) *slossonae barberi* (Krombein), and *M.* (*Nitelopterus*) *s. slossonae* (Ashmead) in New York and Florida extend the range in variation in their ecologies and nesting behaviors. *Miscophus americanus* females nested in sand cliffs, left entrances open and oriented and brought prey to the nests in flight. Their nests were short and simple and were stored with 3–14 tiny, mostly *Theridion* spp. (Theridiidae). *Miscophus slossonae barberi* nested in flat sand, usually left entrances open and oriented by running around the entrances, and transported prey on the ground or in short, low flights. Their longer, simple nests were stocked with 5–14 tiny lycosids and salticids. *Miscophus s. slossonae* constructed the longest and deepest nests of the three taxa, and stored 7–8 tiny spiders of a variety of families (Theridiidae, Micryphantidae, Oxyopidae, Lycosidae, Gnaphosidae, Salticidae). This subspecies nested in flat sand, closed nest entrances or left them open during provisioning, oriented in flight or on the ground, transported prey in low, short flights or on the ground, and often took longer than a day to complete a nest.

In 1969 I summarized much of the known biological and behavioral information for the Nearctic and exotic *Miscophus*, including species in the subgenera *Miscophus* and *Nitelopterus*. Bohart and Menke (1976) encapsuled this information in three paragraphs, and Krombein (1979) summarized the known ecological data, prey records, and biological references for species of *Miscophus*. Neither compilation added much new information to the existing pool of data on the nesting behaviors of species of *Miscophus* simply because no studies of species in this genus were published during the 1970's except for a note on *Nitelopterus* (=*Miscophus*) *evansi* Krombein by Evans (1970). The intent of the present paper is to provide new information on species in both Nearctic subgenera in order to extend the range of biological knowledge for this little-studied group of wasps.

The species of *Miscophus* which are treated in this paper, their localities, dates of observation and collection, and associated ethological note numbers are as follows: *M.* (*Miscophus*) *americanus* Fox—Selkirk Shores St. Pk., Oswego Co., N.Y., 14 June 1971–22 August 1972 (MI 3-6, 8-13); Arcadia, DeSoto Co., Fla., 27 March 1972 (MI-7); *M.* (*Nitelopterus*) *slossonae barberi* (Krombein)—Archbold Biol. Sta., L. Placid, Highlands Co., Fla., 15 March–6 April 1973 (NI-21-24); *M.* (*Nitelopterus*) *s. slossonae* (Ashmead)—Arcadia, DeSoto Co., Fla., 8 April 1971–28 March 1973 (NI-17-20, 25). The wasps and prey have been deposited in the insect and invertebrate collections of the S.U.N.Y. College of Environmental Science and Forestry, Syracuse.

Miscophus (*Miscophus*) *americanus* Fox

Eleven nests were constructed into vertical sand cliffs. The nest at Arcadia, Fla., was situated halfway up a 2.4 m steep cliff, whereas the 10 nests at Selkirk Shores St. Pk., N.Y., were located from 18 to 76 ($\bar{x}$, 53) cm from the top of a 1.8 m high cliff. Although I was unable to locate their nests, provisioning females of *M. americanus* were seen flying to and from a 1 m high sand cliff near the entrance to Presque Isle St. Pk., Erie Co., Pa., during 4–9 July 1971.

Several females began nests in shallow pre-existing depressions in the cliff face or beneath overhanging rootlets in concealed situations. Two such nest entrances were only 1 cm apart, although the cells of these respective nests were separated by 3 cm.

Burrow construction components conformed to those described by Kurczewski (1969), although false starts were made less frequently when nesting in sand cliffs than when nesting in flat sand. The duration of burrow construction for four females averaged 35 (21–44) minutes.

All prey (32) of females of *M. americanus* brought to the nest were carried in flight. Nesting in sand cliffs may restrict females to practice this method of transport. Size of prey influenced the speed of flight but not type of transport. The mechanisms of prey carriage were similar to those described by Kurczewski (1969).

The period of time between 13 consecutive provisioning trips of two females averaged 10 (2–29) minutes. Neither size of prey nor position within the sequence influenced the period of time between such trips. Seven larger prey were taken into the open entrances, released 1–2 mm inside the burrows, and pulled in from inside after the wasps had turned around, whereas 11 smaller prey were transported directly into open burrows without females releasing the spiders. One female exited in flight from 3 to 30 ($\bar{x}$, 8.4; N = 10) seconds after entering with prey. The time between consecutive exits decreased steadily from 1130 hours (30 seconds) to 1326–1334 hours (3 seconds), perhaps a reflection of increased familiarity with the burrow confines and/or increased sand surface temperature.

Upon taking the last prey into the nest females of *M. americanus* briefly appeared headfirst inside the entrance, turned around, and reentered the burrow. From 5 to 9 minutes later they were observed in their entrances making nest closures. Details of the closure were as described by Kurczewski (1969), except for extensive use of the mandibles to break down sand from the walls of the burrows. Five closures were completed by females between 1315 and 1605 hours. They averaged 9.9 (8–15) minutes in duration. This closure activity culminated in burrows filled with loose sand for much of their lengths from the fully provisioned cells to within 1–5 mm of the entrances.

Ten nests of *M. americanus* were short, simple (spurless) and unicellular. Four nests exhibited some lateral curvature upon entering the cliff face, whereas six went in rather straight. The burrows coursed inward almost horizontally with most declining from 5 to 15° with the horizon. Nest entrances were 2.5–3.0 mm in diameter and the burrows, 2.0–2.5 mm. Burrow lengths ranged from 2.0 to 3.8 ($\bar{x}$, 2.8) cm, including cell length. The ellipsoid-shaped cells were 4–6 mm wide, 4–6 mm high and 6–12 mm long.

Females of *M. americanus* preyed almost totally on spiders of the family Theridiidae as follows: *Theridion differens* Emerton, 18 ad. ♀, 1 pen. ♂; 19 imm.; *T. flavonotatum* Becker, 2 ad. ♀; *T. murarium* Emerton, 22 imm.; *T. redimitum* (Linn.), 1 imm.; and, *T.* sp., 5 imm. In Florida one wasp provisioned partly with four immature *Araneus* sp. (Araneidae), an exceptional record. Many of the prey were moving the legs and extruding silk from the spinnerets.

Nine fully provisioned cells of *M. americanus* contained from 3 to 14 ($\bar{x}$, 7.7) prey per cell. The individual spiders ranged in weight from 0.5 to 5.9 ($\bar{x}$, 1.9; N = 67) mg. Four captor wasps averaged 4.4 (3.0–5.7) mg in weight. The contents of eight fully provisioned cells ranged in weight from 8.0 to 20.0 ($\bar{x}$, 14.7) mg.

The prey of *M. americanus* were placed variously in the cells as follows: ventral side upward, head inward, 15; dorsal side upward, head inward, 26; dorsal side upward, head outward, 13; sideways, head upward or downward, 8. No prey were placed ventral side upward and head outward. There was no particular pattern as to the exact positioning of these spiders within the cell, i.e., individuals positioned dorsal side upward and head inward were found at the back or front ends of the cell or toward the center.

The egg of *M. americanus* was attached to the spider as described and figured by Kurczewski (1969). Eggs measured 1.25–1.50 × 0.40–0.45 mm. In eight cells four eggs were attached to the base of the left side of the spider's abdomen and four to the base of the right side. The egg-bearing spiders were placed in the cells either dorsal side upward and head inward (6) or dorsal side upward and head outward (2). They were positioned in the cells near the back (3), middle (2), or front end (3). Spiders with eggs weighed 1.8–5.9 ($\bar{x}$, 3.2) mg and were the largest (3), second largest (3), third largest (1), or second smallest (1) individuals in the cells. In one cell there was an egg of the same size and shape as that of *M. americanus* on the floor in addition to the egg attached to the spider!

Miscophus (Nitelopterus) slossonae barberi Krombein

Three nests were excavated and examined in flat, bare, white sand at the Archbold Biological Station. Several other females were observed nesting in flat or sloping, bare, white sand near Lakes Annie and Placid, Highlands Co., Fla., during March and April 1973, but data were not gathered on these individuals.

Females searching for nesting sites made numerous false starts, especially in the morning between 1100 and 1200 hours (E.S.T.). Components of burrow construction were similar to those described by Krombein and Kurczewski (1963) and Kurczewski (1969). One wasp started a burrow in a depression in bare sand and completed it 1 hour and 58 minutes later. Females completing burrows exited headfirst, turned 180°, walked back and forth on or around the tumulus, entered and exited from the burrow from one to four times, and then began walking increasingly farther away from the entrance in circular or zig-zag routes, an apparent form of orientation. These movements increased in rapidity until the females flew off to hunt.

Prey transport involved a female grasping the spider with the mandibles by its forelegs or pedipalps, head forward and ventral side upward, and walking rapidly forward on the ground or making short, "hopping" flights using the wings. Several prey were released and abandoned when the provisioning wasps were attacked by foraging ants. Such females returned to their nests and immediately closed the nest entrances with sand. Some wasps periodically returned to their nests without prey, examined the open entrance and flew off or entered the burrow, exited several seconds later and flew away.

The size of prey influenced the manner in which the provisioning wasp entered her open nest. Females with 16 "smaller" prey went directly into their open nests without releasing the spiders, whereas wasps with 9 "larger" prey released the spiders just inside the entrances, went into the burrows, turned around and pulled the prey inside. Such wasps spent an average of 19 (5–42; N = 15) minutes between consecutive prey. These females reappeared in their entrances from 10 to 180 ($\bar{x}$, 49; N = 14) seconds after placing their prey in the nests. The longest periods of time were recorded near the end of the provisioning sequence.

Components of final closing the nest were essentially identical to those described for the nominate subspecies by Kurczewski (1969). Three final closures averaged 38 (27–46) minutes in duration. Closed nests contained burrows completely filled with sand. One female attempted to bring prey into a burrow that had been filled with sand and contained prey with one of the spiders bearing a wasp's egg!

The three nests of *M. slossonae barberi* contained straight or slightly curved burrows with diameters of 2 mm and ended in single cells. These burrows ranged from 4.9 to 6.1 ($\bar{x}$, 5.3) cm in length and from 2.9 to 3.9 ($\bar{x}$, 3.5) cm in depth, including cell length and height, respectively. The cells averaged 3.5 (3–4) mm high, 3.5 (3–4) mm wide and 5.5 (5–6) mm long. The diameter of the burrow entrance in all three nests was 2.5 mm.

The females preyed upon tiny wolf and jumping spiders as follows: LYCOSIDAE: *Pirata* sp., 1 imm.; *Schizocosa* sp., 1 imm. SALTICIDAE: *Habrocestum* sp. nr. *pulex* (Hentz), 2 ad. ♀, 6 ad. ♂, 1 imm. ♂, 15 imm. The spiders were incompletely paralyzed, moved their legs, and extruded silk from the spinnerets.

The three fully provisioned cells contained from 5 to 14 ($\bar{x}$, 8.3) prey per cell. The spider individuals ranged in weight from 0.2 to 2.8 ($\bar{x}$, 1.2; N = 26) mg. One wasp weighed 2.2 mg. The cell contents ranged in weight from 4.3 to 15.4 ($\bar{x}$, 9.2) mg.

The prey of *M. slossonae barberi* were placed in various positions within the cells as follows: ventral side upward, head inward, 9; dorsal side upward, head inward, 11; dorsal side upward, head outward, 3; and, sideways, head upward or downward, 2. None of the prey were positioned ventral side upward and head outward.

The egg of this subspecies was affixed to the spider's abdomen as indicated and figured for *M. americanus* by Kurczewski (1969). Eggs measured from 1.2 to 1.8 mm in length. All three eggs were affixed to the left sides of the spiders' abdomens and the three spiders with eggs were positioned dorsal side upward and head inward in the cells. The three spiders were located at the front or back end or in the middle of the cell. Egg-bearing spiders weighed from 1.4 to 2.2 ($\bar{x}$, 1.9) mg. They were the largest prey in each of the three cells.

Miscophus (*Nitelopterus*) *s. slossonae* (Ashmead)

Four nests were constructed into the white sand flats bordering the Peace River, west of Arcadia, Fla. One nest was dug into the slope of an ant-lion pit, near the top, another was concealed beneath two overhanging grass blades, a third into the edge of a cow's hoofprint, and a fourth beneath an overhanging *Mimosa* plant. A fifth wasp attempted to dig in a depression caused by a marking stake. Only one female attempted to nest in bare sand, devoid of vegetation or depressions.

Burrow construction components were identical to those described by

Kurczewski (1969). One wasp searched for only 10 minutes before remaining in one place and completing her burrow. She took 50 minutes to completion, beginning at 1159 and ending at 1249 hours (E.S.T.). She removed sand from the burrow to a distance of 20 mm from the entrance. The resulting tumulus was elongate-ovoidal in shape.

One wasp made a 2-second-long temporary closure of the nest entrance after completing the burrow, after which the entrance remained one-third open at the top. She then ran around the area of the entrance for 30 seconds and flew away. This female returned from her hunting excursions several times but never entered the burrow. Two other females made no closures of their entrances while obtaining a total of six prey. Another wasp, however, after leaving the nest open during her first two provisioning trips made a complete closure of the nest entrance as she obtained her third prey. After placing the spider inside, she exited and closed the entrance with sand. The duration of this closure was 25 seconds; she periodically interrupted five times to turn toward the entrance. This was followed by an orientation flight.

Another wasp opened her nest and entered at 1012 hours (E.S.T.), after spending the night in a short burrow 50 cm away. She exited, turned and entered her nest twice more, then made an 18-second-long temporary closure, including two turns toward the entrance. She, too, made an orientation flight following the closure. The female returned both without and with prey between 1042 and 1052 hours, each time closing the entrance with sand upon leaving. She brought two prey to the nest at 1101 and 1114 hours but did not close the entrance with sand upon leaving. The female made no other closures of this nest until she finally closed it after ovipositing at 1201 hours.

Other females observed later in the day (1400–1530 hours) made brief temporary closures of their nest entrances, which included turning toward the entrance one or more times, and culminated in low orientation flights, or, they left the nest entrance open between consecutive provisions and oriented by running around the entrance on the sand. In two cases females hunted spiders on the sand near their nest entrances. One wasp stung a small spider only 1.5 m from her entrance. Subsequent prey were captured even closer to the entrance in all directions of the compass.

Details of prey transport for this subspecies were described by Krombein (1964) and Kurczewski (1969). Smaller wasps with black and red abdomens brought prey on the ground, whereas one noticeably larger provisioning female with a mostly all-red abdomen made 30-cm-long flights. Females spent from 5 to 44 ($\bar{x}$, 16; N = 9) minutes between consecutive prey. Neither size of prey nor position within the provisioning sequence influenced the period of time between consecutive trips. Two larger prey were released inside the entrances by females and pulled in from inside the burrow, after the wasps had turned around. Eight smaller spiders were taken into the nests without being released or were released and taken in as described above. In the latter case most such releases were determined by a temporary closure of the nest entrance in which case the wasp had to relinquish the spider in order to remove the sand fill. But one release occurred with an open entrance prior to making the final nest closure.

Females of *M. s. slossonae* exited from 15 seconds to 3.5 minutes (N = 7) later. In the case of the wasp spending a long period of time inside the nest prior to exiting, such entries had been deterred by a sand-filled entrance, i.e., temporary closure. One female twice removed her nest closure without relinquishing the spider, i.e., she held the spider with the middle legs as she removed the sand fill with the forelegs.

Another wasp began her final closure after entering her open nest with prey at 1159 hours. The components were identical to those described for this subspecies by Kurczewski (1969). She completed filling the burrow and distributing sand on the area of the entrance at 1216, taking a total of 17 minutes for the closure. Females that did not begin and complete nests in a single day closed their burrow entrances completely with sand in late afternoon, returning often after several minute intervals to throw additional sand on the fill. They then moved 0.5–1.0 m away and dug short burrows in which they spent the night, facing head outward. Females emerged head first from these resting burrows usually between 0930 and 1030 hours (E.S.T.) and completed provisioning their nests after opening the entrances.

Nests of *M. s. slossonae* were moderately short, shallow and unicellular. Nests were either straight or curved considerably. Nest entrances and burrows were 1.5–2.0 mm in diameter. Four burrows averaged 7.8 (7.4–8.4) cm in length and 5.6 (4.9–6.0) cm in depth, including cell length and height. The elongate-ovoidal cells were 3.5–4.0 cm wide and 6–7 mm long.

Females of this subspecies preyed upon a variety of small spiders as follows: THERIDIIDAE: *Steatoda fulva* (Keys.), 1 imm. ♂. MICRYPHANTIDAE: *Grammonata* sp. nr. *texana* Banks, 1 ad. ♀; *Grammonata* sp., 5 imm. OXYOPIDAE: *Oxyopes salticus* Hentz, 1 imm. LYCOSIDAE: *Pirata* sp., 1 imm.; *Arctosa littoralis* (Hentz), 1 imm. GNAPHOSIDAE: *Micaria* sp., 1 imm. ♂. SALTICIDAE: *Pellenes* sp., 7 imm. Prey were incompletely paralyzed and moved their legs and emitted silk from the spinnerets.

Two completely provisioned nests contained 7 and 8 prey. Two unfinished nests held 5 and 2 spiders. Individual spiders weighed from 0.5 to 3.5 ($\bar{x}$, 1.3; N = 22) mg. Two wasps weighed 1.5 and 2.0 mg. The contents of two fully provisioned cells weighed 9.0 and 11.5 mg.

Prey of *M. s. slossonae* were placed variously in the cells as follows: ventral side upward, head inward, 8; dorsal side upward, head inward, 11; and, dorsal side upward, head outward, 3. No prey were placed ventral side upward and head outward or sideways. The contents of one cell with 7 prey exemplifies the heterogeneity of the prey positioning: 2, dorsal side upward, head outward at the back end; 3, dorsal side upward, head inward in the middle; and, 2, ventral side upward, head inward at the front end.

Eggs of *M. s. slossonae* were attached to the spiders as described and figured for *M. americanus* by Kurczewski (1969). Eggs ranged from 1.0 to 1.5 mm in length. Two eggs were affixed to the bases of the left sides of the spiders' abdomens. These prey were placed dorsal side upward and head inward in the middle of the cells. Spiders bearing eggs weighed 1.0 and 1.5 mg; these prey were the second largest individuals in the cells, in each case an imm. *Pellenes* sp.

DISCUSSION

Miscophus (*Miscophus*) *americanus, M.* (*Nitelopterus*) *slossonae barberi*, and *M.* (*Nitelopterus*) *s. slossonae* are multivoltine throughout much of their range. Even in upstate New York, *M. americanus* nests from mid-June through September. All species inhabit areas of sandy soil with sparse vegetation, preferring to build burrows in pits, depressions and hoof- and footprints. The nests observed in the present study were constructed from the sand surface. Whereas both subspecies of *M.* (*Nitelopterus*) *slossonae* preferred to nest in flat sand, *M.* (*Miscophus*) *americanus* dug nests into vertical sand cliffs. This is in sharp contrast with my earlier (1969) paper in which I reported *M. americanus* nesting in flat or slightly sloping sandy soils in New York and Florida.

The behavioral components involved in digging the burrows are similar for all species. Soil removal is accompanied by little or no leveling of the tumulus in front of the entrance. Females of *M.* (*Miscophus*) *americanus* spent less time during burrow construction than either subspecies of *M.* (*Nitelopterus*) *slossonae*, probably a reflection of the shorter burrows of the former species.

Upon completion of the burrow females of *M.* (*Miscophus*) *americanus* and *M.* (*Nitelopterus*) *slossonae barberi* left the nest entrance open as they went in search of prey. Some females of *M.* (*Nitelopterus*) *s. slossonae* left entrances open whereas other females, especially those nesting in late morning, made brief sand closures of their entrances prior to hunting. Both subspecies of *M.* (*Nitelopterus*) *slossonae* were observed making nest closures during the provisioning sequence, typical *slossonae* more frequently and under more varied conditions than *slossonae barberi*. Closures made by the latter subspecies were observed during periods of ant interference. The extent of temporary closure and the situations surrounding its presence or absence have been discussed in some detail by Krombein and Kurczewski (1963) and Kurczewski (1969), suffice it to say it is an extremely variable behavior.

Females of *M.* (*Miscophus*) *americanus* and both subspecies of *M.* (*Ni-

telopterus) *slossonae* were observed making orientation flights or orientation "runs" or "walks" following burrow construction and exit from the entrance. Orientation flights predominated in the case of *M. americanus* females nesting in sand cliffs, whereas those females nesting in flat or slightly sloping sand in an earlier study (Kurczewski, 1969) oriented predominantly by running or walking around the entrance. In *M. slossonae*, especially *s. slossonae*, females which made temporary nest closures usually oriented by flying, whereas those which left nest entrances open oriented by running around the entrances. In neither *M. s. slossonae* nor *M. slossonae barberi* was there a correlation between the form of orientation and the manner in which the prey was brought to the nest. *Miscophus americanus* females, which often oriented in flight in front of sand cliffs, brought prey to their nests in flight.

Females of *M.* (*Nitelopterus*) *s. slossonae* hunted and captured prey near their nest entrances, whereas those of *M.* (*Miscophus*) *americanus* often flew rather long distances in order to obtain prey. The former species preyed upon either wandering or web-spinning spiders on or near the sand surface which were transported to the nest mostly on the ground, whereas *M. americanus* females took mostly combfooted spiders from webs above ground and brought these prey to their nests in flight. In at least *M.* (*Nitelopterus*) *s. slossonae* the prey is stung and paralyzed incompletely. Incomplete paralysis of the prey involving spiders moving their legs and emitting silk from the spinnerets was the rule also in *M. slossonae barberi* and *M.* (*Miscophus*) *americanus*. In contrast to earlier studies of species in this genus (Cazier and Mortenson, 1965; Krombein and Evans, 1954; Krombein and Kurczewski, 1963), I found no evidence of amputation of the legs of the prey in the present study.

The mechanisms of prey transport among species in this genus have been summarized by Kurczewski (1969). The exact manner of transport and the extent of the flight varies with the species of wasp and the relative sizes of the females and their prey. *Miscophus* (*Nitelopterus*) *s. slossonae*, for example, practiced ground transport as well as carrying prey in short flights, whereas *M.* (*Miscophus*) *americanus* invariably transported prey in long, extensive flights. Both Kurczewski (1969) and Bohart and Menke (1976) have speculated on the relationship between the method of prey transport and the length of wings and degree of wing venation in some of the species.

In the species of *Miscophus* studied herein the manner in which prey was taken into the nest was dependent upon the absence or presence of a temporary closure and size of spider. Smaller spiders were usually taken directly into the open burrow, whereas larger prey were often released temporarily just outside or inside the entrance and pulled in from inside after the wasp had turned around.

The behavioral components involved in final closing the nests are similar

Table 1. Species of prey of some species of *Miscophus*.

Species of Prey	No. Specimens, Stage	Source
Miscophus (Miscophus) americanus		
THERIDIIDAE		
Theridion australe Banks	5 imm.	Kurczewski, 1969
Theridion differens Emerton	18 ad. ♀; 1 pen. ♂; 37 imm.	Kurczewski, 1969; MI-3-6, 8-13
Theridion flavonotatum Becker	2 ad. ♀	MI-7
Theridion murarium Emerton	24 imm.	Kurczewski, 1969; MI-3, 4, 6, 8, 9, 11, 13
Theridion redimitum (Linn.)	1 imm.	MI-3
Theridion sp.	5 imm.	MI-7
ARANEIDAE		
Araneus sp.	4 imm.	MI-7
Miscophus (Nitelopterus) slossonae barberi		
LINYPHIIDAE		
Meioneta formica (Emerton)	1 ad. ♀	Krombein and Kurczewski, 1963
LYCOSIDAE		
Pirata sp.	1 imm.	NI-24
Geolycosa sp.	1 imm.	Krombein, 1964
Schizocosa sp.	1 imm.	NI-22
Lycosa sp.	1 imm.	Krombein, 1964
SALTICIDAE		
Habrocestum sp. nr. *pulex* (Hentz)	2 ad. ♀; 6 ad. ♂; 1 imm. ♂; 15 imm.	NI-21-24
Pellenes sp.	1 imm.	Krombein and Kurczewski, 1963
Miscophus (Nitelopterus) s. slossonae		
THERIDIIDAE		
Steatoda erigoniformis (Cambridge)	10 imm.	Kurczewski, 1969
Steatoda fulva (Keys.)	1 imm. ♂	NI-17
MICRYPHANTIDAE		
Grammonata sp. nr. *texana* Banks	1 ad. ♀	NI-18
Grammonata sp.	5 imm.	NI-17-19
LINYPHIIDAE		
Meioneta formica (Emerton)	1 ad. ♀	Krombein and Kurczewski, 1963

Table 1. Continued.

Species of Prey	No. Specimens, Stage	Source
TETRAGNATHIDAE		
Tetragnatha laboriosa Hentz	4 imm.	Kurczewski, 1969
OXYOPIDAE		
Oxyopes salticus Hentz	1 imm.	NI-18
LYCOSIDAE		
Pirata sp.	1 imm.	NI-17
Pardosa sp.	1 imm.	Kurczewski, 1969
Arctosa littoralis (Hentz)	1 imm.	NI-20
Arctosa sp.	1 imm.	Krombein and Kurczewski, 1963
Lycosa sp.	4 imm.	Krombein and Kurczewski, 1963; Krombein, 1964
GNAPHOSIDAE		
Micaria sp.	1 imm. ♂	NI-20
SALTICIDAE		
Habrocestum pulex (Hentz)	1 imm.	Krombein and Evans, 1955
Metaphidippus galathea (Walck.)	1 imm.	Krombein and Evans, 1954
Metaphidippus sp.	1 imm.	Krombein, 1964
Pellenes sp.	7 imm.	NI-18, 19
DICTYNIDAE		
Dictyna altamira Gertsch and Davis	1 ad. ♀	Krombein and Kurczewski, 1963

in not only the species studied herein but also in many other species in both subgenera. The typical closing components in their exact sequence have been detailed by Kurczewski (1969).

The nests of most species of *Miscophus* are relatively short, shallow and unicellular, the exception being *M. evansi* (Evans, 1963, 1970) and some exotic species. Although data on nest dimensions, as summarized by Kurczewski (1969), indicated that the nests of *M.* (*Miscophus*) *americanus* and the two subspecies of *M.* (*Nitelopterus*) *slossonae* are similar, an analysis of the burrow lengths (and cell depths in *M. slossonae*) in the present study revealed that nests of *M.* (*Nitelopterus*) *s. slossonae* are longer and deeper than those of *M.* (*Nitelopterus*) *slossonae barberi* and about twice as long as those of *M.* (*Miscophus*) *americanus*. The differences between the nest dimensions of these species clearly reflect differences in the habitats in which they nested. Cells of *M. americanus* were longer, wider and higher than those of either subspecies of *M. slossonae* and prey biomass was usually greater.

Kurczewski (1969) summarized the prey specificity or lack thereof of species in the subgenera *Miscophus* and *Nitelopterus*. Most of the species appear to restrict their hunting activities to specific ecological situations where particular kinds of prey occur. Thus, *M.* (*Miscophus*) *americanus* preyed almost entirely upon combfooted web-spinning spiders belonging to the family Theridiidae (Table 1). The record of this species using immature araneids in Florida is exceptional, although females of *M. americanus* accepted anesthetized immatures of *Eustala* (Araneidae) when they were substituted at the nest entrance for prey theridiids (Kurczewski, 1969). Both subspecies of *M.* (*Nitelopterus*) *slossonae* were more general in their selection of prey. *Miscophus slossonae barberi* preyed upon small, immature Lycosidae and Salticidae (Table 1). One record of *Meioneta formica* (Linyphiidae) for this subspecies was exceptional (Krombein and Kurczewski, 1963). Thus, this subspecies of *M. slossonae* captures mostly wandering spiders on or near the sand surface. *Miscophus s. slossonae* is heterogeneous in its selection of prey, taking no less than nine families of spiders from a variety of ecological situations (Table 1). Underscoring this lack of specificity is the fact that members of the Theridiidae, Micryphantidae, Linyphiidae, Tetragnathidae and Dictynidae are web-spinners, whereas those of the Oxyopidae, Lycosidae, Gnaphosidae and Salticidae are wanderers.

The number of prey stored in the fully provisioned cells of the species of *Miscophus* does not vary inversely with the sizes of the prey, as indicated by Kurczewski (1969). This is substantiated by the diversity in the biomass as evidenced by the total weights of the prey contents, e.g., *M. americanus* (8–20 mg). Some of the fully provisioned cells of this species and of *M. slossonae barberi* contained much empty space whereas others were fully packed with prey. Variable weather conditions and/or prey abundance may influence the number of prey stored in the cells.

The prey of *M.* (*Miscophus*) *americanus* and both subspecies of *M.* (*Nitelopterus*) *slossonae* were placed in the cell variously with a preponderance of spiders positioned dorsal side upward and head inward (48), then ventral side upward and head inward (32) and dorsal side upward and head outward (19). No prey were positioned ventral side upward and head outward. Egg-bearing prey of these species were positioned either dorsal side upward and head inward (11) or dorsal side upward and head outward (2). The dorsal side upward positioning of the egg-bearing spider is related to the affixment of the egg, i.e., laterally on one side or the other to the base of the spider's abdomen (see Fig. 5, Kurczewski, 1969). The egg may extend well beyond the spider's dorsal abdominal terga and would become dislodged if the prey were placed ventral side upward on the floor of the cell. Egg-bearing spiders were placed in the cells either at the front (4) or back (4) ends or toward the middle (4), with no set pattern for either *M. ameri-*

canus or either subspecies of *M. slossonae*. This find is in agreement with previous studies on these species and *M. kansensis* (Kurczewski, 1969). Spiders with eggs were frequently larger than other prey in the cells or of the same size. Whereas the mean weights of prey for *M. americanus*, *M. slossonae barberi*, and *M. s. slossonae* were 1.9, 1.2, and 1.3 mg, those for egg-bearing prey of these species were 3.2, 1.9, and 1.3 mg, respectively.

Some unusual ovipositional behaviors were noted in the present study. One cell of *M. americanus* contained two eggs of the same size and shape, one affixed to the prey in the position typical of the genus and the other lying on the floor of the cell. It is possible that one egg was dislodged from a spider during oviposition, inducing the female to oviposit again on the same or another prey; or, a second wasp may have inadvertently entered the wrong nest and oviposited and this egg was dislodged by the resident female as she laid her egg. Despite the fact that Kurczewski (1969) stated that the egg of species of *Miscophus* is not deposited until the full complement of prey has been placed in the cell, the possibility of rare instances of progressive provisioning should not be overlooked. One cell of *M. americanus* was closed with only three spiders, an egg, and considerable empty space. Although I observed final closure of this nest the female or another wasp was collected with prey near the nest entrance minutes later. The final closure I observed may have been an extensive, several-minute-long temporary closure. A filled nest of *M. slossonae barberi* was excavated and contained five prey and an egg; shortly thereafter a female with prey arrived and attempted to enter this nest. Whether these observations are, in fact, variations of progressive provisioning behavior or misinterpretations of observations are unknown but they are certainly worth noting.

The behavioral observations presented herein substantiate Bohart and Menke's (1976) inclusion of the former genus *Nitelopterus* as a subgenus of *Miscophus*. My data reveal striking similarities among species in the subgenera *Miscophus* and *Nitelopterus* in nest-site selection, burrow construction, orientation, mechanisms of prey transport, final closure, nest architecture, prey size and their placement in the cell and position of egg attachment. Noteworthy behavioral differences between species in these subgenera include nesting microhabitat and related manner of prey transport, temporary closure activity and kinds (families) of prey. The latter are rather minor distinctions which are ecologically related. Similar differences can be found among species belonging to many genera, e.g., *Tachysphex*, *Ammophila* (Evans, 1959, 1965) and *Bembix* (Evans, 1957, 1966; Evans and Matthews, 1973, 1975).

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LITERATURE CITED

Bohart, R. M. and A. S. Menke. 1976. Sphecid wasps of the world. A generic revision. Univ. Calif. Press, Berkeley. 695 pp.

Cazier, M. A. and M. A. Mortenson. 1965. Studies on the bionomics of sphecoid wasps. IV. *Nitelopterus laticeps* and *Nitelopterus texanus* (Hymenoptera: Sphecidae). Pan-Pac. Entomol. 41: 21–29.

Evans, H. E. 1957. Studies on the comparative ethology of digger wasps of the genus *Bembix*. Comstock Publ. Assoc., Ithaca, N.Y. 248 pp.

———. 1959. Observations on the nesting behavior of digger wasps of the genus *Ammophila*. Am. Midl. Nat. 62: 449–473.

———. 1963. Notes on the prey and nesting behavior of some solitary wasps of Jackson Hole, Wyoming. Entomol. News 74: 233–239.

———. 1965. Simultaneous care of more than one nest by *Ammophila azteca* Cameron (Hymenoptera, Sphecidae). Psyche (Camb. Mass.) 72: 8–23.

———. 1966. The comparative ethology and evolution of the sand wasps. Harvard Univ. Press, Cambridge, Mass. 526 pp.

———. 1970. Ecological-behavioral studies of the wasps of Jackson Hole, Wyoming. Bull. Mus. Comp. Zool. 140: 451–511.

Evans, H. E. and R. W. Matthews. 1973. Systematics and nesting behavior of Australian *Bembix* sand wasps (Hymenoptera, Sphecidae). Mem. Am. Entomol. Soc. 20: 1–387.

———. 1975. The sand wasps of Australia. Sci. Am. 233: 108–115.

Krombein, K. V. 1964. Results of the Archbold Expeditions. No. 87. Biological notes on some Floridian wasps. Am. Mus. Novit. 2201: 1–27.

———. 1979. Larridae, pp. 1617–1650. *In* Krombein, K. V. et al., eds., Catalog of Hymenoptera in America North of Mexico, Vol. 2. Smithsonian Institution Press, Washington, D.C.

Krombein, K. V. and H. E. Evans. 1954. A list of the wasps collected in Florida, March 29 to April 5, 1953, with biological annotations (Hymenoptera, Aculeata). Proc. Entomol. Soc. Wash. 56: 225–236.

———. 1955. Annotated list of the wasps collected in Florida, March 20 to April 3, 1954 (Hymenoptera, Aculeata). Proc. Entomol. Soc. Wash. 57: 223–235.

Krombein, K. V. and F. E. Kurczewski. 1963. Biological notes on three Floridian wasps (Hymenoptera: Sphecidae). Proc. Biol. Soc. Wash. 76: 139–152.

Kurczewski, F. E. 1969. Comparative ethology of female digger wasps in the genera *Miscophus* and *Nitelopterus* (Hymenoptera: Sphecidae, Larrinae). J. Kans. Entomol. Soc. 42: 470–509.

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FOODS OF *CAULOPHILUS* SPP., PARTICULARLY THE BROADNOSED GRAIN WEEVIL, *C. ORYZAE* (GYLLENHAL), BASED ON INTERCEPTION RECORDS (COLEOPTERA: CURCULIONIDAE: COSSONINAE)

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Abstract.—Throughout the native range of the broadnosed grain weevil, *Caulophilus oryzae* (Gyllenhal), its most common agriculturally important food is avocado seed. Although *C. oryzae* has been introduced elsewhere, it is not an efficient stored product pest; it needs moist food. Infestation records confirm various other foods but not banana, whereas other Central American *Caulophilus* are intercepted primarily from banana detritus.

The main purpose of this note is to confirm that the broadnosed grain weevil, *C. oryzae* (Gyllenhal), uses numerous food resources in addition to avocado seeds. A second purpose is to comment on other members of the genus occasionally found with plant materials shipped to the United States from tropical America. This information is from specimen data in the National Museum of Natural History (USNM) and augments previously published records.

Caulophilus oryzae (Gyllenhal)

Kuschel (1962) reviewed the known species of *Caulophilus* Wollaston and recognized *C. oryzae* as the correct name for the species previously known as *C. latinasus* (Say). Junior synonyms are *Rhyncolus lauri* Gyllenhal, *Caulophilus sculpturatus* Wollaston, and *Cossonus pinguis* Horn.

Caulophilus oryzae has been reported as a pest of various plant materials (fruits—acorns, avocado, chickpeas, corn, millet; roots—ginger, sweet potato, taro) and, specifically, of stored products (Chittenden, 1911; Cotton, 1956; McFarlane, 1963; Richards and Herford, 1930). It is most frequently found associated with avocado seeds, and this led me to question that the avocado seed pest and the stored product pest really are the same. I sorted and examined materials in the USNM and prepared appropriate genital dissections, and I conclude that the various samples of *C. oryzae* are conspecific.

The following associations with infested plant materials are noted: avocado seeds—numerous records (Florida, California, Puerto Rico, Mexico, Guatemala). Corn—several records and series (Florida, South Carolina, Puerto Rico, Jamaica, Mexico). Pigeon peas—one series (Bahamas). Spanish pear—one series (Mexico). Seeds of mammy-apple—one series (Puerto Rico). Cola nuts—one series (Jamaica). Yam tubers—several series (Jamaica). Dry ginger roots—several series (Barbados, Jamaica). Philodendron seed pod—one specimen (Mexico). Other quarantine interceptions have been made from various orchids, poinsettia flowers, pineapples, and cycads, apparently as hitchhikers.

Caulophilus rufotestaceus (Champion)

The USNM has numerous individuals and series intercepted from banana leaves and detritus (throughout Mexico and Central America), one specimen from sweet potato (Panama), and one from orchids (Mexico).

Other *Caulophilus* Species

Caulophilus costatus Champion.—Four interception records from bananas (Guatemala, Honduras).

Caulophilus lineaticollis (Champion).—One interception record from bananas (Panama) and one from sweet potato (Panama).

Caulophilus quichensis (Champion).—One interception record, among series of *C. rufotestaceus,* from bananas (Nicaragua).

DISCUSSION

Kuschel (1962) included 16 described species in *Caulophilus,* all except the Nearctic *C. dubius* (Horn) from the American tropics. Most of these species were transferred from other genera (*Stenomimus* Wollaston, *Tytthomimus* Champion).

The records of the four *Caulophilus* species from banana detritus all date from a period in the mid-1930's, when special attention was paid to potential pests introduced with shipments of bananas. Since then, changes in shipping procedures such as refrigeration and cleaner cargoes have cut immigration considerably. There are similar associations with banana detritus for various members of the cossonine genera *Pseudopentarthrum* Wollaston, *Rhinanisus* Broun, and *Rhyncolus* Germar, although not in the numbers recorded for *Caulophilus rufotestaceus.* In contrast, despite the wide diversity of interception records for *C. oryzae,* none is an association with banana.

Bananas and banana-like plants (Musaceae, Araceae) with fleshy stem tissues are probable ancestral hosts for members of *Caulophilus* in general. Thus, the single record of *C. oryzae* from a philodendron seed pod (Araceae) may have significance, as may a similar record of an unidentified *Caulophilus* species. If stem tissues are the ancestral food source for members of the genus, adaptation to fruits of the same or related plants may be an intermediate step toward adaptation to such foods as avocado seeds. Interception records show that avocado seeds are the most frequent cultivated food source for *C. oryzae*, but more information is needed about noncultivated foods.

Despite its name, *C. oryzae* should not be considered an important stored product pest, at least of cereals, because it does not thrive on the commodity if well dried and undamaged. It does not feed on whole grain or seed that is dry and hard but will attack cracked or damaged seeds such as those already attacked by other stored product pests, and it is common on cereals only on the growing plant or just after harvest when the seed is still soft (Cotton, 1956; McFarlane, 1963; Quintana et al., 1960). In Florida avocado plantations, I found it to be abundant in seeds of fallen fruits which had opened husks and little remaining pulp; it is not a pest of the fruits, only of the seeds.

The native range of *C. oryzae* includes Guatemala, Mexico, and perhaps Florida and the West Indies (see Chittenden, 1911), regions inhabited by avocado and other species of *Persea* Gaertn. (Lauraceae). The beetle does not have the cosmopolitan distribution characteristic of the other stored product weevils (*Sitophilus* spp., Rhynchophorinae). To the north, *C. oryzae* ranges at least to South Carolina, probably a secondary extension. Records from California (Barrett, 1931), Hawaii (Beardsley, 1960), Madeira (type-locality of *sculpturatus*), Sweden (type-locality of *oryzae*), and elsewhere are the result of introductions. *Caulophilus oryzae* does not appear to be notably adept at colonization, and I suspect that permanent colonizations are likely only in avocado growing regions.

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LITERATURE CITED

Barrett, R. E. 1931. A new pest of avocado in California. Pan-Pac. Entomol. 7: 191.

Beardsley, J. W. 1960. [Note]. Proc. Hawaii. Entomol. Soc. 17: 176.

Chittenden, F. H. 1911. The broad-nosed grain weevil. (*Caulophilus latinasus* Say.). Papers on insects affecting stored products. U.S. Dep. Agric. Bur. Entomol. Bull. 96: 19–24.

Cotton, R. T. 1956. Pests of stored grain and stored grain products. Burgess Publ. Co., Minneapolis. 306 pp.

Kuschel, G. 1962. Some notes on the cossonine genus *Caulophilus* Wollaston with a key to the species (Coleoptera: Curculionidae). Coleopt. Bull. 16: 1–4.

McFarlane, J. A. 1963. An annotated record of Coleoptera, Lepidoptera, Hemiptera and Hymenoptera associated with stored produce in Jamaica. Tropical Agric. 40: 211–216.

Quintana, R., D. A. Wilbur, and W. R. Young. 1960. Insectos del gráno almacenado que infestan al maíz en el campo. Agric. Tec. Mex. 10: 40–43.

Richards, O. W. and G. V. B. Herford. 1930. Insects found associated with cacao, spices and dried fruits in London warehouses. Ann. Appl. Biol. 17: 367–395.

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ARBORICHTHONIUS N. GEN., AN UNUSUAL ENARTHRONOTE SOIL MITE (ACARINA: ORIBATEI) FROM ONTARIO

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Abstract.—***Arborichthonius styosetosus***, n. gen., n. sp., is proposed based on the holotype female collected from soil, St. Lawrence Islands National Park, Ontario. Unusual plesiomorphies include independent tibial and genual solenidia, astegasimy, and a partially divided femur I. Apomorphies include unusual erectile setae and bidactyly.

The suprafamilial group of macropyline oribatid mites forming the Enarthronota (unspecified rank) of Grandjean (1946c), or the synonymous cohort Euarthronota of Balogh and Mahunka (1979), constitutes an assemblage of families of which all but three are usually considered to represent isolated superfamilies. Except for the Brachychthoniidae which is rich in species, most are apparently relicts, represented by one or a few genera each with one or several nominal species. They often exhibit curious mixtures of rather primitive and specialized structures. With regard to certain characters which are quite fixed in the Brachypylina, for example secondary body divisions and leg chaetotaxy, striking diversity is manifest in the Enarthronota.

The purpose of this paper is to describe a new enarthronote mite exhibiting some of the most primitive character states found in the group, and at the same time, specializations not observed in any other oribatid mite taxon. A new genus is proposed, based on this species, but pending the conclusion of ongoing research on enarthronote phylogeny, no familial assignment will be suggested here.

The holotype (deposited in the Canadian National Collection, Ottawa) is an adult female collected from moist soil beneath moss, on Thwartway Island, St. Lawrence Islands National Park, Ontario, Canada, September 1976, by Evert E. Lindquist and Ian M. Smith, whom I thank for allowing me to study it. No other specimens are known, and due to flattening in the original slide mount general body shape and natural dimensions cannot be definitively described. Despite this, its morphological uniqueness justifies the proposals which follow. Morphological terminology used in the description is mostly that developed by F. Grandjean (see Travé and Vachon, 1975 for references).

Arborichthonius Norton, New Genus

Diagnosis.—With character states of the Enarthronota (Grandjean, 1969) qualified as follows. Distinctly astegasime. Subcapitulum anarthric. Body form dichoid, with light sclerotization. 32 pairs of notogastral setae. One secondary "type S" scissure (Grandjean, 1946c) present, bearing erectile setae e_1 and e_2. Setae f_1, f_2 erectile, inserted on adjacent intercalary sclerites in pair of circular unsclerotized depressions. No suprapleural band; sclerotization continuous between dorsal and lateral regions. Peranal segment absent. Epimera I with one pair of setae. Palp five segmented. Famulus with bract. Solenidial formula unique (see below). Solenidial coupling variously expressed: absent (seta *d* present) on genua I–III; present (imperfect) on genu IV: absent (*d* present) on tibia III; hyperperfect (*d* absent) on tibiae I and II. Femur I incompletely divided into basi- and telofemur. Ambulacrum with symmetrical bidactyly. Adoral seta or_2 enlarged, flattened; or_1 minute. No genital tracheae or eyes.

Type species.—*Arborichthonius styosetosus,* n. sp.

Arborichthonius styosetosus Norton, New Species

Etymology.—The Latin generic prefix *arbori* (meaning tree) and Greek trivial prefix *styo* (meaning to erect or stiffen) both refer to the dendriform erectile setae, f_1 and f_2.

General.—Approximate length of body, not including gnathosoma 245 μm (an estimate due to slightly crushed specimen). Integument, except as noted, lightly but distinctly sclerotized, light yellowish tan in color, finely and irregularly punctate. Unsclerotized arthrodial integument of subcapitulum, legs, and palp distinctly granulate (probable due to localized cerotegument); that of ventral and lateral regions weakly striate.

Prodorsum (Fig. 1).—Lateral regions of prodorsum unsclerotized. Aspis broader than long; posterior margin bends sharply ventrad before joining hysterosomal integument. Rostral tectum very narrow, hardly developed; anterior margin rounded, entire. Bothridial opening flush with surface of aspis; internal ridges circular in distal ½, longitudinal in sharply narrowed proximal ½; with distinctly porose walls. Sensillus (*ss*) of uniform diameter, subpectinate, bowed, with longest branches on convex side; branches nonbirefringent in polarized light. Interlamellar seta (*in*) inserted close to bothridium; slightly longer than sensillus, finely attenuate and sparsely barbed, probably directed vertically in life. Lamellar seta (*le*) and rostral seta (*ro*) progressively shorter than *in* and inserted closer to meson. Exobothridial setae differing in form; *xs* unusually large, attenuate, length intermediate between *in* and *le*, curving dorsad from insertion anterolaterad of bothridium; *xi* short, straight. Supracoxal seta *el* hollow, incorporated with integument (Fig. 2).

Notogaster (Fig. 1).—Suprapleural band absent[1]. Sclerotization weak or absent in anterolateral region. Anterior extent of sclerotization unclear, but greater medially than laterally, where it ends at level of setae c_2 and c_3. Setal pair c_2 inserted at ends of narrow dark, internal thickening or rib (*ti*) traversing the notogaster. Erectile setae e_1, e_2 large, extending beyond posterior margin of notogaster when in relaxed position; narrowly rounded distally; with non-birefringent barbs. Setae of pair e_1 both inserted on unpaired elongated intercalary sclerite; each seta e_2 on a laterally tapering sclerite clearly separated from the central one. Erectile setae f_1 and f_2 unusually large, dendriform, with thick birefringent branches; tips of branches acute or narrowly rounded. Seta f_2 inserted on a simple, trapezoidal intercalary sclerite; f_1 sclerite with a distinct straight or slightly curved medial arm. Setae ps_1, ps_2 broad, foliate; bladelike non-birefringent portion laterally serrated and occupying ⅔ the setal length (ps_2, Fig. 3) or entire and occupying ½ the setal length (ps_1); birefringent portion basally thick and bifurcated, with paraxial branch short, antiaxial branch long and attenuate. Remaining setae of several types: c_2 and c_3 relatively short, acute, with 1 or 2 barbs; *cp*, c_1, d_1, d_2, h_2 attenuate, with sparse, indistinct barbs; h_3 similar, but with barbs distinct; h_1 intermediate in size and general appearance between other *h* setae and setae of row *e*; ps_3 small, simple, inserted its length away from ventral margin of notogaster at level of posterior margin of genital plate. All but smallest of notogastral setae appear hollow, with very narrow central canal; canal extends into branches of f_1, f_2. Lyrifissures in form of round or elliptical cupule leading internally to dark, sclerotized tubular canal; *im* located posterolaterad of seta e_2 insertion; *ip* posterolaterad of f_2 insertion; *ih* located ventrally, anterolaterad of ps_3 insertion; *ips* on extreme ventromedial edge of notogaster at folded junction with anogenital region, slightly posteromediad of ps_3 insertion; lyrifissue *ia* not observed[2].

Ventral region.—Epimera of pairs I and II well defined, broadly convex; each half-epimere separated from its counterpart by narrow, unsclerotized medial groove. Apodemes ap_1 and ap_2 distinct. Epimera III and IV both flat; pair III indistinctly separated, fused medially with each other and posteriorly with epimera IV in proximal ⅔; pair IV medially separated by unsclerotized, striate integument. Apodemes ap_3, ap_4, and *apsj* absent. Epi-

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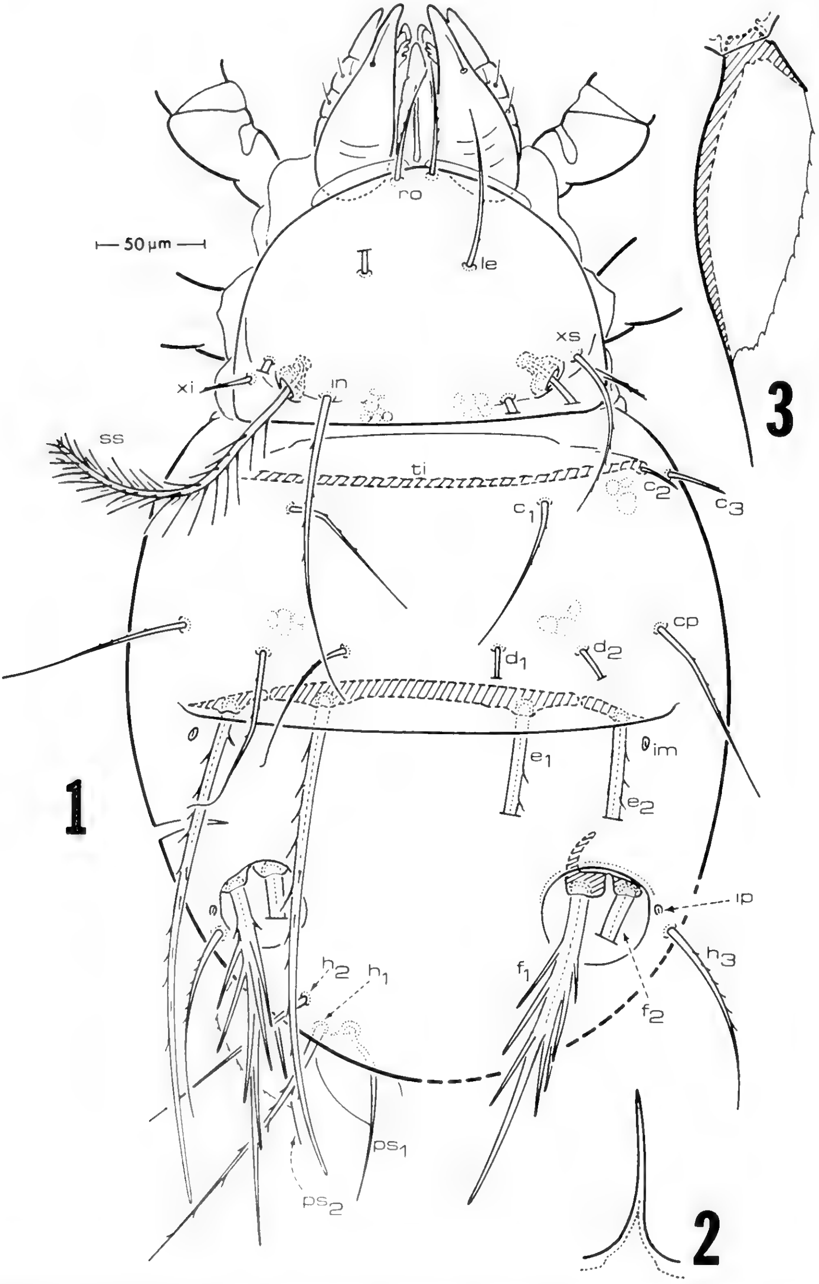
[1] The specimen could not be observed laterally, but there seems to be no lateral break in the sclerotization when viewed dorsoventrally.

[2] It may in fact be present in its usual position posteroventrad of seta c_3, but interference of legs III and IV precluded close examination of this area.



Figs. 1–3. *Arborichthonius styosetosus*, holotype female. 1, Dorsal aspect, slightly flattened and broken. 2, Supracoxal seta *el*, dorsal aspect. 3, Seta ps_2, dorsal aspect (hatched area is birefringent).

meral setation (I to IV): 3-1-3-4 on left, 3-1-3-5 on right. Genital plates with 3 simple setae in lateral row and 5 (left) or 4 (right) in a medial row. Anal plates immediately adjacent to genital plates and of approximately equal length; each with 2 setae, in anterior ½. Adanal plates fused behind anal plates, posterior separation from notogaster indistinct; 3 pairs of adanal setae. Aggenital region very lightly sclerotized posteriad of single aggenital seta and confluent with adanal plates; area approximately between aggenital seta and epimere IV unsclerotized. Ovipositor short, with distinctly plicate walls; with 9 pairs of setae, 3 pairs on dorsal lobe, 3 on each ventral lobe, and 3 pairs of coronal setae; ψ_1 and ζ_1 large and finely attenuate.

Gnathosoma.—Subcapitulum (Fig. 4) with no evidence of secondary articulations. With 4 pairs of subcapitular setae (*a, m, n, h*) of which *a* is clearly thickest and longest. Infrabuccal cleft long; ventral commissure (*Ji*) located slightly posteriad of palpal insertion. Dorsal integument of lateral lips with 4 dark ridges or "chevrons" which appear to radiate from the base of seta *a* in Fig. 4. A pair of sclerotized plates (Fig. 5) present near base of labrum, mediad of seta *m* as seen by transparency, which possess a row of denticles anteriorly and about a dozen longitudinal rows of small rectangular rasplike teeth; laterad, denticles become smaller and longitudinal rows shorter. Rutellum narrow, tridentate. Adoral setae heteromorphic; or_1 reduced to small, simple indistinct seta; or_2 long, acute, undulating, curving dorsodistally; or_3 distally broad, flattened, with a small, but distinct medial notch in the proximal ⅓. Sclerotized pharyngeal cupola (*Co*) present, dorsad of pharynx (*Ph*); without sagittal carina. Chelicera narrow, of the *Hypochthonius* type; each digit with 3 teeth, those of the movable digit concentrated distally. Cheliceral setae subequal; *cha* inserted dorsally, *chb* laterodorsally. Palp (Fig. 6) with setal formula (trochanter to tarsus) of 0-2-1-3-9[3]. Tarsal solenidion ω medium sized, baculiform, inserted on proximal ½ of tarsus, not reaching distally to tip of segment. Palpal setae smooth or with several small barbs; homologies, indicated in Figs. 6 and 7, with pattern similar to *Hypochthonius* (Grandjean, 1946a). Anteriad of ω setal alveoli with tear-drop shape, pointed anteriorly. Only large, distal compound seta (fused *ul′*, *ul″*, *sul*) eupathidic; small size precluded determining whether or not individual branches were hollow.

Legs.—Relatively short, simple in form (Figs. 7, 10, 11, 12); lengths (base of trochanter to base of claws) of legs I to IV in proportions 1.3:1.0:1.0:1.2. Basi-telofemur division of leg I indicated by region of non-granulate, unsclerotized integument, broadest antiaxially (Fig. 8), narrowest paraventrally (Fig. 7), with 2 parts of femur joined by region of sclerotized integument extending from dorsal midline midway down paraxial face; setae *d*,

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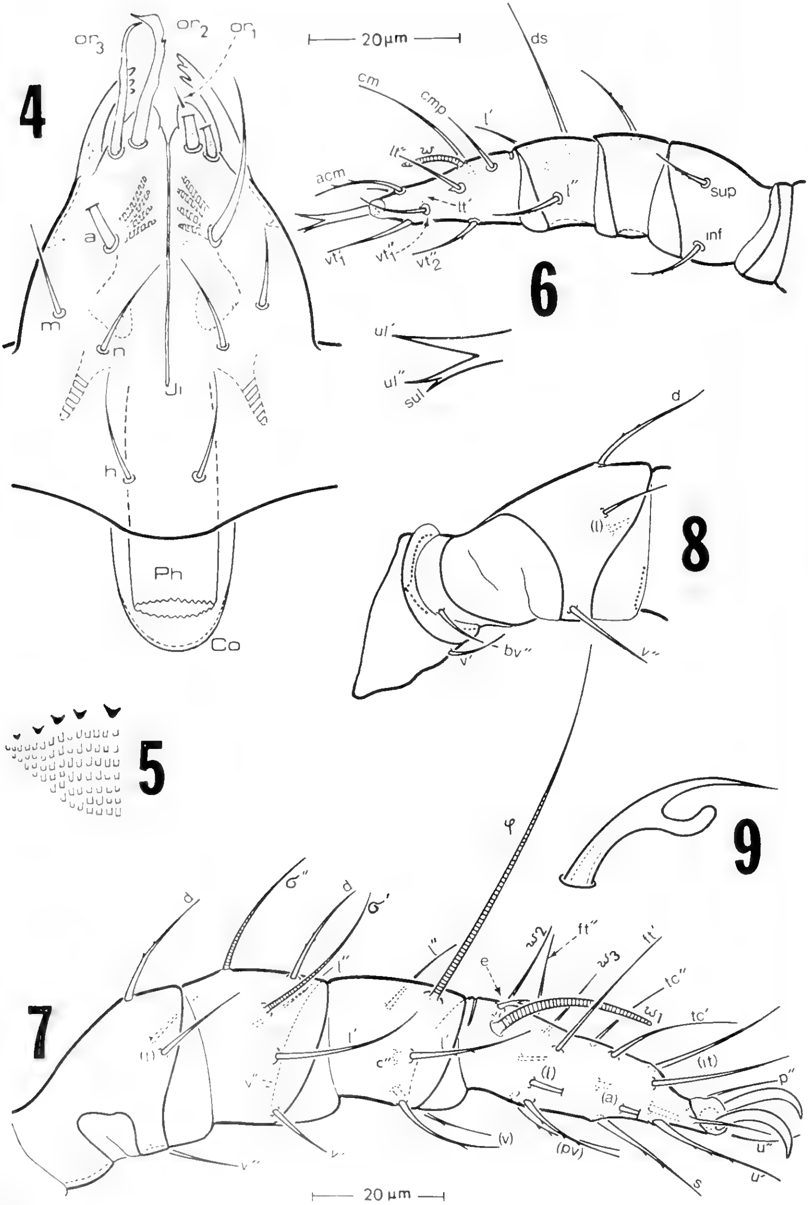
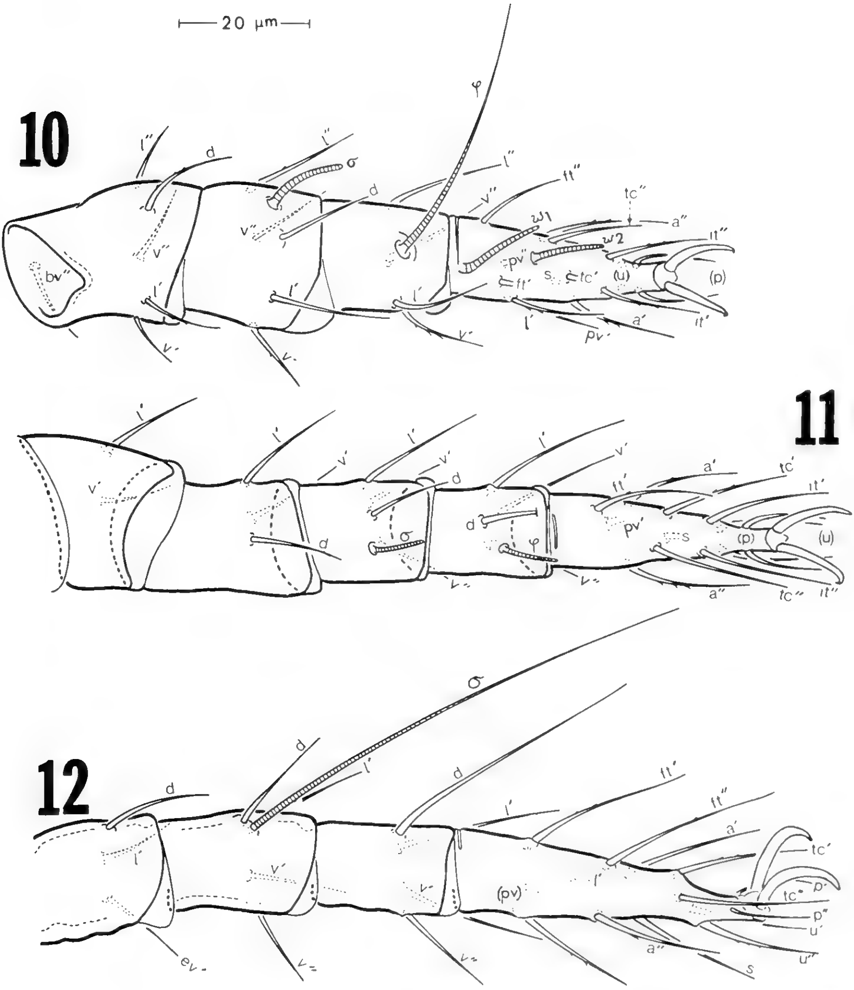
[3] If the branches of the compound eupathid are counted separately, the formula is 0-2-1-3-11.



Figs. 4–9. *Arborichthonius styosetosus*, holotype female. 4, Subcapitulum, ventral aspect. 5, Internal plate of subcapitulum. 6, Palp (same scale as Fig. 4), antiaxial aspect, with enlarged distal eupathid. 7, Leg I (minus trochanter), paraxial aspect. 8, Trochanter and femur I, antiaxial aspect. 9, Famulus.



Figs. 10–12. *Arborichthonius styosetosus*, holotype female. 10, Leg II (minus trochanter), dorsal aspect. 11, Leg III, dorsal aspect. 12, Leg IV (minus trochanter and base of femur), paraxial aspect. Seta *l*′ of tarsus absent on other leg IV.

l′, *l*″, *v*″ on telofemur, *bv*″ on basifemur. Ambulacra symmetrically bidactyl; no trace of medial claw or birefringent vestige. Setal formulae (trochanter to tarsus, famulus included) as follows: leg I (1-5-5-5-18); leg II (1-6-5-4-16); leg III (2-3-4-4-13); leg IV (2-3-4-4-13 or 14). Probable setal homologies indicated in illustrations. Many leg setae appear to have thin, inconspicuous central canal, at least near base. Famulus (Fig. 7, *e*, Fig. 9) bifurcate, with ventral branch curved, somewhat spatulate, dorsal branch in form of overhanging bract. Proral setae (*p*) smooth, with large central canal, the only well defined eupathids on tarsus I; subunguinal (*s*, eupathidic in most oribatid mites) similar to other tarsal setae. Solenidial formulae (genu to tarsus) as follows: leg I (2-1-3); leg II (1-1-2); leg III (1-1-0); leg IV (1-0-0). Three are long, tactile: tibial solenidia ϕ I and ϕ II and genual solenidion σ IV. Remaining solenidia baculiform (ω_1I, ω_2II, ω_1II, ϕ III, σ III, σ IV) or piliform (ω_2I, ω_3I, σ'I, σ''I). Seta *d* coupled to σ on leg IV, in adjacent but separate alveolus. Setae *d* absent on tibiae I and II.

Discussion

Unusual Pleisomorphies

1. Independence of leg setae *d*.—*Arborichthonius styosetosus* is one of the few Enarthronota which do not completely exhibit the derived close association, or coupling, of genual and tibial solenidia (on legs where they exist) with normal setae (usually *d*) of the respective segments. Some terminology helpful in discussing such couplings can be defined as follows: 1) Imperfect coupling occurs when the seta and solenidion are inserted in separate, but adjacent alveoli; 2) perfect, or normal coupling occurs when both are inserted in a common alveolus, although the seta may be small and regressive, or even fused to the solenidion; 3) hyperperfect coupling occurs when the normal seta has regressed to the point of dissappearing, leaving only the solendion, which is typically very large and tactile in form. Hyperperfect coupling may be the culmination of an ontogenetic trend, as seen in certain brachypyline oribatid mites (such as *Epidamaeus*) where *d* becomes gradually smaller in the immature instars and is absent in the adult instar. It also appears to culminate a similar phylogenetic trend, with the result that seta *d* may be absent in all instars, as is common in poronotic Brachypylina. Grandjean (1946b) has called these two apomorphies the *Scutovertex* stage and *Galumna* stage, respectively. It is clear, however, that we are dealing with grades of evolutionary development, which like many regressive apomorphic states, have been reached independently in multiple lineages.

Arborichthonius styosetosus exhibits several grades of coupling. There is none on genua I–III and tibia III, where seta *d* and the respective baculiform solenidion are independent and distant. Imperfect coupling is found on genu IV, where solenidion σ is tactile. Hyperperfect coupling is found on tibiae I and II; whether or not this develops during ontogeny is not known. The absence of coupling on one or more genua or tibiae (where solenidia are present) is known in only three other enarthronote species; these comprise the superfamily Pterochthonioidea (Grandjean, 1948, 1950; Travé, 1967). *Pterochthonius* exhibits perfect and hyperperfect coupling, as well as independence of seta *d*, whereas all setae *d* are independent in *Atopochthonius* and *Phyllochthonius*. Among non-enarthronote oribatid mites independent setae *d* (on genua and tibiae with solenidia) are found only in the Palaeosomata and the genera *Eulohmannia* and *Elliptochthonius*, where coupling is totally absent, and *Nehypochthonius*, *Parhypochthonius*, *Gehypochthonius*, and *Perlohmannia*, where coupling is only found on certain legs.

Although the ultrastructural proof is not yet available, it is reasonable to suggest that the eventual result of the development of coupling and ontogenetic or phylogenetic loss of the normal seta is a gradual takeover of dorsal mechanoreceptive function by the large, flagellate, tactile, chemoreceptive solenidion. Ancestrally, chemoreceptive and dorsal mechanoreceptive functions were presumably performed by the separate structures. From a mechanoreception standpoint, the advantage of coupling, particularly the hyperperfect type, may be that solenidia, which are hollow (and presumably less dense than normal setae) and elastic, may be less prone to breakage than similarly sized flagellate normal setae, which are solid and more brittle.

2. Solenidial formulae.—Also rather primitive is the rich complement of solenidia; next to *Atopochthonius* and *Phyllochthonius*, is the least regressive known in the Enarthronota. Among all known Oribatei (Grandjean, 1964) the specific formula of *Arborichthonius* is unique.

3. Rostral tectum.—*Arborichthonius* is one of the few enarthronote genera to retain the ancestral astegasime condition, whereby the rostral tectum is poorly developed, not fully covering the retracted mouthparts from above. Some Brachychthoniidae, such as *Liochthonius* are astegasime (Grandjean, 1963), as is the haplochthoniid genus *Amnemochthonius* (Grandjean, 1948). Both genera contain very small and incompletely sclerotized species which are regressive in many characters; whether or not the astegasime condition is also a result of regressive loss of rostral sclerotization is not clear in these groups. *Arborichthonius* maintains astegasimy despite light but relatively uniform general sclerotization.

4. Divided femur I.—This is one of the most interesting character states exhibited by *Arborichthonius*. Within the Oribatei, divided femora were known only in the Palaeosomata and are considered ancestral to the typical single femur formed by the integration of these two segments (Grandjean, 1954b). *Arborichthonius* exhibits a partially divided femur (Figs. 7, 8); the separation is incomplete in the paradorsal region and appears, in effect, to form a poorly defined hinge. Is this subdivision ancestral or secondarily derived by localized desclerotization? There is little evidence to support either conclusion and what does exist is somewhat contradictory. The central placement of the division and femoral chaetotaxy support the former conclusion; seta *bv″* is a basifemoral seta in the Palaeosomata, *d*, *l′*, *l″* and

v'' are telofemoral setae (Grandjean, 1954b). Secondary desclerotization might have produced a deviant pattern of setal distribution between the two parts. Also, the fact that the division is on the first leg and not the others is consistent with Grandjean's view on retardation of character appearance; in the Palaeosomata leg I develops the division earlier than the other legs and would be the last to lose this character if retardation was occurring in phylogenetic time. On the other hand, the presence of smooth articulating integument, in contrast to the granulate arthrodial integument between other leg segments, is consistent with a hypothesis of secondary desclerotization.

Unusual Apomorphies

1. Notogastral setae.—Like certain other Enarthronota, *Arborichthonius* has hypertrophied notogastral setae which the mite can raise and lower. The evidence for this is in the nature of their insertions. In sclerotized Enarthronota, erectile setae always insert on an intercalary sclerite which is bordered anteriorly and posteriorly by unsclerotized integument. In previously described species these intercalary sclerites are associated with one of the transverse notogastral scissures characteristic of the Enarthronota, such that when the notogastral plates immediately in front of and behind the scissure are pulled apart, presumably by hysterosomal distension but possibly by bending the hysterosoma ventrally, the unsclerotized connective integument is stretched and the associated setae erected (Grandjean, 1931). Grandjean (1946c) has called this kind of scissure "type S." *Atopochthonius*, *Phyllochthonius* and certain Palaeosomata have erectile setae which apparently function in a similar way, except that there are no articulating notogastral plates and erection appears to be simply a result of general stretching of gastronotic integument by hysterosomal distension (Grandjean, 1948). *Arborichthonius* exhibits a type S scissure bearing erectile setae e_1 and e_2. Although the three dimensional body shape of the *Arborichthonius styosetosus* holotype is difficult to determine, due to flattening on the microscope slide, the fact that the intercalary sclerite bearing the setae of pair e_1 is not divided is evidence that the mite is rather flat in life. Grandjean (1948) has noted that separation of intercalary sclerites, such as is found between all other such sclerites of *Arborichthonius*, is necessary in convex mites in order to avoid cuticular distortion when setae are erected.

Unlike other known sclerotized enarthronote mites, *Arborichthonius* has erectile setae which are not associated with a type S scissure. Setae f_1 and f_2 are inserted in paired circular regions of unsclerotized integument which are concave when setae are in their resting (horizontal) position. The erectile nature is certain because of the adjacent, but independent intercalary sclerites on which they insert. Hysterosomal distension presumably causes the unsclerotized integument to bulge outward, erecting the four setae.

Foliose setae ps_1 and ps_2, while not erectile, are unlike any known in other oribatid mites. Combined with the large dendriform setae of row *f*, they give the posterior region a general appearance more characteristic of certain Scutacaridae (Prostigmata) than an oribatid mite.

2. Pharyngeal cupola.—The most complex, specialized pharyngeal structure known in oribatid mites is found in the enarthronote superfamily Cosmochthonioidea and the derivative Protoplophoridae (Grandjean, 1946c, 1954a, 1962). Included in this aspiratory apparatus is a thin, ventrally concave sclerotized internal plate on which the dilator muscles of the pharynx originate. Because of the association with pharyngeal musculature, this plate, or cupola, appears to be a derivative of the epistome of other arachnid groups. *Arborichthonius, Atopochthonius* and *Phyllochthonius*, while lacking most of the pharyngeal specializations of cosmochthonioid mites, do exhibit a thin cupola dorsad of the pharynx, although it is not as well developed as in the latter group.

3. Adoral setae.—*Arborichthonius* belongs to a small group of Enarthronota with unusual adoral setae; this group also includes *Hypochthonius, Hypochthoniella, Atopochthonius, Phyllochthonius, Mesoplophora,* and *Archoplophora*. Typically, seta or_1 is highly reduced or vestigial; or_2 is large, flattened, spatulate, or otherwise specialized, but always exhibits an unusual medial notch somewhere near its midpoint; or_3 is also large, but attenuate except in the later two genera. This combination of adoral modifications appears to be a synapomorphy.

4. Bidactyly.—Few oribatid mites are symmetrically bidactyl. Except for *Gehypochthonius rhadamanthus* Jacot and the enarthronote genera *Arborichthonius, Atopochthonius,* and *Phyllochthonius*, the only known bidactyl oribatid mites are those in which one of the lateral claws has been lost (Grandjean, 1939). These four taxa have well developed lateral claws as adults but not even a vestige of a central claw. One can suggest that this is an evolutionary grade a step beyond that of *Acaronychus, Eulohmannia, Nehypochthonius, Elliptochthonius, Parhypochthonius,* and *Gehypochthonius xarifae* Strenzke in which the central claw is highly reduced in size. The presence of symmetrical bidactyly in the Enarthronota as well as both bidactyly and centrally regressive tridactyly in the genus *Gehypochthonius*, suggests that symmetrical bidactyly has appeared in more than one lineage.

LITERATURE CITED

Balogh, J. and S. Mahunka. 1979. New taxa in the system of the Oribatida (Acari). Ann. Hist.-Nat. Mus. Natl. Hung. 71: 279–290.

Grandjean, F. 1931. Observations sur les oribates (2^e série). Bull. Mus. Natl. Hist. Nat. 3: 651–665.

———. 1939. L'évolution des ongles chez les oribates (acariens). Bull. Mus. Natl. Hist. Nat. 11: 539–546.

———. 1946a. Au sujet de l'organe de Claparède, des eupathidies multiples et des taenidies manidublaires chez les acariens actinochitineux. Arch. Sci. Phys. Nat. Genève 28: 63–87.

———. 1946b. La signification évolutive de quelques caractères des acariens (1re série). Bull. Biol. Fr. Belg. 79: 297–325.

———. 1946c. Les Enarthronota (acariens). Première série. Ann. Sci. Nat. Zool. 8: 213–248.

———. 1948. Les Enarthronota (acariens) (2^{e} série). Ann. Sci. Nat. Zool. 10: 29–58.

———. 1950. Les Enarthronota (acariens) (3^{e} série). Ann. Sci. Nat. Zool. 12: 85–107.

———. 1954a. Les Enarthronota (acariens) (4^{e} série). Ann. Sci. Nat. Zool. 16: 311–335.

———. 1954b. Sur les nombres d'articles aux appendices des acariens actinochitineux. Arch. Sci. (Genève) 7: 335–362.

———. 1962. Nouvelles observations sur les oribates (2^{e} série). Acarologia 4: 396–422.

———. 1963. Sur deux espèces de Brachychthoniidae et leur développement (oribates). Acarologia (Paris) 5: 122–151.

———. 1964. La solénidiotaxy des oribates. Acarologia (Paris) 6: 529–556.

———. 1969. Considérations sur le classement des oribates. Leur division en 6 goupes majeurs. Acarologia (Paris) 11: 127–153.

Travé, J. 1967. *Phyllochthonius aoutii* nov. gen., nov. spec., un Enarthronota (acarien oribate) nouveau de Côte d'Ivoire, avec la création d'une superfamille nouvelle, Phylochthonoidea. Zool. Meded. (Leiden) 42: 83–105.

Travé, J. and M. Vachon. 1975. François Grandjean, 1882–1975 (Notice biographique et bibliographique). Acarologia (Paris) 17: 1–19.

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NEW SPECIES OF *UROSIGALPHUS* (HYMENOPTERA: BRACONIDAE) FROM MEXICO

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Abstract.—Two new species of *Urosigalphus* subgenus *Neourosigalphus* Gibson are described, ***yucatanensis*** and ***meridianus***. A key to Mexican and Central American species is presented.

The subgenus *Neourosigalphus* was established by Gibson (1972a) and now includes 23 species of which four are known from Mexico and Central America (Gibson, 1972b). Two new species of this subgenus, from Mexico, are described in this paper. Both belong to a group of *Neourosigalphus* that bear carapace tubercles and have 14 antennal segments. They do not resemble previously described species from Mexico but do resemble some South American species.

KEY TO SPECIES OF THE SUBGENUS *NEUROSIGALPHUS* FROM MEXICO AND CENTRAL AMERICA

1\. Carapace with apical tubercles; 14 antennal segments 4
– Carapace without apical tubercles; 15 or 16 antennal segments 2
2\. Antenna 15 segmented; antenna dark brown; hindfemur testaceous 3
– Antenna 16 segmented; antenna medium brown, hindfemur red brown .... *avocadoae* Gibson
3\. Palpi yellow; tegula dark testaceous, mesopleuron impunctate centrally .... *punctifrons* Crawford
– Palpi brown to dark brown, tegula dark red black, mesopleuron sparsely punctate centrally .... *neopunctifrons* Gibson
4\. Carapace tubercles long and well developed, 0.2 mm long (Fig. 3), ♀ with ovipositor as long as carapace length .... *flavens* Gibson
– Carapace tubercles short, less than 0.12 mm long (Figs. 1, 2), ♀ with ovipositor ⅔ as long as carapace length 5
5\. Palpi yellow; wings tinted brown; hindcoxa orange .... *yucatanensis*, new species

– Palpi light to medium brown; wings clear; hindcoxa brown .... *meridianus,* new species

Urosigalphus (Neourosigalphus) yucatanensis **Gibson, New Species**

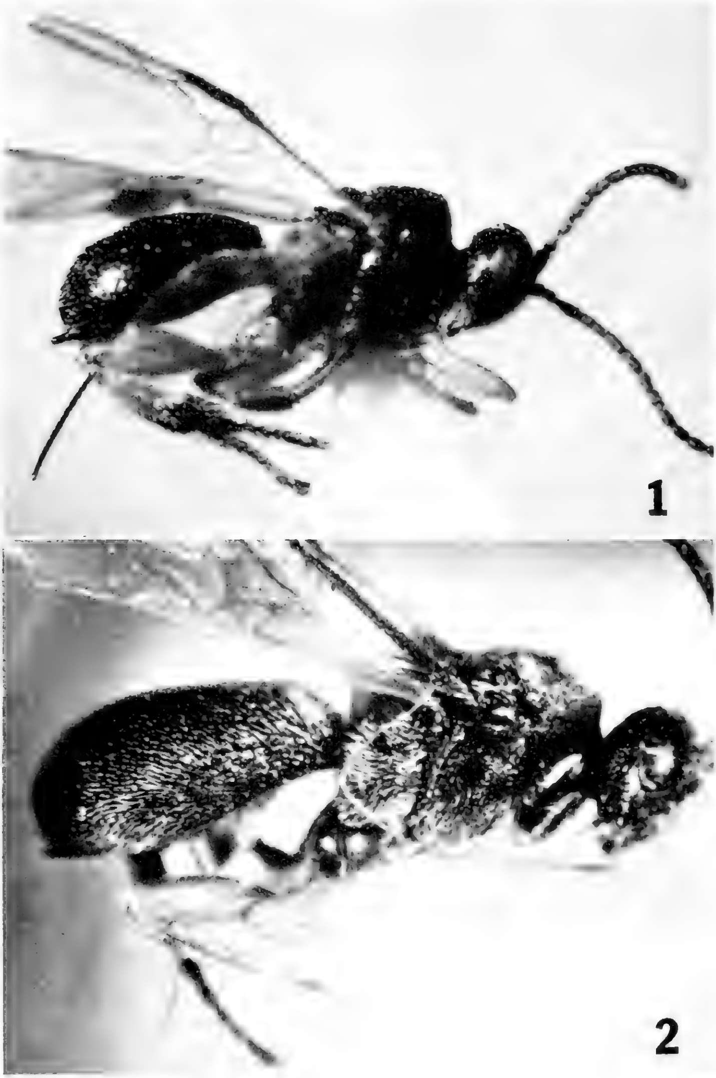
Fig. 1

General features.—Length 2.5 mm. Head and thorax deep red brown; carapace dark red brown; abdomen brown; clypeus red apically; labrum rufotestaceous; mandible rufotestaceous, with red base and apex; palpi pale yellow; antenna medium brown, lighter ventrally and on scape and pedicel. Fore- and midlegs yellow tan; hindcoxa and femur orange and hindtibia and tarsus medium brown. Tegula light red brown. Wings tinted brown, with brown hairs, costa light brown basally and medium brown apically; stigma dark brown; the remaining veins medium brown distally but paler basally.

Female.—*Head:* General anterior outline roundly quadrate. Vertex finely rugoso-punctate, temples and genal regions finely punctured. Lower face rounded, evenly finely punctate; fronto-clypeal groove with an oval anterior tentorial pit near each end. Clypeus elongate quadrate; lower central margin gently concave. Mandible teeth long and narrow, outer surface rugose. Ocelli circular, interocellar area slightly raised. Antennal scapes well separated with area between fossae finely rugoso-punctate and with a shallow, broad, finely punctate antennal sulcus extending to rear ocelli. Antenna 14-segmented; scape long and relatively slender, inner margin slightly rounded; pedicel amost ½ as long as scape. Occipital carina complete.

Thorax: Unevenly punctate. Mesonotum fairly regularly punctate, general surface uneven; notaulices broad, deep, with large foveae, area of convergence broad, rather quadrate, depressed, with large carinate punctures; median lobe densely finely punctate with a small, short central carina anteriorly; lateral lobes gently flattened, finely punctured with a lateral border of carinate punctures; posterolateral carina weakly flangelike. Scutellar groove with 5 dissecting carinae. Scutellum roundly trigonal in dorsal profile, rugoso-carinate; posterior surface abruptly sloped. Propodeum flat posteriorly with a strong transverse carina; central dorsal carina absent, transverse carina proceeds down both sides in an arc to the point of abdominal articulation; dorsal surface narrow with irregular rugae delimiting irregular depressions; posterior surface roughly and densely rugoso-punctate; lateral areas coarsely rugoso-punctate. Mesopleuron punctate; middle central area impunctate, lower anterior area with large carinate punctures in a mesopleural groove; mesosternum punctate with very small longitudinal carinae. Lateral regions of pronotum coarsely punctate, upper posterior corner with a slight bend and with triangular area behind with 2 large punctures separated by a carina. Wings tinted brownish; submedian cell longer than the median basally.

Abdomen: Carapace oval in dorsal and lateral views, longitudinally ru-



Figs. 1–2. 1, *Urosigalphus* (*Neurosigalphus*) *yucatanensis*, type. 2. *U.* (*N.*) *meridianus*, type.

goso-punctate anteriorly, densely punctate and shiny posteriorly, apex with 2 small apical spines, 0.12 mm long (Fig. 1). Ovipositor 1.0 mm long, nearly ⅔ as long as carapace, ovipositor sheath reddish brown.

Male.—Unknown.

Holotype.—♀, Progreso, Yucatán, Mexico; 23-VII-62; H. E. Evans Collector. In MCZC.

Fig. 3. *Urosigalphus* (*Neurosigalphus*) *flavens*.

Distribution.—Mexico: Yucatán.

Biology and host.—Unknown.

Urosigalphus (*Neourosigalphus*) *meridianus* Gibson, New Species
Fig. 2

General features.—Length 3.0–3.5 mm. Head and thorax black; carapace dark red black to black; abdomen medium to dark red brown; clypeus black, labrum maroon to red black; mandible tan with base and apex dark red; palpi light to medium brown, antenna medium to dark brown. Fore- and midlegs yellow tan; hindfemur yellow tan to orange, hindtibia medium brown and tarsus dark brown; all coxae usually brown to dark brown, darker than femora. Tegula dark red brown or red black. Wings clear, hyaline with brown hairs, costa, stigma, and veins medium to dark brown distally but veins becoming paler basally.

Female.—Differs from *yucatanensis* as follows: *Head:* Temples, and genal regions finely to moderately rugoso-punctate. Lower face evenly finely rugoso-punctate; anterior tentorial pit round. Mandible teeth long but broad. Area between antennal fossae finely rugoso-punctate and bicarinate with a small central carina immediately anterior to median ocellus, and a rugoso-punctate antennal sulcus.

Thorax: Notaulices broad but shallow with moderate punctures, area of convergence depressed with moderate to large punctures; lateral lobes densely finely punctured with a foveolate lateral carina. Scutellar groove with 3 dissecting carinae. Scutellum coarsely rugoso-punctate throughout. Propodeum flattened posteriorly with a moderately strong transverse carina; central dorsal carina short and moderate, lateral areas rather irregularly carinate and rugoso-punctate. Lower anterior area of mesopleuron with moderate punctures in a mesopleural groove; mesosternum punctate with a line of large sized punctures along center line and transverse carinae distally. Lateral regions of pronotum irregularly punctured, medially sparsely punctate. Wings clear.

Abdomen: Carapace elongate oval in dorsal and lateral views, rugoso-punctate posteriorly, apex with small apical spines, 0.04 mm long (Fig. 2). Ovipositor 1.2 mm long, ⅔ as long as carapace, ovipositor sheath reddish black.

Male.—Unknown.

Holotype.—♀, Mexico. Yuriria, Guanajuato, 6500′, 7-VIII-62, H. E. Evans Collector. In MCZC.

Paratypes.—1 ♀ Patzcuaro, Michoacán, 15-VII-1965, H. E. Evans; 1 ♀ Chilpancingo, Guerrero, 3800′, 30-VII-1962, H. E. Evans (in MCZC). 1 ♀ Guadalajara, Jal., 23-28-VII-1965, H. E. Evans (in Rijksmuseum van Natuurlijke Historie).

Distribution.—Mexico: Guanajuato, Michoacán, Guerrero, Jalisco.

Biology and host.—Unknown.

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LITERATURE CITED

Gibson, L. P. 1972a. Revision of the Genus *Urosigalphus* of the United States and Canada (Hymenoptera: Braconidae). Misc. Publ. Entomol. Soc. Am. 8(3 & 4): 83–134.

———. 1972b. *Urosigalphus* of Mexico and Central America (Hymenoptera: Braconidae). Misc. Publ. Entomol. Soc. Am. 8(3 & 4): 135–157.

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THE PHENOLOGY OF THE PLANT BUGS (HEMIPTERA: MIRIDAE) ASSOCIATED WITH *CEANOTHUS CRASSIFOLIUS* IN A CHAPARRAL COMMUNITY OF SOUTHERN CALIFORNIA

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Abstract.—Seven species of Miridae were found to develop on *Ceanothus crassifolius* at a locality in southern California. Mirid activity was confined to the first five months of the year, the period of lowest temperatures and greatest precipitation, and also the time of blooming and fruiting for *C. crassifolius*. Although levels of synchrony are high, the periods of greatest abundance of mirid species are spread out through the growing season.

There are little data on the host relationships of western U.S. Miridae. A relatively recent list of associations (Knight, 1968) does not suggest a large fauna on *Ceanothus*. However, I have found that species of *Ceanothus* and other Rhamnaceae serve as hosts for a variety of plant bugs in California. This paper deals with the species on *C. crassifolius* Torrey, or Hoaryleaf Ceanothus, an evergreen shrub common between 450–1100 m in the dry chaparral covered hills of southern California.

The study is based on collections of all instars of Miridae on *C. crassifolius* at a single site throughout most of 1979. Primary objectives were to determine the number of species developing on this plant, their occurrence relative to host phenology, and the degree of interspecific seasonal overlap. Preliminary data of feeding behavior are also presented.

Seven species were found to develop on *C. crassifolius*. Six belong to the Phylini and one to the Mirini. Identification to species is possible for only five of the seven at this time. The phylines collected were *Psallus ancorifer* (Fieber), *Psallus breviceps* Reuter, *Psallus* sp., *Microphylellus bicinctus* (Van Duzee), *Lepidopsallus californicus* Van Duzee, and *Phymatopsallus* sp. near *croceguttatus* Knight. The single mirine present was *Pycnocoris ursinus* Van Duzee. In addition, five adults of *Deraeocoris fulgidus* (Van Duzee) were collected. Since this species was not represented by immatures it is not dealt with further.

SITE DESCRIPTION AND METHODS

The sampling site is located in the hills to the immediate west of Menifee Valley, an inland southern California valley ca. 5 km east of Lake Elsinore in SW Riverside Co. Since the phenology of *C. crassifolius* varies with microhabitat, collections were restricted to an area of .44 hectare atop a north-south running ridge (33°39′N, 117°13′W; 550 m elev.). This relatively small area limited the number of plants, but minimized variation in exposure, drainage and elevation. All samples were from plants judged to be in approximately the same phenological state.

Considering the high level of flight activity in plant bugs (Southwood, 1960), movement of adults to the study area from plants in more advanced phenological states is a confounding variable. However, the effect of adult dispersal was probably minimized by choice of the study site where the host plants were all in a similar stage of development. The site was also situated ca. 0.50 km from locales with plants that were obviously disjunct phenologically. Furthermore, the lack of seasonally disjunct adults during sampling suggests that intersite movement was minimal.

The study area is dominated by chaparral but is distinctly influenced by Coastal Sage Scrub vegetation (see Munz, 1959, for a characterization of these communities). As is typical of the low hills bordering the hot, dry interior valleys of southern California, perennial vegetation on the site is relatively sparse. Only ca. 50% of the surface is covered by perennial canopy. The remainder is bare ground, much of it strewn with large granitic boulders. Annual grasses and herbs cover much of the surface in winter and spring. Dominant perennials are *Salvia mellifera* Greene (Labiatae), *Eriogonum fasciculatum* Bentham (Polygonaceae), and *Adenostema fasciculatum* Hooker and Arnott (Rosaceae). *Ceanothus crassifolius* itself has a patchy distribution and contributes only ca. 5% to the total perennial canopy (E. M. Fisher, personal communication).

Seven relatively large *C. crassifolius* of 2–3 m height were sampled from 21 January to 1 December 1979. Immatures of the season's first mirid species were already present when collections began. Mirid activity continued from that time until 4 July. The sampling dates during this time are given in Figs. 1 and 2. A mean of 6.3 days (range, 4–13) intervened between consecutive collections. On only one occasion (20 June–4 July) did the number of intervening days exceed 8. Samples after 10 July were made twice monthly. This was the first date after 21 January that sampling failed to collect mirids.

Plant bugs were collected by beating vegetation and allowing specimens to fall into a modified sweep net, 12 cm deep and 28 cm in diameter. Three positions at 1–1.5 m height were sampled on each plant. Plant bugs were quickly aspirated at each position. After all plants were sampled, the entire catch was killed in cyanide. Immatures were then transferred immediately

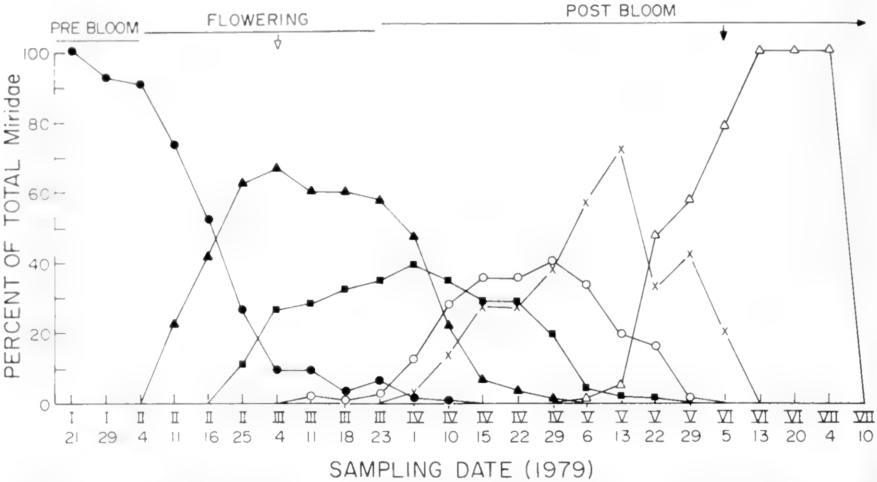

Fig. 1. Phenology of Miridae and host (*Ceanothus crassifolius*) during 1979. Adults and immatures combined for each plant bug species. ● = *Psallus ancorifer*; ▲ = *Psallus breviceps*; ■ = *Psallus* sp.; ○ = *Microphylellus bicinctus*; × = *Lepidopsallus californicus*; △ = *Phymatopsallus* nr. *croceguttatus*. *Pycnocoris ursinus* omitted (see Fig. 2). Summary of host phenology indicated at top. Open arrow indicates day of maximum bloom; closed arrow indicates time of fruit dehiscence.

to 70% alcohol for storage. Most of the adults were point mounted, the remainder were kept in alcohol. All collections were made during daylight, from 0900–1200 hours.

Mirid immatures and adults were readily associated by structural and color traits common to both. Rearings of six of the species verified these associations. *Psallus ancorifer* was the only species not reared. Three to ten nymphs of each species were reared by placing them with fresh vegetation in a covered Petri dish (100 × 10 mm). Plant material was replaced every other day. Specimens in rearing were also utilized for feeding observations. Bugs were provided leaves, fruit and stems. Flowers were also made available to species active early in the season.

Rainfall and mean monthly temperatures were recorded from August 1978–July 1979 (Fig. 3). Precipitation was monitored at the study site. Temperatures are from published U.S. Weather Bureau records from Sun City, Calif., ca. 3.5 km from the site (433 m elev.). The periodicity of rainfall during and immediately before this study was normal for southern California, i.e., winter concentrated. The total amount of precipitation (435 mm), however, was ca. 65% above normal.

Voucher specimens from this study are deposited in the collections of the Department of Entomology, University of California, Riverside, and the National Museum of Natural History, Washington, D.C.

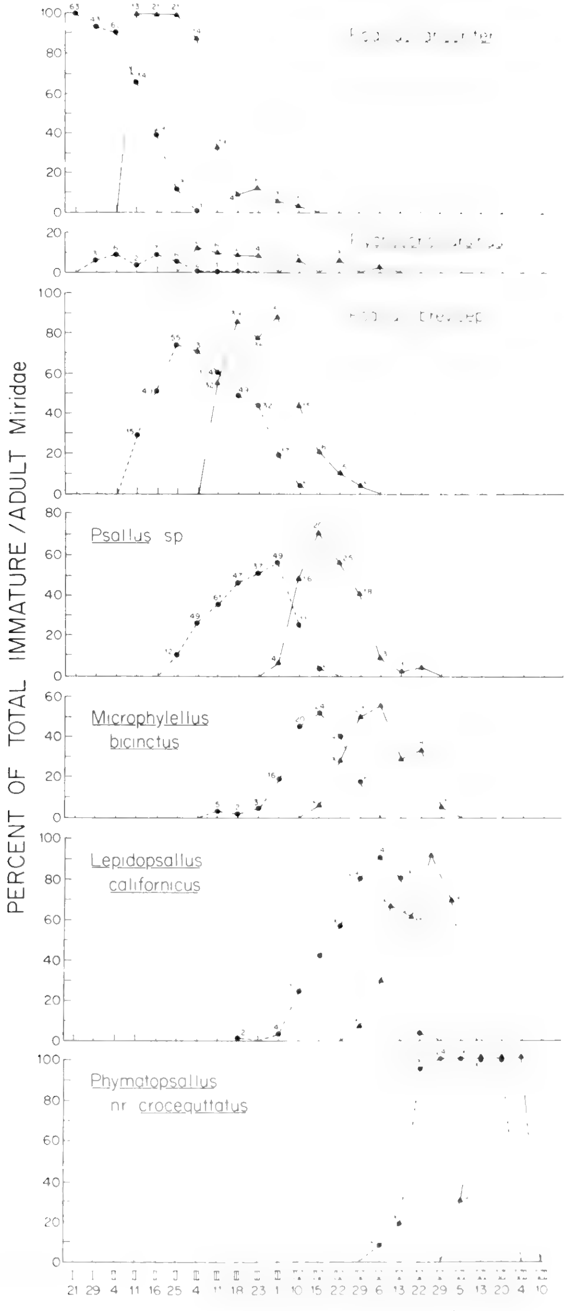

Fig. 2. Phenology of the seven species of Miridae on *Ceanothus crassifolius* during 1979. Dotted lines indicate immatures, solid lines adults.

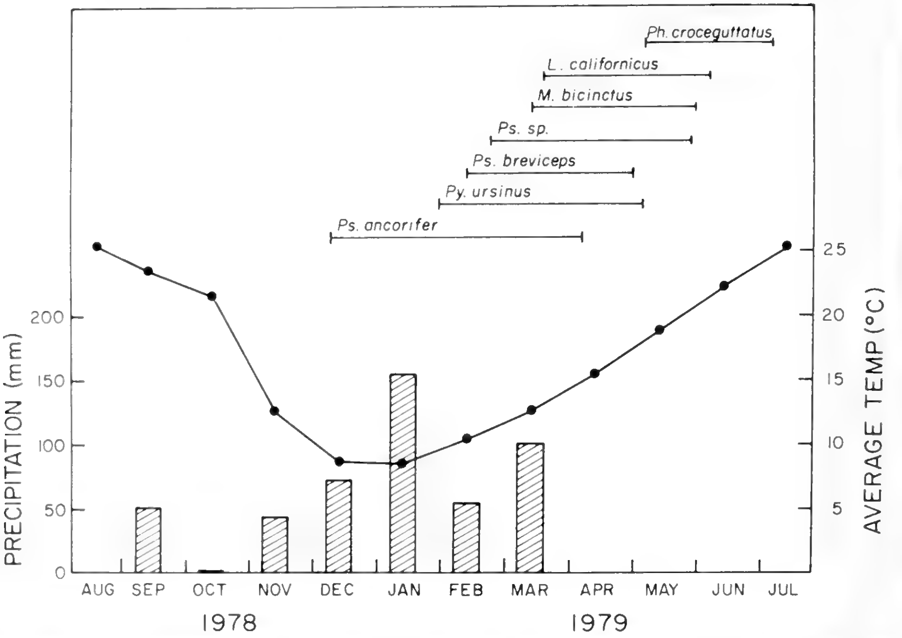

Fig. 3. Occurrence of the Miridae on *Ceanothus crassifolius* relative to monthly precipitation (bars) and average monthly temperature (connected dots) during 1978–79. December occurrence of *P. ancorifer* assumed from collections in 1980.

RESULTS AND DISCUSSION

The results of sampling are given in Figs. 1 and 2. Figure 1 indicates the percentage of all stages of each species relative to the total number of Miridae collected per sampling day. Figure 2 considers the immatures and adults of each species separately as a percentage of total immature, and adult catch, respectively, per sampling day. The latter also includes the total number of individuals collected daily.

All seven species are packed into the first six months of the year. The only mirids collected from 4 July–December were a few adults of various species assumed to be strays from plants other than *C. crassifolius*. The activity period for each species varied from two to three months. There is no evidence for more than a single generation per year for any of the species. Since first-instars of all species were collected prior to successive instars, it is assumed that the summer and autumn are spent in the egg stage.

Although there was substantial synchrony, none of the species overlap completely (Fig. 2). Instead, they follow one another closely throughout the season. Sampling revealed the following order of appearance for phyline species: *Psallus ancorifer*, *Psallus breviceps*, *Psallus* sp., *Microphylellus* *bicinctus, Lepidopsallus californicus,* and *Phymatopsallus* near *croceguttatus.* The mirine, *Pycnocoris ursinus,* was too uncommon to determine confidently its order of appearance relative to *P. ancorifer* and *P. breviceps.* The pattern of species occurrence shown here is similar to that reported by Waloff (1968) for the mirids on Scotch broom in England.

Figure 1, containing all instars, shows that each of the six phylines represented the dominant species at some time during the sampling period. Only the two earliest (*P. ancorifer* and *P. breviceps*) and latest species (*L. californicus* and *Ph.* nr. *croeceguttatus*) were dominant in the absolute sense in representing over 50% of the total mirid catch on any given sampling day. However, the immatures and adults of all six species did so dominate at some time when compared to heterospecific immatures and adults, respectively (Fig. 2).

The appearance of *P. ancorifer,* the season's first species, is not resolved (Fig. 2). It was not yet present when plants were checked in early December 1978. Additional sampling was not possible until 21 January 1979 at which time *P. ancorifer* immatures were in abundance. To better determine the appearance of this species, host plants were checked weekly during the last two months of 1980. In that year, first-instars were first collected on 7 December.

The occurrence of species relative to host phenology is summarized in Fig. 1. The flowering period for *C. crassifolius* is from January to April (Munz, 1959). At the collecting site sampled plants flowered from 4 February to 23 March. *Psallus ancorifer* was the only species active prior to bloom. The appearance of *P. breviceps* was roughly concurrent with the onset of flowering. *Psallus* sp., *M. bicinctus* and *L. californicus* first appeared during flowering but most of their activity was postbloom. The last species, *Ph.* nr. *croceguttatus,* did not appear until well after flowering was complete, and, in fact, was most abundant after fruit dehiscence. Although the largest number of species were active during fruiting, species present during flowering were more abundant. Thus, 936 mirids ($\bar{x}$ = 133.7/day) were collected on the seven sampling dates during flowering whereas only 647 ($\bar{x}$ = 92.4) were taken on the seven dates immediately after bloom.

Although sampling frequency was not designed to detect seasonal variation in sex ratios, such variation was apparent in *P. breviceps, Psallus* sp., *M. bicinctus,* and *L. californicus.* Populations of all four were male-biased at the beginning of adult activity and female-biased toward the end. In *P. breviceps,* for example, collections on 11 and 18 March with 45 males and 26 females deviated significantly from a 1:1 ratio ($P < .05$) as did samples on 23 March and 1 April with 18 males and 58 females ($P < .005$).

Five of the seven mirids on *Ceanothus crassifolius* were observed feeding in the laboratory. Ultimate instar nymphs of *Psallus* sp., *Psallus breviceps, Microphylellus bicinctus,* and *Phymatopsallus* nr. *croceguttatus* were commonly observed to insert their proboscis in the underside of leaves. Since this surface is covered with a woolly pubescence the actual points of insertion relative to leaf venation were not observed. Fruit, stems and the upper surface of leaves were ignored by these species. Flowers were available only to *Microphylellus bicinctus* and *Psallus* sp. The latter fed on floral parts but appeared to prefer leaves. The former was observed feeding on leaves only. Feeding in a single adult of *Pyncnocoris ursinus* was observed intermittently over a period of several days. It fed on fruit and ignored all other vegetative parts provided. Flowers, however, were not available to this species when observations were made.

The occurrence of several related species on the same host plant is of evolutionary and ecological interest. This is especially so if the species occur at the same time. Estimates of interspecific seasonal overlap are given in Table 1. Data are presented for the entire activity period of each species as well as for the period of adult activity. The degree of seasonal overlap for species pairs is reported as a percentage of the number of sampling dates synchrony was confirmed, relative to the total number of sampling days each species occurred. Indices of synchrony, summarizing degree of seasonal overlap for each species, were also calculated (Table 1).

Seasonal overlap of the seven species is considerable (Table 1). As expected from Fig. 1, it is least for the first (*P. ancorifer*) and last (*Ph.* nr. *croceguttatus*) species and greatest for intermediates (*P. breviceps, P.* sp., and *M. bicinctus*).

The degree of synchrony among congeners is of particular interest. Although three of the species are currently placed in *Psallus,* it is clear that *P. breviceps* is closest to *M. bicinctus.* It keys to *Microphylellus* and, according to T. J. Henry (personal communication), it is closer to that genus than to *Psallus.* The only other congeners are *Psallus ancorifer* and *Psallus* sp. Both species pairs show considerable synchrony (Figs. 1, 2; Table 1). However, in each case the overlap is primarily between immatures of one and adults of its relative. This suggests that the potential for interspecific sexual interaction, at least, is minimal. Possible modes of additional separation, such as oviposition sites have not been adequately studied. Waloff (1968) and Dempster (1964) reported some differences in the feeding habits of *Orthotylus* species occurring together on Scotch broom. This had been predicted earlier by Waloff and Southwood (1960) upon noting contrasting rostral lengths among the different species. A similar anatomical difference does not occur between congeners on *C. crassifolius.* Preliminary observation of feeding behavior in nymphs of *P. breviceps* and *M. bicinctus* does not suggest different feeding sites. Both feed commonly on the underside of leaves (see above).

The plant bugs on *C. crassifolius* occur during the coolest time of year and during or directly after months of maximum precipitation (Fig. 3). This

Table 1. Synchronic relationships of the Miridae on *Ceanothus crassifolius*.

	Degree of Seasonal Overlap[a][b]							No. Synchronic Relationships	Index of Synchrony[c]
Species	*ancorifer*	*ursinus*	*breviceps*	sp.	*bicinctus*	*californicus*	*croceguttatus*		
P. ancorifer	X	69	56	44	31	25	0	5	37.5
		67	55	22	0	0	0	3	24.0
Py. ursinus	73	X	80	80	60	53	7	6	58.8
	60		80	60	40	23	0	6	43.3
P. breviceps	75	100	X	83	67	58	0	5	63.8
	63	100		63	38	13	0	5	46.2
P. sp.	54	92	77	X	85	77	23	6	68.0
	25	62	63		75	50	0	5	45.8
M. bicinctus	42	75	67	92	X	83	33	6	65.3
	0	51	43	86		71	0	4	41.8
L. californicus	33	67	58	83	83	X	42	6	61.0
	0	33	17	67	83		16	5	36.0
Ph. nr. *croceguttatus*	0	12	0	38	50	63	X	4	27.2
	0	0	0	0	0	25		1	4.2

[a] Degree to which species X (horizontal) is overlapped seasonally by species Y (vertical) determined by dividing the number of days both were collected together by the total number of days X was collected multiplied by 100.

[b] Figures above horizontal lines in body of table refer to overlap regardless of instar; those below horizontal line refer to adult overlap only.

[c] Index of synchrony for a given species determined by adding individual scores and dividing by 6, the maximum number of synchronic interactions.

is the time of maximum growth and flowering for most chaparral plants. *C. crassifolius* is among the first plants to bloom in the chaparral and its associated mirids are the first of the season to occur. *C. crassifolius* commonly begins to bloom in January, two months or so before the other dominant perennials, and before the appearance of most annuals.

The degree of host specificity for the mirids collected here is unknown, nor is it possible to profitably use species distribution data as a means of speculation since the taxonomy and biology of the species are so poorly known. In any case, near the study site, adults of *M. bicinctus* have been taken in low numbers from *Quercus agrifolia* Neé, and a series of *P. breviceps* was collected from *Rhamnus crocea* Nuttall. Both plants are relatively uncommon at or near the sampling site. The type series of *M. bicinctus* was collected from an unidentified *Ceanothus* (Van Duzee, 1914). *Psallus ancorifer*, a supposedly widespread species, was recorded from "clover" by Knight (1927) and onions by Thompson (1945). *Lepidopsallus californicus* is known from southern California and Fresno, Calif. The latter locale is out of the range of *C. crassifolius* but is close to areas harboring congeners.

Pycnocoris ursinus, so far, has been taken only on *Ceanothus*. I have collected it on at least three species of *Ceanothus*, and two specimens in the P. H. Timberlake collection (UC Riverside) were collected in Ensenada, Baja California on *Ceanothus verrucosus* Nuttall.

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I thank E. M. Fisher for the data on plant cover at the study site and T. J. Henry of the Systematic Entomology Laboratory, USDA, for the identification of the six species of Phylini. Figures 1–3 were prepared by P. Mote.

LITERATURE CITED

Dempster, J. P. 1964. The feeding habits of Miridae (Heteroptera) living on broom (*Sarothamnus scoparius* (L.) Wimmer). Entomol. Exp. Appl. 6: 149–155.

Knight, H. H. 1927. Notes on the distribution and host plants of some North American Miridae (Hemiptera). Can. Entomol. 59: 34–44.

———. 1968. Taxonomic review: Miridae of the Nevada Test Site and the Western United States. Brigham Young Univ. Sci. Bull., Biol. Ser. 9(3): 1–282.

Munz, P. A. 1959. A California Flora. Univ. Calif. Press. 1681 pp.

Southwood, T. R. E. 1960. The flight activity of Heteroptera. Trans. R. Entomol. Soc. Lond. 112: 173–220.

Thompson, B. G. 1945. DDT to control *Psallus ancorifer* in onions. J. Econ. Entomol. 38: 277.

Van Duzee, E. P. 1914. A preliminary list of the Hemiptera of San Diego County, California. Trans. San Diego Soc. Nat. Hist. 2(1): 1–57.

Waloff, N. 1968. Studies on the insect fauna on Scotch Broom *Sarothamnus scoparius* (L.) Wimmer. Adv. Ecol. Res. 5: 87–208.

Waloff, N. and T. R. E. Southwood. 1960. The immature stages of mirids (Heteroptera) occurring on broom (*Sarothamnus scoparius* (L.) Wimmer). Proc. R. Entomol. Soc. Lond. (A) 35: 39–46.

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DESCRIPTIONS OF THE MATURE LARVA AND PUPA OF *HYPOMECIS UMBROSARIA* (HÜBNER) (LEPIDOPTERA: GEOMETRIDAE)[1]

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Abstract.—The mature larva and pupa of *Hypomecis umbrosaria* (Hübner) are described and illustrated. A comparison is made with related genera. What appear to be the first known larval defensive glands in a geometrid are also described, and brief internal morphological studies are included.

The bivoltine *Hypomecis umbrosaria* (Hübner) (Fletcher, 1979), formerly known as *Pseudoboarmia umbrosaria* (Hübner), ranges from coastal Massachusetts to central Florida, west to eastern Texas and north through Arkansas to central Missouri (Rindge, 1973; Heitzman, 1973). *Hypomecis gnopharia* (Guenée) is a sibling species only distinguishable by slight differences in wing pattern and genitalia. The brief larval description of *H. gnopharia* by Guenée (1857), revealed at least no superficial differences from *H. umbrosaria*. The synonymy of these two species is confused, resulting in numerous questionable host records, i.e., horse chestnut, birch, elm, and various conifers (Rindge, 1973).

Hypomecis is a Holarctic genus represented by five species. A single Palearctic species *H. punctalis* (Scopoli), is found from Japan to western Europe, and four Nearctic species occur in eastern and southeastern United States (Rindge, 1973). This genus has affinities to the more primitive members of the Boarmiini, a large worldwide tribe with 34 Nearctic genera. The larval and pupal stages have been studied in many of the related genera, e.g., *Anavitrinella, Anacamptodes, Iridopsis, Glena, Stenoporpia,* and *Cleora* (McGuffin, 1977). The purpose of this paper is to describe the diagnostic morphological characters of the mature larva and pupa of *Hypo-*

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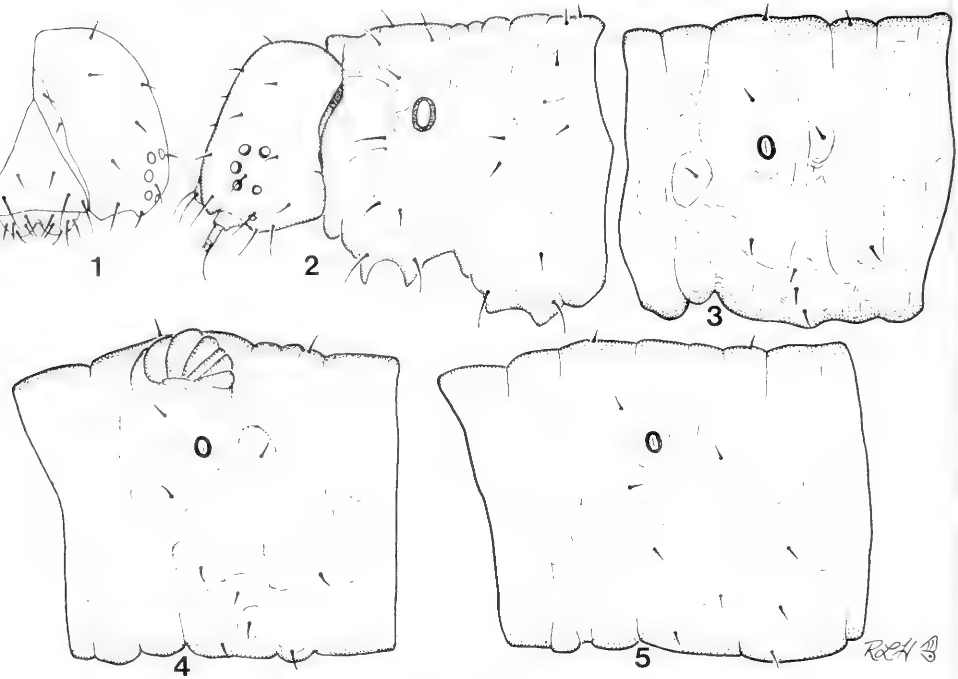


Figs. 1–5. *Hypomecis umbrosaria*, mature larva, 25×. 1, Frontal view of head. 2, Lateral view of head, pro- and mesothorax. 3, Lateral view of abdominal segment 1. 4, Lateral view of abdominal segment 2. 5, Lateral view of abdominal segment 3.

mecis umbrosaria (Hübner) and compare these characters with those of related genera.

MATERIALS AND METHODS

Four mature larvae and two pupae of *Hypomecis umbrosaria* were examined. These were reared on a leaf diet of mixed *Quercus* species from a female (voucher specimen number: GVS-77-25) collected at the Ashland Wildlife Area, near Columbia, Boone Co., Missouri, June 2, 1977. All specimens were preserved on August 7, 1977. Descriptions and drawings are based on these specimens. A WILD M5 microscope and drawing tube attachment were used in making the illustrations. Measurements are based on the average of the available specimens.

DESCRIPTION OF MATURE LARVA AND PUPA

Larva.—*Head:* Height, 2.0 mm; width, 2.7 mm; color reddish brown with areas of dark brown composed of irregular spots located principally above level of ocelli; cuticle heavily granular; ocelli 1–3 largest, 4–6 smaller (Fig.

2); mandibular teeth rudimentary, upper ental surface deeply concave (Fig. 9); labrum moderately bilobed (Fig. 1); epipharynx with inner pair of heli smallest; spinneret short (Fig. 11); postmentum setae short (Fig. 11); maxilla with proximalmost seta longest (Fig. 11).

Body: Length, 35 mm; width 3 mm; mottled in shades of reddish brown; integument finely granular with small, variable, 5- or 6-sided sclerotized, miniature volcano-shaped structures (Fig. 8); most setae short, dark brown, arising from small, black chalazae. Dorsal view: Large areas of light color variably occur at intersegmental folds; prothoracic shield concave on margin above SD setae (Fig. 2); pair of large, wrinkled, invaginating glands on A2 located between D_1 and SD_1 setae (Fig. 4), examination of internal morphology of gland reveals attachment of 5 circular and 2 longitudinal muscles, 1 branching tracheal trunk, and 3 glandular ducts (Figs. 12, 13); A8 with D1 setae on small, black tubercles; anal plate triangular (Fig. 10). Lateral view: Large areas of light color variably occur about spiracles; A6 proleg paler than body; spiracles vary in size, in the following order of decreasing magnitude—T1, A8, A7, A1, and A6, but those on 2–5 of uniform size; peritreme black, spiracular valve pink; hypoproct and paraprocts of about equal length, extending beyond tip of anal plate. Ventral view: Elongate patches of light color centrally located on abdominal segments; thoracic leg bases increasing in size by twice that of preceding segment; thoracic leg bases increasing in size by twice that of preceding segment; thoracic leg claw dark brown (Fig. 14); crochets biordinal and complete (not reduced in size in middle), 38–42 in number on ventral proleg, 49–51 in number on anal proleg.

Chaetotaxy: 5 SV setae on A6 proleg; L1 of A1 at level of top of spiracle (Fig. 3); D1 of A3 (Fig. 5) further anterior than on A1 or A2 (Figs. 3,4); L1 of A7 at level of top spiracle; SV1 seta 3 × length of L1 on A7–9; anal proleg with CD2 closer to level of LG3 than LG2; CP1 and CP2 just above levels of LG2 and LG1, respectively.

Pupa.—*Body:* Height, 15 mm; width, 5 mm.

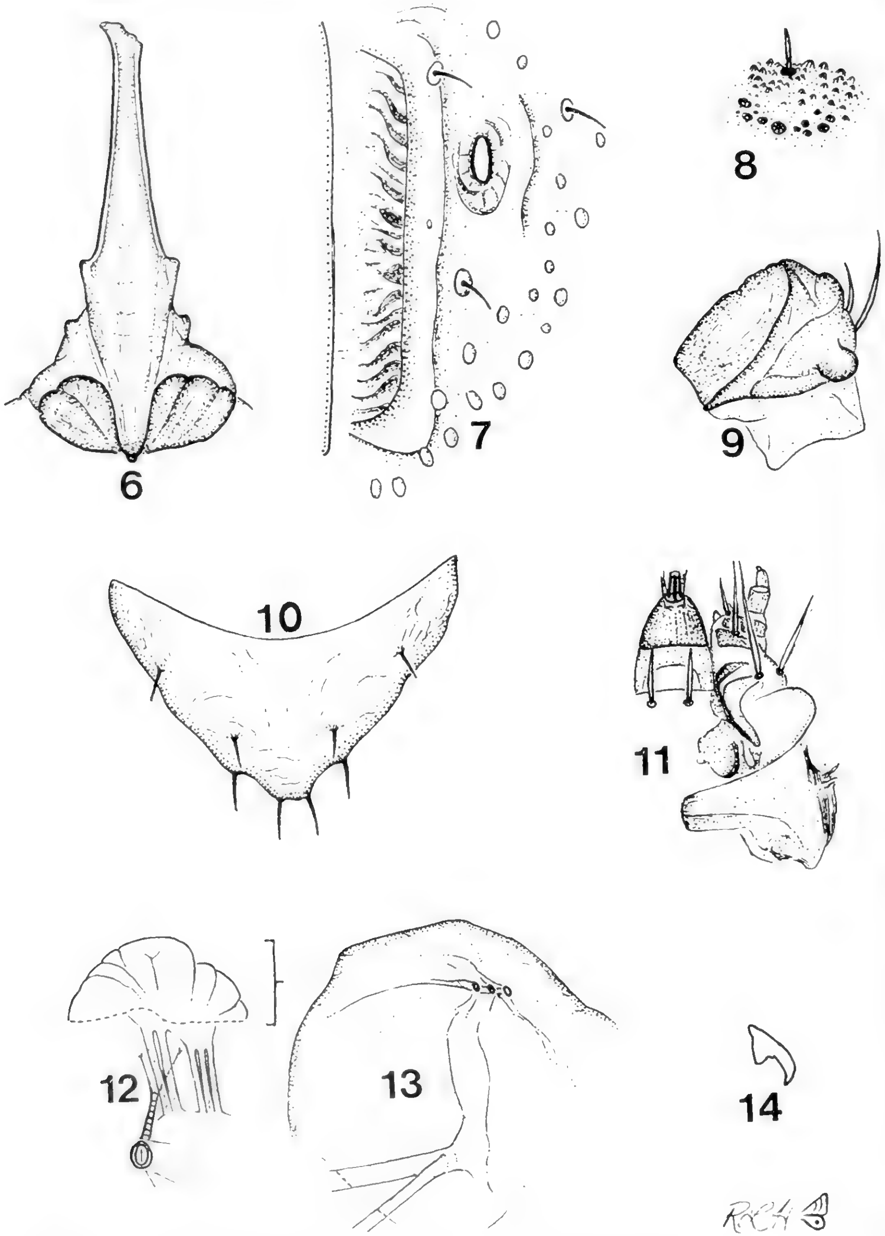
Head: Color dark reddish brown; epicranial suture absent.

Thorax: Wings dark brown, rest variable shades of reddish brown; prothoracic femur not exposed; large, slightly elliptical, pubescent callosities present, ½ size of eyes.

Abdomen: Color dark reddish brown, paler at interfolds; cuticle densely punctate (Fig. 7), setae arising from sunken pits (Fig. 7); A5 with ridged, prespiracular groove (Fig. 7); dorsum of A9 with 4 small, widely spaced teeth on caudal edge. cremaster elongate, blunt-tipped with 4 small, lateral flanges (Fig. 6).

DISCUSSION

The pair of glands on A2, which almost certainly play a defensive role, are of special interest because they apparently have never before been re-



Figs. 6–14. *Hypomecis umbrosaria*. 6–7, Pupa, 50×. 6, Ventral view of cremaster. 7, Right prespiracular furrow on abdominal segment 5. 8–14, Mature larva. 8, Enlargement of cuticle, 50×. 9, Inner view of left mandible, 50×. 10, Anal plate, 25×. 11, Ventral view of mentum, hypopharynx, labial palpi, spinneret and maxilla, 25×. 12–13, Gland on abdominal segment 2

ported to occur in the Geometridae. The closely related *H. gnopharia* possesses the glands also, and Forbes (1948) noted that the penultimate larva of *H. buchholzaria* (Lemmer) has much reduced "warts" at these gland sites. Of the related genera treated by McGuffin (1977), all but *Cleora* include species with one or more protuberances on each side of the second abdominal segment. Except for those of *Anavitrinella pampinaria* Guenée, however, all of these protuberances are tipped with setae, usually the L1 or D2 seta. On *A. pampinaria* the protuberances appear as considerably smaller versions of the glands found on *Hypomecis umbrosaria* as they also lie between the D1 and SD1 setae; however, they are yet to be examined.

In all related genera (based on McGuffin, 1977), the SV4 and SV1 setae on the first abdominal segment are above or above and posterior to the V1 seta, and the L1 seta is at the bottom of the spiracle except in *Anavitrinella*, *Anacamptodes*, and *Iridopsis* (three closely related genera). In *Hypomecis umbrosaria* the SV4 and SV1 setae are above and anterior to the V1 seta and the L1 seta is near the top of the spiracle. Only the L1 of *Anavitrinella* does not correspond to these character states, though it is higher in *Hypomecis umbrosaria* than in the other two genera. In *H. umbrosaria* on the first abdominal segment the L2 seta, second segment the SV4 seta, and third segment the D1 seta are all located further anterior on their respective segments than in any related genera.

The anal plate of *H. umbrosaria* is unusual in lacking a median notch or furrow on its anterior edge. The shape of the plate is similar to many genera but identical to none. The tip of the plate is strongly truncate and the setae are short.

The pupal cremaster is unique for the tribe. Nearly all species have an obvious bifurcation resulting from a deep median groove on the cremasteral tip and lack lateral flanges. The cremaster of *Anavitrinella pampinaria* resembles a distorted, shortened variant of that found on *Hypomecis umbrosaria* in that it possesses three pair of semi-circular ridges that appear homologous to the basal humps and lateral flanges of *H. umbrosaria*. Some species of *Anacamptodes* have a single pair of lateral flanges but the cremaster is rarely as elongate.

Anavitrinella is the most closely related genus to *Hypomecis* on the basis of larval and pupal characters. This is supported in the larva by the location and type of protuberances on the second abdominal segment and the chaetotaxy, and in the pupa by the structure of the cremaster and the type of

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showing internal morphology. 12, Lateral view showing circular muscles and tracheal trunk, 25×. 13, Ental view showing longitudinal muscles and glandular ducts, ×50. 14, Thoracic leg claw, 50×.

prespiracular furrow on the fifth abdominal segment. *Anacamptodes* and *Iridopsis* are also genera closely related to *Hypomecis*, but the second abdominal protuberances have different locations, and the cremaster has only two flanges at most; however, the chaetotaxy in some species is more similar to *Hypomecis umbrosaria* than to *Anavitrinella*. The *Hypomecis* adult, however, shows no clear affinity to any one particular genus.

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LITERATURE CITED

Fletcher, D. S. 1979. *In* Nye, I. W. B. The generic names of moths of the world. Vol. 3: Geometridae. Trustees of the British Mus. (Nat. Hist.), London. xx + 243 pp.

Forbes, W. T. M. 1948. Lepidoptera of New York and neighboring states. Part II. Mem. Cornell Univ. Agrc. Exp. Stn. no. 274, 263 pp., 255 figs.

Guenée, A. 1857. Spécies général des lépidoptères. Uranides et Phalenites. Tome 9, Paris. 514 pp.

Heitzman, R L. 1973 [1974]. An annotated checklist of the Missouri Geometridae (Lepidoptera). J. Res. Lepid. 12: 169–179.

McGuffin, W. C. 1977. Guide to the Geometridae of Canada (Lepidoptera). II. Subfamily Ennominae. 2. Mem. Entomol. Soc. Can. 191 pp., 206 figs.

Rindge, F. H. 1973. A revision of the North American species of the genus *Pseudoboarmia* (Lepidoptera, Geometridae). Am. Mus. Novit. no. 2514, pp. 1–27, 25 figs.

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SYMPHYTA (HYMENOPTERA) OF SRI LANKA

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Abstract.—Seven species of Symphyta in three families, Tenthredinidae, Xiphydriidae, and Orussidae, are known from Sri Lanka. One new species, *Nesoselandria* ***minuta***, is described. *Senoclia bilanga* Rohwer is a new synonym of *Anisoarthra coerulea* Cameron; *Netrocerus nigriceps* Enderlein is a new synonym of *Eusunoxa ceylonica* Malaise; *Nesoselandria ceylonensis* Rohwer is a new synonym of *Nesoselandria thwaitesii* (Kirby), new combination; and *Eusunoxa nigriceps* (Rohwer) is a new combination. Keys to families and genera and to species of *Nesoselandria* are provided.

The sawfly fauna of Sri Lanka has never been reviewed, only descriptions of species are scattered in the literature. Nine species have been described, but because of new synonymy and the possibility that one species, *Anisoarthra cyanella* Cameron, may not occur on the island, seven species in three families (Tenthredinidae, Xiphydriidae, and Orussidae) are actually known.

The data presented here are based on specimens collected during the Smithsonian Ceylonese Insect Project (SC), on a study of the types of species described from Sri Lanka, and on specimens from Sri Lankan collections at the University of Lund, Lund, Sweden (LUND), and the Naturhistorisches Museum Basel, Switzerland (NHMB). During the Smithsonian Ceylonese Insect Project, five species of Tenthredinidae were collected, but the representatives of Orussidae and Xiphyriidae recorded from Sri Lanka were not found. Two species, *Anisoarthra coerulea* Cameron and *Mocsarya metallica* Mocsáry, are also found outside of Sri Lanka; the former occurring in southern India, which has a similar sawfly fauna. Hosts are not known for the species treated here.

KEY TO FAMILIES AND GENERA

1. Antennae inserted on ventral aspect of head, below lower margin of eyes and below clypeus; hindwing without closed cells .... Orussidae

– Antennae inserted on anterior aspect of head, above clypeus and between eyes; hindwing with one or more closed cells 2

2. Foretibia with 1 apical spur; antenna setaceous, with 15 or more segments .... Xiphydriidae

– Foretibia with 2 apical spurs; antenna filiform, with 9–10 segments (Tenthredinidae) 3

3. Anal cell of forewing without a crossvein (Fig. 10); small black species 3–6 mm long (Selandriinae) .... *Nesoselandria*

– Anal cell of forewing with crossvein or petiolate (Figs. 11, 12); usually larger species 7–11 mm long, if about 6 mm, then mostly orange 4

4. Anal cell of forewing complete and with anal crossvein (Fig. 11); tarsal claw with 2 teeth (Fig. 14) (Allantinae) .... *Eusunoxa*

– Anal cell of forewing petiolate, base of vein 2A + 3A atrophied (Fig. 12); tarsal claw comblike, with 4–5 teeth (Fig. 13) (Blennocampinae) .... *Anisoarthra*

Family Tenthredinidae
Subfamily Blennocampinae
***Anisoarthra coerulea* Cameron**
Figs. 1, 9, 13

Anisoarthra coerulea Cameron, 1876: 462 (♀, ♂, "Ceylon"; **lectotype** ♀, by present designation, in British Museum (Natural History), labeled "Type, H.T.," "B.M. Type Hym. 1.363," "B.M. Type, Hym. Anisoarthra coerulea (Cameron, 1876)," "Ceylon," "Kby. p. 8, f. 21"; other specimens were not found).

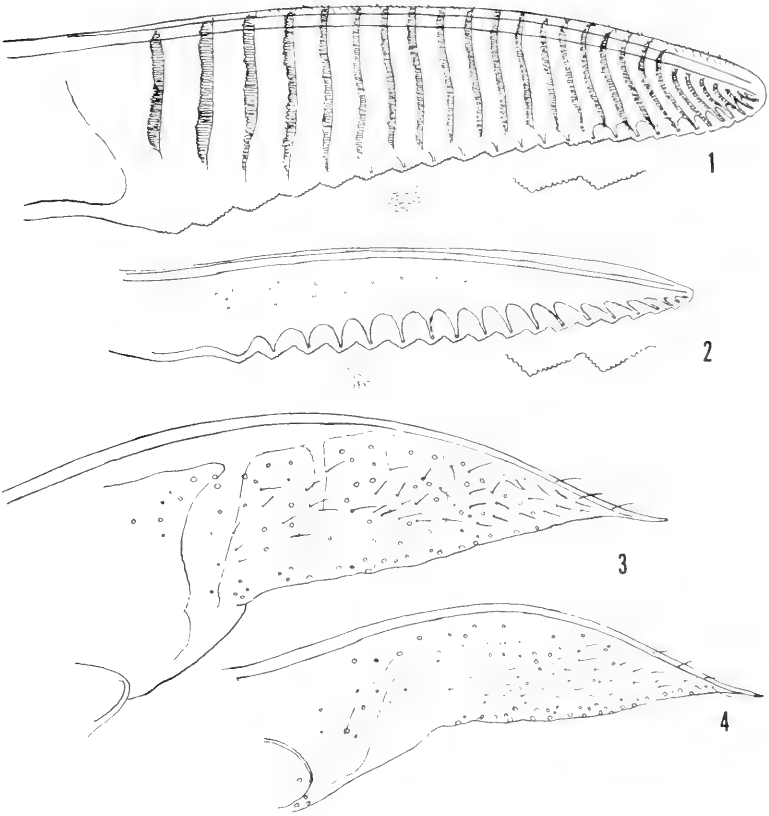
Senoclia bilanga Rohwer, 1921: 106 (♀, ♂, "Kollegal, 2,000 feet (about 606 meters), Coimbatore, S. India"; holotype ♀ in USNM, examined). **New synonymy**.

Remarks.—*Anisoarthra coerulea* is large, 9–11 mm long, and is entirely purplish black, commonly with a purplish iridescent tinge. The tarsal claws are comblike, having 4–5 teeth plus a short basal lobe (Fig. 13). The female ovipositor and male genitalia are as in Figs. 1, 9.

Malaise (1937) treated *bilanga* Rohwer from southern India as a variety of *coerulea*; however, since I did not find differences between them, I believe that they are the same. Four or five other species of *Anisoarthra* are known from Southeast Asia.

In Sri Lanka, this species has been collected in the wet zone, rain forest hill country, with an annual rainfall of 1952 mm as well as in drier zones where the annual rainfall is 1500 mm.

Records.—SRI LANKA: *North Central Province:* Anuradhapura District, Padaviya, 2–8-XI-1970, O. S. Flint, Jr. (1 ♀; SC). *North Western*



Figs. 1–4. Female lancets. 1, *Anisoarthra coerulea*. 2, *Eusunoxa ceylonica*. 3, *Nesoselandria anthracina*. 4, *N. thwaitesii*. Figs. 3 and 4 drawn to same scale, but not same scale as Figs. 1, 2.

Province: Puttalam District, Tabbowa, 17-X-1973, black light, sea level, M. and B. Robinson (1 ♂; SC). *Central Province:* Kandy District, Udawattakele, 1–3-X-1973, K. V. Krombein, P. B. Karunaratne, P. Fernando (1 ♂; SC); Kandy District, Udawattakele, 27–28-X-1972, P. B. Karunaratne (1 ♀; SC); Kandy District, Waharawata, 1-IX-1975, D. M. Davies, S. Karunaratne, D. W. Balasooriya (1 ♂; SC); Kandy District, Kandy, X-07, 9-07, X-09, XI-06, IX-1911, 10-03 (series; USNM); Kandy District, Kandy, 30-IX-1953, F. Keiser (1 ♂; NHMB); Kandy District, Kandy, Roseneath, 29-IX-53, F. Keiser (1 ♀; NHMB); Kandy District, Kandy, Deiyannewela, 17-X-53, F. Keiser (3 ♀, 2 ♂; NHMB); Dambulla, 21-XI-53, F. Keiser (3 ♀; NHMB); Matele District, Nalanda, X-07 (1 ♀; USNM). INDIA: *Karnataka:* Kollegal, 2000 ft., Coimbatore, 1-IX-17 (type-series; USNM). *Tamil Nadu:* Nilgiri Hills, Kallar, 1250 ft., X-1955 (1 ♀; USNM).

Anisoarthra cyanella Cameron

Anisoarthra cyanella Cameron, 1876: 462 (♀, ♂, "Ceylon"; types not found).

Remarks.—The types should be in the British Museum, but because they cannot be found (J. Quinlan, personal correspondence) the status of *cyanella* is uncertain. Kirby (1882) synonymized *cyanella* under *Senoclia purpurata* Smith (currently in the genus *Senoclidea*) and gave the distribution as "Celebes; New Guinea" but did not mention Ceylon. The type-locality given by Cameron may be an error. I have not seen specimens from Sri Lanka that agree with the description of *cyanella* and have not seen specimens of *purpurata* from Sri Lanka. This species, if it is the same as *purpurata* as Kirby indicated, can be distinguished from *coerulea* by the tarsal claws, which have two teeth and a basal lobe, by the antenna which is "shorter, more thickened towards the apex," and by the whitish apex of the foretarsus; otherwise, the size and coloration are similar in the two species.

Subfamily Allantinae

Eusunoxa ceylonica Malaise

Figs. 2, 8, 14

Netrocerus nigriceps Enderlein, 1920: 371 (♀, "Ceylon"; type in Polish Academy of Sciences, Warsaw, examined). **New synonymy**. Preoccupied in *Eusunoxa* by *Eusunoxa nigriceps* (Rohwer), **new combination** (described in genus *Beleses*, 1915).

Eusunoxa ceylonica Malaise, 1932: 147 (♀, ♂, "Colombo, Ceylon"; holotype in British Museum (Natural History), paratype from Swedish Museum of Natural History examined).

Remarks.—*Eusunoxa ceylonica* was one of the most commonly collected sawflies in Sri Lanka and may be distinguished as follows: Orange color with antenna, head, apex of tibia and tarsus of fore- and midlegs, and most of femur, tibia, and tarsus of hindleg black; uniformly blackish infuscated wings, sometimes blackish abdominal apex in male; two teeth of the tarsal claws (Fig. 14); and anal cell of forewing with an anal crossvein (Fig. 11). The female ovipositor and male genitalia are as in Figs. 2, 8.

Other species of *Eusunoxa* are found in southeastern Asia. *Eusunoxa nigriceps* (Rohwer), described from southern India, is entirely black, but it and others are separated from *ceylonica* primarily by differences in the genitalia.

Eusunoxa ceylonica occurs in both open and wooded areas in both dry and wet zones with annual rainfall ranging from 660 to 1952 mm.

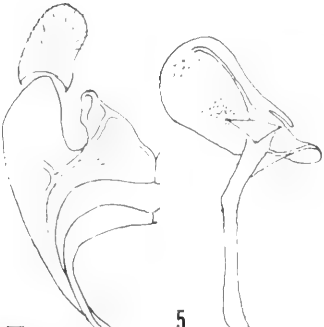
Records.—SRI LANKA: *Western Province:* Colombo District, Colombo, 50 ft. elev., Museum gardens, 15-I-1977, K. V. Krombein, P. Fernando, D. W. Balasooriya, V. Gunawardane (1 ♀; SC); Colombo, Museum gardens, 50 ft., 18-III-1977, P. B. Karunaratne (1 ♂; SC); Colombo, collected in Museum gardens, 22-VI-1977 (10 ♂; SC), 14-VI-1977 (1 ♀, 1 ♂; SC), T. Wijesinhe; Colombo District, Labugama Reservoir, 16-II-1975, K. V. Krombein, P. B. Karunaratne, P. Fernando, S. Karunaratne (1 ♀; SC); Colombo District, Labugama, Reservoir Jungle, 2–4-II-1977, K. V. Krombein, P. B. Karunaratne, D. W. Balasooriya, V. Gunawardane (1 ♀; SC); Colombo District, Ratmalana Airport, Ratmalana, 13-I-1977, K. V. Krombein, P. Fernando, D. W. Balasooriya, V. Gunawardane (1 ♂; SC); Colombo District, Kalatuwawa, Malaise trap, 7–8-VIII-1975, Y.-M. Huang, E. L. Peyton, S. Karunaratne, D. W. Balasooriya (1 ♀; SC); Yakkala, 18 mls NE Colombo, 13–31-I–1962, Loc. 11, swept on veg. at ditches in paddy fields, Lund University Ceylon Expedition 1962, Brinck-Andersson-Cederholm (1 ♀; LUND). *Central Province:* Kandy District, Peradeniya Botanical Gardens, I-1971, Piyadasa and Somapala (1 ♀; SC). *Southern Province:* Hambantota District, Palatupana Tank, 15–20 ft., 18–20 Jan. 1979, Malaise trap, K. V. Krombein, P. B. Karunaratne, T. Wijesinhe, S. Siriwardane, T. Gunawardane (1 ♀, 1 ♂; SC). *Eastern Province:* Amparai District, Ekgal Aru Sanctuary Jungle, 9–11 March 1979, K. V. Krombein, T. Wijesinhe, Y. L. Jayawickrema, S. Sirwardane (2 ♂; SC), same data, Malaise trap added after date (1 ♂; SC). *North Western Province:* Rajakadaluwa, 23–VIII-1953, F. Keiser (2 ♂; NHMB). *Northern Province:* small stream, 2 mls E Mankulam, 14-II-1962, Loc. 75, grassy ground, Lund University Ceylon Expedition 1962, Brinck-Andersson-Cederholm (1 ♂; LUND).

For Loc. 11 and 75 from Lund University specimens, see Brinck et al., 1971.

Subfamily Selandriinae

Genus *Nesoselandria* Rohwer

Nesoselandria is a large genus in Asia. Most species are small, 3–6 mm long, and mostly black. Few good external characters are evident for separating species, and the small, fragile female lancet is very similar throughout the genus. The best characters for species separation seem to be in the male genitalia where good differences were found in the Sri Lankan specimens. Malaise (1944) gave a key to species of *Nesoselandria*, but many described species were omitted, and only one species, *anthracina*, was recorded from Sri Lanka. Malaise also proposed two subgenera, the typical subgenus and *Corrugia*. These subgenera were separated by the sculpturation of the head, *Corrugia* having a transverse furrow and a number of transverse carinae between the eyes on the frons and *Nesoselandria* lacking these. All of the species I have seen from Sri Lanka would belong in the



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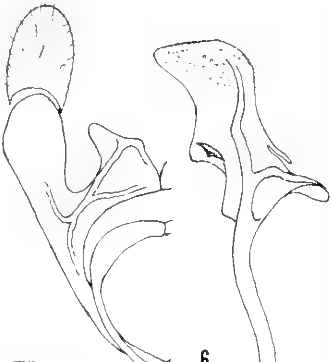

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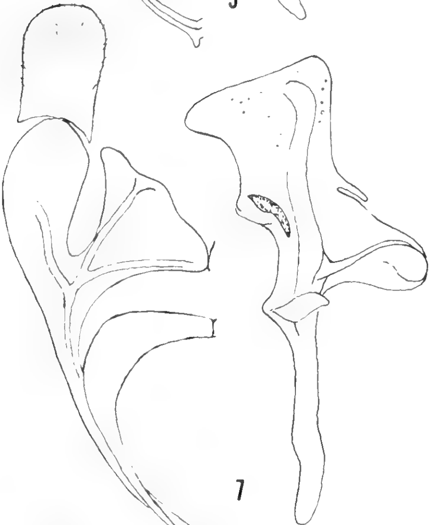

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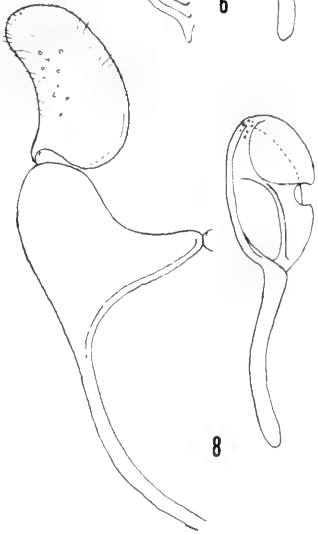

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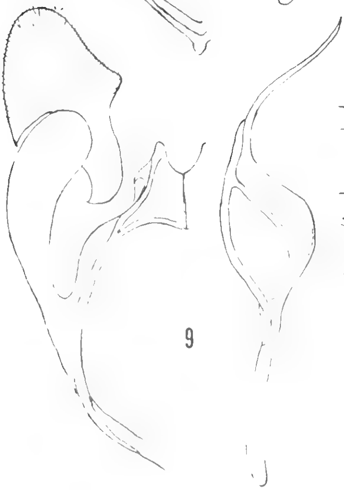

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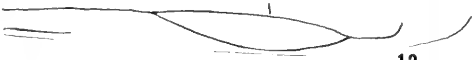

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subgenus *Corrugia*. *Nesoselandria* is also found in southern India, but all of the specimens I examined from southern India belong in the typical subgenus.

KEY TO SPECIES

1. Entirely black; usually larger species, 5–6 mm long; female lancet as in Fig. 3, with annuli indicated; male genitalia as in Fig. 7 .... *anthracina* Malaise
– Black with tarsi, at least basitarsi, and sometimes apex of tibiae whitish; usually smaller species, 3–5 mm long 2
2. Distance between hindocelli, at least in male, nearly 3× diameter of an ocellus; male genitalia as in Fig. 6; female lancet as in Fig. 4 .... *thwaitesii* (Kirby)
– Distance between hindocelli less than 2× diameter of an ocellus; male genitalia as in Fig. 5 .... *minuta*, new species

***Nesoselandria anthracina* Malaise**

Figs. 3, 7

Nesoselandria anthracina Malaise, 1944: 14 (♂, "Ceylon (Ohiya)"; holotype in Swedish Museum of Natural History, Stockholm, examined).

Remarks.—The entirely black coloration, slightly larger size than other species, and genitalia as illustrated are adequate for identifying *anthracina*.

This species is clearly endemic, being restricted to the wet zone of the Central Highlands at altitudes of over 1700 m. The annual rainfall at Nuwara Eliya is 2162 mm.

Records.—SRI LANKA: *Central Province:* Nuwara Eliya District, Hakgala, 6000 ft., 2-VI-1976, K. V. Krombein, S. Karunaratne, D. W. Balasooriya (1 ♀, 2 ♂; SC); Nuwara Eliya District, Kanda-ela Reservoir, 6200′, 1–5-X-1970, O. S. Flint, Jr. (1 ♂; SC); Nuwara Eliya District, Kanda-ela, 2-VI-1975, S. L. Wood and J. L. Petty (5 ♂; SC); Nuwara Eliya District, Kanda-ela Reservoir, 5.6 mi SW Nuwara Eliya, 6200 ft., 10–21-II-1970, Davis and Rowe (2 ♀, 2 ♂; SC); Nuwara Eliya District, Mt. Pidurutalagala, 6500–7500 ft., 8-X-1976, G. F. Hevel, R. E. Dietz IV, S. Karunaratne, D. W. Balasooriya (1 ♀; SC); Nuwara Eliya District, Galway Nat. Reserve, Nuwara Eliya, 6200 ft., 10 June 1978, K. V. Krombein, P. B. Karunaratne,

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Figs. 5–9. Male genitalia; left, capsule, ventral aspect of left half; right, valve, lateral aspect with ventral side to left. 5, *Nesoselandria minuta*. 6, *N. thwaitesii*. 7, *N. anthracina*. 8, *Eusunoxa ceylonica*. 9, *Anisoarthra coerulea*. Figs. 10–12. Anal cell of forewing. 10, *Nesoselandria*. 11, *Eusunoxa*. 12, *Anisoarthra*. Figs. 13–14. Tarsal claws, 13, *A. coerulea*. 14, *E. ceylonica*.

T. Wijesinhe, L. Jayawickrema (16 ♀, 2 ♂ SC); Nuwara Eliya District, Nuwara Eliya, Galway Nat. Res., 1790–1990 m, 22–23-X-1977, K. V. Krombein, T. Wijesinhe, M. Jayaweera, P. A. Panawatta (1 ♀; SC); Pidrutalagala, 2000–2460 m, 19-XI-1953, F. Keiser (1 ♀, 3 ♂; NHMB); Hakgala, 1800–1900 m, 31-V-1953, F. Keiser (1 ♂; NHMB). *Province of Uva:* Badulla District, Ohiya (type and paratype).

Nesoselandria thwaitesii (Kirby), new combination

Figs. 4, 6

Aneugmenus thwaitesii Kirby, 1883: 203 (♂, "Ceylon"; type in British Museum (Natural History), examined).

Nesoselandria ceylonensis Rohwer, 1912: 234 (♀, "Peradeniya, Ceylon"; type in USNM, examined). **New synonymy**.

Remarks.—This species has partly white tarsi, sometimes whitish only on the basitarsi, as does *minuta,* and is 4–5 mm long. Male genitalia should be used to separate *thwaitesii* from *minuta,* although the ocellar triangle seems to be a good character for separating males of the two species. The hindocelli in *thwaitesii* are nearly three ocellus diameters apart, forming a low triangle, whereas in *minuta* the hindocelli are less than two ocellus diameters apart, producing a higher triangle. The value of the ocellar triangle for separation of females of these two species is unknown since only the female of *thwaitesii* is available for study. The types of *thwaitesii* and *ceylonensis* proved to be opposite sexes of the same species. Kirby (1883) stated that *thwaitesii* had 10-segmented antennae, but antennae of the type are actually 9-segmented. The type of *thwaitesii* is a male; this was not stated in the original description. Malaise (1944) indicated that *thwaitesii* belonged in *Nesoselandria,* but he was not certain.

Nesoselandria thwaitesii is also a wet zone species, but it occurs at lower altitudes than does *anthracina.* The average annual rainfall for collection sites is 2400–2700 mm.

Records.—SRI LANKA: *Central Province:* Kandy District, Udawattakele Sanctuary, 26–30-VII-1978, Malaise trap, K. V. Krombein, T. Wijesinhe, V. Kulasekare, L. Jayawickrema (2 ♀; SC); Udawattakele, Kandy, 510–580 m, 8–10-IX-1977, K. V. Krombein, P. B. Karunaratne, T. Wijesinhe, M. Jayaweera (1 ♀; SC); Kandy District, Peradeniya (type of *ceylonensis*); Kandy, 29-X-1953, F. Keiser (1 ♂), 30-IX-53 (1 ♂), 15-X-53 (1 ♀), 15-XI-53 (1 ♀) (NHMB). *Western Province:* Colombo District, Labugama Reservoir, 400 ft., 1-XII-1976, G. F. Hevel, R. E. Dietz IV, P. B. and S. Karunaratne, D. W. Balasooriya (1 ♀; SC); Kalutara District, Agalawatta, black light, 13–14-X-1976, G. F. Hevel R.E. Dietz IV, S. Karunaratne, D. W. Balasooriya (3 ♀, 1 ♂; SC). *Province of Sabaragamuwa:* Kegalla District, Kitulgala, Bandarakele Jungle, 17–18 March 1979, K. V.

Krombein, P. B. Karunaratne, T. Wijesinhe, L. Jayawickrema, T. Gunawardane (1 ♀; SC); Ratnapura District, Rakwana, 1500′, 20-X-1970, O. S. Flint, Jr. (1 ♂; SC); Ratnapura District, Ratnapura, Pompekele, 10-X-1980, P. B. Karunaratne, T. Wijesinhe, L. Jayawickrema, V. Gunawardane (1 ♀; SC). *Province of Uva:* Lunugala, 25-X-1953, F. Keiser (♀; NHMB).

***Nesoselandria minuta* Smith, new species**

Fig. 5

Female.—Unknown.

Male.—Length, 3.7 mm. Black with tarsi whitish, apical 2 or 3 segments of each tarsus infuscated blackish. Wings lightly, uniformly infuscated black; veins and stigma black. Third antennal segment 1¼× length of 4th segment. Head with transverse carinae on frons between eyes; clypeus truncate; malar space linear; postocellar area nearly 5× broader than long; distance between hindocelli less than 2× diameter of an ocellus and ocellar triangle high, nearly equilateral. Genitalia as in Fig. 5.

Holotype.—♂, Province of Sabaragamuwa, Ratnapura District, labeled "Ceylon, Rat. Dist., Uggalkaltota, 350 ft., Irrigation Bungalow, 31 Jan.–8 Feb. 1970, Davis and Rowe." USNM type no. 76875.

Paratype.—Central Province, Kandy District, Thawalamtenne, 2200 ft., 7–8-IX-1980, K. V. Krombein, P. B. Karunaratne, T. Wijesinhe, L. Jayawickrema, V. Gunawardane (1 ♂).

Remarks.—The genitalia of *minuta* are very different from those of the other two species from Sri Lanka, and the specimens do not agree with the other species treated by Malaise in his key (1944). The distance between the hindocelli may be used to separate *minuta* from the males of *thwaitesii*, as given in the key and discussed under *thwaitesii*, but the two species are best separated by comparing Figs. 5–7 of the genitalia. As with the other species of *Nesoselandria*, this is apparently also a wet zone species.

Family Xiphydriidae

***Cingalixiphia striatifrons* (Cameron)**

Xiphydria striatifrons Cameron, 1905: 70, pl. A, fig. 1 (♀, "Pundalu-oya"; type in British Museum (Natural History), examined).

Remarks.—This is the only species of Xiphydriidae known from Sri Lanka. I have not seen specimens other than the type. The type-locality is in Central Province, Nuwara Eliya District.

Family Orussidae

***Mocsarya metallica* (Mocsáry)**

Oryssus metallicus Mocsáry, 1896: 1 (♀, "Sumbawa in Insulis Sundaicis"; type probably in the Hungarian Museum of Natural History, Budapest).

Remarks.—I have not seen specimens of Orussidae from Sri Lanka. *Mocsarya metallica* was described from Indonesia, but it was recorded from Sri Lanka by Bingham (1908) and later by Benson (1935). Bingham stated that his specimen from Sri Lanka corresponded closely with Mocsáry's description of *metallica*, but he noted several differences in the amount of infuscation of the forewings and the coloration of the legs. There is no doubt that an orussid does occur in Sri Lanka, but a comparison of Bingham's specimen with the type of *metallica* will be necessary to determine if Bingham's specimen is actually that species.

ACKNOWLEDGMENTS

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LITERATURE CITED

Benson, R. B. 1935. On the genera of the Orussidae (with an account of the African species (Hymenoptera Symphyta)). Occas. Pap. Rhodesian Mus. No. 4, 10 pp.

Bingham, C. T. 1908. Appendix to Mr. Wickwar's paper. Spolia Zeylan. 5: 122–123.

Brinck, P., H. Andersson, and L. Cederholm. 1971. Report No. 1 from the Lund University Ceylon Expedition in 1962. Entomol. Scand. Suppl. 1: III–XXXVI.

Cameron, P. 1876. Descriptions of new genera and species of Tenthredinidae and Siricidae, chiefly from the East Indies, in the collection of the British Museum. Trans. Entomol. Soc. Lond. 1876: 459–471.

———. 1905. On the phytophagous and parasitic Hymenoptera collected Mr. E. Ernest Green in Ceylon (first paper). Spolia Zeylan. 3: 67–97.

Enderlein, G. 1920(1919). Symphytologica II. Zur Kenntniss der Tenthredininen. Sitzb. Gesell. Naturf. Freunde Berl., No. 9, pp. 347–374.

Kirby, W. F. 1882. List of Hymenoptera in the British Museum, Vol. I. London. 450 pp.

———. 1883. Notes on new or little-known species of Hymenoptera, chiefly from New Zealand. Trans. Entomol. Soc. Lond. 1883: 199–203.

Malaise, R. 1932. A new sawfly from Ceylon (Hym. Tenthredinidae). Ceylon J. Sci., Sect. B, 17: 147–148.

———. 1937. New Tenthredinidae mainly from the Paris Museum. Rev. Fr. Entomol. 4: 43–54.

———. 1944. Entomological results from the Swedish Expedition 1934 to Burma and British India. Hymenoptera: Tenthredinoidea collected by René Malaise, the Tenthredinoidea of South-Eastern Asia. Ark. Zool. 35A: 1–58.

Mocsáry, A. 1896. Species Hymenopterorum magnificae novae in collectione Musaei Nationalis Hungarici. Természetr. Füzetek 19: 1–8.

Rohwer, S. A. 1912. Notes on sawflies, with descriptions of new species. Proc. U.S. Natl. Mus. 43: 205–251.

———. 1915. Some Oriental sawflies in the Indian Museum. Rec. Indian Mus. 11: 39–53.

———. 1921. Notes on sawflies, with descriptions of new genera and species. Proc. U.S. Natl. Mus. 59: 83–109.

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NOTE

Authorship of the Family Name Erotylidae (Coleoptera)

Boyle (1956. Bull. Am. Mus. Nat. Hist. 110) in his monograph of the Erotylidae of North America cited Lacordaire (1842. Monographie des Erotyliens) as the author of the family group name Erotylidae. Sen Gupta (1969. Proc. Zool. Soc. Calcutta 22) cited Guérin-Méneville based on the usage in 1841 (Rev. Zool. 1841).

The earliest usage of a family group name for Erotylidae I have seen, however, is by Leach in the Entomology Section of Brewster's *Edinburgh Encyclopaedia* published in 1815. He used the heading "Tribe X. Erotylides," and beneath it "Family I. Erotylida." His usage of the vernacular and subsequent latinization and acceptance by later authors is consistent with Article 11e, *International Code of Zoological Nomenclature*. The name Erotylidae should therefore be credited to Leach, 1815.

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SEASONAL HISTORY OF THE WHITE PEACH SCALE, *PSEUDAULACASPIS PENTAGONA* (TARG.-TOZZ.) (HOMOPTERA: DIASPIDIDAE), IN NORTHEASTERN PENNSYLVANIA

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Abstract.—The seasonal history of the white peach scale, *Pseudaulacaspis pentagona* (Targioni-Tozzetti), was studied on Kwanzan cherry, *Prunus serrulata* Lindl., during 1980. In northeastern Pennsylvania the scale was bivoltine with fertilized adult females overwintering. Oviposition began 15 May for the first generation and 22 July for the second generation; females produced an average of 27.2 eggs and 78 eggs per generation, respectively. Crawler emergence began 20 May and 28 July; adults appeared 8 July and 3 September. Natural enemies encountered in this study were the twospotted lady beetle, *Adalia bipunctata* (L.) (Coccinellidae), and the wasp parasite *Encarsia berleseii* (Howard) (Aphelinidae).

The white peach scale, *Pseudaulacaspis pentagona* (Targioni-Tozzetti), probably native to China (Gossard, 1902), was described from Italy in 1886. It has been introduced repeatedly into the Western Hemisphere, particularly the United States. The apparent first record of this diaspidid in the continental U.S. was from Florida in 1889 (Van Duyn and Murphey, 1971), or Thomasville, Ga. in the late 1800's (Yonce and Jacklin, 1974). It was also imported into Georgia in 1902 (Bobb et al., 1973). The scale became a major pest of oleander in Bermuda after its introduction in 1917 (Bennett, 1956), and there was concern that oleander might be eliminated. So great was this fear that the Bermudian government passed the White Scale Act in 1921 in an attempt to control the pest. In Florida the demise of the peach industry in the early 1900's can be attributed partially to the white peach scale. In orchard situations it can be as destructive as San José scale, *Quadraspidiotus perniciosus* (Comstock) (Bobb et al., 1973). Since white peach scale is a polyphagous feeder it is a pest not only of fruit trees but many ornamentals. Ferris (1937) noted that it is capable of attacking nearly any nonconiferous host. While this may seem too broad a statement, Borchsenius (1966) recorded it from 54 families and 121 genera of hosts, and Dekle (1976) lists 278 hosts in Florida, including juniper, a conifer. In Pennsylvania the most common hosts are flowering cherry (*Prunus* spp.) and privet (*Ligustrum* spp.).

The life history of white peach scale is well known in the southern states. It is a multivoltine species having as many as four generations per year in Florida (Kuitert, 1968) and three in North Carolina (Smith, 1969). The literature, however, contains little on its life history in the northern states.

In November 1979, my attention was called to a heavy infestation of white peach scale on Kwanzan cherry (*Prunus serrulata* Lindl.) in a park at Wilkes-Barre, Luzerne Co., Pa. Most of the nearly 100 trees in the park were severely infested and had suffered various degrees of dieback. According to the county extension agent, most of the ornamental cherries in the Wyoming Valley were infested with the scale and control attempts with dormant oil had been unsuccessful. In attempting to make a control recommendation, I could find no exact dates of crawler emergence. For that reason, I initiated a seasonal history study of this diaspidid in northeast Pennsylvania.

METHODS

Seasonal history data were compiled from weekly samples of scale-infested Kwanzan cherry taken in Wilkes-Barre, Pa. Sampling began in late March while overwintering scales were still dormant and continued into the following October when the scales ceased development. Throughout the winter, monthly samples were taken to insure that the females were not developing. In the laboratory, specimens were removed and slidemounted in Hoyer's medium and determined to stage with a phase-contrast microscope. Specimens were selected by starting at a random point, then slidemounting all nearby individuals, including eggs, until a minimum of 100 specimens were mounted. Approximately 3000 scales were mounted and identified. Parasites were collected by rearing them from scale-infested twigs in large, covered plastic dishes and placing them into 70% ethanol as they emerged. No predators were encountered in the laboratory samples.

Exact length of stages could not be determined by my sampling procedure, but the precise length of stadia is known (Ball, 1980). My study focused on monitoring a population under field conditions to obtain actual dates of oviposition and crawler emergence. Egg counts were made by lifting the scale's armor and counting the eggs beneath. Empty chorions were not counted. Length of the egg stage was determined by observing newly deposited eggs until they hatched. These eggs were collected by excising an ovipositing female from the host, removing eggs individually, and placing them in separate plastic dishes for observation. Eggs were checked several times daily until they hatched.

SEASONAL HISTORY (Fig. 1)

Pseudaulacaspis pentagona overwinters as fertilized adult females. Eggs could be seen in cleared females by 14 April. Shortly before depositing eggs, females produced crawler emergence flaps on their armor at the end opposite the exuviae. Oviposition began 15 May, when the eggs of 20 females were counted, and the average number of eggs held per female was 27.2 (range 7–46). Crawlers began to emerge about 20 May, as field observations revealed only three active crawlers on that date. Settled crawlers appeared in the 28 May sample, but most certainly were present by 22 May, owing to the short life of active crawlers. By 28 May, settled crawlers composed more than 50% of the sample. By 5 June, most females had finished ovipositing and had died. Settled crawlers were dominant until 19 June when the entire sample consisted of second-instars. Prepupal and pupal males were present in the 25 June sample. Adult males and females of this first generation appeared 8 July, and mated shortly after attaining maturity. By 17 July, cleared females again contained eggs. Second generation eggs were present in the 22 July sample; each ovipositing female had laid 12.4 eggs by this time. The following week (31 July) eggs, active crawlers, and settled crawlers could be found. At this time each of 18 females held an average of 78 unhatched eggs. Second-instars of both sexes appeared 14 August, with males more abundant. Prepupal and pupal males were present in the 27 August sample, and adults of both sexes were found the next week (3 September). By 10 September all males had died, and only fertilized adult females were found in the remainder of the year's samples. By late September almost 33% of the females were parasitized; until this time the rate of parasitism had been low.

Two species of parasites, both Aphelinidae, were reared from the weekly samples: *Encarsia berleseii* (Howard), a primary parasite, and *Marietta carnesi* (Howard), a hyperparasite. The only predator observed was the twospotted lady beetle, *Adalia bipunctata* (L.) (Coccinellidae). Both adults and larvae were observed feeding on scales.

DISCUSSION

While eggs and crawlers of white peach scale are known to exhibit sexual dimorphism in color (Bennett and Brown, 1958; Simmonds, 1958; Kuitert, 1968; Van Duyn and Murphey, 1971), all eggs encountered during this study were coral, although of slightly various shades. Crawlers were light yellow and sexes could not be separated solely on the basis of color. Heavy concentrations of males could be seen on the undersides of limbs and branches, whereas most females settled on the upper portions. The males were so thick that their armor made the undersides of the infested limbs look as though they had been plastered with snow.

FIGURE 1

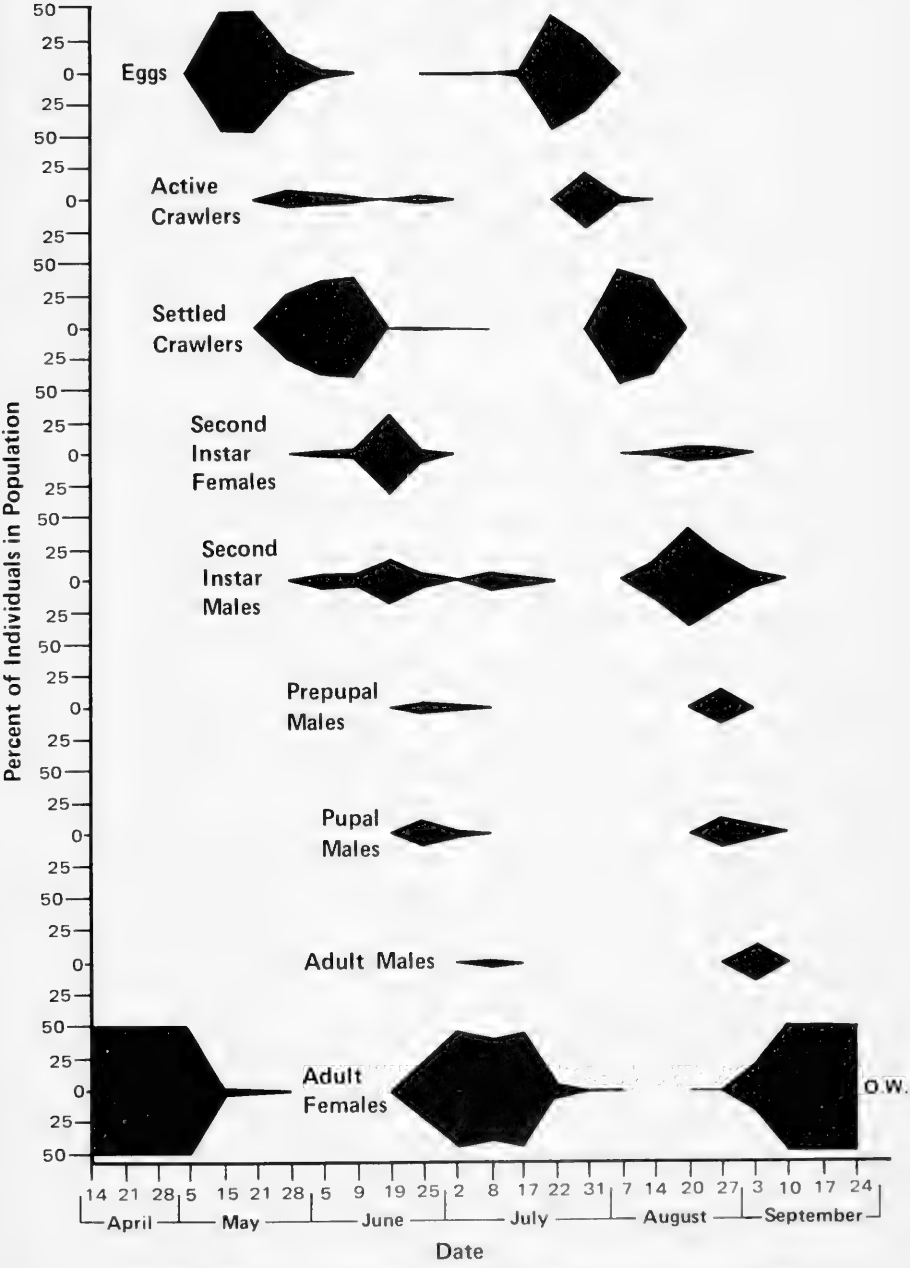

Fig. 1. Seasonal history of white peach scale on *Prunus serrulata* in northeastern Pennsylvania (o.w. = overwinters).

Generations of this species were well defined, unlike the overlapping generations of the multivoltine scale *Fiorinia externa* Ferris (Stimmel, 1980). There are several reasons for this. White peach scale overwintered in only one form, fertilized females, so that in spring all individuals continued to develop from the same stage. The oviposition period was relatively short, so that almost all eggs hatched within a period of a few days. Finally, the females died upon completing oviposition and could not be confused with newly maturing females of the following generation.

Peak oviposition took place during the week of 15 May for the first generation and 22 July for the second. Eggs hatched in an average of four days at laboratory temperatures (23°C). Periods of greatest crawler emergence occurred one week after oviposition peaks, 28 May for generation one and 31 July for generation two.

Populations build quickly because this species is so prolific and has two generations per year. Natural enemies simply cannot keep up with an exploding white peach scale population. Damage by this insect is typical of the family: dieback of smaller twigs, progressing to larger branches and then entire trees, if left unchecked.

White peach scale is uncommon, though not rare, in Pennsylvania. It has been taken primarily on *Ligustrum* and *Prunus* in various locations throughout the state. It has been taken only in ornamental plantings, never in orchards. Infestations appear to be sporadic throughout Pa., with the exception of the Wilkes-Barre population, which covers the entire Wyoming Valley.

Recently, Kawai (1980) split *Pseudaulacaspis pentagona* into two species, *pentagona* (Targ.-Tozz.) and *prunicola* (Maskell). Based on illustrations presented by Kawai, the two can be separated by the structure of the pygidial gland spines, which are fringed in *pentagona*, simple and spike-like in *prunicola*. Some speculation exists among U.S. workers concerning the validity of the species separation, and the presence of *prunicola* in the United States has not been established[1]. Specimens from the Wilkes-Barre population appear to be the *prunicola* type with simple gland spines. However, because of the uncertainty surrounding the status of these species, I have treated the scale in this paper as *P. pentagona*. Slidemounted voucher specimens from the Wilkes-Barre population have been deposited in the Coccoidea collection of the U.S. National Museum at the Beltsville Agricultural Research Center–West, Beltsville, Maryland.

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[1] Personal communication: Douglass R. Miller and Sueo Nakahara.

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LITERATURE CITED

Ball, J. C. 1980. Development and fecundity of the white peach scale at two constant temperatures. Fla. Entomol. 63: 188–194.

Bennett, F. D. 1956. Some parasites and predators of *Pseudaulacaspis pentagona* (Targ.) in Trinidad, B.W.I. Can. Entomol. 88: 704–705.

Bennett, F. D. and S. W. Brown. 1958. Life history and sex determination in the diaspine scale, *Pseudaulacaspis pentagona* (Targ.) (Coccoidea). Can. Entomol. 90: 317–324.

Bobb, M. L., J. A. Weidhaas, Jr., and L. F. Ponton. 1973. White peach scale: life history and control studies. J. Econ. Entomol. 66: 1290–1292.

Borchsenius, N. S. 1966. A catalogue of the armoured scale insects (Diaspidoidea) of the world. Akad. Nauk SSSR Zool. Inst. Leningrad. 449 pp.

Dekle, G. W. 1976. Florida armored scale insects. Arthropods Fla. Neighboring Land Areas, Vol. 3, 343 pp.

Ferris, G. F. 1937. Atlas of the scale insects of North America. Series I. Serial Nos. SI-1 to SI-136. Stanford University Press, California.

Gossard, H. A. 1902. Two peach scales. Fla. Agric. Exp. Stn. Bull. 61: 492–498.

Kawai, S. 1980. Scale insects of Japan in colors (Illus.). Nat. Soc. for Agricultural Educ. TaiNippon Printing Co., Inc., Tokyo, Japan. 455 pp.

Kuitert, L. C. 1968. Observations on the biology, bionomics, and control of white peach scale, *Pseudaulacaspis pentagona* (Targ.). Proc. Fla. State Hort. Soc., 1967 80: 376–381.

Simmonds, F. J. 1958. The oleander scale, *Pseudaulacaspis pentagona* (Targ.) (Homoptera, Coccidae) in Bermuda. Dep. Agric. Bermuda. Bull. No. 31. 44 pp.

Smith, C. F. 1969. Controlling peach scale. Res. Farming (N.C. Agric. Exp. Stn.) 28: 12.

Stimmel, J. F. 1980. Seasonal history and occurrence of *Fiorinia externa* Ferris in Pennsylvania (Homoptera: Diaspididae). Proc. Entomol. Soc. Wash. 82: 700–706.

Van Duyn, J. and M. Murphey. 1971. Life history and control of white peach scale, *Pseudaulacaspis pentagona* (Homoptera: Coccoidea). Fla. Entomol. 54: 91–95.

Yonce, C. E. and S. W. Jacklin. 1974. Life history of the white peach scale in central Georgia. J. Ga. Entomol. Soc. 9: 213–216.

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84(1), 1982, pp. 134–137

A NEW SPECIES OF *ZALE* HÜBNER FROM TEXAS AND NEW MEXICO (LEPIDOPTERA: NOCTUIDAE: CATOCALINAE)

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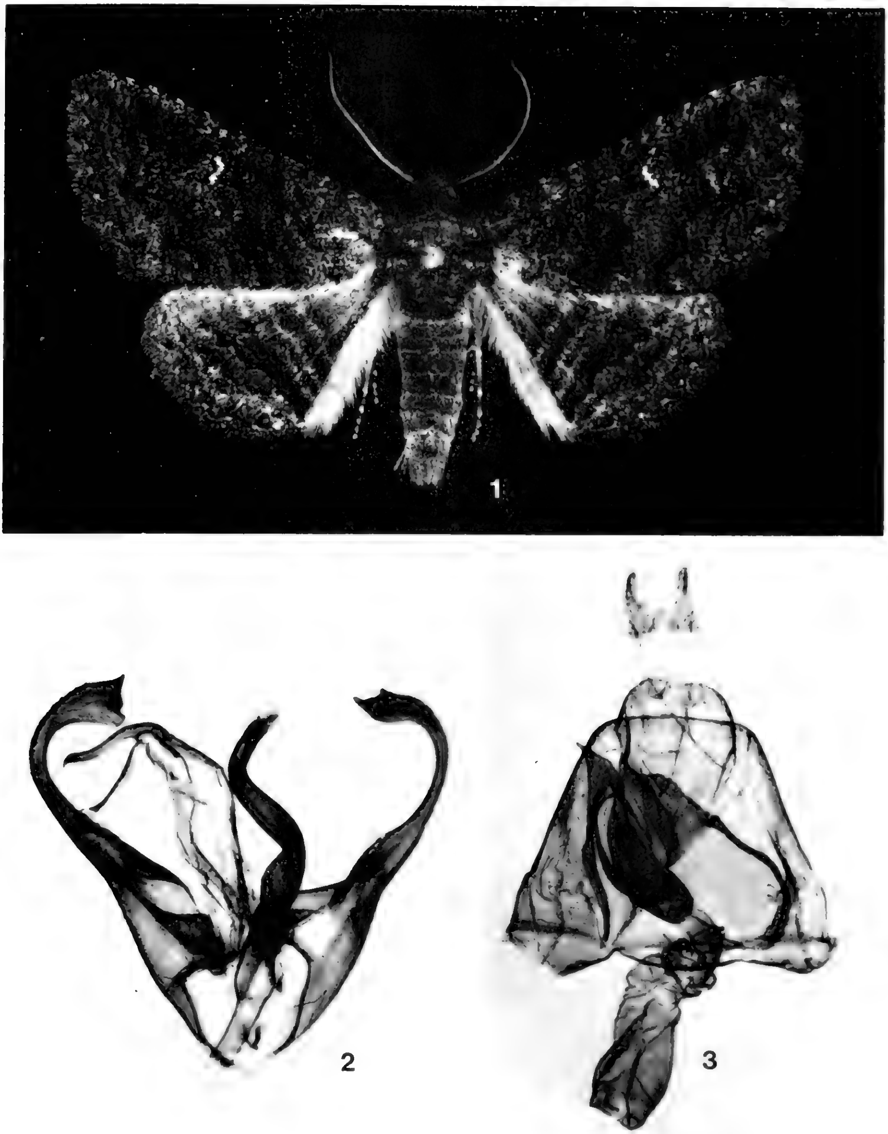
Abstract.—A new species of *Zale,* ***chisosensis***, related to *Zale corvus* (Schaus) from Mexico, is described from Texas and New Mexico. The species is uncommon in collections, a reflection of its limited range in the southwestern United States.

The following species is poorly represented in collections, and it has usually been misidentified as either *Zale undularis* (Drury) or *Zale coracias* (Guenée). When the junior author first saw it, he thought it was *Zale corvus* (Schaus).

Zale chisosensis Blanchard and Franclemont, New Species

Diagnosis.—Among the species of *Zale* that occur north of the Mexican Border this species is superficially most similar to *undularis* (Drury, 1770 [1773], 1: 19), but it differs in the course of the subterminal line which is produced into sharp points filled with black between veins R_5 and M_1 and between veins M_3 and Cu_1. It lacks the conspicuous pale spot in the subterminal line between veins M_1 and M_2, but it has a line of white scales on the outer side of the reniform. The most closely allied species is the Mexican species *corvus* (Schaus, 1901: 78) with which it agrees in all details of pattern. The male genitalia of the two species differ in many ways; those of *corvus* have the left valve with a large, subquadrate projection before the apex which is drawn out into an acute point, and the right valve broad throughout, tapering gradually to a pointed apex, and with a small, pointed lobe on the costal margin before the apex. The aedoeagus of *corvus* is more sharply angled, forming almost a right-angle. The female genitalia of the two species are similar, but the differences are conspicuous; the pointed angle of the ventral plate of *corvus* is on the right side not the left, and the narrow, lateral plate of *corvus* is truncate at the apex not pointed as in *chisosensis*.

Description.—Black with a dull luster and a dusting of yellowish white



Figs. 1–3. *Zale chisosensis*. 1, Paratype, Mt. Locke, 6700 feet, Davis Mountains, Jeff Davis Co., Texas, 10 June 1969, A. & M. E. Blanchard; collection A. Blanchard. 2, Male genitalia, aedoeagus *in situ*; paratype; genitalia slide AB 3712. 3, Female genitalia; paratype; genitalia slide AB 3711.

scales, area beyond subterminal line appearing smoother and with a slight bluish luster; transverse lines more intense black; costa of forewing with white spots near inception of lines; basal line double, curved, undulate, reaching base in fold; antemedial line curved, undulate, starting on costa ¼ from base, reaching inner margin at $^1/_6$ from base, double, elements widely spaced, incurved on veins R and 2nd A; median line angled outward below costa, somewhat undulate, appearing triple on lower ½ of wing; postmedial line angled below costa, incurved toward middle of reniform, undulate to inner margin, starting on costa ¾ from base, reaching inner margin ¾ from base, double, elements fine; subterminal line conspicuous, undulate, more or less parallel to outer margin, sharply angled outward between veins R_5 and M_1 and between veins M_3 and Cu_1, points filled with intense black, some white or yellowish white scaling on outside of line between the two points; a series of vague, fine, vertical striae in terminal area; terminal line represented by pale scales and by pale points with black scales on inner sides between veins; outer margin evenly scalloped, incurved between veins; orbicular punctiform, black; reniform, narrow, elliptical, vaguely defined by black, a line of white scales on outer side. Hindwing with markings of forewing continued; antemedial line and median line represented by broad shades; postmedial line double; subterminal line sharply angled outward between veins M_3 and Cu_1, point black filled; terminal area and terminal line much as on forewing. Some specimens show a brownish flush on the forewing between the median and postmedial lines above vein 2nd A and below Cu_2; the type is such a specimen.

Expanse: Forewing length 23–25 mm.

Male genitalia: As figured.

Female genitalia: As figured.

Type.—♂; Mt. Locke, 6700 feet, Davis Mountains, Jeff Davis County, Texas, 10 June 1969, A. & M. E. Blanchard; collection of the U.S. National Museum of Natural History.

Paratypes.—6 ♂, 3 ♀; Mt. Locke, 6700 feet, Davis Mountains, Jeff Davis County, Texas, 10 June 1969 (3), 5 July 1969 (1), 19 July 1971 (1), A. & M. E. Blanchard; Green Gulch, Big Bend National Park, Brewster County, Texas, 27 June 1965 (1), 12 May 1972 (1), A. & M. E. Blanchard, 10 May 1972 (2), J. G. Franclemont; 5 in collection A. Blanchard; 4 in collection J. G. Franclemont.

In addition to the type-series from Texas, there are three specimens from New Mexico, a male from Beartrap Canyon Camp Ground, San Mateo Mountains, 8000 feet, 11 April 1971, collected by Richard Holland (in the Canadian National Collection), and two females from Near Hot Springs, Las Vegas [San Miguel County], 7000 feet, August 1882, collected by F. H. Snow (in the Cornell University Collection). These two females lack the white scaling and appear entirely black; they were purchased from Snow by J. H. Comstock as *coracias* and stood under that name until recently.

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The photographs are by the senior author.

LITERATURE CITED

Drury, D. 1770 [1773]. Illustrations of Natural History, Volume 1. B. White, London.

Schaus, W. 1901. New Species of Noctuidae from Tropical America. Ann. Mag. Nat. Hist. (7) 8: 77–99.

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FIRST-INSTAR LARVAE OF THE UNIFORMA GROUP OF THE GENUS *EPICAUTA* (COLEOPTERA, MELOIDAE)

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Abstract.—The Uniforma Group of the subgenus *Macrobasis* of *Epicauta* is characterized on the basis of the first-instar larvae of *Epicauta uniforma* Werner, *E. leoni* Dugès, *E. bipunctata* Werner, and *E. niveolineata* (Haag-Rutenberg), which are described and figured from samples from Texas, State of Mexico, Sinaloa, and Oaxaca, respectively. *Epicauta niveolineata* is set apart from the other species of the group by a number of distinctive larval characteristics, including larger body size, marked elongation of the head, and apical branching of the major body setae. In the larval stage, the Uniforma Group is more similar to the Albida Group than to the Fabricii Group of *Macrobasis*. The larva of nominal *E. uniforma* described previously by Werner is not separable from that of *E. bispinosa* Werner in the nominate subgenus of *Epicauta*.

The Uniforma Group, as defined by Werner (1954, 1958), contains 14 species of blister beetles of the subgenus *Macrobasis* LeConte of the genus *Epicauta* Dejean. So far as known, the group is confined to North America, where it ranges from Arizona and Colorado south to Chiapas, Mexico.

In this, the first in a series of articles on the taxonomy and bionomics of the Uniforma Group, we describe and key the first-instar larvae of *Epicauta uniforma* Werner, *E. leoni* Dugès, *E. bipunctata* Werner, and *E. niveolineata* (Haag-Rutenberg) and assess the taxonomic implications of the data provided by them.

Materials and Methods

Larvae of the Uniforma Group used in this study eclosed from eggs laid in the laboratory by female beetles collected in the field. *Epicauta uniforma* larvae were reared from six egg masses, *E. leoni* from seven, *E. bipunctata* from 17, and *E. niveolineata* from three. Each species is represented by the progeny of several females. Although several hundred larvae of each species were examined, only a small proportion was mounted on slides for detailed study.

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) a few days after eclosion. Those selected for detailed study were dehydrated through an alcohol series, cleared in oil of wintergreen and toluene, and mounted on slides in Harleco Synthetic Resin. Measurements and proportions specified in the descriptions refer to mounted specimens. Length of the head is measured from the posterior margin of the head capsule to the posterior margin of the labrum. Color is described from unmounted specimens in alcohol.

In addition to the larval materials described above, we have examined 38 first-instar larvae from Cochise County, Arizona, representing the bulk of the material on which Werner's (1962) description of nominal *E. uniforma* was based and several lots of larvae of *E. bispinosa* Werner obtained from adults collected in West Texas by the senior author and associates.

LARVA OF *EPICAUTA UNIFORMA*

The larva described by Werner (1962) as that of *Epicauta uniforma* from specimens obtained from eggs laid by a female or females collected 20 miles east of Pearce, Cochise County, Arizona, on August 27, 1958, differs from the larvae of *E. leoni, E. bipunctata,* and *E. niveolineata* and from the larva described herein as that of *E. uniforma* in the majority of characters that have proved to be taxonomically significant in the genus *Epicauta.* In Werner's larva the cuticle is pale and weakly sclerotized, the head is strongly constricted basally, the mandibles are unusually slender and elongate and set with numerous minute, truncate teeth (about 12 visible in outline), the maxillary and labial palpi are slender and elongate, the sensory area of segment III of the maxillary palpus is confined to the distal ⅓ of the segment and bears only a few papillae, the antenna is elongate, spinelike evaginations at the bases of the posterior marginal setae of abdominal terga I–VIII are only weakly developed, the coxae are short, and the number of setae on the head and tibiae is reduced. The posterior marginal row of setae on the abdominal terga, containing 10 setae, is unusual in that the third and fifth setae on each side, counting from the midline, are only about ½ as long as the others.

Selander (1981b) recently advanced the hypothesis that several characteristics of Werner's *E. uniforma* larva represent adaptations associated with an evolutionary change from larval predation on grasshopper eggs, which is the norm for the genus *Epicauta,* to predation on the eggs of blister beetles. In this connection, Selander called attention to the similarity between Werner's larva and the larva of *E. bispinosa* recently described by Pinto (1975). Further study of these larvae indicates that minor anatomical differences between them, previously regarded by us as diagnostic, do not hold consistently. As a result, we are presently unable to distinguish Werner's larva from the larva of *E. bispinosa*. Whether we are dealing with a remarkable case of convergence between species in separate subgenera or an instance of mistaken association of larvae of *E. bispinosa* with adults of *E. uniforma* remains to be seen.

Description of the Group

The following description of the Uniforma Group is based on larvae of *E. uniforma, E. leoni, E. bipunctata,* and *E. niveolineata,* as we have identified them. Because of the questionable specific identity of the larva described as that of *E. uniforma* by Werner (1962), we omit that larva from further consideration. In any event, it would be virtually impossible to frame a succinct description of the group that would include Werner's larva and still have diagnostic value.

Body surface (cuticle) finely reticulate. Sides of head parallel or subparallel except at immediate base, where they are abruptly convergent; 13 (9 major, 4 minor) setae on each side of dorsum of head outside frontal area. Antenna moderately robust; segment II at least 1½× as long as III, with anteroventral seta much shorter than posteroventral seta; sensory organ at least as wide and as long as segment III; terminal seta of III at least 1½× as long as segment II. Mandible robust; proximal seta much shorter than distal one. Maxillary palpus with lateral margin of segment III not expanded basally; sensory area of segment III overlapping at least slightly onto ventral surface at apex; papillae of sensory area of III moderately stout, numerous. Labial palpus with segment II as least 2× as long as greatest width, bearing one seta, which reaches apex of segment. Thorax less than ⅓ as long as body; pronotum about as long as meso- and metanotum combined; line of dehiscence well developed and complete on pro- and mesonotum, weakly indicated and incomplete on metanotum. Abdomen with pleurites ventral; pleurite V somewhat wider than long, with spiracle in lateral ½; spiracle I slightly larger than II, II–VIII nearly equal in size; sterna I–VII weakly sclerotized, VIII–IX strongly so; spinelike evaginations absent at bases of setae of median transverse row on terga I–VIII; posterior marginal setae less than 2× as long as those of median transverse row; tergum V more than 3½× as wide as long. Legs with coxae 2½× as long as wide; tibia with 7 setae in anterodorsal row, 6–7 in posterodorsal row, 4–5 in anteromedian row; tarsungulus I with longer seta reaching at least apical ¼.

Systematic Relationships

Epicauta uniforma, E. leoni, and *E. bipunctata* form a homogeneous subgroup which differs from *E. niveolineata* in nearly two-thirds of the characters of larval anatomy that we have studied. Some of the more obvious differences between the subgroups involve the number of mandibular teeth, conformation of the maxillary palpus, number of posterior marginal setae on the abdominal terga, and form (branched or not) of the major body setae. The number of posterior marginal setae on the abdominal terga is compelling evidence of a close phylogenetic relationship between the species of the first subgroup. *Epicauta uniforma* and *E. bipunctata* each has 12 setae, *E. leoni* usually 12 but occasionally 14. Elsewhere in the genus *Epicauta* only *E. conferta* (Say), *E. leopardina* (Haag-Rutenberg), and *E. floydwerneri* Martínez, in the nominate subgenus, have more than 10 setae (12–14 in the first two species, 14 in the last) (Agafitei and Selander, 1980; Selander, 1981a). Consequently, it is reasonable to regard the presence of 10 setae in *E. niveolineata* as the primitive condition for the Uniforma Group and the presence of 12 and 14 in the first subgroup as progressively derived character states.

Within the first subgroup, *E. uniforma* and *E. leoni* are especially similar in appearance in that they lack a distinct abdominal color pattern. *Epicauta bipunctata* has a well developed pattern produced by darkening of the pronotum, metanotum, abdominal terga I and II, and the caudal terga and in this regard closely resembles *E. niveolineata*. However, *E. bipunctata* shares with *E. uniforma* the development of toothlike posterior extensions of the cuticular reticulations of the abdominal pleurites not evident in either *E. leoni* or *E. niveolineata*. These evaginations are weakly and inconsistently developed in *E. uniforma*. In *E. bipunctata* they are strongly developed not only on the pleurites but on the sides of the terga as well. In other characters varying within the first subgroup *E. uniforma* tends to agree more frequently with *E. bipunctata* than with *E. leoni* and therefore is perhaps more closely related to the former species (Selander and Agafitei, *in press*).

The shape of the head in *E. niveolineata* is unique in the genus *Epicauta* and undoubtedly a derived characteristic. Branching of the body setae is assuredly a derived characteristic also. It is known to occur elsewhere in the genus only in two New World species of the Vittata Group [*E. temexa* Adams and Selander and *E. monachica* (Berg)] and in the African *E. albovittata* (Gestro) (Cros, 1938; MacSwain, 1956; Agafitei and Selander, 1980).

Of the several groups of *Macrobasis* currently recognized (Werner, 1954; Selander and Mathieu, 1969), only two, the Albida and Fabricii groups, have been described previously in the larval stage. Larvae of the Uniforma Group more closely resemble those of the Albida Group. No single larval characteristic is unique to the Uniforma and Albida groups, but the following combination of characteristics is diagnostic: Head not or only slightly constricted behind middle; mandibles robust, with relatively few large round teeth visible in outline; segment I of labial palpus with one seta; spiracles

Table 1. Hatching time of eggs (at 27°C) and number of eggs per mass.

	Hatching Time (days)[a]			Eggs per Mass[b]		
Species	Mean	SE	N	Mean	SE	N
E. uniforma	15.7	.49	6	96.8	11.44	5
E. leoni	24.1	.59	7	111.2	5.44	5
E. bipunctata	19.5	.31	12	356.8	14.95	9
E. niveolineata	40.0	1.00	3	157.3	18.28	3

[a] MSE = 1.72, F(3,24) = 256.33, $P < .00001$.

[b] MSE = 1183.77, F(3,18) = 88.59, $P < .00001$.

ventral; femur I with seven lanceolate setae; spinelike evaginations absent at bases of setae in median transverse row of abdominal terga I–VIII; abdominal terga uniform in color or, if patterned, with at least terga VII and VIII dark; abdominal sternum VII weakly sclerotized.

Larvae of the Albida Group are easily distinguished from those of the Uniforma Group by the length of the setae on the abdominal terga. In particular, the setae in the posterior marginal row of tergum V are about as long as the tergum in the Albida Group and never more than ⅔ as long in the Uniforma Group.

BIONOMICS

Data on the hatching time (at 27°C) of eggs and number of eggs per mass for our samples of species of the Uniforma Group are summarized in Table 1. Hatching times for *E. uniforma, E. leoni,* and *E. bipunctata* are comparable in length to those of species of the Albida Group (Selander, 1981b). *Epicauta niveolineata,* in contrast, has an unusually lengthy incubation period, equaled elsewhere in *Macrobasis* only by that of *E. fabricii* (LeConte) of the Fabricii Group (Selander, 1981b).

Hatching time in Table 1 refers to the number of days from oviposition until hatching began in an egg mass. In *E. uniforma, E. leoni,* and *E. bipunctata* the eggs in a mass hatched more or less synchronously. In *E. niveolineata* the hatching period extended over a period of several days.

Proper interpretation of the data on number of eggs per mass in meloids requires that the size of the adult females producing the eggs be taken into consideration (Adams and Selander, 1979). The eggs (and first-instar larvae) of *E. uniforma, E. leoni,* and *E. bipunctata* are nearly equal in size. Consequently, one might expect the ratio of number of eggs per mass to adult body volume in these species to be constant or nearly so. In our samples the adults of *E. uniforma* and *E. leoni* were similar in size and, as shown in Table 1, their egg masses contained, on the average, roughly the same number of eggs. Females of *E. bipunctata* in our samples were 3–4 times as large (in terms of volume) as those of *E. uniforma* and *E. leoni* and, as expected, their egg masses contained more than three times the mean number of eggs. The relationship between adult body size and number of eggs per mass is quite different, however, for *E. niveolineata.* Adults of *E. niveolineata,* although nearly as large as those of *E. bipunctata,* produced egg masses containing less than half the number of eggs. The difference reflects the fact that the volume of an egg in *E. niveolineata* is much greater (about three times) than in *E. bipunctata.*

Larvae of several species of the Albida Group are known to prey on the eggs of grasshoppers of the genus *Melanoplus* in nature (Horsfall, 1943; Parker and Wakeland, 1957). Judging from the anatomical similarity of the larvae of the Albida and Uniforma groups, one would infer that the latter are grasshopper egg predators also and, in fact, both *E. leoni* and *E. niveolineata* have been reared in our laboratory on the eggs of *Melanoplus differentialis* (Thomas).

KEY TO SPECIES OF THE UNIFORMA GROUP BASED ON THE FIRST LARVAL INSTAR

1. Head longer than wide, with sides, except at immediate base, straight and subparallel (Fig. 1b); mandible with 5–6 teeth visible in outline; long setae of thorax and abdomen branched several times near tips .... *niveolineata* (Haag-Rutenberg)
– Head wider than long, with sides rounded and weakly convergent behind middle (Fig. 1a); mandible with 3–4 teeth visible in outline; long setae of body not branched 2
2. Lanceolate setae on femora relatively slender, especially on femur III (Fig. 2c); major seta on coxa III heavy; abdominal terga I–II and VI–VIII much darker in color than III–V; cuticular reticulations near lateral margins of terga I–VIII prolonged posteriad into conspicuous toothlike evaginations .... *bipunctata* Werner
– Lanceolate setae on femora broad, heavy (Figs. 2a, b); major seta on coxa III slender; abdominal terga usually uniform in color; cuticular reticulations of terga not prolonged posteriad 3
3. Mandibular teeth more or less V-shaped in outline; abdominal terga light brown to brown .... *leoni* Dugès
– Mandibular teeth rounded; abdominal terga light yellow brown .... *uniforma* Werner

DESCRIPTIONS OF THE SPECIES

***Epicauta uniforma* Werner**

Figs. 1a, 2a

Description.—Color of head, pro- and metanotum, abdominal tergum I, and, sometimes, terga VI–VIII light brown; rest light yellow brown.

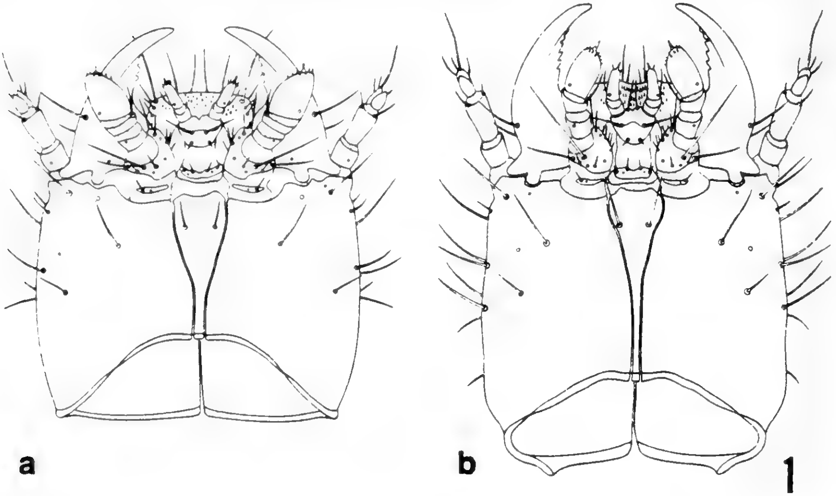

Fig. 1. Head of first-instar larva, ventral view. a, *Epicauta uniforma*. b, *E. niveolineata*.

Head shorter than pro- and mesonotum combined, nearly $1^{1}/_{10}$ as wide as long; sides straight, parallel before middle, rounded and weakly convergent behind (except at immediate base); gula about ½ as long as greatest width of head; gular setae not reaching anterior margin of gula. Antenna with segment II more than 1½× as long as III; sensory organ as long as segment III, extending beyond apex of segment. Mandibles less than $^{3}/_{5}$ as long as head, ½ as wide as long, bearing 5–6 teeth (3–4 visible in outline); teeth rounded. Maxillary palpus with segment III more than 1½× as long as wide; sensory area of segment III extending more than ½ length of dorsal surface; papillae of sensory area moderately dense, partially obscuring one another in dorsal view; length of 2-segmented sensory appendix more than ½ width of segment II of labial palpus. Labial palpus with segment I about ⅓ as long as II; II more than 2× as long as wide. Abdomen with cuticular reticulations prolonged posteriad into inconspicuous toothlike evaginations on median ⅓ of pleurites I–VIII in some specimens; 12 (rarely 10) setae in posterior marginal row on terga I–VIII; setae not divided apically; spinelike evaginations at bases of marginal setae moderately developed on terga I–IV, weakly so on V or V and VI; tergum V about 4× as wide as long, with central pair of posterior marginal setae less than $^{2}/_{5}$ as long as tergum; central pair of setae of median transverse row of tergum V $^{3}/_{10}$ as long as tergum; spiracle I slightly more than ½ as large as mesothoracic spiracle; caudal setae at most as long as combined length of terga VII–IX. Femur I with 7 (rarely 6) lanceolate setae; all lanceolate setae heavy; tarsungulus I with longer seta reaching distal ¼. Length of body 2.2 mm. Length of caudal setae 0.3 mm.

Material studied.—25 larvae, adults from Ft. Davis, Jeff Davis Co., Texas, 7/14-VII-63, R. B. Selander and J. M. Mathieu (Notes 24-63 RBS); 15 larvae, adults from Ft. Davis, Texas, 12-VII-63, R. B. Selander and J. M. Mathieu (Notes 28-63 RBS); 10 larvae, adults from Ft. Davis, Texas, 10/12-VIII-67, R. B. Selander (Notes 8-67 RBS).

Remarks.—This species, *E. leoni,* and *E. bipunctata* run to *E. conferta* (Say) in couplet 1 of MacSwain's (1956) key to the larvae of *Epicauta*. They are immediately distinguished from that species by the shape of the head, the presence of fewer mandibular teeth, and the fact that there are only seven, rather than nine, lanceolate femoral setae.

Epicauta leoni Dugès

Fig. 2b

Description.—Color of head and pronotum brown to dark brown; meso- and metanotum and abdominal terga I–IX light brown to brown.

Head about as long as pro- and mesonotum combined, $1^1/_{10}$ as wide as long; sides straight, parallel before middle, rounded and weakly convergent behind middle (except at immediate base); gula about ½ as long as greatest width of head; gular setae not reaching anterior margin of gula. Antenna with segment II about 2× as long as III; sensory organ longer than segment III, extending well beyond apex of segment. Mandibles about $^3/_5$ as long as head, about ½ as wide as long, bearing 5–6 teeth (3–4 visible in outline); teeth more or less V-shaped in outline. Maxillary palpus with segment III about 1½× as long as wide; sensory area of segment III extending more than ½ length of dorsal surface; papillae of sensory area moderately dense, partially obscuring one another in dorsal view; length of 2-segmented sensory appendix about ⅔ width of segment II of labial palpus. Labial palpus with segment I about ½ as long as II; II 2× as long as wide. Abdomen with cuticular reticulations not prolonged into toothlike evaginations; 12 (rarely 14) setae in posterior marginal row on terga I–VIII; setae not divided apically; spinelike evaginations at bases of marginal setae moderately developed on terga I–IV, weakly so on V; tergum V more than 4× as wide as long, with central pair of posterior marginal setae about ½ as long as tergum; central pair of setae of median transverse row of tergum V $^3/_{10}$ as long as tergum; spiracle I less than ⅔ as large as mesothoracic spiracle; caudal setae longer than combined length of terga VII–IX. Femur I with 7 (rarely 6 or 8) lanceolate setae; all lanceolate setae heavy; tarsungulus I with longer seta reaching distal $^1/_6$. Length of body 2.0 mm. Length of caudal setae 0.4 mm.

Material studied.—32 larvae, adults from Chapingo, Mexico, Mexico, 10-VIII-63, R. B. Selander and R. H. Storch (Notes 3-63 RBS).

Remarks.—See remarks for *E. uniforma*.

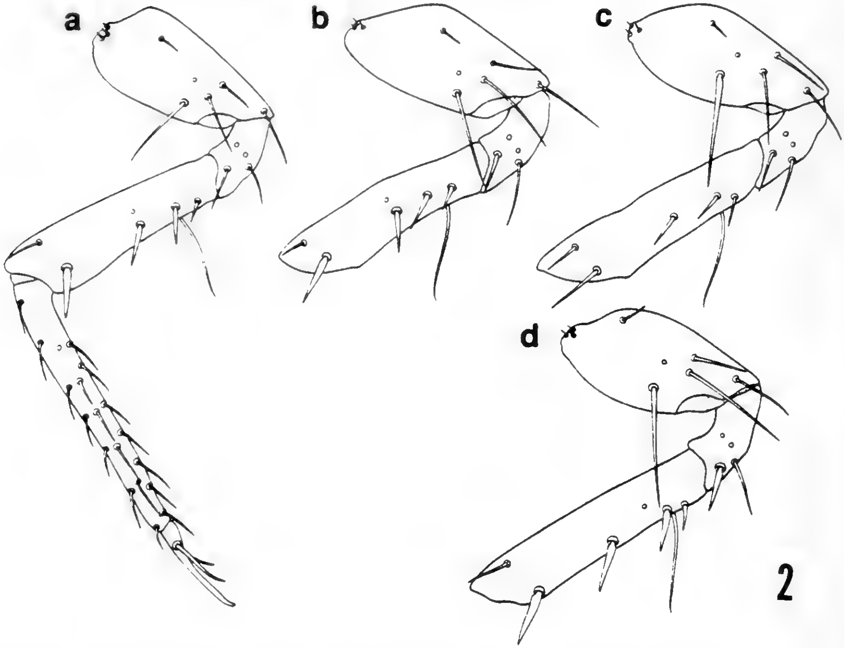

Fig. 2. Leg III of first-instar larva, anterior view (tibia and tarsungulus omitted except in Fig. 2a). a, *Epicauta uniforma*. b, *E. leoni*. c, *E. bipunctata*. d, *E. niveolineata*.

Epicauta bipunctata Werner
Fig. 2c

Description.—Color of head, pro- and metanotum, and abdominal terga I, II, and VI–VIII brown; rest light yellow brown.

Head shorter than pro- and mesonotum combined, nearly $1^1/_{10}$ as wide as long; sides straight, parallel before middle, rounded and weakly convergent behind (except at immediate base); gula ½ as long as greatest width of head; gular setae nearly reaching anterior margin of gula. Antenna with segment II more than 1½× as long as III; sensory organ longer than segment III, extending beyond apex of segment. Mandibles nearly $^3/_5$ as long as head, about $^3/_5$ as wide as long, bearing 5–6 teeth (3–4 visible in outline); teeth rounded. Maxillary palpus with segment III more than 1½× as long as wide; sensory area of segment III extending ½ length of dorsal surface; papillae of sensory area moderately dense, partially obscuring one another in dorsal view; length of 2-segmented sensory appendix more than ½ width of segment II of labial palpus. Labial palpus with segment I about ⅓ as long as II; II 2× as long as wide. Abdomen with cuticular evaginations near lateral margins of terga and on median ½ of pleurites of segments I–VIII prolonged posteriad into conspicuous toothlike evaginations; 12 setae in posterior marginal row on terga I–VIII; setae not divided apically; spinelike evaginations at bases of marginal setae moderately developed on terga I–IV, very weakly so on V; tergum V about 4× as wide as long, with central pair of posterior marginal setae ²/₅ as long as tergum; central pair of setae of median transverse row of tergum V almost ²/₅ as long as tergum; spiracle I ⁷/₁₀ as large as mesothoracic spiracle; caudal setae ⁹/₁₀ as long as combined length of terga VII–IX. Major seta on coxa III unusually heavy; femur I with 7 lanceolate setae; lanceolate setae relatively slender (especially noticeable on leg III); tarsungulus I with longer seta reaching distal ¼. Length of body 2.1 mm. Length of caudal setae 0.3 mm.

Material studied.—27 larvae, adults from Culiacán, Sinaloa, Mexico, 28-IX-72, R. B. Selander and A. Berríos-Ortiz (Notes 599-72 RBS).

Remarks.—See remarks for *E. uniforma*.

***Epicauta niveolineata* (Haag-Rutenberg)**

Figs. 1b, 2d

Description.—Color of head amber; pro- and metanotum and abdominal terga I, II, and VI–IX dark brown; mesonotum and abdominal terga III–V light yellow brown.

Head about as long as pro- and mesonotum combined, about ⁴/₅ as wide as long; sides straight, slightly divergent posteriad to near base; gula about ³/₅ as long as greatest width of head; gular setae extending well beyond anterior margin of gula. Antenna with segment II at least 1⅔× as long as III; sensory organ reaching apex of segment III. Mandibles robust, ³/₅ as long as head, about ½ as wide as long, bearing 7–9 large teeth (4–6 visible in outline); teeth rounded. Maxillary palpus with segment III about 1¾× as long as wide; sensory area of segment III extending at most ½ length of dorsal surface, more clearly overlapping onto ventral surface than in other species; papillae of sensory area sparse, not obscuring one another in dorsal view; length of 2-segmented sensory appendix more than ⅔ width of segment II of labial palpus. Labial palpus with segment I more than ⅓ as long as II; II more than 2× as long as wide. Abdomen with cuticular reticulations not prolonged into toothlike evaginations; 10 setae in posterior marginal row on terga I–VIII; setae divided several times apically; spinelike evaginations at bases of marginal setae strongly developed on terga I–VI, weakly so on VII; tergum V more than 3½× as wide as long, with central pair of posterior marginal setae about ⅔ as long as tergum; central pair of setae of median transverse row of tergum V ²/₅ as long as tergum; spiracle I about ⅔ as large as mesothoracic spiracle; caudal setae longer than combined length of terga VII–IX. Femur I with 7 lanceolate setae; all lanceolate setae very heavy, broad; tarsungulus I with longer seta reaching distal ¹/₅. Length of body 3.3 mm. Length of caudal setae 0.8 mm.

Material studied.—10 larvae, adults from between Tequesistlán and Totolapan, Oaxaca, Mexico, 17-VIII-74, M. Morgan (Notes 1-74 RBS).

Remarks.—This species runs as far as couplet 5 in the key to the larvae of *Epicauta* developed by MacSwain (1956). It can be distinguished from the two alternatives in that couplet by the following combination of characteristics: setae of abdominal tergum V about ⅔ as long as tergum, proximal mandibular seta much shorter than distal one, femur I with seven (or fewer) lanceolate setae.

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LITERATURE CITED

Adams, C. L. and R. B. Selander. 1979. The biology of blister beetles of the Vittata Group of the genus *Epicauta* (Coleoptera, Meloidae). Bull. Am. Mus. Nat. Hist. 162(4): 137–266.

Agafitei, N. J. and R. B. Selander. 1980. First instar larvae of the Vittata Group of the genus *Epicauta* (Coleoptera: Meloidae). J. Kans. Entomol. Soc. 53: 1–26.

Cros, A. 1938. Considérations générales sur le genre *Epicauta* Redtenbacher. Étude biologique sur *Epicauta albovittata* Gestro. Mem. Soc. Entomol. Ital. 16: 129–144.

Horsfall, W. R. 1943. Biology and control of common blister beetles in Arkansas. Arkansas Agric. Exp. Stn. Bull. 456, 55 pp.

MacSwain, J. M. 1956. A classification of the first instar larvae of the Meloidae (Coleoptera). Univ. Calif. Publ. Entomol. 12, 182 pp.

Parker, J. R. and C. Wakeland. 1957. Grasshopper egg pods destroyed by larvae of bee flies, blister beetles, and ground beetles. U.S. Dep. Agric. Tech. Bull. 1165, 29 pp.

Pinto, J. D. 1975. The taxonomy of three species of maculate *Epicauta* (Coleoptera: Meloidae), with descriptions of courtship behavior and first instar larvae. J. Kans. Entomol. Soc. 48: 429–452.

Selander, R. B. 1981a. The Caustica Group of the genus *Epicauta* (Coleoptera, Meloidae). Proc. Entomol. Soc. Wash. 83: 573–591.

———. 1981b. Evidence for a third type of larval prey in blister beetles (Coleoptera: Meloidae). J. Kans. Entomol. Soc. 54: 757–783.

Selander, R. B. and N. J. Agafitei. *In press*. The first instar larva of *Epicauta funesta* (Chevrolat) (Coleoptera, Meloidae). Coleopt. Bull.

Selander, R. B. and J. M. Mathieu. 1969. Ecology, behavior, and adult anatomy of the Albida Group of the genus *Epicauta* (Coleoptera, Meloidae). Illinois Biol. Monogr. 42, 168 pp.

Werner, F. G. 1954. A review of the subgenus *Gnathospasta* of the genus *Epicauta* (Meloidae). Coleopt. Bull. 8: 25–27.

———. 1958. Studies in the genus *Epicauta* of the North American continent (Meloidae). II. The Uniforma Group. Coleopt. Bull. 12: 1–20.

———. 1962. The first instar larva of *Epicauta*, subgenus *Gnathospasta* (Coleoptera: Meloidae). Proc. 11th Int. Congr. Entomol. 1: 106–109.

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NESTING BEHAVIOR OF *LYRODA SUBITA* (SAY) (HYMENOPTERA: SPHECIDAE)

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Abstract.—Observations made on 17 females of *Lyroda subita* (Say) nesting in upstate New York extend the range of variation in the behavioral components and nesting parameters of this species. Characteristic features include nesting in a variety of friable soils, beginning nests from pre-existing depressions, leaving entrances open during provisioning activities, practicing mandibular prey transport, usually in low flights, preying upon mostly immature gryllids which are incompletely paralyzed and stored in multicellular nests, and attaching the egg to the venter of the prey's thorax between the fore- and midlegs. Several of the cells were parasitized by satellite-flies of the genus *Senotainia* (Sarcophagidae: Miltogramminae). The components of *L. subita* behavior are discussed and compared with those of other (exotic) species in the genus.

The genus *Lyroda* contains only two species, *subita* (Say) and *triloba* (Say), in North America north of Mexico (Krombein, 1979). *Lyroda subita* occurs transcontinentally in southern Canada and the U.S., whereas *L. triloba* has been reported from Canada, D.C., Illinois, Indiana, Kansas, Louisiana and Texas (Krombein, 1979). Using larval characters, Evans (1964) placed the genus in the tribe Miscophini. A study of adult characters supports this placement (Bohart and Menke, 1976).

Nothing is known about the biology of *L. triloba*. Patton (1892) reported on the provisions and prey transport of *L. subita*. The Peckhams (1898, 1905) observed a female of *L. subita* nesting in Wisconsin and described prey transport, nest entry, cell depth, prey paralysis, and larval development. Williams (1914) mentioned the searching activity of *L. subita* females. Evans (1964) reported on nest-site selection, cell depth, prey transport, nest entry, provisions, number of prey per cell, egg placement, and parasitism. Our observations add to the knowledge of the nesting behavior of this species, particularly nest structure, dimensions, and cell contents.

ETHOLOGY

Nest-site selection.—Females of *L. subita* were observed nesting at three localities in Cayuga County, N.Y. during August and September 1969–71. Selection of a nesting site involved much searching activity on the surface and exploration below ground level. Active nests were located in the center and at the edge of a sand pit, border of a field, and slope of an erosion ditch. Wasps utilized for nesting sites deep cracks and crevices in the sand as well as both emergence and provisioning burrows of the cicada-killer *Sphecius speciosus* (Say), provisioning burrows of *Tachytes validus* Cresson (Specidae), and resting burrows of larval tiger beetles, *Cicindela* spp. In each case the insect had abandoned the site before *Lyroda* began using it.

Hunting behavior.—Females searched for prey on and in the ground, exploring holes, cracks, and crevices and foraging near the bases of vegetation. The distance of this activity from the nest varied with the success of the excursion; the wasp usually began nearby and gradually moved farther from the entrance. Prey capture was observed twice. In both cases the wasp pounced upon a cricket and inserted her sting in the throat for several seconds. She then reinserted the sting in the throat and, later, after repositioning herself, stung it near the base of a hindleg. The wasp then malaxated the cricket and/or rested on the sand and cleaned.

Prey transport, nest entry and exit.—Following prey paralysis, the female positioned the cricket ventral side upward or on its side (once dorsal side upward) and head forward, and grasped its antennae with her mandibles. She then proceeded forward to the nest either on the ground or in flight. The usual manner of transport involved a series of short, low flights, during which the legs assisted in holding the prey. Some provisioning females returned directly to their nests, almost in a straight line, and plunged inside without hesitating. These wasps left head first several s or min later and resumed hunting activities. One wasp spent one and one-half h provisioning a cell with five crickets, spending 6 to 55 ($\bar{x} = 18$) min between successful hunting excursions.

Nest structure and dimensions.—The entrance to a nest of *L. subita* was either that of the original inhabitant, sometimes slightly modified, or simply an opening in the ground. The tumulus often had been eliminated entirely by weathering. The diameter of the entrance and proximal burrow usually divulged the first inhabitant. For example, burrows of renovated *T. validus* nests leading to burrows and cells of *L. subita* were 6–7 mm wide, those of the cicada-killer, 20–24 mm wide, except for one which narrowed to 6 mm at the entrance, and those of larval tiger-beetles, ca. 6 mm at the entrance, narrowing to 4 mm farther down. One nest had three species, *S. speciosus, T. validus* and *L. subita* nesting in succession, all utilizing a common entrance and proximal burrow.

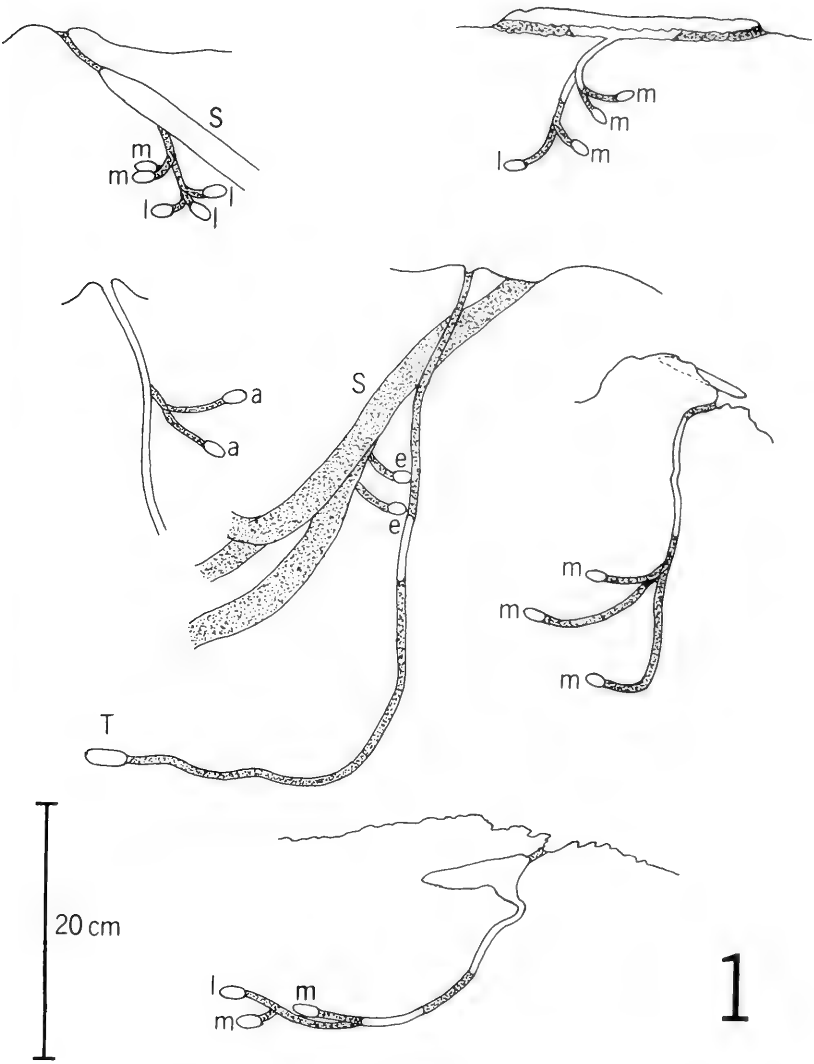

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Fig. 1. Six nests of *Lyroda subita*, as viewed from the side, showing structure of burrow and placement of cells. Abbreviations: S = *Sphecius speciosus* burrow; T = *Tachytes validus* cell. *L. subita* cellular contents: e = egg; l = larva; m = maggot(s); a = ants. Stippling indicates burrow filled with sand. Scale at lower left refers to all six nests.

The *L. subita* portion of the nest exhibited a basic pattern, which included a main burrow and branching side-burrows leading to rearing cells (Fig. 1). The number of completed cells per nest ranged from two to five, the wasp finishing ca. one per day. Cells were located at distances of from 12.5 to

29.5 cm ($\bar{x}$ = 19.5; n = 11) from the surface entrances. However, the bifurcating *L. subita* burrows themselves were only 3 to 19 cm ($\bar{x}$ = 11; n = 6) long. Upon completion of the nest the wasp filled that portion of the burrow directly in front of the cell and all or much of the remaining portion of the burrow with sand, but three finished nests remained partly open near the surface.

Cells of *L. subita* were never built in series but always singly at the ends of short side-burrows. This arrangement, as viewed from above, appeared palmate or fan-shaped. The distance between adjacent cells ranged from 2.5 to 7.0 cm in three nests. Cell depth from the sand surface varied with the dimensions of the pre-existing burrow, and ranged from 6.5 to 26.5 cm ($\bar{x}$ = 14.0; n = 20). Cells in a nest were more nearly equivalent in depth than cells from different nests; e.g., four cells in one nest begun from a shallow subterranean crevice were only 6.5–12.5 cm deep, whereas three cells in a nest modified from a tiger beetle burrow were 17.5–26.5 cm deep.

Cells (19) of *L. subita* were 5 to 8 mm ($\bar{x}$ = 6.4) in diameter, and 10 to 16 mm ($\bar{x}$ = 13.2) long. There appeared to be a correlation between cell size and number of prey per cell in 12 of 17 fully-provisioned cells, i.e., seven "large" cells, 13–16 mm long, contained 3–7 prey per cell, and five "small" ones, 10–12 mm long, only 1–2 prey per cell. Some larger cells were nearly perfectly ovoidal-elliptical, whereas a few smaller ones were rather asymmetrical. Cells were slanted either upward or downward in the sand, or rarely horizontally, to coincide with the course of the burrow at the end. With one exception, all or most cells in a nest sloped in one direction.

Provisions.—*L. subita* preyed on small, mostly nymphal "field-crickets" (Gryllidae). Prey collected from cells consisted of four adults and four nymphs of *Allonemobius carolinus* Scudder, 7 adults and 41 nymphs of *A. fasciatus* (DeGeer), and 11 nymphs of *Gryllus pennsylvanicus* Burmeister. Two nests at one locality contained only *A. fasciatus*. A third nest at the same locality held this species and *G. pennsylvanicus*. A nest in another area contained all *A. carolinus*.

Prey recovered from recently provisioned cells were incompletely paralyzed and moved only the appendages and abdominal segments. Up to one-half of the crickets in a nest had a single hindleg missing; in two nests, the missing leg on four crickets was the left, and in one nest with two prey, the right.

The number of prey stored in fully provisioned cells ranged from 1–7 ($\bar{x}$ = 3; n = 17). The weights of the individual crickets varied from 11–73 mg ($\bar{x}$ = 35; n = 48). Female wasps weighed, on the average, 21 mg (n = 4). The weight of all prey in a completed cell averaged 107 mg (39–173; n = 17). Cells with a greater biomass usually contained more crickets rather than fewer, larger prey.

Forty-four of 49 crickets were placed in cells head inward and ventral side upward. Three individuals were positioned head inward and on the side with their venters facing the cell walls, and two were put head inward and dorsal side upward. In cells containing several prey, crickets were often piled atop one another; however in some cells with only two prey, the crickets were laid in tandem. In one unfinished nest a paralyzed cricket was located outside of the cell in an open burrow.

Egg.—The wasp did not lay her egg on a cricket until the full complement of prey had been put in the cell. Three cells were unearthed, evidently in early stages of provisioning, with only one or a few crickets and no egg or larva. The cricket on which the egg had been laid was invariably placed head inward and ventral side upward ($n = 12$). In five of six cases, this prey was positioned innermost in the cell. Once, the egg-bearing prey was placed atop others in the cell. The cricket containing the wasp's egg was the largest prey in the cell in 4 of 12 examples. The egg-bearing individual averaged 36 mg (18–73; $n = 13$) in weight.

The egg of *L. subita* was 2.0–2.5 mm long, 0.6–0.7 mm in diameter, white, elastic, elongate and slightly curved. It was attached by the cephalic end to the forecoxal corium of the prey, the caudal end extending laterally to the other side between the first and second pairs of legs (Fig. 2). In four nests, eggs or small larvae were attached to either the left or right sides of the crickets in equal numbers.

Mortality.—Of the 21 completed cells, 10 contained up to three maggots feeding on the innermost cricket. At least one cell in every multicellular nest was afflicted and in one nest, all three cells were destroyed. Two maggots were reared and identified as *Senotainia trilineata* (Wulp) (Sarcophagidae). In several instances, female *S. trilineata* were observed actively pursuing provisioning wasps. Two additional cells were destroyed by ants, probably *Solenopis molesta* (Say), and one nest contained cells with moldy prey.

Discussion

Evans (1964, 1973) found *L. subita* renovating pre-existing burrows and cavities in friable soils in Massachusetts and New York. The utilization of such depressions was reflected in the diverse architecture and dimensions of the several nests we excavated. *Lyroda formosa* (F. Smith) also nests in the ground in similar situations, utilizing deep burrows of large sand wasps and crevices for nesting sites (Iwata, 1938, 1964).

The Nearctic *L. subita* stores its nests with Gryllidae (see Patton, 1892; Peckham and Peckham, 1898; Evans, 1974), whereas some Asiatic and African species (*japonica* Iwata, *formosa*, *madecassa* Arnold) prey upon Tetrigidae (Iwata, 1938, 1963, 1964; Tsuneki and Iida, 1969). The fact that

Fig. 2. Egg of *Lyroda subita* attached to gryllid prey at right forecoxal corium and extending laterally between fore- and midlegs. Note missing left hindleg.

some of the *L. subita* nests we excavated contained only *Allonemobius fasciatus* or *A. carolinus* suggests either conditioning on the part of the female wasp during hunting or that individual wasps hunted in areas where each of these species was prevalent. Similar conclusions have been drawn regarding the hunting behavior of *Chlorion aerarium* Patton (Peckham and

Kurczewski, 1978) and *Liris argentata* (Palisot de Beauvois) (O'Brien and Kurczewski, unpublished data).

The transport of prey to the nest in *L. subita* is typically "larrine", i.e., on the ground or in flight depending on the size and weight of the prey, and grasping the prey's antennae with the mandibles. Similar details of prey transport for members of this genus have been recorded by Patton (1892), Iwata (1963, 1964), and Evans (1964). Tsuneki and Iida (1969), on the other hand, reported that females of *L. japonica* carried their prey with the middle legs.

The incomplete paralysis of the prey of *L. subita* coincides with that of most larrine wasps that utilize orthopterous prey (see especially Krombein and Kurczewski, 1963; Iwata, 1942, 1976; Evans, 1966, for summaries). Tsuneki and Iida (1969) reported only partial paralysis with eventual complete recovery of the prey in *L. japonica.*

Gryllid prey missing one or two hindlegs are common among the Sphecidae, e.g., *Chlorion aerarium* (Peckham and Kurczewski, 1978), *Liris nigra* V.d.L. (Steiner, 1968), so that finding a number of prey of *L. subita* missing one or more legs was not unusual. This appendage loss may reflect the manipulation of the prey during the stinging or attempted stinging process (see Steiner, 1968, Plate 22).

We found that the egg of *L. subita* may be laid on the first, last or intermediate prey taken into the nest. Tsuneki and Iida (1969) noted that the egg of *L. japonica* was laid invariably on the last provision taken into the nest. In *L. subita* (Evans, 1964), *L. formosa* (Iwata, 1964) and *L. japonica* (Tsuneki and Iida, 1969) the egg is laid in a rather typically larrine position between the first and second pairs of legs and is affixed to the forecoxal corium of one of the prey. In these species the egg is not laid until the full complement of prey had been placed in the cell despite Peckham and Peckham's (1898) account of progressive provisioning in *L. subita.*

The rather high incidence of miltogrammine parasitism we found in cells of *L. subita* substantiated work by Evans (1964), who noted many *L. subita* nests parasitized by miltogrammine flies, in two cases, *Metopia argyrocephala* Meigen.

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LITERATURE CITED

Bohart, R. M. and A. S. Menke. 1976. Sphecid wasps of the world. A generic revision. Univ. Calif. Press, Berkeley. ix + 695 pp.

Evans, H. E. 1962. The evolution of prey-carrying mechanisms in wasps. Evolution 16: 468–483.

———. 1964. The classification and evolution of digger wasps as suggested by larval characters. Entomol. News 75: 225–237.

———. 1966. The behavior patterns of solitary wasps. Annu. Rev. Entomol. 11: 123–154.

———. 1973. Digger wasps as colonizers of new habitat (Hymenoptera: Aculeata). J. N.Y. Entomol. Soc. 82: 259–267.

Iwata, K. 1938. On the habits of some Larridae in Japan. Kontyû 12: 1–13.

———. 1942. Comparative studies on the habits of solitary wasps. Tenthredo 6: 1–146.

———. 1963. Miscellaneous biological notes on aculeate Hymenoptera in Kagawa in the years of 1948 and 1949. Trans. Shikoku Entomol. Soc. 7: 114–118.

———. 1964. Bionomics of non-social wasps in Thailand. Nat. Life Southeast Asia 3: 323–383.

———. 1976. Evolution of Instinct. Comparative Ethology of Hymenoptera. Amerind Publ. Co., New Delhi. xi + 535 pp.

Krombein, K. V. 1979. Larridae, pp. 1617–1650. In Krombein, K. V. et al., eds., Catalog of Hymenoptera in America North of Mexico, Vol. 2, Smithsonian Institution Press, Washington, D.C.

Krombein, K. V. and F. E. Kurczewski. 1963. Biological notes on three Floridian wasps. Proc. Biol. Soc. Wash. 76: 139–152.

Patton, W. H. 1892. Notes upon Larradae. Entomol. News 3: 89–90.

Peckham, D. J. and F. E. Kurczewski. 1978. Nesting behavior of *Chlorion aerarium*. Ann. Entomol. Soc. Am. 71: 758–761.

Peckham, G. W. and E. G. Peckham. 1898. On the instincts and habits of the solitary wasps. Wisconsin Geol. Nat. Hist. Surv., Sci. Ser., Bull. 2: 1–245.

———. 1905. Wasps social and solitary. Houghton, Mifflin and Co., Boston. xv + 311 pp.

Steiner, A. L. 1968. Behavioral interactions between *Liris nigra* Van der Linden and *Gryllus domesticus* L. Psyche (Camb. Mass.) 75: 256–273.

Tsuneki, K. and T. Iida. 1969. The biology of some species of the Formosan Sphecidae, with descriptions of their larvae. Etizenia 37: 1–21.

Williams, F. X. 1914. The Larridae of Kansas. Univ. Kans. Sci. Bull. 18: 121–213.

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TWO NEW SPECIES OF WATER STRIDERS OF THE GENUS *TREPOBATES* UHLER (HEMIPTERA: GERRIDAE)

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Abstract.—Trepobates **carri**, new species, is described from Guatemala and is also known from Belize, Cuba, Honduras, Jamaica, Mexico, and Texas. *Trepobates* ***polhemi***, new species, is described from Mexico.

In the course of my studies on *Trepobates*, I have discovered two new taxa which are described below.

Trepobates carri Kittle, New Species

Figs. 1–7

Trepobates pictus (Herrich-Schaeffer) [misidentification]; Drake and Harris, 1932: 111.

Diagnosis.—*Trepobates carri* can be separated from all other species of *Trepobates* except *T. pictus* by the presence of a posterior mesonotal projection in the female. Although very similar to *T. pictus*, *T. carri* differs from it in having (1) a more tumid, shorter, and hairier posterior mesonotal projection in the female; (2) a shorter first antennal segment, especially in the male; (3) a slightly different color pattern; and (4) a different shaped paramere (compare Figs. 7 and 8).

Description.—Length: Male 3.09–3.66 mm; female 3.27–4.11 mm. Width: Male 1.22–1.45 mm; female 1.53–1.94 mm.

Head: Marked with black and light yellow (Figs. 2–4). Antennal segment 1 slightly bowed at base, 0.76–0.99 mm long in male, 0.63–0.84 mm long in female. Antennal segments 2–4 straight, 3 without long hairs.

Thorax: Pronotum marked with black and light yellow (Figs. 2–4). Pronotum in alate form prolonged posteriorly, with light yellow lateral, longitudinal stripes usually continuous with light band along posterior margin, sometimes with an anterior median yellow stripe. Anterior femur moderately bowed just beyond middle in male, slightly bowed near base in female, not constricted at apex. Anterior femur 1.19–1.46 mm long in male, 0.99–1.27 mm long in female. Anterior tibia slightly bowed in male, straight in

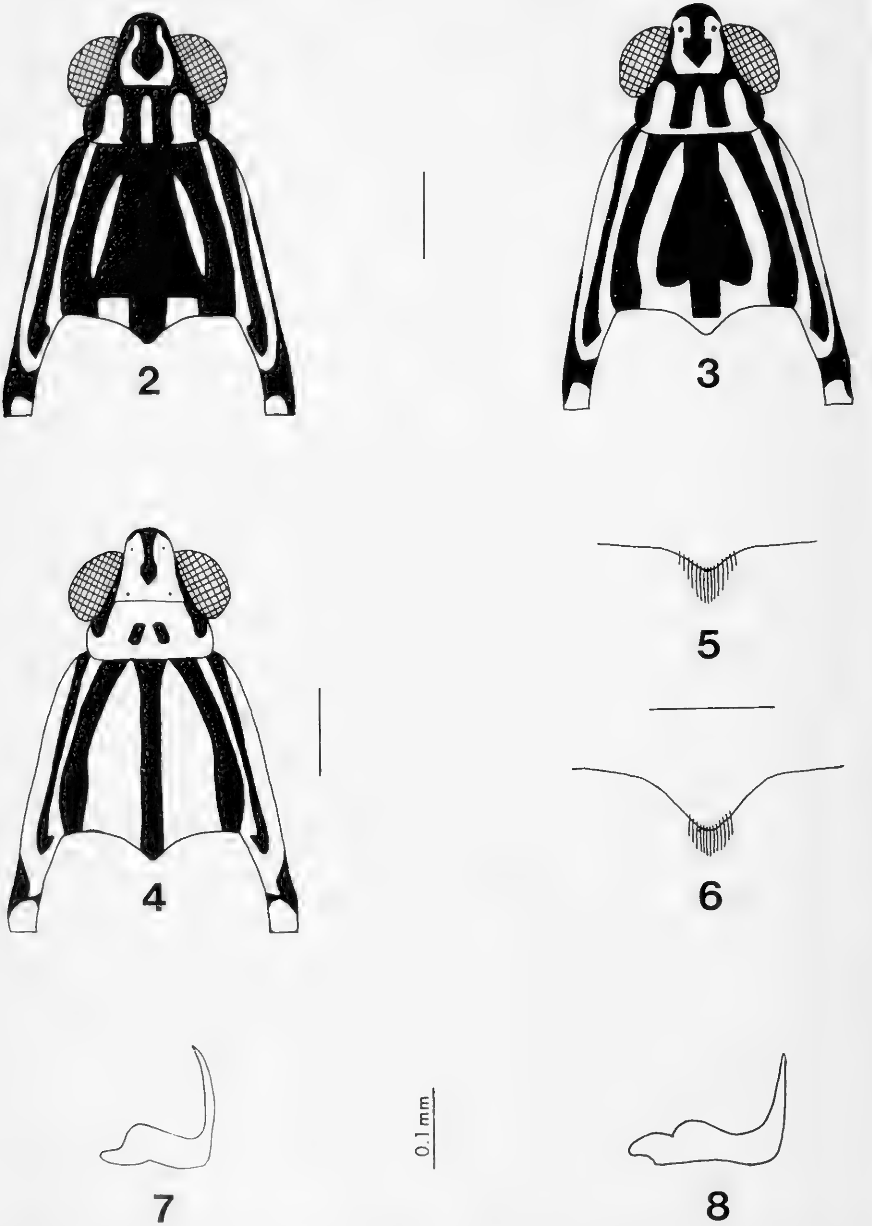
Fig. 1. Distribution of *Trepobates carri* (circles) and *T. polhemi* (triangles).

female. Mesonotum with black and light yellow markings (Figs. 2–4); prolonged posteriorly in female, this projection with long hairs and variable in shape (Figs. 5 and 6); a patch of very short, dark hairs usually present along median portion of mesonotal-mesopleural line in female. A light yellow mesopleural stripe present posterior to black postocular stripe of pronotum. Mesosternum with a pair of small, oval, widely separated brown spots often present posteriorly, especially in female. Middle femur of male with a thick ventral fringe of short, dark brown hairs; these hairs, at maximum length, approximately 20–40% of diameter of femur. Middle femur 1.45–1.88 mm long in male, 1.59–1.95 mm long in female. Middle tibia of male with a single row of short hairs along basal ⅓ which gradually decrease in length posteriorly; these hairs, at maximum length, approximately 40% of diameter of tibia. Middle tibia 2.71–3.76 mm long in male, 2.85–3.59 mm long in female. Metanotum black with paired, light yellow markings, without a median patch of hairs. Posterior femur without long hairs at base. Posterior femur 1.92–2.60 mm long in male, 1.97–2.48 mm long in female.

Abdomen: Abdominal terga mostly black, some marked with light yellow, especially in female, almost entirely black in dark individuals; some gray-blue bloom present, especially in male. Ventrites mostly pale yellow, dark brown along anterior margins and laterally in some individuals; ventrite 7 in female with a row of moderately long, dark brown hairs along posterior margin, this row interrupted at middle. Connexival segments mostly light yellow with black anterior margins; lateral margins of segments 5 and 6 in male and 5–7 in female with moderately long, dark hairs. Connexiva with moderately long, dark hairs at apex and very slightly produced posteriorly but without long spines in female. Abdominal segment 8 of male with scattered, short, brown hairs ventrally. Pygophore with several long, dark brown hairs at middle; short, pale pubescence posteriorly. Paramere sharply pointed (Fig. 7) and shaped different from that of *T. pictus* (Fig. 8).

Holotype.—Guatemala: Apterous ♀, pond, 3 mi. S Tikal, Peten, CL 653, 2 Jan 1973, J. T. Polhemus, in J. T. Polhemus Collection, Englewood, Colorado.

Paratypes.—BELIZE: Beaver Dam Cr., 15 mi. E Roaring Creek, 27 Dec 1973 (1 ♂, 2 ♀; JTP). CUBA: Santiago de Las Vegas, 13 Nov 1922 (1 ♀; UK); Consolacion del Sur, 16 Apr 1930 (1 ♂, 1 ♀; NN). GUATEMALA: pond, 3 mi. S Tikal, Peten, 2 Jan 1973 (17 ♂, 30 ♀; JTP, PDK). HONDURAS: Tela, 15 Mar 1936 (16 ♂, 31 ♀; UK). JAMAICA: Port Antonio (1 ♀; AMNH); pond, St. Ann, Feb. 1928 (1 ♀; UK). MEXICO: *Campeche:* Champoton Janataya, 9 Jul 1932 (1 ♀; USNM). *Nuevo Leon:* Rio Cabezano, 17 mi. N Linares, 14 Dec 1969 (1 ♂; JTP). *San Luis Potosi:* 3 mi. W El Naranjo, 5 Jun 1965 (1 ♂, 1 ♀; JCS). *Tamaulipas:* stream, El Salto, 14 Dec 1969 (2 ♀; JTP). *Veracruz:* 3 mi. W Paso de Ovejas, 17 Aug. 1959 (1 ♀; USNM); stream, 3 mi. N Conejos, 6 Jan 1971 (4 ♂; JTP); borrow pit, 14 mi. N Nautla, 7 Jan 1971 (1 ♀; JTP); stream, 17 mi. S Tuxpan, 7 Jan 1971 (2 ♂; JTP); stream, 19 mi. N Conejos, 6 Jan 1971 (2 ♂; JTP); stream, S Gutierrez Zamora, 7 Jan 1971 (1 ♂, 2 ♀; JTP); 15.8 mi. S Tampico, 19 Apr 1974 (4 ♂, 10 ♀; TAMU); 16 mi. S La Tinaja, 4 Jan 1971 (3 ♀; JTP); 19 mi. SE Tantoyuca, 8 Jan 1971 (7 ♂, 8 ♀; JTP, PDK). *Yucatan:* Carlos Morales Escuela Cenote, Merida, 23 Jul 1932 (3 ♂, 2 ♀; UK, USNM); Uki Cenote, Motul, 26 Jul 1932 (6 ♀; UM, USNM); Manzanilla Cenote, Merida, 23 Jul 1932 (6 ♀; UM, USNM); Chapultapec Cenote, Merida, 20 Jul 1932 (6 ♀; UK, UM, USNM); Geiser Cenote, Merida, 19 Jul 1932 (3 ♂, 3 ♀; UM, USNM); Huntun Cenote, Piste, 19 Jun 1932 (1 ♀; UM), 20 Jun 1932 (1 ♂, 4 ♀; UK, UM, USNM); Choch Cenote, Piste, 21 Jun 1932 (2 ♂, 5 ♀; UK, UM, USNM); Ciruak Cenote, Piste, 22 Jun 1932 (8 ♀; UK, UM, USNM); Ixil Cenote, Chichen Itza, 15 Jun 1932 (1 ♂, 1 ♀; UK, UM); Xanaba Cenote, Chichen Itza, 25 Jun 1932 (2 ♀; UM); Xcan Yui Cenote, Chichen Itza, 16 Jun 1932 (1 ♀; UM), 17 Jun 1932 (1 ♂, 9 ♀; UK, UM, USNM). UNITED STATES: *Texas:* Cameron Co.: 28 Dec 1967 (1 ♂, 1 ♀; NTSU). La Salle Co.: Nueces River, 1 mi. S Cotulla, 13 Jun 1976 (1 ♂, 1 ♀; PDK). Starr Co., Arroyo Salado, 14 mi. E Rio Grande City, 11 Jun 1975 (2 ♂, 1 ♀; CLS). Zapata Co.: pond, Zapata, 13 Jun 1976 (2 ♀; PDK).



Figs. 2–7. *Trepobates carri*. 2–4, Variation of color pattern in female. 5–6, Variation of posterior mesonotal projection. 7, Paramere. Fig. 8, *T. pictus*, paramere. (Scale lines = 0.5 mm except as noted.)

Distribution.—*Trepobates carri* has been collected in southern Texas, Mexico, Belize, Guatemala, Cuba, Honduras, and Jamaica (Fig. 1).

Variation.—The color pattern is highly variable (Figs. 2–4), and individuals examined from Yucatan, Mexico, are almost entirely dark dorsally. The posterior mesonotal projection in the female is somewhat variable in length, tumidity, and hairiness (Figs. 5, 6), and Yucatan specimens have the most tumid and hairy projections. Hairs along the median portion of the mesonotal-mesopleural line usually are present in the female, but are absent in some individuals. Brown mesosternal spots were often present, especially in the female and darker specimens. Thirty-seven percent of the specimens examined were alate.

Biology.—*Trepobates carri* has been taken from both lentic and lotic habitats, including creeks, rivers, ponds, borrow pits, and sinkholes. I collected *T. carri* in association with *T. subnitidus* Esaki and *Rheumatobates hungerfordi* Wiley in Texas. Collection records are known from November through April and June through August.

Etymology.—This species is named in honor of the late Professor Lloyd G. K. Carr, Rio Grande College, Rio Grande, Ohio, who first stimulated my interest in entomology.

Remarks.—I have examined the specimen upon which Drake and Harris (1932) based their record of *T. pictus* from Jamaica and determined that it is *T. carri*. Hungerford (1936) referred to this taxon as *T.* sp.

***Trepobates polhemi* Kittle, New Species**

Figs. 1, 9–14

Diagnosis.—*Trepobates polhemi* can be easily separated from its congeners by the patch of long hairs at the posterior end of the mesonotal-mesopleural line, the long hairs along the basal inner margin of the posterior femur, and the short hairs on the seventh ventrite of the female, and the relatively large size and long appendages in both sexes.

Description.—Length: Male 3.61–4.11 mm; female 4.16–4.80 mm. Width: Male 1.36–1.52 mm; female 1.62–1.98 mm.

Head: Marked with black and light yellow (Figs. 9–11). Antennal segment 1 slightly bowed at base, 0.96–1.09 mm long in male, 0.96–1.12 mm long in female. Antennal segments 2–4 straight, 3 without long hairs.

Thorax: Pronotum marked with black and light yellow (Figs. 9–11). Pronotum in alate form prolonged posteriorly, black with a light yellow band along posterior margin, with light yellow lateral stripes usually continuous with band along posterior margin, and sometimes with an anterior median yellow stripe. Anterior femur strongly bowed just beyond middle in male, only slightly bowed at base in female; apex not constricted but slightly swollen in male. Anterior femur 1.32–1.55 mm long in male, 1.40–1.72 mm long in

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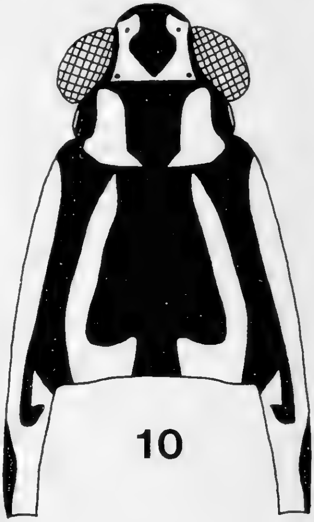

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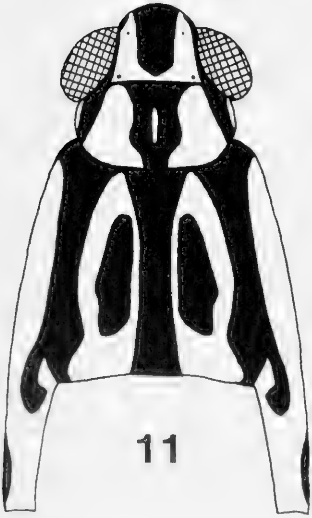

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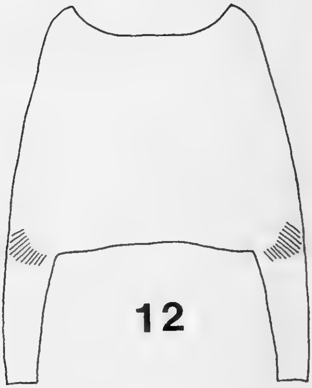

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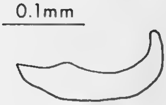

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female. Anterior tibia very slightly bowed in male, straight in female. Mesonotum with black and light yellow markings (Figs. 9–11) and not prolonged posteriorly; a patch of long, dark hairs at posterior end of mesonotal-mesopleural line in female (Fig. 12). A light yellow mesopleural spot absent posterior to black postocular stripe of pronotum. Middle femur of male with a thick ventral fringe of long, dark brown hairs, these hairs, at maximum length, approximately 55–75% of diameter of femur. Middle femur 2.06–2.41 mm long in male, 2.32–2.83 mm long in female. Middle tibia of male with a single row of hairs along basal ½ which gradually decrease in length distally, these hairs, at maximum length, approximately 85–125% of diameter of tibia. Middle tibia 3.89–4.58 mm long in male, 4.46–4.98 mm long in female. Metanotum black, with paired, light yellow spots; rarely with a median patch of long hairs in female. Posterior femur with a dense fringe of very long hairs along basal inner margin in female (Fig. 13). Posterior femur 2.93–3.37 mm long in male, 3.29–3.91 mm long in female.

Abdomen: Abdominal terga mostly black, some marked with light yellow, especially in female; mostly covered with a gray-blue bloom, more extensive in male. Ventrites mostly pale yellow with some black along sides, especially in male; ventrite 7 in female with a row of short, mostly light hairs along posterior margin, these hairs not readily visible. Connexival segments light yellow with black margins; lateral margins of segment 5 in male with moderately long, dark hairs, segment 5 and sometimes 4 with long, dark hairs and segments 2 and 3 sometimes with moderately long hairs in female; connexiva not produced at apex into long spines. Abdominal segment 8 of male with very short, thin, pale pubescence ventrally. Pygophore with very short, pale pubescence posteriorly. Paramere as in Fig. 14.

Holotype.—Mexico: Apterous ♀, stream, 2 mi. S Cuautla, Morelos, CL 1036, 25 Apr 1964, J. T. and M. S. Polhemus, in J. T. Polhemus Collection, Englewood, Colorado.

Paratypes.—MEXICO: *Distrito Federal:* Mexico City, 7 Jul 1937 (4 ♂; UK). *Guerrero:* stream, 40 mi. N Acapulco, 26 Apr 1964 (1 ♂, 2 ♀; JTP); La Sabana, 20 Oct 1936 (1 ♂, 11 ♀; UK). *Morelos:* stream, 20 mi. S Cuernavaca, 27 Apr 1964 (7 ♂, 6 ♀; JTP, PDK); stream, 5 mi. W Zacatepec, 25 Apr 1964 (2 ♂, 2 ♀; JTP); river, 4 mi. N Amacuzac, 25 Apr 1964 (2 ♂, 3 ♀; JTP); river, 8 mi. E Zacatepec, 25 Apr 1964 (1 ♂; JTP); stream, 2 mi. S Cuautla, 25 Apr 1964 (21 ♂, 27 ♀; JTP, PDK); Acatlipa, 5 May 1944 (1 ♀; UK); Mazatepec, 29 Apr 1944 (11 ♂, 10 ♀; UK). *Nayarit:* river, Santa Cruz, 8 Jun 1975 (1 ♂, 1 ♀; JTP); stream, 5 mi. E Tuxpan, 21 Apr 1964 (11

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Figs. 9–14. *Trepobates polhemi*. 9–11, Variation of color pattern in female. 12, Mesonotum of female. 13, Posterior femur of female. 14, Paramere. (Scale lines = 0.5 mm except as noted.)

♂, 12 ♀; JTP, PDK); 23 mi. NW Tepic, 10 Sep 1972 (1 ♂, 1 ♀; USU); stream, 15 mi. E San Blas, 21 Apr 1964 (2 ♂; JTP); river, San Blas, 7 Jun 1966 (1 ♂, 1 ♀; JTP), 28 Nov 1968 (1 ♂; PDK); San Blas, 17–21 Sep 1953 (1 ♀; JTP); spring, San Blas, 3 Jun 1966 (1 ♀; JTP). *Sinaloa:* Rio Presidio, Villa Union Presidio, 21 Jul 1952 (1 ♂, 1 ♀; JTP); Arroyo Sonolona, 18.5 mi. E Culiacan, 2 Apr 1955 (7 ♂, 11 ♀; UM); Los Mayos, 24 Jul 1952 (5 ♂, 11 ♀; JTP, PDK); 10 mi. N Los Mochis, 23 Apr 1977 (1 ♂, 2 ♀; USU). *Sonora:* Arroyo Cuchujaqui, 9 mi. E Alamos, 17 Feb 1957 (1 ♂, 1 ♀; UM); Rio Cuchujaqui, 5 mi. E Alamos, 11 Jun 1974 (2 ♂; PDK); Arroyo El Cajou, Cajou, 16 Feb 1957 (2 ♀, UM); Arroyo Cuchujaqui, Alamos, 21 Mar 1967 (1 ♂; JTP); Arroyo Cuchujaqui, 5 mi. ESE Alamos, 29 May 1966 (3 ♂, 2 ♀; JTP).

Distribution.—*Trepobates polhemi* has been collected in the Distrito Federal and five states of Mexico (Fig. 1).

Variation.—*Trepobates polhemi* is variable in color pattern (Figs. 9–11). Metanotal hairs may be present or absent in the female. The alate form apparently is uncommon and represented 14% of all specimens examined.

Biology.—This species has been collected from lotic habitats, including creeks, rivers, and a large spring. Collection records are known for each month from February through July and September through November.

Etymology.—This species is named in honor of John T. Polhemus, Englewood, Colorado, for his many contributions to our knowledge of the systematics of aquatic and semiaquatic Hemiptera.

ACKNOWLEDGMENTS

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LITERATURE CITED

Drake, C. J. and H. M. Harris. 1932. Some miscellaneous Gerridae in the collection of the Museum of Comparative Zoology (Hemiptera). Psyche (Camb. Mass.) 39: 107–112.

Hungerford, H. B. 1936. Aquatic and semiaquatic Hemiptera collected in Yucatan and Campeche. Carnegie Inst. Wash. Publ. No. 457, pp. 145–150.

PROC. ENTOMOL. SOC. WASH.
84(1), 1982, pp. 165–166

A SECOND SPECIES OF *CERATITIS* (DIPTERA: TEPHRITIDAE) ADVENTIVE IN THE NEW WORLD

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Abstract.—*Ceratitis malgassa* Munro, a species described from Malagasy (Madagascar), was reared in Mexico from nutmegs obtained from Puerto Rico. A key to distinguish the species from its nearest relatives, including *C. capitata,* is given.

In 1968 the Systematic Entomology Laboratory of the U.S. Department of Agriculture received three adult specimens of a species of *Ceratitis* from Chapingo, Mexico that had been reared there from nutmeg seeds received from Mayagüez, Puerto Rico. Information in USDA files indicated that the seeds had been gathered from trees planted in Mayagüez with seeds received from "Granada."

The specimens belong to the typical subgenus of *Ceratitis,* the generitype of which is the Mediterranean fruit fly, *C. capitata* (Wiedemann). The subgenus is characterized by the presence only in the males of elongated, apically spatulate anterior upper fronto-orbital bristles. These bristles are inserted on small conical bases on the upper part of the head a little distance before the ocellar triangle. There are four species known in the subgenus. Our specimens compare well with a pair of *C. malgassa* Munro borrowed from the Museum of Natural History of Paris, France. Paulian (1953) gave a key to the subgenus and stated that *C. malgassa* (incorrectly referred to as *C. malagassa*) had been reared from oranges, mandarins, guavas, and fruit of *Sclerocarya caffra* Sond. (Anacardiaceae; as *Poupartia caffra*). To this list of hosts may now be added nutmeg (Myristicaceae; *Myristica fragrans* Houtt.). The four known species of *Ceratitis* sensu stricto may be distinguished as in the following key, translated with modifications from Paulian (1953). *Ceratitis malgassa* was described by Munro (1939: 141–143).

KEY TO SPECIES OF *CERATITIS* S.S.

1(4). Distal part of wing with 2 transverse bands; male orbital seta with black palette.

2(3). Orbital seta with more or less lozenge-shaped palette borne on stem less than twice as long as palette; basal yellow scutellar mark sinuate . . . . *capitata* (Wiedemann)

3(2). Orbital seta with palette nearly round, borne on stem several times as long as palette; basal yellow scutellar mark with 2 long, posteriorly directed points . . . . *caetrata* Munro

4(1). Distal part of wing with 3 transverse bands; orbital palette more or less oval, whitish to pale brownish.

5(6). Mesoscutum with median dark stripe not connected with pair of posterior spots; stem of spatulate seta round, bristly, palette about as long as wide . . . . *catoirei* Guérin

6(5). Mesoscutum with median dark stripe connected posteriorly with pair of large spots; orbital seta with tapering; ribbon-like stem, palette longer than wide . . . . *malgassa* Munro

LITERATURE CITED

Munro, H. K. 1939. Some new species of South African Trypetidae (Diptera), including one from Madagascar. J. Entomol. Soc. South Afr. 2: 139–153.

Paulian, R. 1953. Recherches sur les insectes d'importance biologique à Madagascar. XII. Les mouches des fruits. Mém. Inst. Sci. Madagascar, Ser. E, 3: 1–7.

PROC. ENTOMOL. SOC. WASH.
84(1), 1982, pp. 167–176

NEW SPECIES OF *UROSIGALPHUS* (HYMENOPTERA: BRACONIDAE) FROM SOUTH AMERICA

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Abstract.—Five new species of *Urosigalphus* are described. One, ***diversus***, is the first species of the subgenus *Microurosigalphus* to be collected in South America. One, ***alius***, belongs to the subgenus *Urosigalphus* and three, ***flexus***, ***porteri***, and ***surinamensis***, belong to the subgenus *Neourosigalphus*. Changes in existing keys to South American species are presented.

This paper describes the first species of the subgenus *Microurosigalphus* collected in South America. A new species of the subgenus *Urosigalphus* is also described along with three new species of the subgenus *Neourosigalphus*. Changes in the existing keys to species (Gibson, 1974) within these subgenera are provided.

***Urosigalphus* (*Microurosigalphus*) *diversus* Gibson, New Species**

Figs. 1, 2

General features.—Length, 2.8 mm. Head and thorax deep reddish black; carapace dark red brown; abdomen brown; clypeus dark red brown apically, labrum yellow tan; mandible yellow tan, with red base and apex; palpi pale yellow; antenna dark brown distally, becoming yellow basally with yellow scape and pedicel; fore- and midlegs yellow; hindcoxa and femur yellow, hindtibia yellow, distal tip of tibia and tarsi brown. Tegula yellow tan. Wings clear, hyaline, with nearly colorless hairs, costa tan basally and light brown apically; stigma medium brown, remaining veins medium brown distally but becoming nearly colorless basally.

Male.—*Head:* General anterior outline quadrate. Vertex, temples, and genal regions sparsely finely punctured. Lower face nearly flat, evenly finely punctate; fronto-clypeal groove with a small, deep, oval anterior tentorial pit near each end. Clypeus impunctate, rather quadrate; lower central margin straight. Labrum punctate. Antennal scapes separated with area between fossae narrow, finely punctate with a small central carina, extending dorsally toward median ocellus, and a shallow, broad, nitidous, sparsely, finely punctate antennal sculcus extending feebly around rear ocelli. Antenna 16-segmented; scape long and relatively slender, inner margin slightly rounded; pedicel almost half as long as scape; 1st flagellar segment longer than 2nd. Ocelli circular, on the ocellar triangle. Occipital carina apparently incomplete dorsally and moderately developed.

Thorax: Unevenly punctate. Mesonotum fairly regularly, finely punctate, the general surface uneven; notaulices narrow, deep, with a row of moderately large punctures, area of convergence broad, nearly square, depressed, bisected centrally with a carina, with moderately large punctures; median lobe regularly, finely punctate; lateral lobes gently rounded, sparsely, finely punctured, with a small lateral carina; posterolateral carina weakly flangelike. Scutellar groove broad and deep with 7 dissecting carinae and 2 bordering lateral carinae. Scutellum roundly trigonal in dorsal profile, with very small sparse punctures; lateral and posterior surface with a line of moderate punctures. Propodeum gently rounded posteriorly, entirely rugoso-punctate without carinae. Mesopleuron impunctate except for a line of moderate punctures around anterior, dorsal, and posterior borders; mesosternum smooth nearly impunctate with a line of small punctures along center line. Lateral regions of pronotum centrally impunctate, rest irregularly punctured with small punctures. Tegula impunctate. Wings hyaline; submedian cell longer than median cell basally.

Abdomen: Carapace elongate oval in dorsal view and teardrop-shaped in lateral view; general surface rugoso-punctate anteriorly, punctate and shiny posteriorly; apex of carapace without apical spines. Parameres of external genitalia very short.

Female.—Unknown.

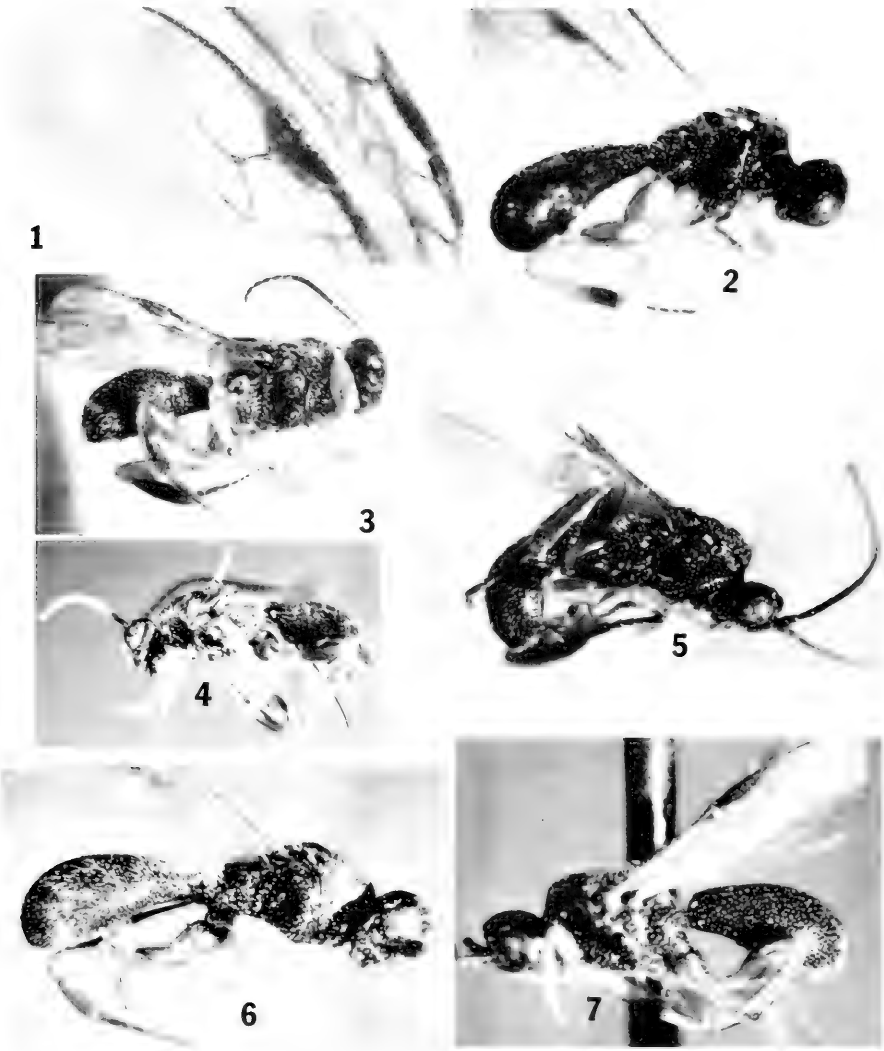
Holotype.—♂, Argentina, "Villa Nouges," Tucumán, XI-26/28-64; 1250 m, C. Porter. In Museum of Comparative Zoology.

Biology and host.—Unknown.

Remarks.—This is the only member of the subgenus *Microurosigalphus* known from South America. The apex of the carapace is without tubercles so it would key *neomexicanus* Crawford in existing keys (Gibson, 1972). It differs from *neomexicanus* by leg, antenna, palpi, and tegula color. These being predominately yellow in *diversus* and medium to dark brown in *neomexicanus*. It is also the only known species of *Microurosigalphus* with 16 antennal segments.

KEY TO SPECIES OF SUBGENUS *UROSIGALPHUS* OF SOUTH AMERICA

1\. Apex of carapace without tubercles 2
– Apex of carapace with tubercles 4
2(1). Thorax and carapace red .... *rubicorpus* Gibson
– Thorax black, carapace red black or black 3



Figs. 1–7. 1, *Urosigalphus* (*Microurosigalphus*) *diversus*, showing open radial cell. 2, *U.* (*M.*) *diversus*, type. 3, *U.* (*Urosigalphus*) *alius*, type. 4, *U.* (*Neurosigalphus*) *surinamensis*, type. 5, *U.* (*N.*) *flexus*, type. 6, *U.* (*N.*) *flexus*, allotype. 7, *U.* (*N.*) *porteri*, type.

3(2). Palpi maroon, fore- and midlegs medium brown basally .... *trinidadensis* Gibson
– Palpi light brown, fore- and midlegs orange tan ... *alius*, new species
4(1). Carapace with short, poorly formed tubercles .. *sanguineus* Gibson
– Carapace with long, well-developed tubercles 5

5(4). Carapace tubercles sharp pointed; wings clear .... *chalcodermi* Wilkinson
– Carapace tubercles blunt tipped; wings tinted brown .... *venezualaensis* Gibson

Urosigalphus (*Urosigalphus*) *alius* Gibson, New Species

Fig. 3

General features.—Length, 4.9 to 5.1 mm. Head black; thorax black; carapace black to red black; abdomen dark brown; clypeus maroon apically; labrum red; mandible orange with red base and black apex; palpi light brown; antennal scape and pedicel deep maroon, pedicel with narrow tan apical band, rest of antenna dark red brown; fore- and midlegs orange tan; hindleg light red, hindtibia apex and tarsi dark red brown. Tegula dark red brown. Wings hyaline, tinted brown, with brown hairs, costa dark red brown, stigma dark red brown, remaining veins dark brown but becoming paler towards base of the wing.

Female.—*Head:* General anterior outline quadrate with small ocellar pyramid. Vertex coarsely rugoso-punctate; temples and genal regions finely punctate. Face finely punctate, fronto-clypeal groove well impressed with small round anterior tentorial pits. Clypeus transverse; finely punctate; lower part wide, margin reflexed and gently concave. Labrum evenly punctured. Mandible surface finely rugoso-punctate. Antennal scapes well separated, with 2 weak carinae dividing the intervening area into 3 equal rugoso-punctate parts, extending dorsally and joining ocellar pyramid carinae; a broad, rugoso-punctate antennal sulcus. Antenna 14-segmented; scape short and broad, arcuate; pedicel short, nearly round; 1st and 2nd flagellar segments subequal. Ocelli small and ovoid. Occipital carina complete.

Thorax: Shorter than carapace, and irregularly punctate. Mesonotum irregularly punctate; notaulices broad, fairly deep, with large punctures, area of convergence quadrate, deeply, coarsely rugoso-punctate; median lobe finely punctate with or without a poorly formed small central carina anteriorly and a transverse carina, coarsely rugoso-punctate, laterally; lateral lobes flattish, finely punctured, with lateral carina bordered by large punctures, posterolateral carina well developed and flangelike. Scutellar groove rather narrow and deep with 3 strong central carinae. Scutellum roundly trigonal in dorsal outline, with moderate to large irregular punctures and moderate to strong rugae forming longitudinal carinae dorsally, coarsely rugoso-punctate and slightly concave laterally. Propodeum flat posteriorly, with a moderately strong transverse carina; dorsal area narrow in lateral profile, the posterior surface abruptly dropping to point of abdominal articulation; central dorsal carina strongly developed, joining the transverse carina which proceeds down both sides in an arc past the point of abdominal articulation; dorsal surface with strong carinae delimiting large, irregular depressions; lateral areas rounded in cross-section and irregularly, strongly rugoso-punctate. Mesopleuron smooth centrally and sparsely, finely punctate; upper margin coarsely rugoso-punctate with a vertical carina; lower central area with a few elongate punctures in the mesopleural groove; posterior margin with a row of large punctures divided by short carinae and a bordering carina; mesosternum rounded and finely, densely punctate, sectioned by low carinae with a punctate median line. Lateral regions of pronotum moderately punctate; the posterior corner similar behind a carina. Tegula broadly pear shaped. Wings hyaline; the stigma long and broad, submedian cell longer than median.

Abdomen: Carapace elongate oval; general surface longitudinally rugoso-punctate, tending to form carinae dorsoanteriorly; apex of carapace rounded, grooved ventrally, without a pair of tubercles. Ovipositor 1.0 mm long, sheath brownish-black clothed with fine hairs.

Male.—Similar to female in general structure and color except for customary sexual differences. Parameres of external genitalia moderately long and narrow, dark brown.

Holotype.—♀, Surinam-Lelydorp; Sumatra Road; 23–26-III-1964, D. C. Geijskes, sandridges in savannah forest. In Rijksmuseum van Natuurlijke Historie, Lieden, Netherlands.

Allotype.—♂, 5 Paratypes. Surinam-Lelydorp; Sumatra Road. (1 ♂) 17–21-IV-1964; (1 ♀) 23–26-III-1964; (1 ♀) 26–31-III-1964; (1 ♀) 4–7-IV-1964; D. C. Geijskes; sandridges in savannah forest. In Rijksmuseum van Natuurlijke Historie. (2 ♀) 17–21-IV-1964. In National Museum of Natural History, Washington, D.C.

Biology and host.—Collected from sand ridges in savannah forest in March and April.

Remarks.—This species is close to *trinidadensis* but separated by the light brown palpi and orange-tan fore- and midlegs. *Urosigalphus trinidadensis* has maroon palpi and medium brown fore- and midlegs.

KEY TO SOUTH AMERICAN SPECIES OF SUBGENUS *NEOUROSIGALPHUS*

1. Carapace with apical tubercles, antenna 14-segmented 2
– Carapace without apical tubercles, antenna 14- to 17-segmented 9
2(1). Carapace with apical tubercles very small to obsolete 3
– Carapace with apical tubercles well developed 4
3(2). Hindleg dark red-brown; body length over 4.5 mm .... *pullatus* Gibson
– Hindleg orange; body length less than 4.0 mm .... *obsoletus* Gibson
4(2). Hindfemur dark red brown .... *acutus* Gibson
– Hindfemur not dark red brown 5

5(4). Hindfemur medium red brown .... *eulechriopis* Cushman

– Hindfemur tan to red orange 6

6(5). Head and thorax maroon .... *tuberculatus* Gibson

– Head and thorax black 7

7(6). Carapace black or nearly black 8

– Carapace red anteriorly, black posteriorly .... *bicolor* Gibson

8(7). Legs yellow tan; ovipositor 0.5 mm long .... *spinatus* Gibson

– Legs red orange; ovipositor 1.2 mm long ...... *bidentata* Gibson

9(1). Antenna 14-segmented 16

– Antenna 16- or 17-segmented 10

10(9). Antenna 17-segmented; interantennal area with a large central carina; body length over 5.0 mm .... *pseudochelonus* Gibson

– Antenna 16-segmented; interantennal area without a large central carina, body length less than 5.0 mm 11

11(10). Hindleg dark red brown to black; palpi dark brown .... *braziliensis* Gibson

– Hindleg yellow to dark brown; palpi yellow or tan 12

12(11). Hindcoxa orange; trochanters tan .... *ornatus* Gibson

– Hindcoxa medium to dark brown 13

13(12). Fore- and midcoxa medium to dark brown 14

– Fore- and midcoxa tan 15

14(13). Trochanters tan; tegula dark brown, carapace apex smooth ... . *cautus* Gibson

– Trochanters medium brown; tegula medium brown, carapace apex punctate .... *obscurus* Gibson

15(13). Wings tinted brown; apex of carapace finely rugoso-punctate .... *surinamensis,* new species

– Wings clear; apex of carapace impunctate ...... *safflavus* Gibson

16(9). With apical projections on ventral flange of carapace; palpi light red .... *paraguayensis* Gibson

– Without apical projections on carapace flange; palpi tan or yellow 17

17(16). Palpi tan; hindcoxa dark red basally; hindfemur and tibia yellow or dark red brown .... *flexus,* new species

– Palpi yellow; hindcoxa brown; hindfemur brown; hindtibia brown, darker dorsally .... *porteri,* new species

Urosigalphus (*Neourosigalphus*) *flexus* Gibson, New Species

Figs. 5, 6

General features.—Length 2.2–3.3 mm. Head and thorax black; carapace black; abdomen brown; clypeus red black to black apically, labrum deep maroon; mandible rufo-testaceous with dark red base and apex; palpi tan, antenna dark brown; forelegs yellow tan; midlegs brown or yellow tan;

hindlegs with coxa dark red basally, hindfemur and tibia yellow or femur, tibia, and tarsus dark red brown. Tegula dark brown to red brown. Wings clear, hyaline, with nearly colorless hairs, costa light brown; stigma medium to dark brown, remaining veins medium brown distally but becoming pale basally.

Male.—*Head:* General anterior outline roundly quadrate. Vertex, temples and genal regions finely punctured. Lower face rounded, evenly, finely punctate; fronto-clypeal groove with a small, deep, oval anterior tentorial pit near each end. Clypeus quadrate; lower central margin gently concave. Mandible teeth long and narrow, outer surface punctate. Antennal scapes well separated, area between fossae smoothly rounded and rugoso-punctate without a small central carina and with a shallow, narrow, nitidous, sparsely, finely punctate antennal sulcus extending to or slightly past rear ocelli. Antenna 14-segmented; scape long and relatively slender, inner margin slightly rounded; pedicel almost half as long as scape. Ocelli ovoid, interocellar area rugose, slightly grooved with slightly raised areas centrally between groove and rear ocelli. Occipital carina complete and well developed throughout.

Thorax: Unevenly punctate. Mesonotum fairly regularly punctate, general surface uneven; notaulices broad and shallow, with moderately large punctures, area of convergence broad, quadrate, depressed, with moderately large punctures; median lobe densely, finely punctate without a small, short central carina anteriorly; lateral lobes gently rounded, sparsely, finely punctured, with a small lateral carina; posterolateral carina weakly flangelike. Scutellar groove rather broad and deep with 3 to 5 dissecting and 2 bordering carinae. Scutellum roundly trigonal in dorsal profile, with irregular moderate to large punctures; posterior surface gently rounded. Propodeum gently sloped posteriorly, with a moderate, irregular transverse carina; central dorsal carina short and prominent, transverse carina becoming lost laterally in the lateral rugosity; dorsal surface and posterior surfaces roughly and densely rugoso-punctate; lateral areas irregularly rugoso-punctate. Mesopleuron punctate; middle central area impunctate, lower anterior area with moderate punctures in a mesopleural groove; mesosternum rugoso-punctate or punctate. Lateral regions of pronotum punctate, upper posterior corner with a slight bend, the triangular area behind bend sparsely, finely punctate and centrally carinate. Wings hyaline; submedian cell as long as median basally.

Abdomen: Carapace teardrop shaped in dorsal view and comma shaped in lateral view; general surface longitudinally rugoso-punctate anteriorly, densely punctate posteriorly; apex of carapace without apical spines. Parameres of external genitalia very short.

Female.—Similar to ♂ but carapace oval in dorsal view and teardrop shaped in lateral view. Ovipositor 0.75 mm long, ½ as long as carapace. Ovipositor sheath brown.

Holotype.—♂, Argentina, "Villa Nouges," Tucumán; XI-26/28/64 7250 m, C. Porter. In Museum of Comparative Zoology.

Allotype.—♀, Same data as holotype.

Paratype.—♂, Same data as holotype. In National Museum of Natural History.

Biology and host.—Unknown.

Remarks.—This species is close to *paraguayensis* by the presence of 14 antennal segments and lack of tubercles on carapace apex but differs in lack of ventral flange projections and tan palpi color.

Urosigalphus (*Neourosigalphus*) *porteri* Gibson, New Species

Fig. 7

General features.—Length, 2.9 mm. Head and thorax black; carapace black with maroon tint basally; abdomen rufo-testaceous; clypeus dark red brown apically, labrum red; mandible yellow with dark red brown base and apex; palpi yellow; antenna dark brown; fore- and midlegs yellow tan; hindlegs with coxa and femur brown, tibia and tarsus dark brown dorsally. Tegula brown. Wings clear, hyaline with colorless hairs, costa light brown basally and medium brown apically; stigma dark brown, remaining veins medium brown distally but becoming paler basally.

Female.—Differs from *flexus* in following: *Head:* Clypeus semi-circular. Interantennal area with a shallow, finely punctate rugoso-punctate antennal sulcus extending past rear ocelli. Interocellar area grooved with slightly raised rugoso-punctate areas between groove and rear ocelli.

Thorax: Mesonotum notaulices broad and deep. Scutellar groove with 3 dissecting and 2 lateral carinae. Scutellum rugoso-punctate with irregular large punctures. Propodeum with dorsal surface with irregular rugae delimiting irregular depressions; posterior surface roughly and densely rugoso-punctate. Mesopleuron lower anterior area with large punctures in a mesopleural groove; mesosternum coarsely rugoso-punctate. Lateral regions of pronotum punctate, with deep, moderate punctures.

Abdomen: Carapace oval in dorsal view and somewhat teardrop shaped in lateral view. Ovipositor 1 mm long, $^4/_5$ as long as carapace, ovipositor sheath brown.

Male.—Unknown.

Holotype.—♀, Quebrada-Lules, Tucumán, Argentina 9-XII-64; C. C. Porter. In Museum of Comparative Zoology.

Distribution.—Known only from type.

Biology and host.—Unknown.

Remarks.—*Urosigalphus porteri* is close to *flexus*, but *flexus* differs in that its palpi color is yellow and the hindleg and coxa are brown.

Urosigalphus (*Neourosigalphus*) *surinamensis* Gibson, New Species
Fig. 4

General features.—Length 4.2 mm. Head and thorax black; carapace dark red black; abdomen dark brown; clypeus dark red brown apically; labrum red tan; mandible red tan with red apex; palpi tan; antenna medium brown with dark brown scape and pedicel; foreleg tan, midleg tan, hindleg dark brown with tan trochanter; coxae same color as legs. Tegula red tan. Wings hyaline with brownish tint, with sparse brown hairs, costa and stigma brownish black, remaining veins pale brown.

Female.—Differs from *flexus* in following: *Head:* Clypeus rather quadrate; lower central margin gently curved. Mandible outer surface fairly smooth. Interantennal area densely, finely punctate and with three small carinae just anterior to the median ocellus, and a fairly deep, finely punctate antennal sulcus extending almost to the rear ocelli. Antenna 16-segmented; scape short and relatively slender; inner margin arcuate; pedicel amost half as long as scape; apical segment of flagellum ¼ longer than the penultimate segment. Ocelli oval, interocellar area deeply, finely punctate, slightly raised. Occipital carina incomplete, poorly developed laterally and absent in dorsal region.

Thorax: Mesonotum irregularly punctate, with notaulices narrow and shallow with large-sized punctures, area of convergence broad and round, with large-sized punctures; median lobe finely punctate with a small central carina; lateral lobes flattened, densely, finely punctured, with a small lateral carina; posterolateral carina not flangelike. Scutellar groove deep, segmented by 5 carinae. Scutellum coarsely, deeply, rugoso-punctate and carinate dorsally, with irregular moderate, carinate punctures laterally and posteriorly. Propodeum nearly flat posteriorly, with a strong transverse carina; the transverse carina proceeds irregularly down both sides to the point of abdominal articulation; dorsal surface irregularly carinate and rugoso-punctate; posterior surface roughly and densely rugoso-punctate and bicarinate. Mesopleuron mostly impunctate; central area impunctate and nitidous, surrounded by large, deep punctures; mesosternum bicarinate and rugoso-punctate with large deep punctures. Lateral regions of pronotum irregularly punctured with moderate, fairly deep punctures, except impunctate centrally; upper posterior corner with a carinate bend, triangular area behind carina with large deep punctures. Wings hyaline, with a brown tint; submedian cell longer than median basally.

Abdomen: Carapace elongate oval in dorsal view and teardrop shaped in lateral view; general surface longitudinally finely carinate dorsally, and finely rugoso-punctate distally. Ovipositor 1.5 mm long, nearly as long as carapace; ovipositor sheath reddish brown.

Male.—Unknown.

Holotype.—♀, Surinam, Phedra, 7 to 14-XII-64; D. C. Geijskes, rain forest in hilly interior. In Rijksmuseum van Natuurlijke Historie.

Biology and host.—Unknown.

Remarks.—This species differs from all known South American species by the brown tinted wings. It is similar to *braziliensis* Gibson in size and keys near *safflavus* Gibson but is easily separated by the brown tinted wings and finely, rugoso-punctate carapace apex.

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Literature Cited

Gibson, L. P. 1972. Revision of the Genus *Urosigalphus* of the United States and Canada (Hymenoptera: Braconidae). Misc. Publ. Entomol. Soc. Am. 8(3 & 4): 83–134.

———. 1974. South American *Urosigalphus* (Hymenoptera: Braconidae). Misc. Publ. Entomol. Soc. Am. 9(4): 201–226.

PROC. ENTOMOL. SOC. WASH.
84(1), 1982, pp. 177–183

COCCOBAPHES SANGUINARIUS AND *LYGOCORIS VITTICOLLIS* (HEMIPTERA: MIRIDAE): SEASONAL HISTORY AND DESCRIPTION OF FIFTH-INSTAR, WITH NOTES ON OTHER MIRIDS ASSOCIATED WITH MAPLE

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Abstract.—Seasonal history of the mirids *Coccobaphes sanguinarius* Uhler and *Lygocoris vitticollis* (Reuter) was followed on red maple, *Acer rubrum* L., in southcentral Pennsylvania during 1979–80. Both are univoltine species whose nymphs feed on the undersides of expanding foliage. Although overwintered eggs of both species hatched in early May, adults of *L. vitticollis* first appeared in early June, about 7–10 days before those of *C. sanguinarius*. Feeding by *L. vitticollis* produces translucent spots at sites of stylet penetration on red maple leaves; when dead tissue tears or drops from the feeding sites, the foliage appears ragged or perforated. A diagnosis of the fifth-instar of both mirids is given, along with biological notes on *L. hirticulus* (Knight) and other mirids found associated with Pennsylvania maples.

During studies on the mirid fauna of Pennsylvania, T. J. Henry and I accumulated data on host plants and phenology of the species associated with maple, *Acer* spp. I began a more intensive study of the fauna when my colleague K. Valley brought to my attention the unusual injury that *Lygocoris vitticollis* (Reuter) produces on leaves of red maple, *A. rubrum* L. In this paper I summarize the seasonal history and host plants of the two principal mirids occurring on Pennsylvania maples, *L. vitticollis* and *Coccobaphes sanguinarius* Uhler, and give a diagnosis of the fifth-instar nymphs. Notes on seasonal history are given for *L. hirticulus* (Knight) and other mirids collected from but not restricted to breeding on maple.

STUDY SITES AND METHODS

The main study area near Harrisburg (Dauphin Co.), Pennsylvania, was dominated by a dense stand of Virginia pine, *Pinus virginiana* P. Mill., with an understory of grasses and forbs mixed with the rosaceous shrub ninebark, *Physocarpus opulifolius* (L.) Maxim., and red maple. The maples were young trees about 2–3 m high, plus smaller saplings.

I sampled red maple weekly from mid-May to late June 1979. In April 1980 I began to collect from red maple to determine first egg hatch of *L. vitticollis* and *C. sanguinarius* and then made weekly collections through July once eggs had begun to hatch (early May). Mirids were sampled by beating branches over a small tray (Wheeler, 1980) or sweeping branches with a beating net. All specimens taken in approximately 15 minutes of collecting were identified to stage in the field (adults, late instars) and returned to the host plants; instars I–III were placed in alcohol and sorted in the laboratory under a binocular microscope. Populations of *L. vitticollis* and *C. sanguinarius* were much smaller than those known for several orthotyline mirids, e.g., *Diaphnocoris chlorionis* (Say) (Wheeler and Henry, 1976), or *Brachynotocoris puncticornis* Reuter (Wheeler and Henry, 1980). Thus, a typical sample consisted only of 3–7 specimens of each species rather than the many hundreds of certain orthotylines that could be collected in 15 minutes. To determine possible injury to host foliage by the two main species, nymphs of different stages were placed in small plastic dishes containing fresh sprigs of red maple, and any feeding damage was noted.

Lygocoris vitticollis (Reuter)

This mirid, widely distributed in eastern North America, is known from Nova Scotia south to Mississippi and west to Kansas (Kelton, 1971). *Lygocoris vitticollis,* along with the ubiquitous tarnished plant bug, *Lygus lineolaris* (Palisot de Beauvois), and fourlined plant bug, *Poecilocapsus lineatus* (F.), was one of the first North American mirids reported to damage shade trees or ornamental plants. In the spring of 1882 Murtfeldt observed injury to young foliage of silver maple, *A. saccharinum* L., at Kirkwood, Missouri; unfolding leaves, initially stippled with transparent spots, soon became perforated (Murtfeldt, 1887). Uhler (1887), unaware of Reuter's (1876) description published without a host association, described Murtfeldt's "noxious capsid" as a new species, *Lygus monachus*. Uhler's name thus is a junior synonym of Reuter's *vitticollis* (Reuter, 1909).

Since Murtfeldt's time, there apparently have been no further reports of *L. vitticollis* damaging maple, and little information on habits has been added. Murtfeldt was perceptive to associate the tattered appearance of maple leaves with a sucking, rather than chewing, insect, but some of her observations, made before life histories of North American mirids were generally known, have proved inaccurate.

Seasonal history and habits.—Eggs that overwintered near dormant leaf buds of red maple began to hatch shortly after leaf flush, about 7 May in 1980. Early instars fed on the undersides of tiny, expanding leaves; the pale, whitish-green nymphs resembled the color of this young foliage. The pop-

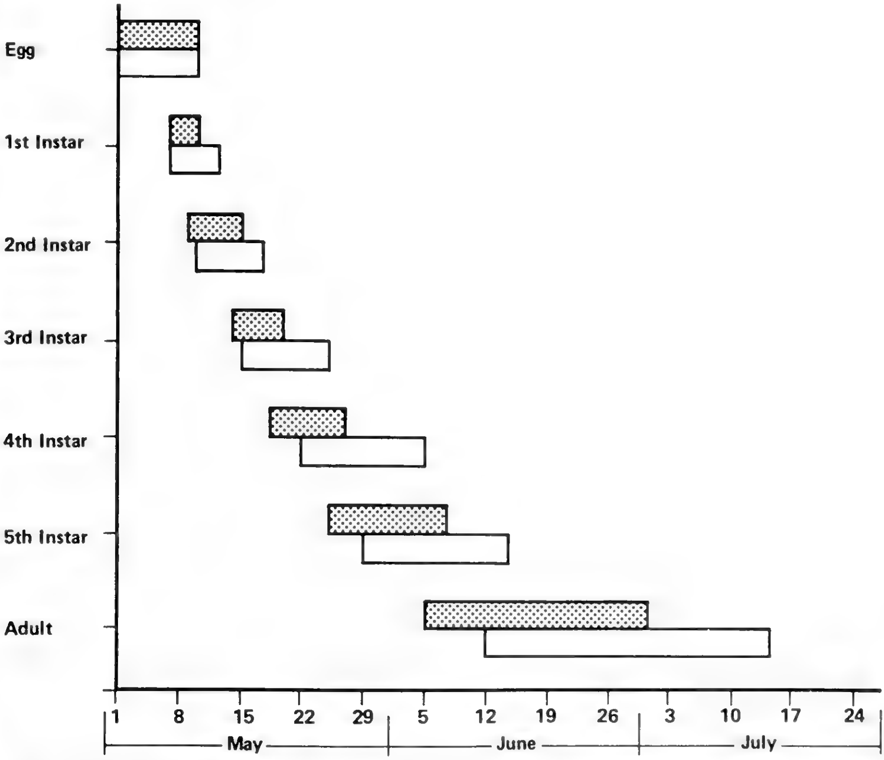
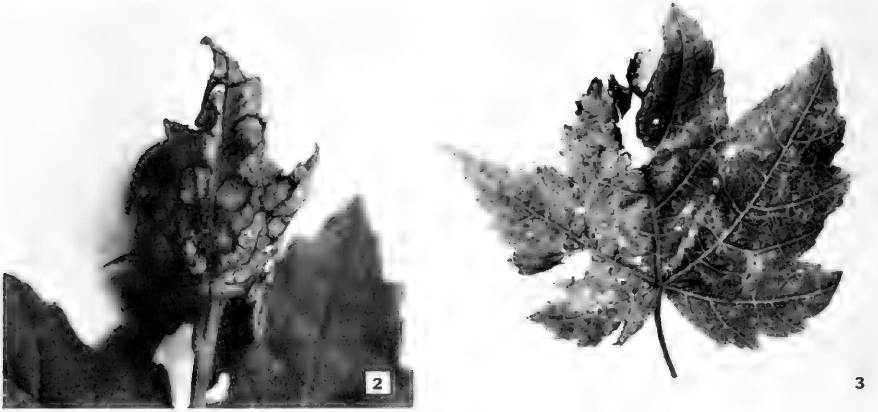


Fig. 1. Generalized seasonal history of *Lygocoris vitticollis* (shaded bar) and *Coccobaphes sanguinarius* (open bar) in central Pennsylvania, 1979–80.

ulation consisted mainly of third-instars by mid-May and fifth-instars by the last week of May in both years of study (Fig. 1). Adults began to appear during the first week of June and were present only for 3–4 weeks, males dying about a week before females. In the weekly collections, adults of this univoltine mirid no longer were present after 21 June in 1979; two females were collected on 30 June in 1980. The latest known collection of *L. vitticollis* in Pennsylvania is 22 July at Patton by the hemipterist Rev. Modestus Wirtner (Wheeler and Henry, 1977).

Injury became noticeable when the population consisted mainly of third-instars (mid-May) and appeared as translucent, irregularly shaped blotches on curled, unfolding leaves (Fig. 2). In the laboratory nymphs provided with fresh foliage produced this characteristic damage within 12–24 hours. As leaves expand, the thin tissue remaining at the feeding site tears or drops out (Fig. 3). The resulting ragged appearance of the foliage easily could be blamed on feeding by lepidopteran larvae or some other chewing insect.



Figs. 2, 3. Injury to red maple by *Lygocoris vitticollis*. 2, Translucent areas on expanding foliage. 3, Ragged edges and holes resulting from dead tissue tearing and dropping from leaf.

Injury seemed disproportionate to the size of populations since fewer than ten bugs were taken in any sample during 1979–80. Populations, however, may fluctuate from year to year; Murtfeldt (1887) noted that populations were greater in 1886 than in her previous seasons of observation. At only two localities in New York, Knight (1917) was able to collect unusually large numbers (250 and 118 adults) from sugar maple, *A. saccharum* H. Marsh.

Host plants.—The principal hosts are silver maple (Murtfeldt, 1887) and red and sugar maple (Knight, 1917). In addition to the population studied on red maple, I collected *L. vitticollis* from this host in other old fields and in hedgerows and nurseries, mostly on cut-over trees or saplings. I also found this species breeding on silver maple in Pennsylvania and have seen a series of specimens taken on silver maple in Berkeley Co., West Virginia.

Lygocoris vitticollis appears to be a specialist mirid confined to maple. Records from other plants, e.g., *Ulmus* sp. (Akingbohungbe et al., 1972), probably reflect dispersal of adults from maple. Adults of *Lygocoris* spp. show a strong tendency to disperse to non-host plants (Kelton, 1971; Wheeler, unpublished data).

Description of fifth-instar.—Length 4.68 mm. Elongate oval, uniformly pale or whitish green, apex of labial segment IV darker. Sparsely clothed with pale, recumbent setae, intermixed with a few semierect setae. Antenna: I, length 0.48 mm; II, 1.46 mm; III, 1.22 mm; IV, 0.66 mm. Rostrum, length 1.20 mm, reaching bases of mesocoxae. Wing pads reaching 4th abdominal segment; dorsal abdominal scent gland opening pale, indistinct.

On maple, nymphs of *L. vitticollis* may be distinguished from those of *L. hirticulus* by their pale, uniformly whitish-green color. Knight (1917) was the first to note that *vitticollis* nymphs differed from those of other species of *Lygocoris* (cited as the *communis* group or Group VI of the genus *Lygus* Hahn).

Coccobaphes sanguinarius Uhler

Although the recorded distribution of *C. sanguinarius* is similar to that of *L. vitticollis*—Ontario south to Florida and west to Missouri (Carvalho, 1959)—its habits are not as well known. Drake (1922) found this mirid on striped maple, *A. pennsylvanicum* L.; Knight (1923) recorded the second growth of young sugar, and less often, red maple as hosts; and Watson (1928) added silver maple as a host. I am aware of only one reference to *C. sanguinarius* in the economic literature. At Knoxville, Tennessee, a population on "hard maples" attracted attention when large numbers of this brilliant red bug fell to the ground beneath host trees (Bentley, 1941).

Seasonal history and habits.—Overwintered eggs, like those of *L. vitticollis,* hatched during early May, and nymphs fed on the lower surfaces of young, expanding foliage. Based on two seasons' observations, nymphal development appeared to take somewhat longer, so that populations of *C. sanguinarius* consisted mainly of fifth- and a few fourth-instars when adults and fifth-instars of *L. vitticollis* were present (Fig. 1). Adults of *C. sanguinarius* first appeared in the 12 June collection and were present at the sample site until mid-July. The latest Pennsylvania record of this single-brooded species is 1 Aug., based on Rev. Wirtner's collecting at Patton (Wheeler and Henry, 1977).

Since *Coccobaphes* nymphs fed on new growth of red maple in company with *Lygocoris* nymphs, it was not possible from field observations to determine whether *C. sanguinarius* also injured host foliage. In the laboratory, nymphs did not produce any visible damage no matter how long they were confined with unblemished leaves of red maple.

The number of specimens taken in both seasons was small, with a typical sample consisting of 4–6 specimens. Froeschner (1949) noted that in Missouri *C. sanguinarius* was "rather scarce."

Host plants.—Although adults have been collected from beech, *Fagus* sp. (Van Duzee, 1889), serviceberry or Juneberry, *Amelanchier* sp. (Wheeler and Henry, 1977), and mountain ash, *Sorbus* sp. (Drake, 1922), there is no evidence that plants other than *Acer* spp. serve as hosts. Like *L. vitticollis, C. sanguinarius* is most abundant on sapling and second-growth red and sugar maple. In addition to Knight's (1923) record of *sanguinarius* from red and sugar maple, this mirid has been taken on the latter host at Cincinnati, Ohio (U.S. National Museum collection). I have seen a series of specimens collected from striped maple at Cranberry Lake, New York (Cornell University collection).

Description of fifth-instar.—Length 4.40 mm. Broadly oval, uniformly bright red except antennal segment II, apex of labial segment IV, and tibiae fusco-reddish to black; and antennal segments III–IV and tarsi white. Head, pronotum, and wing pads with short erect and semierect pale setae; abdomen more sparsely set with pale setae, longer bristle-like setae along lateral margins of segments IX–X. Antenna with black bristle-like setae, becoming more fine and sparse on segments III–IV; I, length 0.88 mm; II, 2.06 mm; III, 1.28 mm; IV, 1.40 mm. Rostrum, length 2.00 mm, reaching bases of metacoxae. Wing pads reaching abdominal segment VI; dorsal abdominal scent gland opening indistinct, surrounded by brighter red area.

Nymphs of *C. sanguinarius* may be separated easily from nymphs of other mirid species breeding on maple. They are distinguished by their bright red color with contrasting white on the last two antennal segments and the tarsi.

Other Species

Several mirids whose hosts include various hardwoods were found breeding on maple in Pennsylvania. The mirine *Lygocoris hirticulus* was the most common of these additional *Acer* inhabitants. This species was present on red maple at the sample site in both years of study, with adults appearing the first week of June along with those of *L. vitticollis*. Nymphs of the two *Lygocoris* species often are distinguishable in the field; those of *L. hirticulus* differ from those of *vitticollis* by being yellowish green rather than pale whitish green. Adults of *L. hirticulus* were present at the main sample site until mid-July. This phytophagous, univoltine mirid, collected previously on maple (Hussey, 1922; Blatchley, 1926), also breeds on other deciduous trees, especially birch (*Betula* spp.) and beech (*Fagus* spp.) in Pennsylvania.

Other mirids found breeding on Pennsylvania maples include the predators *Deraeocoris nebulosus* (Uhler), *Diaphnocoris provancheri* (Burque) (=*pellucida* (Uhler)), *Hyaliodes* sp. (nymphs only—*harti* Knight or *vitripennis* (Say), or both), and *Phytocoris* spp. *Deraeocoris nebulosus* was common on sycamore maple, *A. pseudoplatanus* L., heavily infested with the aphid *Drepanosiphum platanoides* (Schrank) (Wheeler et al., 1975). *Diaphnocoris provancheri*, a species of at least partially predacious habits, is known to occur on maple (Hussey, 1922).

Acknowledgments

I thank my colleagues J. F. Stimmel for the photographs and K. Valley for calling my attention to damage inflicted by *L. vitticollis* and for reading the manuscript. E. R. Hoebeke, Cornell University, Ithaca, N.Y., also read the manuscript.

Literature Cited

Akingbohungbe, A. E., J. L. Libby, and R. D. Shenefelt. 1972. Miridae of Wisconsin (Hemiptera: Heteroptera). Univ. Wis.–Madison Res. Div. R 2396. 24 pp.

Bentley, G. M. 1941. A mirid (*Coccobaphes sanguinareus* Uhl.). Insect Pest. Surv. Bull. 21: 205.

Blatchley, W. S. 1926. Heteroptera or true bugs of eastern North America, with special reference to the faunas of Indiana and Florida. Nature Publ. Co., Indianapolis. 1116 pp.

Carvalho, J. C. M. 1959. Catalogue of the Miridae of the world. Part IV. Arq. Mus. Nac., R. de J. 48: 1–384.

Drake, C. J. 1922. Heteroptera in the vicinity of Cranberry Lake, pp. 54–86. *In* Osborn, H. and C. J. Drake, An ecological study of the Hemiptera of the Cranberry Lake region, New York. N.Y. State Coll. For. Tech. Publ. 16.

Froeschner, R. C. 1949. Contributions to a synopsis of the Hemiptera of Missouri, Pt. IV. Am. Midl. Nat. 42: 123–188.

Hussey, R. F. 1922. Hemiptera from Berrien County, Michigan. Occas. Pap. Mus. Zool. Univ. Mich. No. 118, 39 pp.

Kelton, L. A. 1971. Review of *Lygocoris* species found in Canada and Alaska (Heteroptera: Miridae). Mem. Entomol. Soc. Can. 83: 1–87.

Knight, H. H. 1917. A revision of the genus *Lygus* as it occurs in America north of Mexico, with biological data on the species from New York. Cornell Univ. Agric. Exp. Stn. Bull. 391: 555–645.

———. 1923. Family Miridae (Capsidae), pp. 422–658. *In* Britton, W. E., ed., Guide to the insects of Connecticut. Part IV. The Hemiptera or sucking insects of Connecticut. Conn. State Geol. Nat. Hist. Surv. Bull. 34.

Murtfeldt, M. E. 1887. Notes from Missouri for the season of 1886, pp. 59–65. *In* Reports of observations and experiments in the practical work of the Division, made under the direction of the Entomologist. U.S. Dep. Agric. Div. Entomol. Bull. 13.

Reuter, O. M. 1876. Capsinae ex America boreali in Museo Holmiensi asservatae, descriptae. Ofv. Svenska Vet.-Ak. Forh. 32(9): 59–92(1875).

———. 1909. Bemerkungen über nearktische Capsiden nebst Beschreibung neuer Arten. Acta Soc. Sci. Fenn. 36(2): 1–86.

Uhler, P. R. 1887. A new noxious capsid. Can. Entomol. 18: 208–209 (1886).

Van Duzee, E. P. 1889. List of Hemiptera from the Muskoka Lake District, Canada. Can. Entomol. 21: 1–11.

Watson, S. A. 1928. The Miridae of Ohio. Ohio Biol. Surv. Bull. 16: 1–44.

Wheeler, A. G., Jr. 1980. Life history of *Plagiognathus albatus* (Hemiptera: Miridae), with a description of the fifth instar. Ann. Entomol. Soc. Am. 73: 354–356.

Wheeler, A. G., Jr. and T. J. Henry. 1976. Biology of the honeylocust plant bug, *Diaphnocoris chlorionis*, and other mirids associated with ornamental honeylocust. Ann. Entomol. Soc. Am. 69: 1095–1104.

———. 1977. Rev. Modestus Wirtner: Biographical sketch and additions and corrections to the Miridae in his 1904 list of western Pennsylvania Hemiptera. Great Lakes Entomol. 10: 145–157.

———. 1980. *Brachynotocoris heidemanni* (Knight), a junior synonym of the Palearctic *B. punticornis* Reuter and pest of European ash. Proc. Entomol. Soc. Wash. 82: 568–575.

Wheeler, A. G., Jr., B. R. Stinner, and T. J. Henry. 1975. Biology and nymphal stages of *Deraeocoris nebulosus* (Hemiptera: Miridae), a predator of arthropod pests on ornamentals. Ann. Entomol. Soc. Am. 68: 1063–1068.

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NEW CENTRAL AND SOUTH AMERICAN LEAFHOPPERS OF THE "BAHITA" GROUP (HOMOPTERA: CICADELLIDAE: DELTOCEPHALINAE)

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Abstract.—Seven new species and a new genus of the "Bahita" group of Deltocephaline leafhoppers, *Perubahita* ***confusa*** n. sp., ***Angubahita atra***, n. gen., n. sp., *Megabahita* ***patula***, n. sp., *Parabahita* ***lamina***, n. sp., ***P. thalla***, n. sp., *Frequenamia* ***particula***, n. sp., and ***F. atrata***, n. sp., are described.

The genus *Bahita* was described by Oman (1936). DeLong (1947) described the genus *Frequenamia* from Mexican specimens. Several related genera (including *Parabahita*) were described by Linnavuori (1959). The "Bahita" group of genera was treated by Linnavuori and DeLong (1978a, b). A new genus and seven new species are described in this paper. All types are in the DeLong collection.

Perubahita confusa DeLong, New Species
Figs. 1–6

Description.—Length of male 6 mm, female unknown. Crown longer at middle than next to eyes, ½ as long at middle as wide at base between eyes. Crown dull white, a dark brown spot at each side of apex which becomes paler brown caudally, and both spots merge near middle of crown. With dark brown spot, each side, between eye and middle line at base. Basal ½ of crown mostly tinted with orange brown. Pronotum brown with irregular black markings and a narrow whitish transverse band across middle of pronotum. Scutellum with basal angles mostly dark brown, with a small white triangle in each basal angle, apical ⅓ white. Forewing pale brownish subhyaline with a few dark brown spots; veins mostly dark brown.

Male genital plates 3× as long as wide at middle, apex narrow, bluntly pointed, styles with apophyses slender, curved outwardly. Aedeagus curved, tapered from rather broad base to slender pointed apices. Apical portion composed of 2 lateral, contiguous portions. Pygofer narrowed apically and rounded.

Holotype.—♂, Boa Vista, Mu Castanbal, Pará, Brazil 13-I-1965, W. France coll.

Comments.—*Perubahita confusa* is related to *P. longifal* Linnavuori and DeLong and can be separated by the small, rather slender, pointed, curved aedeagus.

Angubahita DeLong, New Genus

Description.—Head as wide as pronotum, crown produced, rounded apically, almost as long at middle as wide at base between eyes, ⅓ longer at middle than length at eyes, ¾ as long as pronotum. Crown angled with face, margin, thick. Forewings parallel sided, longer than abdomen, with 3 closed apical cells. Crown, pronotum, and scutellum marked with bright red spots. Style triangular, aedeagus bifid apically. Species small in size, male 4 mm in length and slender.

Type-species.—*Angubahita arta* DeLong, new species.

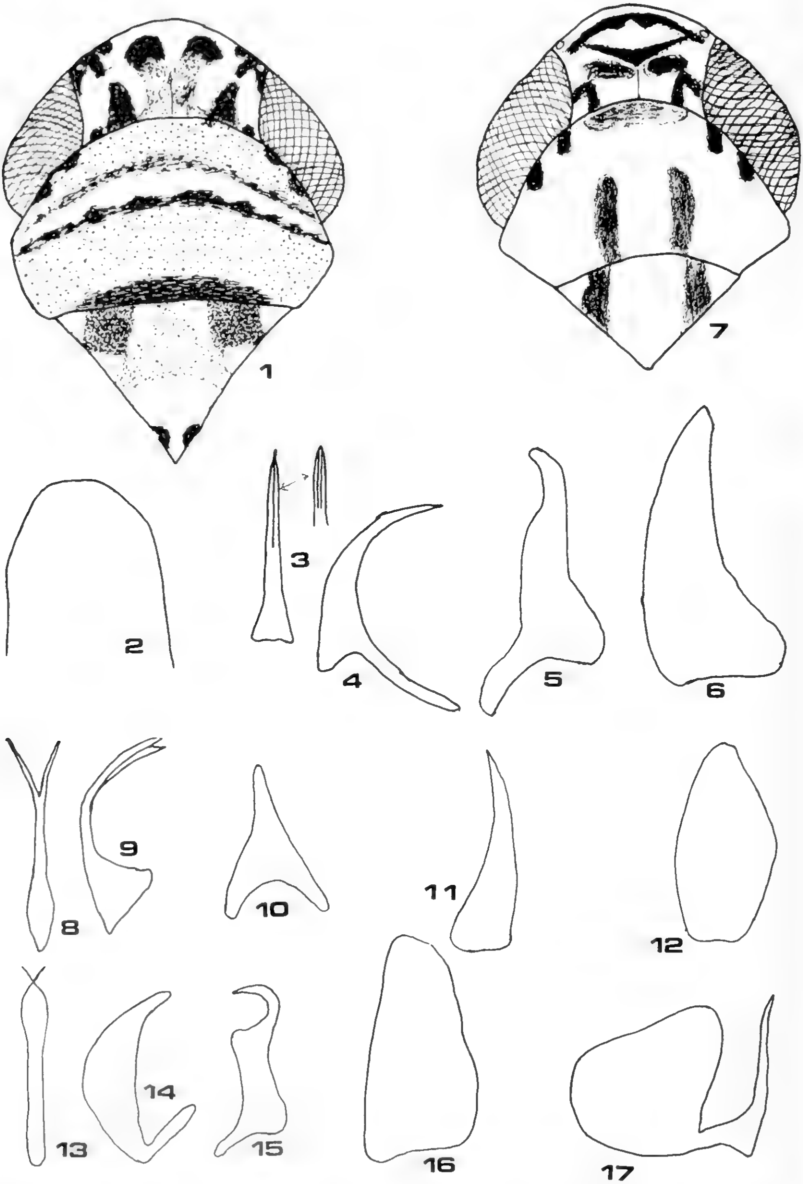
A key to the known genera of the *Bahita* group was published by Linnavuori and DeLong (1978a). The genus *Angubahita* would key out to couplet 6, *Taperinha*. The species of *Taperinha* are larger, more robust than *Angubahita* with a more broadly angled crown. The eyes are proportionately larger in *Angubahita*, occupying about ½ of the dorsal surface of the head, while in species of *Taperinha* the eyes occupy about ⅓ of the head area, and have a crown which is 1½ to twice as wide at base as long at middle.

Angubahita arta DeLong, New Species

Figs. 7–12

Description.—Length of male 4 mm, female unknown. Crown roundly produced, almost as long at middle as wide between eyes at base. Ocelli large. Crown whitish, a black transverse stripe between ocelli just above marginal white band. The black stripe surrounding ocelli, narrowed at middle and thickened on basal side, each side of middle. A black triangular area, with pointed apex basad, on middle of crown. A red area at each side of apex of black triangle and a black area along basal portion of each eye. Pronotum with a reddish area at each side of apical portion, and with 4 black spots, 2 behind each eye at base. Scutellum grayish brown, basal angles mostly reddish. Forewing grayish subhyaline, veins brown, color intensified on costal veinlets, claval veinlets at commissure, and at base of apical cells.

Male genital plates 5× as long as wide at middle, apices narrowed, sharply pointed. Style triangular, longer than wide, apical portion straight, narrow, finger-like, apex rounded. Aedeagus narrow, except near base, curved, apical ½ divided into 2 narrow divergent processes. Pygofer narrowed, rounded apically.



Figs. 1–17. 1–6, *Perubahita confusa*. 7–12, *Angubahita arta*. 13–17, *Megabahita patula*. 1, 7, Head, pronotum, scutellum, dorsally. 2, 12, 17, Pygofer laterally; apical portion in Fig. 2. 3, 8, 13, Aedeagus ventrally. 4, 9, 14, Aedeagus laterally. 5, 10, 15, Style laterally. 6, 11, 16, Plate ventrally.

Holotype.—♂, Las Cumbres, Panama, at light, 23-VI-1975, H. Wolda coll.

Megabahita patula DeLong, New Species

Figs. 13–17

Description.—Length of male 5.5 mm, female unknown. Crown 3/5 as long at middle as wide at base between eyes. Crown with apical ⅓ white, with a black spot at each side of apex. Remainder of crown reddish brown at each side of a median grayish area. Pronotum dark gray, anterior ⅓ brownish. Scutellum grayish, apical ⅓ white. Forewing grayish yellow, costal veinlets broadly brown, veins brown.

Male genital plates 2× as long as wide at middle, apex rather broad, rounded. Style with apophysis narrow, curved dorsally. Aedeagus broad at middle (in lateral view) narrow at base and with a slender apex bearing 2 short apical processes. Pygofer bearing a base-apical process, enlarged, and bearing a ventrally angled tooth near base, extending dorsally beyond margin of pygofer, apical portion slender, tapered, sharp pointed.

Holotype.—♂, Panama, El Llano, Carte Rd., 8-X-1974, H. Wolda coll.

Comments.—*Megabahita patula* is related to *M. irroratus* (Osborn) and can be separated by the more broadened (lateral view) and the more basally broadened pygofer spine.

Parabahita lamina DeLong, New Species

Figs. 18–23

Description.—Length of male 5.5 mm, female unknown. Crown short, broadly rounded, appearing parallel margined. Pale brownish, crown with a marginal, narrow, black, transverse band. A straighter, narrow, transverse band between ocelli, and portions of a basal, wider, broken, black band next to eyes. Pronotum rather dark brownish with blackened areas. Scutellum pale brown with darker brown angles. Forewing dull yellowish, subhyaline, veins pale to dark brown, some broadly embrowned.

Male genital plates 2½× as long as wide at middle, apices rounded. Style triangular, with the basal portion broad, apical portion thumblike, apex narrow, rounded. Aedeagus curved, sickle-shaped bearing a nonsclerotized, saucer-shaped disc attached to the basal portion, extending across opening between base and pointed apex. Apical portion of aedeagus divided, apices pointed. Connective with basal, divided portion twisted at middle. Pygofer bearing a long, slender, tapered, apical process which arises basocaudally and extends dorsally beyond dorsal portion of pygofer.

Holotype.—♂, Santa Cruz, Bolivia, Exper. Sta. Saavedra, 350 m, 12-IV-1979, 131Bb, D. Foster, V. Gongalez, and I. Caballero colls., at trap light. Paratype male same data as holotype.

Comments.—*Parabahita lamina* is related to *P. vesenyii* Linnavuori and can be separated by the slender, smooth tip of the apical portion of the pygofer appendage, the rounded, nonsclerotized vertical disc at the base of the aedeagus, and the twisted, basal portion of the connective.

Parabahita thalla DeLong, New Species

Figs. 24–28

Description.—Length of male 6 mm, female unknown. Crown short, broadly rounded, appearing parallel margined. Crown pale brown with a curved, transverse, dark brown, narrow band, broadened at middle, just above margin. A very narrow, straight, black, transverse band between ocelli. A broader brown band between eyes, near base, slightly broken at middle. Pronotum pale brown on anterior ⅓, posterior ⅔ dark brown. Scutellum with dark brown basal angles surrounded by white. Median longitudinal portion pale brown.

Male genital plates 3½× as long as wide at middle, apices narrowed, bluntly pointed. Style elongate, narrow, apical ½ long, narrow, slightly curved, apex rounded. Aedeagus sickle-shaped, apical portion divided into 2 pointed processes. Pygofer bearing a long curved apical process, the apical ⅓ of which is broadened and pointed, spear-shaped.

Holotype.—♂, Santa Cruz, Bolivia, 2-IV-1979, 350 m, D. Foster, V. Gonzalez, and I. Caballero colls, at trap light. Paratype male same data as holotype.

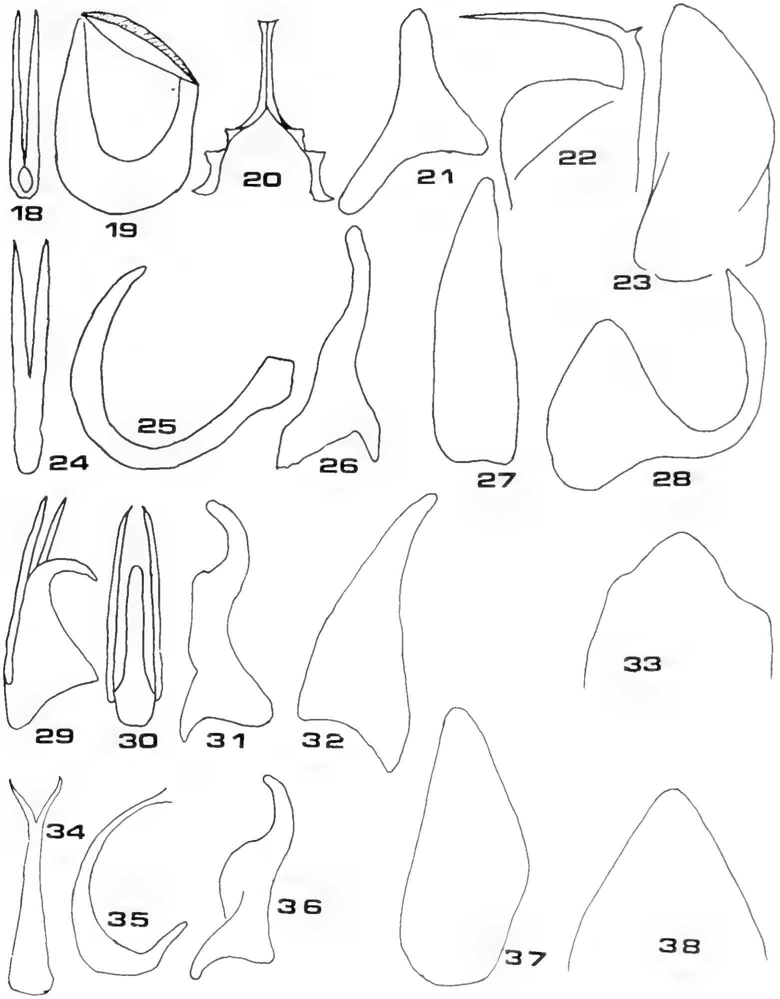
Comments.—*Parabahita thalla* is related to *P. vezenyii* Linnavuori and can be separated by the long slender apophysis of the style and the broadened spearlike apical portion of the pygofer apical process.

Frequenamia particula DeLong, New Species

Figs. 29–33

Description.—Length of male 5.5 mm, female unknown. Crown produced and rounded, 3× as wide at base between eyes as long at middle. Crown white, a brown marginal line. A dark brown narrow transverse band just distal to a narrow whitish band between the 2 brownish bands. Basal ½ of crown, pale brown. Pronotum dark brown with paler brownish mottling. Scutellum with basal ⅔ brown, apical ⅓ white. Forewing pale brownish subhyaline, with numerous white areolar spots, 5 prominent spots on clavus, veins mostly pale brown.

Male genital plates more than 3× as long as wide at middle, apex narrowed, bluntly pointed. Style with apophyses narrow, rounded. Aedeagus rather broad at base, narrowed to a curved, narrow, bluntly pointed apex, with 2 straight, long, slender processes attached laterally, which extend caudally beyond curved apex of aedeagus. Pygofer narrowed and rounded apically.



Figs. 18–38. 18–23, *Parabahita lamina*. 24–28, *P. thalla*. 29–33, *Frequenamia particula*. 34–38, *F. atrata*. 18, 24, 30, 34, Aedeagus ventrally. 19, 25, 29, 35, Aedeagus laterally. 20, Connective ventrally. 21, 26, 31, 36, Style laterally. 22, 33, 38, Pygofer laterally, apical portion. 28, Pygofer laterally. 23, 27, 32, 37, Plate ventrally.

Holotype.—♂, Panama, Chiriqui, Fortuna, 1050 m, 26-IX-1976, H. Wolda coll.

Comments.—*Frequenamia particula* is related to *F. crassistylus* Linnavuori and can be separated by the two long slender processes attached to the aedeagus extending caudally beyond the apex of aedeagus.

Frequenamia atrata DeLong, New Species

Figs. 34–38

Description.—Length of male 4 mm, female unknown. Crown broadly rounded, twice as wide at base between eyes as long at middle. Crown declivated, margin thick, rounded to front. Anterior ½ of crown with deep lateral striae. Crown brownish, apical ½ black, basal ½ brownish. Pronotum black with brownish, widened punctate spots. Scutellum black with pale brownish spots on central portion. Forewing appearing black, a few brownish areas on corium, apical, and anteapical cells.

Male genital plates more than twice as long as wide at middle, apex narrowed, bluntly rounded, style with apophyses narrow, slightly curved, extending almost caudally. Aedeagus rather narrow, curved, tapered from base to slender apex, divided apically into 2 divergent processes. Pygofer narrowed apically, rounded.

Holotype.—♂, Panama, Barro Colorado, at light, 22-IX-1975, H. Wolda coll.

Comments.—*Frequenamia atrata* is related to *F. lacerae* (Signoret) and can be separated by the unbranched apical process of the aedeagus.

LITERATURE CITED

DeLong, D. M. 1947. A new genus (*Frequenamia*) and species of Mexican leafhoppers related to *Mesamia* (Homoptera: Cicadellidae). Bull. Brooklyn Entomol. Soc. 42: 63–64.

Linnavuori, R. 1959. Revision of the Neotropical Deltocephalinae and some related subfamilies (Homoptera: Cicadellidae). Ann. Zool. Soc. Vanamo 20: 1–370.

Linnavuori, R. and D. M. DeLong. 1978a. Neotropical leafhoppers of the "Bahita" group (Homoptera: Cicadellidae: Deltocephalinae), a contribution to the taxonomy. Brenesia 14/15: 109–169.

———. 1978b. Some new or little known Neotropical Deltocephalinae (Homoptera: Cicadellidae). Brenesia 14/15: 227–247.

Oman, P. H. 1936. A generic revision of American Bythoscopinae and South American Jassinae. Univ. Kans. Sci. Bull. 24: 343–429.

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REPRODUCTIVE AND CALLING BEHAVIOR IN TWO CLOSELY RELATED, SYMPATRIC LACEWING SPECIES, *CHRYSOPA OCULATA* AND *C. CHI* (NEUROPTERA: CHRYSOPIDAE)

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Abstract.—The sister species *Chrysopa oculata* Say and *C. chi* Fitch, like other green lacewings of eastern North America that have been studied, jerk their abdomens vigorously while courting and mating. The substrate-borne signals (calls) produced principally by male insects are simple and repetitive, consisting of more or less extended trains of discrete volleys or bursts of abdominal vibration. The calls of both species are similar but distinctive, differing significantly and consistently from one another in their volley spacing, volley duration, and frequency of abdominal vibration. Some inter- and intra-individual variation in call parameters exists within each species; for example, vibration frequency is particularly well correlated with ambient temperature, at least in *C. oculata*. Acoustical communication in these two *Chrysopa s. str.* species seems much less crucial to successful courtship than it is in *Chrysoperla* species, indicating that calling patterns probably do not serve a reproductive isolating function within species of the *oculata* group. Alternative functions for jerking behavior are therefore considered, and an attempt is made to relate acoustical performance with other aspects of lacewing reproductive biology and ecology.

A special form of acoustical communication, in which courting conspecific individuals exchange substrate-borne low-frequency signals, has been shown to be widespread in North American green lacewings of the family Chrysopidae (Henry, 1979, 1980a, b, c; Smith, 1922; Toschi, 1965; Tauber, 1969). Transverse "sound" waves are generated in lightweight substrates by vigorous jerking motions of a lacewing's abdomen and are thereby transmitted over short distances to other insects standing on those surfaces (Henry, 1980c). Calls consist of bursts or volleys ("pulse trains"—see Graf, 1970) of such abdominal jerking or vibration, usually modulated with respect to frequency and amplitude structure and released over a period of time at species-characteristic intervals. Calling duets are usually established between two sexually receptive conspecifics of opposite sex, and often copulation will not occur without a period of such reciprocal signaling.

Chrysopa (broad sense) in North America includes at least three distinct species-groups, called subgenera by Tjeder (1966) but recognized as full genera by Séméria (1977). These, commonly known in the United States as the *oculata* group, *carnea* group, and *lineaticornis* group, are defined by features of the male terminalia (Bram and Bickley, 1963), but possess distinctive and consistent bionomic characteristics as well. For example, members of the *oculata* group (*Chrysopa s. str.* Séméria) produce strong-smelling "repugnatorial" secretions, are predatory as adults, and overwinter as prepupae within the cocoon, while those of the *carnea* group (*Chrysoperla* Steinmann) are neither odoriferous nor obligatorily carnivorous as adults and pass the winter as diapausing, reproductively immature imagos (Tauber and Tauber, 1974; Séméria, 1977). This strong dichotomy between *Chrysopa s. str.* and *Chrysoperla* is substantiated by calling behavior patterns: members of the latter taxon will not mate without first participating in prolonged, often elaborate calling duets, while those of the *oculata* group that I have studied call in a simpler, more perfunctory, and less predictable manner and will occasionally copulate without acoustical preliminaries. In this paper, I describe abdominal jerking behavior and courtship and mating patterns in two closely related species of *Chrysopa s. str., C. oculata* Say and *C. chi* Fitch, confirming in this case that members of species-pairs not dependent for mating success on acoustical communication can be more similar in their calls than those for which such communication is a necessary adjunct to copulation. That prediction is derived from the hypothesis that calling in lacewings functions at least in part, or once functioned, to isolate closely related species reproductively from one another; in two close relatives which utilize acoustical signals extensively, selection against hybrids would likely cause rapid divergence in call characteristics, as seen in *Chrysoperla* species.

Chrysopa oculata and *C. chi* are common Nearctic green lacewings of medium size. *Chrysopa oculata* is found throughout most of North America north of Mexico and is the most abundant chrysopid species at most sites (Smith, 1922; Bickley and MacLeod, 1956; Bram and Bickley, 1963). It is a meadow species, confined to low vegetation, and passes through three generations each summer in New England (Propp et al., 1969). *Chrysopa chi* is thought, on morphological grounds, to be *C. oculata*'s closest relative (Bram and Bickley, 1963), and similarly occupies a large but rather more northerly range in the United States, Canada, and Alaska. It is described as an "early" species (Smith, 1922), inhabiting the taller shrubs, like meadowsweet (*Spiraea latifolia*), of overgrown fields; little is known of its life history and habits beyond the brief comments by Smith (1922) on hatching, larval development, and eclosion. The reproductive behavior of neither species has been described in detail, although Smith (1922) observed abdominal jerking, courtship, and copulation in *C. oculata* on two separate occasions.

METHODS AND MATERIALS

Specimens of the two species were collected during the summers of 1977 through part of 1981 from Mansfield, Connecticut; Rensselaerville, New York; Echo Lake, Vermont; and North Conway, New Hampshire. Breeding colonies in 2-gallon cardboard cartons were provided with water, artificial WHEAST™ diet (Hagen et al., 1970), and black aphids from *Nasturtium*. Eggs were removed daily and larvae reared on ether-killed *Drosophila* spp., as described in an earlier paper (Henry, 1979). All adults and larvae were maintained under long day (16L:8D) light conditions at 28 ± 1°C and 40–80% relative humidity. Populations from the different collecting locales were maintained separately only until calling patterns were shown to be identical in lacewings from all four areas. First through third laboratory generations were tested for reproductive and acoustical behavior.

Since lacewing signals are of low frequency and are transmitted through the substrate, a simple piezoelectric transducer contacting the thin plastic cover of the experimental arena sufficed as a detector of insect-induced substrate vibrations, as in earlier experiments (Henry, 1979, 1980a, b, c). The electrical output of that transducer was then fed to a Tektronix™ 511 storage oscilloscope through a matching 5A25 dual differential amplifier; tracings of lacewing calls could then be viewed and photographed for future analysis. Both *Chrysopa oculata* and *C. chi* displayed greater sexual activity under red rather than fluorescent illumination; a GE™ 60-watt BCJ incandescent bulb was used for that purpose.

The results and conclusions that follow are based upon 193 hours of observations, approximately equally divided between *C. oculata* and *C. chi*. For *C. oculata*, 197 calls consisting of three or more volleys were analyzed; these represent the recorded activities of 11 different males and 4 females, including two heterosexual duets involving 4 different individuals. Six copulations (12 individuals) were also observed in that species. For *C. chi*, I recorded and analyzed 158 calls of three or more volleys, representing the activities of 8 males and one female. Additionally, one heterosexual duet produced 7 male and 11 female recordable responses (calls). Nine *C. chi* copulations (7 different males, 8 females) were tabulated. During observation sessions of *C. oculata* and *C. chi*, temperature averaged 26.46 ± 1.62°C (n = 53 sessions) and 25.94 ± 3.01°C (n = 36), respectively.

Any reference in the Results or Discussion sections to "significant differences" indicates that the means of two normally distributed samples were demonstrated to differ from one another by a 2-tailed t-test using confidence limits of 95% or better. Similar confidence limits were used in chi-square evaluations. Values following a ± sign are one standard deviation of the mean.

RESULTS

My collecting records confirm the ecological observations of earlier workers (Smith, 1922). In three successive years at the New York State site, adult *C. chi* appeared at least as early in the spring as *C. oculata,* and in one year (1980) were abundant on the 29th of May when no *C. oculata* could be found. At all locales, populations of both species were emphatically sympatric throughout the summer; moving one or two meters from a meadow dominated by *Solidago* spp. to an open aspen grove with a thick *Spiraea* understory resulted in complete replacement of *C. oculata* by *C. chi* in the collecting samples. Adults of both species disappeared from all my sites by 15 September, with *C. oculata* persisting consistently longer (by a week or two) than its relative in each of three consecutive years.

Reproductive behavior is basically similar in both *Chrysopa oculata* and *C. chi,* although it differs significantly from that described for members of the *Chrysoperla* group. Sexual receptivity in both sexes is first signaled by lowered head and elevated abdomen, accompanied by vigorous antennal movements. The abdomen is then waved slowly back and forth several (up to 12–15) times at 1.5 second intervals and is flexed ventrally at its tip as it approaches the left and right limits of its excursion. The wings on that side of the body toward which the abdomen is swinging are partially raised and lightly fluttered; simultaneously, one can detect the characteristic, unpleasant odor of species in this taxon. The male may then produce a series of volleys of abdominal vibration (Fig. 1A–D), either continuously for a minute or more (*C. oculata* and highly receptive *C. chi*) or more sporadically (less receptive *C. chi*). Females may also jerk their abdomens in a manner quite similar to that of the males; however, female activity of this kind is rare in either species. In the unlikely event of a heterosexual duet, the male and female will reciprocally exchange bouts of abdominal jerking, exchanging volley for volley in *C. chi* but alternating longer trains (series) of volleys in *C. oculata* (Fig. 1E, G). More commonly, however, courtship will be brief and copulation sudden, accompanied by little if any jerking activity: typically the female will approach and antennate the male, after which the two insects will immediately swing their bodies into parallel positions and effect copulation. Individuals of each species averaged 30.60 ± 8.02 (*C. oculata*; $n = 5$) and 14.00 ± 4.76 (*C. chi*; $n = 7$) minutes *in copulo* ($t = 2.62$). In *C. oculata,* three out of six copulations were preceded by at least one series of volleys from the female, while in *C. chi* three of nine included such participation.

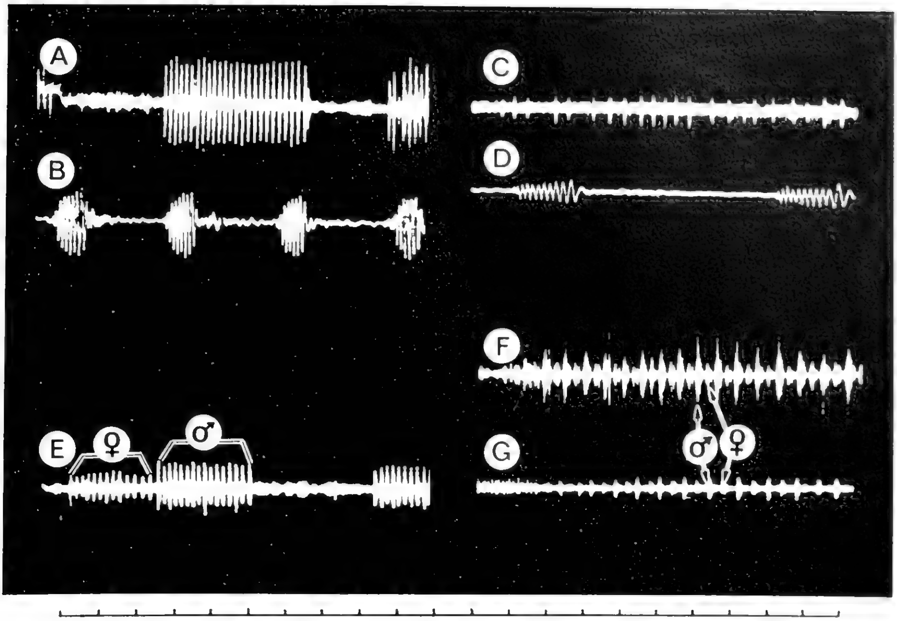

Fig. 1. Oscillographs of abdominal vibration patterns produced by sexually receptive individuals of *Chrysopa oculata* (A, B, E) and *C. chi* (C, D, G). Heterosexual duets are recorded in E and G at an oscilloscope writing speed of 2 seconds/major division; in *C. oculata*, whole trains of volleys of abdominal jerking are exchanged between partners, while in *C. chi* each insect exchanges single volleys with its partner. Note striking convergence between the duet sequence of *C. chi* (G) and that *C.* (*Chrysoperla*) *carnea* (F), recorded at the same writing speed. Traces B and D are 20× details of A and C (writing speed = 0.10 sec/div. vs. 2 sec div.), showing volley structure characteristic of each species.

Calls of both *Chrysopa oculata* and *C. chi* are simpler in structure than those of any *Chrysoperla* species yet studied, consisting of long trains of identical volleys of abdominal vibration lacking pronounced frequency or amplitude modulation (Fig. 1). Differences between the calls of the two species include (a) average volley spacing, (b) frequency of abdominal vibration within volleys, (c) volley duration, and (d, calculated from b and c) number of abdominal jerks per volley (Table 1). In *C. oculata* (Fig. 1A, B), volleys are spaced closely together (interval = 0.266 sec) and are characterized by high rates of abdominal jerking (av. = 109.18 abdominal strokes/sec), short durations (av. = 0.082 sec), and relatively few total strokes (jerks) per volley (av. = 8.95). On the other hand, *C. chi* produces volleys (Fig. 1C, D) that are more distantly spaced (interval = 0.813 sec), lower in vibration frequency (76.11 strokes/sec), longer by a factor of two (0.168 sec), and composed of considerably more abdominal strokes (12.79) than

Table 1. Important measureable characteristics of the calls (volley trains or sequences) of males and females of *Chrysopa oculata* and *C. chi*. Mean values and their standard deviations are tabulated. Sample sizes are entered parenthetically; the larger figure of each pair represents either the number of calls ("volley spacing" part of table) or the number of volleys ("volley parameters" part of table) measured, while the smaller one is the number of individuals producing those calls or volleys. Volley spacing is measured from onset to onset of each jerking volley. Portions of calls consist of eight volleys selected from appropriate regions of continuous volley trains.

		Volley Spacing Within Calls (in Seconds, ± SD)				Volley Parameters (± SD)		
	Temp. (°C)	Early Portion	Middle Portion	Late Portion	Average	Frequency (Strokes/sec)	Duration (Seconds)	# Abd. Strokes
C. oculata								
Male calls (all)	26.34 ± 1.59 (48)	0.244 ± 0.046 (118, 11)	0.259 ± 0.048 (130, 11)	0.289 ± 0.063 (125, 11)	0.269 ± 0.059 (184, 11)	109.18 ± 15.43 (168, 4)	0.082 ± 0.015 (217, 4)	8.95 (168, 4)
Female calls (all)	27.62 ± 1.67 (5)	0.215 ± 0.038 (8, 3)	0.227 ± 0.048 (9, 2)	0.249 ± 0.045 (10, 3)	0.229 ± 0.040 (13, 4)	—	—	—
C. chi								
Male calls (all solos)	25.79 ± 3.04 (34)	0.680 ± 0.195 (25, 5)	0.819 ± 0.207 (28, 5)	0.956 ± 0.304 (27, 5)	0.813 ± 0.225 (155, 7)	73.47 ± 10.21 (45, 4)	0.176 ± 0.021 (49, 4)	12.79 (45, 4)
Female calls (all solos)	28.50 (2)	—	—	—	0.851 ± 0.277 (3, 1)	82.07 ± 4.58 (20, 1)	0.148 ± 0.016 (20, 1)	12.15 (20, 1)
All duets	28.50 (2)	1.260 (1)	1.489 (1)	1.725 (1)	1.38 ± 0.507 (7, 1)	—	—	—

those of *C. oculata*. These differences are all significant to a high degree, even when data are averaged for each individual insect and sample sizes are accordingly reduced from total number of calls to number of different individuals (not tabulated). Both species, but particularly *C. chi*, display slight but detectable frequency modulation of each volley: the rate of abdominal jerking decreases somewhat toward the end of each volley (Fig. 1B, D).

Variation in call parameters exists both among individuals and within a single individual of *C. oculata* and *C. chi*. Inter-individual variation was not usually very pronounced in either species; however, one *C. oculata* displayed consistently and significantly longer intervals between its volleys than any other conspecific individual (other features of its call were less deviant). Temperature was the major determinant of intra-individual variation: decreasing temperatures tended in both species to increase volley spacing but lower the frequency of abdominal vibration, the latter in a highly significant linear manner for *C. oculata* (Fig. 2; slope = 5.87, coefficient of determination = 0.94, n = 6). A third type of variation, existing within a call, was also identified. Here, it was noticed in both species that volley spacing nearly always increased significantly during the course of an extended call. Table 2 documents this observation, for each individual studied, and includes the highly significant results of a chi-square analysis; the trend is also reflected in the average volley spacing of "early" vs. "late" portions of calls listed in Table 1. It should be mentioned that, despite such multifaceted variation, no significant interspecific overlap existed in any call parameter between *C. oculata* and *C. chi* even when calls of the most extreme (and therefore most similar) individuals, under unrealistically different temperature conditions, were compared with each other.

As mentioned earlier, *C. oculata* and *C. chi* differ from one another in their manner of alternating acoustical signals during heterosexual duets (Fig. 1E, G). The longer spacing between volleys in *C. chi* seems consistent with the interdigitated volleys typical of dueting insects of that species, while *C. oculata* individuals produce volleys so rapidly that exchanging volley for volley is probably not feasible. In *C. oculata*, calls produced by an individual during a duet appear to be physically indistinguishable from those produced by that same individual alone. However, individuals of *C. chi* make their already-large solo volley spacing significantly greater when dueting, as if to make it even easier for their partners to synchronize with them: the best-studied male, CHM-41, increased its between-volley interval from 0.873 ± 0.251 sec (n = 16) to 1.376 ± 0.507 sec (n = 7; same temperature) when alternating volleys with the female CHF-41 (t = 3.23). It should be stressed again, though, that acoustical alternation during heterosexual interactions is rarely seen in either species.

Male-male interactions in *C. oculata* and *C. chi* are infrequent and involved the exchange of acoustical signals on only one occasion (in *C. chi*).

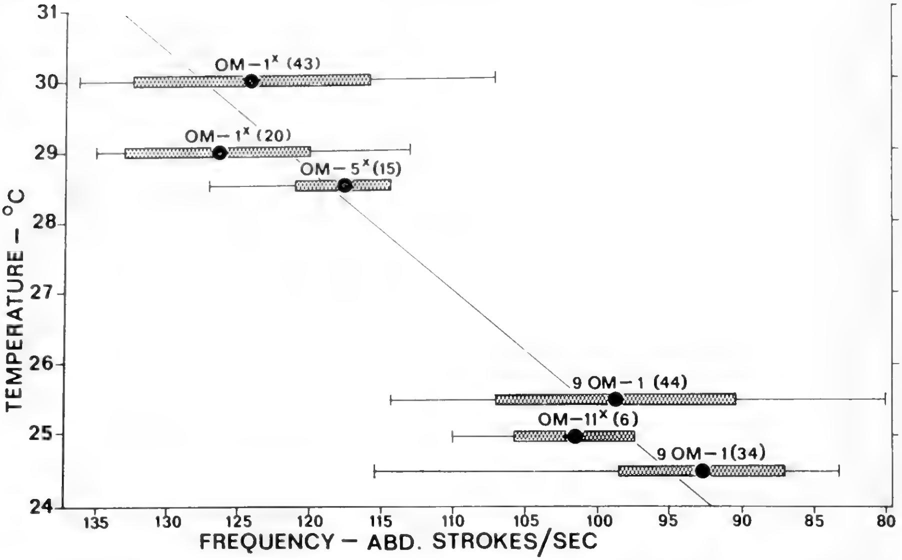

Fig. 2. Graph showing the effect of temperature on abdominal vibration frequency in *Chrysopa oculata*, for four different individuals. Solid dots are means, shaded areas are standard deviations, and lines extend to extremes. In each case, sample size, in parentheses, is the total number of volleys measured. The sloping line corresponds to the linear equation $y = 5.87x - 48.77$, with vibration frequency plotted on the y-axis (turn graph clockwise 90 degrees).

No special patterns could thus be discerned. My impression is that males do not interfere acoustically with the reproductive activities of other males, since on 30 out of 34 occasions peripheral males showed no interest in courting and copulating conspecifics in the cup-sized experimental arenas. However, when crowded together for long periods of time, males undoubtedly interact aggressively, since nearly every individual of both species exhibited antennal injury under those conditions.

Discussion

Collecting data suggest that little interaction will occur between *Chrysopa oculata* and *C. chi* under natural conditions, since each species occupies a different microhabitat. For most of the summer, *C. oculata* seems to be the only lacewing species inhabiting the low vegetation at most meadow sites in the Northeast; only *C.* (*Chrysoperla*) *carnea* Stephens is likely to co-occur with it (Smith, 1922; Bickley and MacLeod, 1956), but in practice I have never collected those two species together. On the other hand, *C. chi*'s ecological preferences overlap with those of several other lacewings, including *C. nigricornis* Burmeister, *C. quadripunctata* Burmeister, *C.* (*Chrysoperla*) *rufilabris* Burmeister, *C.* (?) *lineaticornis*, and even the conifer-associated *C.* (*Chrysoperla*) *harrisii* Fitch and *Meleoma* Fitch (two

Table 2. Number of calls that increased, decreased, or remained constant in volley spacing, tabulated for each individual of *Chrysopa oculata* and *C. chi*. Only calls consisting of 10 or more volleys were considered. Changes in spacing of less than 0.01 second in *C. oculata* and less than 0.04 second in *C. chi* were judged insignificant. For the chi-square tests, the expected value was calculated by halving, for each individual, the sum of calls that were observed to increase or decrease.

	Chrysopa oculata																*Chrysopa chi*						
	Males											Females					Males					Female	
	OM77-3	OM77-Q	OM77-2Q	OM-1^x	OM-5^x	OM-6^x	OM-7^x	OM-9^x	OM-10^x	OM-11^x	9OM-1	OF-5^x	OF-6^x	OF-8^x	9OF-2	Total	CHM-3	CHM-4	CHM-5	CHM-6	CHM-41	CHF-41	Total
Change in volley spacing (# calls)																							
Increased	2	7	7	5	12	19	1	3	6	5	23	0	8	0	1	99	3	14	1	4	4	1	27
Decreased	0	0	2	0	0	2	0	0	1	0	0	0	0	0	0	5	0	0	0	1	0	0	1
No change	0	1	3	0	0	3	0	0	0	1	1	0	0	0	0	9	0	0	0	0	0	0	0
Observed vs. expected to increase: χ^2 test	$\chi^2 = 43.556$, 12 degrees of freedom																$\chi^2 = 12.40$, 5 degrees of freedom						

species) (Balduf, 1939; Bickley and MacLeod, 1956); in fact, all of those species have been found associated with *C. chi* at one time or another at the New York State site alone. Perhaps this abundance of competitors partially explains why populations of *C. chi* always remain smaller and more patchy than those of its closest relative. Of course, factors underlying species composition are completely unknown in this case.

As mentioned, calls are much simpler and less consistently delivered in *C. oculata* and *C. chi* than they are in *Chrysoperla* species. Of the call types so far described, their calls most closely resemble that of *C.* (*Chrysoperla*) *carnea,* which also produces trains of short, identical volleys during courtship and mating (Henry, 1979, 1980c). In fact, volley spacing is virtually the same in *C.* (*C.*) *carnea* and *C. chi,* and both species alternate single volleys rather than whole trains of volleys during heterosexual duets (Henry, 1979), so that dramatic convergence is readily apparent in oscillographs of their calls (Fig. 1F, G). However, closer inspection of volley structure reveals that *C. carnea*'s volleys are significantly longer and characterized by much more pronounced frequency modulation than those of either *C. chi* or *C. oculata* (see Fig. 1B in Henry, 1980c); additionally, neither of the latter two species depends for its mating success upon acoustical interactions between the sexes. At any rate, convergence in calls between two such distantly related species as *C. chi* and *C. carnea* has little biological meaning even if calls are important premating barriers, since differences in the habitats, food preferences, pheromone repertoires, and behavioral responses of the two species preclude such close-range interactions.

In the basic components of their reproductive and calling behavior, *C. oculata* and *C. chi* are not only similar to each other, but also resemble other members of their species-group, including *C. nigricornis* (Toschi, 1965, and personal observation) and *C. quadripunctata* (unpublished data). All species of *Chrysopa s. str.* that have been studied assume a characteristic "head down" position when sexually receptive, wave their abdomens in the manner described earlier, and produce superficially similar, simple volleys of abdominal vibration that differ primarily in repetition rate (temporal patterning). Additionally, copulation is usually swift and preceded by the release of a strong-smelling secretion, presumably from the prothoracic "repugnatorial glands" of one or both sexes (McDonnough, 1909; Sulc, 1914; Withycombe, 1924). As mentioned earlier, *Chrysoperla* species never produce noticeable odors, although the prothoracic glands seem to be as fully developed in them as in members of *Chrysopa s. str.* (E. G. MacLeod, pers. comm., 1967). It is thus tempting to correlate the production of odors during copulation with relatively low acoustical sophistication, speculating that more complex, intense pheromones have replaced acoustical modes of communication as species-isolating mechanisms in *Chrysopa s. str.* Selective pressures favoring radically different calling patterns in closely related sympatric species, as seen in *Chrysoperla*, are thus weakened in *Chrysopa s. str.*, leading incidentally to the relatively weak distinctions described here between the calls of *C. oculata* and *C. chi*. That complex jerking behavior is the primitive, rather than derived, condition in green lacewings is an assumption that needs more support: outgroup comparison can tell us that some Hemerobiidae, the sister-group to Chrysopidae, also jerk their abdomens (Smith, 1922), but those calls have never been studied. Similarly, it is not necessarily valid that lacewing odors can function as reproductive pheromones, since their repugnatorial function has always been taken for granted and has even been confirmed by Blum et al. (1973), who isolated the active ingredient skatole from the prothoracic exudate of *C. oculata* and showed that it repelled fire ants (*Solenopsis richteri* Forel) and some albino mice. Nevertheless, skatole might both repel enemies and attract conspecifics in *C. oculata*, and slightly different substances could function as sexual attractants in other members of *Chrysopa s. str.*; Blum et al. (1973) did not analyze the secretions of any other species. Even if skatole is present in other "stinkflies," it may be mixed with other, rarer active ingredients (Blum et al.'s 5% unidentified "volatiles") in unique, species-specific proportions for sexual attraction, as are other blends of pheromones in certain groups of Lepidoptera (Roelofs and Cardé, 1974; Silberglied, 1977). Certainly the release during lacewing courtship and mating of secretions presumed to be defensive is provocative and suggests the need for further research.

I feel that to reject the hypothesis that calls serve a species-isolating function in *Chrysopa s. str.* is premature, especially in view of the measureable and consistent differences detected between the calls of *C. oculata* and *C. chi*. However, alternative functions for acoustical behavior in these insects must also be considered, since calling differences do seem weak among species of this group. For example, jerking behavior may additionally serve to induce sexual activity in a partner, to facilitate dispersal of some other pheromone from an exocrine gland in the male genitalia (MacLeod, pers. comm. 1967; personal observation), or even to interfere with the mating success of other males in competition for females (see Cade, 1980, for a review of competition among singing crickets). Short-distance attraction of females to calling males may also be important in nature, occurring after aggregation of conspecific individuals to a site by pheromones, local prey abundance (Hagen et al., 1976), or plant odors (Flint et al., 1979). Several of the above alternatives predict intensified sexual selection in males of *Chrysopa s. str.*, especially in view of the polygamous or even polygynous (unpublished data) mating systems characteristic of species of that taxon (see Halliday, 1978, for a general discussion of sexual selection). In fact, as predicted, males of both *C. oculata* and *C. chi* do most of the calling and display considerably more aggression toward other males than do males of any *Chrysoperla* species yet studied. However, as far as I can tell, male-male competition has not generated in males of either species studied here the kinds of aggressive calls and chorusing interactions found in some other polygynous singing insects and amphibians (Alexander, 1975; Wells, 1977).

The physiological basis of jerking behavior in green lacewings is not known. Earlier work (Henry, 1980b, c) demonstrated that conspecific individuals of different size (mass) do not differ significantly from one another in abdominal vibration frequency, suggesting that abdominal motion is controlled by a neural oscillator rather than by the resonant properties of the moving mass. That view is substantiated by the pronounced temperature effects described in this study (Fig. 2), since resonant properties should not change much, if at all, with temperature. In fact, the linear relationship observed in *C. oculata* is consistent with the more complex exponential and logistic curves describing various inorganic and organic chemical reactions and biological processes (Wigglesworth, 1965), since most of those curves approximate linear equations over a narrow range of temperatures. Here, the temperature coefficient Q_{10} for vibration frequency in *C. oculata* is 1.86, meaning that for temperatures from 24.5–30°C, frequency will increase by a factor of 1.86 for each 10°C increment. If frequency differences are at all important to lacewings in the recognition of conspecifics, for whatever fundamental purpose, neural control provides the best means of achieving consistency among individuals of different sex and sizes under a given set of environmental conditions.

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LITERATURE CITED

Alexander, R. D. 1975. Natural selection and specialized chorusing behavior in acoustical insects, pp. 35–77. *In* Pimentel, D., ed., Insects, Science, and Society. Academic Press, N.Y. 284 pp.

Balduf, W. V. 1939. The Bionomics of Entomophagous Insects. Part II. John S. Swift Co., Inc., N.Y. 384 pp.

Bickley, W. E. and E. G. MacLeod. 1956. A synopsis of the Nearctic Chrysopidae with a key to the genera (Neuroptera). Proc. Entomol. Soc. Wash. 58(4): 177–202.

Blum, M. S., J. B. Wallace, and H. M. Fales. 1973. Skatole and Tridecene: identification and possible role in a chrysopid secretion. Insect Biochem. 3: 353–357.

Bram, R. A. and W. E. Bickley. 1963. The green lacewings of the genus *Chrysopa* in Maryland (Neuroptera: Chrysopidae). Bull. Univ. Md. Agric. Exp. Stn. A-124: 1–18.

Cade, W. 1980. Alternative male reproductive strategies. Fla. Entomol. 63(1): 30–45.

Flint, H. M., S. S. Salter, and S. Walters. 1979. Caryophyllene: an attractant for the green lacewing. Environ. Entomol. 8(6): 1123–1125.

Graf, R. G. F. (ed.). 1970. Modern Dictionary of Electronics (3rd ed.). Bobbs-Merrill Co., Minneapolis, Minn. 408 pp.

Hagen, K. S., P. Greany, E. F. Sawall, Jr., and R. L. Tassan. 1976. Tryptophan in artificial honeydews as a source of an attractant for adult *Chrysopa carnea*. Environ. Entomol. 5: 458–468.

Hagen, K. S., R. L. Tassan, and E. F. Sawall, Jr. 1970. Some ecophysiological relationships between certain *Chrysopa*, honeydews, and yeasts. Portici Boll. Lab. Entomol. Agr. Filippo Silvestri 28: 113–134.

Halliday, T. R. 1978. Sexual selection and mate choice, pp. 180–213. *In* Krebs, J. R. and N. B. Davies, eds., Behavioral Ecology. Blackwell Sci. Publs., Oxford.

Henry, C. S. 1979. Acoustical communication during courtship and mating in the green lacewing *Chrysopa carnea* (Neuroptera: Chrysopidae). Ann. Entomol. Soc. Am. 72(1): 68–79.

———. 1980a. Acoustical communication in *Chrysopa rufilabris* (Neuroptera: Chrysopidae), a green lacewing with two distinct calls. Proc. Entomol. Soc. Wash. 82(1): 1–8.

———. 1980b. The courtship call of *Chrysopa downesi* Banks (Neuroptera: Chrysopidae): its evolutionary significance. Psyche (Camb. Mass.) 86(2–3): 291–297.

———. 1980c. The importance of low-frequency, substrate-borne sounds in lacewing communication (Neuroptera: Chrysopidae). Ann. Entomol. Soc. Am. 73(6): 617–621.

McDonnough, J. 1909. Über den Bau des Darms und seiner Anhänge von *Chrysopa perla* L. Arch. Naturgesch. 75: 313–360.

Propp, G. D., M. J. Tauber, and C. A. Tauber. 1969. Diapause in the neuropteran *Chrysopa oculata*. J. Ins. Physiol. 15: 1749–1757.

Roelofs, W. L. and R. T. Cardé. 1974. Sex pheromones in the reproductive isolation of Lepidoptera species, pp. 96–114. *In* Birch, M. C., ed., Pheromones. Am. Elsevier Publ. Co., N.Y.

Séméria, Y. 1977. Discussion de la validité taxonomique du sous-genre *Chrysoperla* Steinmann (Planipennia, Chrysopidae). Nouv. Rev. Entomol. 7(2): 235–238.

Silberglied, R. E. 1977. Communication in the Lepidoptera, pp. 362–402. *In* Sebeok, T. A., ed., How Animals Communicate. Indiana Univ. Press, Bloomington, Ind.

Smith, R. C. 1922. The biology of the Chrysopidae. Cornell Univ. Agric. Exp. Stn. Mem. 58: 1291–1372.

Sulc, K. 1914. Über die Stinkdrüsen und Speicheldrüsen der Chrysopen. Stitzungsberichte Kgl. Bohmischen Gesellschaft der Wissenschaften 11: 1–50.

Tauber, C. A. 1969. Taxonomy and biology of the lacewing genus *Meleoma* (Neuroptera: Chrysopidae). Univ. Calif. Publ. Entomol. 58: 1–62.

Tauber, M. J. and C. A. Tauber. 1974. Dietary influence on reproduction in both sexes of five predacious species (Neuroptera). Can. Entomol. 106: 921–925.

Tjeder, B. 1966. Neuroptera-Planipennia. The lacewings of Southern Africa. 5. Family Chrysopidae. S. Afr. Anim. Life 12: 228–534.

Toschi, C. A. 1965. The taxonomy, life histories, and mating behavior of the green lacewings of Strawberry Canyon. Hilgardia 36: 391–431.

Wells, K. D. 1977. The social behaviour of anuran amphibians. Anim. Behav. 25: 666–693.

Wigglesworth, V. B. 1965. The Principles of Insect Physiology (6th ed.). Methuen and Co., Ltd., London. 741 pp.

Withycombe, C. L. 1924. Further notes on the biology of some British Neuroptera. Entomologist 57: 145–152.

PROC. ENTOMOL. SOC. WASH.
84(1), 1982, pp. 204–207

HEMEROBIUS STIGMA STEPHENS (NEUROPTERA: HEMEROBIIDAE): EXTERNAL MORPHOLOGY OF THE EGG

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Abstract.—Adult brown lacewings, *Hemerobius stigma* Stephens, collected from white pine were maintained under laboratory conditions at 18.3°C ± 1.0°C and 6L:18D. Females laid 133 (72–176) eggs. Each egg was yellow, 730 μm (675–750) long, 335 μm (300–375) wide, and weighed 0.046 mg. The eggs possessed reticulations arranged in a diagonal pattern on a smooth chorion. The micropylar process consisted of a series of waxlike projections arranged in groups on the anterior pole.

Smith (1923) and Withycombe (1922) provided the first life history investigations on *Hemerobius stigma* Stephens (=*H. stigmaterus* Fitch), including a brief description of the egg. Advances in microscopy have provided the opportunity to examine in greater detail the external morphology of the egg. Mazzini (1976) noted that ultrastructural morphology of the egg chorion and micropyle has provided information useful for inferring phylogenetic relationships for insects in several orders.

Identification of hemerobiids is presently based on morphological characteristics of the adults (MacLeod and Stange, 1981). Our objective was to describe the external morphology of the egg of *H. stigma*. Additional investigations on eggs of related species may assist in identifying other hemerobiid species.

MATERIALS AND METHODS

A laboratory colony of *H. stigma* was established 3 March 1981 at The University of Tennessee from adults collected on white pine, *Pinus strobus* L. The colony was maintained at 18.3°C ± 1.0°C on an 8L:16D cycle.

Male-female pairs were placed in 3.5 × 9.5 cm petri dishes and allowed to mate. The bottom of each petri dish was lined with a 9.0 cm disk of Fisher brand coarse filter paper. A 10 dr vial filled with distilled water and plugged with cotton was placed in each petri dish to provide water and

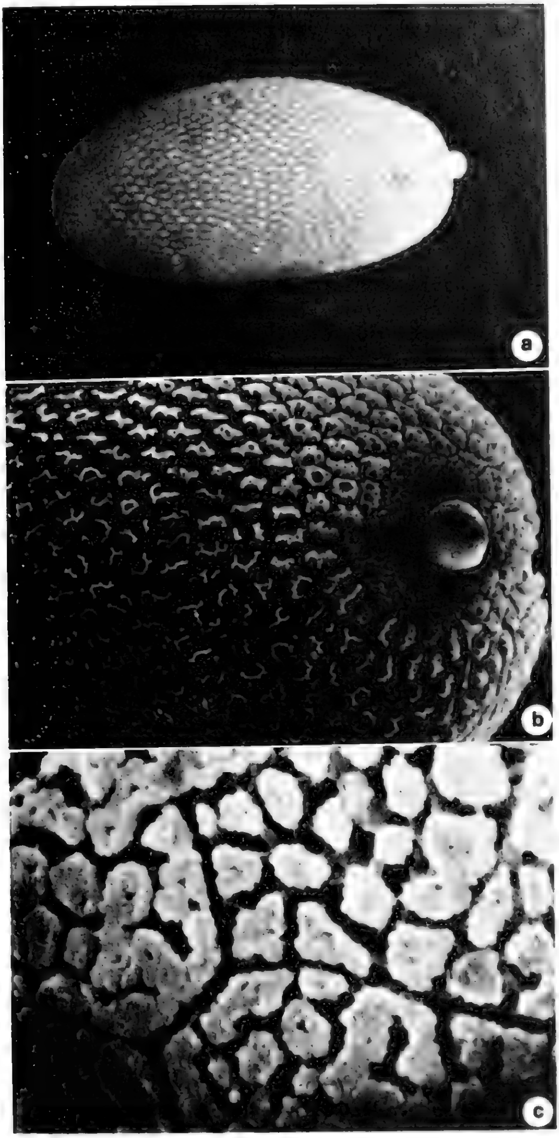

Fig. 1. a, Egg of *Hemerobius stigma* (116×); b, Surface of anterior pole showing waxlike projections and micropylar process (144×); c, Tubercles and fissures on the micropylar surface (1200×).

moisture. A cotton ball, ca. 1.5 cm diam., and pine needles were placed in the petri dish to serve as a substrate for oviposition. Females were maintained until death to determine fecundity and ovipositional habits.

Eggs were collected within 24 h after oviposition and weighed using an Ainsworth SCV electrobalance. Egg size was determined using an ocular micrometer. Egg color was compared with color charts in the Munsell Book of Color (1929), and the color description was recorded (e.g., yellowish red in Munsell might be written as 5 YR 6/8 or a No. 5 yellow red hue, color value No. 6 and a chroma No. 8).

External morphology was examined using an ETEC Autoscan scanning electron microscope. Eggs were placed on aluminum studs and coated with gold-palladium in a Denton Vacuum DV-515 vacuum evaporator. S.E.M. photographs were taken using Polaroid 55 film, and photomicrographs were taken using 35 mm Kodak Panatomic X film.

RESULTS

Field-collected adult females of *H. stigma* maintained in the laboratory laid an average of 133 (72–176) eggs. Eggs were deposited singly or in groups of 2–5 on filter paper, cotton balls, pine needles, and in the scaly sheath at the base of the needles. Withycombe (1922) reported that females occasionally laid up to seven eggs in groups.

Eggs were ellipsoid (Fig. 1a), 730 μm (675–750) long, 335 μm (300–375) wide, and weighed 0.046 mg. Color of eggs 24–72 h after deposition was yellow (5Y 8/6), but changed to yellowish red (10 YR 7/6) after 96 h, followed by more intensified darkening (10 YR 7/8) with embryonic development until eclosion after ca. 120 h. Hinton (1981) concluded that many insect eggs undergo coloration change during incubation due either to a change in color of the chorion or to a color change of the embryo as seen through the eggshell. We observed that the maturing embryo caused color changes in the chorion.

Withycombe (1922) reported the surface of *H. stigma* eggs was smooth, but broken by many small granular pits. Smith (1923) described the chorion as dotted with undulating rows of minute or microscopic elongate white raised, rounded spots. Scanning electron microscopy revealed that the "spots" consisted of irregular shaped waxlike projections somewhat evenly spaced on a smooth chorion (Fig. 1b). These projections form diagonal patterns around the egg. However, the chorion may lack these reticulations where the egg is attached to the substrate. The projections near the anterior pole fuse to encircle the micropylar process. The waxlike projections directly adjacent to the micropyle are connected by narrow bridges similar to those on the chorion of *Chrysopa carnea* Stephens (Mazzini, 1976). The projections on the surface of the chorion probably form a boundary layer to retain air which establishes a humidity gradient that retards water loss (Hinton, 1981).

Described simply as a button-like structure on most hemerobiid eggs (Smith, 1923; Withycombe, 1923), the micropylar process is nipple-shaped and consists of irregularly shaped, tubercle-like projections grouped into sections separated by fissures (Fig. 1c). Narrow bridges proximally located interconnect each tubercle with adjacent tubercles. Each tubercle possesses an aperture usually centrally located. Additional studies may reveal that ultrastructure of hemerobiid eggs is diagnostic at the species level.

ACKNOWLEDGMENT

Grateful appreciation is extended to A. G. Wheeler, Jr., Bureau of Plant Industry, Pennsylvania Department of Agriculture, for his critique of this manuscript before publication.

LITERATURE CITED

Hinton, H. E. 1981. Biology of insect eggs. Pergamon Press Ltd, New York, Vol. 1. 473 pp.

MacLeod, E. G. and L. A. Stange. 1981. The brown lacewings of Florida (Neuroptera: Hemerobiidae). Fla. Dep. Agric. Consum. Serv. Div. Plant Ind. Entomol. Circ. 227: 1–4.

Mazzini, M. 1976. Fine structure of the insect micropyle—III. Ultrastructure of the egg of *Chrysopa carnea* Steph. (Neuroptera: Chrysopidae). Int. J. Insect Morphol. Embryol. 5: 273–278.

Munsell Book of Color. 1929. Munsell Color Co., Inc., Baltimore. 26 color charts.

Smith, R. C. 1923. The life histories and stages of some hemerobiids and allied species (Neuroptera). Ann. Entomol. Soc. Am. 16: 129–151.

Withycombe, C. L. 1922. Life-history of *Hemerobius stigma* Steph. Entomologist 55: 97–99.

———. 1923. Notes on the biology of some British Neuroptera (Plannipennia). Trans. Entomol. Soc. Lond. 1922: 501–594.

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NOTE

The Status of *Nomia foxii* Dalla Torre (Hymenoptera: Halictidae)

T. D. A. Cockerell mixed the various species of *Nomia* (*Curvinomia*) in his published papers (e.g., see Ribble. 1965. Univ. Kans. Sci. Bull. 45: 302–303). *Curvinomia* contains six valid species and one valid subspecies. Even though I (1965: 277–359) revised this subgenus and examined the type-specimens still in existence, confusion over the proper scientific name remains with three of the species (Hurd and Linsley. 1974. Proc. Entomol. Soc. Wash. 76: 198–199; Hurd. 1979. pp. 1941–1942. *In* Krombein, K. V. et al., eds., Catalog of Hymenoptera in America North of Mexico. Smithsonian Institution Press).

The three species in question and their synonyms are as follows:

1. *Nomia* (*Curvinomia*) *tetrazonata* Cockerell, 1910 (=*moctezumae* Crawford, 1911; *californiensis* Michener, 1937).
2. *Nomia* (*Curvinomia*) *universitatis* Cockerell, 1908 (=*punctata* var. (?) Fox, 1893).
3. *Nomia* (*Curvinomia*) *foxii* Dalla Torre, 1896, new name for *punctata* Fox (=*punctata* Fox, 1893 [preoccupied by Smith, 1875]; *mesillensis* Cockerell, 1908).

Even though specimens of *tetrazonata* have been misidentified, as well as other species as it, by Cockerell and others, there is no question that *moctezumae* and *californiensis* are junior synonyms (see key and diagnoses in Ribble, 1965, for identification).

In 1965 (p. 296) I stated, "Cockerell (1906a) selected Denver as the type locality for *foxii*. This is an incorrect designation of the type locality, because the Denver [and South Dakota] specimen probably was an *universitatis*, which is Fox's 'variety.' Cockerell later (1908) correctly selected the 'New Mexico species as the true *foxii*' (!)." In selecting a lectotype, the rules and procedures of zoological nomenclature require the lectotype to be "typical" for the species and match the description (e.g., see Mayr, Linsley, and Usinger. 1953. Methods and Principles of Systematic Zoology. McGraw-Hill, New York, pp. 241–242). I continued, "The specimen from New Mexico most closely agrees with the description of *punctata* [=*foxii* D. T.], while *universitatis* most closely agrees with Fox's (1893. Entomol. News 4: 134–135) var. (?)." The specimen from Denver has been lost, but on circumstantial evidence it fits (contrary to Hurd and Linsley, 1974[1]) *universitatis* or Fox's var. (?) which then would not be typical of *foxii*.

---

[1] Two errors in this paper may cause confusion: Page 198, line 20, "Ribble (1905)" should be "Ribble (1965)"; and line 38, "new Mexico species" should be "New Mexico species."

The restrictions of the type-locality by Cockerell (1906. Trans. Am. Entomol. Soc. 32: 289–314; 1908. Ann. Mag. Nat. Hist. (8) 2: 323–334) were not accompanied by the designation of a lectotype. I (1965: 298) was the first to designate a lectotype for *foxii*: "Cockerell (1908) did not specifically designate the New Mexico specimen as the lectotype, but that was clearly his intent. I therefore here designate the female from Vega San Jose, New Mexico, as the lectotype of *N. foxii*." In view of the fact that the New Mexico specimen was the only remaining syntype of *foxii*, this action seems entirely prudent. An amendment to Article 74. Lectotypes.—(a) Designation of a specimen.—(1974. Bull. Zool. Nomencl. 31: 85) of the *International Code of Zoological Nomenclature* (1964. London) stated "(ii) The first published designation of a lectotype supersedes all previous restrictions of the use of the name of the species. Example.—The type-locality becomes the geographical place of origin of the lectotype, despite any previous restrictions of the type-locality."

Because of my lectotype designation, *mesillensis* is a junior synonym of *foxii*, and the list above, therefore, shows the correct synonymies as I did in 1965.

D. W. Ribble, *197 Poplar Avenue, Campbell, California 95008.*

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84(1), 1982, pp. 209–210

NOTE

Hybridization between *Gerris alacris* Hussey and *Gerris comatus* Drake and Hottes (Hemiptera: Heteroptera: Gerridae) in Nature

Males of two middle-sized northeastern species of *Gerris* Fabricius, *G. comatus* Drake and Hottes and *G. alacris* Hussey, are easily identified. Tufts of golden hairs within the two impressions of the first genital segment ventrally are unique among males of *G. comatus* and a prominent mesosternal scent gland (omphalium) characterizes *G. alacris* males (Calabrese. 1974. Mem. Conn. Entomol. Soc., pp. 227–266; Drake and Harris. 1934. Ann. Carnegie Mus. 23: 179–240). While collecting specimens from adjacent populations of *G. alacris* and *G. comatus* at a lagoon at Presque Isle State Park, Pennsylvania in June 1980, I took a certain hybrid between the species. The venter of the specimen, a male, is shown (Fig. 1). Both the long hairs on the first genital segment ventrally and the prominent omphalium are present.

Fig. 1. Male hybrid of *Gerris comatus* × *G. alacris*, venter of abdomen.

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NOTE

New Records of Mites (Acari: Digamasellidae; Erythraeidae) Phoretic on Biting Midges (Diptera: Ceratopogonidae)

Records of larval mites associated with adult biting midges are fairly well known (Whitsel and Schoeppner. 1967. Proc. Entomol. Soc. Wash. 69: 284–286; Grogan and Navai. 1975. Proc. Entomol. Soc. Wash. 77: 214–215). At least two associations have yielded new species of Trombidiform mites (Vercammen-Grandjean. 1957. Ann. Mag. Nat. Hist. 10: 283–286; Vercammen-Grandjean and Cochrane. 1974. J. Kans. Entomol.Soc. 47: 66–79). Recent evidence by Grogan and Navai (1975) and Grogan (1977. Proc. Entomol. Soc. Wash. 79: 24) indicated that adult mites in the families Phytoseiidae and Macrochelidae (Parasitiformes: Gamasida) may be phoretic on adult biting midges. Two new records of phoresy are presented in this paper.

An adult female *Bezzia bivittata* (Coquillett) taken by W. J. Hanson in west Hodges Canyon, Cache County, Utah by Malaise trap 25–28 July 1978 had a mite attached to its abdomen. The mite was removed and mounted in phenol-balsam and was identified as an adult *Leptus* sp. (Erythraeidae). This is the first record of this mite family on ceratopogonids and the first record of adult mites of the order Acariformes, suborder Actinedida on these midges. Krantz (1978, A Manual of Acarology, 509 pp.) indicates that larval erythraeid mites are parasitic on a variety of insects and other arthropods. Krantz (1978) also states that adult and nymphal erythraeids are predaceous on small insects or other mites. In this particular instance it is most parsimonious to assume that this association represents a case of phoresy due to the fact that the mite was much smaller than the fly.

An adult male *Dasyhelea oppressa* Thomsen taken by Malaise trap 15–21 May 1979 by W. L. Grogan, Jr., in Salisbury, Wicomico County, Maryland had a mite attached to its abdomen that was removed and mounted in phenol-balsam. This mite was identified as an adult *Digamasellus* sp. (Digamasellidae) of the order Parasitiformes, suborder Gamasida. This is the first record of this mite family associated with ceratopogonids. According to Krantz (1978) phoresy is common for digamasellid mites on geotrupine dung beetles.

The above two mites are deposited in the acarology collection of the National Museum of Natural History. Special thanks are extended to Robert L. Smiley, Systematic Entomology Laboratory, USDA, Beltsville, Maryland, for identification of the mites and for suggestions on the manuscript.

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RHOPALUS (BRACHYCARENUS) TIGRINUS, RECENTLY ESTABLISHED IN NORTH AMERICA, WITH A KEY TO THE GENERA AND SPECIES OF RHOPALIDAE IN EASTERN NORTH AMERICA (HEMIPTERA: HETEROPTERA)

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Abstract.—Rhopalus (*Brachycarenus*) *tigrinus* (Schilling) was collected in New Jersey in 1977, the first record of this European species for North America; it also has been found in Pennsylvania and on Long Island, New York. This rhopalid is briefly described and its dorsal habitus, diagnostic external features, and male genitalic characters are illustrated. Known host plants of the family Cruciferae are recorded, and North American locality records are listed and mapped. A key to the genera and species of Rhopalidae in eastern North America is presented, including for the first time *R. tigrinus*.

A European scentless plant bug, *Rhopalus* (*Brachycarenus*) *tigrinus* (Schilling), was recently reported new to North America (Hoebeke, 1977). This detection resulted from the USDA-APHIS "High Hazard Pest Survey" program and was based on specimens submitted (to ERH) for identification. The first North American collection of this species consisted of specimens taken in southern New Jersey in 1977. We initiated a survey of portions of south-central and southern New Jersey to determine the distribution and relative abundance of this newly detected species, and to gather information on its biology, seasonal history, and host plant preferences.

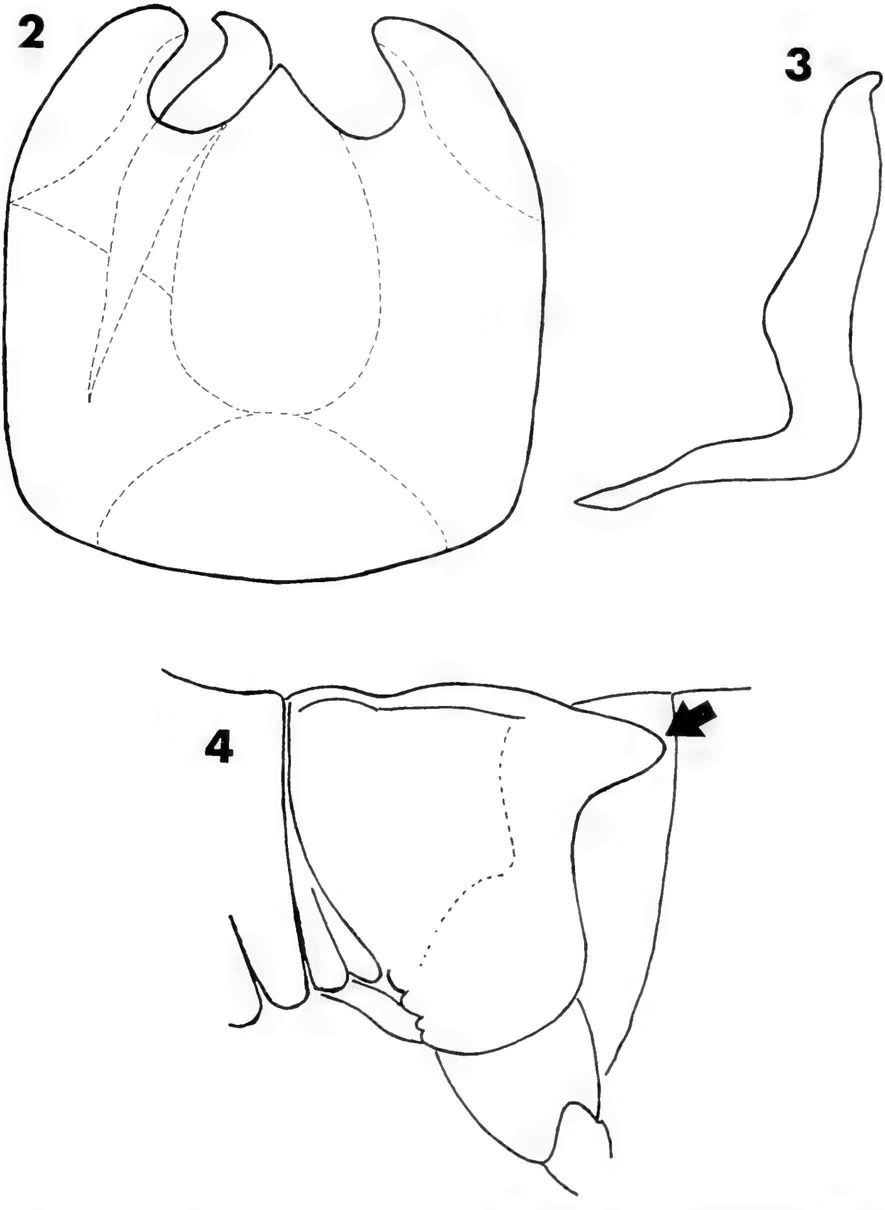
In this paper we describe and illustrate the important adult characters of *R. tigrinus*, record its known host plants, list and map locality records in North America, and provide a key to the genera and species of Rhopalidae in eastern North America, including *Rhopalus tigrinus*.

The adults of *Rhopalus tigrinus* (Fig. 1) closely resemble those of some native species of rhopalids occurring in eastern North America (especially species of *Arhyssus*, *Niesthrea*, and *Liorhyssus*), but may readily be distin-

Fig. 1. *Rhopalus (Brachycarenus) tigrinus,* dorsal habitus.

guished by the following diagnosis: Head more than 1½× as broad as long; bucculae covering ⅔ the length of 1st rostral segment in profile; rostrum not usually extending beyond mesosternum; metapleuron with posterior margin strongly angulate with prominent postero-lateral projection (Fig. 4); male pygophore and paramere as in Figs. 2, 3; dorsal coloration yellowish or grayish with black markings on the head, anterior margin of the pronotum, anterior corners of the scutellum, and spots on the veins of the hemelytra; abdomen beneath hemelytra black except for yellow markings at apex; connexiva generally yellow, sometimes with black spots; 6.5–7.0 mm in length.

Rhophalus tigrinus is considered a relatively common species in the Pale-

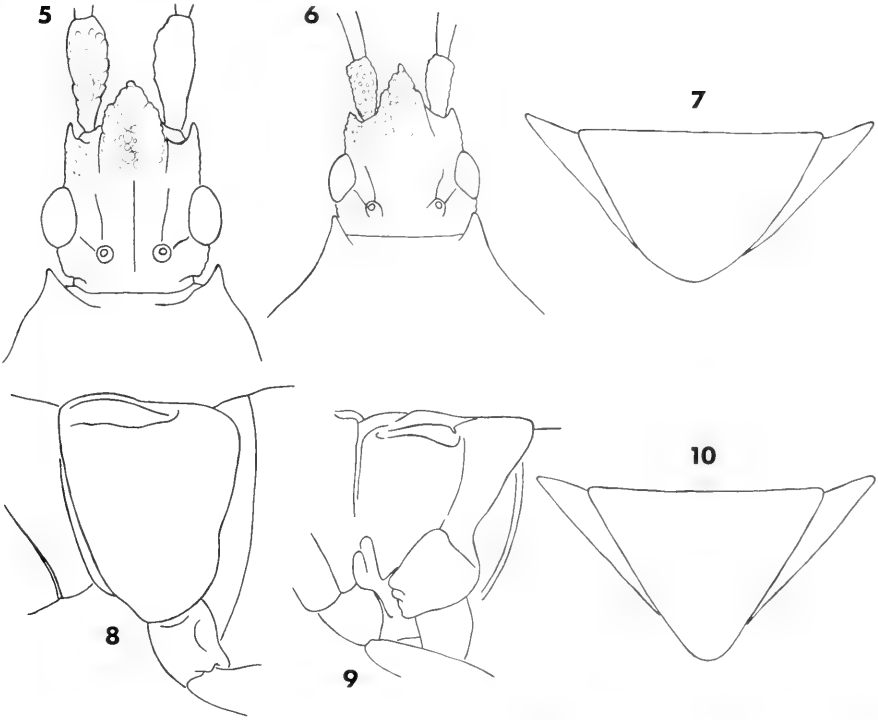


Figs. 2–4. *Rhopalus* (*Brachycarenus*) *tigrinus*. 2, Male pygophore. 3, Paramere. 4, Metapleural region and base of hindleg, showing extreme prolongation of the dorsal half of metapleuron (arrow). (Figs. 2 and 3 redrawn from Göllner-Scheiding, 1978b.)

arctic Region, found throughout much of Europe (except the British Isles) and the Mediterranean Region including Algeria and Morocco, Madeira and Canary Islands, and Asia Minor. In its native habitat little or nothing is known about its biology and habits. The egg and third-instar nymph of *R. tigrinus* have been figured and included in a key to these life stages by Puchkov and Puchkova (1956) and Puchkova (1957). According to Lindberg (1953), the species is found chiefly on low plants and weeds in waste places adjoining cultivated areas. In European USSR, *tigrinus* is noted by Kerzhner (1967) to be a general feeder with an apparent preference for members of the mustard family, the Cruciferae. Stichel (1960) has reported *tigrinus* feeding on weedy crucifers such as hoary alyssum, *Berteroa incana* (L.) DC; flixweed, *Descurainia sophia* (L.) Webb (cited as *Sisymbrium sophia*); and *Alyssum incanum* L. Stichel also noted *tigrinus* on *Trifolium* (Leguminosae) and *Cirsium arvense* (L.) Scop. (Compositae). In a study of Hemiptera associated with crucifers in Poland, Studzinski and Malachowska (1973) collected adults of *R. tigrinus* on various species of Cruciferae.

Rhopalus tigrinus at present is known in eastern North America only from a few localities (see Fig. 25). The original collection consisted of two adult males taken from wheat on a farm at North Vineland, New Jersey (Cumberland Co.), 16 August 1977, by R. Morris. In 1978, eight specimens were collected from weeds, 5 September, and three specimens from a pasture, 1 September, on farms also at North Vineland. Ten specimens were taken from grasses in a railroad yard at Camden, New Jersey (Camden Co.), Jefferson Avenue at 4th Street, 4 August 1978, by B. C. Emens. We have taken specimens at the same North Vineland and Camden locations in 1979 and 1980. AGW has found populations of adults and nymphs feeding and developing on crucifers in two railroad yards in Pennsylvania, one at west Philadelphia (along Pennsylvania Railroad near 30th Street Station) in 1980 and the other near Harrisburg (Enola Railroad Yards) in 1980 and 1981. We have found a population along a railroad track south of Yaphank, Long Island, on 30 May 1981. Furthermore, AGW and T. J. Henry (Systematic Entomology Laboratory, USDA) collected additional specimens by sweeping vegetation near Medford, Long Island (Suffolk Co.), on 29 August 1981. The fact that specimens of *tigrinus* have been taken on plants in three railroad yards in New Jersey and Pennsylvania and along the railroad on Long Island strongly indicates that this species may be dispersed passively via the railroad. Further study and field observations will be needed to support this speculation. Many other examples of this type of passive dispersal may be cited (e.g., *Catorhintha mendica* Stål (Balduf, 1957); *Coccinella undecimpunctata* L. (Wheeler and Hoebeke, 1981); *Subcoccinella vigintiquatuorpunctata* L. (Wheeler and Henry, 1981)).

Our field and laboratory observations supplement the list of host plants recorded in the literature and support the supposition that *R. tigrinus* exhibits a preference for species of Cruciferae. We have observed or have



Figs. 5–10. Structural characters. 5, Dorsal view of head, *Harmostes reflexulus*. 6, Dorsal view of head, *H. fraterculus*. 7, Dorsal view of apex of female abdomen, *Arhyssus lateralis*. 8, Metapleural region, *Stictopleurus punctiventris*. 9, Metapleural region, *Arhyssus nigristernum*. 10, Dorsal view of apex of female abdomen, *A. nigristernum*. (Figs. 5, 6, 8, and 9 redrawn from Hoffman, 1975.)

taken eggs, nymphal stages, or adults from the following cruciferous species: *Capsella bursa-pastoris* (L.), shepherd's purse; *Lepidium virginicum* L., peppergrass; *Thlaspi perfoliatum* L., a pennycress; and *Arabidopsis thaliana* (L.), mouse-ear cress. We will provide a summary of the biology and seasonal history, and descriptions and illustrations of the egg and nymphal instars in a forthcoming paper.

The following key is provided to aid in the recognition and identification of all genera of Rhopalidae now known to occur in North America (modified principally after Chopra, 1967; Harris, 1943; and Slater and Baranowski, 1978), and all species that occur in eastern North America[1] (adapted from

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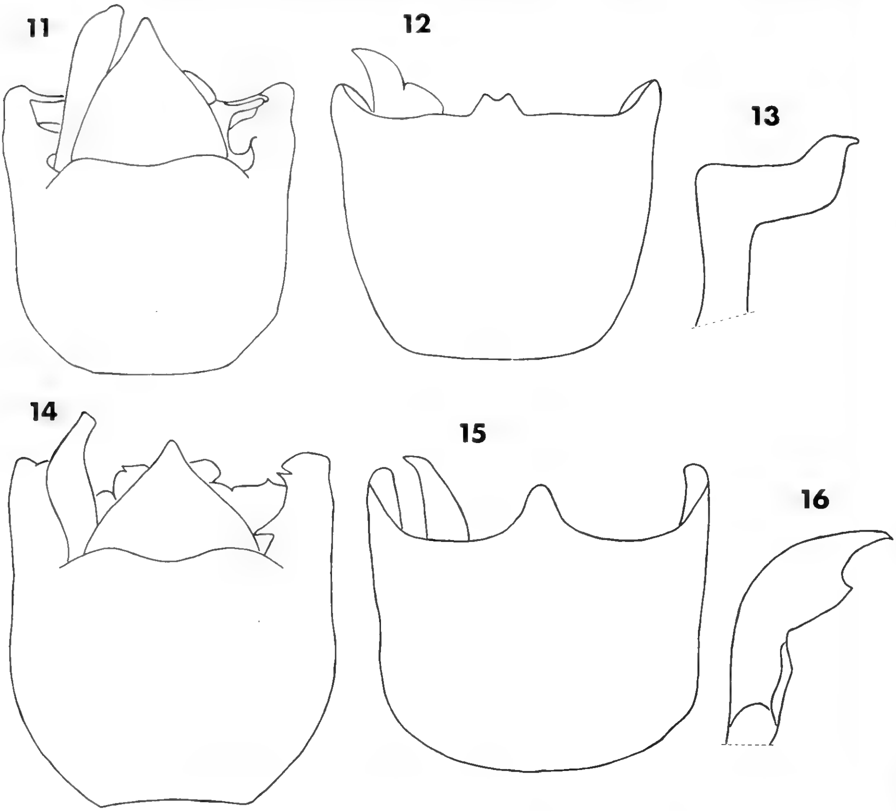
[1] Eastern North America is defined here as in Blatchley (1926): "the United States east of the Mississippi River and Canada east of the 90th Meridian."

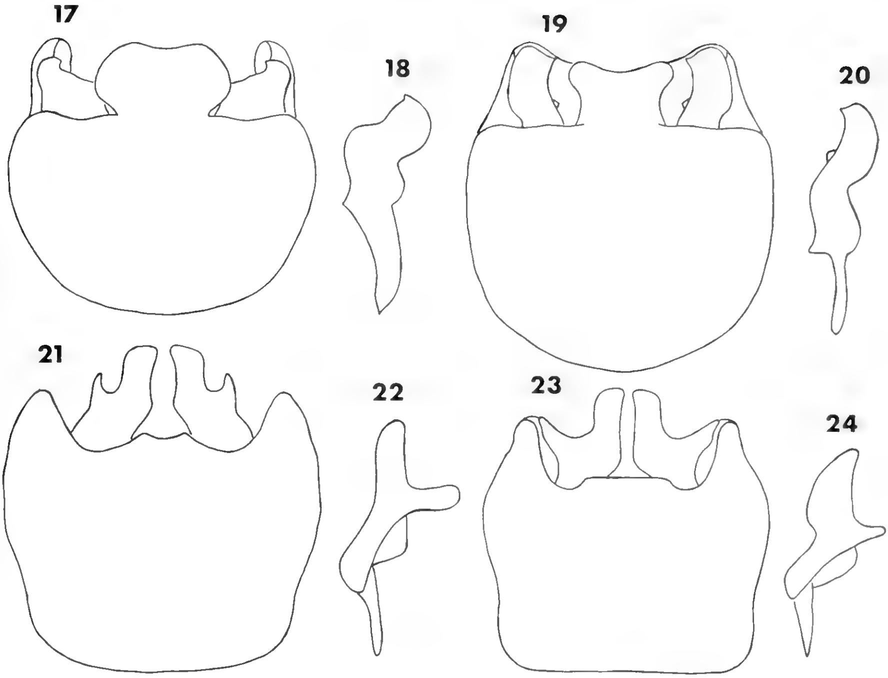


Figs. 11–16. Male genitalia. 11, Pygophore, *Jadera haematoloma*. 12, Pygophore, *Stictopleurus punctiventris*. 13, Paramere, *S. punctiventris*. 14, Pygophore, *Jadera antica*. 15, Pygophore, *Stictopleurus knighti*. 16, Paramere, *S. knighti*. (Figs. 11 and 14 redrawn from Göllner-Scheiding, 1979; Figs. 12, 13, 15, and 16 redrawn from Göllner-Scheiding, 1975.)

Hoffman, 1975; Harris, 1944; Chopra, 1968, 1973; Blatchley, 1926; and Göllner-Scheiding, 1975, 1976, 1978a, 1978b, 1979, 1980).

KEY TO GENERA AND SPECIES OF RHOPALIDAE IN EASTERN NORTH AMERICA

1. Lateral pronotal margins distinctly notched behind anterior margin; generally conspicuously colored; 11 mm or more in length 2
– Lateral pronotal margins straight or slightly sinuate, without a distinct notch behind anterior margin; generally inconspicuously colored; usually a little more than 9 mm 4
2. Bucculae long, reaching base of head; *Jadera* Stål (2 eastern spp.) 3



Figs. 17–24. Male genitalia. 17, Pygophore, *Niesthrea sidae*. 18, Paramere, *N. sidae*. 19, Pygophore, *N. louisianica*. 20, Paramere, *N. louisianica*. 21, Pygophore, *Arhyssus lateralis*. 22, Paramere, *A. lateralis*. 23, Pygophore, *A. nigristernum*. 24, Paramere, *A. nigristernum*. (Figs. 17–20 redrawn from Chopra, 1973; Figs. 21–24 redrawn from Chopra, 1968.)

– Bucculae short, not extending beyond middle of head; *Boisea* Kirkaldy[2] (1 sp.) .... *Boisea trivittata* (Say)
Widespread throughout North America.

3. Species predominantly brownish black; male pygophore and paramere as in Fig. 11; large species, 9.6–13.3 mm in length .... *Jadera haematoloma* (Herrich-Schaeffer)
In the U.S. known from the southeastern states west to Louisiana, Texas, and California, also from the central states including Iowa, Illinois, Kansas, Colorado, Oklahoma, and Missouri; also in Mexico, Middle America, and the West Indies to Colombia and Venezuela, and in Hawaii.

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[2] Historically, the species *trivittata*, best known as the boxelder bug, has been placed in the genus *Leptocoris*. *Boisea* Kirkaldy, originally proposed as a subgenus of *Leptocoris* and including *trivittata*, is accorded generic rank in a recent revision by Göllner-Scheiding (1980) and is so recognized here.

– Species predominantly brownish red or only reddish; male pygophore and paramere as in Fig. 14; smaller species, 7.4–10.3 mm in length .... *Jadera antica* (Walker)
Florida and the West Indies and south to Central America.

4. Hindfemur incrassate, bearing a series of prominent spines 5

– Hindfemur not incrassate, lacking prominent spines 8

5. Abdomen not dilated; hemelytra covering abdominal connexiva; *Harmostes* Burmeister (3 spp.) 6

– Abdomen dilated laterally; hemelytra not covering abdominal connexiva; connexiva widely exposed; *Aufeius* Stål (1 sp.) .... *Aufeius impressicollis* Stål
Ohio west to South Dakota, Colorado, and California and southwest to Arizona and Mexico.

6. Lateral pronotal margins irregularly, but distinctly, finely toothed .... *Harmostes serratus* (Fabricius)
Texas, Florida, Arizona, California, Mexico, and Cuba.

– Lateral pronotal margins entire 7

7. Basal antennal segment large, thickened, and extending far beyond apex of tylus (Fig. 5); costal margin of hemelytra usually unicolorous .... *Harmostes reflexulus* (Say)
Generally distributed throughout U.S. and southern Canada.

– Basal antennal segment relatively small, scarcely exceeding apex of tylus (Fig. 6); costal margin of hemelytra spotted with fuscous .... *Harmostes fraterculus* (Say)
New Jersey west to southern Indiana, Oklahoma, and California south to Georgia and Arizona.

8. Metapleuron not, or only indistinctly divided into episternum and epimeron; metathoracic scent gland openings indistinct or absent; pronotal cicatrices generally ending in a closed loop; *Stictopleurus* Stål (2 spp.) 9

– Metapleuron distinctly divided into episternum and epimeron; metathoracic scent gland openings conspicuous; pronotal cicatrices not ending in a closed loop 10

9. Male pygophore as in Fig. 12; paramere with a pronounced globose enlargement basally, strongly tapering distally, recurved so that posterior face is concave (Fig. 13); female usually grayish yellow with dark markings .... *Stictopleurus punctiventris* (Dallas)
Holarctic, across Canada and northern U.S. and southward along mountains.

– Male pygophore as in Fig. 15; paramere without subbasal enlargement, flat and tapering (Fig. 16) female distinctly reddish .... *Stictopleurus knighti* Harris
Michigan and Minnesota west to Wyoming.

10. Pronotum with a distinct, but narrow collar anteriorly; pronotum

25

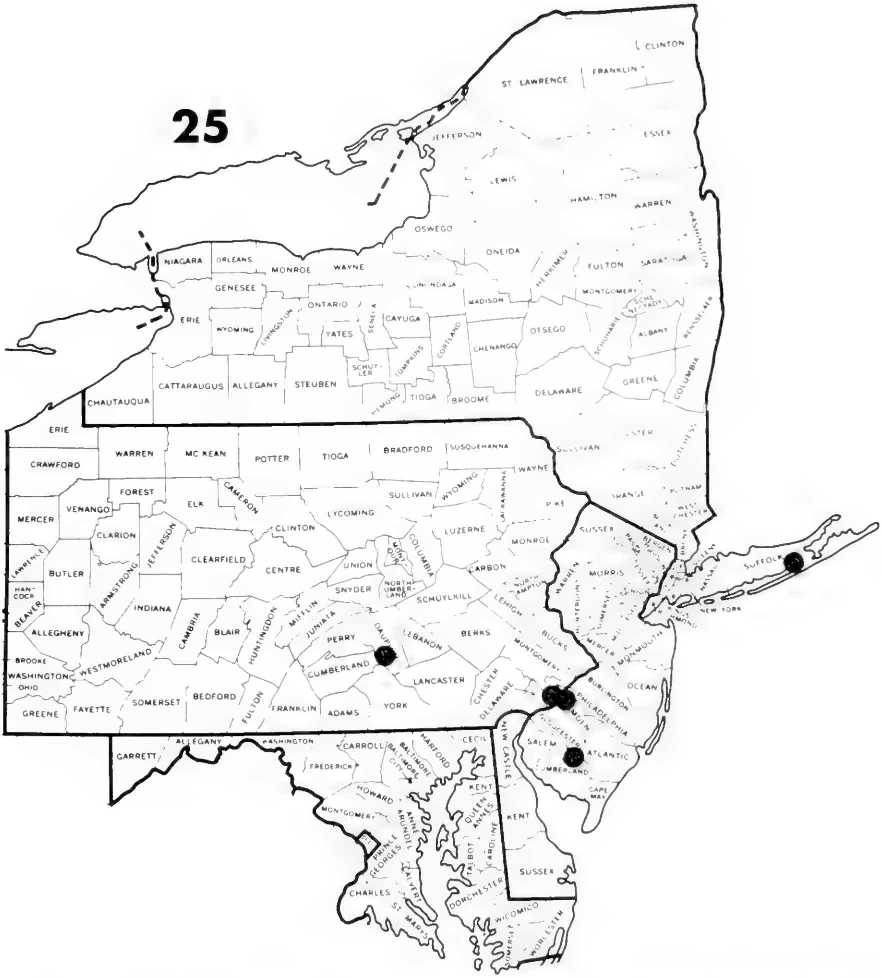

Fig. 25. Distribution of *Rhopalus* (*Brachycarenus*) *tigrinus* in eastern North America. Map shows N.Y., Pa., N.J., Md., and Del.

between collar and cicatrices forming a distinct ridge which is polished and impunctate, or at most with a few punctures; *Liorhyssus* Stål (1 sp.) .... *Liorhyssus hyalinus* (Fabricius)
Cosmopolitan; widespread throughout North America.

– Pronotum without collar anteriorly; pronotum anterior to cicatrices not smooth or polished, always with numerous coarse punctures .. 11

11. Head quite short, more than 1½× as broad as long; rostrum short, not or barely extending to metasternum; postero-lateral margin of

metapleuron strongly angulate, with a prominent and pointed projection laterally (Fig. 4); male pygophore and paramere as in Figs. 2, 3; *Rhopalus* (*Brachycarenus*) Schilling (1 sp.) .... *Rhopalus tigrinus* (Schilling)
A Palearctic species, reported new to North America; known only from New Jersey, Pennsylvania, and New York (Long Island).

– Head longer, less than 1½× as broad as long; rostrum extending beyond metasternum; postero-lateral margin of metapleuron usually straight or slightly sinuate (Figs. 8, 9) 12

12\. Hindtibia possessing a number of black rings; rostrum extending to or beyond 3rd abdominal sternum; *Niesthrea* Spinola (2 spp.) .. 13

– Hindtibia often speckled or spotted with black or fuscous, but lacking a series of black rings; rostrum not extending posteriorly beyond 3rd abdominal sternum; *Arhyssus* Stål (3 spp.) 14

13\. Small species, usually less than 6.5 mm; male pygophore with median lobe constricted at base, broad proximally and slightly concave distally (Fig. 17); paramere slender with subapical projection, broad and somewhat flattened distally (Fig. 18) .... *Niesthrea sidae* (Fabricius)
Maryland south to Florida and west to Oklahoma, Texas, and Arizona; also in South America.

– Larger species, usually much greater than 6.5 mm; male pygophore with median lobe slightly constricted medially and concave distally (Fig. 19); paramere slender, with subapical and dorsal projection (Fig. 20) .... *Niesthrea louisianica* Sailer
Long Island, New York south to Florida, west to Arizona and California, and in Mexico; more common in southern states.

14\. Scutellum reaching to or beyond clavus; antenniferous tubercles inconspicuous or obsolete .... *Arhyssus hirtus* (Bueno)
An eastern species, known only from New York (Long Island) and Massachusetts.

– Scutellum not reaching clavus; antenniferous tubercles readily visible 15

15\. Apex of last abdominal tergum of female broadly rounded in dorsal outline (Fig. 7); male pygophore with median lobe slightly concave (Fig. 21); paramere broad in middle, lateral projection with tip broadly rounded (Fig. 22) .... *Arhyssus lateralis* (Say)
Widely distributed in North America and ranging into southern Mexico.

– Apex of last abdominal tergum of female subacuminate or pointed in dorsal outline (Fig. 10); male pygophore with median lobe almost truncate (Fig. 23); paramere flat, broad, lateral projection with tip narrowly rounded (Fig. 24) ..... *Arhyssus nigristernum* (Signoret)

Widely distributed in eastern North America, ranging from Quebec and Ontario south to central Florida and west to Oklahoma and Kansas.

Acknowledgments

We thank John E. Rawlins, Cornell University, Ithaca, N.Y., for reading and commenting on the manuscript.

Literature Cited

Balduf, W. V. 1957. The spread of *Catorhintha mendica* Stal. Proc. Entomol. Soc. Wash. 59: 176–185.

Blatchley, W. S. 1926. Heteroptera or true bugs of eastern North America, with especial reference to the faunas of Indiana and Florida. Nature Publishing Co., Indianapolis, 1116 pp., 215 figs., XII pls.

Chopra, N. P. 1967. The higher classification of the family Rhopalidae (Hemiptera). Trans. R. Entomol. Soc. Lond. 119: 363–399, 75 figs.

———. 1968. A revision of the genus *Arhyssus* Stål (Rhopalidae: Hemiptera). Ann. Entomol. Soc. Am. 61: 629–655, 146 figs.

———. 1973. A revision of the genus *Niesthrea* Spinola (Rhopalidae, Hemiptera). J. Nat. Hist. 7: 441–459, 16 figs.

Göllner-Scheiding, U. 1975. Revision der Gattung *Stictopleurus* Stal. Dtsch. Entomol. Z. 22: 1–60.

———. 1976. Revision der Gattung *Liorhyssus* Stal, 1870 (Heteroptera, Rhopalidae). Dtsch. Entomol. Z. 23: 181–206.

———. 1978a. Revision der Gattung *Harmostes* Burm., 1835 (Heteroptera: Rhopalidae) und einige bemerkungen zu den Rhopalinae. Mitt. Zool. Mus. Berl. 54: 257–311.

———. 1978b. Bemerkungen zu der Gattung *Rhopalus* Schilling einschliesslich *Brachycarenus* Fieber (Heteroptera, Rhopalidae). Mitt. Zool. Mus. Berl. 54: 313–330.

———. 1979. Die Gattung *Jadera* Stål, 1862 (Heteroptera, Rhopalidae). Dtsch. Entomol. Z. 26: 47–75.

———. 1980. Revision der afrikanischen Arten sowie Bemerkungen zu weitern Arten der Gattung *Leptocoris* Hahn, 1833, und *Boisea* Kirkaldy, 1910. Dtsch. Entomol. Z. 27: 103–148.

Harris, H. M. 1943. Concerning the Rhopalidae (Hemiptera). Iowa State Coll. J. Sci. 17: 197–204.

———. 1944. Concerning American Rhopalini (Hemiptera, Rhopalidae). Iowa State Coll. J. Sci. 19: 99–109.

Hoebeke, E. R. 1977. (Note). *In* Cooperative Plant Pest Report 2(40): 802.

Hoffman, R. L. 1975. Squash, broad-headed and scentless plant bugs of Virginia (Hemiptera: Coreoidea: Coreidae, Alydidae, Rhopalidae). *In* "The Insects of Virginia," No. 9, Va. Polytech. Inst. State Univ. Res. Div. Bull. 105, 52 pp., 20 figs.

Kerzhner, I. M. 1967. Order Hemiptera (Heteroptera), pp. 851–1118. *In* Bei-Beinko, G. Ya., ed., Keys to the insects of the European USSR, Vol. 1. (Translated from Russian. Israel Program for Scientific Translations, Jerusalem.)

Lindberg, H. 1953. Fam. Coreidae (subfam. Corizinae), pp. 52–54. *In* Hemiptera Insularum Canariensium. Societas Scientiarum Fennica, Commentationes Biologicae XIV.1. Central tryckeriet, Helsingfors.

Puchkov, V. G. and L. V. Puchkova. 1956. A key to the eggs and larvae of Hemiptera-Heteroptera injurious to crops. Tr. Vses. Entomol. Obva. 45: 218–342. (In Russian.)

Puchkova, L. V. 1957. Eggs of Hemiptera-Heteroptera. III. Coreidae (Supplement), IV. Macrocephalidae. Entomol. Obozr. 36: 44–58. (In Russian.)

Slater, J. A. and R. M. Baranowski. 1978. Family Rhopalidae, the scentless plant bugs, pp. 66–70. *In* How to know the true bugs (Hemiptera-Heteroptera). Wm. C. Brown Company Publishers, Dubuque, Iowa.

Stichel, W. 1960. Pentatomomorpha, Coreiodea: Corizidae, vol. 4, 14 Heft, pp. 417–448. *In* Illustrierte Bestimmungstabellen der Wanzen. II. (Europa Hemiptera-Heteroptera Europae). Martin-Luther, Berlin–Hermsdorf.

Studzinski, A. and D. Malachowska. 1973. Tluskwiaki Roznoskrzydle (Heteroptera) wystepujace na dziko Rosnacych roslinach Krzyzowych (Cruciferae) w Polsce w 1970 R. [Hemipterous bugs (Heteroptera) occurring in 1970 on wild cruciferous plants (Cruciferae) in Poland]. Rocz. Nauk. Roln. Ser. E Ochr. Rosl. 3: 79–100. (In Polish with English summary.)

Wheeler, A. G., Jr. and T. J. Henry. 1981. Seasonal history and habits of the European alfalfa beetle, *Subcoccinella vigintiquatuorpunctata* L. (Coleoptera: Coccinellidae). Coleopt. Bull. 35(2): 197–203.

Wheeler, A. G., Jr. and E. R. Hoebeke. 1981. A revised distribution of *Coccinella undecimpunctata* L. in eastern and western North America (Coleoptera: Coccinellidae). Coleopt. Bull. 35(2): 213–216.

PROC. ENTOMOL. SOC. WASH.
84(2), 1982, pp. 225–231

FURTHER OBSERVATIONS ON THE ETHOLOGY OF *ALYSSON CONICUS* PROVANCHER (HYMENOPTERA: SPHECIDAE)

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Abstract.—Females of *Alysson conicus* Provancher were observed nesting in large aggregations in a sandy road and path in the Adirondacks. They were active at ambient temperatures of from 15° to 22°C. Females stored adult Cicadellidae (94% *Empoa albicans* Walsh) in their nests. From 5 to 12 leafhoppers were placed in the fully provisioned, spherical cells, 1.4 to 6.0 cm beneath the surface. Prey were transported to the nests in flight and held by the beak and body with the wasp's mandibles and legs, respectively. Entrances were left open while provisioning. Prey (61%) were parasitized by dryinid wasps in 1980 prior to capture by *A. conicus*.

Little is known about the bionomics of the genus *Alysson* in North America. Of the nine species in the Nearctic Region, only *A. melleus* Say has been studied to any extent (Hartman, 1905; Rau and Rau, 1918; Evans, 1966; Kurczewski and Kurczewski, 1971).

Alysson conicus Provancher is one of the less commonly collected species. It ranges throughout the northeastern U.S. from southeastern Canada into Virginia (Krombein, 1979). The only known information on its nesting behavior has been published by O'Brien and Kurczewski (1979). The present report adds considerably more data and complements the behavioral information presented in 1979.

ECOLOGY

We observed *A. conicus* during August 6–10, 1979 and July 20–25, 1980 at the Cranberry Lake Biological Station of the College of Environmental Science and Forestry, in St. Lawrence Co., N.Y. The wasps occupied a 52 m segment of a sandy road which parallels Sucker Brook (Fig. 1), and a compacted, sandy-clayey path 2 m from the lake shoreline on the opposite side of the Station. Dominant vegetation along these areas comprised sec-

Fig. 1. Nesting habitat of *Alysson conicus* at Cranberry Lake, N.Y., showing 80 marked nests within a 6.0 × 0.9 m area. Individual nests are denoted by white plastic stakes.

ond-growth stands of northern hardwoods, especially red maple (*Acer rubrum*), sugar maple (*Acer saccharum*), American beech (*Fagus grandifolia*), yellow birch (*Betula allegheniensis*), poplar (*Populus tremuloides*), and black cherry (*Prunus serotina*). Herbaceous plants, bracken fern (*Pteris latiuscula*), and grasses grew at the edges of the road and path. The road was shaded during much of the day, and the sand in which the wasps nested was uniformly moist. The daily ambient temperatures at the nesting sites ranged from 15° to 22°C during periods of observation. Temperatures in 1979 were unusually cool at night, plunging once to 7°C. Several cool windy days interspersed with rain in 1979 and periods of heavy rain in 1980 dampened wasp activity.

Females of *A. conicus* were active from 0830 to 1630 h (EDT), being most active on sunny days; however, they carried on some "typical" nesting activities during periods of unfavorable weather. Between 0730 and 1000 h many females remained inside their nests, either in terminal cells or lower parts of their burrows. When removed from their nests, such wasps became active within 20 s.

Males were found in sunny spots within the nesting area or resting on overhanging vegetation along the road between 0930 to 1400 h. Some males were observed lapping honeydew off blackberry (*Rubus* sp.) leaves; others were found on flowers of tall meadow rue (*Thalictrum polygamum*).

No copulation was observed; however, males frequently followed closely behind provisioning females on the ground and hunting females on vegetation.

NESTING BEHAVIOR

Females were aggregative, possibly due to the limited suitable nesting habitat. Distances between conspecific entrances ranged from 2 to 25 cm in dense groups but over 1 m in others. The densest aggregation contained 80 nests within a 6 × 0.9 m area (Fig. 1). Nest tumuli (276) were marked within a 52 × 1.8 m stretch of the road in 1980. On the lakeside path, we marked 29 nest entrances within a 16.5 × 1.5 m area.

Six females were observed excavating burrows between 0830 and 1000 h, and from 1500 to 1600 h. They formed pellets of sand with the forelegs, transferred them backwards to the midlegs, and pushed them into the entrance with the hindlegs. The pygidium often assisted in pushing pellets into the opening. The pellets were then pushed to the side of the entrance, the female rotating in a clockwise direction. Often, after several pellets had accumulated in the entrance, the female would move them to one side, forming an asymmetrical tumulus. As a wasp dug deeper, she took increasingly longer (10–25 s) to deposit the soil in the entrance.

Provisioning females flew into the nesting areas from the surrounding vegetation at a sharp angle. One female, grasping a leafhopper venter-up by its beak and body with her mandibles and legs, respectively, flew from a red maple 1.5 m above ground level to the nest. Within 15 to 30 cm of her entrance, she held the prey venter-up on the ground by its beak (Fig. 2). Females walked in a zig-zag manner near their entrances, dropped their prey just outside, entered, turned around, and pulled the leafhoppers inside head-first. One wasp took 5 min between provisioning trips.

Provisioning wasps were skittish on the ground, and flew away at the slightest provocation, often releasing the prey. Such prey were usually not retrieved by the wasps. Some disoriented females flew in circles above the area until they found their entrance, then retrieved the leafhopper and took it into the nest.

All nests were left open during provisioning. Many nests were easily recognized by their characteristic tumuli (Fig. 3), in the form of a simple conical mound, an elongate-convex mound with the entrance off-center, or a turret. Weathering was important in shaping the tumulus, the oldest ones being either absent or inconspicuous. Dimensions of 33 tumuli varied from 4 to 18 mm high ($\bar{x}$ = 8.4 ± 3.1 mm), and from 10 to 20 mm wide ($\bar{x}$ = 15.9 ± 2.3 mm).

Nest entrances (16) ranged from 1.5 to 2.5 mm in diameter ($\bar{x}$ = 2.1 ± 0.2 mm). Burrows went either straight downward through symmetrical tumuli or obliquely downward through asymmetrical ones (Fig. 4). Unfinished nests

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Figs. 2, 3. 2, *Alysson conicus* female carrying prey to her nest. 3, Tumulus and nest entrance.

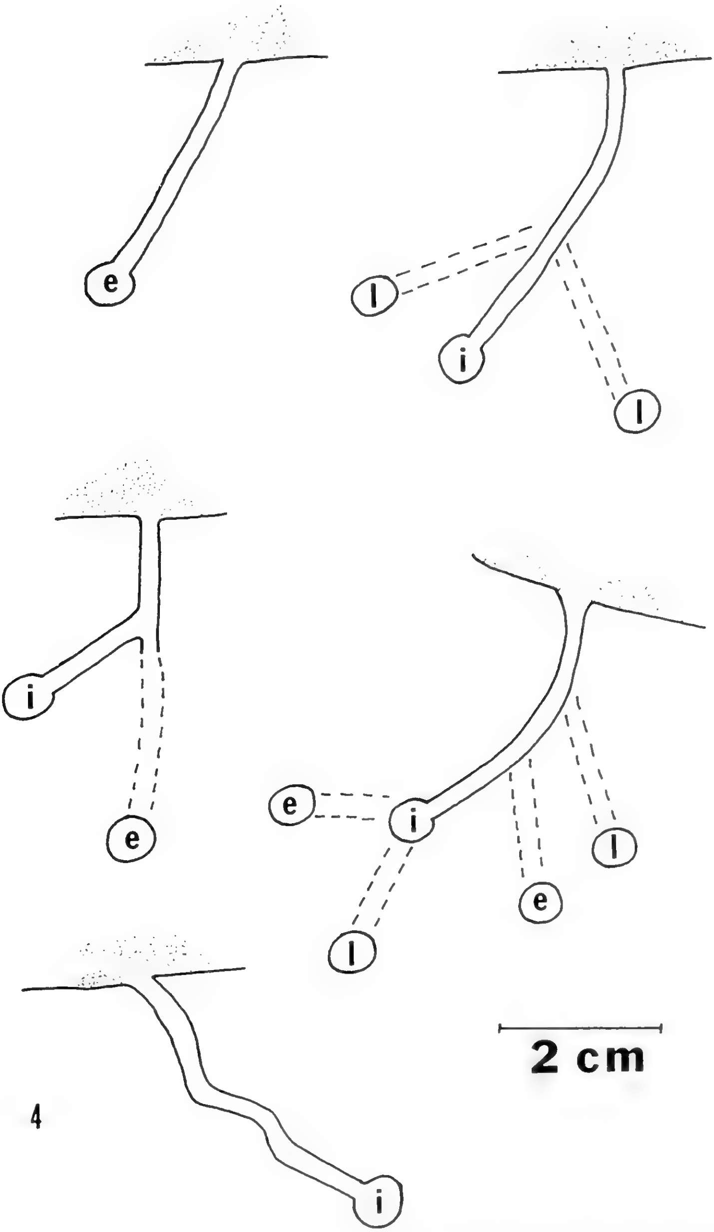

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Fig. 4. Side views of *Alysson conicus* nests. Broken lines indicate burrows which could not be traced exactly. Completed cells contained an egg (e) or larva (l). Uncompleted cells are designated by "i."

(20) contained a single terminal cell, but 5 completed or nearly completed nests had from 2 to 5 cells. Cells (34) were spherical (Fig. 4) with a mean diameter of 4.5 ± 0.7 mm (3.0–5.5 mm). Cell depth varied from 1.4 to 6.0 cm ($\bar{x}$ = 3.8 ± 1.0 cm; N = 34) beneath the soil surface. The soil was invariably moist at cell depth.

Prey consisted of adult Cicadellidae, subfamily Typhlocylinae as follows: 218 *Empoa albicans* Walsh, 2 *E. querci* Fitch, 2 *E. latifasciata* Christian, 8 *Empoasca atrolabes* Gillette, 1 *Typhlocyba persephone* McAtee, and 1 *Ribautiana* sp. The prey appeared to be either fully-paralyzed or dead, with no visible appendage or breathing movements.

Fully-provisioned cells, i.e., those with an egg or larva, contained prey placed head-inward and venter-upward. The mean number of prey per completed cell was 8.8 ± 2 (5–12; N = 14). An egg was laid on the uppermost leafhopper in the cell, either to the right or left of center on the sternum as in *A. melleus* (see Fig. 20, Evans, 1966). Four eggs averaged 0.75 × 0.2 mm. Two cells contained prepupae within ovoidal cocoons, measuring 6.0 × 2.5 and 5.6 × 2.3 mm. The cocoons were constructed of silk, sand grains, and leafhopper remains.

There was no evidence of parasitism or predation in 1979. In 1980, however, 61% of the prey were parasitized by dryinid wasps prior to capture by *A. conicus*. Dryinidae are parasitoids of Homoptera, developing at first internally, then extruding through the integument (Krombein, 1979). It is doubtful that there would have been any effect upon *A. conicus* by the dryinid infestation due to the faster development of the *A. conicus* larva. *Alysson conicus* females may have captured parasitized leaf-hoppers because they were less successful than non-parasitized leafhoppers in evading capture.

DISCUSSION

Alysson conicus exhibits the behavioral traits of the genus, as outlined by Evans (1966). It nests in aggregations in cool, moist sandy situations, with females hunting near their nests. Burrows are nearly vertical, with conspicuous, often irregular tumuli. Completed nests are 2- to 5-celled, as in *A. melleus* (Evans, 1966), with the deeper cells in a nest being older.

Although we observed *A. conicus* females releasing prey outside their entrances and pulling them in, other species of *Alysson* have been noted carrying prey directly into their nests (Evans, 1966; Tsuneki, 1969). Perhaps many of the entrances at Cranberry Lake were blocked with sand grains, and the females had to clear these away prior to entering.

Alysson conicus prefers *Empoa albicans* as prey at Cranberry Lake, N.Y. *Empoa albicans* was common on low vegetation, shrubs, and trees paralleling the nest sites, and the wasps hunted in these areas. *Alysson melleus* takes a broader range of prey (Evans, 1966). Observations of *A. conicus* in other areas would undoubtedly reveal differences from the Cranberry Lake population in regards to prey selection.

It is surprising to find *A. conicus* preying on dryinid infested leafhoppers. This phenomenon has not been noted for any other wasps preying on Homoptera, although it would have been easily overlooked unless the dryinids were extruding through their host's integument.

Alysson conicus nests were shallower than those reported for *A. melleus* (Evans, 1966) and were less variable in cell depth. The shallower *A. conicus* nests may reflect the continual, moist sand in perpetual shade, or limitations of the sand layer overlying the compacted organic layer of the road.

ACKNOWLEDGMENT

We thank J. P. Kramer, Systematic Entomology Laboratory, USDA, Washington, D.C. for identifying the prey Cicadellidae.

LITERATURE CITED

Evans, H. E. 1966. The comparative ethology and evolution of the sand wasps. Harvard Univ. Press, Cambridge, Mass. xvi + 526 pp.

Hartman, C. 1905. Observations on the habits of some solitary wasps of Texas. Bull. Univ. Texas 65: 1–72.

Krombein, K. V. 1979. Family Dryinidae, pp. 1240–1251; family Nyssonidae, pp. 1684–1720. *In* Krombein, K. V. et al., eds., Catalog of Hymenoptera in America North of Mexico. Vol. 2, Apocrita (Aculeata), Smithsonian Institution Press, Washington, D.C.

Kurczewski, F. E. and E. J. Kurczewski. 1971. Host records for some species of Nyssoninae. J. Kans. Entomol. Soc. 44: 334–337.

O'Brien, M. F. and F. E. Kurczewski. 1979. Observations on the nesting behavior of *Alysson conicus* Provancher (Hymenoptera: Sphecidae). Proc. Entomol. Soc. Wash. 81: 435–437.

Rau, P. and N. Rau. 1918. Wasp studies afield. Princeton Univ. Press, Princeton, N.J. xv + 372 pp.

Tsuneki, K. 1969. Gleanings on the bionomics of the East-Asiatic non-social wasps (Hymenoptera). IV. Some species of Bembecini, Stizini, Gorytini, Mellinini, and Alyssonini. Etizenia 41: 1–19.

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POECILOCRYPTICUS FORMICOPHILUS GEBIEN, A SOUTH AMERICAN BEETLE ESTABLISHED IN THE UNITED STATES (COLEOPTERA: TENEBRIONIDAE)[1]

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Abstract.—Poecilocrypticus formicophilus Gebien, known from the Atlantic coast of South America, has been collected recently in Alabama, Florida, and Mississippi, and is reported as a species introduced to the United States. The small, colorful beetle is apparently associated with the imported fire ant. The species is illustrated and redescribed; known distribution records and biological observations are given.

In Mississippi during February of 1978, I collected a single specimen of a very small, colorful tenebrionid beetle which proved to be difficult to identify; no similar specimens were in the National Museum of Natural History collection. The species was apparently a member of the tribe Crypticini, but the only crypticine known to occur in the United States is *Gondwanocrypticus obsoletus* (Say), a broadly oval, dull black species (Arnett, 1968). My specimen was examined by C. A. Triplehorn, who had seen one other example of this beetle, taken in northern Florida in May of the same year. He suspected (personal communication) that it represented an introduction.

After searching the literature and examining types I was able to identify it as *Poecilocrypticus formicophilus* Gebien (1928). The species was described from southern Brazil and northern Argentina, and presumably has been introduced to the Gulf States from South America. Three more specimens were taken by me in Alabama in April of 1980. Evidence indicates that the beetle may be associated with the imported fire ant.

The monotypic genus was described in detail by Gebien, but the general body form and male genitalia of *P. formicophilus* were not figured. Since the species apparently has become established in North America, the fol-

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lowing illustrations and brief redescription are presented, so this distinctive tenebrionid can be easily recognized by collectors. The key couplet below will separate *Poecilocrypticus* from members of the other Western Hemisphere crypticine genus, *Gondwanocrypticus*.

1. Body elongate oval in dorsal view, more than 2× as long as wide; dorsum brightly colored, with pronotum orange and elytra yellow and black .... *Poecilocrypticus* Gebien
– Body broadly oval in dorsal view, not more than 2× as long as wide; dorsum usually dark and uniformly colored; if elytra maculate then pronotum brown or black, not orange ... *Gondwanocrypticus* Español

Poecilocrypticus formicophilus Gebien

Description.—Length 2.6–2.8 mm; greatest width 1.0–1.2 mm; greatest thickness 0.7–0.8 mm. Form elongate oval, head prognathous; dorsum brightly colored, polished, punctate (Fig. 1).

Head dark brown to black, epistoma lighter, gular area yellowish; form rounded, with evenly spaced setigerous punctures. Eye small, reniform. Antenna long, reaching base of elytron if folded back along body; basal 6 segments dull yellow, nearly twice as long as wide; apical 5 segments dark brown, thicker, nearly as wide as long. Mouthparts yellow except for dark mandibles.

Pronotum uniformly bright reddish orange, finely margined laterally, slightly wider than long, widest at midlength, rounded and narrowed anteriorly, nearly parallel sided near base; apex and base evenly truncate; dorsal surface with scattered punctures that are smaller toward middle and each with a short, inconspicuous seta. Scutellum orange, small, triangular, rounded apically, without punctures.

Elytra together as wide as pronotum, elongate, tapering to a point, with longitudinal rows of alternating large and small punctures, each with a minute, decumbent seta; color pattern dark brown to black and yellow, with a less distinct dark basal band, a prominent, wide, median quadrate patch of black extending nearly to margin, and a black apical patch across suture and extending up suture to about midlength of elytra, leaving a prominent C-shaped area of yellow on each elytron.

Ventral surfaces punctate, yellowish orange in color except apical 2 visible abdominal sterna black; punctures very fine and dense on abdominal sterna, with relatively long, fine setae. Legs yellow, setose; tibiae spiny and pubescent, with 2 large, unequal apical spurs; tarsal formula 5-5-4; claws small, simple.

Male genitalia (Figs. 2, 3) with tegmen well sclerotized; basal piece dorsoventrally flattened, arched dorsally, widest at apical ¼, rounded and slightly asymmetrical at base, membranous ventrally. Fused parameres

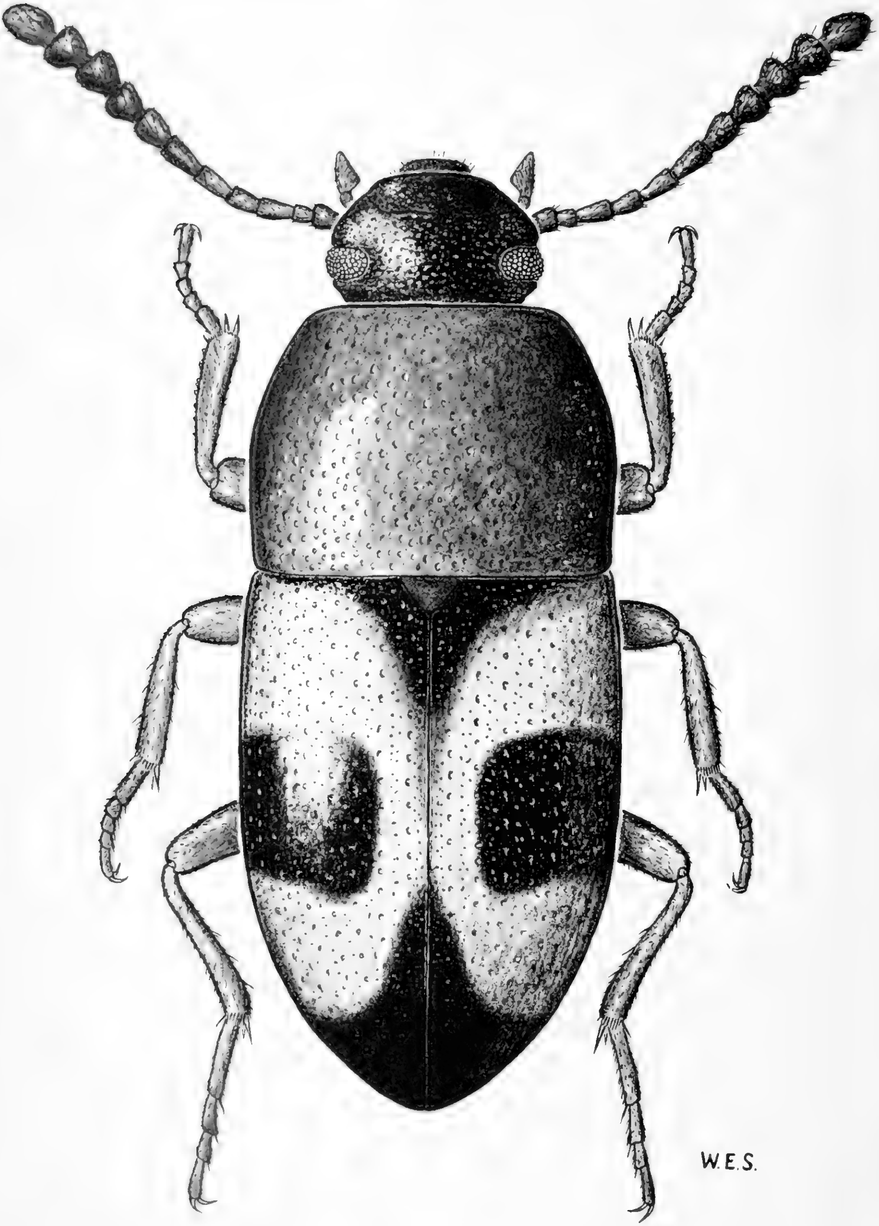
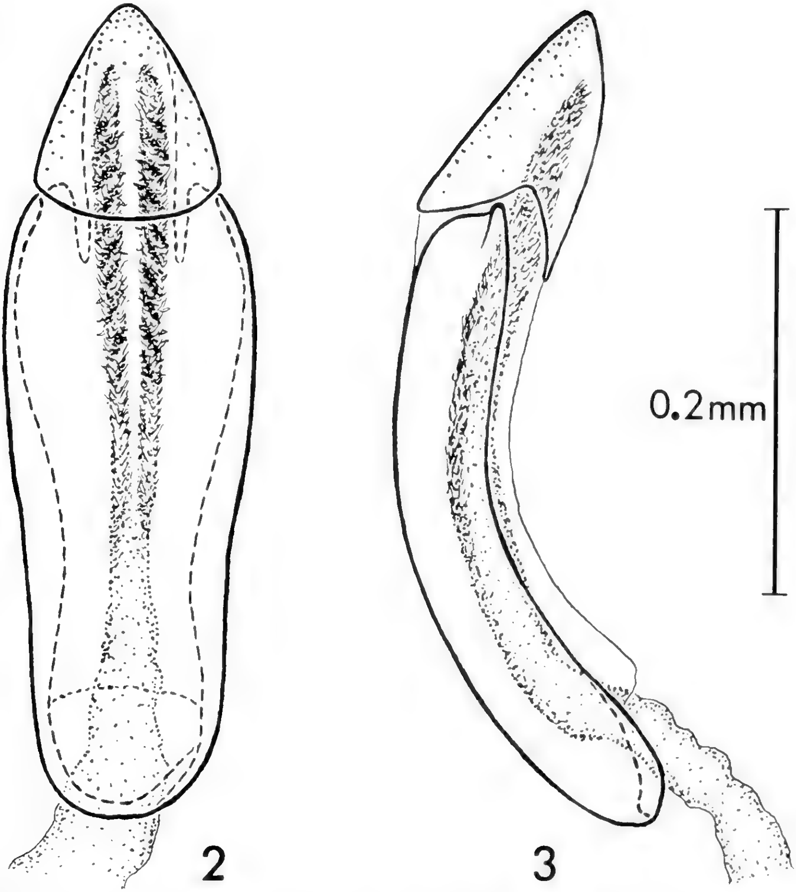


Fig. 1. *Poecilocrypticus formicophilus*, dorsal habitus.



Figs. 2, 3. *Poecilocrypticus formicophilus,* male genitalia. 2, Dorsal view. 3, Lateral view.

forming a conical apex, with scattered small punctures dorsally; basal processes (struts) short. Median lobe membranous; internal sac laterally lined with 2 longitudinal, dense patches of fine spicules; lining of sperm duct granular. Female genitalia unmodified; styli short, 1 segmented, setose apically.

Variation.—The elytral color pattern in *P. formicophilus* is quite variable, as was noted by Gebien (1928). He figured three elytra which differed in the extent and shape of the black areas. The form described and illustrated above is that of the holotype, and represents an intermediate coloration in the series of specimens available. The basal dark band varies in shape and extent, and in one of the paratypes from Argentina the elytra are entirely yellow at the base, and the median and apical black patches are reduced in size. The head is reddish in this specimen also. Other specimens from the same locality and the U.S. have a darkened stripe along the suture that connects the basal dark band and apical patch; this stripe varies from a fine sutural line (as in the Alabama specimens) to a wide band that blends into the black median patch, separating the C-shaped yellow area into two quadrate patches (as in the specimen from Mississippi). The antennae may be uniformly pale colored.

All four specimens in the type-series are probably males; the female specimens from Florida and Alabama are slightly larger than the others, with a more robust and rounded pronotum. In addition, the antennae in females are shorter and less robust in proportion to body size than in males. Unlike many other tenebrionids, however, there are no noticeable sexual differences in the front tarsi.

Figures 2 and 3 of the male genitalia were drawn from one of the paratypes of *P. formicophilus*; these structures in males from North America are identical to those of the paratype from Argentina.

Specimens examined and known distribution.—In addition to the type-series from South America and the 5 specimens from the Gulf States, 29 other specimens found in collections of unidentified beetles were examined, for a total of 38 specimens with the following data:

South America: ARGENTINA: Buenos Aires: Mendoza, 3 ♂ labeled "cotype"; Santiago del Estero: "Chaco," Sept. 1903 (E. R. Wagner), 1 ♂; 1914 (E. R. Wagner), 2 ♂, 3 ♀. BOLIVIA: Santa Cruz: 20 km N. Montero, 31 Dec. 1970 (R. T. Allen), "treading," 8 ♂, 6 ♀; 4 km W. Portachuelo, 17 Dec. 1970 (R. T. Allen), "cane debris," 1 ♂. BRAZIL: Pernambuco: Pery-Pery, 5 June 1892 (Gounelle), 1 ♀; Rio Grande do Norte: Ceará Mirim, 6–7 July 1969 (P. & P. Spangler), 1 ♀; Rio Grande do Sul: São Leopoldo (Heyer), 1 ♂ labeled "type." PARAGUAY: Paraguari: Sapucay, Mar. (W. T. Foster), 1 ♂. URUGUAY: Montevideo, 30 Aug. 1962 (Silviera-Guido), "*saevissima richteri* nest," 1 ♂; 21 Dec. 1922 (F. Felippone), 1 ♂.

North America: USA: ALABAMA: Russell Co., 6 km S. Crawford, 9 April 1980 (W. E. Steiner), 1 ♂, 1 ♀; 10 April 1980 (W. E. Steiner), 1 ♂. FLORIDA: Leon Co., Tall Timbers Res. Sta., 29 May 1978 (M. Altieri), "In pitfall trap; in corn field," 1 ♀. MISSISSIPPI: Hancock Co., Bay St. Louis (Diamondhead), 19 Feb. 1978 (W. E. Steiner), "Pine woods; in humus under opossum dung," 1 ♂.

An additional 3 specimens are labeled as intercepted at U.S. ports in shipments from Argentina: "Ex Argentina, 6 May 1933, N.Y., in grapes," 1 ♂; "Ex Argentina, New York, N.Y., 20 May 1940," 1 ♂; "Ex Argentina, 29 May 1937, on grapes, New Orleans," 1 ♀.

The type-specimens are deposited in the Frey Museum, Munich (Tutzing), West Germany; other specimens are in the National Museum of Natural

History, Washington, D.C., the Museum National d'Histoire Naturelle, Paris, the University of Arkansas Collection, Fayetteville, the Florida State Collection of Arthropods, Gainesville, and in my private collection.

Remarks.—Although the species is apparently widespread, it probably is not often collected because of its small size. It also appears to be flightless, so it would not be taken in light traps. I suspect that the species is much more abundant than indicated by the collection data at present; the observations on habits and habitat discussed below suggest that this beetle is probably a common soil surface insect in open, disturbed areas and would be expected to occur frequently in turf samples and pitfall traps.

The beetle may not be recognized as a tenebrionid by the general collector; the bright coloration, body form, and active running behavior make it resemble a mycetophagid. *Poecilocrypticus formicophilus* may also be confused with another tenebrionid, *Alphitophagus bifasciatus* (Say), a widespread beetle of occasional economic importance (Triplehorn, 1965). The markings and coloration are not as striking in the latter species, but the light and dark banded elytra, general body form and size make it resemble *P. formicophilus*. In *A. bifasciatus* the elytral apices and abdominal sterna are light colored rather than black, the dorsal pubescence is more prominent, and (in males) the clypeus is ornately sculptured.

BIOLOGY

The type-specimen from southern Brazil is pinned with two ants on cards, labeled as "*Prenolepis fulva* Mayr." According to Gebien (1928), the beetles were found under moist bark among soil partitions of an abandoned part of an ant nest. The hindgut of the dissected paratype contained rough, dark colored, granular material, probably soil particles.

The specimen from Montevideo, Uruguay is labeled "*saevissima richteri* nest," in reference to the fire ant, *Solenopsis richteri* Forel. A survey of animals associated with fire ants was done by Silviera-Guido (1972), who collected the above specimen; 28 species of Coleptera were listed but not identified. The ant above and the closely related *S. invicta* Buren have been introduced to the Gulf States from South America (Buren, 1972); *Poecilocrypticus* could have been introduced with one or both of these species of imported fire ants. The localities where *P. formicophilus* has been taken surround Mobile, Alabama, where *Solenopsis* spp. were supposedly first introduced.

Two other myrmecophilous beetles were presumably introduced from South America in this manner. *Myrmecosaurus ferrugineus* Bruch (Staphylinidae), a species described from Argentina, has been taken in fire ant nests in Alabama, Florida, and Louisiana (Frank, 1977). *Myrmecaphodius excavaticollis* (Blanchard) (Scarabaeidae), also from Argentina, is common wherever fire ants occur in the Gulf States (Woodruff, 1973). These and other beetles were listed as inquilines in fire ant nests in the U.S. (Collins and Markin, 1971) but no tenebrionids have previously been associated with imported fire ants.

Poecilocrypticus formicophilus has not been found in close association with *Solenopsis* spp. in the U.S., but fire ant mounds were very common at the localities where I collected the beetle in Mississippi and Alabama; some ant nests that I examined yielded *Myrmecosaurus* and *Myrmecaphodius*. At the Alabama site, specimens of *P. formicophilus* were seen running rapidly in open, sparse turf in bright sunlight; specimens of the related tenebrionid *Gondwanocrypticus* were also taken there in this situation. My single specimen of *P. formicophilus* from Mississippi was taken (with some leiodids) in leaf litter beneath old remains of opossum droppings, in a narrow strip of disturbed, secondary growth pine forest. Fire ant mounds were located 20–30 m from each of these sites.

The beetle seems to be feeding on decaying organic plant debris. Gut contents of the above specimens was made up of fibrous plant tissue, plant hairs, fungus spores, and other particulate matter.

The collection data at present suggest that *P. formicophilus* is associated with imported fire ants, but probably is an occasional ant nest scavenger rather than a specialized myrmecophile, being more agile and free-living than some other more specialized ant guests. Its immature stages are unknown, however, and may be found to be more closely associated with ant nests. The establishment of this beetle in North America probably will be of no economic importance, but further study is needed to better define the niche of this interesting species.

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With the generous help of Gerhard Scherer, Zoologische Sammlung des Bayerischen Staates, Munich, I was able to examine the types of *P. formicophilus* in the Gebien collection. Theodore J. Spilman, Systematic Entomology Laboratory, USDA, Washington, D.C., provided references on the Crypticini and reviewed the manuscript. Charles A. Triplehorn, Ohio State University, Columbus, called my attention to other specimens in collections, and also reviewed the study. Robert E. Woodruff, Florida State Collection of Arthropods, Gainesville, lent the Florida specimen for my examination. Help with literature and identifications concerning fire ants was given by David R. Smith, Systematic Entomology Laboratory, USDA, Washington, D.C. Joseph J. Anderson, University of Maryland, College Park, assisted in collecting in Alabama. For the kind hospitality given during my trips to the Gulf States, I thank Standley and Phyllis Haight, Bay St. Louis, Mississippi, and Mary Love Smith, Seale, Alabama.

LITERATURE CITED

Arnett, R. H., Jr. 1968. The Beetles of the United States. Am. Entomol. Inst., Ann Arbor, Mich. 1112 pp.

Buren, W. F. 1972. Revisionary studies on the taxonomy of the imported fire ants. J. Ga. Entomol. Soc. 7(1): 1–26.

Collins, H. L. and G. P. Markin. 1971. Inquilines and other arthropods collected from nests of the imported fire ant, *Solenopsis saevissima richteri*. Ann. Entomol. Soc. Am. 64(6): 1376–1380.

Frank, J. H. 1977. *Myrmecosaurus ferrugineus*, an Argentinian beetle from fire ant nests in the United States. Fla. Entomol. 60: 31–36.

Gebien, H. 1928. Über einige Gruppen Amerikanischer Tenebrioniden (Col. Heter.). Stettin. Entomol. Ztg. 89(1): 97–234.

Silviera-Guido, A., J. Carbonell, and C. Crisci. 1972. Animals associated with the *Solenopsis* (fire ants) complex, with special reference to *Labauchena daguerri*. Proc. Tall Timbers Conf. Ecol. Control Habitat Manage. 4: 41–52.

Triplehorn, C. A. 1965. Revision of Diaperini of America north of Mexico with notes on extralimital species (Coleoptera: Tenebrionidae). Proc. U.S. Natl. Mus. 117: 349–458.

Woodruff, R. E. 1973. The scarab beetles of Florida (Coleoptera: Scarabaeidae). Part I. The Laparosticti. Arthropods Fla. Neighboring Land Areas 8: 1–220.

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NOTES ON THE WINTER STONEFLY GENUS *ALLOCAPNIA* (PLECOPTERA: CAPNIIDAE)

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Abstract.—Allocapnia zekia Ross is shown to be only a variant of *A. wrayi* Ross and is synonymized with that species. The female of *A. fumosa* Ross is described for the first time from specimens collected in Virginia, and the male of *A. frisoni* Ross and Ricker is reillustrated to aid other workers in the identification of this species. Variations in habitat and male morphology are noted for *A. stannardi* Ross.

All material listed and not specifically marked otherwise is in the collections of the Virginia Polytechnic Institute and State University (BCK) and R. F. Kirchner (RFK).

Allocapnia wrayi Ross

Figs. 1, 2

Allocapnia wrayi Ross, 1964: 170. Holotype and Allotype, Richmond, Virginia.

Allocapnia zekia Ross, 1964: 171. Holotype, Zekiah Swamp, La Plata, Charles County, Maryland, examined. **New synonymy.**

Allocapnia wrayi is a common winter stonefly east of the Appalachian Mountains ranging from Maryland to Georgia. *Allocapnia zekia* was described from a single male (Ross, 1964). Ross and Ricker (1971) already indicated that *A. zekia* may be only a local variant of *A. wrayi.* Recent collections of *Allocapnia* from the type-locality of *A. zekia* and surrounding areas in Maryland and throughout eastern Virginia confirm this. Characters used to separate *A. zekia* from *A. wrayi* (``seventh tergite with a complete sclerotized basal strap and a large apical hump, and the lower limb of the epiproct shorter and relatively deeper'') were found to completely intergrade with typical *wrayi* populations. Several *A. wrayi* populations examined (Maryland and Virginia) contained individuals which varied from typical *wrayi* to ``*zekia*'' forms. Figures 1–2 illustrate some of these variations.

Material examined.—MARYLAND: Charles Co., Zekiah Swamp Run, Rt. 382, 28 Feb 1976, R. M. Patterson, 4 ♂, (USNM); Zekiah Swamp Run at Rt. 5, 29 Nov 1975, R. M. Patterson #3, 15 ♂, 1 ♀, (USNM); Zekiah Swamp Run at Rt. 6, 29 Nov 1975, R. M. Patterson #1, 15 ♂, 5 ♀, (USNM); Zekiah Swamp Run, Rt. 382, Waldorf, 14 Feb 1981, M. Firth, 1 ♂; Zekiah Swamp Run, Rt. 6, Dentsville, 14 Feb 1981, BCK, 2 ♂; Zekiah Swamp Run, Rt. 6, 14 Feb 1981, M. Firth, 3 ♂; Clark Run, Rt. 558, 14 Feb 1976, R. M. Patterson, 1 ♂, (USNM); Clark Run, 5 mi. SE of La Plata, Bel Alton-Newtown Rd., Rt. 558, 14 Feb 1981, M. Firth, 2 ♂; Clark Run, Rt. 6, La Plata, 14 Feb 1981, BCK, 1 ♂; Clark Run, Springhill-Newtown Rd., 1 mi. SE of La Plata, 14 Feb 1981, BCK, 1 ♂; Bryantown Bridge, Rt. 232, 28 Feb 1976, R. M. Patterson, 10 ♂, 1 ♀, (USNM); Dentsville Bridge, Rt. 6, 14 Feb 1976, R. M. Patterson, 1 ♂ (USNM); Gilbert's Creek, Rt. 231, 1 mi. W of Hughesville, 14 Feb 1981, BCK, 1 ♂; Kerrick Swamp at Rt. 488, 29 Nov 1975, R. M. Patterson, 1 ♂, (USNM); small stream 1.5 mi. S off Rt. 382 on Rt. 232, 14 Feb 1981, BCK, 1 ♂; stream at Rt. 232, 1 mi. N of Rt. 15, 14 Feb 1981, M. Firth, 2 ♂; Calvert Co., Penny's Run, Scientist's Cliff at Gate B, 15 Feb 1981, BCK, 5 ♂, 2 ♀. VIRGINIA: Albemarle Co., North Rivanna River, Co. Rt. 606, off St. Rt. 29 March 1979, P. Firth, 6 ♂; Bedford Co., Big Otter River, St. Rt. 122, 7 Feb 1981, J. Despins, 1 ♂; Halifax Co., North Fork of Aarons Creek, Co. Rt. 732 bridge, 17 March 1978, BCK, 6 ♂; Aarons Creek, Co. Rt. 604, 17 March 1978, BCK, 4 ♂, 3 ♀; Hanover Co., Falling Creek, Co. Rt. 667 bridge, 25 Feb 1978, BCK, 1 ♂, 3 ♀; Stagg Creek, Co. Rt. 696 bridge, BCK, 25 Feb 1978, 2 ♂; Loudoun Co., small spring-fed stream into Goose Creek, Co. Rt. 733, 15 Feb 1981, BCK, 1 ♂; Lunenburg Co., Middle Meherrin River, St. Rt. 49, 17 March 1978, J. R. Voshell, 1 ♂, 1 ♀; Mecklenburg Co., Butcher's Creek, St. Rt. 92, 17 March 1978, BCK, 2 ♂.

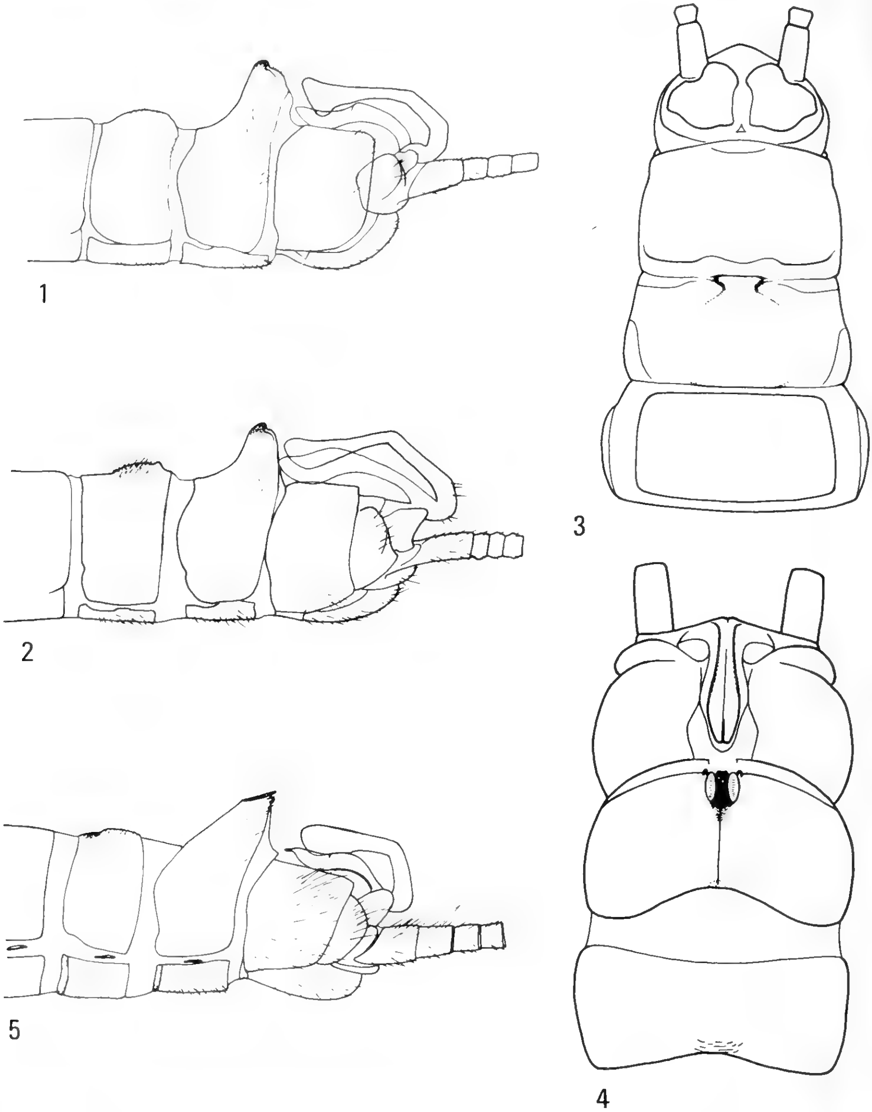
Allocapnia fumosa Ross

Fig. 3

Allocapnia fumosa Ross, 1964: 174; Ross and Ricker, 1971: 26.

Allocapnia fumosa has been known previously from a few localities in the mountains of North Carolina and Tennessee. The female has remained undescribed. Populations of this distinctive species were found in several streams in the Mount Rogers National Recreation Area, Virginia (the highest point in Virginia, 1746 m). Most adults were captured running about on small trees and shrubs surrounding small spring-fed seeps flowing into first order streams. The description and morphological terms follow those of Ross and Ricker (1971).

Female.—Length of body 7–8 mm; wings reaching to 6th tergum. Eighth sternum more heavily sclerotized and separate from 7th, with medial area heavily sclerotized into a truncate process (Fig. 3).



Figs. 1–5. Terminalia of *Allocapnia* spp. 1, 2, *A. wrayi,* male, lateral view; 1, Mecklenburg Co., Va.; 2, Calvert Co., Md. 3, *A. fumosa,* female, ventral view; Grayson Co., Va. 4, 5, *A. frisoni,* male, Greenbrier Co., W. Va.; 4, dorsal view; 5, lateral view.

Material examined.—VIRGINIA: Grayson Co., spring seeps into Lewis Fork, .05 mi. off Co. Rt. 603, 16 Feb 1981, BCK and RFK, 13 ♂, 2 ♀ (one pair in copulo); same, 3 April 1981, 1 ♀; small spring-fed stream into Fox Creek, off Co. Rt. 603, 16 Feb 1981, BCK, 1 ♂; Fox Creek, 2 mi. W of

Troutdale, Co. Rt. 603, 23 Dec 1980, RFK, 1 ♂; Lewis Fork, Co. Rt. 603, 7 Feb 1981, BCK, 1 ♂; same, but 27 Dec 1978, RFK, 1 ♂; Smyth Co., small spring-fed stream at entrance of Grindstone Campground, Co. Rt. 603, 7 Feb 1981, BCK, 1 ♂, 1 ♀; Washington Co., Straight Branch of Big Laurel Creek, 4 mi. E of Damascus, St. Rt. 58, 25 Dec 1977, RFK, 1 ♂.

Allocapnia frisoni Ross and Ricker

Figs. 4, 5

Allocapnia frisoni Ross and Ricker, 1964: 90. Holotype and Allotype, Evansville, West Virginia; Ross and Ricker, 1971: 30.

The description of *A. frisoni* is adequate. However, the illustration in Ross and Ricker (1971, Fig. 25b) is not representative of the rugosity of the dorsal process on the eighth tergum. Apparently the extent and shape of the dorsal rugosities were not completely illustrated. This has caused some problems with the identification of this species. We present additional illustrations (Figs. 4, 5) to assist other workers in identifying *A. frisoni*. Paratypes were examined from Tompkins Co., New York.

Material examined.—VIRGINIA: Rockingham Co., Kephart Run, St. Rt. 33, W of Harrisonburg, 24 Dec 1977, P. K. Powell, 4 ♂; Rocky Run, St. Rt. 33, W of Harrisonburg, 24 Dec 1977, P. K. Powell, 3 ♂. WEST VIRGINIA: Logan Co., Frogtown Hollow of Copperas Mine Fork, Holden, 27 Jan 1975, RFK, 43 ♂, 26 ♀; same but 11 Dec 1975, 8 ♂, 6 ♀; same but 11 March 1976, 37 ♂, 20 ♀; Fayette Co., Big Hollow of Paint Creek, 2 mi. NW of Kingston, WV-Turnpike, 22 Dec 1979, RFK, 4 ♂, 4 ♀; same but 24 Jan 1980, 5 ♂, 1 ♀; same but 1 Feb 1981, 61 ♂, 52 ♀; Greenbrier Co., Rocky Run, Forest Rd. 139, Blue Bend Rec. Area, 29 Dec 1980, BCK and RFK, 5 ♂; Meadow Creek, Co. Rt. 14, near Rucker Gap, 29 Dec 1980, BCK and RFK, 10 ♂.

Allocapnia stannardi Ross

Allocapnia stannardi Ross, 1964: 174. Holotype and Allotype, Sevier Co., Tennessee; Ross and Ricker, 1971: 42.

Allocapnia stannardi Ross was collected at two locations in Virginia. The habitat of both localities vary from the description of Ross and Ricker (1971). Three males and one female were collected from small spring-seeps in Patrick County, Virginia, (BCK) at an altitude of only 580 m. Nearly 200 males and females were collected in Smyth County, Virginia, (BCK and RFK), also from spring seeps and from a nearby small head water stream at an altitude of 1060 m. This species is found in a broader range of habitats and at lower elevations than mentioned by Ross and Ricker (1971). Several males from the second collection site had small processes on the sixth tergum and others had the process of the seventh tergum slanted distad rather than erect.

Both *A. fumosa* and *A. stannardi* represent new range extensions and new state records for Virginia (Kondratieff and Voshell, 1979).

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We thank John D. Unzicker of the Illinois Natural History Survey, Champaign, for loan of the holotype of *A. zekia* and Oliver S. Flint, Jr., National Museum of Natural History, Washington, D.C., (USNM) for loan of paratypes of *A. frisoni* and additional specimens of *A. wrayi*. Penelope F. Kondratieff is gratefully acknowledged for the illustrations. We also thank Martin J. Firth, Port Republic, Maryland, for helping with the Maryland collections.

Literature Cited

Kondratieff, B. C. and J. R. Voshell, Jr. 1979. A checklist of the stoneflies (Plecoptera) of Virginia. Entomol. News 90: 241–246.

Ross, H. H. 1964. New species of winter stoneflies of the genus *Allocapnia* (Plecoptera, Capniidae). Entomol. News 75: 169–177.

Ross, H. H. and W. E. Ricker. 1964. New species of winter stoneflies, genus *Allocapnia* (Plecoptera: Capniidae). Trans. Ill. Acad. Sci. 57: 88–93.

———. 1971. The classification, evolution, and dispersal of the winter stonefly genus *Allocapnia*. Ill. Biol. Monogr. 45: 1–166.

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THE FOUR "OCELLI" OF THE ISOMETOPINE GENUS *ISOMETOCORIS* CARVALHO AND SAILER (HEMIPTERA: MIRIDAE)

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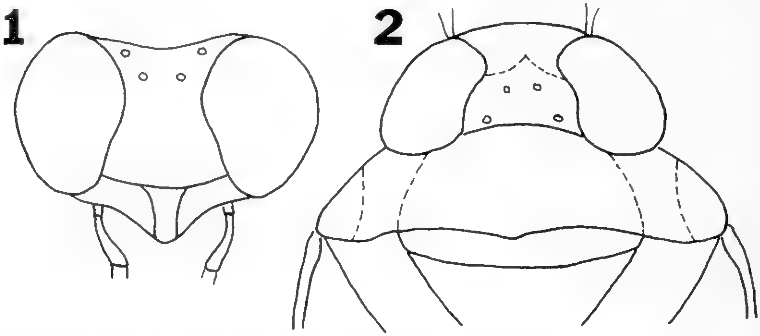
Abstract.—Isometocoris blantoni Carvalho and Sailer (Hemiptera: Miridae), described as having four ocelli and previously placed in the subfamily Isometopinae, is re-examined and transferred to the subfamily Psallopinae on the basis of pronotal, hemelytral, and pretarsal characters. This is the first report of Psallopinae in the Western Hemisphere. Electron microscopy is used to show that *I. blantoni* does not have true ocelli.

Carvalho and Sailer (1954) described the attractive species *Isometocoris blantoni* from a single male collected in Panama. On the basis of four minute "ocelli" located on the vertex (Figs. 1, 2), they placed this genus in the Isometopidae (now a subfamily of the Miridae), a family characterized by two distinct ocelli. In reference to this peculiar condition, they commented, "Only with the discovery of additional specimens will it be possible to determine with certainty whether this specimen is a freak or whether it is a representative example of the species."

We recently discovered seven additional specimens of *blantoni* in the collection of the National Museum of Natural History and the personal collection of the second author. Because *blantoni* was described from a single male, our original interest was to present new distribution records and a description of the female of this unusual species. Closer examination, however, provided new information regarding the presence of the four ocelli, a condition not known to occur in any other group of insects (unless the "ocelli" of certain male sternorrhynchus Homoptera are considered).

The holotype of *blantoni* exhibits four tiny, symmetrically placed, shiny spots on the vertex. When viewed with a stereomicroscope, these "ocelli" are, at best, difficult to see; their pattern, suggestive of more than a mere random placement of small shiny spots, was mistaken for true ocelli.

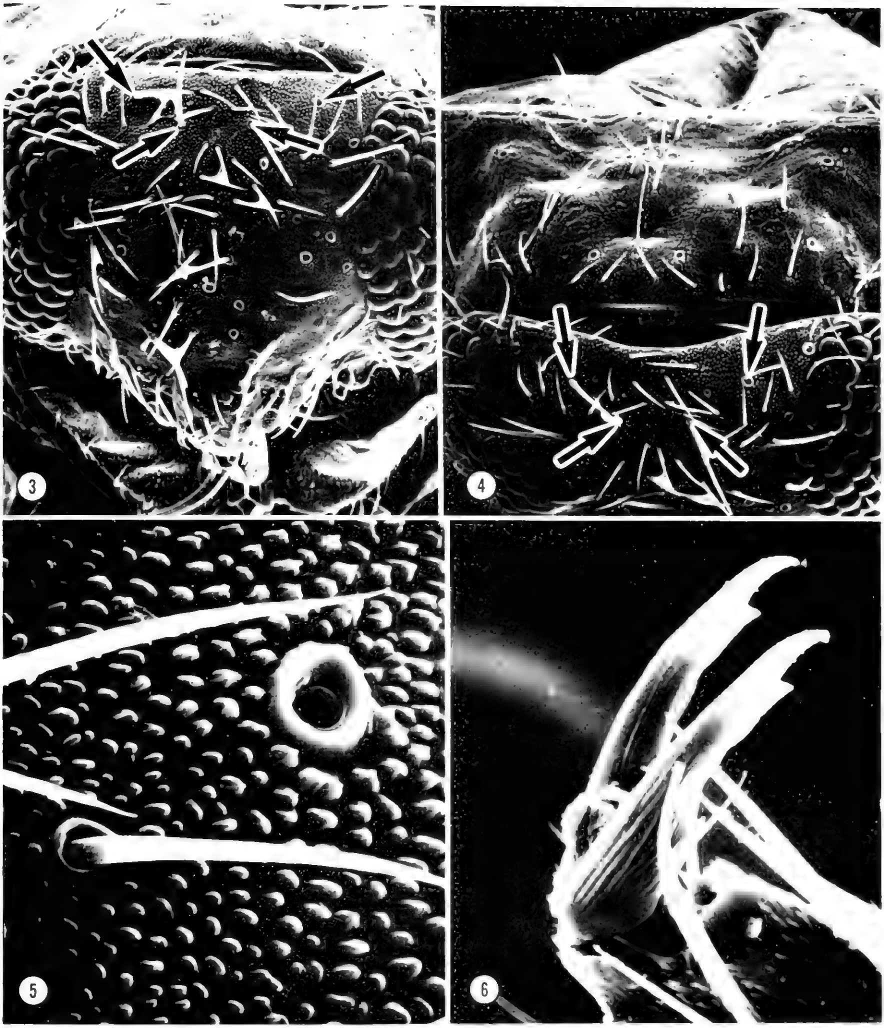


Figs. 1, 2. Line drawings indicating position of "ocelli" on vertex of *Isometocoris blantoni* (redrawn from Carvalho and Sailer, 1954). 1, Frontal view of head. 2, Dorsal view of head and pronotum.

We first doubted that these structures were true ocelli when we discovered that all of our specimens possessed additional similarly developed spots between the compound eyes (Figs. 3–5) and on the pronotum (Fig. 4). Electron microscopy revealed that the 4 spots originally described as ocelli for *blantoni* are not ocelli but are actually enlarged, pigmented setigerous cavities (Figs. 3, 5) common to several parts of the insect's dorsum. When a seta is broken or lost, the remaining cavity (Fig. 5) appears as a small polished spot or "ocellus" when viewed at magnifications of 100× or less. Carvalho and Sailer's (1954) drawings are reproduced here (Figs. 1, 2) to allow comparison with our electron micrographs (Figs. 3, 4). Arrows on our figures indicate corresponding setal bases shown in Carvalho and Sailer's line drawings.

The lack of ocelli in this genus requires that *Isometocoris* be removed from the subfamily Isometopinae and from Henry's (1980) key to the New World genera. Further examination of the claws (Fig. 6), tarsi, and anterior margin of the pronotum (Fig. 4) indicates that *Isometocoris* belongs in the Old World subfamily Psallopinae.

Schuh (1976) defined Psallopinae based on the only included genus, *Psallops* Usinger. Most previous workers had put this genus in the subfamily Phylinae, although Carvalho (1956), in describing *Psallops occulatus,* pointed out that *Psallops* has all the facies of the subfamily Isometopinae (then considered a family), but the lack of ocelli placed the genus outside this group. He also noted that the genitalia of *Psallops* were entirely different from those of the Phylinae. Eyles (1972), following Carvalho, transferred this genus to Isometopidae. Schuh (1976) defined *Psallops* as having a fine upturned anterior pronotal margin, a simple male vesica without spicules, subapical claw teeth, one or two cells in the membrane of the forewings, 2-segmented tarsi, and nine metafemoral trichobothria.



Figs. 3–6. Micrographs of *Isometocoris blantoni*. 3, Frontal view of head (×250); arrows indicate position of false ocelli. 4, Head and pronotum showing numerous ocelli-like setal bases (×250); arrows indicate position of false ocelli. 5, High magnification (×2500) of the setal base indicated by arrow in upper right corner of Figs. 3 and 4. 6, Claw showing subapical teeth (×2500).

Isometocoris exhibits the finely upturned and narrow anterior margin of the pronotum (Fig. 4), simple male genitalia, a subapical tooth on each claw (Fig. 6), a single closed cell in the membrane of each forewing, and 2-segmented tarsi. This combination of characters dictates that *Isometocoris* be transferred to Psallopinae; thus it becomes the first member of this subfamily to be recognized in the Western Hemisphere.

Isometocoris is separated from *Psallops* by the broader vertex that is equal to the dorsal width of an eye and by the strongly concave basal margin of the pronotum. In *Psallops*, the eyes cover much of the dorsal surface of the head, the vertex is less than ½ the dorsal width of an eye, and the base of the pronotum is nearly straight.

Isometocoris blantoni Carvalho and Sailer

Diagnosis.—Female, length 1.74–1.76 mm, width 0.90–0.94 mm. *Head:* Width 0.46–0.48 mm, vertex 0.22 mm. *Rostrum:* Length 0.76 mm, reaching beyond base of ovipositor. *Antenna:* Segment I, length 0.08 mm; II, 0.38 mm; III, 0.18 mm; IV, broken. *Pronotum:* Length 0.20–0.22 mm; basal width 0.74–0.76 mm.

General coloration of dorsum pallid, set with numerous brown setigerous pores; head pallid, becoming somewhat darker toward frons, set with numerous brown setigerous pores, including 4 symmetrically positioned ones on vertex (Figs. 3, 4); pronotum pallid with a few dark blotches on disc and at lateral angles; hemelytra pallid with a large orange blotch near middle of clavus and corium, on apical ⅓ of corium and on apical ⅔ of embolium; inner angle of cuneus fuscous; hemelytra with numerous brown setigerous spots that become more reddish on cunei and apical ⅓ of coria; membrane opaque white, tinged with brown; membrane with a single closed cell and distal spurious vein. Venter fuscous, meso- and metapleura tinged with pink or red. Ostiolar evaporative area brownish except for a pale or whitish winglike plate arising from apex of ostiolar channel. Legs brown, metafemora becoming fuscous. Setae of body simple, long pallid and semierect, nearly all arising from darkened bases; eyes thickly pubescent.

Diagnosis.—Male, length 1.72–1.74 mm, width 0.86 mm. *Head:* Width 0.52 mm, vertex 0.20 mm. *Rostrum:* Length 0.80 mm, reaching near 5th abdominal segment. *Antenna:* Segment I, length 0.08 mm; II, 0.44 mm; III, 0.16 mm; IV, broken. *Pronotum:* Length 0.20 mm; basal width 0.70–0.72 mm.

Males are very similar to females in markings and coloration, but the head and pronotum are more strongly infuscated and the eyes are proportionately larger and more deeply faceted.

Specimens examined.—Holotype ♂, Pedroesa, Republic of Panama, Oct. 28, 1953, F. S. Blanton coll., USNM type no. 61950; 2 ♂, Pt. Aguadulce, R. P., June 21, 1952, F. S. Blanton coll. (USNM); 1 ♂, Mojinga Swamp, Canal Zone, Panama, Jan. 9, 1953; F. S. Blanton coll. (USNM); 1 ♂, 2 ♀, Panama, Lt. Barro Colorado Isl., Jan.–Apr.–June, 1972, D. Engleman coll. (Maldonado colln.); 1 ♀, Panama, Lt. Coco Solo, Canal Zone, July 1973, D. Engleman coll. (Maldonado colln.).

LITERATURE CITED

Carvalho, J. C. M. 1956. Heteroptera: Miridae. Insects Micronesia 7(1): 1–100.

Carvalho, J. C. M. and R. I. Sailer. 1954. A remarkable new genus and species of Isometopidae from Panama (Hemiptera: Isometopidae). Entomol. News 65: 85–88.

Eyles, A. C. 1972. Supplement to list of Isometopidae (Heteroptera: Cimicoidea). N.Z. J. Sci. 15: 463–464.

Henry, T. J. 1980. Review of *Lidopus* Gibson and *Wetmorea* McAtee and Malloch, descriptions of three new genera and two new species, and key to New World genera (Hemiptera: Miridae: Isometopinae). Proc. Entomol. Soc. Wash. 82: 178–194.

Schuh, R. T. 1976. Pretarsal structure in the Miridae (Hemiptera) with a cladistic analysis of relationships within the family. Am. Mus. Novit. 2601, 39 pp.

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84(2), 1982, pp. 250–255

AN OLD WORLD SPECIES OF *SCYMNUS* (*PULLUS*) ESTABLISHED IN PENNSYLVANIA AND NEW YORK (COLEOPTERA: COCCINELLIDAE)

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Abstract.—A European species of Coccinellidae, *Scymnus* (*Pullus*) *suturalis* Thunberg, is reported for the first time from North America. All collection localities are in Pennsylvania and New York. The known distribution, possible origins of the introduction, and taxonomic affinities of *S. suturalis* are discussed.

In a taxonomic treatment of certain genera of North American Scymnini (Gordon, 1976), I discussed *Scymnus* (*Pullus*) *coniferarum* Crotch. The distribution of this species is primarily Californian with outlying records from British Columbia, South Dakota, and Colorado (Fig. 1) (this map is reproduced as published in 1976). I also included in the treatment of this species data from specimens taken from several Pennsylvania localities with the speculation that they had been artificially distributed on nursery stock. Subsequent investigation has revealed that all of the Pennsylvania specimens are *Scymnus* (*Pullus*) *suturalis* Thunberg, a species not previously recorded from North America. A single New York record (1981) was received from A. G. Wheeler. Korschefsky (1931) gives the distribution of *S. suturalis* as "Europa, Caucasus, Sibirien, Tunis." *Scymnus suturalis* and *S. coniferarum* are extremely similar in appearance, with the primary diagnostic difference being the shape of the infundibulum in the female genitalia. This and other differences are discussed below.

Scymnus (*Pullus*) *suturalis* Thunberg

Scymnus (*Pullus*) *suturalis* Thunberg, 1975: 106.

Description as for *Scymnus* (*Pullus*) *coniferarum* except: Body slightly broader, less elongate in appearance; punctures on elytron coarse, dense, separated by the diameter of a puncture or less; basal lobe of male genitalia broad in ventral view, abruptly narrowed in apical ¼ (Fig. 2), apex in lateral

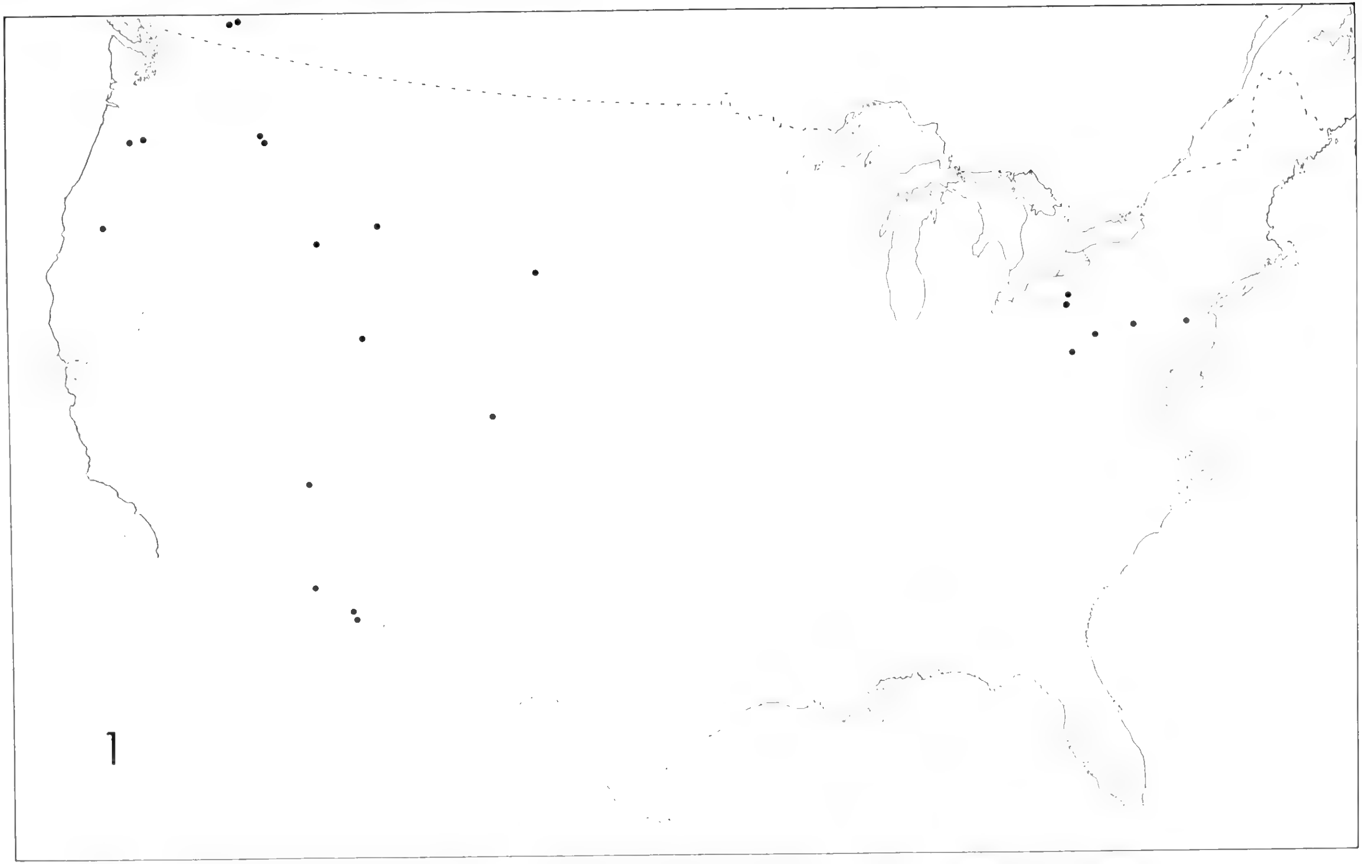
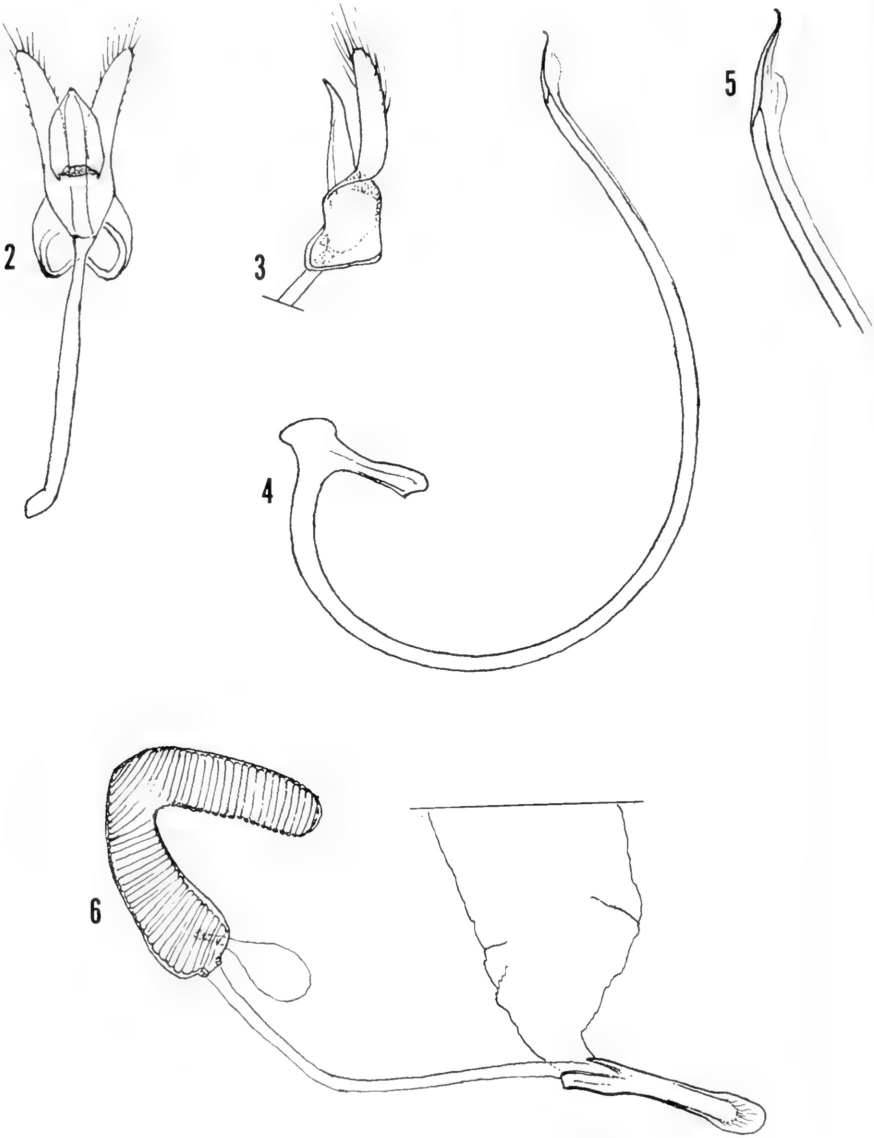


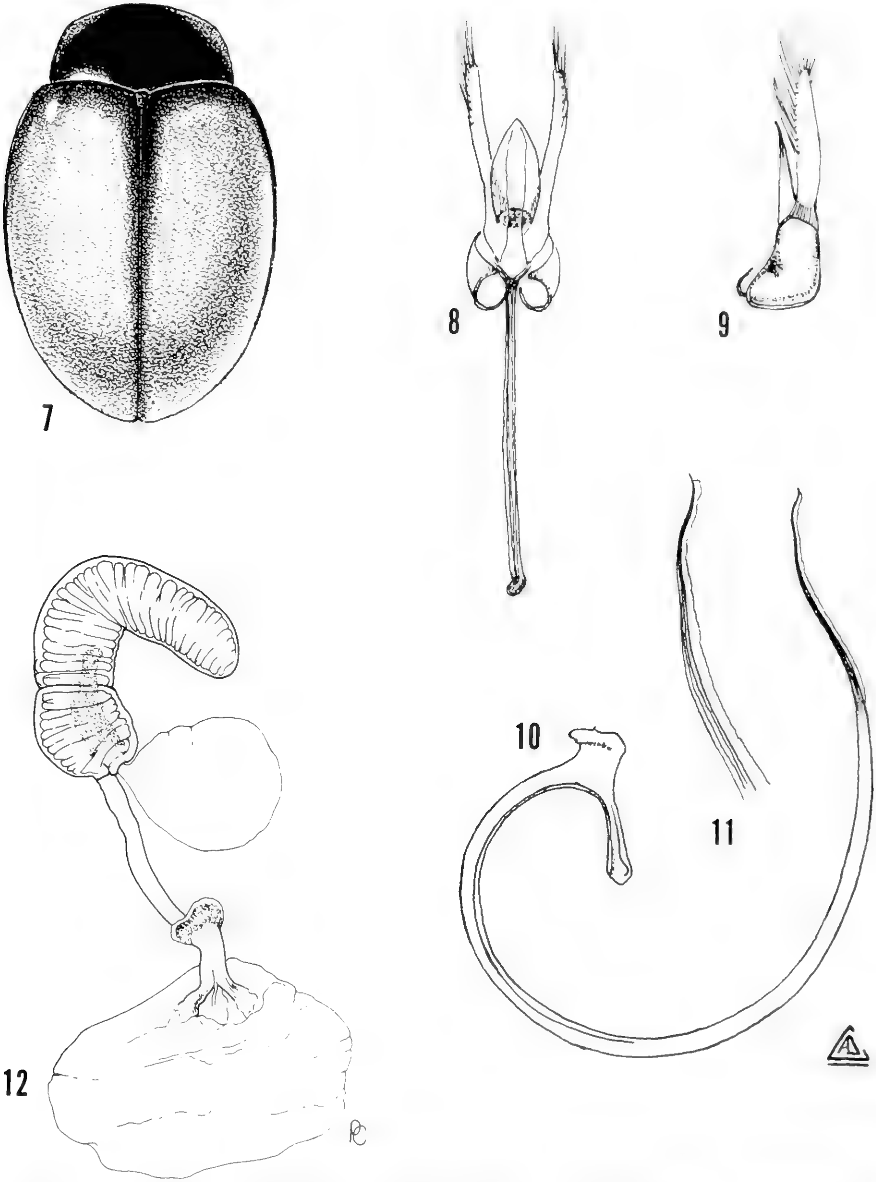
Fig. 1. Distribution of *Scymnus coniferarum* in western North America and *S. suturalis* in Pennsylvania (1976).



Figs. 2–6. *Scymnus suturalis*. 2–5, Male genitalia. 6, Female genitalia.

view distinctly bent downward (Fig. 3), apex of sipho S-shaped (Figs. 4, 5); female genitalia with infundibulum slender, rodlike (Fig. 6).

Scymnus coniferarum differs from *Scymnus suturalis* in being extremely elongate (Fig. 7), with elytral punctures small and separated by about twice



Figs. 7–12. *Scymnus coniferarum*. 7, Habitus view. 8–11, Male genitalia. 12, Female genitalia.

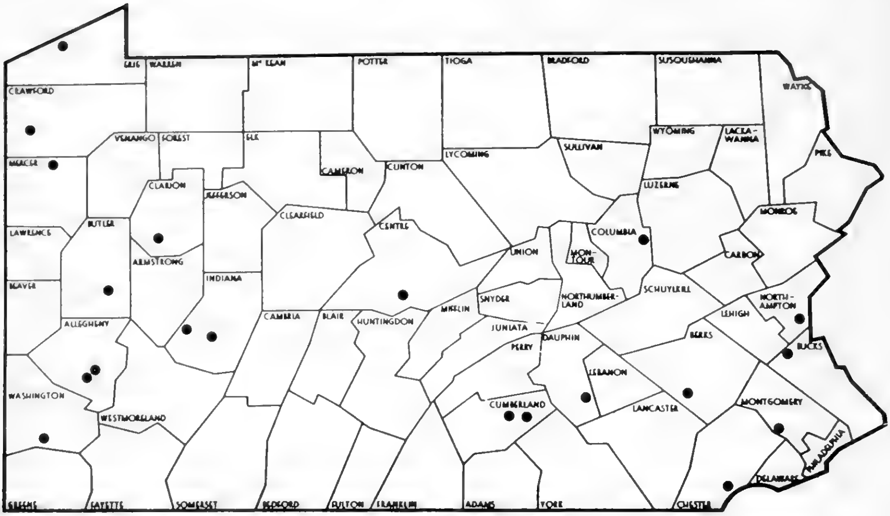


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Fig. 13. Known distribution of *Scymnus suturalis* in Pennsylvania (1981).

the diameter of a puncture; the male genitalia are different as in Figs. 8–11, and the female infundibulum is short and thickened at both ends (Fig. 12).

The known distribution of *S. suturalis* in Pennsylvania is depicted in Fig. 13. However, it also occurs in New York, and it is not likely that the species is restricted to those states. All specimens were received from A. G. Wheeler and T. J. Henry of the Pennsylvania Department of Agriculture and were taken mostly on pine (*Pinus sylvestris, P. strobus, P. resinosa*). One record was from spruce (*Picea pungens*). Nearly all records were from trees used as ornamentals such as ornamental plantings, nursery stock, or Christmas tree plantations.

Both *S. suturalis* and *S. coniferarum* are aphid predators and apparently feed mainly or entirely on aphids infesting conifers. Gordon (1976) recorded *S. coniferarum* on lodgepole pine and Monterey pine infested with woolly aphids. I have no specific predation records for *S. suturalis*, but its food preference is apparently very similar to that of *S. coniferarum*.

Because the shipment of two- and three-needled pines into this country has been prohibited by quarantine laws since 1915 (Wheeler and Henry, 1973), *S. suturalis* was probably established prior to that year. Before 1915 (prior to current quarantine laws), vast amounts of live nursery stock were imported from Europe and distributed throughout Pennsylvania and elsewhere (personal communication, A. G. Wheeler). Under those conditions *S. suturalis* had many opportunities to become established.

Collection localities for *S. suturalis*.—PENNSYLVANIA: (20 specimens examined) (Allegheny Co.) Cheswick, Pittsburgh; (Berks Co.) Shillington; (Bucks Co.) Coopersburg; (Butler Co.) Herman; (Centre Co.) State College; (Chester Co.) Longwood Gardens; (Clarion Co.) Rimersburg; (Columbia Co.) Berwick Cemetery; (Crawford Co.) Conneaut Lake; (Cumberland Co.) Camp Hill, Hagestown; (Dauphin Co.) Hershey; (Erie Co.) Fair View; (Indiana Co.) Indiana, Shelocta; (Mercer Co.) Sheakleyville; (Mongomery Co.) Norristown; (Northampton Co.) Easton; (Washington Co.) Marianna, Squirrel Hill Nursery. NEW YORK: (2 specimens examined) (Tompkins Co.) Ithaca.

Acknowledgments

I thank A. G. Wheeler, Jr., Pennsylvania Department of Agriculture, Harrisburg, and T. J. Henry, now with the Systematic Entomology Laboratory, USDA, Washington, D.C., for help in locating specimens and discussing the probable reasons for the establishment of *suturalis* in Pennsylvania and New York.

Literature Cited

Gordon, R. D. 1976. The Scymnini (Coleoptera: Coccinellidae) of the United States and Canada: Key to genera and revision of *Scymnus*, *Nephus* and *Diomus*. Bull. Buffalo Soc. Nat. Sci. 28: 1–362.

Korschefsky, R. 1931. Coleopterorum catalogus. Coccinellidae I, pars 118. 224 pp.

Thunberg, C. P. 1795. Dissertatio entomologica sistens Insecta Suecica. Pp. 105–113. Upsaliae.

Wheeler, A. G., Jr. and T. J. Henry. 1973. *Camptozygum aequale* (Villers), a pine-feeding mirid new to North America (Hemiptera: Miridae). Proc. Entomol. Soc. Wash. 75: 240–246.

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A KEY TO THE FEMALES OF THE GENUS *OXYETHIRA* (TRICHOPTERA: HYDROPTILIDAE) FROM THE SOUTHERN UNITED STATES[1]

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Abstract.—Associations of females with the males for most species of the genus *Oxyethira* known from the southern United States has made possible the construction of a key to females of that region. Illustrations for 24 of the 27 species are provided along with a discussion of the general morphology of the genital segments of females of the genus. Three new synonyms are proposed: *O. barnstoni* Harper is a synonym of *O. mirabilis* Morton, *O. allosi* Blickle is a synonym of *O. dualis* Morton, and *O. cirrifera* Flint is a synonym of *O. arizona* Ross.

Microcaddisflies (Hydroptilidae) are among the most poorly known Trichoptera, primarily due to their small size. Blickle (1979) provided a key to the males of North American species of the family, but females of few species have been associated with corresponding males (see Table 1). Published illustrations for most of these females are insufficiently detailed to allow comparisons adequate for species discrminations. Furthermore, the majority of species have remained unassociated.

This paper provides illustrations and a key for 24 of the 27 species of *Oxyethira* that are known from across the southern half of the continental United States. A list of these species and their known geographical ranges are provided in Table 1. No females were available of three species; *O. coercens* Morton, *O. leonensis* Kelley, and *O. setosa* Denning. *Oxyethira coercens* is known primarily from the northeastern United States and the latter two from the Florida panhandle and southern Georgia.

Characters of both external and internal morphology of the genital segments are used in the key, such that specimens must be cleared in KOH in

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[1] Technical contribution no. 1916 of the South Carolina Agricultural Experimental Station, Clemson University.

Table 1. Species of *Oxyethira* from the southern United States.

Species	Known Distribution				Previous Descriptions of Female
	States	Mountain	Piedmont or Plateau	Coastal Plain	
O. abacatia Denning	Fla., Ga., S.C.	X	X	X	None
O. aculea Ross	Ariz., N. Mex., Okla.	X	X		None
O. arizona Ross	Ariz.		X		Flint, 1968a
O. azteca (Mosely)	Tex.		X		Flint, 1968b
O. coercens Morton	Okla., Va.	X			None
O. dualis Morton	Ark., Ariz., N. Mex., Tenn., Tex., Va.	X			Ross, 1944
O. dunbartonensis Kelley	Ga., S.C.	X	X		Kelley, 1981
O. elerobi (Blickle)	Fla., S.C.			X	Kelley, 1981
O. florida Denning	Fla.			X	Botosaneanu, 1979
O. forcipata Mosely	Ga., N.C., S.C., Va.	X	X		None
O. glasa (Ross)	Fla., Ga., La., Okla., S.C.			X	None
O. grisea Betten	S.C., Tenn., Va.	X	X		None
O. janella Denning	Fla., Ga., La., Miss., S.C.	X	X	X	Flint, 1968a
O. leonensis Kelley	Fla.			X	None
O. lumosa Ross	Fla., Ga., S.C.		X	X	None
O. maya Denning	Fla., Ga.			X	None
O. michiganensis Mosely	Ga., S.C., Va.	X			None
O. novasota Ross	Fla., Ga., La., Miss., S.C., Tex.			X	None ("*novasota*" of Ross, 1944, is actually *verna*)
O. pallida (Banks)	Ala., Fla., Ga., La., Miss., Okla., S.C.	X	X	X	Ross, 1944
O. rivicola Blickle and Morse	Tenn., Va.	X			None
O. rossi Blickle and Morse	Tenn.	X			None
O. serrata Ross	Tenn.	X			Ross, 1944
O. setosa Denning	Fla., Ga.			X	None
O. sininsigne Kelley	Fla., La., S.C.			X	Kelley, 1981
O. ulmeri (Mosely)	Tex.		X		None
O. verna Ross	Fla., La., S.C., Tex.			X	Denning, 1947; Ross, 1944 (as "*novasota*")
O. zeronia Ross	Fla., Ga., La., N.C., S.C., Tenn., Va.	X	X	X	None

Table 2. Species groups of *Oxyethira* in North and Central America (adapted from Marshall, 1979).

Azteca Group
- *azteca* (Mosely)
- *janella* Denning
- *quelinda* Botosaneanu
- *puertoricensis* Flint

Bidentata Group
- *abacatia* Denning
- *aeola* Ross
- *anabola* Blickle
- *mirabilis* Morton
  - *barnstoni* Harper, **new synonym**

Distinctella Group
- *araya* Ross
- *serrata* Ross
- *setosa* Denning

Dualis Group
- *dualis* Morton
  - *allosi* Blickle, **new synonym**
- *sininsigne* Kelley

Falcata Group[1]
- *rossi* Blickle and Morse

Forcipata Group
- *forcipata* Mosely
- *michiganensis* Mosely
- *obtatus* Denning

Grisea Group
- *allagashensis* Blickle
- *coercens* Morton
- *dunbartonensis* Kelley
- *grisea* Betten
- *lumosa* Ross
- *novasota* Ross
- *rivicola* Blickle and Morse
- *sida* Blickle and Morse

Pallida Group
- *alaluz* Botosaneanu
- *arizona* Ross
  - *cirrifera* Flint, **new synonym**
- *campesina* Botosaneanu
- *maya* Denning
- *pallida* (Banks)
- *verna* Ross

Ulmeri Group
- *aculea* Ross
- *florida* Denning
- *simulatrix* Flint
- *ulmeri* (Mosely)

Zeronia Group
- *glasa* (Ross)
- *jamaicensis* Flint
- *leonensis* Kelley
- *zeronia* Ross

Incertae sedis
- *elerobi* (Blickle)

[1] Primarily Palearctic.

order to see the distinguishing characters of many of these species. Details of the clearing procedure were provided by Ross (1944). Morphological nomenclature is based upon the work of Nielsen (1980). Species groups recognized herein (Table 2) have been modified from those of Marshall (1979). Voucher specimens are in the collections mentioned in Acknowledgments and in the Clemson University Insect Museum.

Three synonyms were discovered in the course of this research. Examination of specimens of *O. mirabilis* Morton from the British Museum (Natural History) showed them to be identical with *O. barnstoni* Harper. Type-specimens of both *O. arizona* Ross and *O. cirrifera* Flint were studied and found to be synonyms. Blickle (1980) did not mention *O. dualis* Morton in

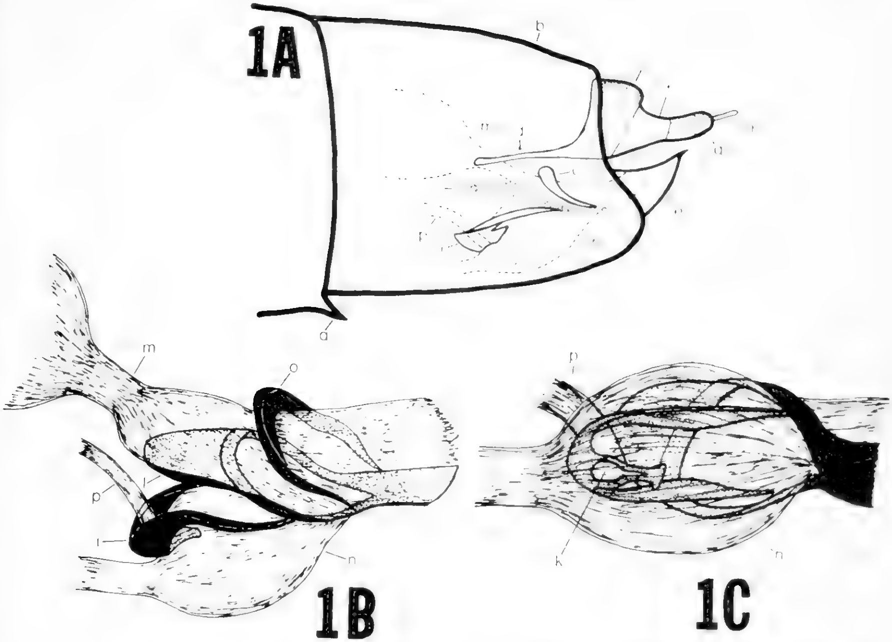


Fig. 1. Generalized views of genital segments of *Oxyethira* females. A, Left lateral view. B, Left dorsolateral oblique view of internal sclerites. C, Left ventrolateral oblique view of internal sclerites. a = apicomesal spur of segment VI; b = segment VII; c = tergum VIII; d = apodeme of tergum VIII; e = sternum VIII; f = tergum IX; g = tergum X; h = cercus; i = spermathecal sclerite; j = spermathecal process; k = foramen of spermathecal process; l = horizontal lamella; m = collaterial duct; n = venter of oviduct; o = posterior ring sclerite; p = spermathecal duct.

his diagnosis of *O. allosi* Blickle. A review of the illustrations of each species reveals their synonymy.

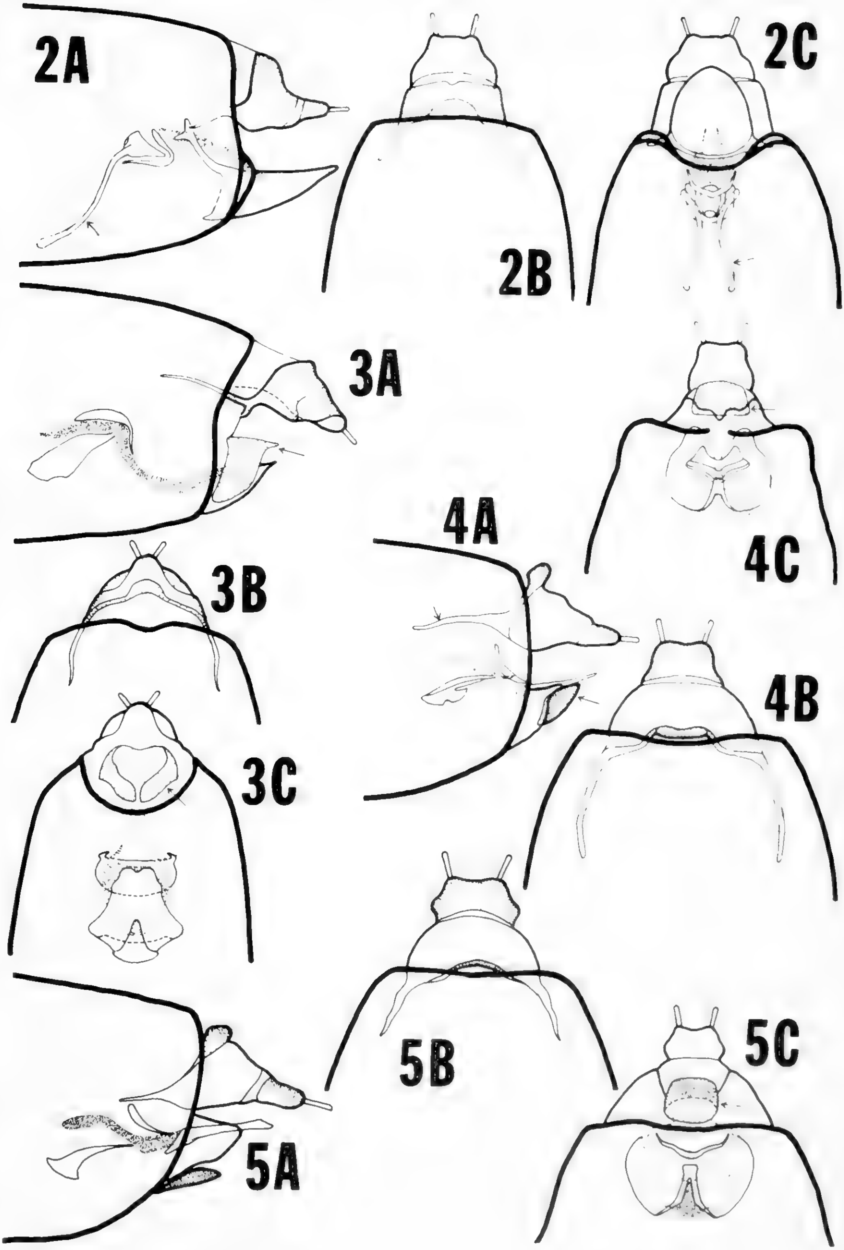
GENERAL MORPHOLOGY

Nielsen (1980) reviewed the internal and external anatomy of the genital segments of female Trichoptera, including the microcaddisfly genera *Agraylea, Hydroptila* and *Orthotrichia.* Although similar in general features to these genera, several modifications can be noted in *Oxyethira* (Fig. 1). In females of most species of the genus, segment VIII is incomplete with a short tergum. Laterally the segment narrows into apodemes which proceed anteriorly ⅓ to ½ the length of segment VII. Ventrally, segment VIII is represented by a short sternum which is sclerotized to various degrees in different species. In some species, sclerites are present on sternum VIII and still others have sternum VIII retracted within segment VII. Segment IX is reduced to a short, lightly sclerotized tergum. Tergum X is more heavily sclerotized with a pair of cerci distally.

Several sclerites are associated with the internal reproductive system (Figs. 1A–C). The spermathecal sclerite is similar to that of other Trichoptera with a spermathecal process originating anterioventrally. A keyhole-shaped foramen can be seen ventrally in the spermathecal process through which the spermathecal duct enters dorsally. The sclerotized dorsum of the oviduct, which Nielsen called the horizontal lamella, is prominent in most *Oxyethira* females. In many species the posteriolateral corners of this sclerite continue posterioventrally to encircle the oviduct and fuse ventrally, forming the floor of the oviduct. Immediately posterior to the horizontal lamella the collaterial duct enters the dorsum of the oviduct. Further posteriorly another sclerite nearly encircles the oviduct, although it is reduced to a membranous structure in many species. Nielsen did not mention a homolog for this sclerite in other hydroptilids; thus, we refer to it here as the "posterior ring sclerite." Species of the *azteca* group bear sclerotized processes supporting the oviduct ventrally which do not appear to be present in other species groups (Figs. 2A, C).

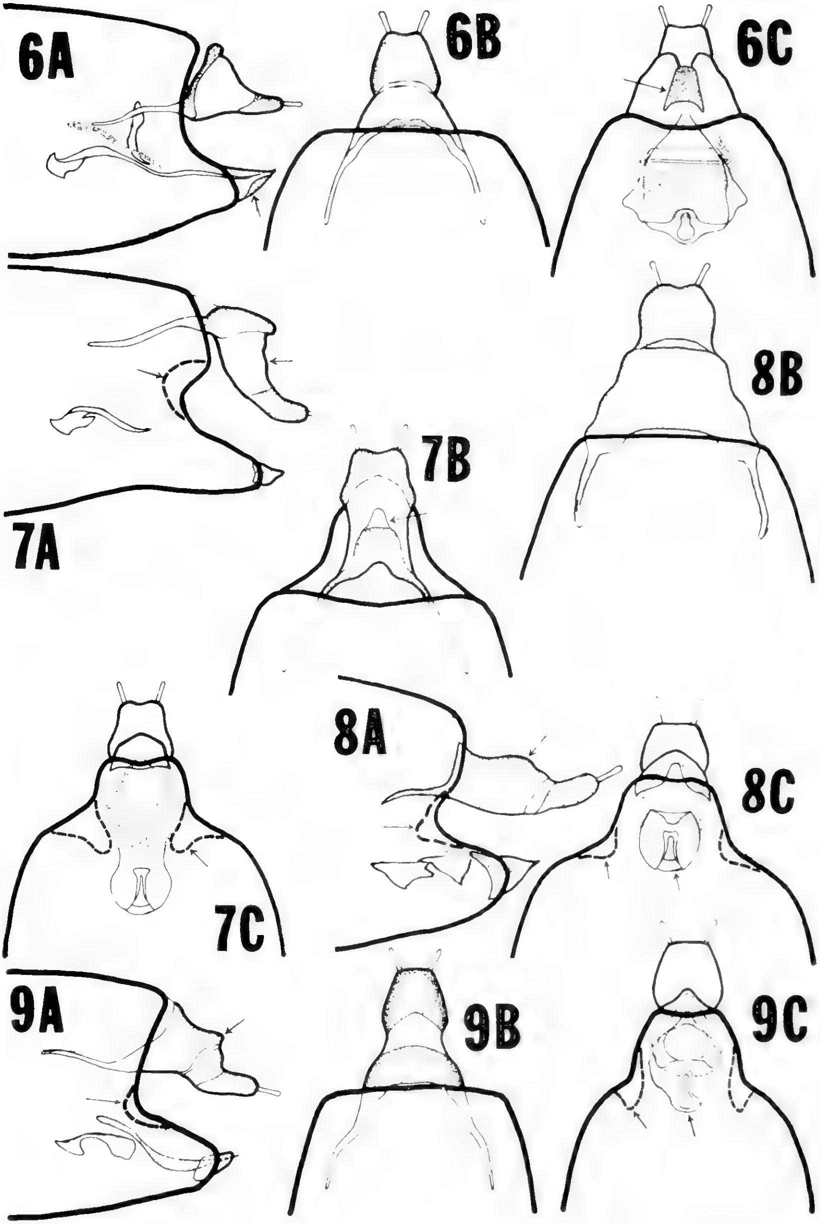
KEY TO THE FEMALE *OXYETHIRA* FROM THE SOUTHERN UNITED STATES

1. Pair of sclerotized parallel rods proceeding anterioventrally from spermathecal sclerite, nearly reaching sternum VII (Figs. 2A, C) .. .. *janella* Denning
– Pair of rods shorter or lacking beyond spermathecal sclerite (Figs. 3A, C) 2
2. Sternum VIII with 1 or 2 distinct sclerites ventrally (Figs. 3A, C; 4A, C) 3
– Sternum VIII without ventral sclerites, retracted within segment VII, or entire sternum moderately sclerotized (Figs. 22A, C) 6
3. Sternum VIII with ventral paired sclerites which are congruent anteriorly, diverging posteriorly (Figs. 3A, C); apico-mesal process lacking from sternum VI .... *elerobi* (Blickle)
– Sternum VIII with single sclerite (Figs. 4C; 6C); apico-mesal process present on sternum VI 4
4. Sternite VIII broad, as wide as, or wider than, long (Figs. 4C; 5C) 5
– Sternite VIII small, longer than wide, trapezoidal (Figs. 6A, C) ... . *dunbartonensis* Kelley
5. Apodemal rods of segment VIII proceeding anteriorly as far as, or farther than, spermathecal sclerite (Figs. 4A, B) ..... *novasota* Ross
– Apodemal rods of segment VIII not proceeding as far anteriorly as spermathecal sclerite (Figs. 5A, B) .... *grisea* Betten

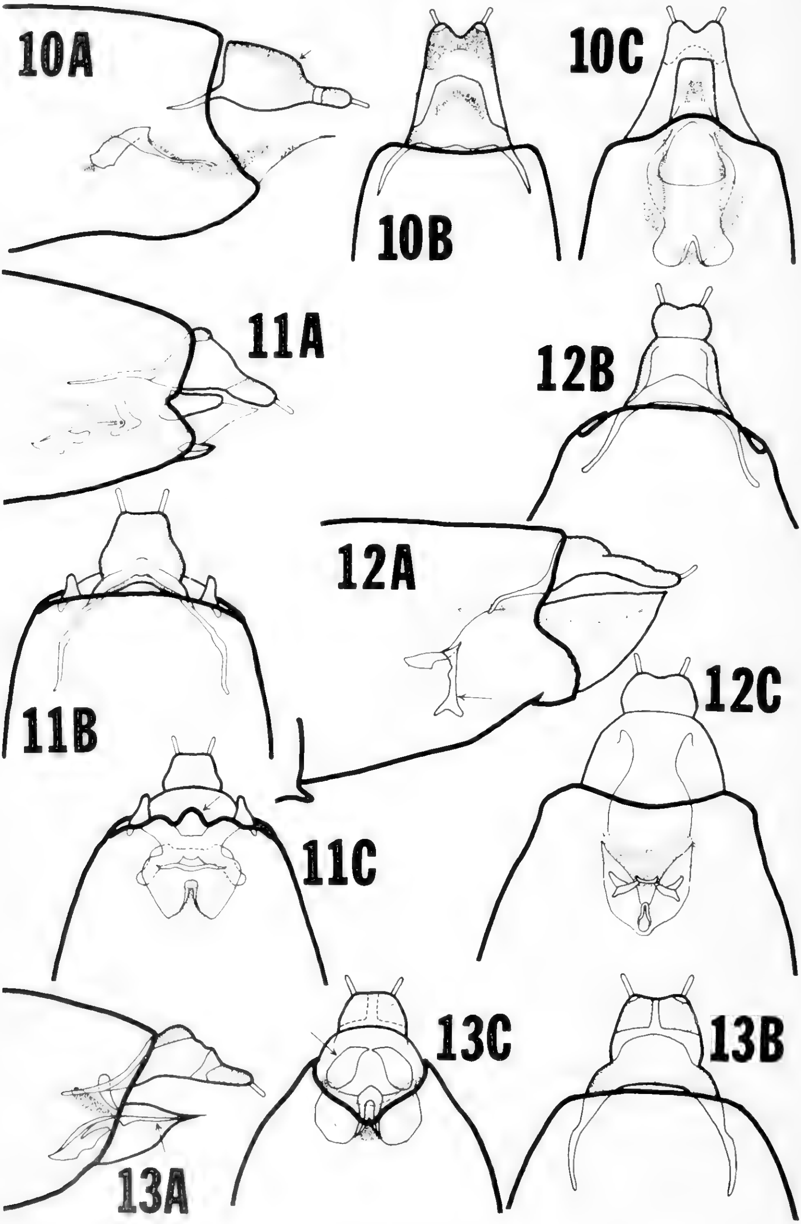


Figs. 2–5. Terminal abdominal segments of *Oxyethira* spp., females. 2, *O. janella*. 3, *O. elerobi*. 4, *O. novasota*. 5, *O. grisea*. A, Lateral. B, Dorsal. C, Ventral.

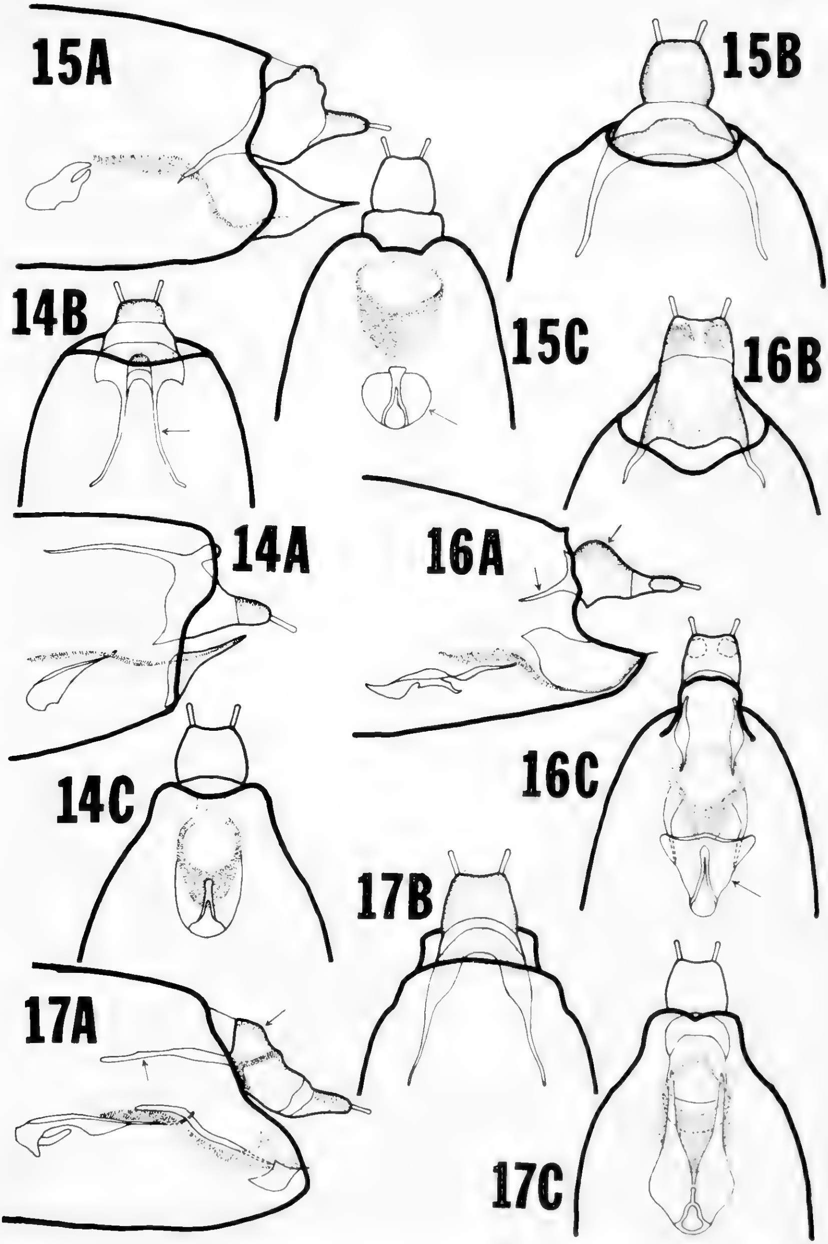
6. Segment VII infolded laterally (Figs. 7A, C; 8A, C; 9A, C) 7
– Segment VII not infolded laterally (Figs. 10A, C) 9
7. Tergum IX elongate (Fig. 7A); distal end of tergum VIII nipple-shaped in dorsal view (Fig. 7B) .... *arizona* Ross
– Tergum IX shorter (Figs. 8A; 9A); distal end of tergum VIII broadly rounded or truncate in dorsal view (Figs. 8B; 9B) 8
8. Spermathecal sclerite broadly rounded anteriorly (Fig. 8C); terga VIII and IX flattened dorsally in lateral view (Fig. 8A) .... *maya* Denning
– Spermathecal sclerite more acutely rounded anteriorly (Fig. 9C); tergum VIII with knoblike process dorso-distally and tergum IX proceeding ventrally from tergum VIII in lateral view (Fig. 9A) .... *pallida* (Banks)
9. Tergum VIII large, longer than wide; tergum IX reduced; tergum X heavily sclerotized (Figs. 10A, B) .... *glasa* (Ross)
– Tergum VIII small, wider than long; tergum X usually lightly sclerotized (Figs. 11B; 13B) 10
10. Posterior margin of sternum XII sinuate, with tongue-shaped process in ventral view (Fig. 11C) .... *rivicola* Blickle and Morse
– Posterior margin of sternum VII not both sinuate and tongue-shaped (Fig. 14C) 11
11. Sclerotized process proceeding ventrally from spermathecal sclerite, appearing distally forked in lateral and ventral views (Figs. 12A, C) .... *azteca* (Mosely)
– No such sclerite proceeding ventrally from spermathecal sclerite (Fig. 15A) 12
12. Posterior end of oviduct floor with paired sclerites (Figs. 13 A,C); paired, lightly sclerotized tergites on tergum X (Fig. 13B) .... *rossi* Blickle and Morse
– Oviduct floor without paired sclerites; sclerotized tergites usually absent from tergum X (Fig. 18C) 13
13. Terga VIII, IX and X and sternum VIII largely retracted within segment VII (Figs. 14A–C); apodemes of segment VIII nearly parallel in dorsal view and much nearer each other than to lateral walls of segment VII (Fig. 14B) .... *michiganensis* Mosely
– Terminal segments exserted in normal position, apodemes of VIII much farther apart (Fig. 17A) 14
14. Spermathecal sclerite visible as distinct oval structure in ventral view and set anteriorly to horizontal lamella (Figs. 15A, C) .... *sininsigne* Kelley
– Spermathecal sclerite not anterior to horizontal lamella and may or may not be oval (Fig. 14C) 15



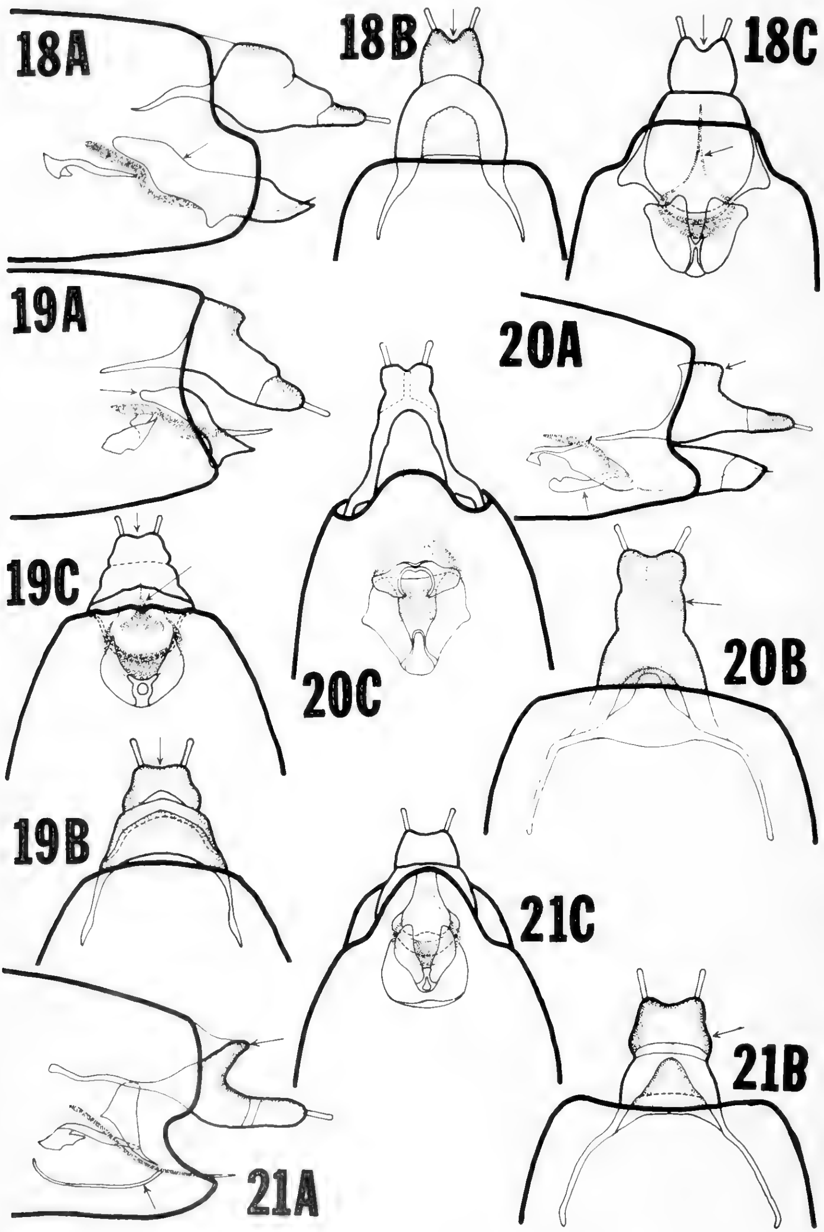
Figs. 6–9. Terminal abdominal segments of *Oxyethira* spp., females. 6, *O. dunbartonensis*. 7, *O. arizona*. 8, *O. maya*. 9, *O. pallida*. A, Lateral. B, Dorsal. C, Ventral.



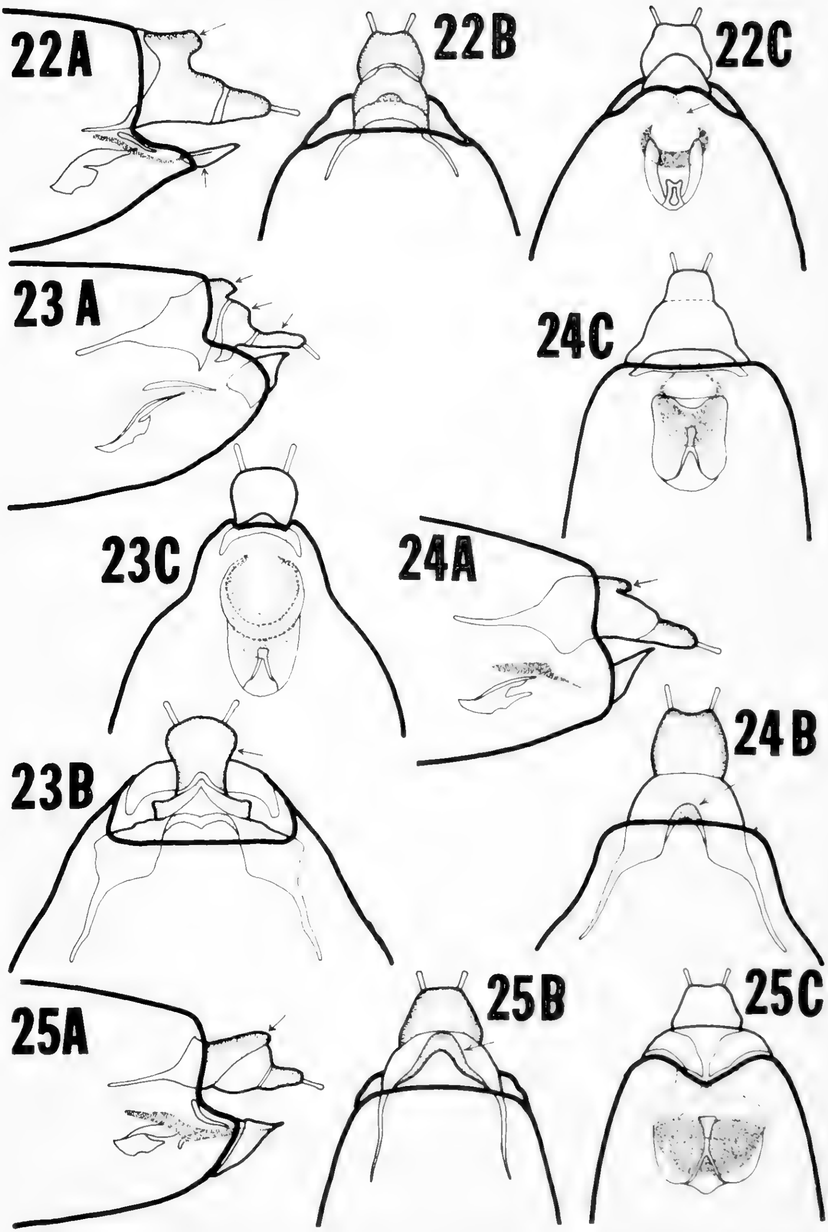
Figs. 10–13. Terminal abdominal segments of *Oxyethira* spp., females. 10, *O. glasa*. 11, *O. rivicola*. 12, *O. azteca*. 13, *O. rossi*. A, Lateral. B, Dorsal. C, Ventral.



Figs. 14–17. Terminal abdominal segments of *Oxyethira* spp., females. 14, *O. michiganensis*. 15, *O. sininsigne*. 16, *O. dualis*. 17, *O. abacatia*. A, Lateral. B, Dorsal. C, Ventral.



Figs. 18–21. Terminal abdominal segments of *Oxyethira* spp., females. 18, *O. florida*. 19, *O. aculea*. 20, *O. zeronia*. 21, *O. verna*. A, Lateral. B, Dorsal, C. Ventral.



Figs. 22–25. Terminal abdominal segments of *Oxyethira* spp., females. 22, *O. ulmeri*. 23, *O. serrata*. 24, *O. forcipata*. 25, *O. lumosa*. A, Lateral. B, Dorsal. C, Ventral.

15. Spermathecal sclerite extending anteriorly at least ⅔ the length of segment VII; tergum VIII broadly rounded dorsally in lateral view (Figs. 16A; 17A) 16
 – Spermathecal sclerite extending anteriorly less than ½ the length of segment VIII; tergum VIII with bulbous process dorsally (Figs. 24A; 25A) or acutely pointed (Figs. 20A; 21A) 17
16. Spermathecal sclerite triangular in ventral view (Fig. 16C); apodemes of segment VIII shorter than segment dorsally (Figs. 16A, B) . . . . *dualis* Morton
 – Spermathecal sclerite more nearly diamond-shaped in ventral view (Fig. 17C); apodemes of segment VIII long, much longer than segment dorsally (Figs. 17A, C) . . . . *abacatia* Denning
17. Floor of oviduct with sclerotized area attenuated posteriorly (Figs. 18C; 19C; 22C) 18
 – Sclerotized area on floor of oviduct broader posteriorly (Figs. 20C; 21C) 20
18. Sternum VIII extending anteriorly into segment VII to encircle oviduct and fuse dorsally (Figs. 18A; 19A); attenuate sclerite continuing posteriorly as spinelike process (Figs. 18C; 19C); tergum VIII rounded or pointed posterio-dorsally (Figs. 18A; 19A) 19
 – Sternum VIII not extending into segment VII (Figs. 22 A,C); attenuate sclerite not continuing posteriorly as spinelike process; tergum VIII with truncate process in lateral view (Fig. 22A) . . . . *ulmeri* (Mosely)
19. Tergum X moderately excised distally in dorsal view (Figs. 18B, C) . . . . *florida* Denning
 – Tergum X only slightly excised distally in dorsal view (Figs. 19B, C) . . . . *aculea* Ross
20. Apico-mesal process absent from venter VI or very minute; dorso-distal end of tergum VIII angulate in lateral view, dropping sharply posteriorly (Figs. 20A; 21A) 21
 – Apico-mesal process present on venter VI (Fig. 1A); dorso-distal end of tergum VIII bulbous 22
21. Tergum X with two sclerites dorsally (Fig. 20B); floor of spermatheca sclerotized only posteriorly (Figs. 20A, C); apex of tergum VIII angled at approximately 90° in lateral view (Fig. 21A) . . . . *zeronia* Ross
 – Tergum X only lightly sclerotized in a single plate (Fig. 21B); floor of spermatheca completely sclerotized, oval in ventral view (Figs. 21A, C); apex of tergum VIII protruding posterio-dorsally, acutely angled in lateral view (Fig. 21A) . . . . *verna* Ross
22. Tergum X widening distally in dorsal view (Figs. 23B, C); terga VIII, IX and X distinct (Figs. 23A, B) . . . . *serrata* Ross

– Tergum X narrowing distally in dorsal view; terga VIII, IX and X not clearly distinct (Figs. 24A, B; 25A, B) 23

23\. Distal end of tergum VIII not proceeding posteriorly as far as anterior end of tergum X in dorsal view (Figs. 24A, B) .... *forcipata* Mosely

– Distal end of tergum VIII proceeding posteriorly as far as anterior end of tergum X (Figs. 25A, B) .... *lumosa* Ross

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LITERATURE CITED

Blickle, R. L. 1979. Hydroptilidae (Trichoptera) of America north of Mexico. Bull. N.H. Agric. Exp. Stn. 509: 1–97.

———. 1980. A new *Oxyethira* (Hydroptilidae, Trichoptera) of the *aeola* Ross group; with a key to separate the five males of the group. Pan-Pac. Entomol. 56(2): 101–104.

Botosaneanu, L. 1979. The caddis flies (Trichoptera) of Cuba and of Isla de Piñes. Stud. Fauna Curacao Other Caribb. Isl. 59(185): 1–62.

Denning, D. G. 1947. Hydroptilidae (Trichoptera) from southern United States. Can. Entomol. 79: 12–20.

Flint, O. S. 1968a. The caddisflies of Jamaica (Trichoptera). Bull. Inst. Jam. Sci. Ser. 19: 1–68.

———. 1968b. Bredin-Archbold Smithsonian Biological Survey of Dominica, 9. The Trichoptera (caddisflies) of the Lesser Antilles. Proc. U.S. Natl. Mus. 125(3665): 1–86.

Kelley, R. W. 1981. New species of *Oxyethira* (Trichoptera: Hydroptilidae) from the southeastern United States. J. Ga. Entomol. Soc. 16(3): 368–375.

Marshall, J. E. 1979. A review of the genera of the Hydroptilidae (Trichoptera). Bull. Br. Mus. (Nat. Hist.) Entomol. 39(3): 135–239.

Nielsen, A. 1980. A comparative study of the genital segments and the genital chamber of female Trichoptera. Biol. Skr. Dan. Vid. Selsk. 23(1): 1–200.

Ross, H. H. 1944. The caddisflies, or Trichoptera, of Illinois. Ill. Nat. Hist. Surv. Bull. 23: 1–236.

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MARILOPTERYX CARANCAHUA, A NEW GENUS AND NEW SPECIES FROM EAST TEXAS (LEPIDOPTERA: NOCTUIDAE: HADENINAE)

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Abstract.—A new genus and new species of hadenine Noctuidae, ***Marilopteryx carancahua***, is described from East Texas. The genus includes one other species occurring in the United States, *lutina* (Smith), new combination, from Florida, and a few tropical American species, all of which, except *lamptera* (Druce), new combination, are apparently undescribed.

The new species described here is one of the very striking moths that have been collected in recent years in Texas; its description is to be attributed to both authors. The new genus has been in manuscript by the junior author for a long time, and its description is to be attributed to him.

Marilopteryx Franclemont, New Genus

Type-species.—*Agrotis lamptera* Druce, 1890, **new combination.**

Diagnosis.—A genus in the large American complex that includes *Eriopyga* Guenée, 1852, *Chabuata* Walker, 1857 [1858], *Orthodes* Guenée, 1852, and relatives. Hampson, 1905 (vol. 5, p. 313) placed *lamptera* in *Eriopyga* to which there is some superficial similarity, but he gave it a section by itself. The genitalia of both sexes, especially those of the male, are strikingly different from those of *Eriopyga*. The males of *Marilopteryx* have the genitalia of a more or less normal configuration although with some special modifications; those of the males of *Eriopyga* have the valves much less sclerotized, extended laterally, and deeply cleft. The females of *Marilopteryx* have the sternum of the seventh abdominal segment highly modified and heavily sclerotized; those of *Eriopyga* have the sternum of the seventh abdominal segment little or not modified and no more heavily sclerotized than those of the other segments.

Description.—Head with vestiture deep, front rounded, ridge of scales above antennae, male antenna pubescent, with fine, short, closely set setae of more or less equal length, female antenna with shorter pubescence, eye with hairs over entire surface, palpus with 1st segment short, 2nd segment moderate, upcurved to about middle of eye, 3rd segment short, porrect, haustellum well developed, strong; thorax with vestiture of hairlike scales and narrow, forked scales, a prominent median, longitudinal ridge from behind patagia, venation as figured by Hampson (1905, text fig. 70, p. 313), forewing with R_1 from beyond middle of discal cell, R_2 from near apex of accessory cell, R_3 and R_4 short stalked from apex of accessory cell, R_5 connate with stalk of $R_3 + R_4$, M_1 from upper angle of discal cell, hindwing with Rs and M_1 connate from upper angle of discal cell, M_2 obsolescent, M_3 and Cu_1 connate from lower angle of discal cell, discocellular veins more or less erect, legs of male with large tufts on femora and tibiae, especially the latter, tarsi with 3 rows of spines beneath, abdomen with vestiture of long hairlike scales overlying flat scales, male with evident lateral tufts on segments 1 through 6, dorsal tufts on segments 1 through 3, conspicuous caudal tufts, last sternum with large, spreading tuft from pocket, 1st sternum modified, usually with lateral hair-pencil on each side, female without tufts except those on dorsum, last sternum, 7th segment, highly modified, heavily sclerotized.

Male genitalia.—The species agree in basic structure with *carancahua* but with various individual modifications of tegumen, uncus, and aedoeagus. (The type of the genus, *lamptera,* is most similar to *carancahua.*)

Female genitalia.—The species agree with *carancahua,* differing in modifications of 7th abdominal sternum, sclerotization of ductus bursae, shape of bursa, and shape of appendix bursae.

Remarks.—The species of the genus are mostly dull reddish or reddish-brown moths with some grayish overtones; the new species described here has most of the examples grayish with a pink tint, but there are some reddish-brown ones, thus the name *Marilopteryx* (ember + wing).

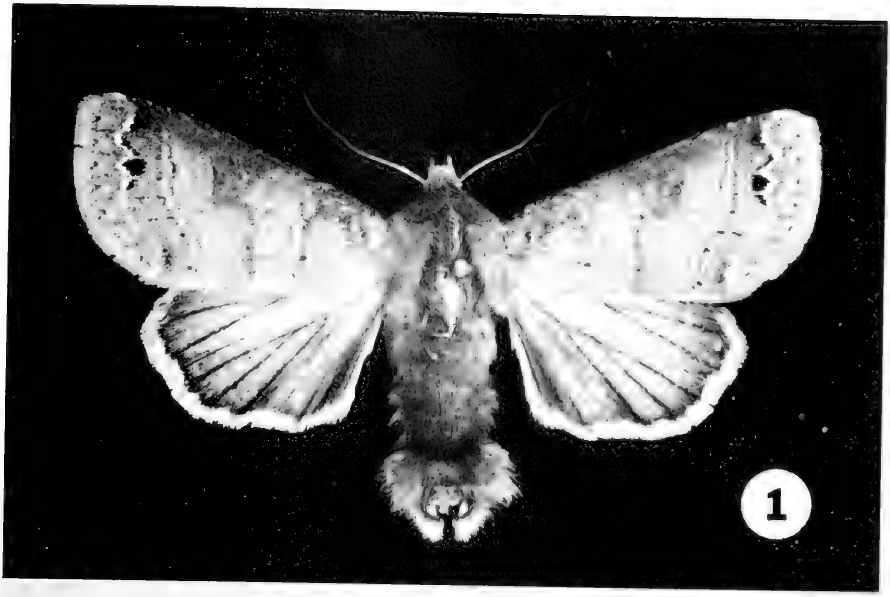
In addition to the type-species and the new species the genus contains *Leucania lutina* Smith, 1902, **new combination** (*L. velutina* Smith, 1900, preoccupied), placed in *Tricholita* by McDunnough (1938: 73) and three or four undescribed species from the American tropics.

Marilopteryx carancahua Blanchard and Franclemont, New Species

Figs. 1–6

Diagnosis.—This species is most closely related to *lamptera* and an apparently undescribed species from Panama. It differs from *lamptera* in many obvious characters of the male genitalia. The expansion of the penicillus of the tegumen is highly rugose in *carancahua*; it is not rugose in *lamptera.* The upper lobe of the vinculum of *lamptera* is widely expanded, but that of *carancahua* is not. The cuculli of the valves of *carancahua* are two times the width of those of the valves of *lamptera*; the expanded lobe of the right valve of *lamptera* is ligula-like in shape, not racquet shaped as is that of *carancahua*; the lobe of the left valve of *lamptera* is two times as wide as that of *carancahua*, and *lamptera* has an additional small, rounded lobe at the angulation of the cucullus with the longitudinal axis of each valve, but in *carancahua* in addition to the absence of the small lobe, the angulation of the cucullus is absent, and the cucullus is on the longitudinal axis of each valve. The vesica of the aedoeagus of *lamptera* has a single cornutus, not two cornuti as in *carancahua*. The male genitalia of the undescribed species from Panama have the rugose lobes of the penicilli smaller, the lobes of the valves much different in shape, and the uncus with two long projections. The only other species, *lutina*, occurring in the United States differs from *carancahua* in having the male genitalia with very small cuculli, very small lobes on the valves, and a narrow uncus. The females of *carancahua, lutina*, and *lamptera* have the seventh abdominal sternum of the same basic confirmation; that of *carancahua* is more or less quadrate with the apical excavation broad; that of *lutina* is somewhat oval, flattened at the base, and with the excavation narrow; and that of *lamptera* has the lobes prolonged and the excavation broad. The ductus bursae of *lutina* and that of *lamptera* are longer and narrower than that of *carancahua*; the appendix bursae of *lutina* is much longer than those of *carancahua* and *lamptera*; *lutina* has a separate, longitudinal, sclerotized plate near the origin of the appendix bursae. The female of the Panamanian species is not known to us. Superficially *carancahua* is unique in the possession of the conspicuous black spot in the subterminal line and the somewhat sinuous, slightly irregular antemedial and post medial lines which in all the other species, except the Panamanian, are straight from costa to inner margin.

Description.—Head, patagia, disc of thorax, and tegulae concolorous with ground color of forewing, palpus with 1st and 2nd segments reddish black, upper margin of 2nd segment and all of 3rd segment light tan, all segments with some reddish scales, behind, below, and in front of eye black, pale above; forewing varying from ashy, olive gray with just a faint pinkish tinge to dark vinaceous red, color uniform on any one specimen, all steps in variation present from extremes, basal, antemedial, and postmedial lines double, filling between darker lines ground color or slightly paler, basal line traceable from costa to cubital vein, outer of 2 lines often faint, antemedial line crenulate, forming 3 loops, black dots on vague outer line on Cu and 2nd A, postmedial line slightly excurved to M_3 then incurved to inner margin, vague outer line followed by black points on veins M_1 through 2nd A, often with an indication of one on R_5, median shade often obsolescent, dusky, angled from costa to inner side of reniform then straight to inner margin, subterminal line irregularly wavy, paler than ground, often with considerable white scaling, conspicuous black spot on inner side of subterminal line between veins M_1 and M_2, often with smaller black spots between



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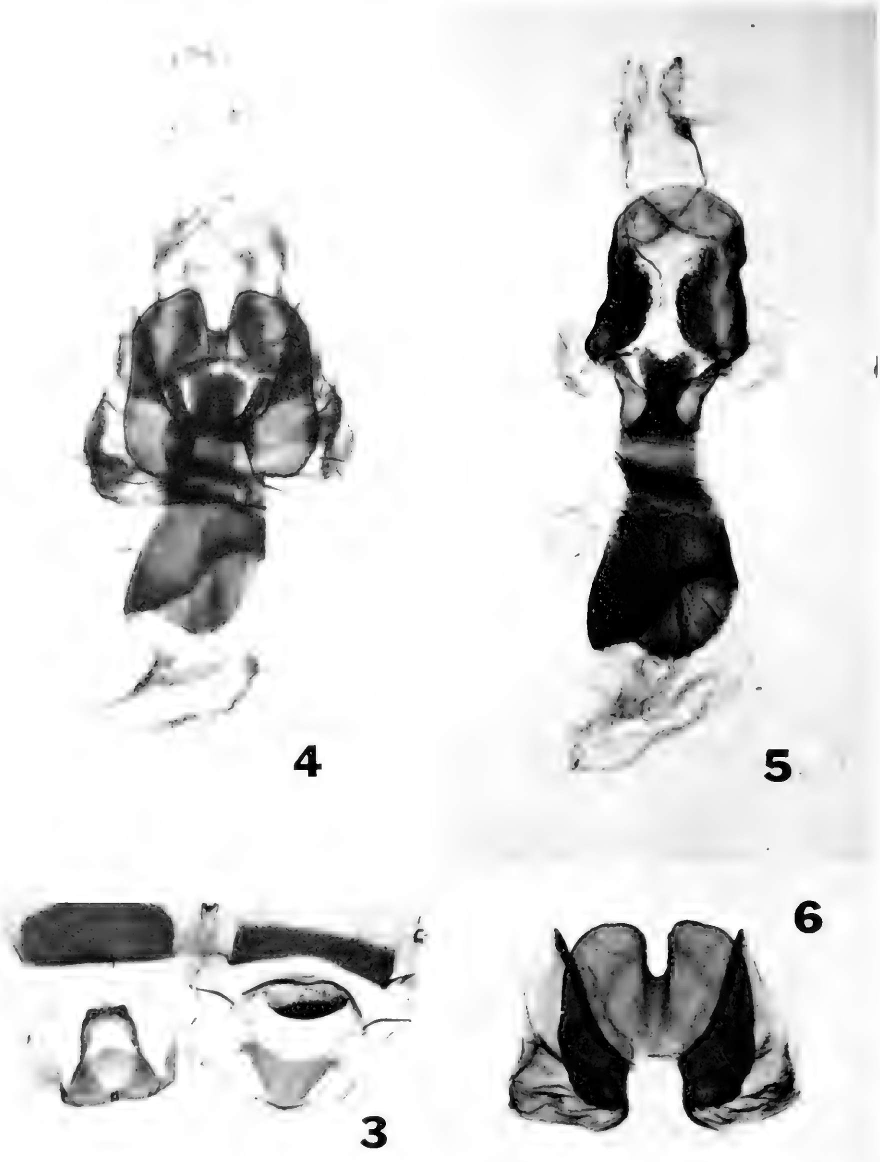
Figs. 1, 2. *Marilopteryx carancahua*. 1, Holotype, Deutchburg, Jackson Co., Texas, 6 March 1975, A. & M. E. Blanchard; collection USNM. 2, Male genitalia with aedoeagus removed, aedoeagus with vesica everted at right; genitalia slide AB 3618.



Figs. 3–6. *Marilopteryx carancahua*. 3, Male abdomen, 8th abdominal segment, sternum (right) and tergum (left); genitalia slide AB 3618. 4, Female genitalia, 7th abdominal segment in place; genitalia slide AB 3279. 5, Female genitalia, 7th abdominal segment removed; genitalia slide AB 3620. 6, Female, 7th abdominal segment, modified sternum; genitalia slide AB 3620.

veins M_2 and M_3 and between veins R_5 and M_1, sometimes other small black spots toward costa, terminal line a series of small black dots in the interspaces between the veins connected by a very fine, dentate, black line, fringe concolorous with ground, reniform and orbicular large, with inconspicuous, pale annuli, reniform barely darker than ground; orbicular no darker than ground, often not discernible; hindwing much less variable than forewing, vinaceous gray, heavily infuscate toward outer margin, veins contrasting, blackish, discal dot moderate, fringe pinkish; dorsum of abdomen tending to agree in color with ground of forewing, with some darker scales and hairlike scales, terminal and lateral tufts of male with a decided reddish tint. Beneath: forewing dark gray, paler toward extreme base, a conspicuous postmedial line and discal spot, veins pale scaled beyond postmedial line; hindwing sordid, pinkish gray, darker beyond conspicuous, dark, punctate postmedial line, discal spot punctiform, dark, fringe of both wings much as above, of hindwing less contrasting.

Expanse.—Male, 36.5–40.5 mm, female, 35.4–41.4 mm; forewing length 20.5–23 mm.

Male genitalia.—As figured; Fig. 3 illustrates sclerotized areas of tergum and sternum of 8th abdominal segment, sternum, on right, shows pocket (dark) from which large tuft arises.

Female genitalia.—As figured; Fig. 4 illustrates genitalia with 7th sternum in place; Fig. 5 illustrates genitalia with sternum removed, sclerotization of ductus bursae visible, ligulate plate, excavated at apex, is on back (upper) wall of ductus; Fig. 6 illustrates the modified 7th sternum, a more or less quadrate ventral plate with wide apical excavation and 2 apically pointed, more dorsad, lateral plates.

Holotype.—Male (Fig. 1). Deutchburg [near Carancahua Creek], Jackson County, Texas, 6 March 1975, A. & M. E. Blanchard. In the National Museum of Natural History, Washington, D.C.

Paratypes.—45 ♂, 10 ♀; 54: Deutchburg, Jackson County, Texas, 14 March 1975 (1), 18 March 1974 (8), 3 March 1975 (18), 6 March 1975 (26), 15 March 1977 (1); 1: Eagle Lake, Colorado County, Texas, 27 April 1978; A. & M. E. Blanchard. Paratypes are in the following collections: American Museum of Natural History, New York (2), British Museum (Natural History), London (2), Canadian National Collection, Ottawa (2), National Museum of Natural History (27), A. Blanchard (12), E. C. Knudson (2), J. G. Franclemont (8).

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LITERATURE CITED

Druce, H. 1890. Descriptions of new species of Lepidoptera Heterocera from Central and South America. Proc. Zool. Soc. (London), 1890: 493–520, pl 42 & 43.

Hampson, G. F. 1905. Catalogue of the Lepidoptera Phalaenae in the British Museum. Volume 5; xvi + 634 pp. Trustees of the British Museum (Natural History), London.

McDunnough, J. H. 1938. Check List of the Lepidoptera of Canada and the United States of America, Part 1, Macrolepidoptera. Mem. South Calif. Acad. Sci. Vol. 1, 174 pp.

Smith, J. B. 1900. A hundred new moths of the family Noctuidae. Proc. U.S. Natl. Mus. 22: 413–495.

———. 1902. Contributions toward a monograph of the Lepidopterous family Noctuidae of Boreal North America. A revision of the moths referred to the genus *Leucania,* with descriptions of new species. Proc. U.S. Natl. Mus. 25: 159–209.

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OVOVIVIPARITY IN THE BLATTELLID COCKROACH, *SYMPLOCE BIMACULATA* (GERSTAECKER) (DICTYOPTERA: BLATTARIA: BLATTELLIDAE)

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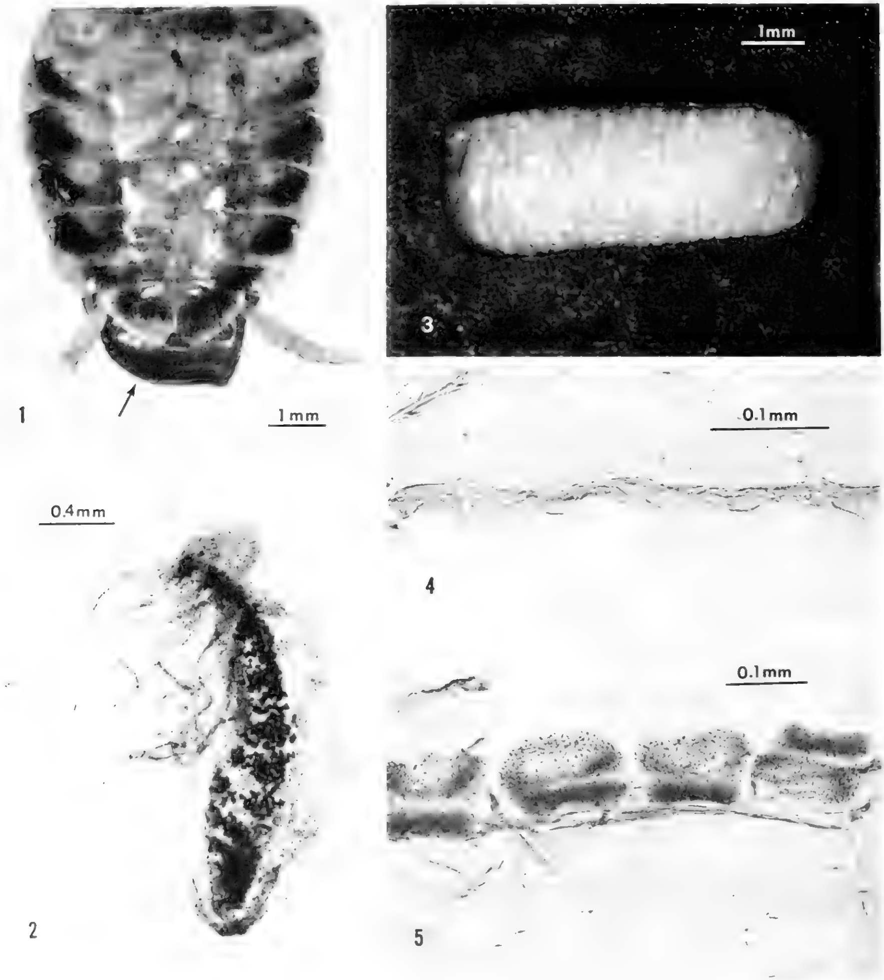
Abstract.—The only cockroach genera considered to be ovoviviparous belong to the Blaberidae. However, the African blattellid, *Symploce bimaculata* (Gerstaecker), is ovoviviparous. Apparently ovoviviparity arose independently in both the Blattellidae and Blaberidae. *Symploce capitata* (Saussure) is a new synonym of *S. pallens* (Stephens).

According to McKittrick (1964), cockroaches have evolved along two phyletic lines, the superfamilies Blaberoidea and Blattoidea. Species in the former group evolved ovoviviparity and viviparity, whereas the Blattoidea remained oviparous. McKittrick's hypothesis is supported by considerable biological evidence (Roth, 1970).

During the course of evolution of ovoviviparity in the Blattaria, the oötheca changed from a hard, rigid egg case that was dropped shortly after its formation, to a soft, flexible, reduced structure which was retracted into a uterus or brood sac. Such changes have taken place in the Blaberoidea (Polyphagidae, Blattellidae, and Blaberidae), which evolved internal incubation, but not in the Blattoidea (Cryptocercidae and Blattidae) (Roth, 1968a, 1971).

Because species of *Blattella* carry their oöthecae externally for about the entire embryogenetic period, Roth and Willis (1958) suggested that the *Blattella* type of oviposition behavior is an intermediate stage between oviparous and ovoviviparous forms. Two other blattellid genera, *Chorisia* and *Onycholobus* have similar oöthecae and oviposition behavior (Roth, 1968a, 1971). After studying the ovarioles of various species of Blattaria, I (Roth, 1968b, 1970) suggested two possible pathways within the Blattellidae that led to ovoviviparity in the Blaberidae. At that time, the available evidence indicated that only the Blaberidae are ovoviviparous or viviparous [only *Diploptera punctata* (Eschscholtz) is known to be viviparous, but presumably the other species of *Diploptera* are also].



Figs. 1–5. *Symploce bimaculata.* 1, Abdomen (dorsal) of a pregnant female showing the end of the oötheca (arrow) protruding slightly beyond the supraanal plate. 2, Embryo removed from an oötheca that was carried internally in the brood sac. 3, Oötheca removed from the uterus. 4, Part of the keel region of an oötheca showing the absence of respiratory tubules and calcium oxalate crystals. 5, Spongy bodies in the keel region of the oötheca. Figures 2, 4, and 5 are chitin preparations.

Recently while working on a taxonomic revision of the blattellid genera *Blattella* and *Symploce*, I found several female specimens of the African *Symploce bimaculata* (Gerstaecker) that had oöthecae internally in a uterus (Fig. 1). The egg cases occupy practically the entire abdominal cavity, as they do in pregnant blaberids. Shelford (1910) stated that the oötheca of *S.*

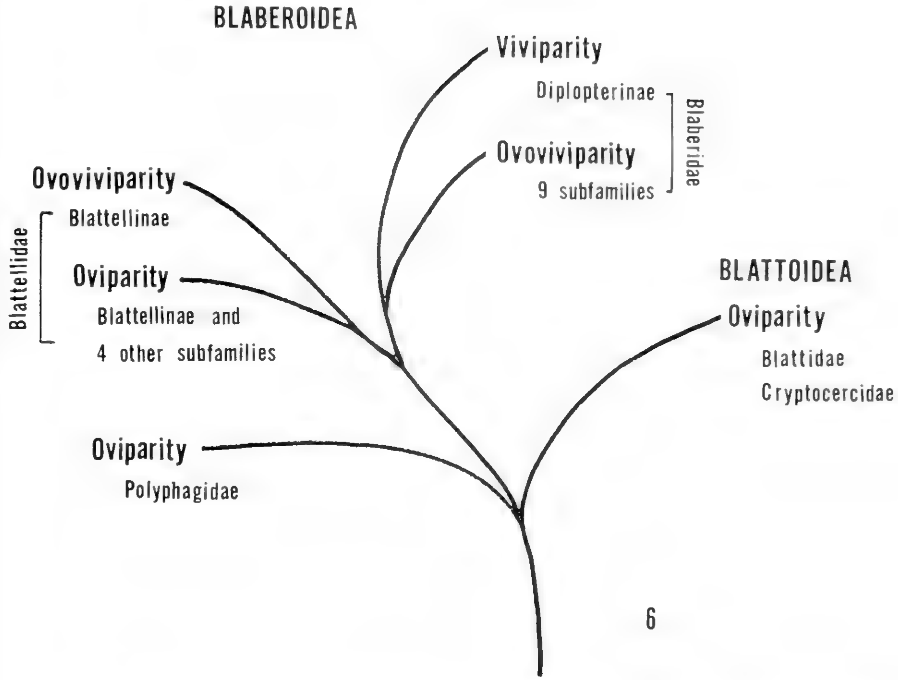


Fig. 6. Phylogenetic tree of the Blattaria (abbreviated and modified from McKittrick, 1964), showing the evolution of ovoviviparity and viviparity.

bimaculata is similar to that of *Blattella germanica* (L.), but he did not indicate that it is carried internally.

Two of the oöthecae of *bimaculata* contained 38 and 40 eggs, which, in the latter, contained developing embryos (Fig. 2). Superficially the oötheca resembles that of species of *Blattella* but is more transparent throughout (Fig. 3; however, the portion near the end of the female's body is slightly darker than the remainder of the egg case), and its keel is further reduced and lacks respiratory tubules (Fig. 4). The spongy bodies in the interior of the seam (Fig. 5) are still present and are similar to those of *Blattella germanica* (Lawson, 1951). Calcium oxalate crystals are completely absent from the walls of the egg case. The oöthecae of various species of *Blattella* may have a few calcium oxalate crystals, or none at all (Roth, 1968a). That *Symploce bimaculata* incubates its eggs internally shows that ovoviviparity actually has evolved independently in at least two families of the Blaberoidea, the Blattellidae and Blaberidae (Fig. 6).

Symploce pallens (Stephens) [=*Symploce capitata* (Saussure), **new synonymy**] is oviparous and deposits its oötheca shortly after its formation. The hard, rigid oöthecae of *Symploce ruficollis* (F.) (reported as *Symploce* *bilabiata* Rehn and Hebard), and *Symploce jamaicana* Rehn, both of which contain large amounts of calcium oxalate crystals, indicate that these species also are oviparous (Roth, 1968a). Several species of African *Symploce* have oöthecae and oviposition behavior similar to species of *Blattella,* but these actually belong to the latter genus (unpublished data). That *Symploce bimaculata* is ovoviviparous suggests that it is not a *Symploce,* and based on male characters, I believe, should be removed from that genus, which I have done elsewhere (Roth, *in press*).

There are about 209 genera and about 1740 species of Blattellidae, and approximately 155 genera, and about 1020 species of Blaberidae, The oviposition behavior of relatively few genera and species in these two families is known. Probably other genera of blattellids will be found that are ovoviviparous. I (Roth, 1970: 79) stated that "It would be safe to say that any species which carries its egg case internally is a blaberid . . . ." I should have known better than to be so dogmatic, and I would not be too surprised if oviparous blaberids are eventually found.

Acknowledgment

I thank Inge Persson of the Swedish Museum of Natural History, Stockholm, for the series of specimens of *Symploce bimaculata*.

Literature Cited

Lawson, F. A. 1951. Structural features of the oöthecae of certain species of cockroaches (Orthoptera, Blattidae). Ann. Entomol. Soc. Am. 44: 269–285.

McKittrick, A. F. 1964. Evolutionary studies of cockroaches. Cornell Univ. Agric. Exp. Stn. Mem., No. 389, 197 pp.

Roth, L. M. 1968a. Oöthecae of the Blattaria. Ann. Entomol. Soc. Am. 61: 83–111.

———. 1968b. Ovarioles of the Blattaria. Ann. Entomol. Soc. Am. 61: 132–140.

———. 1970. Evolution and taxonomic significance of reproduction in Blattaria. Annu. Rev. Entomol. 15: 75–96.

———. 1971. Additions to the oöthecae, uricose glands, ovarioles, and tergal glands of Blattaria. Ann. Entomol. Soc. Am. 64: 127–141.

———. *In press. Stayella,* a new genus of ovoviviparous blattellid cockroaches from Africa (Dictyoptera: Blattaria: Blattellidae). Entomol. Scand.

Roth, L. M. and E. R. Willis. 1958. An analysis of oviparity and viviparity in the Blattaria. Trans. Am. Entomol. Soc. 83: 221–238.

Shelford, R. 1910. Wissenschaftliche Ergebnisse der Schwedischen Zoologischen Expedition nach dem Kilimandjaro, dem Meru und den Umgebenden Massaisteppen Deutsch-Ostafrikas 1905–1906, Dr. Yngve Sjöstedt. 17. Orthoptera. 2. Blattodea. Königl. Schwed. Akad. Wissen. (1907), 3 (17.2): 13–48.

PROC. ENTOMOL. SOC. WASH.
84(2), 1982, pp. 281–296

A REVISION OF *EUSCHISTUS* DALLAS SUBGENUS *LYCIPTA* STÅL (HEMIPTERA: PENTATOMIDAE)

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Abstract.—The subgenus *Lycipta* Stål of *Euschistus* Dallas is redefined and five species, one of them new, are added to it. *Euschistus* (*Lycipta*) ***machadus***, n. sp., is described, *E.* (*L.*) *luridus* (Dallas) is transferred from *Agroecus*, and *E. aceratos* Berg is placed in the synonymy of this species. A key is given for species of the subgenus.

The subgenus *Lycipta* of the genus *Euschistus* contains ten South American species from the southern temperate zone and bordering tropics. One species, *E. cornutus* Dallas, seems to be the most abundant South American member of the genus.

Stål (1862a) proposed *Lycipta* as a genus to contain three species which earlier (1860) he had placed in *Euschistus*; but in his work on the Hemiptera of Mexico, which also appeared in 1862, he demoted *Lycipta* to subgeneric rank by describing *E.* (*Lycipta*) *spurculus*. A decade later Stål (1872) corrected his initial placement of *E. spurculus* by relocating this species in the nominate subgenus. At the same time he retrieved one of the species, now *Agroecus scabricornis* (Herrich-Schäffer), from those that he originally placed in *Lycipta* and included this species among the "species incerti generis." Also, he added three more species to the subgenus *Lycipta*. From then until now *Lycipta* has included only the five South American species assigned to it by Stål: *E. triangulator* (Herrich-Schäffer), *E. illotus* Stål, *E. cornutus* (Dallas), *E. cribrarius* Stål, and *E. picticornis* (Stål). Of the ten species under consideration, only the above five were known to Stal.

Five additional species are here added to the subgenus: *E. circumfusus* Berg, *E. imitator* Berg, *E. luridus* (Dallas), *E. machadus*, n. sp., and *E. sharpi* Bergroth. *Euschistus luridus* is transferred from *Agroecus* and is a senior synonym of *Euschistus aceratos* Berg.

***Euschistus* subgenus *Lycipta* Stål**

Lycipta Stål, 1862a: 58.
Euschistus (*Lycipta*): Stål, 1862b: 100; Stål, 1872: 23; Kirkaldy, 1909: XXIX.

Type-species.—*Cimex triangulator* Herrich-Schäffer, 1842: 95, fig. 667 (by subsequent designation, Kirkaldy, 1909: XXIX).

Diagnosis.—Lateral walls of genital cup consisting in part of inflatable membrane located just beneath rim of cup and turning ventrad near anterior wall of cup (Fig. 11). Penisfilum coiled (Fig. 12). Thecal processes incrassate basally (Fig. 13). Spermatheca with secondary dilation at base of proximal flange; duct bent rather abruptly at proximal end of primary dilation, often with funnel shaped pigmented area enclosing base of dilation and bend of duct (Fig. 15). Apex of head incised between each jugum and tylus (Fig. 7).

Comments.—The partially membranous lateral walls of the genital cup, which appear as a white cushion when inflated, are apparently unique within *Euschistus*. The secondary dilation of the spermatheca basad of the proximal flange may also be unique to *Lycipta*, although the spermatheca of many *Euschistus* species has not been examined. However, the incisions in the apex of the head, one between each jugum and the tylus, also occur in at least some specimens of *E. quickua* Pirán and *E. rufimanus Stål.*

The spermatheca of eight of the ten species of *Lycipta* were examined, but no females of *E. cribrarius* or *E. sharpi* were available for dissection.

The subgenus is remarkable in that it contains three species pairs, each pair with virtually identical genitalia but with non-genitalic differences that are apparently consistent. While such genitalic similarity among species arouses suspicion that the forms may represent disjunct variation of a single species, a comparable situation exists within the *servus* group of *Euschistus* species in North America, and in the latter instance genetic isolation, although incomplete, has been demonstrated (Sailer, 1954). It would be desirable to subject the members of these three species pairs to tests for genetic isolation. Until such testing is done the status of the form most recently named in each pair is likely to remain in doubt. The species involved are: *luridus* and *cribrarius*; *circumfusus* and *imitator*; and *triangulator* and *picticornis*.

KEY TO SPECIES OF SUBGENUS *LYCIPTA*

1. Venation in membrane of hemelytra simple or branched with only 1 or 2 closed cells at most; male with conspicuous tuft of setae at posterolateral corners of genital cup in addition to scattered setae (Fig. 2) 2
– Venation in membrane of hemelytra reticulate or if not scutellum

bearing small black macule on each side of apex; setal tufts inconspicuous or absent 6

2(1). Three irregular black vittae on abdominal venter, 1 median and 1 on each side; veins in membrane of hemelytra with many short branches (Fig. 1) . . . . *illotus* Stål

– Abdominal venter lacking vittae; veins in membrane of hemelytra sparsely branched 3

3(2). Margins of connexiva alternated, pale with black macules at transverse sutures . . . . *machadus*, new species

– Connexiva without macules 4

4(3). Humeral angles spinose, turned obliquely forward (Fig. 16) . . . . *imitator* Berg

– Humeral angles obtuse 5

5(4). Denticles on anterolateral margin of pronotum red or yellow; connexiva entirely dark or with yellow margin . . . . . . *circumfusus* Berg

– Denticles black; connexiva entirely pale . . . . *sharpi* Bergroth

6(1). Apex of scutellum covered with large pale spot 7

– Apex of scutellum not strongly differentiated by color 8

7(6). Last 2 antennal segments predominately reddish; apex of scutellum usually somewhat reflexed . . . . . *triangulator* (Herrich-Schäffer)

– Last 2 antennal segments predominately blackish; apex of scutellum not reflexed . . . . *picticornis* Stål

8(6). Humeri cornute, apically obtuse, projecting anterolaterad about as far forward as base of head (Fig. 33); apex of scutellum with small black mark on each side . . . . *cornutus* Dallas

– Humeri not cornute; apex of scutellum uniformly colored 9

9(8). Humeri produced laterad of base of coria by width of eye or less, obtuse . . . . *luridus* (Dallas)

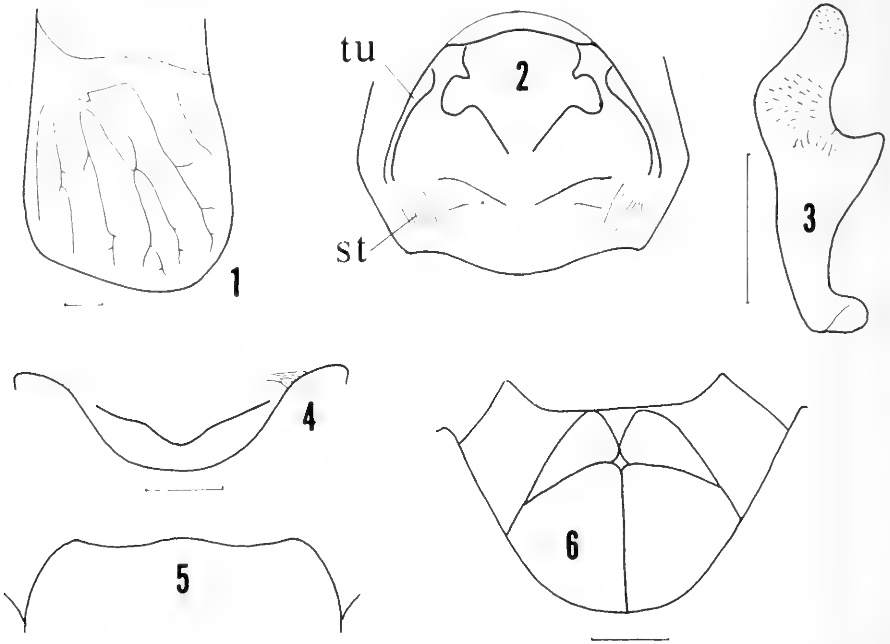
– Humeri produced laterad of base of coria by about 1.5× width of eye, acute . . . . *cribrarius* Stål

***Euschistus (Lycipta) illotus* Stål**

Figs. 1–6

Euschistus illotus Stål, 1860: 19.
Lycipta illotus: Stål, 1862a: 58 (listed).
Euschistus (*Lycipta*) *illotus:* Stål, 1872: 24 (keyed, descriptive note).

Veins in hemelytral membranes with many short branches but forming few or no closed cells (Fig. 1). Three irregular vittae present on abdominal venter, 1 median (sometimes tenuous) and 2 lateral, formed by black patches. Gonocoxae 2 not evident (Fig. 6). Emargination in posterior pygophoral margin broad and moderately deep from caudal view (Fig. 4),



Figs. 1–6. *Euschistus* (*L.*) *illotus*. 1, Membrane of right hemelytron. 2, Genital cup, proctiger and parameres removed; tuft of setae (st); tumescence (tu). 3, Paramere. 4, Posterior pygophoral margin, caudal view. 5, Same, ventral view. 6, Genital plates, caudoventral view. Dimensional lines equal 0.5 mm.

sinuous from both ventral and dorsal views (Figs. 2, 5). Cup of paramere densely setose, apex minutely ridged (Fig. 3).

Distribution.—Argentina (Misiones); Brazil (Espirito Santo, Mato Grosso, São Paulo, Santa Catarina, Rio de Janeiro); Paraguay; Bolivia.

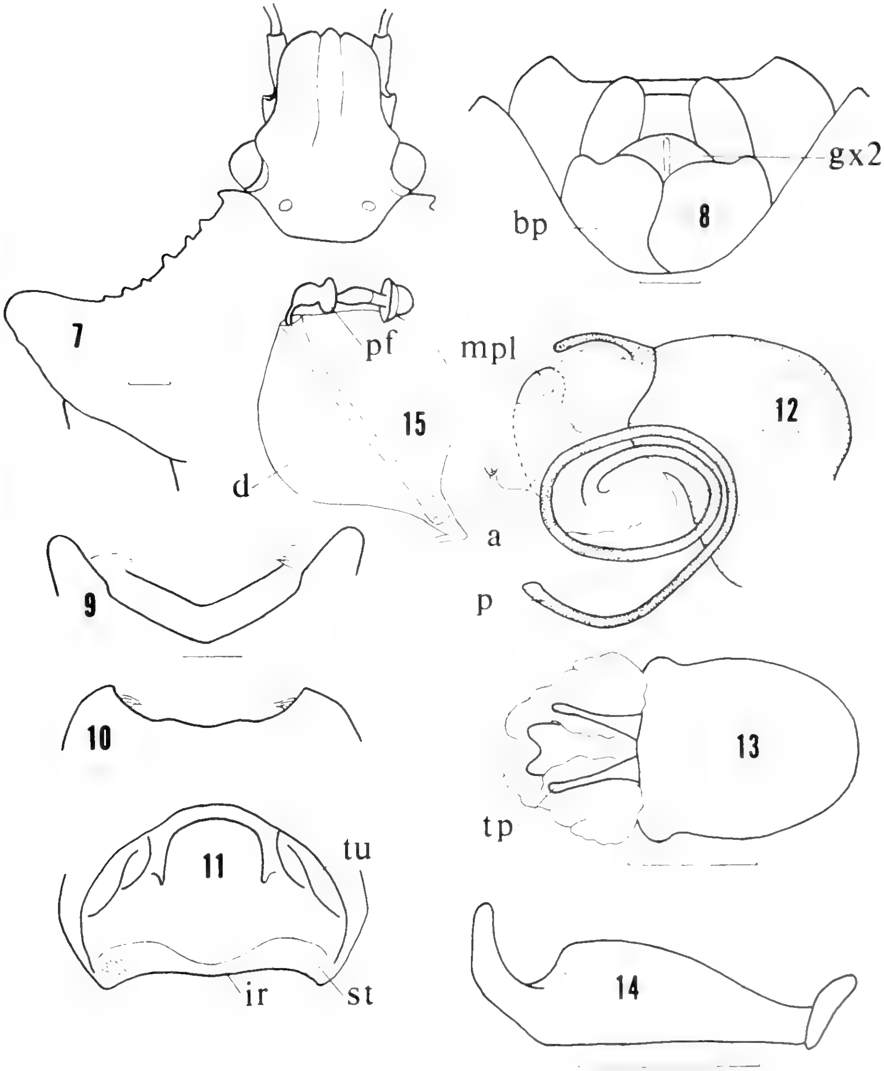
Comment.—The holotype was examined.

Euschistus (*Lycipta*) *machadus* Rolston, New Species

Figs. 7–15

Light yellowish brown above, becoming reddish yellow on humeri; punctures rather small and evenly distributed, black in clusters on each side of calloused spot at posterior margin of each cicatrice, along anterolateral pronotal margins, especially on anterior humeral margins, and at posterior margin of ocelli, concolorous on humeral apex, otherwise dark brown to fuscous; each side of scutellar apex with black spot. Ventral surfaces as dark as or a little darker than dorsum; punctation fuscous to black, very dense on abdomen. Length of body 10.1–11.5 mm.

Width and length of head subequal, 2.1–2.4 mm wide at eyes, lateral



Figs. 7–15. *Euschistus* (*L.*) *machadus*. 7, Head and pronotum. 8, Genital plates; caudoventral view; basal plates (bp); second gonocoxae (gx 2). 9, Posterior margin of pygophore, caudal view. 10, Same, ventral view. 11, Genital cup, parameres and proctiger removed; inferior ridge (ir); tuft of setae (st); tumescence (tu). 12, Aedeagus, lateral view; conjunctival appendage (a); penisfilum (p); median penal lobes (mpl). 13, Aedeagus, dorsal view; thecal processes (tp). 14, Paramere. 15, Spermatheca; proximal flange (pf); dilation of spermathecal duct (d).

margins subparallel for middle ⅓ of distance from eyes to apex; juga and tylus subequal in length, separated at apex by shallow incision between each (Fig. 7). Basal antennal segment pale with black spots usually coalescing into streak on dorsal and ventral surfaces, remaining segments black except basal $^1/_4$ of last and usually basal $^1/_8$ of 4th pale; basal segment reaching apex of head; length of segments 0.6–0.7; 0.9–1.1; 1.0–1.1; 1.2–1.5; 1.4–1.7 mm. Bucculae subtruncate at base of head, surpassing slightly basal segment of rostrum.

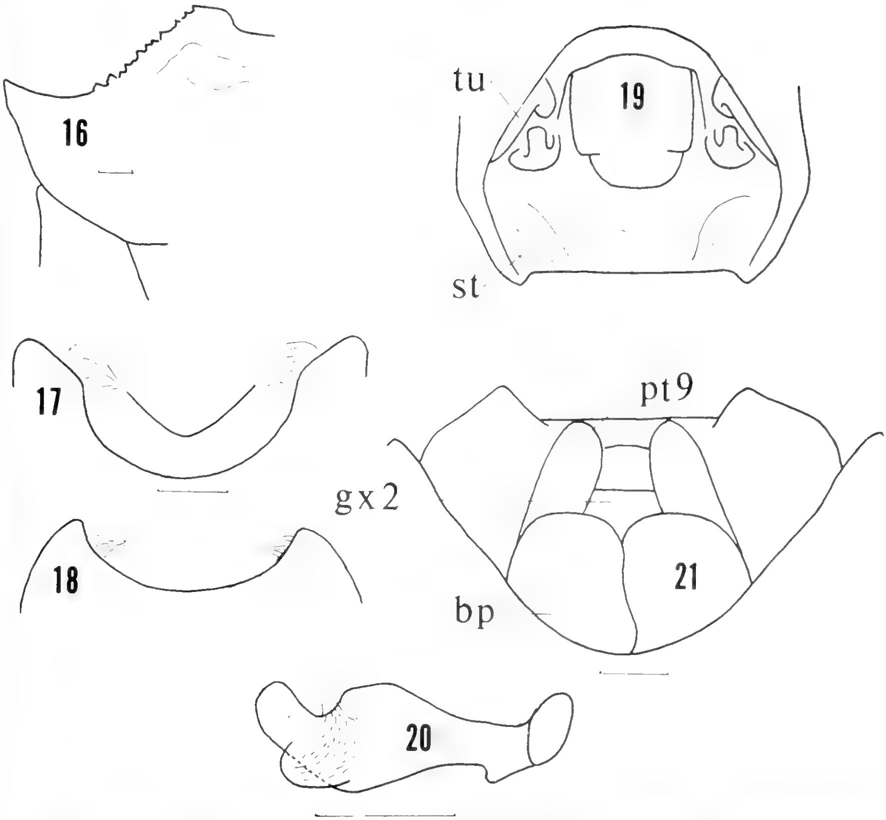
Pronotum 2.3–2.7 mm long at meson, 2.7–3.0 times as wide at humeri. Anterolateral margins concavely arcuate, denticulate onto humeri; denticles obtuse, well separated from each other, yellowish brown. Humeral angles produced moderately laterad, slightly cephalad, a little elevated; apex narrowly rounded. Disk slightly rugose; cluster of black punctures laterad of calloused spot at posterior border of each cicatrice larger than mesal cluster, subcircular, sometimes subfoveate; mesial cluster linear, rarely lacking.

Scutellar width and length subequal, 3.6–4.2 mm across base; fovea in basal angles moderately large and deep, black; apex slightly depressed between marginal black spot on each side, sometimes weakly emarginate. Membrane of hemelytra hyaline; venation light brown, usually with a few closed cells. Connexivum moderately exposed, concolorous with corium excepting black marginal spot on each side of segmental sutures and between these a smaller black spot on protruding apical angle of sternite.

Evaporative areas small for genus, extending about 0.4 distance from ostiole to lateral margin of metapleuron; sparingly black punctate. Large black spots on femora and tibiae, many coalescing on femora; tarsi fuscous to black usually excepting superior face of basal segment. Apical angles of abdominal sternites produced into small obtuse tubercle, black at apex; basal angles with larger black spot. Spiracles concolorous with or darker than supporting sternum.

Broad emargination in posterior margin of pygophore irregularly concave from both caudal and ventral views, shallowly so from dorsal view (Figs. 9, 10, 11). Inferior ridge entirely exposed from caudal view. Large tubercle on each side on posterior border of genital cup bearing dense tuft of setae; large pale tumescence on lateral walls of genital cup paralleling rim for most its length, bending abruptly ventrad anteriorly. Parameres terminating in rather thin simple hook (Fig. 14). Conjunctiva with 2 appendages on each side; apex of appendage nearest median penal lobes subacute, sclerotized; other appendage hyaline (Fig. 12). Penisfilum coiled, making about 2 complete loops. Median penal lobes projecting dorsad at apex. Lateral lobes of theca moderately developed, median lobe obscure.

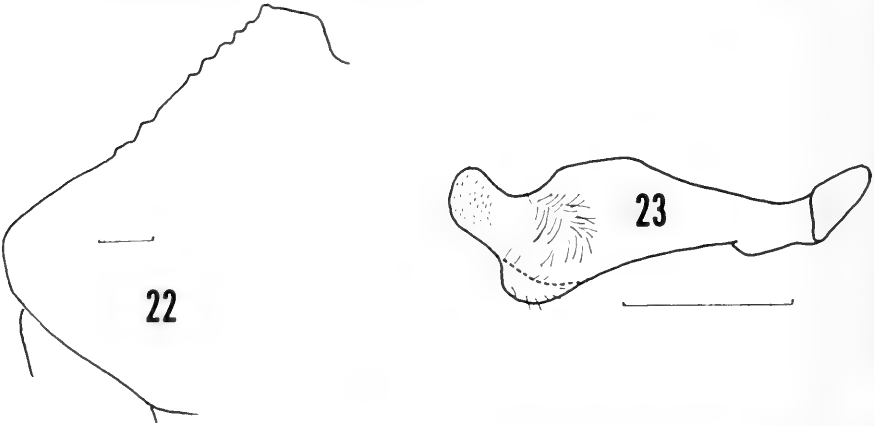
Holotype.—♂, labeled Brazil, São Paulo, Serra Bocaina, S. J. Barreiro, 1650 m. (b) Oct.–Nov. 1969, Alvarenga and Seabra. Deposited in American Museum of Natural History, New York.



Figs. 16–21. *Euschistus* (*L.*) *imitator*. 16, Humeral angle. 17, Posterior pygophoral margin, caudal view. 18, Same, ventral view. 19, Genital cup, parameres and proctiger removed; tuft of setae (st); tumescence (tu). 20, Paramere. 21, Genital plates, caudoventral view; basal plates (bp); 9th paratergites (pt 9); 2nd gonocoxae (gx 2).

Paratypes.—10 ♂, 23 ♀. Same data as holotype (♂, ♀ LHR; ♂, ♀ UNLP; ♂, ♀ USNM; ♂, ♀ NR; ♂, ♀ BMNH; ♂, 8 ♀ AMNH); same data as holotype except Nov. 1968, M. Alvarenga (♂ TAMU; ♂, ♀ LHR; 6 ♂ AMNH) same data as holotype except Jan. 1969, M. Alvarenga (♀ AMNH); Italiaya, 1100 m, E. do Rio, 30-XI-42, W. Zikan (♂ RNH); "Itatiaia," 1960 m, N. B. Fagundes, 1-933 (♀ RNH); "Itatiaia," N. B. Fagundes, 1-933 (♂ RNH); Bananal, Bocaina, S. Paulo, D. Mendes, 1-937 (♀ RNH).

Deposition of paratypes.—American Museum of Natural History, New York (AMNH); British Museum (Natural History), London (BMNH); author's collection (LHR); Naturhistoriska Riksmuseet, Stockholm, Sweden (NR); Rijksmuseum van Naturlijke Historie, Leiden, Netherlands (RNH); Texas A&M University, College Station (TAMU); Universidad Nacional de



Figs. 22, 23. *Euschistus (L.) circumfusus*. 22, Humerus and anterolateral margin of the pronotum. 23, Paramere.

LaPlata, Argentina (UNLP); National Museum of Natural History, Washington, D.C. (USNM).

Distribution.—Southern Brazil in states of Mato Grosso, São Paulo, and Rio Grande do Sul, and presumably in states of Santa Catarina and Paraná.

Euschistus (Lycipta) imitator Berg

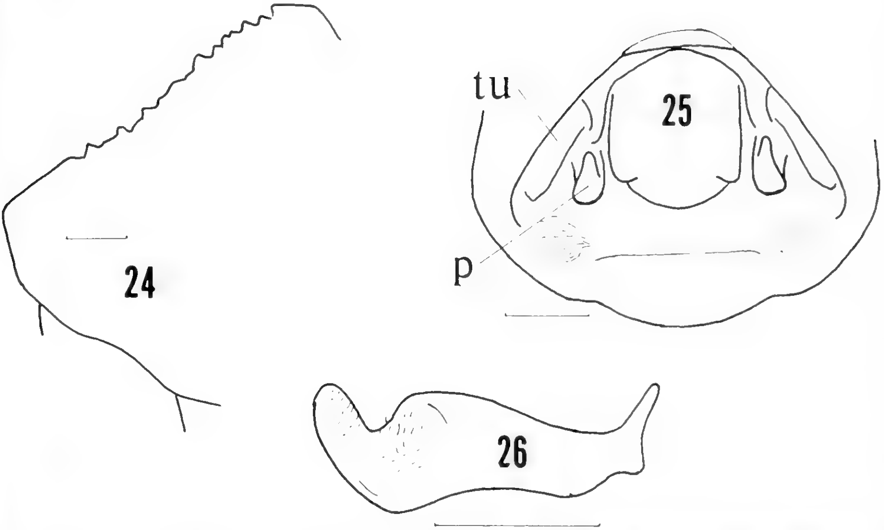
Figs. 16–21

Euschistus imitator Berg, 1878: 306; Berg, 1879: 45–46 (reprint); Pirán, 1948: 11 (record); Pirán, 1968: 19, fig. 1G (record, pygophore).

Euschistus sellowi Berg, 1883: 208–209; Berg, 1884: 24–25 (reprint). **New Synonymy.**

Humeral angles moderately produced laterad, acute, directed anterolaterad (Fig. 16). Connexiva broadly margined laterally with brownish yellow to castaneous. Abdominal venter brownish yellow or rufous; dark punctation usually becoming sparse mesially. Veins in hemelytral membranes simple or branched, sometimes with 1 or 2 closed cells basally. Posterior margin of basal plates mesially and mesial margin of 9th paratergites much thickened, leaving 2nd gonocoxae sunken (Fig. 21). Emargination in posterior pygophoral margin broad, concave, moderately deep from both caudal and ventral view (Figs. 17, 18), shallow and transverse from dorsal view (Fig. 19). A large tuft of setae located on prominence at posterolateral corners of genital cup. Parameres as in Fig. 20.

Distribution.—Argentina (Buenos Aires, Entre Rios, Santa Fé); Brazil (Rio Grande do Sul, Santa Catarina); Paraguay; Uruguay.



Figs. 24–26. *Euschistus* (*L.*) *sharpi*. 24, Humerus and anterolateral pronotal margin. 25, Genital cup; paramere (p); tumescence (tu). 26, Paramere.

Types.—The following specimen is designated **lectotype** of *Euschistus sellowi*: male, labeled (a) "*Euschistus selowianus* Berg Typen!," (b) "Typus," (c) "Zoolog. Museum Berlin," (d) "1010," (e) "Montevideo Sello." Three female paralectotypes are all labeled (a) "Typus" (b) "Montevideo Sellow No. 1010" (c) "Zoolog. Museum, Berlin." All 4 specimens are in the Museum für Naturkunde der Humboldt—Universität zu Berlin. These specimens and the holotype of *Euschistus imitator* Berg were examined.

***Euschistus* (*Lycipta*) *circumfusus* Berg**
Figs. 22, 23

Euschistus circumfusus Berg, 1883: 208; Berg, 1884: 24 (reprint); Buckup, 1961: 10 (record).

Dorsum fuscous with lateral margins of pronotum and basal margins of coria yellow or red. Connexiva entirely dark or yellow margined. Abdominal venter dark brown, densely and uniformly black punctate. Humeri scarcely produced laterad, obtusely angulate (Fig. 22). Venation of hemelytral membrane simple or furcate, sometimes with 1 or 2 closed cells basally. Genital plates and pygophore as in *L. imitator*. Parameres as in Fig. 23.

Distribution.—Argentina (Entre Rios); Brazil (Santa Catarina, Rio Grande do Sul); Paraguay; Uruguay.

Types.—The following specimen is designated **lectotype**: Male, labeled

(a) "Euschistus circumfusus typen! Berg" (b) "Typus" (c) "Zoolog. Museum Berlin" (d) "795" (e) "Montevideo, Sell." The 3 paralectotypes, 2 ♀, 1 ♂, are all labeled (a) "Typus" (b) "Montevideo, Sellow no. 795" (c) "Zoolog. Museum Berlin." All 4 specimens are in the Museum für Naturkunde der Humboldt—Universität zu Berlin and were examined.

Comments.—The genitalia of this species and of *E. imitator* seem inseparable excepting perhaps minor differences in the parameres. In the relatively few specimens of *E. circumfusus* and *E. imitator* that have been available, differences in the humeral form and color have been consistent.

***Euschistus (Lycipta) sharpi* Bergroth**

Figs. 24–26

Euschistus sharpi Bergroth, 1891: 223.

Dorsum including anterolateral pronotal margins fuscous to black, only posterolateral margins of humeri, basal portion of coria along margin, and entire connexiva pale. Abdominal venter brownish yellow with small punctures rather weakly and uniformly dark colored. Humeri weakly produced laterad, obtusely angled (Fig. 24). Venation in membrane of hemelytra simple or furcate. Posterior margin of pygophore sinuously convex from dorsal view. A tuft of setae present at posterolateral corners of genital cup (Fig. 25). Parameres as in Fig. 26.

Distribution.—Brazil (Minas Gerais, São Paulo).

Type.—The type is apparently missing from the Fallou collection.

Comment.—This species closely resembles *E. circumfusus* but differs in having the anterolateral pronotal margins black, in the punctation and coloration of the abdominal venter, in the uniformly pale connexiva, and in the convexity of the posterior pygophoral margin when viewed dorsally.

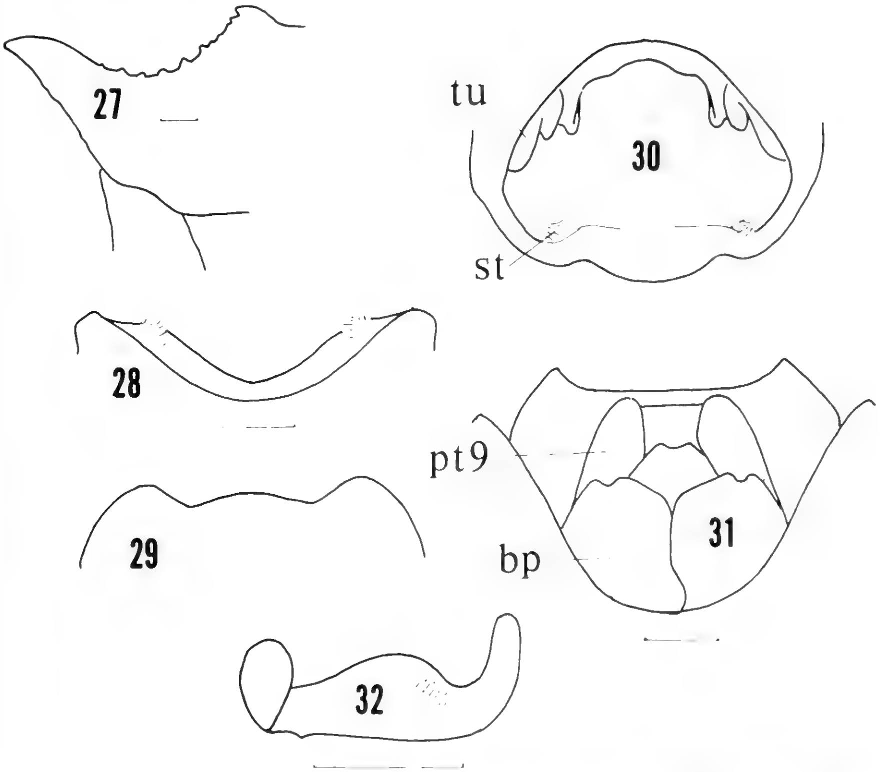
I have seen no females of this species.

***Euschistus (Lycipta) triangulator* (Herrich-Schäffer)**

Figs. 27–32

Cimex triangulator Herrich-Schäffer, 1842: 95–96, fig. 667.
Euschistus triangulator: Stål, 1860: 19 (listed).
Lycipta triangulator: Stål, 1862a: 58 (listed).
Euschistus (Lycipta) triangulator: Stål, 1872: 23 (keyed).

Veins of hemelytral membrane reticulate. Apex of scutellum ivory, usually somewhat reflexed. At least last 2 segments of antenna rufous, occasionally pale at base. Humeri strongly projecting anterolaterad, acute apically (Fig. 27). Posterior margin of basal plates emarginate at base of 9th parategites, mesially thickened; mesial margin of one basal plate overlapping other basally (Fig. 31). Posterior margin of pygophore trisinuate from dorsal



Figs. 27–32. *Euschistus* (*L.*) *triangulator*. 27, Humerus and anterolateral pronotal margin. 28, Posterior pygophoral margin, caudal view. 29, Same ventral view. 30, Genital cup, parameres and pygophore removed; tuft of setae (st); tumescence (tu). 31, Genital plates, caudoventral view; basal plates (bp); 9th paratergites (pt 9). 32, Paramere.

and ventral views (Figs. 29, 30), broadly concave from caudal view (Fig. 28); setae tuft in posterolateral corners of genital cup inconspicuous amongst other setae in cup.

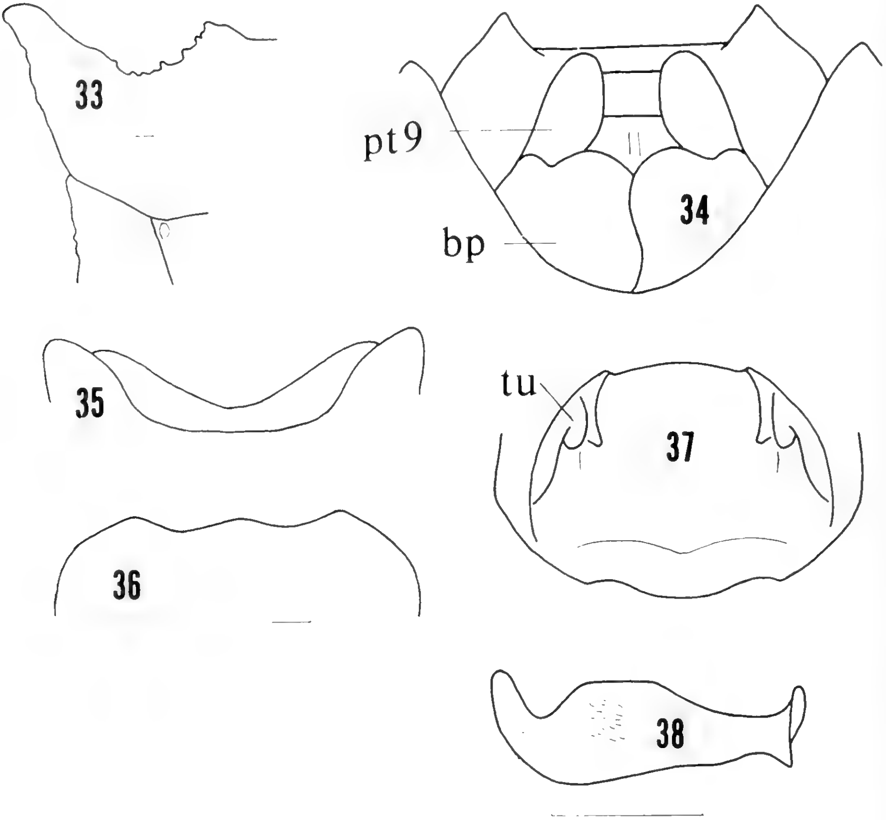
Distribution.—Brazil (Santa Catarina, São Paulo, Rio de Janeiro).

Comment.—This species and the following one, *E. picticornis*, apparently differ consistently only in the color of the antennae.

The type was not located. My concept of this species is based on the literature.

Euschistus (*Lycipta*) *picticornis* Stål

Euschistus (*Lycipta*) *picticornis* Stål, 1872: 23.
Euschistus picticornis: Berg, 1879: 280–281 (nymph described); Berg, 1880:



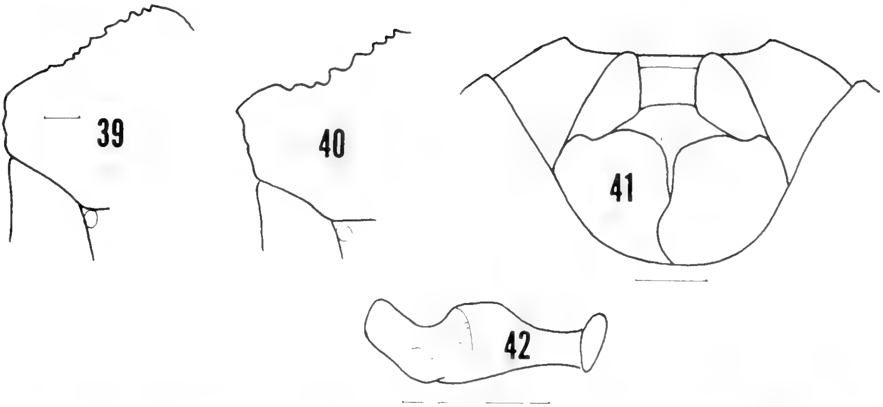
Figs. 33–38. *Euschistus* (*L.*) *cornutus*. 33, Humerus and anterolateral pronotal margin. 34, Genital plates, caudoventral view; basal plates (bp); 9th paratergites (pt 9). 35, Posterior margin of pygophore, caudal view. 36, Same, ventral view. 37, Genital cup, proctiger and parameres removed; tumescence (tu). 38, Paramere.

8–9 (reprint); Berg, 1883: 206–208 (description); Berg, 1884: 22–24 (reprint); Pirán, 1948: 11 (record); Buckup, 1961: 11 (record); Grazia, 1977: 165–166.

Apparently differing consistently from *E. triangulator* only in rufous color of antenna, especially last 2 segments. Apex of scutellum not reflexed. Dorsum usually a little darker in color than in *E. triangulator*.

Distribution.—Argentina (Buenos Aires, Parana de las Palmas, Sierra de Cordoba); Brazil (Rio Grande do Sul, Santa Catarina, São Paulo).

Comments.—Berg (1883, 1884) listed a number of characters in which *E.*



Figs. 39–42. *Euschistus* (*L.*) *luridus*. 39–40, Variation in humeri. 41, Genital plates, caudoventral view. 42, Paramere.

picticornis and *E. triangulator* purportedly differ. None of these characters, unfortunately, consistently differentiates between these species.

The holotype of *E. picticornis* was examined.

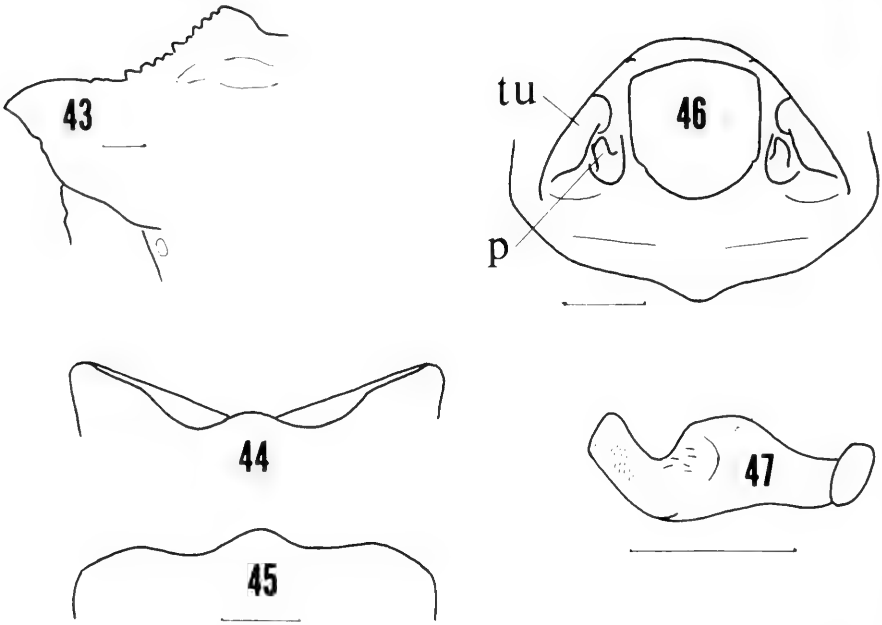
Euschistus **(*****Lycipta*****)** ***cornutus*** **(Dallas)**

Figs. 33–38

Euschistus cornutus Dallas, 1851: 201; Berg, 1878: 303–305 (description); Berg, 1879: 42–44 (reprint); Bergroth, 1891: 223 (descriptive note); Jensen-Haarup, 1922: 11, figs. 2a, 2b (habitus); Buckup, 1961: 11 (record); Pirán, 1962: 6, 9, fig. 6 (pygophore).
Euschistus (*Lycipta*) *cornutus:* Stål, 1872: 23 (keyed).

Veins of hemelytral membrane usually reticulated. Apex of scutellum with a small dark marginal macule on each side. Humeri cornute, projecting anterolaterad, narrowly rounded at apex (Fig. 33). Dorsum yellowish brown, humeri rufous. Costal margin of hemelytra toward base with small denticles. Posterior margin of basal plates emarginate at base of 9th paratergites, thickened mesially; mesial margin of one basal plate overlapping other basally; 2nd gonocoxae sulcate along meson (Fig. 34). Posterior margin of pygophore broadly emarginate to moderate depth from caudal view (Fig. 35), less deeply emarginate and with bottom of emargination slightly convex from ventral view (Fig. 36), sinuous from dorsal view (Fig. 37). Setal tufts absent. Paramere as in Fig. 38.

Distribution.—Argentina (Misiones); Brazil (Rio Grande do Sul, Santa Catarina, Minas Gerais); Paraguay.



Figs. 43–47. *Euschistus* (*L.*) *cribrarius*. 43, Humerus. 44, Posterior margin of pygophore, caudal view. 45, Same, ventral view. 46, Genital cup; paramere (p); tumescence (tu). 47, Paramere.

Comments.—This common species resembles *E. machadus* in coloration, but the cornute humeri of *E. cornutus* separate these two species at a glance.

The type was examined.

***Euschistus* (*Lycipta*) *luridus* (Dallas), New Combination**

Figs. 39–42

Agroecus luridus Dallas, 1851: 200; Jensen-Haarup, 1937: 171 (keyed); Buckup, 1961: 8, 11, Pl. 1 fig. 1, Pl. 2 fig. 1 (keyed, synonymy, description).

Euschistus aceratos Berg, 1894: 17. **New synonymy.**

Veins in membrane of hemelytra reticulate. Apex of scutellum not differentiated by color or punctation. Humeri obtuse, produced laterad of base of coria by width of eye or less (Figs. 39, 40). Genital plates (Fig. 41) similar to those of *E. cornutus* (Fig. 34). Posterior margin of pygophore like that of *E. cribrarius* (Figs. 44–46). Setal tufts absent. Pigmentation of parameres disappearing basad of cup (Fig. 42).

Distribution.—Argentina (Misiones); Brazil (Rio Grande do Sul, Santa Catarina, Minas Gerais); Bolivia.

Comment.—This species and *E. cribrarius* seem to differ only in the form of the humeri and in minor differences in the parameres.

The types of *Agroecus luridus* and *Euschistus aceratos* were examined.

***Euschistus* (*Lycipta*) *cribrarius* Stål**
Figs. 43–47

Euschistus (*Lycipta*) *cribrarius* Stål, 1872: 24 (keyed).

Differing from *E. luridus* in form of humeri and pigmentation of parameres. Humeri produced laterad of base of coria by about 1.5× width of eye, apically acute and slightly retrorse (Fig. 43). Posterior margin of pygophore broadly and sinuously concave from caudal view (Fig. 44) sinuous from ventral view (Fig. 45), convex with median projection from dorsal view (Fig. 46). Paramere pigmented to basal disk (Fig. 47).

Distribution.—Brazil (Rio de Janeiro); Bolivia.

Comments.—The only substantial and apparently consistent difference that I see between *E. cribrarius* and *E. luridus* is the form of the humeri, which in many species of the genus, but by no means all of them, is notoriously variable. I have seen few males and no females of *E. cribrarius*, all uniform with respect to their humeri, and about a score of *E. luridus*, the humeri of none approaching the form of *E. cribrarius*.

The holotype was examined.

ACKNOWLEDGMENTS

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Richard C. Froeschner, National Museum of Natural History, Washington, D.C., offered valuable suggestions for improving the manuscript.

LITERATURE CITED

Berg, C. 1878–80. Hemiptera Argentina enumeravit speciesque novas descripsit. An. Soc. Cient. Argent. 5(6): 297–314 (1878); 9(1): 5–22 (1880). Reprinted 1879. Buenos Aires and Hamburg. 316 pp. (Berg's papers under this title in the Anales de la Sociedad Cientifica Argentina were published as a book in December, 1879. The papers in this series that appeared in the Anales in 1880 (vol. 9, no. 1) were also included, and presumably first published, in the book.)

———. 1883. Addenda et emendanda ad Hemiptera Argentina. An. Soc. Cient. Argent. 15: 193–217. (Reprinted 1884. Buenos Aires and Hamburg. 213 pp.)

———. 1894. Descripciones de algunos Hemipteros Heteropteros nuevos o poco conocidos. An. Mus. Montev. 1: 13–17.

Bergroth, E. 1891. Contributions à l'étude des pentatomides. Rev. Entomol. 10: 200–235.

Buckup, L. 1961. Os pentatomideos do estado do Rio Grande do Sul (Brasil) (Hemiptera-Heteroptera-Pentatomidae). Iheringia Ser. Zool. 16: 5–23.

Dallas, W. S. 1851. List of the specimens of hemipterous insects in the collection of the British Museum. Part 1. London.

Grazia, J. 1977. Revisão dos pentatomineos citados no "Quarto Catalogo dos Insetos Que Viven nas Plantos do Brasil" (Hemiptera-Pentatomidae-Pentatomini). Dusenia 10(3): 161–174.

Herrich-Schäffer, G. A. W. 1842. Die Wanzenartigen Insecten. Vol. 6, 118 pp., 34 pls.

Jensen-Haarup, A. C. 1922. Hemipterological notes and descriptions II. Entomol. Medd. Copenhagen 14: 1–16.

———. 1937. Einige neue Pentatomidenarten aus der Sammlung des Zoologischen Museums in Hamburg (Hem. Het.) Entomol. Rundschau 54: 169–171, 321–324.

Kirkaldy, G. W. 1909. Catalogue of the Hemiptera (Heteroptera) Vol. 1. Cimicidae. XL + 392 pp.

Pirán, A. A. 1948. Contribución al conocemiento de la dispersión geográphica de los Hemípteros neotropicales. Acta Zool. Lilloana 5: 5–17.

———. 1968. Hemiptera neotropica. XI. Rev. Soc. Entomol. Argent. 30: 17–25.

Sailer, R. I. 1954. Interspecific hybridization among insects with a report on cross breeding experiments with stink bugs. J. Econ. Entomol. 47: 377–383.

Stål, C. 1860–62a. Bidrag till Rio Janeiro-traktens Hemipter-fauna. K. Svenska Vet.-Ak. Handl. 2(7): 1–84 (1860); 3(6): 1–75 (1862).

———. 1862b. Hemiptera Mexicana enumeravit speciesque novas descripsit. Stettin. Entomol. Ztg. 23: 81–118.

———. 1872. Enumeratio Hemipterorum. Enumeratio Cimicinorum Americae. K. Svenska Vet.-Ak. Handl. 10(4): 3–65.

PROC. ENTOMOL. SOC. WASH.
84(2), 1982, pp. 297–300

CLANONEURUM AMERICANUM (DIPTERA: EPHYDRIDAE), A LEAFMINER OF THE LITTORAL CHENOPOD *SUAEDA LINEARIS*

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Abstract.—The first larval feeding habits are recorded for *Clanoneurum americanum* Cresson, a psilopine ephydrid restricted to saline habitats. In the Florida Keys larvae were found mining the leaves of sea blite, *Suaeda linearis* (Ell.) Moq. (Chenopodiaceae). Brief notes on biology and behavior and a scanning electron micrograph of the peculiar adult habitus are presented.

Clanoneurum americanum Cresson, a psilopine ephydrid or shore fly of saline environments, exhibits a distinctive adult habitus, particularly the wing venation. Cresson (1940) described this species from San Diego, California, noting that it was closely related to the Palearctic *C. cimiciforme* (Haliday) and that all records of the genus in North America should refer to this new species. Previous records included Maine (Mount Desert), Massachusetts (Woods Hole), New Jersey (Morgan, in salt marsh), and New York (Gardiners Island) (Weiss, 1924). Cresson (1942) summarized the distribution of this "comparatively scarce species" as the Atlantic and Gulf States, in addition to Arizona, California, and Utah. Wirth (1968) added Mexico and the West Indies (Bahamas) to the known range of *C. americanum,* the only known North American species of the genus.

Larval feeding habits are recorded for few psilopine species (Foote and Eastin, 1974), and no information is available on the habits of *C. americanum* (Simpson, 1976). Old World members of the genus are known to mine leaves of Chenopodiaceae (Hering, 1957; Wirth, 1965), with *C. cimiciforme* recorded from sugar beets, *Beta vulgaris* L., by Balachowsky and Mesnil (1936) and Hennig (1943) (cited as *C. menozzii,* a junior synonym of *C. cimiciforme*); and from a glasswort, *Salicornia europaea* L. (cited as *S. herbacea* L.), by Meijere (1947). Meijere's paper included a brief description and an illustration of the puparium and an illustration of the cephalopharyngeal skeleton. Because the habits of *C. americanum* are unknown, it

Figs. 1, 2. *Clanoneurum americanum.* 1, Adult habitus, scanning electron micrograph (50×). 2, Proboscis extended, feeding on brewer's yeast.

seems worthwhile to record this species as a leafminer of a littoral chenopod and present notes on its life history and habits.

Biological Notes

I made observations on *C. americanum* during a trip to the Florida Keys in April 1981. The habitat on Upper Key Largo consisted of coral rock land dominated by various halophytes. Large colonies of saltwort, *Batis maritima* L. (Bataceae), were growing among smaller patches of sea purslane, *Sesuvium portulacastrum* L. (Portulacaceae), and perennial saltwort, *Salicornia virginica* L. (Chenopodiaceae). *Clanoneurum americanum*, however, was observed only on another chenopod, *Suaeda linearis* (Ell.) Moq., or sea blite. This herbaceous halophyte has numerous fleshy, linear leaves that form terminal spikes. It occurs in salt marshes from Maine south to Florida and west to Texas, and also is known from the West Indies (Long and Lakela, 1976).

In the field, adults of *C. americanum* appeared more homopteran than dipteran. The infumate wings held almost rooflike over the abdomen (Fig. 1) and the short hopping flight were suggestive of a small black fulgoroid, especially the macropterous form of the issid planthopper, *Bruchomorpha oculata* Newman. Adults also superficially resembled a small dark weevil (Fig. 2) as they walked over leaves, proboscices extended, apparently for probing the surface.

Field-collected adults were placed in small plastic boxes containing sprigs of *S. linearis*. Pairing occurred within minutes, apparently without a premating display or elaborate mating behavior; some pairs remained *in copula* for several hours. The white eggs were deposited singly on host foliage and, upon hatching, larvae bored into tissue beneath or adjacent to the egg shell and tunneled through the linear leaf. Leaves containing mature larvae appeared hollowed out or traversed by a wavy, light-colored thread. In the laboratory, puparia were found within the mines or on the bottom of the rearing containers just beneath mined leaves.

Adult emergence from foliage began on May 5–6; eggs had been laid on the same foliage on April 15. Under laboratory conditions, the approximate developmental time was 3 weeks. Old mines and eggs were present in the field on April 13; it is likely that *C. americanum* is multivoltine, producing successive generations in Florida. A careful study of this specialized shore fly would add to the knowledge of feeding habits reported for the large and diverse subfamily Psilopinae.

Acknowledgments

I thank my Harrisburg colleagues K. Valley, for identifying the ephydrid and reading the manuscript, and J. F. Stimmel, for the photograph. E. R. Hoebeke (Department of Entomology, Cornell University, Ithaca, New

York) and K. W. Simpson (Div. Lab. and Research, State of New York Department of Health, Albany) also made valuable comments on the manuscript.

LITERATURE CITED

Balachowsky, A. and L. Mesnil. 1936. Les insectes nuisibles aux plantes cultivées. Vol. 2. Presses des Etablissements Busson, Paris. Pp. 1141–1921.

Cresson, E. T., Jr. 1940. Descriptions of new genera and species of the dipterous family Ephydridae. Paper XII. Acad. Nat. Sci. Phila. Notulae Nat. 38: 1–10.

———. 1942. Synopses of North American Ephydridae (Diptera). Trans. Am. Entomol. Soc. 68: 101–128.

Foote, B. A. and W. C. Eastin. 1974. Biology and immature stages of *Discocerina obscurella* (Diptera: Ephydridae). Proc. Entomol. Soc. Wash. 76: 401–408.

Hennig, W. 1943. Übersicht über die bisher bekannten metamorphosesstadien der Ephydriden Neubeschriebungen nach dem Material der Deutschen Limnologischen Sunda-Expedition (Diptera: Ephydridae). Arb. Morphol. Taxon. Entomol. 10: 105–138.

Hering, E. M. 1957. Bestimmungstabellen Blattminen von Europa einschliesslich des Mittelmeerbeckens und der Kanarischen Inseln. Band I. Pfanzengattungen A–L. Dr. W. Junk, 's-Gravenhage. 648 pp.

Long, R. W. and O. Lakela. 1976. A flora of tropical Florida; a manual of the seed plants and ferns of southern peninsular Florida. Banyan Books, Miami, Fla. 962 pp.

Meijere, J. C. H. de. 1947. Over eenige Dipterenlarven, waaronder een galmug, die mijngangen maakt, en twee Dipteren, die gallen op paddenstoelen veroorzaken. Tijdschr. Entomol. 88: 49–62 (1945).

Simpson, K. W. 1976. Shore flies and brine flies (Diptera: Ephydridae), ch. 17, pp. 465–495. *In* Cheng, L., ed., Marine insects. North-Holland Publishing Co., Amsterdam.

Weiss, H. B. 1924. Diptera collected on a New Jersey salt marsh. Can. Entomol. 56: 255–257.

Wirth, W. W. 1965. Family Ephydridae, pp. 734–759. *In* Stone, A. et al., eds., A catalog of the Diptera of America north of Mexico. U. S. Dep. Agric. Agric. Handb. 276.

———. 1968. Family Ephydridae, pp. 1–43. *In* Papavero, N., ed., A catalogue of the Diptera of the Americas south of the United States. Dep. Zool. Sec. Agric., São Paulo.

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IS THE BINOMEN *LYGAEUS KALMII* STAL (HEMIPTERA: HETEROPTERA: LYGAEIDAE) APPLIED TO SIBLING SPECIES?

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Abstract.—Populations of *Lygaeus kalmii* Stål from west Texas show a diploid number of 18 and a homogametic sex determination mechanism in the male. A diploid number of 14 and a heterogametic male have been reported for the species in the literature.

We report unexpected results obtained when one of us (JD) began a cytogenetic study of *Lygaeus kalmii* Stål from west Texas in order to learn cytogenetic technique. A diploid number of 14 (XY) has already been reported for the species (Ueshima and Ashlock, 1980; Ueshima, 1979) and a diagram of its chromosome complement given (Ueshima and Ashlock, 1980).

Materials and Methods

Lygaeus kalmii adults and immatures were collected from *Solanum* sp. in El Paso, Tex. at different times over a three month period from June to August 1980. Some bugs were lab-reared, and some were used immediately in preparations.

Testes of fifth-instar stage nymphs were dissected in insect Ringer's solution and fixed (15 ml glacial acetic, 45 ml ethanol, 5 ml acetone). Testes were stained with lacto-proprio orcein and squashed. Numerous squashes were made. Preparations showing metaphase I (meiotic) chromosomes were photographed, although other stages were observed. Figures were photographed at about 6400× under oil on a Zeiss compound microscope with a Wetzler large format camera attachment.

Results

All results for west Texas populations are consistent. The chromosome number appears to be $2N = 18$ ($N = 8A + W$) based on spermatogenic metaphase I cells (Fig. 1). The male appears to be homogametic (Fig. 1).

Fig. 1. *Lygaeus kalmii*, metaphase I chromosomes photographed at about 6400×.

Discussion

The difference in chromosome number between *L. kalmii* collected from west Texas and specimens collected from California and reported by Ueshima and Ashlock (1980) suggest the possibilities of clinal variation and sibling species. One of us (DMC) contacted N. Ueshima for his opinion of the discrepancy in results between the two populations. He suggested (personal communication) that a series of fusions may have led to the differences between the populations. Such an explanation would be consistent with the large size of two of the chromosomes (Fig. 1), if Fig. 1 were a mitotic phase as Ueshima believes (personal communication). However, after viewing series of maturation stages in spermatogenic cells of *L. kalmii* we are certain that we have metaphase I chromosomes (e.g. Fig. 1). Tetrads are visible and kinetochores are terminal (typical meiotic kinetochore behavior in the Heteroptera; Ueshima, 1979) and therefore, our conclusion is well-supported. No figures were photographed by Ueshima or Ashlock for *L. kalmii* (personal communication, Ueshima and Ashlock).

Within the Heteroptera fragmentation and fusion of autosomes have probably been important in producing changes in chromosome numbers (Ueshima, 1979; Schrader and Hughes-Schrader, 1956; Schrader, 1947). Thus, it is not unreasonable to assume that we are looking at a dynamic process in evolution within the populations recognized under the binomen *L. kalmii*.

The question of whether we have clinal variation in chromosome number or sibling species will be determined by a combination of hybridization studies (including cytogenetic study of eastern United States populations (DMC) and life history and host plant studies (JD)).

ACKNOWLEDGMENTS

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LITERATURE CITED

Schrader, F. 1947. The role of the kinetochore in the chromosomal evolution of the Heteroptera and Homoptera. Evolution 1: 134–142.

Schrader, F. and S. Hughes-Schrader. 1956. Polyploidy and fragmentation in the chromosomal evolution of various species of *Thynata* (Hemiptera). Chromosoma (Berl.) 7: 469–496.

Ueshima, N. 1979. Animal Cytogenetics. Vol. 3. Insecta 6. Hemiptera II, Heteroptera. Gebrüder Borntraeger, Stuttgart. 117 pp.

Ueshima, N. and P. D. Ashlock. 1980. Cytotaxonomy of the Lygaeidae (Hemiptera-Heteroptera). Univ. Kans. Sci. Bull. 51: 717–801.

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84(2), 1982, pp. 304–314

DESCRIPTION OF THE LARVA AND FEMALE OF *PYCNOPSYCHE FLAVATA* (BANKS) WITH COMPARATIVE NOTES ON THE ECOLOGY OF *P. FLAVATA* AND *P. GENTILIS* (MCLACHLAN) (TRICHOPTERA: LIMNEPHILIDAE)

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Abstract.—The larva and female of *Pycnopsyche flavata* (Banks) are described and figured for the first time. Ecological notes are provided for sympatric populations of *P. flavata* and *P. gentilis* (McLachlan). The highly variable morphology of *P. gentilis* larvae throughout the range of the species is discussed.

Members of the genus *Pycnopsyche* are of widespread and common occurrence throughout eastern North America. Larvae have been described for only six of the presently recognized 16 species in the genus (Flint, 1960). Reared material and/or metamorphotypes are available for *P. subfasciata* (Say) (Vorhies, 1909; Flint, 1960; G. B. Wiggins, personal communication) and *P. sonso* (Milne) (Flint, 1960); however, no specific characters for their identification have yet been elucidated.

The known distribution of *P. flavata* (Banks) is restricted to the mountains of western North Carolina, southwestern Virginia (C. R. Parker, personal communication), eastern Tennessee, northwestern South Carolina (J. C. Morse, personal communication), and northern Georgia. Collections of *P. flavata* larvae in Tennessee and North Carolina indicate a fairly specialized habitat preference.

Herein is described the larva of *P. flavata* with notes on its ecology obtained from year-round collections at a site in Tennessee. Because of the close morphological and behavioral similarity and frequent sympatric occurrence of *P. flavata* and *P. gentilis* (McLachlan), information on their life history in the southern Appalachians and on the variability of certain characters of *P. gentilis* larvae from five localities in eastern North America is also included. The female of *P. flavata* is described and figured for the first time.

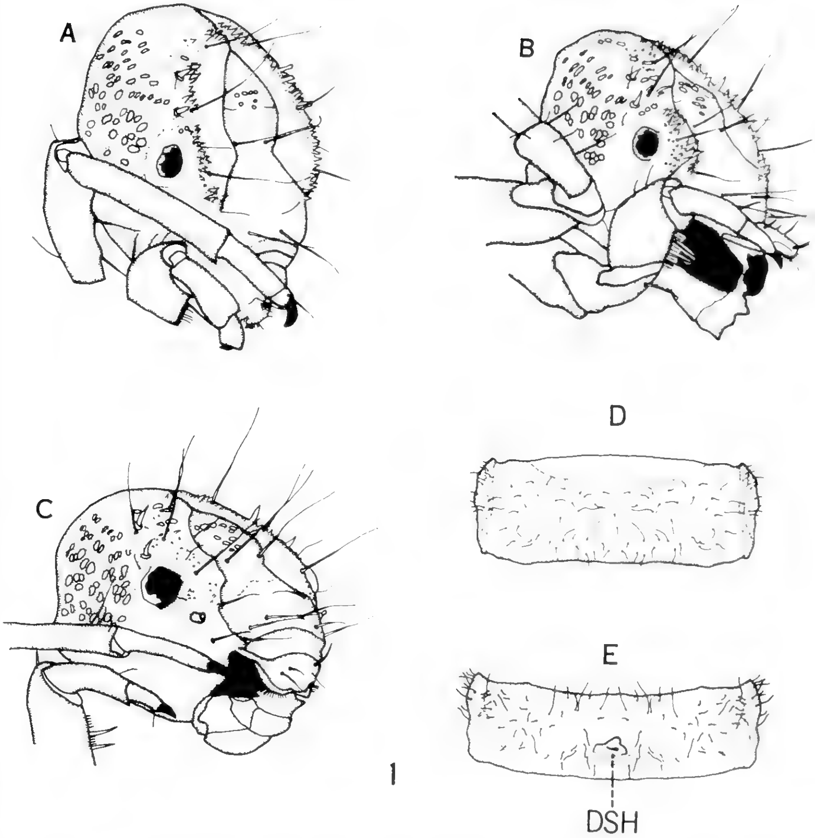

Fig. 1. Larvae of *Pycnopsyche flavata* and *P. gentilis*. A, Head of *P. flavata*. B, Head of southern *P. gentilis*. C, Head of northern *P. gentilis*. D, Dorsal view of first abdominal segment of *P. gentilis*. E, Dorsal view of first abdominal segment of *P. flavata*. DSH = dorsal spacing hump. Camera lucida drawings.

MATERIALS AND METHODS

Collections of *P. flavata* larvae were first made in December 1977 in the Tellico Wildlife Management Area of the Cherokee National Forest, Monroe Co., Tennessee. Light trap samples of adults were obtained in July 1978, and pupae and larvae were brought back for rearing. Specimens were reared in aluminum window-screen envelopes partially submerged in a spring seep. Ten collections of larvae and/or pupae were made on an approximately monthly basis between July 1978 and June 1979. Additional larvae and pupae were obtained for rearing in June 1979. In all, 18 pupae and larvae were reared for association purposes. An additional reared specimen was also discovered in some unidentified material borrowed from the Illinois Natural History Survey.

The description of the larva of *P. flavata* is based on 11 fifth-instar larvae from the Tellico site. Numerous other larvae from several localities were examined for much of the additional information in this paper. Larval instar determinations for *P. flavata* and *P. gentilis* were made using the method of approximate head widths (Dyar, 1890; Mackay, 1978). The notes on variation in *P. gentilis* were obtained from a study of 9 to 10 larvae from each of five localities including Essex Co., N.Y., Westmoreland Co., Pa., Bath Co., Va., Monroe Co., Tenn., and Morgan Co., Tenn. The larval description follows the format of Flint (1960) who provided a comparative account of *Pycnopsyche* larvae. The description of the female is based on 8 adults from Tennessee and North Carolina.

Description of Final Instar Larva of *Pycnopsyche flavata*

Length, 19.8–24.8 mm. Maximum width, 3–4 mm. *Head:* Yellowish brown. Muscle scars with dark borders on frons and posterior portion of genae. Front of head distinctly flattened with ridge of spines arcing from eye to eye. All 18 major setae present. Setae 13 and 16 flat and bladelike. Seta 16 on ridge of head appearing as member of arcuate band of spines. Setae 1 and 4 hyaline and appressed. Setae 6, 10, 11, and 12 light colored and cryptic. Seta 18 small and not obvious. Head width, 1.7–2.1 mm. *Thorax:* Pronotum yellowish brown with a series of spines on anterior edge and spinelike and hairlike setae dorsally. Mesonotum yellowish brown with spinelike and hairlike setae dorsally. Muscle scars present on pro- and mesonotum. Metanotum with Sa1, Sa2, and Sa3 sclerites. Metanotal Sa1 sclerites unfused. Setae present on membrane of metanotum. Legs yellowish brown. Prothoracic leg with 2 major spinelike setae ventrally on femur. Femora of meso- and metathoracic legs each with 2 major hairlike setae on ventral ridge. *Abdomen:* First segment with lateral spacing humps and remnants of dorsal spacing hump. Elongate sclerite present at posterior of each lateral hump. Dorsum (Sa1 + Sa2 areas) of 1st segment with 42–54 setae on either side of dorsal hump. Venter (Sa1 area) of 1st segment with 20–31 setae on either side. Sa2 sclerites on venter of 1st segment with 4–9 setae each. Eighth segment with 9–14 setae posteriorly on dorsum. Dorsal sclerite of 9th segment with 10–15 setae. *Gills:* Dorsal, II 0,1; III 1,1; IV 1,1; V 1,0-1; VI 0-1,0. Dorso-lateral, III 1,0; IV 0-1,0. Ventrolateral, II 0,1; III 0,0-1. Ventral, II 0,0-1; III 1,1; IV 1,1; V 1,1; VI 1,1; VII 1,1.

Diagnosis.—Of the known larvae of *Pycnopsyche,* that of *P. flavata* bears closest resemblance to that of *P. gentilis.* The larvae of both species possess bladelike 13th and 16th head setae. In *P. gentilis* both seta 13 and 16 are located on the curvature of the genae distinctly separate from other setae

Fig. 2. *Pycnopsyche flavata* larva showing placement of setae 13 and 16. 76×. SEM photograph.

and spines of the head (Figs. 1B, C; 3, 4). In *P. flavata* seta 16 is located in close apposition to an arcuate band of spines extending from eye to eye (Figs. 1A, 2). In addition, the head of *P. flavata* is distinctly flattened anteriorly. The head of *P. gentilis,* although often with a band of spines, displays a gradual rounding both laterally and dorsally. Finally, *P. gentilis* larvae lack a dorsal spacing hump on the 1st abdominal segment while *P. flavata* larvae possess at least the remnants of such a hump (Fig. 1D, E).

Description of Female of *Pycnopsyche flavata*

Length of forewing, 18–21 mm. Pale orange to tan. Forewing with a slight darkening along cord from R_5 to M_2 and with M-vein just proximal to cord, pale. Spur formula, 1-3-4. Opening of abdominal scent gland on anterolateral portion of 5th sternum. *Genitalia.* (Fig. 5): Segment IX in lateral view extended posteriad to sharp point dorsally, narrowed medially and widened and rounded ventrally. Dorsal IX with central concavity when viewed obliquely. Segment IX narrowed, rounded and tonguelike with median notch posteriorly in dorsal view. Ventral IX produced into cercus-like lobes. Dorsal X short and indistinct, slightly visible in dorsal view. Ventral X produced posteriorly into long, sclerotized scoop. Supragenital plate (SG.P.) membranous and not produced in lateral view. Vulvar scale (V.S.) produced to sharp point in lateral view, trilobed with central lobe mucronate viewed ventrally. Patches of setae on posterior VII and lateral to V.S. on VIII.

Diagnosis.—*Pycnopsyche flavata* is a member of the *divergens* group of Schmid (1955). Within this group the closest relative of *P. flavata* is *P. gentilis.* The female of *P. flavata* differs from that of *P. gentilis* mainly in the greater development of segment X. In *P. flavata* ventral X extends well beyond dorsal IX in lateral view. In *P. gentilis* ventral X extends at most even with dorsal IX and is often shorter.

Variation in the Larvae of *P. gentilis*

Although in all known instances the larvae of *P. gentilis* are readily distinguishable from those of *P. flavata,* a sizeable amount of variation is evident in *P. gentilis* from different localities. As previously reported by Flint (1960) the southern larvae of *P. gentilis* (Fig. 1B) display a much greater development of head spination than do the northern larvae (Fig. 1C), making them strikingly similar to the larvae of *P. flavata* (Fig. 1A). In this study, larvae from northern New York State were found to show extremely sparse spicule development. Those from southern Pennsylvania and southward, however, show considerably greater spicule development. Because of the difficulty of quantifying such a character, no attempt was made to determine if the variation is clinal. In addition, significant mean differences were shown to occur among localities in dorsal (Sa1 + Sa2) and ventral

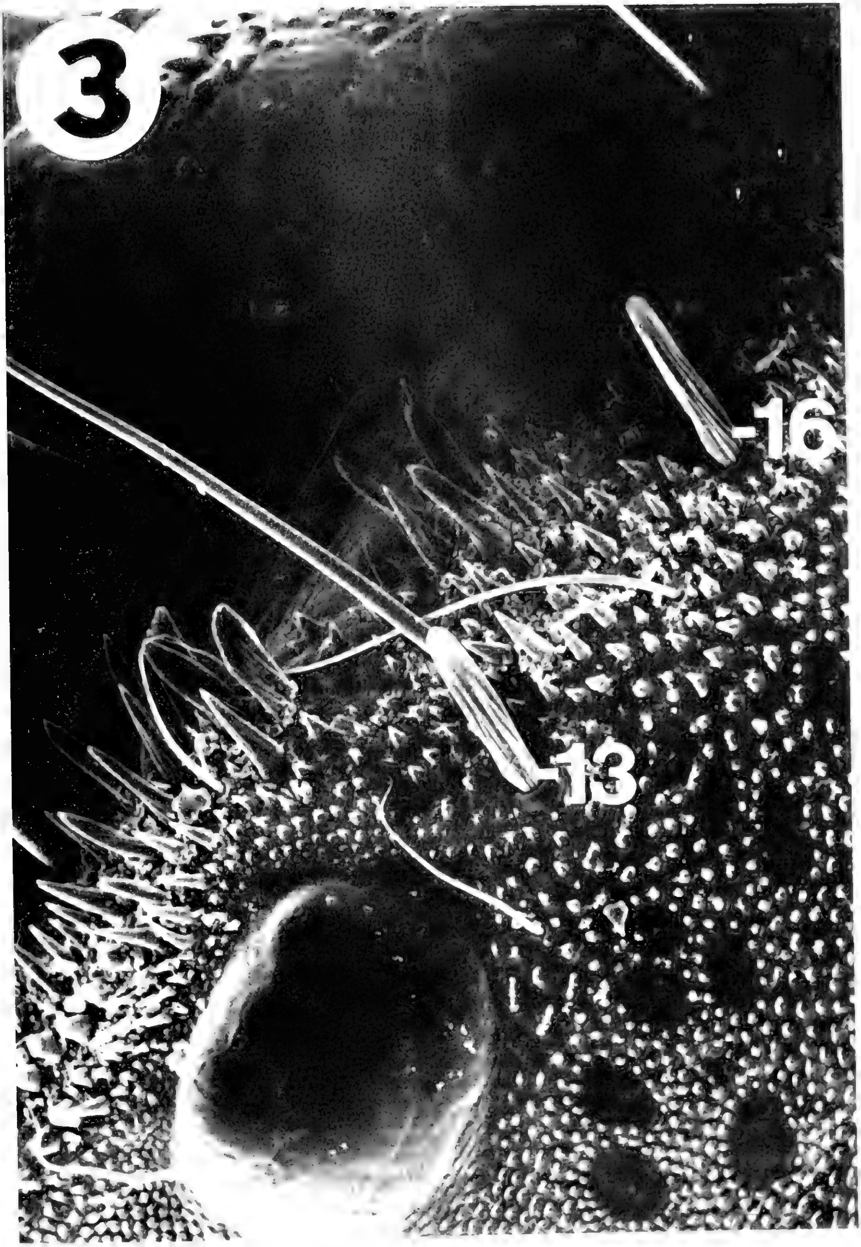

Fig. 3. *Pycnopsyche gentilis* larva, southern, showing placement of setae 13 and 16, 76×. SEM photograph.

(Sa1) setal counts of the first abdominal segment ($P > F = .01$). Gill formulas also showed a degree of variability (mostly on the posterior segments), for the most part showing a greater development of gills than reported by Flint (1960).

Recently, it was brought to the author's attention that certain populations of *P. gentilis* adults have males with aedeagal titillators strikingly different from those of typical *P. gentilis* (D. A. Etnier, personal communication). Further study has revealed variability in tibial spur counts both among and within localities of *P. gentilis*, most of the males with the unique titillators having 1-2-4 spur formulas as opposed to the typical 1-3-4. Unfortunately, the 1-2-4 spur formulas are not restricted to the *P. gentilis* with the unique titillators and further work will be necessary to clarify the significance of this variability.

NOTES ON THE LIFE HISTORY AND ECOLOGY OF *P. FLAVATA* AND *P. GENTILIS*

Habitat.—The larvae of *P. flavata* are restricted to a rather specific habitat type in the southern Appalachians. Collections in North Carolina and Tennessee show that the larvae are most often found in the headwater areas of streams, typically at elevations near or above 1000 m. Within this habitat *P. flavata* larvae prefer spring heads where the water is slow moving and shallow (ca. 2–5 cm), although they may be found quite commonly in larger streams earlier in their development. Within their range, the larvae of *P. flavata* are nearly always found to occur sympatrically with the larvae of *P. gentilis* and occasional collections have also yielded both *P. sonso* and *P. luculenta* (Betten) at the same locality.

Case structure.—Monthly collections during 1978 and 1979 at sites in eastern Tennessee indicate that early instar *P. gentilis* and *P. flavata* may construct triangular leaf cases as reported by Flint (1960) and Mackay (1972) or may instead by-pass these and immediately begin construction of stone cases. The later instar cases of both species are cylindrical and constructed of small stones. The type and particular size of stones used in the case appear to be more a function of availability than of specific preference, as indicated by variability among collection sites, especially in *P. gentilis*. Although selection for specific substrate sizes in case building may occur within locality (Mackay, 1977) my observations suggest that this is not a species-wide phenomenon.

Larval development.—The third-, fourth-, and fifth-instars were readily identifiable for both species. Mean head widths of comparable instars of *P. flavata* and *P. gentilis* differ noticeably, those of *P. gentilis* being somewhat smaller. A comparison of data for *P. gentilis* with that of Mackay (1972) indicates a slightly smaller head width for the southern larvae. Third-instar *P. flavata* show a mean head width of .82 mm (range: .71–.87 mm; mode:

4

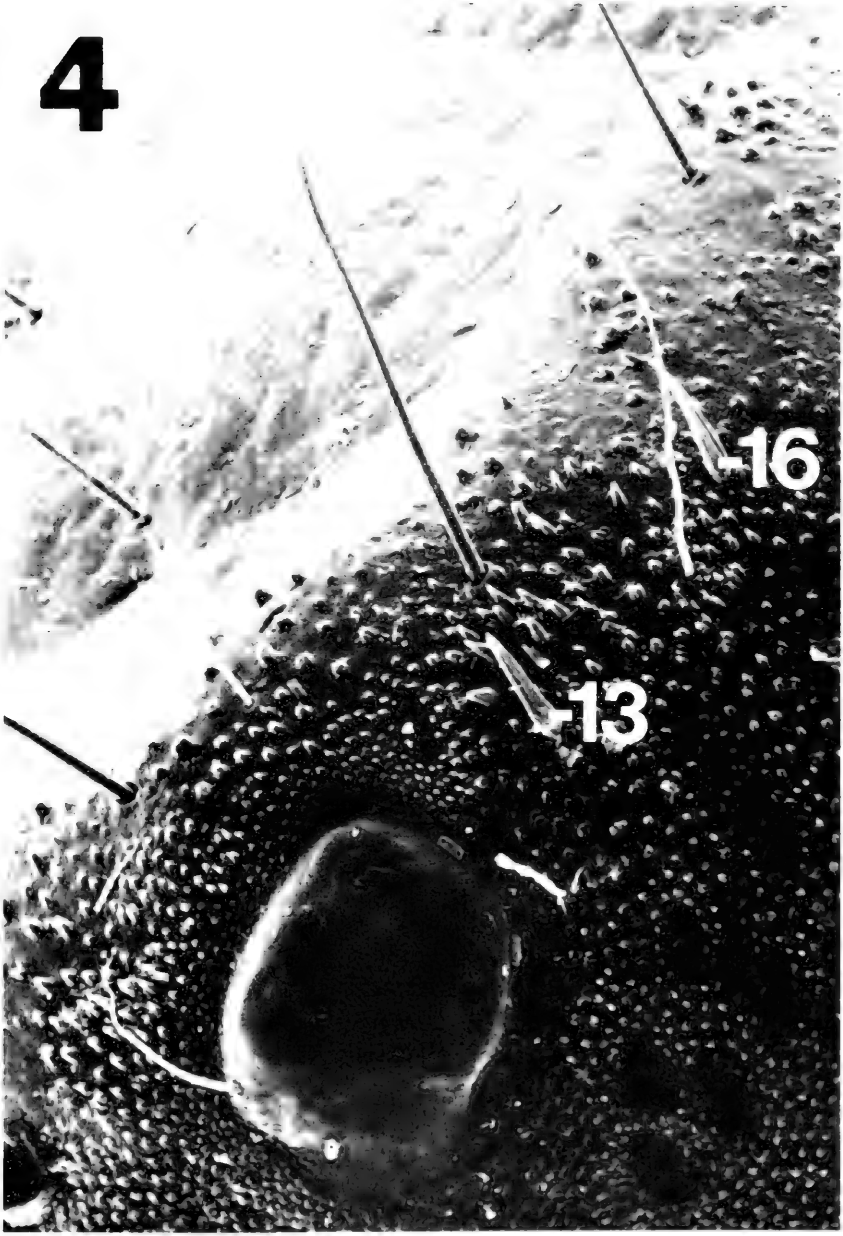

Fig. 4. Northern *Pycnopsyche gentilis* larva showing placement of setae 13 and 16. 76×. SEM photograph.

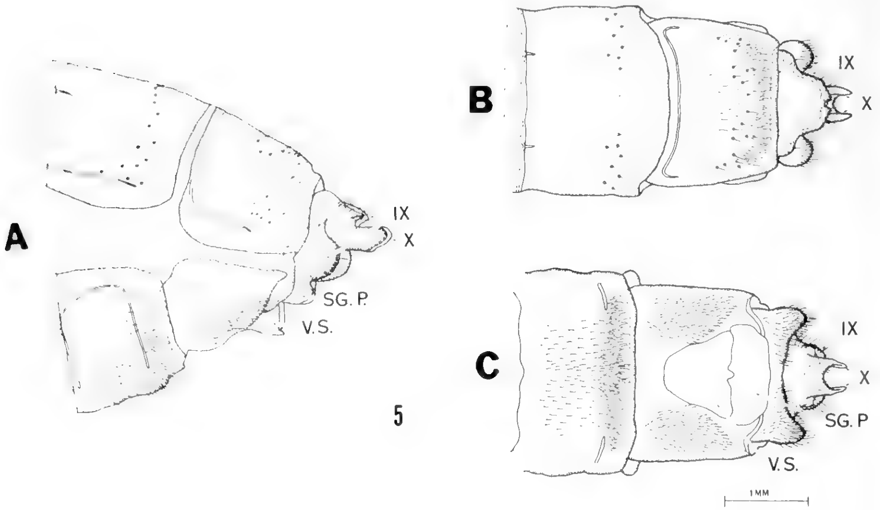

Fig. 5. Female genitalia of *Pycnopsyche flavata*. A, Lateral view. B, Dorsal view. C, Ventral view. SG.P. = supragenital plate; V.S. = vulvar scale. Camera lucida drawings.

.74 mm; *n* = 66) vs. a mean of .76 mm (range: .71–.90 mm; mode: .74 mm; *n* = 44) in *P. gentilis*. Mean head widths for fourth-instar larvae are 1.25 mm (range: 1.15–1.36 mm; mode: 1.26 mm; *n* = 83) for *P. flavata* and 1.17 mm (range: 1.05–1.29 mm; mode: 1.18 mm; *n* = 23) for *P. gentilis*. Fifth-instar larvae of *P. flavata* have a mean head width of 1.84 mm (range: 1.68–2.06 mm; mode: 1.84 mm; *n* = 121) while those of *P. gentilis* have a mean head width of 1.65 mm (range: 1.58–1.87 mm; mode: 1.71 mm; *n* = 30). Identification of second-instar *P. flavata* was tenuous at best. Second-instar identification of *P. gentilis* was more dependable because of the obvious lack of a dorsal spacing hump. Mean head width for second-instar *P. gentilis* larvae is .47 mm (range: .45–.52mm; mode: .48 mm; *n* = 32). No first-instar larvae could be positively identified for either species. Results indicate that larvae of *P. flavata* may begin to reach fifth (final) instar as early as October, with a large number of fifth-instar larvae occurring by December and January. In *P. gentilis,* on the other hand, although second- and third-instar larvae were collected in late November, no fifth-instar larvae were evident until March[1]. This agrees with the findings of Mackay (1972) which is surprising considering the difference in the latitude of the populations studied.

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[1] The fifth-instar of *P. gentilis* may have been reached as early as February; however, weather conditions did not permit collection of a sample in February.

Diapause and pupation.—A number of larvae of both species attain final instar as early as five or six months before pupation and adult eclosion. This suggests some sort of resting period such as has been reported for other species of *Pycnopsyche* (Wiggins, 1977; Mackay, 1972; Cummins, 1964). Present data do not allow distinction between a period of reduced larval activity or true physiological diapause.

The larvae of *P. flavata* do not appear to seal the front of their cases with small stones much in advance of the actual time of pupation. Sealed cases are evident only infrequently before June. Placement of an anterior sieve plate appears to occur just prior to pupation. Larvae with sealed cases but no anterior sieve plate often re-emerge when disturbed.

Prior to their resting period and subsequent pupation the larvae of both *P. gentilis* and *P. flavata* may anchor their cases to either larger stones or, occasionally, pieces of wood. In some instances a number of smaller stones may be attached to the front of the case to serve as an anchor.

Adult emergence.—Available records for emergence of *P. flavata* adults range from May 18 in Virginia (C. R. Parker, personal communication) to October 2 in North Carolina (G. B. Wiggins, personal communication). Southern Appalachian *P. gentilis* emerge later with records ranging from August 12 to October 30 in Virginia (C. R. Parker, personal communication). The majority of records, however, indicate that most *P. flavata* emerge from early May to late August, while most *P. gentilis* from comparable latitudes emerge in September and October. The virtual lack of overlap between the adult flights of the two sympatrically occurring species probably serves as a reproductive isolating mechanism leading to later hatching and development of *P. gentilis* larvae which limits competition between comparable instars of both species.

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LITERATURE CITED

Dyar, H. G. 1890. The number of molts of lepidopterous larvae. Psyche (Camb. Mass.) 5: 420–422.

Cummins, K. W. 1964. Factors limiting the microdistribution of larvae of the caddisflies *Pycnopsyche lepida* (Hagen) and *Pycnopsyche guttifer* (Walker) in a Michigan stream (Trichoptera: Limnephilidae). Ecol. Monogr. 34: 271–295.

Flint, O. S., Jr. 1960. Taxonomy and biology of Nearctic limnephilid larvae (Trichoptera), with special reference to species in eastern United States. Entomol. Am. 40: 1–117.

Mackay, R. J. 1972. Temporal patterns in life history and flight behaviour of *Pycnopsyche gentilis*, *P. luculenta*, and *P. scabripennis* (Trichoptera: Limnephilidae). Can. Entomol. 104: 1819–1835.

———. 1977. Behavior of *Pycnopsyche* (Trichoptera: Limnephilidae) on mineral substrates in laboratory streams. Ecology 58: 191–195.

———. 1978. Larval identification and instar association in some species of *Hydropsyche* and *Cheumatopsyche* (Trichoptera: Hydropsychidae). Ann. Entomol. Soc. Am. 71: 499–509.

Schmid, F. 1955. Contribution a l'étude des Limnophilidae (Trichoptera). Mitt. Schweiz. Entomol. Ges. 28: 1–245.

Vorhies, C. T. 1909. Studies on the Trichoptera of Wisconsin. Trans. Wis. Acad. Sci. 16: 647–738.

Wiggins, G. B. 1977. Larvae of the North American caddisfly genera (Trichoptera). Univ. of Toronto Press, Toronto. 401 pp.

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THE NOCTUOID MOTHS OF THE ANTILLES—PART II (LEPIDOPTERA: ARCTIIDAE: PERICOPINAE)

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Abstract.—Sixteen Pericopinae species reported from the Antilles are treated. Thirteen species, including *Stenognatha flinti*, n. sp., are illustrated. *Ira gundlachiana* Neumoegen is transferred to *Syntomidopsis* and is thus included in the subfamily.

The Arctiidae of the Antilles represent a fairly large group of species and remain mostly unstudied. In the course of my studies of the noctuoid moths of the Antilles, I have checked collections for material, collected on seven of the Islands, attempted to identify the material located in collections or recently collected, reviewed the literature pertaining to previous studies, tried to recognize undescribed species, etc. Unfortunately, visual problems in 1979 necessitated retirement and brought detailed study of the Arctiidae to a halt. Since that time, I decided to publish illustrations of the Antillean species available to me, and to indicate what problems are unresolved. Much more work is required to characterize the various subfamily groups. At the present time classification is based mainly on venation. Characters of the tympanum, genitalia, thoracic furrows, and other systems need to be examined and combined with venational characters to develop a sound classification. All genera and species should be studied because several at present appear to be misplaced.

Syntomidopsis gundlachiana (Neumoegen), NEW COMBINATION

Fig. 1

Ira gundlachiana Neumoegen, 1890: 64.

Length of forewing.—Male, 12 mm.

This species has not been included in the Pericopinae previously. When described, Neumoegen proposed a new genus, *Ira*, 1890, but that generic name is preoccupied by *Ira* Walker, 1866 (Geometridae). The species is close to the following species, but the male of *S. variegata* (Walker) has some longitudinal black marks on the base of the forewing, has three distinct white spots in the black apex of that wing, and the white spot of the tornal angle is much more distinct. The only specimen I have examined is the type male. The female sex is unknown to me. The type-specimen is from Plantation Jagey, S.E. Cuba.

Syntomidopsis variegata (Walker)

Figs. 2, 3

Eudule variegata Walker, 1854: 380.
Syntomidopsis variegata (Walker): Hering, 1925: 452.
Syntomidopsis variagata (*sic*) (Walker): Bryk, 1931: 47.

Length of forewing.—Male, 15 mm; female, 17 mm.

Fifteen examples from Jamaica in the collection of the National Museum of Natural History have been examined. The species differs from *S. gundlachiana* as explained under that species, and it is also slightly larger. The pink coloration of the wings of both species separate them from all other Pericopinae species I know.

Stenognatha cinda (Schaus)

Figs. 4, 5

Hyalurga cinda Schaus, 1938: 508.
Stenognatha cinda (Schaus): Lane and Watson, 1975: 109.

Length of forewing.—Male, 20 mm; female, 24.5 mm.

Lane and Watson (1975: 109–117) stated how the species of the genus known to them differed from each other. In total I have examined four examples. The pair figured here are the types and are in the National Museum of Natural History. The other two are in the British Museum (Natural History), London, England. The type-locality is Las Animas, Pinar del Rio, Cuba. The maculation of the forewing and coloration of the hindwing as shown in the figures is distinctive for each species of this genus.

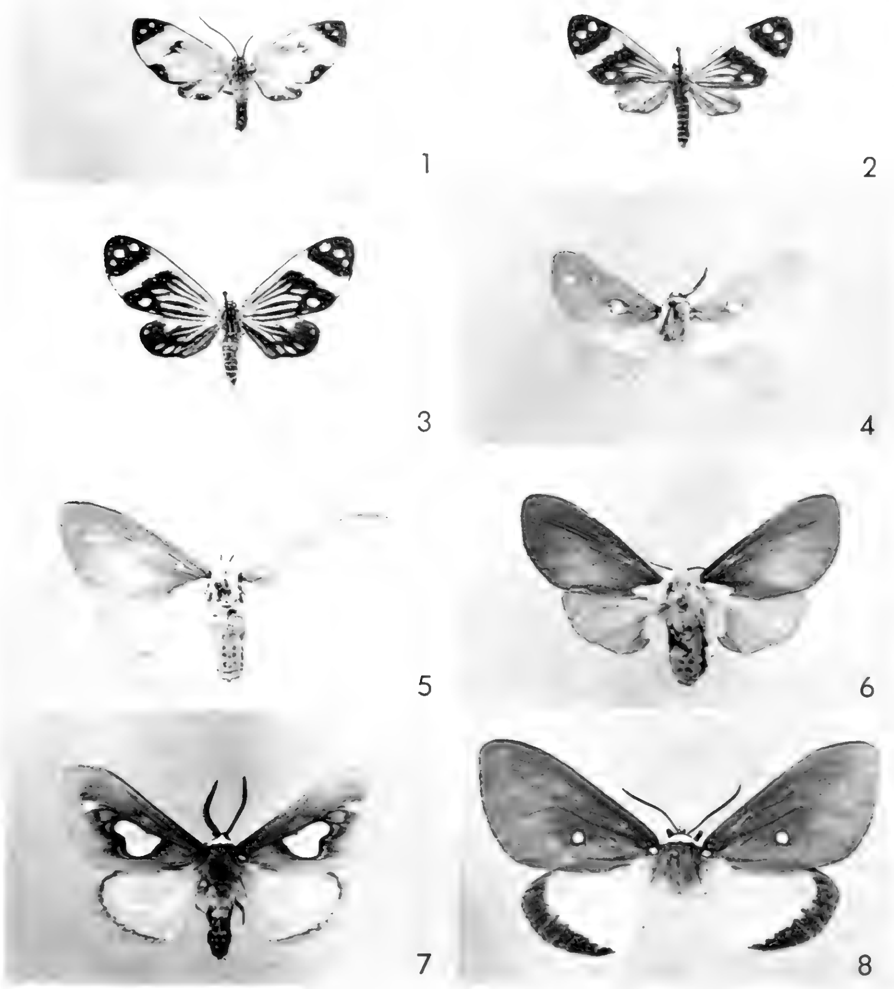
Stenognatha flinti Todd, New Species

Fig. 6

Length of forewing.—Female, 23.5 mm.

Type.—Holotype, ♀, 12 km N. of Constanza, Dominican Republic, 6–18 June 1969, Flint and Gomez, in the National Museum of Natural History.

This female and the species described by Lane and Watson as *S. toddi* in 1975 were known to me before Don R. Davis went to Jamaica and to Hispaniola in 1973. I showed him examples including the unique type-specimen of this species and asked that he try to get males on Hispaniola, but he collected no examples there, so I know only the type of this species. The hindwing of this species is so different from that of the other species that I decided to describe it even though the male is not known. The hindwing



Figs. 1–8. Dorsal view of adults. 1, *Syntomidopsis gundlachiana*, type male, Cuba. 2, *S. variegata*, male, Jamaica. 3, *S. variegata*, female, Jamaica. 4, *Stenognatha cionda*, male, Cuba. 5, *S. cionda*, female, Cuba. 6, *S. flinti*, type female, Dominican Republic. 7, *S. toddi*, male, Jamaica. 8, *S. toddi*, female, Jamaica.

is mostly smoky gray except for a small yellow patch on the anal margin and the fringe is completely white and contrasts with the rest of the wing.

Stenognatha toddi Lane and Watson

Figs. 7, 8

Stenognatha toddi Lane and Watson, 1975: 114.

Length of forewing.—Male, 23.5 to 29 mm; female, 28.5 to 33 mm.

This species is known only from Jamaica. Both sexes, male (Fig. 7) and female (Fig. 8), are easily recognized by the maculation and coloration of the wings. Five males and one female collected by Davis in Jamaica, including the holotype, have been examined. In addition I examined another male in the British Museum (Natural History) collected before 1973. The specimens figured in this paper are the ones figured by Lane and Watson, 1975, in figures 11–14.

Hyalurga vinosa (Drury)

Figs. 9–15

Sphinx vinosa Drury, 1773, 1: 47, pl. 23, fig. 4.
Ephestris vinosa (Drury): Hübner, 1820: 178.
Dioptis (Hyrmina) vinosa (Drury): Walker, 1854: 332.
Hyalurga vinosa (Drury): Herrich-Schaeffer, 1866: 131.
Lauron vinosa (Drury): Dewitz, 1877: 95.
Lauron domingonis Butler, 1876: 120.
Dioptis ergolis Walker, 1854: 335.
Hyalurga ergolis (Walker): Hering, 1925: 450.
Nectua horologica Goeze, 1781: 242.
Lauron horologica (Goeze): Kirby, 1892: 411.
Hyalurga horologica (Goeze): Hering, 1925: 450.
Dioptis rica Hübner, 1825: 31.
Hyalurga rica (Hübner), Dewitz, 1879: 170.

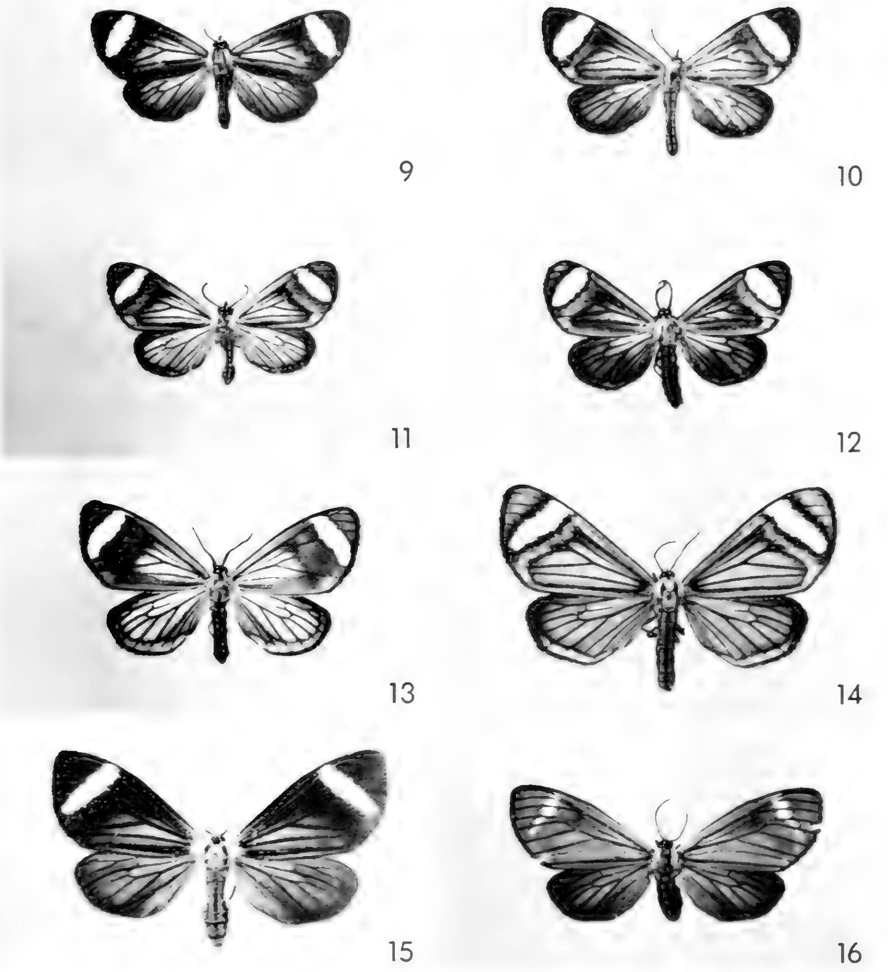
The many problems related to the species of this genus occurring in the Antilles and the proper application of names are mostly unresolved. Bryk (1931: 41–46) listed 42 species, and Antillean localities are given for four species. The type of one species, *H. rica* Hübner, is from Cuba. Genitalia of the types of all species need to be examined and specific characters, if any in either sex, should be noted. In addition, the mimetic relationships, if any, to certain ithomiid butterflies in Central and South America should be studied. For this species, I have followed previous workers in using the name *H. vinosa* (Drury) and accepting certain synonyms; I have not checked them. A total of 176 specimens was available for study. Food plants reported for this species by earlier workers are: *Heliotropium indicum* L., *H. angiospermum* Murray, and *Tournefortia hirsutissima* L.

Hyalurga halizoa Druce

Fig. 16

Hyalurga halizoa Druce, 1907: 308.

Three specimens of this species from Jamaica have been identified and studied among material in the National Museum of Natural History in Washington. The four small white spots composing the transverse band of the



Figs. 9–16. Dorsal view of adults. 9–15, *Hyalurga vinosa* variants. 9, From Cuba. 10, From Cuba. 11, From Puerto Rico. 12, From Jamaica. 13, From Puerto Rico. 14, From Dominica. 15, From Jamaica. 16, *H. halizoa*, Jamaica.

forewing and the orange scaling over much of the forewing make this species easy to recognize. I have not studied the genitalia.

Hyalurga diastilha Hering ?

Hyalurga diastilha Hering, 1925: 451, pl. 65, row f.

This species is doubtfully recorded because I have not seen a specimen that agrees with the illustration in Seitz (1925: pl. 65, row f). That illustration shows a very narrow transverse bar on the forewing, but the part next to the costal margin is bent basad in a crescent shape. In the series of *Hyalurga* specimens in the National Museum of Natural History there are eleven examples with a straight very narrow transverse bar which is not curved basad just before the costal margin. Unfortunately I have no illustration of this form for this paper. The female type in the Tring Museum needs to be checked to determine whether the illustration in Seitz is correct, if both wings are marked the same way, and whether the female genitalia agree with genitalia of a female with the straight bar from Jamaica in the National Museum of Natural History. If this identification, based on a female, seems correct, the male genitalia of the National Museum specimens need to be examined to learn whether *diastilha* is different from *H. vinosa* and *H. halizoa*.

Are marginata (Drury)
Fig. 17

Bombyx marginata Drury, 1773: 38.
Are marginata (Drury): Walker, 1855: 758.

Length of forewing.—Male, 23 to 26 mm; female, 26 to 30 mm.

This species is readily identified by the maculation. The shape of the black discal spot and the pale costal margin of the forewing are characteristic. The sexes are marked the same, but the females are slightly larger. I have examined 42 specimens, all from Jamaica. The subfamily placement of this genus and species needs to be checked.

Ctenuchidia virgo (Herrich-Schaeffer)
Figs. 18, 19

Ctenucha virgo Herrich-Schaeffer, 1855, 1: fig. 301.
Ctenuchidia virgo (Herrich-Schaeffer): Grote, 1865: 227.

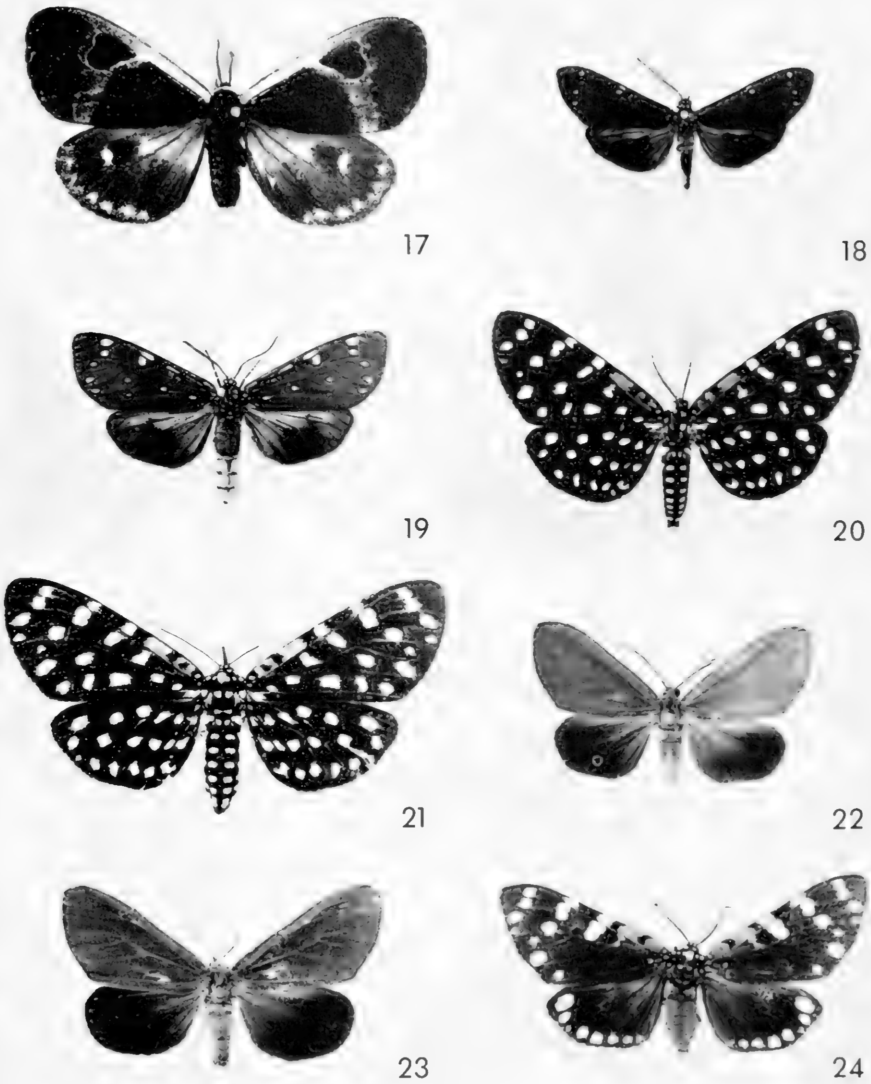
Length of forewing.—Male, 16 mm; female, 19 mm.

I have not resolved any problems connected with this genus. I have seen only 37 specimens, 28 of them from Puerto Rico. Other examples are from Cuba and Jamaica. More material needs to be studied, especially examples from other islands. Genitalia should be studied, and also an attempt should be made to determine if there exists differences in maculation in the different island populations.

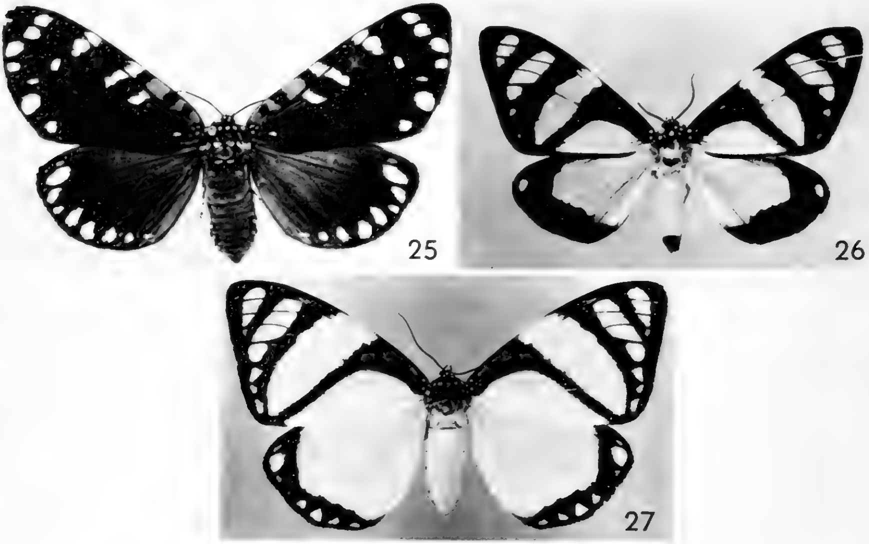
Ctenuchidia fulvibasis Hering ?

Ctenuchidia fulvibasis Hering, 1925: 447.
Centuchidia virgo fulvibasis Hering: Forbes, 1930: 42.

I have not identified this name. The male type in the Berlin Museum needs to be examined and the genitalia studied. It is quite possible that Forbes



Figs. 17–24. Dorsal view of adults. 17, *Are marginata*, Jamaica. 18, *Ctenuchidia virgo*, male. 19, *C. virgo*, female. 20, *Composia credula*, male. 21, *C. credula*, female. 22, *Eucyane gundlachia*, male. 23, *E. gundlachia*, female. 24, *Composia fidelissima*, male.



Figs. 25–27. Dorsal view of adults. 25, *Composia fidelissima*, female. 26, *Sphaeromachia cubana*, male. 27, *S. cubana*, female.

was correct in treating *fulvibasis* as a race of *C. virgo*, but I have considered the specimens I have from Jamaica as typical *virgo*.

Ctenuchidia interrupta Hering ?

Ctenuchidia interrupta Hering, 1925: 448.

I have not seen examples. The type, a male, is in the Tring Museum, England.

Composia credula (Fabricius)

Figs. 20, 21

Bombyx credula Fabricius, 1775: 584.
Composia credula (Fabricius): Hübner, 1820: 179.
Phal.[*aena*] *Noct.*[*ua*] *sybaris* Cramer, 1775: 112.

Length of forewing.—Male, 24 mm; female, 29 mm.

This species is easily recognized by the maculation, especially the numerous white spots. The species occurs throughout the Greater Antilles, and south to Brazil on the continent. The continental distribution needs to be studied and better recorded.

Composia fidelissima Herrich-Schaeffer

Figs. 24, 25

Composia fidelissima Herrich-Schaeffer, 1866: 131.
Composia fidellissima (*sic*) Herrich-Schaeffer: Kirby, 1892: 190.

Phaloesia olympia Butler, 1871: 290.

Length of forewing.—Male, 23 mm; female, 33 mm.

This species is easily identified by the maculation, as illustrated. The two sexes are much alike, but the female is much larger. This species apparently occurs from southern South America (Uruguay) into Central America (Honduras and Mexico) across to Cuba, Florida, and the Bahama Islands. Gowdey (1926: 57) reported the species from Jamaica.

Sphaeromachia cubana **(Herrich-Schaeffer)**

Figs. 26, 27

Pericopis cubana Herrich-Schaeffer, 1866: 131.
Sphaeromachia cubana (Herrich-Schaeffer): Grote, 1867: 304.

Length of forewing.—Male, 30 mm; female, 36 mm.

This species is recognized by the maculation, coloration, and size. The sexes are dimorphic, the pale areas of the wings being of a different color. In the male the color is dark yellow or yellowish orange, in the female, pale whitish green. The tip of the abdomen of the male is black, but not so in the female. The trivial name implies the species occurs in Cuba. It also occurs in Mexico. I examined only five specimens.

Eucyane gundlachia **Schaus**

Figs. 22, 23

Eucyane gundlachia Schaus, 1904: 138.

In the original description Schaus stated ". . . quite similar to *Napata chalybea* Hbn., except in neuration." It does look like a species of *Ctenucha*. Two syntypes from Baracoa, Cuba are figured in this work. The subfamily placement should be checked.

LITERATURE CITED

Bryk, F. 1931. Pericopinae. *In* Strand, Lepidopterorum Catalogus, Pt. 45, Berlin: Junk. 57 pp.

Butler, A. G. 1871. Descriptions of some new species of Lepidoptera. Ann. Mag. Nat. Hist. (4) 8: 282–291.

———. 1876. On the Lepidoptera referred by Walker to the genus *Dioptis* of Hübner. Cistula Entomol. 2: 107–121.

Cramer, P. 1775. Di uitlandsche kapellen voorkomende in de drie waerelddeelen Asia, Africa en America (Papillons exotiques des trois parties du monde, l'Asie, l'Afrique et l'Ámerique) V. 1. Amsterdam: Baalde and Utrecht: Wild. 155 pp., 96 pls. pp. 1–132, 1775; pp. 133–155, 1776.

Dewitz, H. 1877. Dammerungs—und Nachtfalter von Portorica, gesammelt von Herrn Consul Krug. Mitt. Muench. Entomol. Ver. 1: 91–96.

———. 1879. Naturgeschichte cubanischer Schmetterlinge/Nach beobachtungen des Herrn Dr. Gundlach bearbeitet. Z. Ges. Naturwiss. 52: 155–174, 1 pl.

Druce, H. 1907. Descriptions of new species of Heterocera belonging to the families Syntomidae, Hypsidae, Cyllopodidae, Dioptidae and Eratinidae. Ann. Mag. Nat. Hist. (7) 19: 299–371.

Drury, D. 1773. Illustrations of Exotic Entomology. Vol. 2. London: Bohn. 90 pp. + ix, 50 pls.

Fabricius, J. C. 1775. Systema Entomologiae . . . , Lipsiae Kovte. 832 pp. + xxx.

Forbes, W. T. M. 1930. Insects of Porto Rico and the Virgin Islands—Heterocera or Moths (excepting the Noctuidae, Geometridae and Pyralidae). Scientific Survey of Porto Rico and the Virgin Islands, V. 12, pt. 1. New York: New York Academy of Sciences. Pericopidae, pp. 40–43.

Goeze, J. A. E. 1781. Entomologische Beytrage zu des Ritter Linne zueliten Ausgabe des Natursystems. Leipzig. Weidmann. Vol. 3, Theil 3, 439 pp.

Gowdey, C. C. 1926. Catalogus Insectorum Jamaicensis. Jamaica Dep. Agric. Entomol. Bull. No. 4, Part 1, pp. 1–114.

Grote, A. R. 1865. Notes on the Bombycidae of Cuba. Proc. Entomol. Soc. Phil. 5: 227–255.

———. 1867. Notes on the Zygaenidae of Cuba. Proc. Entomol. Soc. Phil. 6: 297–329.

Herrich-Schaeffer, G. A. W. 1855. Sammlung neuer oder wenig bekannter Ausseuropaischer Schmetterlinge. Regensburg, Manz. Plates 49–78. Figs. 259–451.

———. 1866. Schmetterlinge aus Cuba. Corresp.–Blatt. Zool.–Min. Ver. Regensberg 20: 131–132.

Hering, M. 1925. *In* Seitz, Die Gross-schmetterlinge der Erde, Pericopinae. 6: 423–455, pl. 60–65.

Hübner, J. 1816 [1826]. Verzeichniss bekannter Schmettlinge (*sic*), pp. 1–431 + 1–72.

———. 1825 [1827–1831]. Zutrage zur Sammlung Exotischer Schmetterlinge. Drittes Hundert. Augsburg [no publisher listed]. 40 pp. + 8 unnumbered pages, 33 plates [1824–1825]. Figs. 401–600.

Kirby, W. F. 1892. A synonymic catalogue of Lepidoptera Heterocera. London: Gurney and Jackson. 951 pp.

Lane, M. A. and A. Watson. 1975. A revision of the genus *Stenognatha* Felder (Lepidoptera: Arctiidae: Pericopinae). J. Nat. Hist. 9: 107–117.

Neumoegen, B. 1890. New beauties from near and far. Entomol. Am. 6: 61–64.

Schaus, W. 1904. New species of American Heterocera. Trans. Am. Entomol. Soc. 30: 135–178.

———. 1938. On new species of American Heterocera. Ann. Mag. Nat. Hist. (11) 2: 506–509.

Walker, F. 1854. List of the specimens of lepidopterous insects in the collection of the British Museum, Part 2. London: Trustees British Museum. pp. 279–581.

———. 1855. List of the specimens of lepidopterous insects in the collection of the British Museum, Part 3. London: Trustees British Museum. pp. 583–774.

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A KEY TO THE SPECIES IN *HYALOMYZUS* (HOMOPTERA: APHIDIDAE) IN NORTH AMERICA, WITH THE DESCRIPTION OF A NEW SPECIES[1]

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Abstract.—Keys are given for the apterous and alate viviparae of *Hyalomyzus* Richards known to occur in North America and Puerto Rico. All of the morphs of *Hyalomyzus* ***mitchellensis***, n. sp., are described. They were collected on *Hypericum mitchellianum* Rydberg at Mt. Mitchell, N.C.

Richards (1958) described the genus *Hyalomyzus* and characterized it as follows: Alate viviparae with many secondary rhinaria on antennal segments III, IV, and V, and without a dorsal sclerotic patch on the abdomen; apterous vivipara with the dorsum of the abdomen strongly wrinkled on segments I–IV; cornicles swollen, generally imbricated. Other characters are similar to *Myzus* Passerini. Nielsson and Habeck (1971) discussed the relationship of *Hyalomyzus* with closely related genera, and placed *H. collinsoniae* (Pepper, 1950) as a synonym of *H. eriobotryae* Tissot (1935). Eastop and Hille Ris Lambers (1976) and Smith and Parron (1978) considered *H. collinsoniae* to be a valid species.

Measurements are in mm in the following description and key.

Hyalomyzus mitchellensis Smith, NEW SPECIES

Figs. 1A–D, 2A

Fundatrix (Fig. 1A).—Color of living material, yellowish green, 1st-instar nymphs, yellowish. Color of cleared specimens, dusky on antenna beyond mid-section of antennal segment III, tip of tibiae, tarsi, siphunculi, cauda, anal plate, sclerotic areas on integumental sutures of abdomen.

Measurements (4 specimens).—Body length, 1.45–1.77; head width,

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0.33–0.40; length antennal segment III, 0.19–0.25, IV, 0.11–0.17, V, 0.15–0.16, VI, 0.09–0.13 + 0.11–0.16; rostral IV + V, 0.08–0.09, metatibia, 0.61–0.68; metatarsomere II, 0.08–0.11; siphunculus, 0.31–0.36; cauda, 0.16–0.17.

Some specimens collected May 12, 1969, with 2–6 sensoria on metatibia. Antenna without secondary rhinaria, head rugose with only slight indication of antennal tubercles. Siphunculi slightly imbricated. Cauda bearing 4 setae. Tarsal chaetotaxy, 3-3-3.

Apterous vivipara (Fig. 1B).—Color of living specimens, pale to dark green with conspicuous black siphunculi. Cleared specimens, dark on antennal segments IV, V, and VI, siphunculi, cauda, anal plate, tip of tibiae, and metatarsomere II. Dusky on head, rostrum, and sclerotic areas on intersegmental areas of dorsum of abdomen.

Measurements (first measurement is that of holotype) (range of 9 specimens).—Body length, 1.35 (1.34–1.90); head width, 0.36 (0.36–0.42); length of antennal segment III, 0.26 (0.21–0.31), IV, 0.20 (0.17–0.28), V, 0.17 (0.15–0.23), VI, 0.10 (0.09–0.11) + 0.20 (0.18–0.21); rostral IV + V, 0.08 (0.06–0.09); metatibia, 0.66 (0.62–0.88); metatarsomere II, 0.09 (0.08–0.11); siphunculi, 0.33 (0.31–0.39); cauda, 0.17 (0.12–0.18).

Cauda bearing 4 (3–5) setae, tarsal chaetotaxy 3-3-3. Abdomen strongly wrinkled on dorsal surface.

Alate vivipara.—Color of cleared specimens, dark on head, antenna, legs, thorax, siphunculi, cauda, and anal plate. Dusky sclerotic areas on intersegmental area on dorsum of abdomen.

Measurements (4 specimens).—Body length, 1.42–1.58; head width, 0.36–0.46; length antennal segment III, 0.43–0.50, IV, 0.28–0.32, V, 0.21–0.26, VI, 0.12–0.13 + 0.22–0.28; rostral IV + V, 0.07–0.09; metatibia, 0.75–0.98; metatarsomere II, 0.09–0.11; siphunculi, 0.30–0.33; cauda, 0.14–0.17. Secondary rhinaria on antennal segment III, 19–28, IV, 13–21, V, 3–8.

Cauda with 4–5 setae, tarsal chaetotaxy 3-3-3 (2). Cubitus of hindwing present or absent. Venation of forewing (Fig. 2A), dusky but very slight fuscus area on margins of veins.

Apterous male (Fig. 1D).—Color of living specimens pale, dark green to brownish, dark on tip of abdomen; siphunculi brown black. Color of cleared specimens dusky to dark on head, antenna, legs, siphunculi, cauda, anal plate, and sclerotic areas on abdomen.

Measurements (4 specimens).—Body length, 0.65–0.88; head width, 0.22–0.28; length antennal segment III, 0.13–0.18, IV, 0.09–0.11, V, 0.09–0.11, VI, 0.07–0.08 + 0.11–0.13; rostral IV + V, 0.06; metatibia, 0.35–0.41; metatarsomere II, 0.06–0.08; siphunculi, 0.19–0.20.

Antennal segment III with 7–13 secondary rhinaria, IV, 4–8; V, 2–3; VI, 0. Antennal segment III and IV may not be distinctly separated. Dorsum of abdomen slightly wrinkled.

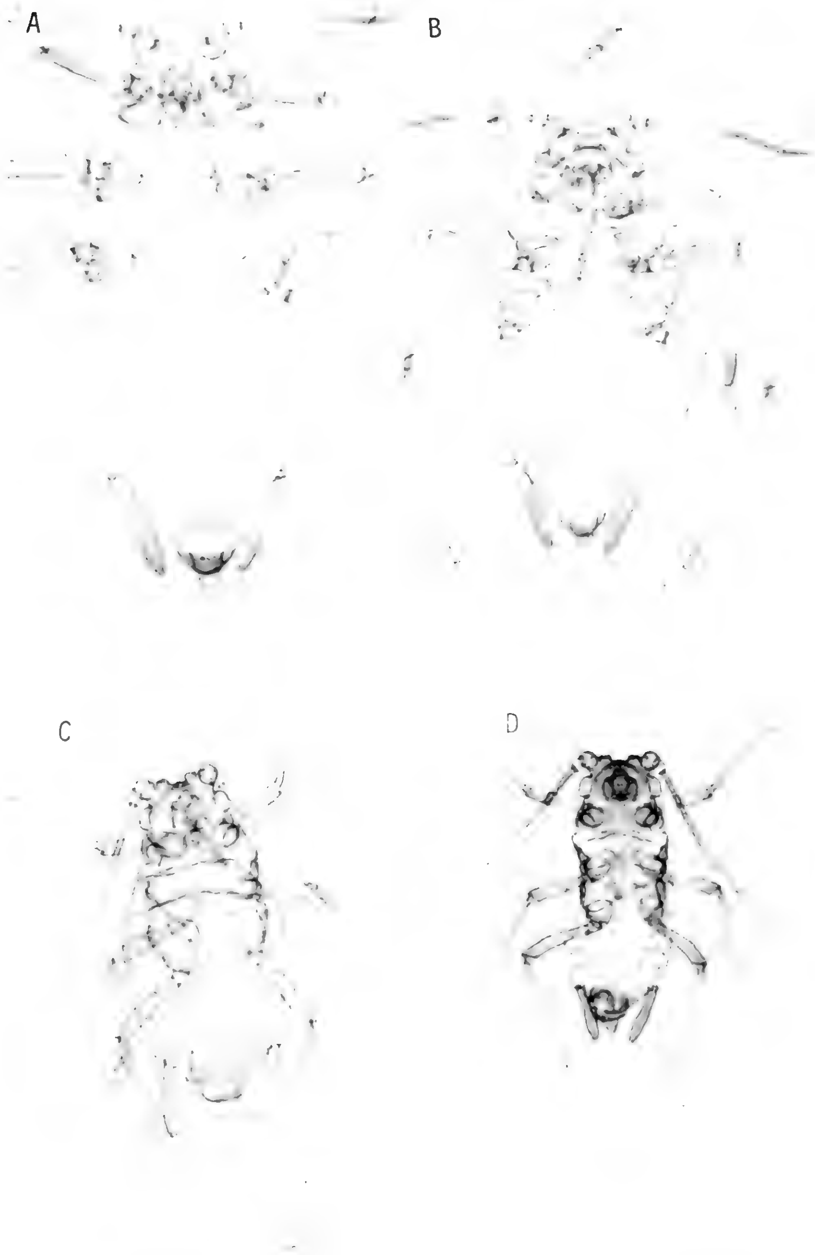

Fig. 1. *Hyalomyzus mitchellensis* from *Hypericum mitchellianum*, Mt. Mitchell, N.C. (all figures the same magnification). A, Fundatrix, collec. 69-111, May 12, 1969. B, Apterous vivipara (holotype), collec. 79-4, June 19, 1979. C, Apterous ovipara, collec. 67-417, October 11, 1967. D, Apterous male, collec. 67-417, October 11, 1967.

Apterous ovipara (Fig. 1C).—Color of living specimens, dark green to brownish, dark on tip of abdomen, siphunculi brownish black. Color of cleared specimens, similar to apterous male except abdomen usually not as dark and sclerotic areas on intersegmental areas on dorsum of abdomen prominent.

Measurements (5 specimens).—Body length, 0.96–1.32; head width, 0.29–0.31; length antennal segment III, 0.10–0.17, IV, 0.09–0.12, V, 0.08–0.12, VI, 0.07–0.08 + 0.12–0.15; rostral IV + V, 0.06–0.07; metatibia, 0.37–0.43; metatarsomere II, 0.07–0.09; siphunculi, 0.20–0.27; cauda, 0.09–0.11.

Antennae without secondary rhinaria. Metatibia with numerous sensoria on the basal ¾, sensoria confined primarily to the ventral portion. Cauda with 4 setae.

Eggs.—Deposited on tips of shoots. Eggs white when first deposited, becoming dark olive green to black later.

Type-locality.—Mt. Mitchell, North Carolina.

Types.—Holotype from collection 79-4. Apterous specimen no. 4 at 6 o'clock position on slide, collected 20 June 1979 on *Hypericum mitchellianum* Rydberg, Mt. Mitchell, North Carolina by C. F. Smith and C. K. Smith. All other specimens listed below are paratypes. The holotype and paratypes are in the National Museum of Natural History, Washington, D.C. (USNM); paratypes in the collections of USNM; Canadian National Collection, Ottawa; British Museum (Natural History), London; North Carolina State University; and the author.

Collections.—All known specimens of this species were collected on *Hypericum mitchellianum*, on Mt. Mitchell, North Carolina along the "Camp Alice Trail," 9 September 1963, collection 63-64, C. F. Smith, C. K. Smith, J. O. Pepper, A. N. Tissot (2 slides); 11 October 1967, collection 67-417, C. F. Smith (7 slides); 10 September 1968, collection 68-208, C. F. Smith, M. G. Robertson (1 slide); 12 May 1969, collection 69-11, C. F. Smith, M. G. Robertson (15 slides); 11 June 1969, collection 69-168, M. G. Robertson, C. F. Smith (11 slides); 11 June 1976, C. F. Smith, collection 76-39 (18 slides); 12 August 1976, collection 76-46, C. F.Smith, M. Cermeli (10 slides); 20 September 1976, collection 76-56, C. F. Smith, C. K. Smith (5 slides); 10 August 1978, collection 78-258, C. F. Smith, C. K. Smith (3 slides); 12 October 1978, collection 78-260, C. F. Smith, C. K. Smith (4 slides); 12 October 1978, collection 78-261, C. F. Smith, C. K. Smith (1 slide); 19 June 1979, collection 79-4, C. F. Smith, C. K. Smith (32 slides).

Biology.—*Hyalomyzus mitchellensis* apparently spends its entire life cycle on *Hypericum mitchellianum* at the base of leaf axels and flower buds, and on stems of its host under rocks. Alate viviparae were abundant June 1979, at the time of the other collections alates were absent or very scarce. Males and oviparous females were collected 11 October. Fundatrices were

Fig. 2. Wings of alate viviparae. A, *Hyalomyzus mitchellensis* from *Hypericum mitchellianum*, Mt. Mitchell, N.C., collec. 79-4, June 19, 1979. B, *H. collinsoniae* from crab apple (*Pyrus augustifoliae*), Laurel Springs, N.C., collec. 6-247, July 4, 1966.

collected on 12 May, some specimens had slightly swollen metatibia bearing 2–6 sensoria.

Etymology.—Named for Mt. Mitchell, the type-locality.

Discussion.—The alate and apterous viviparae of *Hyalomyzus mitchellensis* can be separated from other species of *Hyalomyzus* by characters given in the key. I do not have specimens of the other morphs of the other species of *Hyalomyzus*.

KEY TO APTEROUS VIVIPARAE OF *HYALOMYZUS*

1. Processus terminalis shorter than antennal segment III 2
– Processus terminalis equal to or longer than antennal segment III 3

2(1). Abdomen without sclerotic spots. Siphunculi and antennal segments IV–VI not distinctly darker than base of antennal segment III. On *Crataegus, Aster, Hypericum* . . . *sensoriatus* (Mason) (1940)

– Abdomen with sclerotic spots (Fig. 1B). Siphunculi and antennal segments IV–VI distinctly darker than base of antennal segment III (Fig. 1B). On *Hypericum mitchellianum* . . . . *mitchellensis,* new species

3(1). Siphunculi dark, at least distal ½. Not on *Monarda* 4

– Sipunculi pale. On *Monarda* . . . . *monardae* (Davis) (1911)

4(3). Not on *Jussiaea* 5

– On *Jussiaea* . . . . *jussiaeae* Smith (1960)

5(4). Antennal segments I and II pale. Not on *Collinsonia* 6

– Antennal segments I and II dark. On *Collinsonia* . . . . *collinsoniae* Pepper (1950)

6(5). Length of antennal segment III, 0.27–0.40, IV, 0.18–0.29, V, 0.20–0.28, VI, 0.10–0.13 + 0.49–0.52 . . . . *tissoti* Nielsson and Habeck (1971)

– Length of antennal segment III, 0.40–0.50, IV, 0.33–0.43, V, 0.28–0.33, VI, 0.11–0.13 + 0.46–0.55 . . . . . *eriobotryae* Tissot (1935)

Key to Alate Viviparae of *Hyalomyzus*

1. Processus terminalis less than 3× length of base of antennal segment VI 2

– Processus terminalis more than 3× length of base of antennal segment VI 3

2(1). Secondary rhinaria on antennal segment III, 19–23, IV, 15–18, V, 3–5. On *Hypericum mitchellianum* . . . . . *mitchellensis,* new species

– Secondary rhinaria on antennal segment III, 45–62, IV, 27–43, V, 11–17. On *Crataegus, Aster, Hypericum* . . . . . . *sensoriatus* (Mason)

3(1). Alate vivipara with antennal segment V with 0–11 secondary rhinaria. Anal vein of forewing may or may not be distinctly bordered (Fig. 2) 4

– Alate vivipara with antennal segment V with 10–20 secondary rhinaria. Anal vein of forewing not distinctly bordered . . . . *eriobotryae* Tissot

4(3). Antennal segment III usually with 20 or more secondary rhinaria. Not on *Monarda* 5

– Antennal segment III with 8–12 secondary rhinaria. On *Monarda* . . . . *monardae* (Davis)

5(4). Antennal segment III with 11–40 secondary rhinaria. Anal vein of forewing not distinctly bordered 6

– Antennal segment III with 40–52 secondary rhinaria. Anal vein of forewing distinctly bordered (Fig. 2B) . . . . *collinsoniae* Pepper

6(5). Antennal segment III with 11–25 secondary rhinaria. On *Crataegus* sp., *Isnerdia intermedia*, *Drosera* sp. .... *tissoti* Nielsson and Habeck

– Antennal segment III with 26–40 secondary rhinaria. On *Jussiaea* .... *jussiaeae* Smith

LITERATURE CITED

Davis, J. J. 1911. Williams' "The Aphididae of Nebraska;" a critical review. Univ. Stud. (Nebr.) 11: 253–291.

Eastop, V. F. and D. Hille Ris Lambers. 1976. Survey of the World's Aphids. Dr. W. Junk b.v., The Hague. 573 pp.

Mason, P. W. 1940. A revision of the North American aphids of the genus *Myzus*. U.S. Dep. Agric. Misc. Publ. 371: 1–30.

Nielsson, R. J. and D. H. Habeck. 1971. The genus *Hyalomyzus* (Homoptera: Aphididae), with the description of a new species. Ann. Entomol. Soc. Am. 64: 883–887.

Pepper, J. O. 1950. Six new aphids from Pennsylvania. Fla. Entomol. 33:3–15.

Richards, W. R. 1958. A new aphid genus (Homoptera: Aphididae). Fla. Entomol. 41: 169–172.

Smith, C. F. 1960. A new species of Aphidae: Homoptera from Puerto Rico. J. Agric. Univ. Puerto Rico 44: 157–162.

Smith, C. F. and C. S. Parron. 1978. An annotated list of Aphididae (Homoptera) of North America. N.C. Agric. Exp. Stn. Tech. Bull. No. 255: 1–427.

Tissot, A. N. 1935. A new *Myzus* from Florida. Fla. Entomol. 18: 49–52.

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84(2), 1982, pp. 332–336

TWO NEW SPECIES OF *NEPHASPIS* CASEY (COLEOPTERA: COCCINELLIDAE) FROM TRINIDAD AND COLOMBIA

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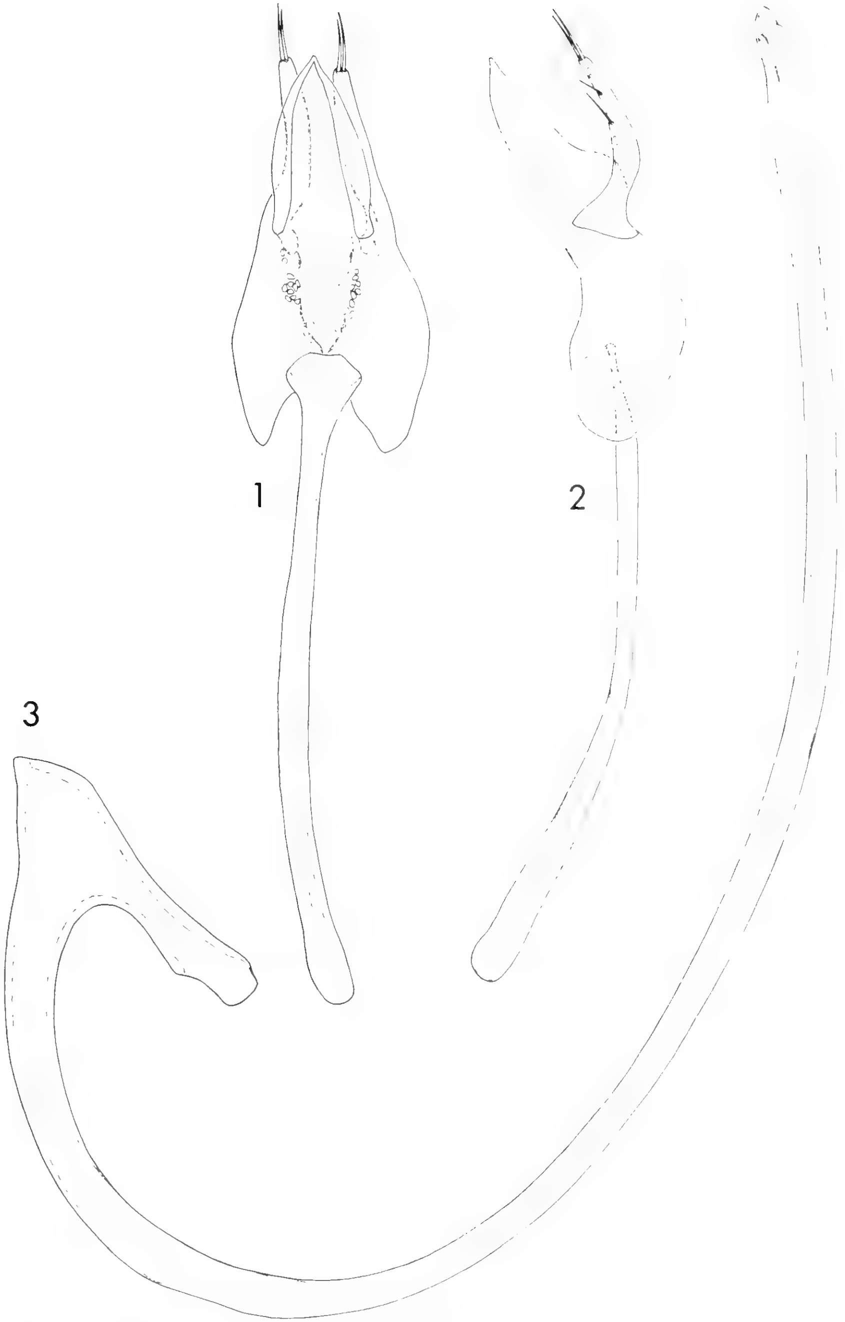
Abstract.—Two new species, *Nephaspis* **bicolor** and *N.* **namolica**, are described from Trinidad and Colombia, and reference is made to whitefly predation by members of the genus. *Nephaspis amnicola* Wingo is reported as being established in Hawaii.

Nephaspis is a Western Hemisphere genus first recognized by Casey (1899). Gordon (1972) discussed the generic affinities and provided a key to the four species recognized at that time. One additional species was later described from Trinidad and a revised key to the species prepared (Gordon, 1978). Since then, two more undescribed species have been discovered, and they are added to the classification herein. One of these species is native to Trinidad, but has been introduced into Hawaii in an effort to control the spiraling whitefly, *Aleurodicus dispersus* Russell. A request from S. Higa, Plant Pest Control Branch, Department of Agriculture, Honolulu, Hawaii, for a determination of this species of *Nephaspis* led to the realization that it was undescribed. Another undescribed species of *Nephaspis* was received from Fred Bennett of the Commonwealth Institute of Biological Control, Curepe, Trinidad. These specimens were collected in Colombia feeding on a species of whitefly on guava.

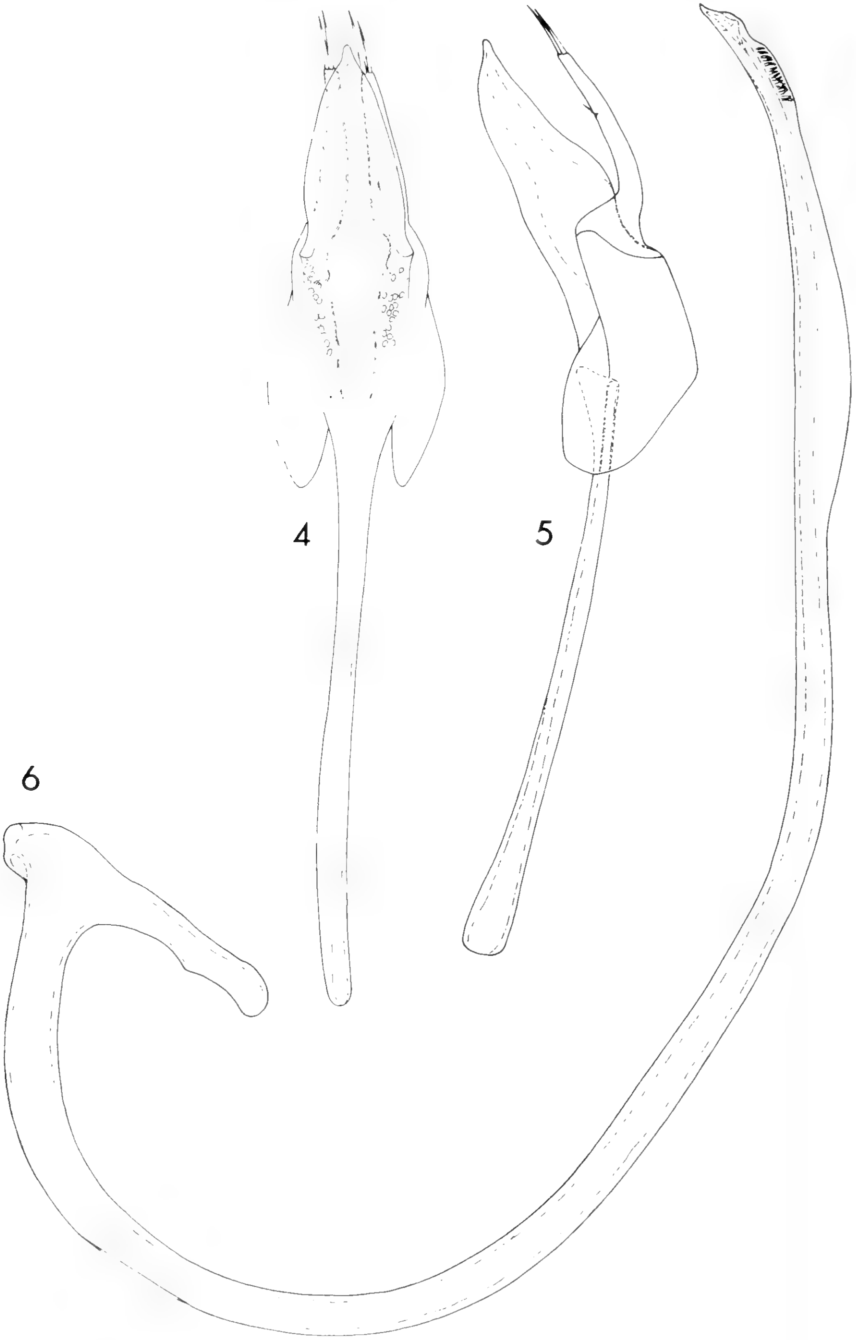
In addition to the new species now being released in Hawaii, *Nephaspis amnicola* Wingo now occurs there, having been introduced into Hawaii from Honduras and Trinidad in 1979 for control of the spiraling whitefly.

Type-materials of the two new species are deposited in the collection of the National Museum of Natural History, Washington, D.C. (USNM) and that of Fred Bennett, CIBC.

I thank Linda Lawrence, Systematic Entomology Laboratory, USDA, staff artist, for preparing the illustrations used herein.



Figs. 1–3. Male genitalia of *Nephaspis bicolor*.



Figs. 4–6. Male genitalia of *Nephaspis namolica*.

Nephaspis bicolor Gordon, New Species

Figs. 1–3

Holotype.—Male, length 1.40 mm, width 1.0 mm. Black; head, pronotum, mouthparts, legs, and apical 2 abdominal sterna yellow. Head finely punctured, punctures separated by 1–3× a diameter; pronotal punctures equal in size to head punctures, separated by a diameter or less. Ventral surface coarsely punctured, punctures separated by a diameter or less medially, contiguous laterally. Genitalia as in Figs. 1–3.

Allotype.—Female, length 1.45 mm, width 1.05 mm. Similar to male except head black, pronotum black except lateral ⅓ yellow.

Variation.—Length 1.40 to 1.50 mm, width 1.0 to 1.10 mm. Head of female often entirely yellow with vertex black.

Type-material.—Holotype (USNM 100004) and 10 paratypes; Trinidad, St. Joseph, Apr 16, 1980, R. Burkhart, on guava. Allotype and 5 paratypes; Trinidad, Curepe, May 28, 1980, R. Burkhart, *A. dispersus* on Guava and Candlestick.

Comments.—This species has male genitalia most similar to those of *N. amnicola* Wingo, and it will key to that species in Gordon (1978). However, the sipho of *N. bicolor* is straight before the apex, not sinuate as in *N. amnicola*. The male color pattern is not diagnostic for this species in any way, but the female pronotum with the wide yellow area on each side is unique and will separate that sex from females of all other species. The specific epithet refers to the pronotal color pattern of the female.

Nephaspis namolica Gordon, New Species

Figs. 4–6

Holotype.—Male, length 1.40 mm, width 0.95 mm. Black; pronotum yellow with median black spot at base; head, mouthparts, legs, and apical 3 abdominal sterna yellow. Head finely punctured, punctures separated by 1–3× a diameter; pronotal punctures slightly larger than on head, separated by 1 or 2 times a diameter; punctures on elytron coarse, separated by less than a diameter to twice a diameter. Ventral surface coarsely punctured, punctures separated by less than a diameter. Genitalia as in Figs. 4–6.

Allotype.—Female, length 1.35 mm, width 0.95 mm. Similar to male except vertex of head black, pronotum black except anterolateral angle narrowly yellow.

Variation.—Length 1.35 to 1.45 mm, width 0.95 to 1.0 mm. Black spot on male pronotum confined to basal ½, or extending to midpoint of pronotum.

Type-material.—Holotype (USNM 100005), allotype, and 10 paratypes; Colombia, Palmira (V), IV-79, F. Garcia, hojas guayobo (leaves of guava), predator mosca blanca (whitefly predators).

Comments.—*Nephaspis namolica* has male genitalia very similar to those of *N. amnicola* and will key to that species in Gordon (1978). The dorsal surface of the basal lobe in *N. namolica* is strongly sinuate in lateral view, and the shape of the basal lobe in ventral view is broader and more abruptly tapered before the apex. In *N. amnicola,* the dorsal surface of the basal lobe is feebly sinuate, and the shape of the basal lobe in ventral view is slender and tapered to the apex. The specific epithet is an anagram.

LITERATURE CITED

Casey, T. L. 1899. A revision of the American Coccinellidae. J. N.Y. Entomol. Soc. 7: 71–169.

Gordon, R. D. 1972. A review of the genus *Nephaspis* Casey and a comparison with the genus *Clitostethus* Weise (Coleoptera: Coccinellidae). Rev. Agric. (Piracicaba) 47: 145–154.

———. 1978. West Indian Coccinellidae II (Coleoptera): some scale predators with keys to genera and species. Coleopt. Bull. 32: 205–218.

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NEW SYNONYMIES AND A NEW COMBINATION IN THE NORTH AMERICAN MIRIDAE (HEMIPTERA)

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Abstract.—Four species of Miridae (Hemiptera) from the eastern United States are shown to be synonyms: *Phytocoris discoidalis* Henry, 1974 = *P. dreisbachi* Knight, 1974; *Plagiognathus inopinus* Knight, 1926 = *P. albatus* Van Duzee, 1915; *Rhinocapsus miniatus* Knight, 1923 = *R. rubricans* Provancher, 1887; and *Texocoris secludis* Schaffner, 1974 = *Parthenicus nigrellus* Knight, 1939. The monotypic genus *Texocoris* Schaffner, 1974 is retained to accommodate *nigrellus* (new combination).

A forthcoming paper on the Miridae associated with ericaceous plants in eastern North America has prompted me to provide information showing that *Rhinocapsus miniatus* Knight is a junior synonym of *R. rubricans* (Provancher). Additional synonymies and a new combination involving three other species from the eastern United States are also presented. Unless otherwise noted, all specimens examined are deposited in the collections of the Pennsylvania Department of Agriculture, Harrisburg, or the National Museum of Natural History, Washington, D.C.

Phytocoris dreisbachi Knight

Phytocoris dreisbachi Knight, 1974: 125; Kelton, 1980: 177.
Phytocoris discoidalis Henry, 1974: 187; Henry, 1979: 9. NEW SYNONYMY.

Knight (1974) described 15 new species of the *Phytocoris junceus* group. That same year I described the new species *discoidalis* (Henry, 1974). Because my species belonged to the *junceus* group, I used Knight's key and found that *discoidalis* runs to couplet 4 with *dreisbachi*. Recently, after examining Knight's type-specimens, I found that *discoidalis* is conspecific with *dreisbachi*. Because Knight's description appeared a few months prior to mine, I must recognize *P. discoidalis* as a junior synonym of *P. dreisbachi*.

Phytocoris dreisbachi, originally described from Michigan, is now known to occur in Pennsylvania, Virginia, Wisconsin (Henry, 1979), and Alberta and Manitoba (Kelton, 1980). This species has been collected on *Pinus banksiana* Lamb. and *P. virginiana* Mill.

***Plagiognathus albatus* (Van Duzee)**

Psallus albatus Van Duzee, 1915: 116.

Plagiognathus albatus: Van Duzee, 1916: 46; Van Duzee, 1917: 410; Knight, 1923: 445; Blatchley, 1926: 943; Knight, 1941: 36; Froeschner, 1949: 160; Davis, 1955: 132; Carvalho, 1958: 94; Wheeler and Henry, 1977: 153; Wheeler, 1980: 354 (see for review of economic literature).

Plagiognathus inopinus Knight, 1926: 11; Blatchley, 1926: 942; Carvalho, 1958: 103. **New Synonymy.**

Plagiognathus albatus often has been implicated as a pest of sycamore or American plane, *Platanus occidentalis* L. Wheeler (1980) studied the life history and gave evidence that *P. albatus* caused necrotic lesions and eventual holes in the foliage of London plane, *Platanus* × *acerifolia*. This common eastern North American mirid occurs wherever *Platanus* species grow (Wheeler, 1980).

Plagiognathus inopinus, the only other member of this genus recorded from *Platanus* spp. (Knight, 1926), was found to be common on street plantings of London plane at Harrisburg, Pennsylvania (the type-locality for this species). Having had the advantage to collect in Harrisburg for eight years, I was able to observe a close relationship between *inopinus* and *albatus*. *Plagiognathus inopinus* is a uniformly dark species; *P. albatus* is largely pale with darker markings. Continued collecting in this area showed that besides the typically dark *inopinus* and the much lighter colored *albatus*, at least three intermediate color morphs were present concurrently. All morphological structures are the same, including color and lengths of the antennal segments and the distinct spots on the pale femora. Male genitalia offer no distinctions. I have examined Knight's holotype and conclude that *inopinus* is only a dark extreme of *albatus*.

***Rhinocapsus rubricans* (Provancher)**

Plagiognathus rubricans Provancher, 1887: 154.

Microphylellus rubricans: Van Duzee, 1912: 323.

Rhinocapsus rubricans: Van Duzee, 1917: 409; Carvalho, 1958: 140; Kelton, 1968: 1075 (lectotype designation); Kelton, 1980: 306.

Rhinocapsus miniatus Knight, 1923: 460; Blatchley, 1926: 926. **New Synonymy.**

Rhinocapsus miniatus, described from a single male taken at Lakehurst, New Jersey, is one of several species of Miridae in North America that has remained obscure since its original description. Over the past eight years,

Table 1. Comparison of the length of the second antennal segment and the basal width of the pronotum for specimens of *Rhinocapsus rubricans* (in mm).

Male			Female		
Length of Antennal Segment II	Difference	Basal Width of Pronotum	Length of Antennal Segment II	Difference	Basal Width of Pronotum
1.18	+.12[a]	1.06	1.14	+.04[a]	1.10
1.36	+.06	1.30	1.22	+.14	1.08
1.14	.00	1.14	1.20	+.02	1.18
1.34	+.04	1.30	1.04	−.02	1.06
1.26	+.06	1.20	1.22	−.12	1.34
1.30	+.12	1.18	1.08	+.04	1.04
1.20	+.08	1.12	1.18	−.08	1.26
1.30	+.06	1.24	1.18	.00	1.18
1.32	+.04	1.28	1.18	−.10	1.28
1.36	+.06	1.30	1.20	−.08	1.28
1.30	+.06	1.24	1.16	−.10	1.26
1.32	+.02	1.30	1.24	−.04	1.28
1.34	+.22	1.12	1.18	−.08	1.26
1.36	+.10	1.26	1.26	−.04	1.30
1.24	+.06	1.18	1.14	+.04	1.10

[a] Differences (in mm) of measurements with "+" indicating that the second antennal segment is longer than the basal width of the pronotum and "−" indicating that the second antennal segment is shorter.

I have obtained numerous specimens of *Rhinocapsus* species, including examples from southern New Jersey. In an attempt to identify this material, I found that Knight's (1923: 459) key for separating *miniatus* from *rubricans* is unworkable.

Knight presented only two distinguishing characters for recognizing these two species: (1) Length of second antennal segment less than or subequal to basal width of pronotum (*rubricans*) or second antennal segment distinctly greater than basal width of pronotum (*miniatus*); and (2) size larger (4.3–4.6 mm for *rubricans*) or size smaller (3.4 mm based on the holotype of *miniatus*).

In measuring 15 males and 15 females of *rubricans*, I discovered that, in all but one specimen, the lengths of male second antennal segments are greater than the basal width of the pronotum; in females the lengths of the second segments were, in all but five examples, less than the basal width of the pronotum (Table 1). For the same number of specimens, males of *rubricans* averaged 4.26 mm in body length, with a range of 4.00–4.67 mm, and females averaged 3.86 mm, with a range of 3.25–4.33 mm.

It is apparent that *rubricans* males in most cases will key to *miniatus* and females to *rubricans*. Perhaps, in assembling his key, Knight used females of *rubricans* for his comparison to *miniatus* (a male). Also, the size of females frequently falls into the small-size range diagnosed for *miniatus*. Although no males were found that measured less than 4.00 mm, it is within the bounds of variation for such smaller specimens to occur, especially if the more harsh conditions of the Lakehurst-New Jersey Pine Barrens region are considered. I have remeasured the holotype of *miniatus* and find it to be 3.64 mm in length (by my ocular micrometer), rather than 3.4 as given by Knight.

Knight also commented that *miniatus* was more uniformly red than *rubricans* (which is typically fuscous on the hemelytra). An examination of his holotype suggests that the specimen is teneral; the color is light red and the metafemora are collapsed. Reared adults (teneral) of *rubricans*, also, are lighter or more uniformly reddish. Other than the slight size difference, teneral males of *rubricans* are indistinguishable from *miniatus*; thus, I consider *miniatus* a junior synonym of *rubricans*.

***Texocoris nigrellus* (Knight), New Combination**

Parthenicus nigrellus Knight, 1939: 23; Froeschner, 1949: 166; Carvalho, 1958: 123, Akingbohungbe et al., 1972: 11; Akingbohungbe et al., 1973: 14; Henry and Smith, 1979: 214.

Texocoris secludis Schaffner, 1974: 283. **New Synonymy.**

While examining Miridae in the Texas A&M University insect collection, I recognized that specimens identified as *Texocoris secludis* were very similar to *Parthenicus nigrellus*. Further examination of Schaffner's (1974) figures of male genitalia and comparison of type-material of both species confirmed that *secludis* is a junior synonym of *nigrellus*. Because *nigrellus* does not belong in the genus *Parthenicus* Reuter, I find it necessary to retain the monotypic genus *Texocoris* Schaffner to accommodate *nigrellus*.

Texocoris nigrellus has been reported from Georgia, Illinois, Iowa, Texas (Knight, 1941), and Missouri (Froeschner, 1949). Akingbohungbe et al. (1972) added Wisconsin and listed bloodroot as the host. Recently, I identified a series of *nigrellus* collected in Missouri (Columbia, Boone Co., 31 May 1981) on a fruiting mulberry tree, *Morus* sp.

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LITERATURE CITED

Akingbohungbe, A. E., J. L. Libby, and R. D. Shenefelt. 1972. Miridae of Wisconsin (Hemiptera: Heteroptera). Univ. Wis.–Madison Coll. Agric. Life Sci. Res. Div. Res. Bull. R 2396, 24 pp.

———. 1973. Nymphs of Wisconsin Miridae (Hemiptera: Heteroptera). Univ. Wis.-Madison Coll. Agric. Life Sci. Res. Div. Res. Bull. R 2561, 25 pp.

Blatchley, W. S. 1926. Heteroptera or true bugs of eastern North America. Nature Publ. Co., Indianapolis, Indiana. 1116 pp.

Carvalho, J. C. M. 1958. Catalog of the Miridae of the world. Arq Mus. Nac., Rio de J. Part II. Phylinae 45: 1–216; Part III. Orthotylinae 47: 1–161.

Davis, N. T. 1955. Morphology of the female organs of reproduction in the Miridae (Hemiptera). Ann. Entomol. Soc. Am. 48: 132–150.

Froeschner, R. C. 1949. Contribution to a synopsis of the Hemiptera of Missouri. Pt. IV. Am. Midl. Nat. 42: 126–188.

Henry, T. J. 1974. Two new pine-inhabiting *Phytocoris* from Pennsylvania (Hemiptera: Miridae). Entomol. News 85: 187–191.

———. 1979. Descriptions and notes on five new species of Miridae from North America (Hemiptera). Melsheimer Entomol. Ser. 27: 1–10.

Henry, T. J. and C. L. Smith. 1979. An annotated list of the Miridae of Georgia (Hemiptera-Heteroptera). J. Ga. Entomol. Soc. 14: 212–220.

Kelton, L. A. 1968. On the Heteroptera in the Provancher collection (Hemiptera). Nat. Can. (Que.) 95: 1065–1080.

———. 1980. The plant bugs of the Prairie Provinces. Agric. Can. Publ. 1703, Ottawa. 408 pp.

Knight, H. H. 1923. Family Miridae (Capsidae), pp. 422–655. *In* Britton, W. E., ed., Hemiptera of Connecticut. Conn. State Geol. Nat. Hist. Surv. Bull. 34.

———. 1926. Descriptions of four new species of *Plagiognathus* from the eastern United States (Hem., Miridae). Entomol. News 37: 9–12.

———. 1939. Three new species of Miridae from North America. Bull. Brooklyn Entomol. Soc. 34: 21–23.

———. 1941. The plant bugs, or Miridae, of Illinois. Bull. Ill. Nat. Hist. Surv. 22, 234 pp.

———. 1974. A key to species of *Phytocoris* Fallén belonging to the *Phytocoris junceus* group of species (Hemiptera, Miridae). Iowa State J. Res. 49: 123–135.

Provancher, L. 1886–98. Petite faune entomol. du Canada. Les Hemipteres 3, 354 pp.

Schaffner, J. C. 1974. *Texocoris secludis*, a new genus and species of Orthotylinae from Texas (Heteroptera: Miridae). J. Kans. Entomol. Soc. 47: 281–284.

Van Duzee, E. P. 1912. Synonymy of the Provancher collection of Hemiptera. Can. Entomol. 44: 317–332.

———. 1915. New genera and species of North American Hemiptera. Pomona J. Entomol. Zool. 7: 109–121.

———. 1916. Checklist of the Hemiptera of America north of Mexico. New York (N.Y. Entomol. Soc.). 111 pp.

———. 1917. Catalog of the Hemiptera of America north of Mexico. Univ. Calif. Publ. Entomol. 2: 1–902.

Wheeler, A. G. 1980. Life history of *Plagiognathus albatus* (Hemiptera: Miridae), with description of the fifth instar. Ann. Entomol. Soc. Am. 73: 354–356.

Wheeler, A. G., Jr. and T. J. Henry. 1977. Rev. Modestus Wirtner: Biographical sketch and additions and corrections to the Miridae in his 1904 list of western Pennsylvania Hemiptera. Great Lakes Entomol. 10: 145–157.

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A CO_2 PLATFORM TRAP FOR TAKING ADULT *DERMACENTOR ANDERSONI* (ACARI: IXODIDAE)

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Abstract.—A simple, light, and inexpensive CO_2 platform tick trap is described, and its effectiveness in attracting and collecting *Dermacentor andersoni* Stiles is evaluated. Tests utilized 8 traps set equidistant from a central tick release point. In 1979, traps were placed at distances of 6 m, 9 m, and 12 m on different dates. At 6 m, 76% of the ticks were recovered in 72 h, 40% in the 1st 24 h. At 9 m, only 3% of the released ticks were taken in 48 h, and 2% were trapped at 12 m in 72 h. In 1980, simultaneous tests were performed at 6-m and 9-m distances, with an additional 6-m test at a later date. In the 6-m tests, 50% of the ticks were captured in 24 h and 62% in 48 h. One of the 6-m tests was continued for 72 h, during which time 82% of the released ticks were taken. In the 9-m test, tick captures were 2% in 24 h, 15% in 48 h, and 23% in 72 h.

The Rocky Mountain wood tick, *Dermacentor andersoni* Stiles, is an important vector and pest species in the Rocky Mountain region. Colorado tick fever is the most prevalent disease with which the species is associated; some 150–250 cases are reported each year in Colorado, chiefly in Larimer and Boulder Counties (Goodpasture et al., 1978). Actual prevalence of the disease is difficult to assess, as it is considered to be underreported.

Vector-Borne Diseases Division personnel have conducted studies on the natural history of Colorado tick fever in Colorado. In connection with these studies, a CO_2 platform trap has been developed to study the seasonal host-seeking activities of unfed, adult *D. andersoni.* Garcia (1962) first demonstrated the effectiveness of CO_2 emitted by dry ice in attracting certain species of ticks in the field. Miles (1968) devised a CO_2 trap to collect ticks and fleas from mammal burrows. Wilson et al. (1972) reviewed the literature dealing with the utilization by ticks of chemoreceptors in host-seeking. They also described a CO_2 platform trap effective in collecting all stages of *Amblyomma americanum* (Linnaeus) and demonstrated the advantages of this

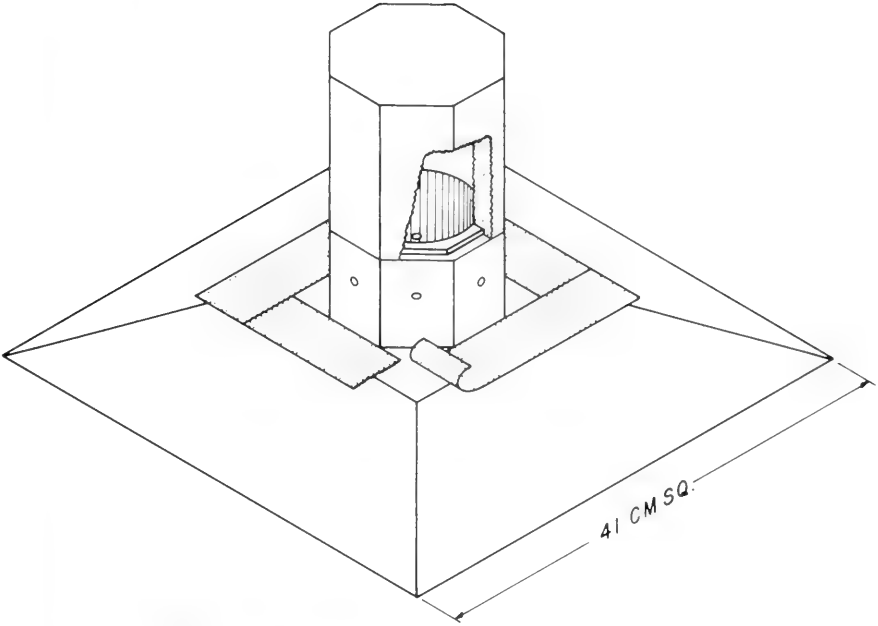

Fig. 1. CO_2 platform trap for ticks.

type of trap over flagging with white flannel cloth to study unfed (flat) tick populations. Our trap is discussed here, with an evaulation of its effectiveness in attracting adult *D. andersoni.*

Materials and Methods

The trap (Fig. 1) differs from the Wilson model primarily in the type of CO_2-holding container, and in that it is in two pieces rather than one. A 1-liter Boston Mailer®[1] of moulded styrene foam for holding dry ice is inserted in a central, octagonal opening in a fiberglass shell platform to complete the trap. The container holds ca. 650 g of chipped dry ice, an amount sufficient to operate a trap in shade or partial shade for 24 h even at the upper end of the summer air temperature range in the study area (ca. 32°C).

To activate a trap, a base is anchored firmly in litter or top soil on the ground. The container halves are filled with small chunks of dry ice and sealed with masking tape. A charged container is inserted into the central opening in a base and 5-cm masking tape is placed around the container.

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[1] Use of trade names is for identification only and does not constitute endorsement by the Public Health Service or by the U.S. Department of Health and Human Services.

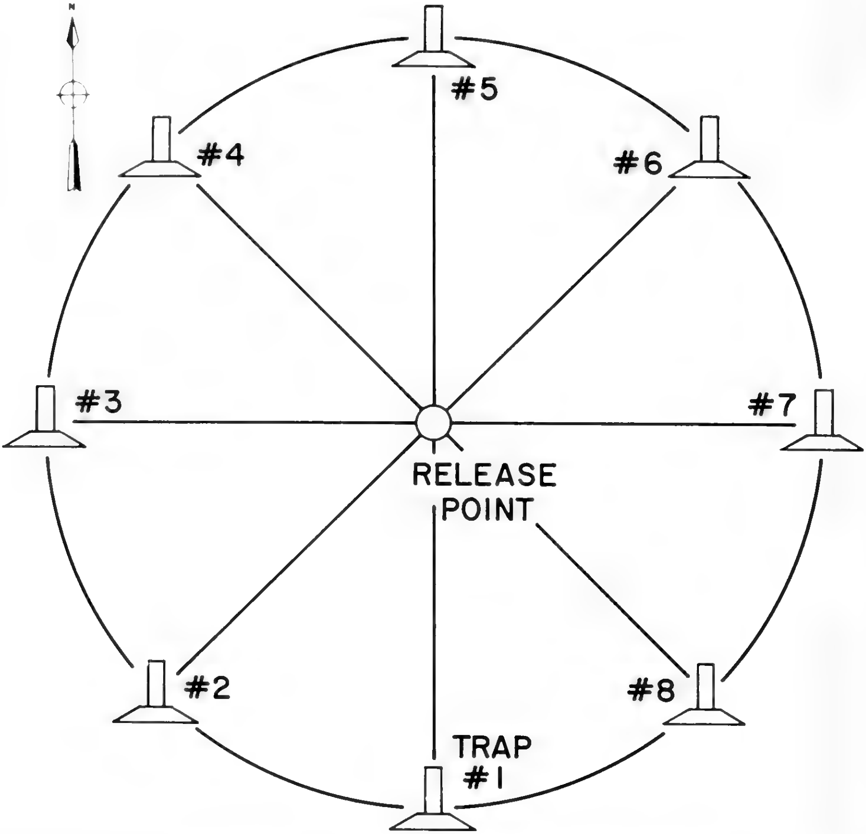

Fig. 2. Design to evaluate the effectiveness of CO_2 platform traps in attracting adult *Dermacentor andersoni*.

Only the proximal 2.5 cm of the tape is attached. The outer 2.5 cm is unattached and entangles ticks crawling up the sloping sides of the platform.

The design for the placement of the CO_2 platform traps, under field conditions, to attract adult *D. andersoni* is shown in Fig. 2. Releases of adult *D. andersoni* marked with a small spot of HiGlo fluorescent paint® were made at the center of the 8 equidistant CO_2 traps. Separate experiments were made in 1979 with the traps at 6 m, 9 m, and 12 m from the center. The ticks were obtained by flagging in the vicinity of the release sites, marked, and held in the laboratory for a week at 4°C prior to the first release experiment. Sufficient numbers of ticks were not available to permit simultaneous testing of the tick responses at the three distances. The same ticks were used at all three distances. Between tests they were held at 4°C, with negligible mortality; diminished vigor was not observed. In 1980, the traps

Table 1. Adult *Dermacentor andersoni* response to CO_2 platform traps, 1979.

	6 Meters 245 Marked Ticks Released			9 Meters 200 Marked Ticks Released		12 Meters 255 Marked Ticks Released		
	Marked Recoveries			Marked Recoveries		Marked Recoveries		
Trap Station	May 16 24 h	17 48 h	18 72 h	June 5 24 h	June 6 48 h	May 22 24 h	23 48 h	24 72 h
1	0	4	1	0	1	0	1	0
2	0	17	16	0	1	0	0	0
3	0	18	14	1	1	0	0	0
4	0	8	2	1	0	1	0	0
5	0	1	0	0	0	0	0	0
6	1	1	0	0	0	1	0	0
7	87	3	3	0	0	0	1	0
8	9	0	1	0	0	1	0	0
Totals	97	52	37	2	3	3	2	0
% available ticks recaptured	39.6	35.1	38.5	1.0	1.5	1.2	0.8	0

were tested simultaneously in different grids at 6 m and 9 m from the release point, and a third test at 6 m was done 12 days later. Insufficient numbers of ticks were taken by flagging near the release sites for the tests, and ca. 50% of the test ticks were taken by flagging at the Moraine Campground, Rocky Mountain National Park. All were marked and held 1–2 weeks at 4°C prior to the tests.

In each test the 8 traps were charged with CO_2 ca. 0800, just prior to the release of the marked ticks. The traps were checked at 24-h intervals at ca. 0800, trapped ticks were removed from the experiment, and the traps were recharged with CO_2. This was repeated for the desired number of days in each test period.

Temperature and relative humidity at the study site were recorded continuously during the tests on 7-day charts with a Belfort Hygrothermograph.® An anemometer was available for continuous recording of wind speed during the last of the tests.

STUDY AREA

The study site, on the Cherokee Christian Ranch, is 40 km NW of Fort Collins, within the Roosevelt National Forest, along the east slope of the front range of the Rocky Mountains in north-central Larimer County, Colorado (40°53′N lat., 105°28′W long.). Marr (1961) has described front range ecosystems and Marr et al. (1968) have characterized the climate. Soils are derived mainly from granite, schist-gneiss, and undivided metamorphic and igneous rocks, with occasional sedimentary formations at lower elevations

Table 2. Adult *Dermacentor andersoni* response to CO_2 platform traps, 1980.

	6 Meters 179 Marked Ticks Released			9 Meters 179 Marked Ticks Released			6 Meters 250 Marked Ticks Released	
	Marked Recoveries			Marked Recoveries			Marked Recoveries	
Trap Station	May 27 24 h	28 48 h	29 72 h	May 27 24 h	28 48 h	29 72 h	June 10 24 h	June 11 48 h
1	22	1	1	0	1	2	9	2
2	13	2	1	0	0	0	2	0
3	20	0	0	0	0	0	1	1
4	0	0	0	0	0	1	1	1
5	0	0	0	1	0	1	1	1
6	1	0	1	1	3	2	5	1
7	29	16	5	0	8	4	47	14
8	24	8	2	2	11	4	41	4
Totals	109	27	10	4	23	14	107	24
% available ticks recaptured	60.9	38.6	23.3	2.2	13.1	9.2	42.8	16.8

(Lovering and Goddard, 1950). Dominant plants on the hillsides are ponderosa pine, *Pinus ponderosa*; mountain mahogany, *Cercocarpus montanus*; and bitter-brush, *Purshia tridentata*.

Cherokee Christian Ranch was chosen for this study because it is a persistent focus of Colorado tick fever. For several years, an annual attack rate of 3–5 cases per 1000 camp days has been documented (Poland, unpublished data, Vector-Borne Diseases Division Annual Reports 1975–79). The site at which the ticks were released to test the effectiveness of the CO_2 traps was at an elevation of ca. 2179 m (7150 ft.). The immediate release area is flat, without rocky outcroppings, and with scattered ponderosa pines; small bitter-brush bushes and short grasses offer little obstruction to tick dispersal.

RESULTS

The first of the tests of the effectiveness of the CO_2 traps in attracting *D. andersoni* was done for three 24-h trapping periods May 16, 17, and 18, 1979, with the 8 traps placed 6 m from the central release point (Fig. 2). This point was continuously in the shade of a small ponderosa pine which provided several inches of litter for tick cover.

As shown in Table 1, at 6 m almost 40% of the marked ticks released May 15 were recovered in 24 h. All of the ticks were taken at trap stations 6, 7, and 8. The 97 captured ticks were removed from the experiment, and the traps were recharged with CO_2. After 48 h, 52 of the remaining 148 ticks

(35%) were captured. Ticks were taken from all stations except number 8. However, the majority were from stations 1, 2, 3, and 4. After 72 h, 37 of the remaining 96 ticks (39%) were captured, in essentially the same traps that took ticks at the 48-h interval. Since 76% of the marked ticks were recovered at a distance of 6 m in three consecutive trap days, the trap distances were increased to 12 m on the second test run May 22, 23, and 24. Catches were poor. Three of 255 were taken after 24 h (1%); two of the remaining 252 (.8%) were trapped after 48 h; no ticks were on the traps after the third 24-h trapping period.

With only 5 of 255 (2%) ticks recovered at the 12-m distance in three consecutive trap days, a third test was run at 9 m June 5 and 6. Results differed little from those obtained at the 12-m distance. Five ticks of the 200 marked specimens released (3%) were trapped.

Additional evaluation studies were made of the CO_2 platform traps in 1980 in the same study area. Simultaneous releases were made at distances of 6 m and 9 m May 26, and trapping was conducted May 27, 28, and 29. At 6 m, 109 of 179 ticks (61%) were recovered in 24 h; 27 of the remaining 70 (39%) were taken at 48 h; and 10 of the remaining 43 (23%) were on the traps at 72 h (Table 2). Of the 179 marked ticks released at 6 m, 146 (82%) were recovered at 6 m in three consecutive trap days. As in 1979, the traps were recharged with CO_2 at 24-h intervals.

Four of 179 marked ticks released 9 m from the traps were taken in 24 h (2%), 23 (13%) of the remaining 175 ticks in 48 h, and 14 (9%) of the remaining 152 ticks at 72 h. Forty-one of the 179 ticks released (23%) were trapped at 9 m in three consecutive trap days.

An additional release with the 6-m traps was made of 250 marked ticks June 10, and the traps operated for two consecutive trap days. As shown in Table 2, 107 ticks (43%) were trapped in 24 h, and 24 of the remaining 143 (17%) were taken on the second day (48 h).

Temperature and humidity readings were similar during the tests in both years, with the days cool and sunny and the nights at or near freezing. The average daily high was 24°C, the low 3°C, and the mean 13.5°C. Ambient humidity high averaged 94.6% (night), low 22.3% (day), and the mean 58.4%.

DISCUSSION

This tick trap apparently depends to a considerable extent on the wind to disseminate the sublimating dry ice. In this respect, the 6-m release May 16–18, 1979, is especially interesting. May 16 the ticks were captured in trap stations 6, 7, and 8, suggesting the wind was from the east, southeast. May 17 and 18 the ticks were taken mainly in stations 1, 2, 3, and 4, indicating a wind shift to south, southwest. Wind velocity was recorded only during the 6-m tests June 10 and 11, 1980. Tick recoveries (Table 2) were obtained when the wind was light (1.6–4.8 km/h) during the day and gentle (6.4–9.6 km/h) at night.

Comparing the efficacy of the CO_2 platform trap described here and the Wilson model in attracting ticks is difficult. Different species of ticks were tested, and evaluation techniques differed. The Wilson trap released 1 kg of dry ice over a 7-day period, while our trap released ca. 650 g in 24 h. In seven days, the Wilson trap took 5% of the marked *A. americanum* ticks released at 6.1 m from the trap, an average of 7.5% at 9.4 m and an average of 3.5% at 12 m. As shown in Tables 1 and 2, our trap was much more effective in taking *D. andersoni* at release distances of 6 m.

We believe that this CO_2 platform trap is a useful tool in studying the host-seeking activities of adult *D. andersoni*. It is of light weight, and fairly large numbers can be carried over rough terrain without difficulty. For optimal sampling effectiveness, trap stations should probably be 12 m apart, to avoid competition in attracting ticks.

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LITERATURE CITED

Garcia, R. 1962. Carbon dioxide as an attractant for certain ticks (Acarina; Argasidae and Ixodidae). Ann. Entomol. Soc. Am. 55(5): 605–606.

Goodpasture, H. C., J. D. Poland, D. B. Francy, G. S. Bowen, and K. A. Horn. 1978. Colorado tick fever: Clinical, epidemiologic and laboratory aspects of 228 cases in Colorado in 1973–74. Ann. Intern. Med. 88(3): 303–310.

Lovering, T. S. and E. N. Goddard. 1950. Geology and ore deposits of the Front Range, Colorado. U.S. Geol. Surv. Prof. Paper 223: 1–319.

Marr, J. W. 1961. Ecosystems of the east slope of the Front Range in Colorado. Univ. Colo. Biol. Ser. 8, Univ. Colo. Press, Boulder, Col. 134 pp.

Marr, J. W., J. M. Clark, W. S. Osburn, and M. W. Paddock. 1968. Data on mountain environments. III. Front Range, Colorado, four climax regions, 1959–64. Univ. Colo. Biol. Ser. 29, Univ. Colo. Press, Boulder, Col. 181 pp.

Miles, V. I. 1968. A carbon dioxide bait trap for collecting ticks and fleas from animal burrows. J. Med. Entomol. 5: 491–495.

Wilson, J. G., D. R. Kinzer, J. R. Sauer, and J. A. Hair. 1972. Chemo-attraction in the lone star tick (Acarina: Ixodidae): 1. Response of different developmental stages to carbon dioxide administered via traps. J. Med. Entomol. 9: 245–252.

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COEXISTENCE IN TWO SPECIES OF *HOLCOCEPHALA* (DIPTERA: ASILIDAE) IN A MARYLAND HABITAT: PREDATORY BEHAVIOR

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Abstract.—Coexistence was studied in two species of *Holcocephala* in a Maryland habitat. General behavior patterns of *H. abdominalis* (Say) and *H. calva* (Loew) were similar although each species exhibited significant variations. Coexistence is possible because the species differed in their selection of prey and foraging and feeding patterns.

The three Nearctic species of *Holcocephala, abdominalis* (Say), *calva* (Loew), and *fusca* Bromley, are usually found in mesic habitats and range from the eastern United States west to eastern Texas, Kansas, and Nebraska (Martin and Wilcox, 1965). They typically forage from tips of dead twigs or leaves of rank vegetation, located near or along margins of streams, fields, and woods (Baker and Fischer, 1975; Brimley, 1922; Bromley, 1931, 1946, 1950a, b; McAtee and Banks, 1970; Hull, 1962; Scarbrough, 1974; Johnson, 1976; Dennis, 1979). They sometimes forage from edges of wooded areas where vegetation patterns change abruptly, e.g. clearings, trails, and streams, but typically avoid dark thickly vegetated areas of forest (Scarbrough, 1974; Dennis, 1979). *Holcocephala abdominalis* is sometimes found foraging in dry fields, a short distance from streams (Scarbrough, 1974) and forest margins (Johnson, 1976), especially when the fly is abundant. *Holcocephala calva* and *H. fusca* appear to restrict selection of perches to vegetation along tree lined margins of trails, footpaths, lawns, and streams (Scarbrough, 1974; Dennis, 1979).

Holcocephala abdominalis and *H. calva* are sometimes found within a common habitat, with the former species being apparently more abundant (Baker and Fischer, 1975; Bromley, 1931; McAtee and Banks, 1920). Dennis (1979) suggested that differences in population densities of the two coexisting species may result from interspecific competition. Coexistence between interacting populations occurs when the species involved exploit resources differentially, with their realized niches being dissimilar in at least one important dimension (MacArthur, 1958; DeBach, 1966). If this principle is operable then it can be assumed that one or both *Holcocephala* species have adjusted, e.g. partitioned resources, in such a way as to reduce competition by more effectively exploiting the available resources. The purpose of this study was to examine coexistence of *H. abdominalis* and *H. calva* in a Maryland habitat in terms of resource partitioning involving foraging behavior, prey selection, and predation between the two species.

HABITAT AND METHODS

This study was conducted in a mesic hardwood picnic area, located near York Road in the northeast section of the Towson State University campus, during July, August, and September of 1973 through 1977. The linear 2.2 ha plot has steep margins, which drop 8 to 10 m in elevation from the surrounding campus, and is traversed by a stream and several footpaths. Woody vegetation in the study area consisted of a mixed stand of bottom land trees, with *Liriodendron tulipifera* L., *Platanus occidentalis* L., *Quercus* spp., *Prunus serotina* Ehrh., and *Gleditsia triacanthos* L. along the sloped margins; and with *Juglans nigra* L. and scattered *Ulmus americana* L., *Fagus grandifolia* Ehrh., *Acer* spp., and *Pinus* spp. predominating on the flat. This overstory produced a continuous shaded condition during the day, except for brief periods in the middle of the day and late afternoon. A dense shrub growth of *Vitis* sp., *Rubus* sp., *Lonicera* sp., *Lindera benzoin* Blume, and herbaceous plants occurred along the steep slopes, stream and less disturbed areas. Temperatures and relative humidities ranged from 14°C and 99% in early morning to 36°C and 28% in mid-afternoon.

Prey selection and predation by the two species was determined via surveying flies along a standard route of ca. 100 m and following individual flies for 1–2 h periods. These techniques were necessary in order to identify the timing of major behavior patterns and for subsequent analysis of individual patterns. Prey samples were taken hourly per day during the survey and later measured for total body length (Scarbrough and Sraver, 1979). Further information on types and selection of prey was taken while individuals were under surveillance, although prey were not taken. Surveillance of flies was made under bright skies from 0600 to 2000 h (EST) during 1974 and 1975. Flies were selected randomly for surveillance (see Scarbrough and Norden, 1977), marked on their thoracic notum with fast drying enamel paint and released. They were then followed to a perch where a 15 min interval elapsed before data was taken. As indicated above, most flies were observed for two consecutive hours during which time their complete behavioral repertoire was recorded. Males, however, were sometimes difficult to follow when they were actively searching for mates. Consequently males were followed for only one hour. At the end of each observation period, additional flies were selected and followed for the subsequent period. Data, resulting from the observation of adults of each species, were then compiled to form a theoretical 14 h ten-day period. A combined total of 140 females and 198 males were monitored. Temperatures and relative humidities were taken approximately 1.5 m above ground level and adjacent to each perched fly each observation hour.

RESULTS AND DISCUSSION

Foraging behavior.—Data generated by this study showed that the general foraging behavior of the two *Holcocephala* species was similar, and essentially agreed with that reported in earlier studies (Dennis, 1979; Johnson, 1976). Both species usually foraged from shaded vegetation along tree line margins of the study site, utilizing perches between 0.2 and 5.0 m above ground level. However, *H. abdominalis* differed in that it was invariably more abundant and foraged from perches on low vegetation (<1.0 m), whereas *H. calva* was more abundant and foraged from perches on taller vegetation (>1.5 m). *Holcocephala abdominalis* also differed from *H. calva* in that as its population density increased in late August, it dispersed into the open, dry sunlit clearings and foraged from flower spikes and leaf tips of *Plantago lanceolata* L. and other herbaceous vegetation (0.2 to 0.4 m). These results agree with other reports (Scarbrough, 1974; Johnson, 1976) wherein *H. abdominalis* has been found resting on and foraging from weedy vegetation in dry fields which border streams and wooded areas. Dispersion to adjacent areas is apparently initiated by increased interactions between increased densities of conspecifics and congenerics for limited perches (unpublished data). *Holcocephala calva*, like *H. fusca* (Dennis, 1979), was rarely found utilizing perches away from the edges of these clearings, but usually rested on and foraged from perches in the aforementioned locations.

Asilids, except those of the Leptogasterinae, typically forage under brightly lit conditions. *Holcocephala fusca* in Virginia (Dennis, 1979) and *H. abdominalis* in Indiana (Johnson, 1976) behave similarly in that they usually foraged and captured prey in open sunlit areas. In an earlier study, I found several specimens (>300) of *H. abdominalis* foraging from sunlit weedy vegetation throughout an abandoned pasture (20,235 m^2) at Allerton Park, Ill. (unpublished data). However, at the Towson study site and others in Maryland, neither species consistently foraged nor captured prey in direct sunlight. Both species usually foraged from shaded sites and captured prey which were "back lighted" against a bright sky, often without venturing into direct sunlight. The exception to the latter occurred in late afternoons when forage sites were sunlit for short periods and temperatures were high (Fig. 1). These sites were also sunlit for short periods in early morning, but temperatures and foraging activities were correspondingly low. *Holcoceph-*

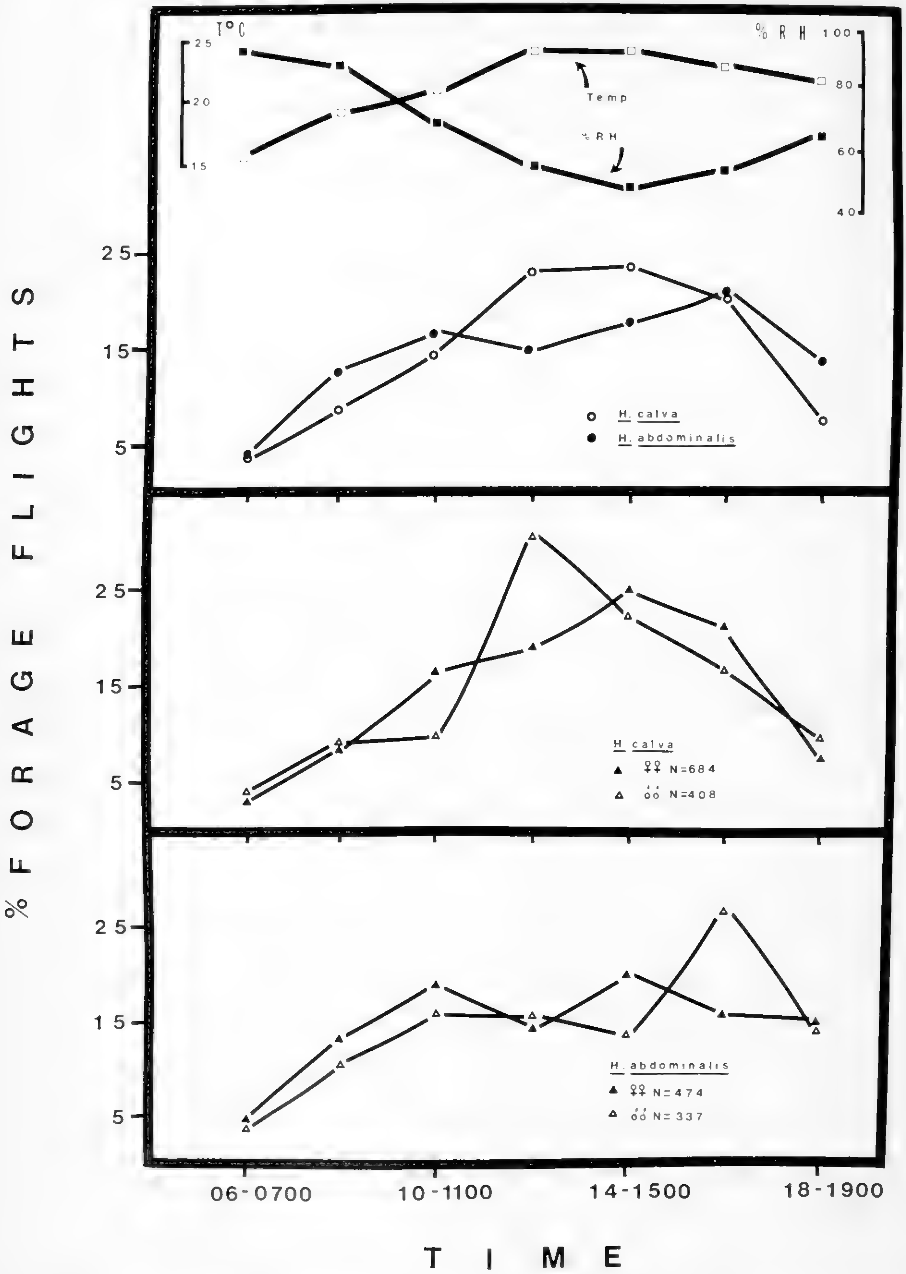

Fig. 1. Comparisons of intra- and interspecific foraging behavior per two hour period during a 14 h day for two species of *Holcocephala* in Maryland.

ala abdominalis differed from *H. calva* in that its foraging sites were sunlit more often and for longer periods and, hence, it foraged more frequently under sunlit conditions.

Length of forage flights of the two species varied ($R = 3–150$ cm), although most prey (90.5%) were captured between 15 to 100 cm from the forage site. *Holcocephala abdominalis* captured most prey (88.2%) between 20 and 60 cm of the forage site, whereas *H. calva* captured most prey (92.1%) between 40 and 100 cm. As reported in other studies of *Holcocephala* (Dennis, 1979; Johnson, 1976), prey were captured in air either in front of the forage site or to one side of it, with the predator usually returning to the same forage site. Both species foraged in an oblique path, with the greatest rise occurring near the interception point. Thus, prey were invariably captured above the forage site. Upon capturing the prey, the predator's flight path looped above, and sometimes behind the previous perch where it came to rest. If the interception point was far to one side of the forage site, the fly did not always compensate in the return flight, missing the previous perch but landing at a nearby site. The latter usually occurred when prey were large (>3 mm) or the distance to the prey was unusually long (>100 cm).

Figure 2 shows foraging patterns of *Holcocephala* expressed as proportions of total flights. Foraging activities between species ($\chi^2 = 75.1$, $P < .001$) were significantly different, with each species showing characteristic foraging patterns. Both species foraged during each observation period, with the lowest proportion of flights occurring during the first and last periods of the day. The foraging pattern of *H. calva* peaked during the early afternoon, but had decreased significantly by the last observation period. In contrast, the peak foraging period of *H. abdominalis* was short and occurred in late afternoon, following a consistent but lower level of foraging. The latter species also exhibited a significant decrease in foraging by late afternoon, but the decrease was less than that for *H. calva*. Furthermore, a greater proportion of the foraging flights were made earlier in the day ($Z^1 = 3.08$, $P < .05$) by *H. abdominalis* than *H. calva*, producing a slightly greater rapid rise in foraging activities.

Foraging patterns of conspecifics ($\chi^2 = 17.6$, $P < .01$, *H. a.*; $\chi^2 = 35.6$, $P < .001$, *H. c.*) and congenerics ($\chi^2 = 33.1$, $P < .001$, ♂; $\chi^2 = 42.1$, $P < .001$, ♀) also differed significantly (Fig. 1). Males of both species showed abrupt, rapid increases in foraging flights which exceeded that for conspecific females. However, the peaks produced by male activity differed in time and duration from that of *H. calva*, occurring earlier in the day, but extending for longer periods in late afternoon. Female *H. calva* foraged

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[1] Differences between proportions (Z) from Zar (1974).

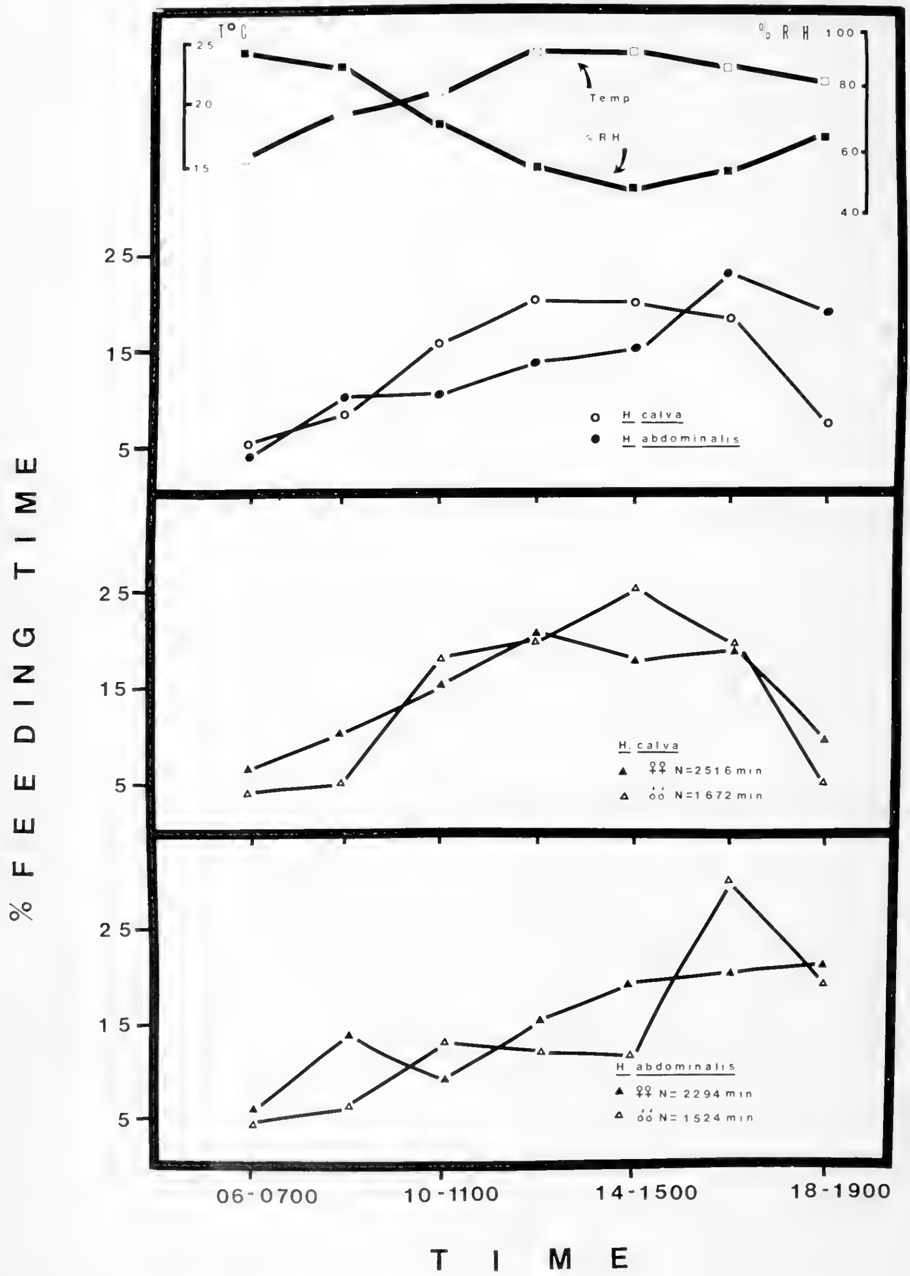

Fig. 2. Comparisons of intra- and interspecific feeding behavior per two hour period during a 14 h day for two species of *Holcocephala* in Maryland.

Table 1. Foraging responses of two species of *Holcocephala* toward potential prey. Data for conspecific males and females within a column are not significantly different. Data between congeneric sexes or totals for species within a column are significantly different at $P < .01$ level.

Species	Captured		Non-Captured		Investigated	
	No.	%	No.	%	No.	%
H. abdominalis	350	43.9	26	3.3	421	52.8
Males	142	42.1	13	3.9	182	54.0
Females	208	45.2	13	2.8	239	52.0
H. calva	452	37.7	25	2.1	721	60.2
Males	179	37.9	5	1.0	294	61.5
Females	273	37.7	20	2.8	427	59.3

more frequently in mid- to late afternoon following a steady increase during the earlier part of the day. In contrast, female *H. abdominalis* showed an increase in foraging until 1000 h, after which no significant change occurred.

When potential prey flew near specimens of either perched species, their movements usually stimulated them to chase. Upon approaching the potential prey in flight, the asilids either rejected the prey item without physical contact or attempted to capture it. Table 1 shows the responses of *Holcocephala* to potential prey. Foraging responses between conspecific males and females were similar ($\chi^2 = 1.21$, $P < .05$, *H. a.*; $\chi^2 = 3.14$, $P < .05$, *H. c.*), whereas significant differences ($\chi^2 = 11.63$, $P < .01$) existed between species. *Holcocephala abdominalis* successfully captured ($\chi^2 = 7.93$, $P < .01$) a greater proportion of prey, but investigated ($\chi^2 = 10.59$, $P < .01$) fewer potential prey than did *H. calva*. Both species immobilized most prey that they captured. Some large prey were released or dropped without being immobilized during the return flight to the forage perch. These data suggest that perched *H. abdominalis* may be more capable of recognizing capturable potential prey than *H. calva*.

Feeding behavior. —Prey were usually impaled upon the hypopharynx of the predator at the time of capture, although large prey (>3.4 mm, e.g., *Reticulitermes flavipes* (Kollar) and *Ponera pennsylvanica* Buckley) were manipulated with all six tarsi near the forage site before insertion. The hypopharynx was usually inserted in the dorsum of the prey, normally in the thorax. The eyes and tip of the abdomen were sometimes used when prey were small (<2 mm) or following manipulation and after the asilid had been feeding for extended periods. Apparently the choice of the site for hypopharynx insertion was related to the manner in which the predator captured its prey. Both asilids usually captured prey by grasping the margin of the thorax, resulting in the largest part of the prey's body being directly below the predator's head.

Additional activities exhibited by both species while feeding included grooming, head movements, and manipulating prey. Perched asilids may groom any part of their body at any time. However, while feeding, grooming was limited to rubbing the hindlegs together or over the surface of wings and abdomen. Grooming of the more anterior parts of the body usually followed feeding. Rapid head and body movements directed toward moving objects suggested that the asilids detected both crawling and flying insects and other arthropods in the vicinity of their perches. Prey were manipulated while the asilids perched or hovered near the feeding site. During manipulation, the position of the hypopharynx in the prey was adjusted, usually involving its removal and insertion at a different site. The flies removed prey from the hypopharynx by pushing it off with the foretarsi while perching, whereas all six legs were used during its removal and manipulation while hovering. Hovers ($\bar{x}$ = 10 s, R = 6–20, N = 66, *H. c.*; $\bar{x}$ = 7 s, R = 4–17, N = 48, *H. a.*) varied in length, with longer times being associated with larger prey. The asilids invariably returned to previous perches to resume feeding following manipulation. *Holcocephala calva,* in contrast to *H. abdominalis,* sometimes manipulated prey without removing it from the hypopharynx by using one tarsus to "spin" it on the hypopharynx, or adjusting the depth of the hypopharynx by pushing the prey against the perch. *Holcocephala fusca* (Dennis, 1979) also has been reported to hover and manipulate prey.

While perching or feeding, the asilids were sensitive to moving shadows that accompanied abrupt changes in air currents. Depending upon the strength of the stimulus, they responded by flying to another location or by moving their hindlegs in an alternating "kicking" motion. If the stimulus occurred often, they retreated (ca. 2–3 cm) from the tip of a twig and repeated the "kicking." If the stimulus was strong, such as that produced by an approaching predator (e.g., *Vespula* spp., conspecifics and Araneida), they invariably flew to a nearby perch. Flight was more frequent when the stimulus was generated in front of the perched asilids. Leg motion and retreating occurred more frequently than flight, especially when the stimulation originated behind the asilids. Speed of leg movement was highly variable, but was apparently related to air velocity. The asilids were induced to kick at different frequencies either by blowing air upon them via a hollow tube at different velocities or by waving a hand near them at different speeds. Leg movement usually increased with either increased air current velocity or increased frequency of waving.

Dennis (1979) and Johnson (1976) reported that *Holcocephala* removed prey by either pushing it off the hypopharynx with a foretarsus or withdrawing the hypopharynx while perched or flying, allowing the prey to drop. Both species in this study also used these methods to remove prey at the completion of feeding. Furthermore, when the latter method was used at a

Table 2. Mean feeding times per prey and mean number of prey fed upon per unit time for two species of *Holcocephala* during 10 observation days in Maryland.

Species	Sample	Time/prey (min)	Prey/h/d	Prey/d
H. abdominalis	430	8.58	1.5	21.5
Male	172	8.25	1.2[a]	17.1[a]
Female	258	8.91	1.8	25.8
H. calva	423	9.15	1.8	25.3
Male	148	8.80	1.3[a]	18.4[a]
Female	275	9.44	2.3	32.2

[a] Means followed by the same letter within a column are not significantly different. Remaining data between congeneric sexes or species within a column are significantly different at $P < .05$ level (t test).

perch, the asilid's head was tilted forward approximately 90°, positioning the hypopharynx in an almost 180° vertical plain to the ground. This behavior apparently enhances the role of gravity in removing the prey.

Table 2 depicts the mean feeding time per prey and mean number of prey fed upon per unit time for ten observational days. These data show that *H. calva* fed for significantly longer periods per prey and fed upon larger numbers of prey per h and per day than *H. abdominalis*. Similar differences were found between sexes of each species, with females feeding for longer periods and upon larger numbers of prey than males. In contrast, males differed from females in that they fed upon approximately equal numbers of prey per unit time. Differences in mean feeding times and mean number of prey are attributed to greater predator-prey size relationships and greater energy demands between the sexes and the species.

Time utilized for feeding per 2 h period per day for both species of *Holcocephala* varied significantly ($\chi^2 = 152.4$, $P < .001$), although each exhibited a distinct feeding pattern (Fig. 2). Both species fed for shorter periods during early morning, but showed increased feeding times by mid-morning. *Holcocephala calva* fed for consistently longer periods (1000 to 1700 h, no significant difference per 2 h period) through most of the day, although a significant decrease ($Z = 5.28$, $P < .05$) occurred in late afternoon. In contrast, feeding times were less ($\chi^2 = 4.9$, $P < .05$) from 1000 to 1500 h for *H. abdominalis* than for *H. calva*, but were significantly greater ($\chi^2 = 69.1$, $P < .001$) from 1600 to 1900 h. Feeding times also decreased ($Z = 16.7$, $P < .001$) in late afternoon for *H. abdominalis* but the decrease was significantly less than that for *H. calva*.

Conspecific asilids displayed significant variations ($\chi^2 = 134.1$, $P < .001$ ♂ vs. ♀ *H. a.*; $\chi^2 = 105.4$, $P < .001$ ♂ vs. ♀ *H. c.*) in feeding proportions during certain periods of the day (Fig. 2). Conspecific males utilized less feeding time than conspecific females from 0600 to 1000 h, but feeding times

Table 3. Correlations between foraging and feeding behavior with two environmental parameters for two species of *Holcocephala*.

Species	Temperature		RH	
	Foraging	Feeding	Foraging	Feeding
H. abdominalis	0.912[a]	0.746[b]	−0.821[b]	−0.848[b]
H. calva	0.786[b]	0.861[b]	−0.827[b]	−0.856[b]

[a] $P < .01$.
[b] $P < .05$.

increased significantly by the 10–1100 period. Feeding times of male *H. calva* increased until 1500 h when they began to decrease. In contrast, feeding times of male *H. abdominalis* did not change significantly between 10–1500 h, but were followed by a rapid rise by 16–1700 h and a subsequent rapid decrease by 1900 h. Feeding times of females of both species tended to level off with only minor fluctuations following the rise in early morning. Feeding times of female *H. calva* decreased rapidly by 1900 h whereas those of *H. abdominalis* remained relatively consistent with former periods.

Foraging and feeding patterns for both species were positively correlated with temperature and negatively correlated with relative humidity (Table 3). As air temperatures increased and relative humidities decreased, both foraging rates and feeding times increased (Figs. 1, 2). Both species utilized less time for feeding and foraged less during early morning when temperatures were lowest and relative humidities greatest. Also, *H. calva* showed a significant decrease in foraging rates and feeding times in afternoon as relative humidities increased. Activities remained relatively constant in

Table 4. Dietary composition and characteristics of prey captured by two species of *Holcocephala* in Maryland. Predator lengths (mm) *H. calva*, $\bar{x} = 7.25 \pm 0.58$; *H. abdominalis*, $\bar{x} = 5.81 \pm 0.64$.

Prey	*H. abdominalis*			*H. calva*		
	No.	%	$\bar{x}$ SD	No.	%	$\bar{x}$ SD
Diptera	235	35.8	1.58 ± 0.65[a]	184	31.1	1.97 ± 0.756[a]
Hymenoptera	223	34.0	2.36 ± 0.87[b]	170	28.7	2.36 ± 1.19[b]
Coleoptera	106	16.2	1.54 ± 0.59[a]	59	10.0	1.88 ± 0.67[a]
Homoptera, Hemiptera	45	6.8	1.47 ± 0.49[a]	89	15.0	1.80 ± 0.77[a]
Psocoptera	27	4.1	1.67 ± 0.42[a]	72	12.2	1.82 ± 0.50[a]
Misc.	20	3.0	1.74 ± 0.40[b]	18	3.0	1.89 ± 0.47[b]
	656	99.9	1.73 ± 0.57	592	100.0	1.95 ± 0.73

[a] Significant difference within prey taxa between species at $P < .05$ level.
[b] No significant difference within prey taxa between species (*t* test).

Table 5. Dietary composition and characteristics of prey captured for *Holcocephala abdominalis* in Maryland. Predator lengths (mm) 5.63 ± 0.59 ♂, $N = 20$; 5.9 ± 0.69 ♀, $N = 20$. Means within common taxa are not significantly different (t test).

	Females			Males		
Prey	No.	%	$\bar{x}$ SD	No.	%	$\bar{x}$ SD
Diptera	121	35.6	1.59 ± 0.71	114	36.1	1.13 ± 0.70
Hymenoptera	118	34.7	2.44 ± 0.83	105	33.2	2.35 ± 0.86
Coleoptera	51	15.0	1.47 ± 0.56	55	17.4	1.50 ± 0.57
Homoptera, Hemiptera	27	7.9	1.52 ± 0.47	18	5.7	1.43 ± 0.50
Psocoptera	13	3.8	1.67 ± 0.53	14	4.4	1.58 ± 0.35
Misc.	10	2.9	1.74 ± 0.40	10	3.2	1.74 ± 0.40
	340	99.9	1.74 ± 0.53	316	100.0	1.71 ± 0.56

afternoon with only male *H. abdominalis* showing a decrease in these two patterns.

Prey selection.—Both species of *Holcocephala* selected similar prey taxa, with Diptera and Hymenoptera being taken most frequently (Table 4, see list of prey). Others (Dennis, 1979; Johnson, 1976; Bromley, 1950b; McAtee and Banks, 1920) have also reported that *Holcocephala* feed primarily on prey within these insect orders. *Holcocephala abdominalis* captured proportionally more hymenopterous and coleopterous prey and fewer homo-hemipterous and psocopterous prey than did *H. calva*. Both sexes of *H. abdominalis* captured prey in each taxa in almost equal proportions (Table 5). In contrast, female *H. calva* captured significantly larger proportions of hymenopterous, coleopterous, and homo-hemipterous prey and fewer dipterous and psocopterous prey than did conspecific males (Table 6).

Table 6. Dietary composition and characteristics of prey captured for *Holcocephala calva* in Maryland. Predator lengths (mm) 7.0 ± 0.52 ♂, $N = 20$; 7.48 ± 0.52 ♀, $N = 20$.

	Females			Males		
Prey	No.	%	$\bar{x}$ SD	No.	%	$\bar{x}$ SD
Diptera	96	26.2	2.08 ± 0.08[a]	88	39.1	1.85 ± 0.73[a]
Hymenoptera	119	32.4	2.52 ± 1.21[a]	51	22.7	2.00 ± 1.02[a]
Coleoptera	38	10.4	1.86 ± 0.62[b]	21	9.3	1.90 ± 0.74[b]
Homoptera, Hemiptera	64	17.4	1.85 ± 0.70[b]	25	11.1	1.82 ± 0.87[b]
Psocoptera	39	10.6	1.82 ± 0.54[b]	33	14.7	1.81 ± 0.45[b]
Misc.	11	3.0	1.89 ± 0.54	7	3.1	1.86 ± 0.31[b]
	367	99.9	2.11 ± 0.92	225	100.0	1.89 ± 0.80

[a] Significant difference within prey taxa between sexes at $P < .05$ level (t test).

[b] No significant difference within prey taxa between sexes at $P < .05$ level (t test).

Larger asilids usually selected larger prey and vice versa (Table 4). Mean sizes for all prey taxa for *H. abdominalis* and *H. calva* were 1.73 and 1.95 mm, yielding predator-prey length ratios of 3.4 and 3.7, respectively. Most prey were less than 3 mm in length, with 96.3% and 87.2% for each species, respectively. Thus *H. abdominalis* captured significantly more ($Z = 4.53$, $P < .05$) small prey than did *H. calva*. Within the major prey taxa, only hymenopterous prey were not significantly different in size for the two species. The latter is the result of the proportionally large number of winged reproductive ants (70.4% *H. a.*; 34.1% *H. c.*) in each of the samples.

Females of *Holcocephala* were significantly larger than their conspecific males, and both sexes of *H. calva* were larger than those of *H. abdominalis* (Tables 5, 6). Sexes of *H. calva* usually selected larger prey within common taxa than did *H. abdominalis*. Furthermore, female *H. calva* selected larger dipteran and hymenopteran prey than did its conspecific male. Male *H. calva* captured primarily Apocrita Hymenoptera (98.9%), whereas females captured more formicids (48.1%). Removal of formicids from the females list reduced the mean hymenopteran size to 2.18 mm, which does not differ significantly from that of the male. Similar larger hymenopterous prey means for both sexes of *H. abdominalis* resulted from the large number of reproductive ants captured, and their removal produced similar results ($\bar{x} = 1.98$ mm). Comparisons of prey means within common taxa for the sexes of *H. abdominalis* show no significant difference in mean size.

The following are lists of prey taken by *H. abdominalis* and *H. calva* at the study site. In some instances prey are determined only to order or family level, since some prey were not taken or they were too damaged for identification. 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 taken.

Prey of *H. abdominalis*.—ARANEIDA (all immatures): Agelenidae, unidentified 20 (2) 27.VIII.74; Clubionidae, Liocraninae 23.VIII.74; Thomisidae, Misumeninae 23.VIII.74; Salticidae unidentified (2) 28.VIII.74; Pisauridae, *Dolomedes* sp. 8.VIII.73. PSOCOPTERA: Unidentified 9.VIII.72; Ectopsocidae, *Ectopsocopsis cryptomeriae* (Enderlein) 22 (3) 27, 29.VIII.74, (9) 16.VIII.77, (6) 1, (2) 3.IX.77; Lepidopsocidae, *Echmepteryx hageni* (Packard) 22.VIII.74, 30.VIII.77; Psoquillidae, *Rhyopsocus* sp. 15.VIII.74. HOMOPTERA-HEMIPTERA: Aleyrodidae, unidentified 3.IX.77; Anthocoridae, *Orius insidiosus* (Say) 9.VIII.72, 30.VIII, (3) 1.IX.77; Aphididae, unidentified (11) 28.VIII.74, *Anoecia corni* (F.) 16.VIII.74, *A. cornicola* Walsh 22.VIII.74, 16, (2) 30.VIII.77, *Aphis forbesi* Weed 22.VIII.74, *Chaitophorus pusillus* Hottes and Frison 25.VIII.74, *Macrosiphum* sp. 9.VIII.72, *M. liriodendri* (Monell) 22.VIII.74, (3) 16.VIII, (2) 1.IX.77, *Myzocallis* sp. 27.VIII.74, *Thecabius* sp. 22, 29.VIII.74; Cicadellidae, *Macrosteles fasciformis* (Stål) 11.VIII.72, nymphal Cicadellinae 27.VIII.74; Coccoidea, unidentified 16.VIII, 3.IX.77; Delphacidae, *Delphacodes* sp. 28.VIII.74; Miridae, unidentified 25.VIII.74, (2) 28.VIII.75, *Halticus intermedius* Uhler (2) 3, 9.VIII.72. THYSANOPTERA: Phlaeothripidae, unidentified 9.VIII.72, 22, 23.VIII.74, 1.IX.77: COLEOPTERA: Chrysomelidae, *Chaetocnema* sp. 9.VIII.72, 23.VIII.74; Hydrophilidae, *Cryptopleurum minutum* Fabricius 7.VIII.72; Mycetophagidae, *Litargus tetraspilotus* LeConte 25.VIII.74, (12) 16.VIII, 3.IX.77; Orthoperidae, *Orthoperus* sp. (3) 16.IX.74; Phalacridae, *Olibrus* sp. 28.VIII.74; Ptilidae, *Actinopteryx* sp. (13) 27, (12) 23, (6) 22, 25, (5) 27, (3) 28, (2) 29.VIII.74, 16.IX.74; Rhizophagidae, *Monotoma longicollis* Gyllenhal 27.VIII.74; Scaphidiidae, *Eubaeocerus* sp. 23.VIII.74; Scolytidae, *Hypothenemus* sp. 29.VIII.74, 30.VIII, 1.IX.77, *Pityogenes hopkinsi* Swaine 20.VIII.74, *Pityophthorus pulicarius* (Zimmermann) 27.VIII.74, *P.* sp. near *puberulus* LeConte 27.VIII.74, *Xyleborus rubricollis* Eichhoff 27.VIII.74; Staphylinidae 22, (2) 23, (13) 27, (2) 28, 29, (3) 14, (6) 16, (4) 30.VIII.77. LEPIDOPTERA: Elachistidae, *Elachista* sp. 27.VIII.74. DIPTERA: Anthomyzidae, *Mumetopia occipitalis* Melander 9.VIII.72, 25.VIII.74, (2) 30.VIII.77, 1.IX.77; Cecidomyiidae, *Asteromyia* sp. 27, (13) 28.VIII.74, *Atrichopogon* sp. (2) 22, 25, 28, 29.VIII.74, 16, (2) 30.VIII.77, (13) 1.IX.77, *Cecidomyiidii* spp. (22) 22, 23.VIII.74, *Contarinia* sp. 28.VIII.74 (2) 16.VIII, (3) 3.IX.77, *Dasineura* sp. (2) 28.VIII.74, *Lestodiplosis* sp. (2) 27.VIII.74, *Lestremia* sp. (2) 28.VIII.74, *Micromya* sp. 27, 29.VIII.74, *Porricondyla* sp. 27.VIII.74, *Procystiphora* sp. 28.VIII.74, *Trisopsis* sp. 27.VIII.74; Ceratopogonidae, *Dasyhelea* sp. 29.VIII.74, *Forcipomyia* sp. (7) 28.VIII.74; Chironomidae, Orthocladinae 29.VIII.74, *Cricotopus* sp. (2) 9.VIII.72, unidentified 22, 27, (16) 28.VIII.74, (13) 16, (4) 30.VIII.77, (3) 1.IX.77; Chloropidae, *Oscinella carbonaria* (Loew) 29.VIII.74, *O. umbrosa* (Loew) 9.VIII.72, 25.VIII.74, *Thaumatomyia bistriata* (Walker) 28.VIII.74; Dolichopodidae, *Chrysotus* sp. 9.VIII.72, 1.IX.77; Drosophilidae, *Drosophila melanogaster* Meigen (2) 9.VIII.72, (2) 30.VIII.77; Empididae, *Tachypeza* sp. 27.VIII.74; Ephydridae, *Discocerina* sp. 9.VIII.72, *Hydrellia formosa* Loew (2) 22.VIII.74, *Leptopsilopa nigrimana* (Williston) 28.VIII.74; Muscidae, *Coenosia* sp. 9.VIII.72; Phoridae, *Megaselia* sp. 20, (12) 28.VIII.74, (3) 16, 17, (2) 30.VIII.77, (3) 1.IX.77, *Puliciphora* sp. 20, (2) 28.VIII.74; Pipunculidae, *Chalarus spurius* (Fallén) 27.VIII.74; Psychodidae, *Psychoda* sp. 23.VIII.74; Scatopsidae, *Scatopse fuscipes* Meigen 28.VIII.74, 30.VIII.77; Sciaridae, *Bradysia* spp. (17) 22, (3) 23, (5) 25, (5) 27, (3) 28, (5) 29.VIII.74, *Sciara* sp. 15.VIII.74, (2) 30.VIII.77, (2) 1.IX.77; Sphaeroceridae, *Leptocera* sp. 28, (2) 29.VIII.74, *L. palliceps* Johnson 25, 28.VIII.74, 16.VIII.77. 3.IX.77. HYMENOPTERA: Unidentified (2) 27, (2) 28.VIII.74; Aphelinidae, unidentified 22.VIII.74; Aphidiidae, *Praon* sp. 23.VIII.74; Braconidae, *Aphaereta pallipes* (Say) 27.VIII.74, *Aspilota* sp. 20, 23, 28.VIII.74, *Chorebus* sp. 28.VIII.74, 12, 16.VIII.77; Ceraphronidae, *Ceraphron* sp. 20, 23, 29.VIII.74, *Dendrocerus* sp. 20, 23, 29.VIII.74; Cynipidae, *Hexacola* sp. 28.VIII.74, 16.VIII.77; Diapriidae, *Trichopria* sp. 28.VIII.74; Encyrtidae, unidentified 28.VIII.74, (4) 1.IX.77; Eulophidae, unidentified 22, 28.VIII.74, 12, (3) 16.VIII.77; Formicidae, *Ponera pennsylvanica* Buckley 28.VIII.72, 22, (13) 23, (22) 27, (12) 28, (17) 29.VIII.74, (16) 12.IX.74, (17) 16, (15) 30.VIII.77, (16) 1, (2) 3.IX.77, *Myrmecina americana* Emery (13) 22, 27, (3) 28.VIII.74, (6) 12, (2) 30.VIII.77; Mymaridae, unidentified 22, 28.VIII.74; Pteromalidae, 7.VIII.72, 20, 22, 28, 29.VIII.74, 30.VIII.77, 1, 3.IX.77; Scelionidae, *Gryon* sp. 27.VIII.74, *Telenomus* sp. 25, (3) 28.VIII.74.

Prey of *H. calva*.—ARANEIDA: Unidentified immatures 1.VIII.75, 9, 10, 12.VII.76, 1, 20, (3) 23.VII.77, 16.VIII.77; Linyphiidae, *Meioneta unimaculata* (Banks) 17.VII.74. PSOCOPTERA: Unidentified (2) 19.VIII.72, 12.VII.76; Caecilidae, *Caecilius aurantiacua* (Hagen) 30.VII.74, (2) 17.VII.75, (2) 10.VII.76; Ectopsocidae, *Ectopsocopsis cryptomeriae* (Enderlein) 1, (2) 16, (2) 22, (3) 29.VII.74, 20.VII.75, (2) 9, 10, (8) 12, (4) 13.VII.76, 1, (2) 20, 23.VII.77, 5, (3) 11, 15, (12) 16, (4) 22, (4) 25.VIII.77; Lepidopsocidae, *Echmepteryx hageni* (Packard) (3) 30.VII.74, 9.VII. 76, 23.VII.77, (2) 16, 22.VIII.77; Philotarsidae, *Aaroniella* sp. 29, 30.VII.74, 12.VII.76. HOMOPTERA-HEMIPTERA: Aleyrodidae, unidentified 25.VIII.77; Anthocoridae, *Orius insidiosus* (Say) 22, (3) 25.VIII.77; Aphididae, *Anoecia graminis* G. and P. 1, *Aphis* sp. 30.VIII.74, *Chaitophorus pusillus* H. and F. 15.VIII.74, Drepanosiphinae (5) 9.VIII.72, *Myzocallis tiliae* (L.) 30.VIII.74, *Myzus* sp. 30.VIII.74, 25.VIII.77, *Prociphilus fraxinifolii* (Riley) 1.VIII.74, *Rhopalosiphum rufiabdominalis* (Sasaki) 30.VII.74, *Tinocalis ulmifolii* (Monell) (5) 30.VII.74, (2) 12, 15, (4) 30.VII.75, 1, (2) 5.VIII.75, (2) 1, (3) 9, (6) 15, (3) 16, (5) 20, 23.VII.77, 5, (5) 11, 15, (2) 16, (4) 22, (3) 25.VIII.77, unidentified 9, 10, 12.VIII.76; Cicadellidae, *Dikraneura* sp. (2) 27.VII.74, 9.VII.76, (2) 23, 11.VIII.77, *Scaphytopius* sp. 12.VII.76; Cixiidae, *Myndus pictifrons* Stål 16.VII.74; Delphacidae, *Delphacodes* sp. 16.VII.76, 25.VIII.77; Miridae, *Halticus intermedius* Uhler 9.II.72, 30.VII.74, 13.VII.76, 8.VIII.75, unidentified 20.VII.77, 16.VIII.77; Tingidae, *Corythuca ciliata* (Say) 12.VII.76. THYSANOPTERA: Unidentified 1, (2) 12.VIII.74, 5, 20.VII.77, 16, 22, 25.VIII.77. COLEOPTERA: Anobiidae, *Petalium* sp. 19.VIII.74; Chrysomelidae, *Chaetocnema* sp. 3.VIII.72, 30.VII.75, 13.VII.76, (2) 25.VIII.77; Ciidae, unidentified 29.VII.74, 23, (2) 16.VIII.77; Hydrophilidae, *Cercyon* sp. 6.VIII.75; Lathridiidae, *Aridius nodifer* (Westwool) 9.VIII.72, *Corticaria* sp. 30.VII.74, 9.VII.77, 11, (2) 16, 25.VIII.77; Mycetophagidae, *Litargus tetraspilotus* LeConte (2) 16, 22, (3) 25.VIII.77; Orthoperidae, unidentified 10.VII.76; Ptilidae, *Actinopteryx* sp. 10.VII.76; Staphylinidae, unidentified 29, (2) 30.VII.74, 1.VIII.74, 10, (4) 17, 22, 23, 29.VII.75, (5) 3.VIII.75, 10, (2) 12, 13.VII.76, 20.VII.77, (3) 23.VII.77, 5, (4) 16, (3) 22.VIII.77. LEPIDOPTERA: Tineidae, *Homosetia* sp. 25.VIII.74. DIPTERA: Agromyzidae, *Phytomyza* sp. 16.VII.74, 13.VII.76, 16, (2) 22.VIII.77, *Cerodontha dorsalis* (Loew) 16.VII.74; Chironomidae, unidentified 15.VII.75, (12) 10.VII.76, (2) 5, 23.VII.77, 5, (4) 16, (3) 22, 25.VIII.77; Cecidomyiidae, *Lestremia* sp. 30.VII.75, 12.VII.76, 5, 13, (2) 20, 23.VII.77, 16, 22.VIII.77, *Lasioptera* sp. 9.VII.77, (2) 25.VIII.77; Ceratopogonidae, *Atrichopogon* sp. 12.VII.76, 5, 16, 22.VIII.77, *Forcipomyia* sp. 12.VII.76, (6) 16.VIII.77; Chloropidae, *Elachiptera erythropleura* Sabrosky (2) 22.VII.74, *Hippelates bishoppi* Sabrosky 22.VII.74, 1.VIII.74, 15.VIII.75, *Oscinella frit* (L.) 29.VII.74, (2) 22.VIII.77, *O. soror* (Macquart) 29.VII.74, 10.VII.76; Empididae, unidentified 22.VIII.77; Dolichopodidae, unidentified 13, 29.VII.75, 3.VIII.76, *Chrysotus* sp. 20, 23, 16.VIII.77; Mycetophilidae, unidentified 25.VIII.75; Phoridae, *Dohrniphora* sp. 30, (2) 9, (3) 12, 13.VII.76, 11, 15, (4) 16, 22.VIII.77, *Megaselia* sp. 30.VII.74, (3) 1.VIII.75, (4) 12, 13.VII.76, (2) 13, 15, 16, (4) 20, (4) 23.VII.77, 5, 16, 22.VIII.77, *Puliciphora* sp. (2) 30.VII.74, 9, 12.VII.76; Pipunculidae, *Tomosvaryella* sp. 25.VIII.77; Psychodidae, *Psychoda* sp. 25.VIII.77; Scatopsidae, *Scatopse fuscipes* Meigen 31.VII.75, 10, (2) 13.VII.76, 25.VIII.77; Sciaridae, *Bradysia* sp. 17.VII.74, (2) 29, (3) 30.VII.74, (3) 1.VIII.74, (2) 10.VIII.75, (2) 9, 10, (2) 13.VII.76, 1, (2) 5, (2) 9, (2) 13, 15, 16, (4) 20.VII.77, 5, (3) 11, (3) 15, (6) 16, (2) 23.VIII.77; Sphaeroceridae, *Leptocera* sp. 9.VII.72, (2) 12.VII.74, 15, 16, 20, (3) 23.VII.77, (5) 25.VIII.77; Stratiomyiidae, *Microchrysa polita* (L.) 19.VII.72. HYMENOPTERA: Unidentified (3) 17, (3) 22, (3) 29.VII.74, 1.VIII.74, (8) 26, (12) 29.VII.75, (5) 3, (6) 15.VIII.75; Aphidiidae, *Praon* sp. 30.VII.74; Braconidae, *Aphaereta* sp. 12, 9.VII.74, (3) 30.VII.75, 12.VII.76, 15, (2) 20.VII.77, (3) 5, 11.VIII.77, *Chorebus* sp. 30.VII.74, 9.VIII.74, 2.VII.75, *Euphoriella* sp. 30.VII.74; Ceraphronidae, *Ceraphron* sp. 22.VII.74, *Dendrocerus* sp. 30.VII.74; Cynipidae, unidentified (3) 15.VIII.75, 12, 13.VII.76; Encyrtidae, unidentified 15, (2) 20, 23.VII.77, 5.VIII.77, (2) 16, 22, 23.VIII.77; Eupelmidae, unidentified (2) 20.VII.77; Eulophidae, unidentified 5, 16, 20, (5) 23.VII.77, 5.VIII.77, 11, 15, (3) 16, 22, 25.VIII.77; Formicidae, *Lasius* sp. (4) 26.VII.72, (3) 30.VII.74, 13.VII.77, *Myrmecina* sp. 5, 20.VII.77, (3) 11, 15, (3) 16.VIII.77, *Ponera pennsylvanica* Buckley (3) 30.VII.74, (10) 12, (7) 14, (8) 15.VIII.75, 9.VII.76, 13, 20, (3) 11, (4) 16, (3) 22.VIII.77; Perilampidae, unidentified 20.VII.77, 16, (7) 25.VIII.77; Pteromalidae, prob. *Habrocytus* sp. 9, (5) 12.VII.76, unidentified 15.VIII.77; Scelionidae, *Telenomus* sp. 30.VII.74, unidentified (2) 5.VIII.75.

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LITERATURE CITED

Baker, N. T. and R. L. Fischer. 1975. A taxonomic and ecological study of the Asilidae of Michigan. Great Lakes Entomol. 8: 31–91.

Brimley, C. S. 1922. List of the robber flies (Asilidae, Diptera) of North Carolina. Entomol. News 33: 294–298.

Bromley, S. W. 1931. A preliminary annotated list of the robber flies of Ohio (Diptera: Asilidae). Ohio State Univ. Mus. Sci. Bull. 1: 3–19.

———. 1946. Honeybee predators. J. N.Y. Entomol. Soc. 36: 195–199.

———. 1950a. Florida Asilidae (Diptera) with description of one new species. Ann. Entomol. Soc. Am. 43: 227–239.

———. 1950b. Ohio robber flies. V. Ohio J. Sci. 50: 229–234.

DeBach, P. 1966. The competitive displacement and coexistence principles. Annu. Rev. Entomol. 11: 183–213.

Dennis, D. S. 1979. Ethology of *Holcocephala fusca* in Virginia (Diptera: Asilidae). Proc. Entomol. Soc. Wash. 81: 366–378.

Hull, F. M. 1962. Robber flies of the world. The genera of the family Asilidae. U.S. Natl. Mus. Bull. 224 (pt. 1), 430 pp.

Johnson, P. E. 1976. A preliminary investigation of the behavior of adult *Holcocephala abdominalis* (Say) (Diptera: Asilidae) in Putnam County, Indiana, with a description of the larvae and eggs. Master's Thesis. DePauw University, Greencastle, Indiana.

Martin, C. H. and J. Wilcox. 1965. Family Asilidae, pp. 360–401. *In* Stone, A. et al., eds., A

Catalog of the Diptera of America North of Mexico. U.S. Dep. Agric., Agric. Handb. No. 276.

MacArthur, R. H. 1958. Population ecology of some warblers of northeastern coniferous forest. Ecology 39: 599–619.

McAtee, W. W. and N. Banks. 1920. District of Columbia Diptera: Asilidae. Proc. Entomol. Soc. Wash. 22: 19.

Scarbrough, A. G. 1974. A faunistic study of Asilidae (Diptera) at three locations in northern Baltimore County, Maryland: Incidence, relative abundance and seasonal distribution. Proc. Entomol. Soc. Wash. 76: 385–396.

Scarbrough, A. G. and A. Norden. 1977. Ethology of *Cerotainia albipilosa* Curran (Asilidae: Diptera) in Maryland: Diurnal activity rhythm and seasonal distribution. Proc. Entomol. Soc. Wash. 79: 538–554.

Scarbrough, A. G. and B. Sraver. 1979. Predatory behavior and prey of *Atomosia puella* (Diptera: Asilidae). Proc. Entomol. Soc. Wash. 81: 630–639.

Zar, J. H. 1974. Biostatistical analysis. Prentice-Hall, Inc. 619 pp.

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AN ADDITION TO THE GENUS *ANISOPS* OF AUSTRALIA (HEMIPTERA: NOTONECTIDAE)

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Abstract.—*Anisops* ***ayersi***, a new species from Ayers Rock, Northern Territory, Australia, is described and the male diagnostic features figured.

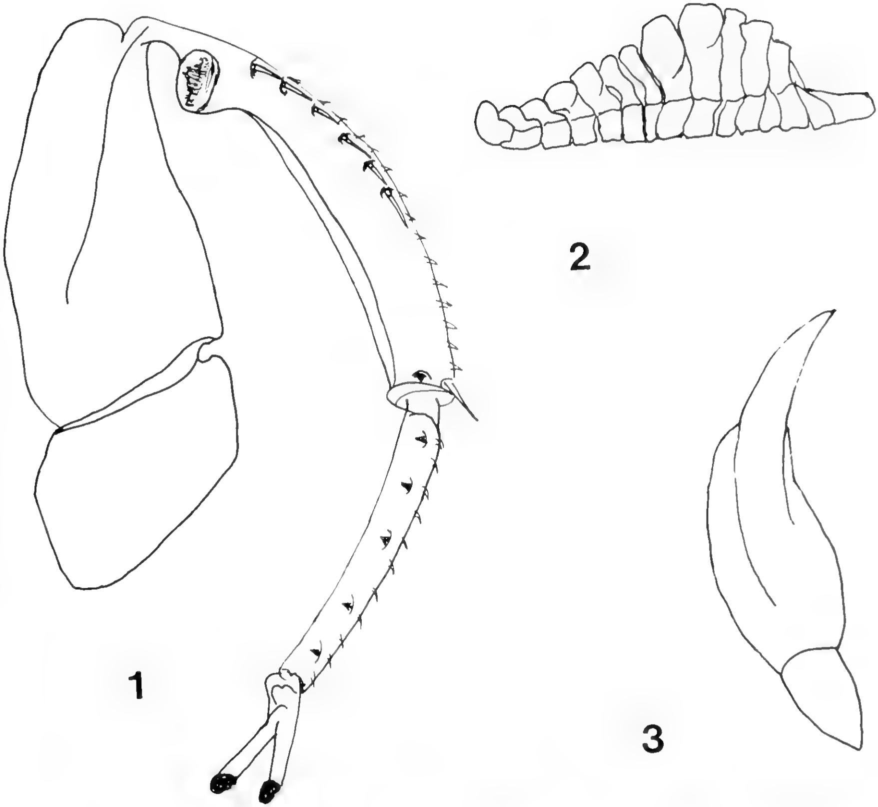
During a three month collecting tour of Australia for notonectids in the fall of 1980, I had the opportunity to visit Ayers Rock. This giant sandstone monolith (4 miles long × 1½ miles wide × 1143 feet high) is located about 280 road miles southwest of Alice Springs, Northern Territory.

The annual rainfall at Ayers Rock averages only about six inches a year, but, at the base of the Rock, two shallow pools are sustained by the groundwater that results from the runoff of these occasional rains. The first of the two pools, Initi, on the north side, has a circumference of about 25 feet; the second, called Mutidjula, is on the south side and is about 10 feet larger. Vegetation is sparse in each pool but a population of tadpoles and small *Anisops* seem to thrive. The *Anisops* turned out to be an undescribed species herein described as *Anisops ayersi*.

Anisops ayersi Reichart, NEW SPECIES

Size: Male, 5.9 mm long, greatest body width 1.6 mm; female, 5.7 mm long, greatest body width 1.58 mm. *Shape:* Short, robust species. *Color:* Eyes yellowish grey, mottled with red. Vertex greyish red. Pronotum hyaline permitting color beneath to show through. Scutellum yellowish brown except apex which is clear hyaline. Hemelytra hyaline. Abdomen yellowish brown, ventrally dark reddish brown with keel and segmental margins of connexivum brownish yellow. Legs yellowish brown.

Male structural characteristics.—Viewed from above, head rounded with vertex slightly indented. Greatest width of head slightly less than pronotal humeral width, 8½ × anterior width of vertex and slightly less than 3× median head length. Synthlipsis $^3/_5$ as wide as anterior width of vertex. Median head length equal to median pronotal length. Humeral width of pronotum slightly more than 2× the longitudinal length of pronotum; lateral



Figs. 1–3. *Anisops ayersi*. 1, Left foreleg. 2, Stridulatory comb of tibia. 3, Rostral prong.

margins of pronotum divergent and ½ median longitudinal length of pronotum; posterior margin of pronotum subtly sinuous in the conventional convex-concave anisopine pattern; median shallow depression extending almost full length of pronotal disk. Scutellum ¼ wider than long. Facial tubercle slightly swollen, truncate above labrum with a few scattered white hairs. Frons depressed between eyes from tubercle to vertex. Labrum barely wider than long, apex broadly rounded with 3 long, white hairs on midline. Rostral prong (Fig. 3) bluntly acuminate and shorter than 3rd rostral segment. Stridulatory comb (Fig. 2) with 14–15 teeth which increase in length from outer and inner margins to center. Chaetotaxy of left foreleg as shown in Fig. 1.

Female structural characteristics.—Viewed from above head rounded with anterior margin fairly straight; vertex slightly indented; greatest head width slightly less than pronotal humeral width; 6⅔× anterior width of vertex. Synthlipsis ½ anterior width of vertex. Median length of head $^5/_6$ median length of pronotum. Humeral width of pronotum 2½× median length; lateral margins divergent and ½ median longitudinal length of pronotum; posterior margin weakly convex and medianly indented. Scutellum length $^{11}/_{13}$ of width. Frons above facial tubercle slightly swollen; truncate above labrum. Labrum with base slightly wider than long; apex bluntly rounded.

Types and type-locality.—♂ (holotype) and 2 ♀ (paratypes), Initi waterhole, Ayers Rock, Northern Territory, Australia, 8-X-80. Mark E. Pion and C. V. Reichart.

Deposition of types.—Holotype and one paratype desposited in the Australian National Insect Collection at Canberra, A.C.T.; one paratype retained in author's collection.

Comparative notes.—*Anisops ayersi* is similar in appearance and measurements to *A. nabilla* Lansbury (1969) but can be easily distinguished from the latter by the arrangement of teeth in the stridulatory comb and the structure of the third rostral segment. In *A. ayersi* the teeth increase in length from inner and outer margins toward the center while those of *A. nabilla* increase in length from inner to outer margin. The apex of the third rostral segment is wider than the base of the fourth segment in *A. nabilla,* as in *A. deanei* Brooks (1951), whereas in *A. ayersi* the two segments are the same width at the junction.

I did not attempt to place this species in Brooks' (1951) key. Since the revision by Brooks, 27 species have been added to *Anisops,* and a new key is badly needed.

LITERATURE CITED

Brooks, G. T. 1951. A revision of the genus *Anisops* (Notonectidae, Hemiptera). Univ. Kans. Sci. Bull. 34: 304–519.

Lansbury, I. 1969. The genus *Anisops* in Australia. J. Nat. Hist. 3(3): 433–458.

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ECTOPARASITES (MALLOPHAGA, ACARINA) FROM THE DOUBLE-CRESTED CORMORANT (*PHALACROCORAX AURITUS*) IN FLORIDA

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Abstract.—Seventy-seven double-crested cormorants, *Phalacrocorox auritus* (Lesson), taken between 1973 and 1977 in Florida, were examined for ectoparasites. Six species of ectoparasites were recovered (3 mallophagans, 1 tick, 2 mites). Quantitative data are given, with significant differences being noted in the distribution of the parasites on the hosts, and in the proportion of various age classes of parasites recovered.

The literature on the Mallophaga of Pelecaniformes is quite extensive with Emerson (1972a) having gathered together North American records. Further, several species of ticks and mites have been described and/or recovered from these hosts, e.g. *Dinalloptes chelionatus* Atyeo and Peterson from the double-crested cormorant (*Phalacrocorax auritus* (Lesson)) in Florida. The majority of the works, however, tend to be qualitative in nature and not quantitative, e.g. Marshall and Nelson (1967), Price (1970), Ryan and Price (1969) and von Timmermann (1967). A study of ectoparasites of the double-crested cormorant in Florida was initiated in 1977 to determine the parasite species present, density of infestation, frequency of occurrence of each parasite species within the host population, and their distribution on the host. It was also hoped that differences in density of infestation between males and females, and between nestlings and adults, would be revealed.

Materials and Methods

Seventy-seven double-crested cormorants from several locations in Florida were examined for ectoparasites. Forty-four birds (22 adult males, mean wt 1468 ± 391 g, range 960–2100 g; 22 adult females, 1236 ± 329 g, 750–2080 g) were taken on the west coast of the peninsula (2 on Sanibel

Island, 24 in the Tampa Bay area, 18 on the Withlacoochee River) in the period October 1973 to February 1976. An additional 33 birds (17 nestlings, mean wt 895 ± 503 g, range 159–1730 g; 8 adult males, 1953 ± 124 g, 1690–2060 g; 8 adult females, 1574 ± 146 g, 1310–1720 g) were collected near the Merritt Island National Wildlife Refuge, on the east coast of the Florida Peninsula in June and July of 1977. No attempt was made to systematically examine the former sample, thus only a qualitative picture is presented for the sample. In the latter case, however, detailed necropsies were undertaken and quantitative data were obtained. The population sampled in 1973–1976 was composed of two subspecies (*P. a. auritus* (Lesson) and *P. a. floridanus* (Audubon)) while that of 1977 contained only *P. a. floridanus*. The former is migratory, the latter a permanent resident.

The techniques for obtaining and examining birds in this study were the same as those outlined in Eveleigh and Threlfall (1976), as was the treatment of any parasites found. Mites were sampled by examining 10 feathers from each region. The classification of the Mallophaga listed herein follows the scheme of Emerson (1972b, c). Data were analysed using the t statistic for two means, the Chi-squared evaluation and 2 × K contingency tables. Specimens of the Mallophaga found have been deposited in the National Museum of Natural History, Washington, D.C. (Nos. 75898–75900), while representative ticks and an *Ornithonyssus* sp. are in the collection of Harry Hoogstraal, NAMRU 3, Cairo, UAR (Nos. HH22,071–HH22,074).

Results and Discussion

Six species of ectoparasites were taken from the 77 birds examined (34 (44%) infested). Birds from the west coast bore the Mallophaga *Eidmanniella pellucida* (Rudow) (11% birds infested), *Piagetiella incomposita* (Kellogg and Chapman) (27% infested), and *Pectinopygus farallonii* (Kellogg) (43% infested). The first two species are amblycerans (Menoponidae), while the latter is an ischnoceran (Philopteridae). East coast birds were host to 1 mallophagan, 1 tick, and 2 mites (Table 1). The difference noted in the species composition of the ectoparasite fauna of the two groups may be attributed to differences in sampling time (month and/or year), to geographical factors, or to migratory vs. permanent resident subspecies of host.

Table 2 gives details of the distribution of the most common mallophagan *P. farallonii*, on the 33 nestling and adult birds. Statistically significant differences ($P < .005$) were noted in the distribution of adults and nymphs, and in the infestations with adults and nymphs, on both nestling and adult birds. No differences were detected in the infestations of nestlings as compared to adult birds, other than the fact that no Mallophaga were located on the crown, auricular, and gular region of nestlings. Far greater numbers of mallophagan nymphs were found than adults, this perhaps being related to an increasing population and transfer of organisms from adult birds to

Table 1. Details of ectoparasite infestation of 33 double-crested cormorants from the east coast of Florida. a = no. (%) infested; b = mean no. per bird ± SD; c = range of numbers.

Age/Sex (No. Examined)	*Pectinopygus farallonii*			*Argas radiatus*			Mites[1]			Total		
	a	b	c	a	b	c	a	b	c	a	b	c
Nestling (*N* = 17)	14 (82)	30 ± 28	2–83	12 (71)	27 ± 61	1–207	7 (41)	7 ± 16	2–60	16 (94)	64 ± 70	3–271
Adult male (*N* = 8)	7 (88)	26 ± 24	1–67	—	—	—	3 (38)	9 ± 14	12–37	7 (88)	29 ± 35	1–104
Adult female (*N* = 8)	8 (100)	24 ± 29	4–91	—	—	—	3 (38)	2 ± 4	1–20	8 (100)	26 ± 28	4–91
Total adult (*N* = 16)	15 (94)	25 ± 26	1–91	—	—	—	6 (38)	5 ± 10	1–37	15 (94)	28 ± 31	1–104

[1] Sample only, represents minimum numbers. Two species identified, *Ornithonyssus* sp. (Macronyssidae) and *Michaelichus* sp. (near *urile* Dubinin) (Freyanidae).

Table 2. Distribution of *Pectinopygus farallonii* on 33 double-crested cormorants from the east coast of Florida. a = no. (%) occurrence; b = no. (%) occurrence/infested region; c = mean no. ± SD; d = range of numbers.

	Nestling Bird (*N* = 17)								Adult Bird (*N* = 16)							
	Nymph				Adult				Nymph				Adult			
Region	a	b	c	d	a	b	c	d	a	b	c	d	a	b	c	d
Crown	—	—	—	—	—	—	—	—	3 (19)	3 (60)	2.2 ± 2.5	2–6	2 (13)	2 (40)	1.0 ± 1.7	1–4
Auricular	—	—	—	—	—	—	—	—	4 (25)	4 (80)	1.8 ± 1.3	1–3	4 (25)	4 (80)	0.8 ± 0.5	1
Gular	—	—	—	—	—	—	—	—	3 (19)	3 (100)	2.3 ± 0.6	—	—	—	—	—
Nape	9 (53)	9 (100)	4.9 ± 7.6	2–25	1 (6)	1 (11)	0.6 ± 1.7	1–5	7 (44)	7 (88)	5.3 ± 4.6	1–12	2 (13)	2 (25)	0.6 ± 1.2	2–3
Jugulum	7 (41)	7 (88)	3.3 ± 3.2	1–9	4 (24)	4 (50)	0.8 ± 0.9	1–2	8 (50)	8 (100)	5.0 ± 3.9	2–13	4 (25)	4 (50)	1.5 ± 1.9	1–5
Side of neck	5 (29)	5 (83)	3.7 ± 3.3	1–8	5 (29)	5 (83)	1.5 ± 1.1	1–2	7 (44)	7 (88)	5.8 ± 4.6	1–12	1 (6)	1 (13)	0.1 ± 0.4	1
Back	11 (65)	11 (92)	1.7 ± 1.8	1–6	3 (18)	3 (25)	1.3 ± 3.5	1–12	7 (44)	7 (88)	2.9 ± 3.4	1–11	4 (25)	4 (50)	0.6 ± 0.7	1–2
Breast	7 (41)	7 (88)	1.8 ± 1.6	1–5	4 (24)	4 (50)	3.1 ± 5.8	1–17	3 (19)	3 (60)	1.0 ± 1.0	1–2	2 (13)	2 (40)	0.8 ± 1.3	1
Abdomen	5 (29)	5 (63)	1.6 ± 1.6	1–4	5 (29)	5 (63)	0.8 ± 0.7	1–2	3 (19)	3 (60)	1.0 ± 1.0	1–2	2 (13)	2 (40)	0.4 ± 0.6	1
Wing (left)	9 (53)	9 (100)	5.3 ± 4.2	1–11	6 (35)	6 (67)	2.2 ± 1.9	1–5	10 (63)	10 (91)	3.1 ± 3.2	1–11	4 (25)	4 (36)	1.4 ± 1.9	1–5
Wing (right)	11 (65)	11 (100)	3.0 ± 2.6	1–9	5 (29)	5 (45)	3.8 ± 2.8	1–8	10 (63)	10 (100)	3.7 ± 2.3	1–9	4 (25)	4 (40)	0.6 ± 0.8	1–2
Leg (left)	3 (18)	3 (100)	2.7 ± 1.2	2–4	—	—	—	—	2 (13)	2 (100)	1.5 ± 0.7	1–2	—	—	—	—
Leg (right)	4 (24)	4 (80)	1.0 ± 0.7	1–2	1 (6)	1 (20)	0.7 ± 0.8	1–2	1 (6)	1 (100)	1	—	—	—	—	—
Tail	5 (29)	5 (83)	1.8 ± 1.7	1–5	3 (18)	3 (50)	3.1 ± 4.1	1–12	5 (31)	5 (100)	1.6 ± 0.9	1–3	—	—	—	—

Table 3. Distribution of ticks and mites on 33 double-crested cormorants from the east coast of Florida. Number of mites refer to parasites seen on samples of 10 feathers from each region. a = no. (%) birds with region infested; b = mean no. parasites ± SD; c = range of numbers.

	Nestling Bird									Adult Bird					
	Argas radiatus			*Ornithonyssus* sp.			*Michaelichus* sp.			*Ornithonyssus* sp.			*Michaelichus* sp.		
Region	a	b	c	a	b	c	a	b	c	a	b	c	a	b	c
Nape	4 (24)	3.3 ± 3.3	1–8	—	—	—	—	—	—	—	—	—	—	—	—
Jugulum	2 (12)	5.0 ± 5.7	1–9	—	—	—	—	—	—	1 (6)	1	1	—	—	—
Side of neck	4 (25)	4.0 ± 3.2	1–8	—	—	—	—	—	—	—	—	—	—	—	—
Back	4 (24)	19.3 ± 23.4	1–50	5 (29)	2.4 ± 1.5	1–4	—	—	—	1 (6)	1	1	—	—	—
Breast	6 (35)	9.8 ± 12.2	1–26	2 (12)	3.5 ± 3.5	1–6	—	—	—	1 (6)	2	2	—	—	—
Abdomen	5 (29)	7.4 ± 11.1	1–27	6 (35)	1.2 ± 0.4	1–2	—	—	—	1 (6)	1	1	—	—	—
Wing (left)	6 (35)	8.0 ± 9.3	1–22	—	—	—	3 (18)	5.3 ± 3.8	1–8	—	—	—	5 (31)	8.6 ± 6.0	1–17
Wing (right)	3 (18)	19.7 ± 3.2	16–22	—	—	—	3 (18)	5.3 ± 1.5	4–7	—	—	—	5 (31)	4.4 ± 3.2	2–10
Leg (left)	6 (35)	9.7 ± 10.9	1–24	1 (6)	5	5	—	—	—	—	—	—	—	—	—
Leg (right)	6 (35)	13.0 ± 15.2	1–36	3 (18)	3.0 ± 1.7	2–5	—	—	—	—	—	—	—	—	—
Tail	2 (12)	3.0 ± 2.8	1–5	—	—	—	—	—	—	—	—	—	—	—	—

nestlings with reproduction occurring to rebuild the populations. The sex ratio of the adult mallophagans was 1 male : 1.5 females, once again indicating that the population is most probably an expanding one.

Argas radiatus (Railliet) (Argasidae) larvae were found only on chicks, and in greatest numbers (up to 271 individuals) on birds which were only a few days old and lacking all but a thin coat of down. No adults of this species were recovered. A statistically significant difference ($P < .001$) was noted in the distribution of these organisms on the host (Table 3). No ticks or mites were located on the crown, auricular or gular regions of the birds. The mites did, however, show a distinct preference for various regions of the body as evidenced by the *Michaelichus* sp. which was located only on the primaries and secondaries of the wings.

While the foregoing account shows that differences in the ectoparasite burden may vary from region to region on a host, between different ages of host, and from one geographic location to another, we are not yet able to explain the reasons underlying these differences and much work remains to be done to elucidate these anomalies.

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LITERATURE CITED

Emerson, K. C. 1972a. Checklist of the Mallophaga of North America (North of Mexico). Part IV Bird host list. Deseret Test Center, Dugway, Utah, 216 pp.

———. 1972b. Checklist of the Mallophaga of North America (North of Mexico). Part I Suborder Ischnocera. Deseret Test Center, Dugway, Utah, 200 pp.

———. 1972c. Checklist of the Mallophaga of North America (North of Mexico). Part II Suborder Amblycera. Deseret Test Center, Dugway, Utah, 118 pp.

Eveleigh, E. S. and W. Threlfall. 1976. Population dynamics of lice (Mallophaga) on auks (Alcidae) from Newfoundland. Can. J. Zool. 54: 1694–1711.

Marshall, A. G. and B. C. Nelson. 1967. Bird ectoparasites from South Farallon Island, California. J. Med. Entomol. 4: 335–338.

Price, R. D. 1970. The *Piagetiella* (Mallophaga: Menoponidae) of the Pelecaniformes. Can. Entomol. 102: 389–404.

Ryan, S. O. and R. D. Price. 1969. A review of the genus *Eidmanniella* (Mallophaga: Menoponidae) from the Pelecaniformes. Ann. Entomol. Soc. Am. 62: 815–823.

von Timmermann, G. 1967. Gruppen Revisionen bei Mallophaga VII. Die *Pectinopygus*-Arten der Groskormorane (Gen. *Phalacrocorax* Brisson, 1760 s. st.). Mitt. Hamb. Zool. Mus. Inst. 64: 83–85.

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DENSITY, FECUNDITY, HOMOGENEITY, AND EMBRYONIC DEVELOPMENT OF GERMAN COCKROACH (*BLATTELLA GERMANICA* (L.)) POPULATIONS IN KITCHENS OF VARYING DEGREES OF SANITATION (DICTYOPTERA: BLATTELLIDAE)[1]

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Abstract.—Populations of the German cockroach, *Blattella germanica* (L.), were mass-collected on a seasonal basis in low-income apartments in Raleigh, North Carolina. Numbers of oothecae and each sex and instar were enumerated. Oothecae collected in June were examined for embryonic development.

Density showed a significant correlation with sanitation. However, certain kitchens had fewer cockroaches than expected at sanitation rating #6 (poorest sanitation) and others with good sanitation (rating #1) had more than expected. Possible explanations of these occurrences were based on analysis of age class frequencies. A structure apparently indicative of a stabilized population occurred at high density in sanitation 6 and low density at sanitation 1. Variability of age class structure stemmed from the individual kitchen infestation, nevertheless, there were several general characteristics. Adults and first-instars were usually the largest groups and nymphal mortality was highest among first-instars. The latter was a secondary factor in regulation of population growth, with primary control occurring at the level of oothecal production.

The German cockroach, *Blattella germanica* (L.), has been the subject of numerous biological studies (Cornwell, 1968). For example, *B. germanica*

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is known to shun light (Gunn, 1940), to prefer temperatures of 24–33°C (Gunn, 1935), and, indeed, to avoid unfavorable temperatures in choosing its habitat (Ogata, 1976). Water and humidity also affect habitat selection, as seen in a preference for both warm and steamy conditions (Gunn and Cosway, 1938; Cornwell, 1968). Less is known concerning factors that affect the growth of natural populations. Laboratory studies showed an increase of nymphal mortality with density (Chauvin, 1946). Under uncrowded conditions, Ross (1976) and Willis et al. (1958) found 83–85% of nymphs that hatched matured, although Ross (1929) reported mortalities of 5% for early molts and 40% for the last molt. An analysis of age class frequencies of collections from single family homes showed little decrease in numbers between first and last stage nymphs, suggesting low mortality (Ross and Wright, 1977). These collections were characterized by high proportions of non-productive females. It was suggested that failure to mate or produce egg cases, known results of insufficient food/water (Kunkel, 1966; Roth and Stay, 1962), were major factors in controlling growth of these populations. Moreover, it appeared that an adequate supply of water might be the most critical factor in the survival of early instars. High cockroach populations were correlated with poor sanitation (Wright, 1979).

This paper reports on a year long study of German cockroach populations in apartments characterized by six sanitation ratings. Selected data on cockroach age composition, density, fecundity, homogeneity and embryonic development, and temperature and relative humidity in apartments are presented. The data increase our understanding of free populations and provide information which can be used in the design of cockroach pest management systems and the evaluation of their success.

MATERIALS AND METHODS

Four low-income apartment complexes in Raleigh, North Carolina, were used as research sites. Two factors determined apartment selection within each complex: 1) Presence, verified by visual inspection during the day, of numerous cockroaches in an apartment, and 2) permission of the tenants, since the apartments were sampled while the tenants occupied them. Inspection and response of tenants indicated that commercial pest control technicians had not recently disturbed the cockroach populations.

Three apartment complexes, designated A, B, and C, had almost identical construction and floor plans. Each complex was composed of brick and concrete, and contained a number of apartments with tiled concrete floors in the kitchen and bathroom and concrete floors elsewhere. Some apartments were interconnected by holes around stove fixtures, and some tenants spoke of spaces behind cabinets and sink areas. The fourth complex (D) had fewer apartments in each building and more distance between buildings. The floor plan was slightly different from complexes A, B, and C, with much less wall space between kitchens and living rooms and long, wall-sized glass doors on one side of the kitchen. All floors had tile on concrete. Apartments in all complexes had small bathrooms, two floor levels, and continuous stove and cabinet areas along three walls of the kitchen.

Collections in September and December of 1977 were made in apartments in one complex, while those in March and June of 1978 were from apartments in all four complexes where no previous collecting had occurred. Collecting during four months (Sept., Dec., Mar., June) provided seasonal information on German cockroach populations. Six apartments per complex were sites for September and December collections, while three apartments in each of the four complexes were sites for March and June collections. All collecting occurred during the early afternoon and on different days in the month.

Collections immediately followed crack-and-crevice treatments with a synthetic pyrethroid flushing agent, resmethrin. A modified vacuum cleaner (Wright, 1966) was used to collect the cockroaches. Extensive flushing and vacuuming were done where an initial, visual examination revealed abundant cockroaches which appeared evenly distributed throughout a room. In areas of spotty infestation, such as occurred in most bedrooms, crevices in furniture and closets were flushed. Cockroaches were separated immediately according to size of sieves of the USA Standard Sieve Series, numbers 7, 8, and 14. Specimens and oothecae were preserved in 70% ethanol for later classification.

Terminal sternum characters (Ross and Cochran, 1960) and the number of antennal doublets (Campbell and Priestly, 1970) were used for instar and sex determinations with a Wild-Heerbrugg M3 microscope at 40× magnification. With older nymphs, instar determinations were made by a judgement of their relative size after sexing, as breakage of antennae usually precluded use of doublets for instar determination. By combining fourth- and fifth-instars, the problem of classifying damaged, middle-sized nymphs was avoided.

At the time collections were made, an Atkins Thermistor Psychrometer, Model Number 3702B, was used to record ambient humidities and temperatures in each kitchen, living room, bathroom, and bedroom. A sanitation scale (Bennett, 1978; Table 1) was utilized to classify rooms in apartments according to sanitation.

The methods of Barr et al. (1976) were used to analyze information relative to the effects of humidity, temperature, and sanitation level on population density and age structure among German cockroaches. *F*-values were compared at the 0.05 level of significance.

Numbers of first-instar nymphs, oothecae, and adult females, and in the case of June collections, the numbers and progress of developing embryos, permitted fecundity comparisons among German cockroach populations.

Table 1. Sanitary rating scale (Bennett, 1978).

Scale	Sanitary Condition
1. Fairly clean, not cluttered	Floors not very dirty, shelves and cupboards not cluttered, except for normal amount of content, no obvious piles of trash.
2. Fairly clean and cluttered	Floors fairly clean but may be cluttered with trash, clothes, etc. (nongarbage); cupboard filled with nongarbage articles.
3. Generally dirty, not cluttered	Floors generally dirty and/or greasy; cupboards dirty and not washed out for some time.
4. Generally dirty and cluttered	Floors generally dirty and piled with nongarbage trash, clothing, or small amounts of garbage; cupboards not washed out, dirty, and filled with nongarbage articles.
5. Severely dirty, not cluttered	Very dirty with garbage obvious; area very greasy and uncleaned in a long time; dead cockroaches obvious and not swept up.
6. Severely dirty and cluttered	Very dirty with garbage obvious and piled around, greasy areas filled with articles, trash, papers, etc. (which make counting difficult); dead cockroaches obvious and not swept up.

The presence or absence of eye pigment was used to determine the extent of embryo development in oothecal chambers (Tanaka, 1976). In addition, various estimates of first-instar nymph production during selected months for each apartment complex and season aided productivity comparisons. It was assumed throughout that productivity did not vary within a complex during a month's time.

Estimates of monthly nymphal production were calculated three ways. The first method was based on the numbers of first-instar nymphs collected. The first nymphal stadium lasts about five days (Woodruff, 1938). Monthly hatch was considered to be composed of six equal "waves" of first-instar nymphs (30 days per month ÷ 5 days per first-instar = 6), giving rise to the following formula: No. of first-instar nymphs per month = (No. of first-instar nymphs counted in one wave) × (6 waves per month).

The second method was based on numbers of oothecae collected. Using a hatch estimate of 76% (Willis et al., 1958) and the mean of 37.6 embryos per ootheca (Table 2) the formula was: No. of first-instar nymphs per month = (No. of oothecae per month) × (28.6 nymphs emerging per ootheca).

The third method was based on the reproductive potential of all adult females collected. Assuming that a female German cockroach produces one egg case per month (Cornwell, 1968), and applying the hatch estimate of

Table 2. Estimates of numbers of first-instar nymphs hatching in a month per apartment complex, based on numbers of first-instar nymphs, oothecae, and adult females collected during each season.

		Method of Calculation		
		First-Instar Nymphs[a]	Oothecae[b]	Adult Females[c]
Month	Complex	Estimated Number		
September	A	9708	9667	22,451
December	B	16,728	19,191	40,869
March	A	5610	4919	11,268
	B	3246	5834	12,899
	C	8644	9381	22,222
	D	6258	16,645	34,063
	$\bar{x}$	5940	9195	20,113
June	A	5112	2889	7550
	B	3072	4004	10,096
	C	4512	9095	21,078
	D	11,094	7808	18,847
	$\bar{x}$	5948	5949	14,392

[a] Based on the formula: No. of first-instar nymphs per month = (No. of first-instar nymphs counted in one wave) × (6 waves per month).

[b] Based on the formula: No. of first-instar nymphs per month = (No. of oothecae) × (28.6 nymphs emerging per ootheca).

[c] Based on the formula: No. of first-instar nymphs per month = (No. of adult ♀) × (28.6 nymphs emerging per ootheca).

Willis et al. (1958), and the mean number of embryos per ootheca (Table 2), the formula was: No. of first-instar nymphs per month = (No. of adult ♀'s per month) × (28.6 nymphs emerging per ootheca).

Results and Discussion

Ambient relative humidity of rooms was variable, ranging from 25–83%, with an average of 54.5%. Means were lower in December (52.5) and March (42.6) and higher in June (64.7) and September (63.3). The humidity in cracks and crevices is assumed to have varied similarly on a seasonal basis. Preliminary measurements under the kitchen sinks in September were nearly identical to the ambient values for kitchens. Neither relative humidity nor the related factor of temperature showed a correlation with either the density or age structure of the populations at the 0.05 level of significance. It is doubtful if either of these factors exerted much effect on the populations. The mean temperature of 26.1°C and range of 21–30° were close to the optimal temperature of about 25° (Gould, 1941) and the optimal range of 24–33° (Gunn, 1935), respectively. Providing the cockroach has water to drink, its response to humidity is weak (Gunn and Cosway, 1938).

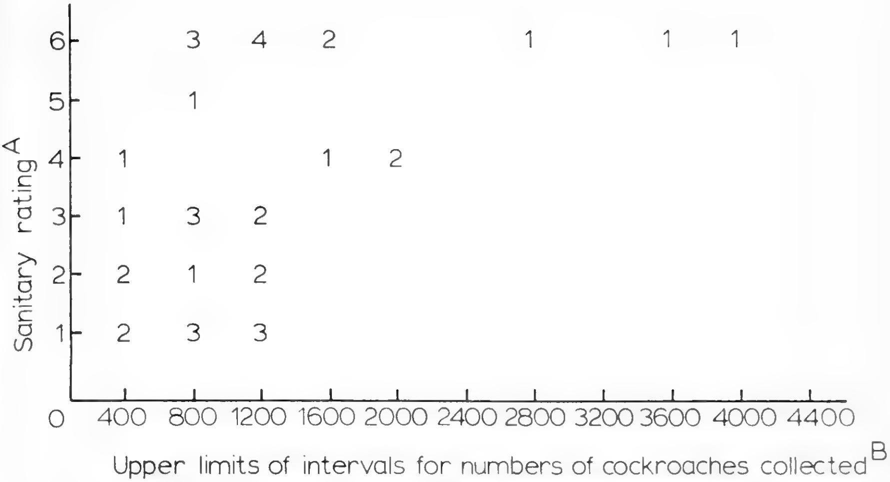

Fig. 1. Numbers of German cockroach samples collected in kitchens in 36 low-income apartments arranged by class size and sanitary rating. The numbers 1, 2, 3, and 4 refer to the total number of kitchens where samples were collected with a specific sanitary rating and a designated range of cockroaches. For example, there were 3 kitchens where samples were collected which had a sanitary rating of 3 and the number of observed cockroaches was over 400, but less than 800. A, Based on a sanitation scale developed by Bennett (1978). B, For example, an upper limit of 400 includes an interval of 1–400 cockroaches.

Sanitation had a significant effect (0.05) on population density in kitchens. In apartments rated poor in sanitation, greater populations of cockroaches were present (Fig. 1). One-third of the kitchens had the poorest possible sanitation rating (rating of 6). Three of these kitchens with poor sanitation contained cockroach populations exceeding 2400 cockroaches. The German cockroach is typically active in darkness (Gunn, 1940), yet kitchens with large cockroach populations had many individuals active in the day. Crowding in shelter areas could make this unusual behavior necessary. Productivity in kitchen populations was not affected by sanitation as rated on Bennett's sanitary scale (see Table 1). Cockroach populations in kitchens with sanitary ratings of 4–6 produced an estimated average of 22.9 first-instar nymphs emerging per ootheca, while populations in kitchens with sanitary ratings of 1–3 produced an estimated average of 23.5 nymphs emerging per ootheca, based on the number of oothecae and first-instar nymphs collected in the kitchens. Populations in apartments with unsanitary conditions (4–6 on the sanitary rating scale) averaged 36.7 developing embryos per ootheca, while those in apartments with better sanitation (1–3 on the sanitary rating scale) averaged 38.2 embryos per ootheca.

The data have implications for population dynamics in addition to those

Table 3. Development of German cockroach oothecae collected in kitchens in low-income apartments in June 1978.

Complex	No. Oothecae Examined	Mean No. Live Embryos Per Oothecae[a]	No. Oothecae with Embryos Having Eye Pigment[b]	
			Visible	Not Visible
A	26	37.0 ± 3.8	16	10
B	35	35.9 ± 4.7	28	7
C	55	37.5 ± 2.3	37	18
D	66	39.7 ± 0.7	47	19
$\bar{x}$		37.6 ± 2.9	32	14

[a] Based on the shape and pigment of oothecal compartments. Mean and standard deviation.

[b] Presence of eye pigment indicates less than 10 days until hatch.

noted above related to environmental factors. Comparison of the three types of monthly nymphal production in Table 2 gives an indication of the relative importance of hatch-survival of first-instars vs. egg case production as mechanisms that limit population growth. Estimates of monthly hatch based on observed numbers of first-instars are shown in column 3. These estimates tended to be lower than those based on the total number of oothecae × the average number of nymphs emerging from an ootheca in the laboratory (column 4). However, the magnitude of the difference was frequently small, especially in lower density apartments in complexes A and B. Apparently neither hatch nor immediate post-hatch survival were drastically reduced in these apartments. In contrast, March data from complex D and June data from complex C suggest a greater hatch reduction and/or post-hatch mortality. In these instances monthly hatch as estimated from observed numbers of first-instars (column 3) was less than half that expected from estimates based on the number of oothecae (column 4). Surprisingly, June results from complex D showed the reverse situation. In complex D, it appears that populations were growing very little in March, but did increase in growth in June. If collections were made at a time of first egg case hatch of a large proportion of the females, overall monthly hatch would be over-estimated. The one "wave" would be larger than the others. Alternatively, it would be difficult to account for a higher hatch from estimates based on observed numbers of first-instars than those from laboratory hatch. The large number and low variability of egg cases of June collections (Table 3, complex D) support this hypothesis of high input from first egg case hatch. Whether these differences between population structure-growth in complex D and the other three complexes are related to structural differences noted earlier is unknown.

The hatch estimates shown in Table 2 (column 5) are based on an assumption that all adult females were reproductively active. The disparity between these data and the estimates based on numbers of oothecae (column

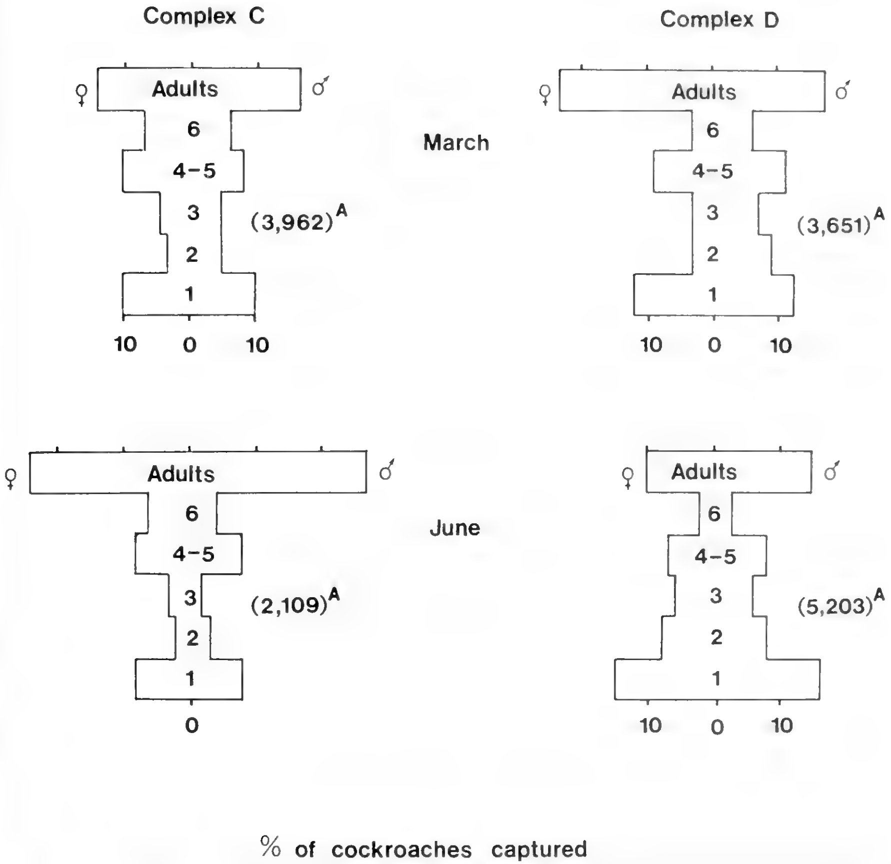

Fig. 2. Instar-sex pyramids of German cockroaches collected in kitchens during four seasons of 1977–1978. Numbers in parentheses (A) next to the pyramids are the total numbers of captured cockroaches.

4) indicates that less than one-half of the adult females were producing viable oothecae. In this species, limited availability of food causes failure to mate (Roth and Stay, 1962) and failure of mated females to produce oothecae (Kunkel, 1966). Either limited food and/or water in relatively sanitary conditions or limited access to these resources due to crowding in unsanitary conditions could account for the heavy proportion of reproductively inactive females. A few may have been past the productive part of their life span (Willis and Lewis, 1957; Willis et al., 1958), although death, rather than failure to produce viable oothecae, is the major age-related cause of reproductive failure among females of this species (Cochran and Ross, unpublished data). The present data provide strong evidence that major

Table 4. Oothecae and first- and second-instar German cockroach nymphs collected in kitchens by sanitation grade.

Number of				Number of			
		Nymphs by Instar[a]				Nymphs by instar[a]	
Apts.	Oothecae[a]	1st	2nd	Apts.	Oothecae[a]	1st	2nd
Sanitation Grade 1				Sanitation Grade 4			
9	33	151	83	3	95	240	139
	(10–67)	(25–269)	(11–149)		(88–109)	(102–364)	(73–173)
Sanitation Grade 2				Sanitation Grade 5			
6	38	89	48	1	230	499	239
	(9–79)	(18–219)	(15–101)		(0)	(0)	(0)
Sanitation Grade 3				Sanitation Grade 6			
4	39	195	99	13	114	410	192
	(27–59)	(124–239)	(52–209)		(33–369)	(104–1077)	(38–531)
$\bar{x}$ per Sanitation Grades 1–3				$\bar{x}$ per Sanitation Grades 4–6			
19	36	141	76	17	101	385	185
	(9–79)	(18–269)	(11–209)		(33–369)	(102–1077)	(38–531)

[a] Mean with range in parentheses.

control of population density was at the level of oothecal production. Secondary factors were reduced hatch and/or post-hatch mortality (Table 2, columns, 3 vs. 4) and nymphal mortality causing a drop between numbers of first- and second-instars (Fig. 2). Keil (1981) also noted a tendency towards high proportions of non-productive females among shipboard populations.

Mortality between the first- and second-nymphal instars ranged from 45–53% when the apartments were grouped together by sanitation grade (Table 4). The 5% mortality reported by Ross (1920) for early instars is much less than that observed in these complexes. There was no significant difference in the percent of nymphal mortality between the first- and second-nymphal instars when compared by kitchens grouped into the sanitary grades 1–3 and 4–6. Mortality was 45.2% and 47.9% respectively. However, there was extensive variation among individual collections (see below). The number of oothecae collected in apartments grouped by sanitation grade also varied widely, but more oothecae were collected in apartments with sanitation grades of 4–6 than in those with grades of 1–3 (Table 4).

Examination of oothecae collected in June from apartments in the four complexes showed consistency in the number of live embryos per ootheca, with an average of 37.6 live embryos per ootheca (Table 3), which is less than the 45 embryos reported by Tanaka (1976). Eye pigment, indicating nymphal emergence from the oothecae would occur in 10 or fewer days, was visible in 70% of the oothecae examined.

Table 5. Comparative densities in collections at the two extremes of the sanitation ratings, i.e., best sanitation (#1) vs. poorest sanitation (#6).

	Number of Apartments With Ratings of:	
Cockroaches[a]	#1	#6
>2000		3
1500–2000	1	1
1300	1	1
1200	1	1
1100		
1000		2
900	2	3
800		1
700		2
600	3	
500		1
<500	2	

[a] Rounded to nearest 100.

Continuous maturation of new adults and egg case hatch indicated complete overlap of generations. In this situation, there are general patterns of age class composition that characterize populations at or near balance for their particular environmental situation. Patterns of age class frequency should give an indication of the state of the population, i.e., whether stabilized, rapidly growing, or, perhaps, affected by extrinsic influences (in the present case, tenant's efforts at control). Such patterns would only be revealed through analysis of individual collections, since these were the source of significant differences in age composition. In order to explore this possibility, collections from contrasting sanitation ratings (1 vs. 6) were compared. It was assumed those with maximum numbers for the particular environment would give the best indication of the age composition of a stabilized population.

Collections ranging from 300–900 predominated at sanitation 1 (Table 5). In contrast, at sanitation 6 most fell within a range of 900–4000, with 900 apparently on the low side for poor sanitation. Age composition of the higher density collections differed from that of the smaller collections. Among the former, at least 25% were first-instars (Fig. 3A). A drop of over 12% occurred between first- and second-instars and, in all except one collection, first-instars outnumbered adults (difference ranging from 6–16%). In contrast, first-instars formed less than 25% of sanitation 6, low density collections. The drop between first- and second-instars was smaller (<12%), except in one intermediate density collection (Fig. 3A–952), and adults outnumbered first-instars consistently. The unifying feature found at sani-

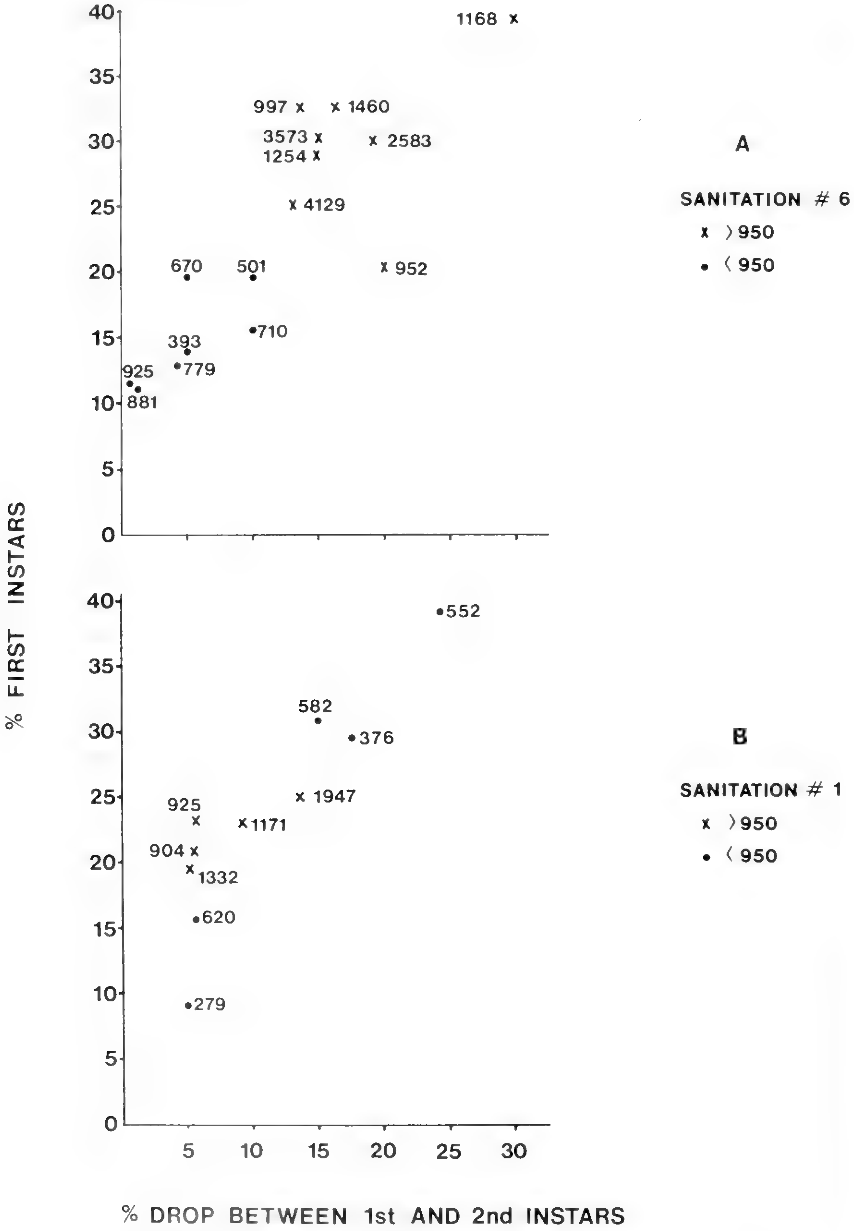

Fig. 3. Comparison of the proportion of first-instar German cockroaches and first-instar mortality at sanitation 6 vs. 1 for low and high density groups. A, Differences between high and low density groups at sanitation 6; characteristics of high density (x) presumably are those of a stabilized population. B, Characteristics of presumed stabilized populations which occur among low density groups at sanitation 1 (first-instars >25%).

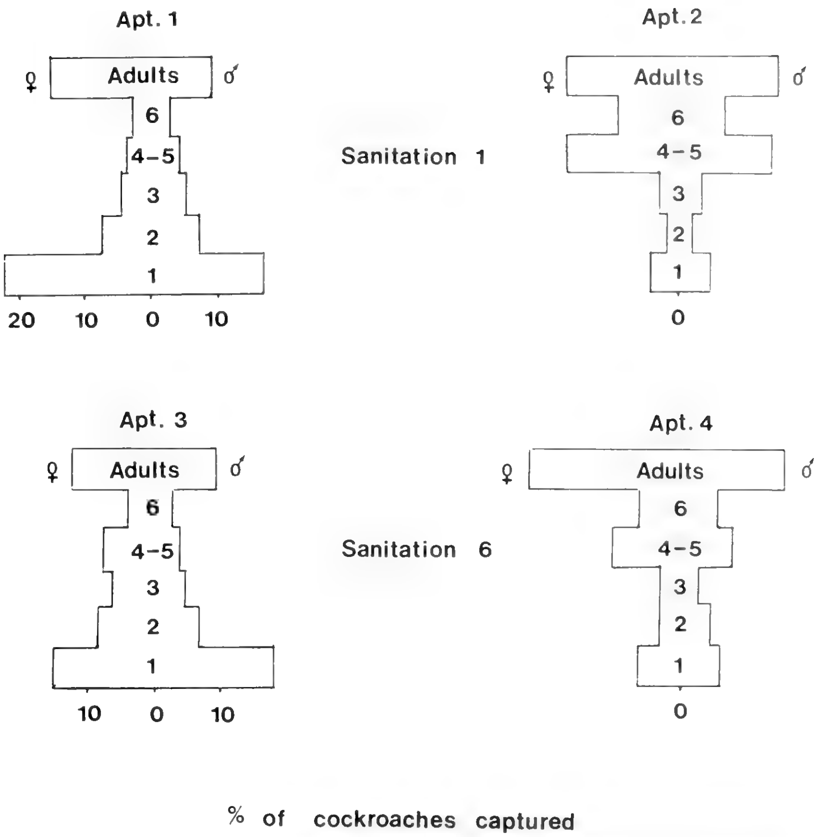

Fig. 4. Examples of German cockroach age class frequencies from single apartments. Apts. 1 and 3 are typical of presumed stabilized type as seen at sanitation 1 and 6, respectively. Apt. 2 shows a composition that may be indicative of a recent immigration. Apt. 4 illustrates the structure typical of low density, sanitation 6 groups, as well as some at sanitation 1, in which reproduction was apparently more limited than in the type shown in apts. 1 and 3.

tation 6 was that high density apparently characterizes populations that are essentially stabilized for their particular environmental situation. Therefore the age composition of the low density collections was examined for clues as to why they were smaller than expected and whether they might provide insight into situations where sanitation and density do not show a close correlation. Recent introductions would represent expanding populations, with higher proportions of immatures than in stabilized groups. This possibility was ruled out since none of the low density groups had higher proportions of nymphs than the high density groups. Rather, age class frequencies suggested a more limited reproduction. The proportion of first-instars was smaller, as in the example shown in Fig. 4, Apt. 4. Possible explanations are that (1) tenant's control efforts decreased hatch or caused high mortality among first-instars or (2) age composition reflected a second type of stabilized population. The latter might occur if there was a difference in the relative impact of limiting factors, as suggested earlier in connection with differences in age class frequencies of "field" and laboratory populations (Ross and Wright, 1977). At high density, harborage space may have been an important limiting factor. Among the sanitation 6, low density groups, the rating might have reflected abundant harborage space (clutter), obscuring limits on the supply of resources affecting reproduction (food and/or water). If so, reliable estimates of density for particular environmental situations may require refining sanitation ratings in terms of relative availability of the three resources, i.e., food, water, and harborage.

Figure 4, Apts. 1 and 3, shows examples of the general age class composition that apparently reflects at least one type of stabilized population. As expected, such occurred among several of low density (600) at sanitation 1 (Fig. 3B, first-instars >25%) as well as sanitation 6, high density groups (Fig. 3A). Another small collection (620) at sanitation 1 was similar to the sanitation 6, low density type noted above and illustrated in Fig. 4, Apt. 4, in which reproduction was apparently more limited. The smallest collection showed the pattern illustrated in Fig. 4, Apt. 2. The extremely high proportions of late instars may be indicative of a recent invasion, possibly dispersal from an adjacent apartment. Data from a shipboard experiment suggested more widespread dispersal of middle to late instars than other age groups following an insecticide treatment (Ross et al., 1981). The largest collection (1947) was close in number and structure to that stabilized at high density, sanitation 6. Other large collections for sanitation 1 tended to be intermediate in that first-instars were <25% but generally higher than the 11–20% range typical of those with apparent limited reproduction. A possible explanation of both unusually high densities for sanitation 1 and incipient limits on reproduction is a recent change for the better in house-keeping habits.

The data presented here and those published earlier (Ross and Wright, 1977) provide some of the first evaluations of the effects of density-independent factors (temperature and humidity) and density-dependent factors (food/water) on density and age class structure. We suggest that the latter, when considered in conjunction with an evaluation of the environmental resources, may prove to be a useful tool in evaluating the state of the population (stable, growing, new introduction, decreasing) and, possibly, assessing the effects of control measures. The evidence of population control at the level of oothecal production is primarily important in respect to recovery potential. Lowered density would stimulate reproduction among an increased proportion of the adult females. This would engender far more rapid growth than if expansion depended on decreased nymphal mortality, with the necessity for nymphs to mature and reproduce before the population could undergo significant increases in size.

We note an absence of morphological deviants that might have been indicative of mutant phenotypes as this could be helpful if future studies lead into areas of population genetics.

LITERATURE CITED

Barr, A. J., J. H. Goodnight, J. P. Sall, and J. T. Helwig. 1976. A user's guide to SAS [Statistical Analysis System]. Sparks Press, Raleigh, N.C. 329 pp.

Bennett, G. W. 1978. Evaluating pesticides in urban environments. Chem. Times and Trends 2: 55–61.

Campbell, F. L. and J. D. Priestly. 1970. Flagellar annuli of *Blattella germanica*. Ann. Entomol. Soc. Am. 63: 81–88.

Chauvin, R. 1946. Notes sur la physiologie comparée des Orthoptères. Bull. Soc. Zool. Fr. 71: 39–48.

Cornwell, P. B. 1968. The Cockroach, Vol. 1. Hutchinson and Co., London. 391 pp.

Gould, C. E. 1941. Effect of temperature on the development of cockroaches. Proc. Indiana Acad. Sci. 50: 242–250.

Gould, C. E. and H. O. Deay. 1940. The biology of six species of cockroaches which inhabit buildings. Purdue Univ. Agric. Exp. Stn. Bull. No. 451.

Gunn, D. L. 1935. The temperature and humidity relations of the cockroach. III. A comparison of temperature preference, rates of dessication and respiration of *Periplaneta americana, Blatta orientalis* and *Blattella germanica*. J. Exp. Biol. 12: 185–190.

———. 1940. Daily activity rhythm of the cockroach. J. Exp. Biol. 17: 267–277.

Gunn, D. L. and C. A. Cosway. 1938. The temperature and humidity relations of the cockroach. V. Humidity preference. J. Exp. Biol. 15: 555–563.

Keil, C. B. 1981. Structure and estimation of shipboard German cockroach (*Blattella germanica*) populations. Environ. Entomol. 10: 534–542.

Kunkel, J. G. 1966. Development and the availability of food in the German cockroach, *Blattella germanica* (L.). J. Insect Physiol. 12: 227–235.

Ogata, K. 1976. Studies on establishing factors of domiciliary cockroaches. 2. Experimental observations of development of German cockroaches in various environments. Jpn. J. Sanit. Zool. 27: 411–421. In Japanese, English Summary.

Ross, H. H. 1929. The life-history of the German cockroach. Trans. Ill. State Acad. Sci. 21: 84–93.

Ross, M. H. 1976. Laboratory population studies of the German cockroach using a two-chromosome and a three-chromosome reciprocal translocation. Ann. Entomol. Soc. Am. 69: 1973–1981.

Ross, M. H. and D. G. Cochran. 1960. A simple method for sexing nymphal German cockroaches. Ann. Entomol. Soc. Am. 53: 550–551.

Ross, M. H. and C. G. Wright. 1977. Characteristics of field-collected populations of the German cockroach. Proc. Entomol. Soc. Wash. 79: 411–416.

Ross, M. H., C. B. Keil, and D. G. Cochran. 1981. The release of sterile males in natural populations of the German cockroach. Entomol. Exp. Appl. 30: 241–253.

Roth, L. M. and B. Stay. 1962. Oocyte development in *Blattella germanica* (L.) and *Blattella vaga* Hebard (Blattaria). Ann. Entomol. Soc. Am. 55: 633–642.

Tanaka, A. 1976. Stages in the embryonic development of the German cockroach *Blattella germanica* (Blattaria, Blattellidae). Kontyû 44: 512–525.

Willis, E. R. and N. Lewis. 1957. The longevity of starved cockroaches. J. Econ. Entomol. 50: 438–440.

Willis, E. R., G. R. Riser, and L. M. Roth. 1958. Observations on reproduction and development of cockroaches. Ann. Entomol. Soc. Am. 51: 53–69.

Woodruff, L. C. 1938. The normal growth rate of *Blattella germanica*. J. Exp. Zool. 79: 145–165.

Wright, C. G. 1966. Modification of a vacuum cleaner for capturing German (*Blattella germanica*) and brown-banded (*Supella supellectilum*) cockroaches. J. Econ. Entomol. 59: 759–760.

———. 1979. Survey confirms correlation between sanitation and cockroach populations. Pest Control 47: 28.

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84(2), 1982, p. 390

NOTE

A 2000+-Year-Old Beetle (Coleoptera: Dermestidae)

Robert Brier, Philosophy Department, Long Island University, Greenvale, N.Y., recently submitted for identification nine adult specimens of a dermestid beetle found inside a wrapped, mummified cat. I identified them as *Dermestes frischii* Kugelann, a widely distributed species in Europe, Asia, Africa, and North America. The larvae of this species feed on carcasses, bones, dried fish, and a number of other substrates, usually dead animal matter, and have been found in mummies (Hope. 1834. Proc. Entomol. Soc. Lond. 1834: 11–13; Lesne. 1930. Bull. Soc. Entomol. Egypte 1930: 21–24).

The exact origin of the mummified cat is not known, but Brier placed the date at 332 BC to 30 BC based on the wrapping which he regards as characteristic of the Ptolemaic dynasty in Egypt. The beetle specimens would thus be 2011 to 2313 years old.

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NEW SPECIES OF XESTOCEPHALINAE (HOMOPTERA: CICADELLIDAE) FROM MEXICO, PANAMA, PERU, AND BRAZIL

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Abstract.—Three new species of *Portanus*, *P.* ***bilineatus*** (Peru), *P.* ***spinosus*** (Bolivia), and *P.* ***caudatus*** (Panama), and three new species of *Xestocephalus*, *X.* ***variabilis*** (Mexico), *X.* ***dubius*** (Bolivia), and *X.* ***similis*** (Brazil), are described.

Most species of both *Portanus* and *Xestocephalus* have rather definite color patterns. Miguel Estribi, working in the tropical laboratory of the Smithsonian Institution in Panama, has been able to separate the 25, or more, species of *Xestocephalus* known to occur in Panama by their color patterns.

Species of *Portanus* have previously been treated by Linnavuori (1959), Kramer (1964), and DeLong (1980). Species of *Xestocephalus* have previously been treated by Linnavuori (1959), DeLong and Linnavuori (1978), and DeLong et al. (1980).

Three species of *Portanus* and three species of *Xestocephalus* are described in this paper. All types are in the DeLong collection.

Portanus bilineatus DeLong, New Species

Figs. 1–4

Description.—Length of male 6 mm, female unknown. Crown bluntly angled, apex rounded, a little longer at middle than wide at base between eyes. Crown except marginal gray area, mostly white with a black squarish spot, each side, just above and mesad of ocelli and a broad longitudinal dark brown stripe extending from brown spot to base along median line. A narrow lateral band extends from broad stripe, just basad of ocelli, then basally along each eye. Pronotum white with 4 dark brown, broad, longitudinal stripes: 2 at middle, widening near posterior margin, and 1 each side behind eye, along lateral margin to apex, then curved to merge with median stripe along posterior margin of pronotum. Scutellum pale gray with darker basal angles. Forewing brownish subhyaline, marked with white and darker brown spots.

Male genitalia, style elongate with main rod-shaped portion narrowed apically and finger-like, apex bluntly pointed. A short process arises at half length of blade, extending laterocaudally, apex bluntly pointed. Aedeagus short and broad, open anteroventrally, bearing a dorsal spine ¼ length of aedeagus which extends ventrally, along caudal margin.

Holotype.—♂, Sinchono, Peru, November 1934, J. G. Sanders, coll.

Comments.—*Portanus bilineata* resembles *P. minor* Kramer in general form and appearance and can be separated by the brown longitudinal stripes on the crown and pronotum and by the aedeagus which bears a spine at the apex.

Portanus spinosus DeLong, New Species

Figs. 5–8

Description.—Length of male 4.5 mm, female 5 mm. Crown produced and bluntly angled. Crown brownish yellow. Pronotum dark brown with numerous small whitish spots. Scutellum yellowish with basal and apical angles brown. Forewing brownish subhyaline with dark brownish spots or areas, especially on costa and basal crossveins of apical cells. Most veins with alternating dashes of brown and white.

Female posterior margin of 7th sternum broadly convexly rounded.

Male genitalia, style narrow, elongate, apical portion pincer-like with the 2 portions of about equal length. Aedeagus slender, curved and elongate with apex bearing 4 slender apical processes. In apical view the median portion appears serrate just before slender, pointed, apical tip.

Types.—Holotype: ♂, Santa Cruz, Bolivia, 21-IX-1980, D. Foster coll. Paratypes: 5 ♂, 1 ♀, same data as holotype; 1 ♂, same data except 17-VIII-1980.

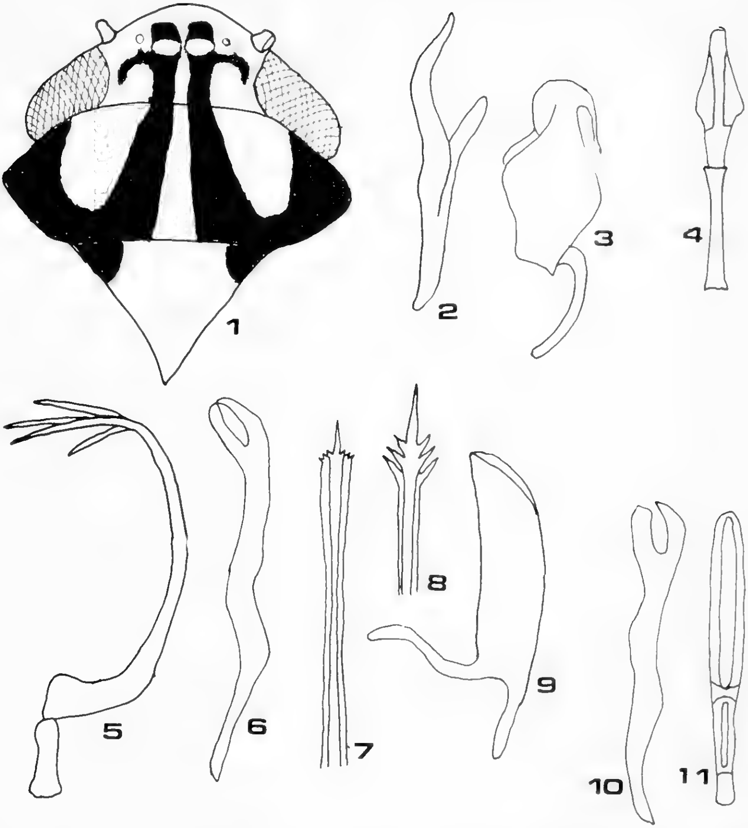
Comments.—*Portanus spinosus* resembles *P. lex* Kramer in form and appearance, but *P. spinosus* can be separated by the long slender curved aedeagus.

Portanus caudatus DeLong, New Species

Figs. 9–11

Description.—Length of male 6 mm, female unknown. Crown produced, apex rounded, a little longer at middle than wide at base, between eyes. Crown white with a pair of small round black spots between ocelli at apex, just above margin, and an orange area just behind each black spot. Pronotum white with faint orange markings. Scutellum white. Forewing whitish subhyaline with faint orange markings on clavus, corium, and apical portion.

Male ganitalia, style pincer-like, with 2 processes about equal in length. Aedeagus elongate, apical portion curved and narrowed, apex bluntly point-



Figs. 1–11. 1–4, *Portanus bilineatus*. 5–8, *P. spinosus*. 9–11, *P. caudatus*. 1, Head, pronotum, and scutellum. 2, 6, 10, Style, laterally. 3, 5, 9, Aedeagus, laterally. 4, 7, 11, Aedeagus, ventrally. 8, Aedeagus, dorso-apical portion enlarged.

ed. Basal end bearing a rather slender finger-like process which is more than ⅓ length of aedeagus and is rounded apically.

Holotype.—♂, Panama, Chiriqui, Fortuna 1058 m, 8°44′N, 82°15′W, 24-IX-1977, H. Wolda coll.

Comments.—*Portanus caudatus* is related to *P. eburatus* Kramer and can be separated by the whitish predominant color and the absence of apical processes.

Xestocephalus variabilis DeLong, New Species

Figs. 12–15

Description.—Length of male 5.5 mm, female unknown. Crown produced and bluntly angled. Crown dull yellow with a brownish circular line extending from near apex to eye, curving around ocellus. This line joins a circular line arising near eye, extends to base each side of median ¼, and encloses a brownish spot. Pronotum pale yellow with a dark brown spot behind each eye enclosing 2 small yellowish spots. Anterior portion at middle and disc pale brownish. Scutellum yellowish with basal angles dark brown. Forewing whitish or pale yellow with some veins and numerous spots dark brown.

Male genitalia, style with apical footlike portion with a definite "heel" which is formed by curvature of blade. Aedeagus V-shaped with the basal portion of "V" broadened. Ventral portion of shaft elongate, slender, tapered to a pointed curved apex. Dorsal portion of shaft ⅔ length of ventral portion and robust.

Types.—Holotype: ♂, Vergel, Chiapas, Mexico, 19-V-1935, A. Dampf coll. Paratypes: 13 ♂, same data as holotype; 14 ♂, Finca Vergel, Chiapas, Mexico, 16,29-V-1935; 1 ♂, Mont. Grande, Chiapas, Mexico, 28-III-1931, A. Dampf coll.

Comments.—*Xestocephalus variabilis* has been collected only in the southeastern portion of Mexico, in the state of Chiapas. It is closely related to *X. dedecus* DeLong, Wolda, and Estribi from Panama and *X. similis* DeLong from Brazil but the basal portion of the aedeagal shaft is thicker and shorter, and the apical "foot" portion of the style is less angled with the blade. The aedeagus is the general shape of the aedeagus of the *X. tessellatus–desertorum* complex but bears no aedeagal processes.

Xestocephalus dubius **DeLong, New Species**

Figs. 16–18

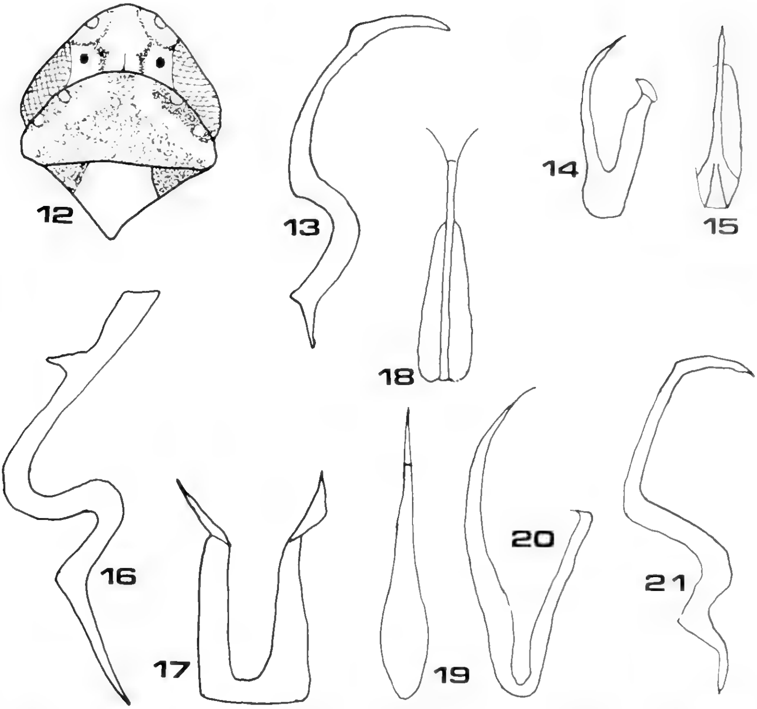
Description.—Length of male 3.5 mm, female 4 mm. Crown produced and rounded apically. Crown yellowish with brownish irrorations. Pronotum yellowish, rather uniformly mottled with brownish areas. Scutellum same as pronotum with dark brown basal angles. Forewing pale brownish with darker brown spots and areas. Costa broadly white near middle.

Female posterior margin of 7th sternum broadly, slightly, concavely rounded.

Male genitalia, style bearing a spine on ventral margin at more than ⅔ its length, apical portion broadened just before pointed apex. Aedeagus broadly U-shaped, with 2 portions of shaft about equal in length. Dorsal portion narrowed to form a bluntly pointed apex. Ventral portion of shaft broader, pointed apically.

Types.—Holotype: ♂, Teguipana, Bolivia, 12-X-1980, Don Foster coll. Paratypes: 13 ♂, same data as holotype; 5 ♂, Santa Cruz, Bolivia, 1-VI-1980, D. Foster coll.; 9 ♂, same except 21-X-1980; 4 ♂, Portachuela, Bolivia, 21-X-1980; 1 ♀, same as holotype except 21-VII-1980.

Comments.—*Xestocephalus dubius* is related to *X. albometus* DeLong,



Figs. 12–21. 12–15, *Xestocephalus variabilis*. 16–18, *X. dubius*. 19–21, *X. similis*. 12, Head, pronotum, and scutellum. 13, 16, 21, Style, laterally. 14, 17, 20, Aedeagus, laterally. 15, 18, 19, Aedeagus, ventrally.

Wolda, and Estribi which has a similar style. They can be separated by comparing the bifid portion of the aedeagus which is longer in *albometus*.

Xestocephalus similus DeLong, New Species

Figs. 19–21

Description.—Length of male 4 mm, female unknown. Head produced and bluntly pointed. Crown, pronotum, and scutellum dark brownish. Darker brown markings behind each eye and dark brown spots in basal angles of scutellum. Forewing rather uniformly pale brown with a few darker brown spots.

Male genitalia, style with apex elongate, footlike, "heel" scarcely visible. Apical footlike portion elongate, slender. Aedeagus V-shaped with the 2 portions slightly separated at base. Main shaft almost twice as long as ventral portion, tapered apically and with a slender sharp pointed apex, basal portion slender.

Holotype.—♂, Viscosa, Amazonas, Brazil, 14-X-1929.

Comments.—*Xestocephalus similis* is related to *X. superbus* VanDuzee and can be separated by the absence of the aedeagal processes and the distinct heel on the apical footlike portion of the style.

LITERATURE CITED

DeLong, D. M. 1980. New South American xestocephaline leafhoppers (Homoptera: Cicadellidae). Entomol. News 91(3): 79–84.

DeLong, D. M. and R. E. Linnavuori. 1978. New tropical *Xestocephalus* (Homoptera: Cicadellidae) and illustrations of little known species. J. Kans. Entomol. Soc. 51(1): 35–41.

DeLong, D. M., H. Wolda, and M. Estribi. 1980. The xestocephaline leafhoppers (Homoptera: Cicadellidae) known to occur in Panama. Brenesia 17: 251–280.

Kramer, J. P. 1964. A key for *Portanus* with new records and descriptions of new species (Homoptera: Cicadellidae: Xestocephalinae). Proc. Entomol. Soc. Wash. 66(1): 5–11.

Linnavuori, R. E. 1959. Revision of the Neotropical Deltocephalinae and some related families (Homoptera). Ann. Zool. Soc. 'Vanamo' 20(1): 1–370 (pp. 35–45).

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AXILLARY STRUCTURE OF THE TORTRICIDAE (LEPIDOPTERA)

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Abstract.—A fourth axillary sclerite (axillary$_{1A}$) is reported within the hindwing base of the Tortricidae. Pivot points of coupled forewings and hindwings in tortricids are in the same plane, parallel to the median longitudinal body axis. These observations contradict previous interpretations that imply pivotal points must be contiguous to their corresponding body segment. Supportive evidence regarding our findings is provided by photographs of whole mount preparations and a diagrammatic illustration.

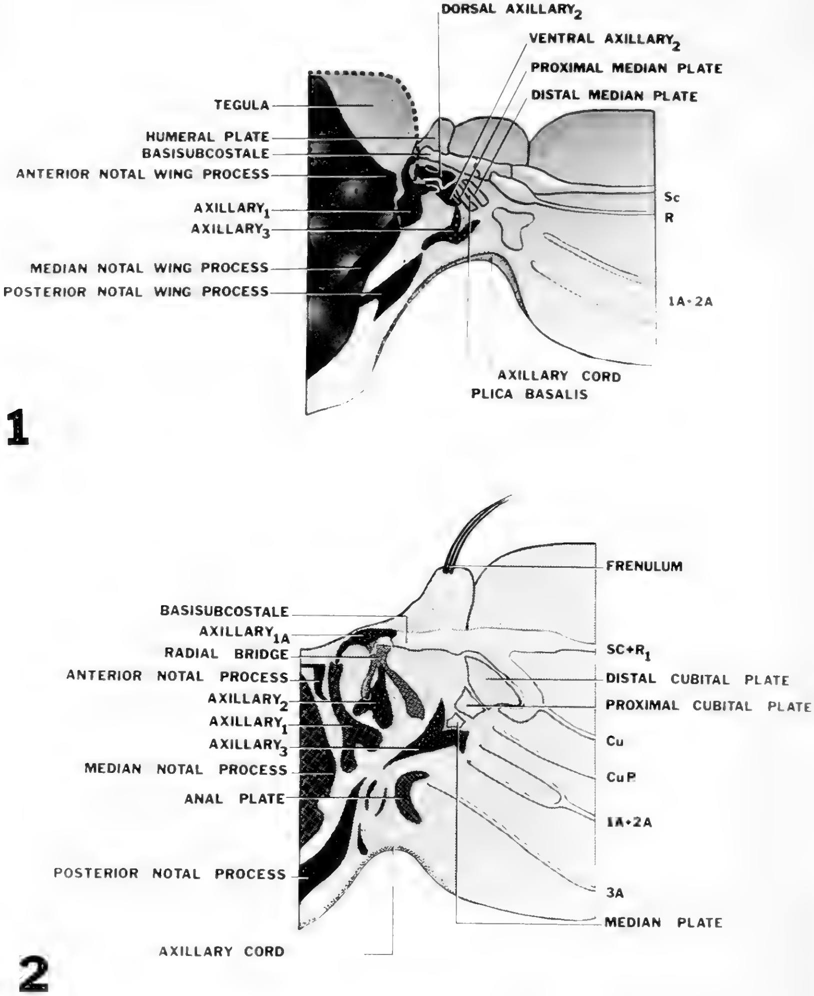
The axillary area of Lepidoptera has been studied by several early investigators (Comstock and Needham, 1898–99; Berlese, 1909; Crampton, 1909, 1920; Snodgrass, 1909, 1935). Recent work by Sharplin (1963a, 1963b, 1964) on lepidopteran wing articulation has provided nomenclatural stability, has more clearly defined functional organization, and has traced an evolutionary series from monotrysian to ditrysian forms.

Wing folding of Lepidoptera, with respect to the axillary sclerites, has been reviewed by the aforementioned investigators, however, emphasis was restricted to the forewing. This paper describes a new axillary sclerite in the base of the hindwing of Tortricidae and discusses the morphological relationships between the anterior hinge of the forewing and hindwing as to their function in wing folding.

The present morphological work was conducted as a part of a taxonomic revision of Nearctic species of the moth genus *Apotomis* Hübner (Olethreutinae). All tortricid species examined exhibit pivot points of the hindwing in the same plane as the forewing, parallel to the median longitudinal body axis. These findings contradict previous interpretations that imply pivotal points are contiguous to their corresponding body segment. A study of this discrepancy has led to our discovery of a fourth axillary sclerite within the hindwing base of Tortricidae.

Materials and Methods

Eight species of Tortricidae were examined; these represented two of the three subfamilies of North American Tortricidae, as recognized by Powell



Figs. 1, 2. Wing bases of *Apotomis albeolana*. 1, Forewing. 2, Hindwing.

(*in press*). Species of Tortricidae examined are: Tortricinae: *Acleris minuta* (Robinson), *Choristoneura fumiferana* (Clemens), *Archips cerasivoranus* (Fitch), *Tortrix viridana* (L.); Olethreutinae: *Apotomis albeolana* (Zeller), *Hedia ochroleucana* (Hübner), *Cydia pomonella* (L.), *Grapholita molesta* (Busck). Specimens of the Chlidanotinae were not available for study.

Specimens were heated in 10% KOH until cleared. Pterothoracic segments were dissected along the median longitudinal body axis and treated

Table 1. Structural differences between forewing and hindwing bases of Tortricidae.

Structure	Forewing	Hindwing
Median arm of axillary$_1$	present (well developed)	absent
Cubital plates	absent	present
Median plates	present (well developed)	present (reduced)
Radial bridge	absent	present
Axillary$_2$	complex	simple
Axillary$_{1A}$	absent	present

with Mallory's triple stain (Barbosa, 1974). Right half-sections were slide mounted in balsam. Left half-sections were studied in temporary glycerine mounts using depression slides. Phase contrast and interference contrast microscopes were used to examine both sections of the pterothorax. "True" pivot points were determined from glycerine by securing the thorax with forceps and flexing the forewing and hindwing.

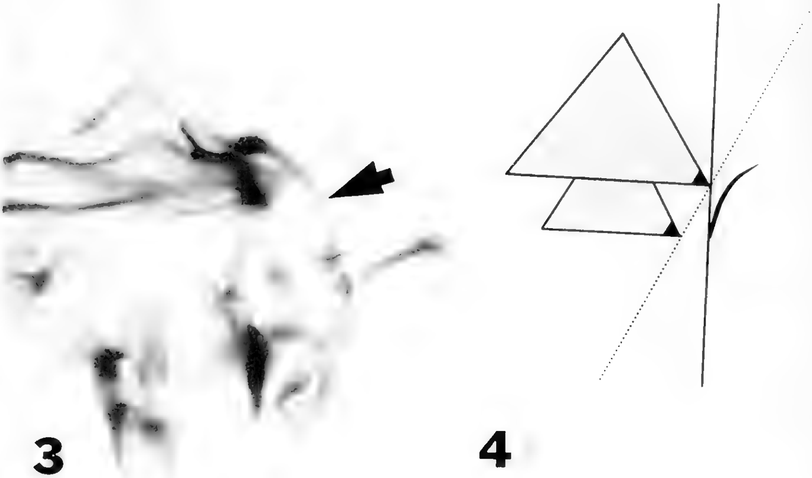
RESULTS AND DISCUSSION

Forewing and hindwing bases of examined specimens are similar to descriptions by earlier workers. Differences between forewing and hindwing bases are illustrated (Figs. 1, 2) and are summarized (Table 1). Except for axillary$_{1A}$ (which Sharplin, 1963b, misidentified as the basisubcostale in the hindwing of *Tortrix viridana*) our findings agree with Sharplin (1963a, 1963b).

The small axillary$_{1A}$ (Fig. 3) is received by a cuplike invagination of the anterior apex of axillary$_1$. Movement of axillary$_{1A}$ is restricted by a flat strip of thin cuticle attached to its base. Axillary$_{1A}$ articulates distally with the basisubcostale. This juncture marks the "true" pivot point of the hindwing.

Figure 4 is a diagrammatic representation of the tortricid pterothorax with the large triangle representing the mesothorax, followed by the smaller metathorax. According to the workers previously cited, the blackened apexes would depict the approximate location of axillary$_1$. In their interpretation the pivot point axis represented by a broken line is contiguous to the respective body segment. However, our study reveals the observed pivot point axis to be along the solid line, axillary$_{1A}$ of the hindwing, accounting for the difference in angle.

We have not conducted an extensive survey throughout the order to determine if the axillary sclerite we describe is present only in the tortricids; the literature does not indicate its presence in other lepidopteran families. The structure may have originated along the axis (solid axis of Fig. 4) where the wing buckled due to frenular wing coupling and the mechanical stress



Figs. 3, 4. 3, Hindwing base of *Apotomis albeolana*; axillary$_{1A}$ indicated by arrow (100×). 4, Diagrammatic representation of the tortricid pterothroax. Large triangle represents mesothorax, small triangle represents metathorax. Blackened apexes depict approximate location of axillary$_1$ demarking the pivot point axis represented by a broken line. Observed pivot point axis is along the solid line. Note that the frenulum is along observed pivot point axis.

at that point. We suggest that this hypothesis could be tested outside the tortricidae. Further studies are needed to (1) define structural and functional homologies of axillary$_{1A}$ and (2) determine to what degree, if any, wing coupling (jugal lobe, frenulum, or expanded costa of the hindwing) is correlated with the evolution of axillary$_{1A}$.

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LITERATURE CITED

Barbosa, P. 1974. Manual of Basic Techniques in Insect Histology. Autumn Publishers. Amherst, Mass. 253 pp.

Berlese, A. 1909. Gli Insetti. Milan. 1004 pp.

Comstock, J. H. and J. G. Needham. 1898–99. The wings of insects. Am. Nat. 32: 43–48, 81–89, 231–257, 413–422, 560–565, 769–777, 903–911; 33: 117–126, 573–582, 845–860.

Crampton, G. C. 1909. A contribution to the comparative morphology of thoracic sclerites of insects. Proc. Acad. Nat. Sci. Phila. 61: 3–54.

———. 1920. A comparison of the external anatomy of the lower Lepidoptera and Trichoptera from the standpoint of phylogeny. Psyche (Camb., Mass.) 27: 23–34.

Powell, J. A. *In press*. Tortricoidea. *In* Hodges, R. W., ed., A Checklist of the Lepidoptera of America, North of Mexico. London.

Sharplin, J. 1963a. Wing base structure in Lepidoptera. I: Forewing base. Can. Entomol. 95: 1025–1050.

———. 1963b. Wing base structure in Lepidoptera. II: Hindwing base. Can. Entomol. 95: 1121–1145.

———. 1964. Wing folding in Lepidoptera. Can Entomol. 96: 148–149.

Snodgrass, R. E. 1909. The thorax of insects and articulation of the wings. Proc. U.S. Natl. Mus. 36: 511–595.

———. 1935. Principles of Insect Morphology. McGraw-Hill, New York. 667 pp.

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NEW SYNONYMIES, LECTOTYPE DESIGNATIONS, AND OTHER NOTES ON NORTH AMERICAN *EPICAUTA* (COLEOPTERA: MELOIDAE)

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Abstract.—Eight nominal species of North American *Epicauta* are reduced to junior synonyms. *Epicauta mixta* Dugès, long considered a junior synonym of *E. neglecta,* is given renewed status. The taxonomic position of *E. atricolor* Champion and *E. unicalcarata* Champion is discussed. Both are herein placed in the subgenus *Macrobasis.* Also, lectotypes for 11 nominal species are designated.

A revision of the nominate subgenus of *Epicauta* of North America including Mexico and Central America is now in progress. The establishment of certain synonyms and lectotypes is necessary now, however, to allow correct name usage in impending biological studies. Brief justifications for synonymies are presented here. More detailed treatment of the intraspecific variation relating to these as well as complete species synonymies will follow in the revision. The subgeneric assignment of two species, *E. atricolor* Champion and *E. unicalcarata* Champion, also is discussed.

SYNONYMIES

Epicauta brunnea Werner, 1944: 67

Epicauta innomina Dillon, 1952: 401. **NEW SYNONYMY.**

Dillon (1952) differentiated *E. innomina* from *E. brunnea* by its lighter body color, more flattened hindtibial spurs and the single foretibial spur in the male. Comparison of numerous *E. brunnea* with the type of *E. innomina* indicates that these traits are not significant. The presence of one rather than two foretibial spurs would appear to be important, but this turns out to be variable throughout the range of *E. brunnea.* In fact, the anterior spur is absent from the foretibia of the holotype of *E. innomina* but present in the male paratype from the same locale. In some cases the anterior spur is absent from one leg but not the other. It is not clear if the missing anterior spur is always due to breakage. In certain individuals the socket of the missing spur is visible suggesting breakage. In others, including the holotype of *E. innomina,* a distinct socket cannot be seen.

Coloration of *E. brunnea* varies geographically. Representatives from the eastern portion of the range (central Texas) are considerably lighter than those from Arizona. Those from western Texas are somewhat intermediate.

The hindtibial spurs vary in width only slightly in *E. brunnea.* Those of the type of *E. innomina* are well within the range of variation.

Epicauta cinctipennis **(Chevrolat, 1834: 59)**

Epicauta ruidosana Fall, 1907: 258. New Synonymy.

Fall (1907) apparently was unaware of *E. cinctipennis* at the time *E. ruidosana* was described. Material from Arizona, New Mexico, and Texas has been historically identified as *E. ruidosana* (e.g. Dillon, 1952; Werner, 1945), that from Mexico as *E. cinctipennis* (Werner et al., 1966). However, no appreciable differences exist between these populations. Some of the material from Arizona has black rather than white setae on much of the mid- and hindlegs, but this trait is variable even within Arizona.

Epicauta nigritarsis **(LeConte, 1853: 340)**

Epicauta hesitata Dillon, 1952: 398. New Synonymy.

Dillon (1952) considered *E. hesitata* closest to *E. crassitarsis.* Examination of the types of *E. hesitata* shows them to be merely a minor color variant of *E. nigritarsis.* The head, pronotum, and elytra are uniformly tan in most *E. nigritarsis.* Several specimens throughout its range, however, have a dark head and pronotum. At an extreme, as in the types of *E. hesitata,* the head and anterior half of the pronotum are almost entirely black. The entire range of variation commonly occurs within the same series. In fact, a specimen from the same series as the holotype of *E. hesitata* (but not designated as a paratype) is of a lighter color.

Epicauta obesa **(Chevrolat, 1835: 81)**

Epicauta auricomans Champion, 1892: 424. New Synonymy.
Epicauta ficta Werner, 1949: 100. New Synonymy.
Epicauta pseudosolani Dillon, 1952: 395. New Synonymy.

Epicauta obesa, as now defined, ranges from south central United States to Oaxaca, Mexico. Several traits vary geographically. Specimens from central and southern Mexico are generally less densely setate and have finer setae than those to the north. Mexican populations have somewhat more slender hindtibial spurs. The structure of the foretarsus in the male also varies. The first two segments are elongate, broadened, heavily padded, and lack cinereous setae on the dorsum. This characterizes all populations but is better developed in Mexican material. All variation that I am aware of is clinal and not taxonomically significant.

Epicauta ficta and *E. pseudosolani,* described from Oklahoma and Texas, respectively, represent variants typical of the northern portion of the range. Type-material of *E. auricomans,* from Coahuila and Oaxaca, have longer and denser body setation more typical of populations from south central United States rather than from Mexico.

Epicauta rufipedes **(Dugès, 1870: 163)**

Epicauta insignis Horn, 1885: 110. **New Synonymy.**

Epicauta rufipedes is one of the most widespread and common species of *Epicauta* in Mexico. The species is characterized by the strongly ensiform antenna and single foretibial spur in the male. Variation in color pattern is extensive. In the commonest pattern the cuticle of the head and pronotum is black; the elytra also are black except for a narrow band of brown on the lateral, medial, and apical margins. These structures are generally covered with short, relatively sparse, cinereous pubescence which is denser at the elytral margins and along a narrow line down the center of the elytral disc.

Epicauta insignis, from southern Arizona and northwestern Mexico, appears to be nothing more than a variant of *E. rufipedes.* Unlike most *E. rufipedes,* specimens conforming to *E. insignis* have entirely brown elytra, which contrasts with the black head and pronotum. The elytral vitta is either absent or obsolescent. This color pattern, however, is not entirely unknown in central and southern Mexico, and, similarly, some individuals from Arizona have almost entirely black elytra as in typical *E. rufipedes.* The similarity of courtship behavior and first-instar larvae in a population from southeastern Arizona and one of typical *rufipedes* from the state of Puebla further supports synonymy (Pinto, unpublished data).

Epicauta stigmata **(Dugès, 1870: 159)**

Lytta neglecta Haag-Rutenberg, 1880: 54. **New Synonymy.**

The type-series of *E. neglecta* is mixed. The lectotype designated below for *E. neglecta* belongs to *E. stigmata,* a species of *Macrobasis.* One paralectotype belongs to the nominate *E. mixta* (Dugès). See discussion of *E. mixta* below.

RENEWED STATUS

Epicauta mixta **Dugès, 1889: 83**

Lytta neglecta: Haag-Rutenberg, 1880: 54 (in part).
Epicauta neglecta: Champion, 1892: 423 (in major part).

Epicauta mixta was treated as a junior synonym of *E. neglecta* (Haag-Rutenberg) by Champion (1892). However, of the three syntypes of *E. neglecta* examined, two belong to *Epicauta* (*Macrobasis*) *stigmata* (Dugès). Only the third represents the nominate species recognized as *E. neglecta* by Champion. Since Haag-Rutenberg's description of *E. neglecta* clearly correlates with the two misidentified types, I have chosen one of these as lectotype (see below). *Epicauta neglecta* now is a junior synonym of *E. stigmata*, and *E. mixta* Dugès is the valid name for the *E. neglecta* of Champion (1892).

The source of confusion in this case stems from the superficially similar variation in *E. stigmata* and *E. mixta*. Pubescence color varies similarly, ranging from entirely cinereous to entirely black. Both have a form that is black with intermixed cinereous hairs. The three types of *E. neglecta* are of this form. Also, a smooth glabrous callus on either side of the pronotal midline, a common feature in *E. mixta*, is present in some *E. stigmata*, including the two misidentified types of *E. neglecta*.

As indicated, Haag-Rutenberg's original description of *E. neglecta* clearly refers to *E. stigmata*. He states that the first antennal segment of the male is thick, three times as long as broad, and that the second segment is half as long as the third. Both traits characterize *Macrobasis*. He also states that the pronotum is somewhat longer or as long as broad. Again, this agrees with *E. stigmata*, but not *E. mixta* where the pronotum is noticeably broader than long.

Dugès' (1889) description of *E. mixta* was based on material from Oaxaca. It is not clear how many specimens were before him, but the lack of a range in his length measurement suggests only one. I have examined two specimens in what remains of the Dugès Collection at the Universidad Nacional Autonoma de Mexico (UNAM) labeled as types of *E. mixta*. One is labeled "Oaxaca," the other, "Moro Leon." Both fit Dugès' rather generalized description. However, the latter is almost certainly not a type since Moroleon is a Guanajuato locality.

TRANSFERS TO *MACROBASIS*

***Epicauta atricolor* Champion, 1892: 419**

Epicauta atricolor was removed from *Macrobasis* (as *Gnathospasta*) and placed in the nominate subgenus by Werner (1958). Its transfer was justified primarily by the absence of the hindtibial comb in one of the types. This trait is characteristic of most *Macrobasis* but is absent in some species (Selander and Mathieu, 1969). Examination of the type-series convinces me that *E. atricolor* should be reassigned to *Macrobasis*. The male lectotype (designated below) actually does have a poorly developed comb of three teeth. Also, the first antennal segment of the male is slightly enlarged and curved. The antennal dimorphism is not as marked as in most *Macrobasis* but is no less developed than in certain species of the subgenus such as *E. evanescens* Champion. *Epicauta atricolor* should tentatively be placed in the Uniforma Group as originally indicated by Werner (1954).

Epicauta unicalcarata Champion, 1892: 412

Epicauta unicalcarata has never been formally assigned to subgenus, but its omission from Werner's (1954) list of species in *Macrobasis* (as *Gnathospasta*) and from other discussions of the limits of that subgenus (Werner, 1958; Selander and Mathieu, 1969) suggest its placement in the nominate subgenus. Indeed, Champion made no mention of antennal modifications typical of *Macrobasis* and considered this species closest to *E. horni* Champion, a nominate species.

I have examined the male holotype of *E. unicalcarata* in the British Museum (from Amula, Guerrero). It is badly damaged with the head and pronotum entirely missing. The hindlegs, however, are intact and the presence of a well-developed hindtibial comb indicates that the species belongs to *Macrobasis*.

I am not aware of additional material of this species. Features not mentioned by Champion that should help identify it are a small patch of brown pubescence on the apex of each elytron, a distinctly concave metasternum, flattened hindtrochanters, and the glabrous, subconcave ventral surface of the hindfemora.

It is not possible to assign *E. unicalcarata* to species group at this time.

LECTOTYPE DESIGNATIONS

Syntypes of several North American species described by Champion (1892), Haag-Rutenberg (1880), and Chevrolat (1834) were examined, and lectotypes are designated below. Syntypes were primarily identified by the correspondence of specimens and attached labels with original descriptions. All lectotypes are labeled as such and deposited in their appropriate museums. Additional syntypes are labeled paralectotypes.

Specific names are listed below in alphabetical order. The original genus follows the specific name in parentheses. Locales and other data are given as they appear on labels. Data from individual labels are delimited by a slash (/).

Abbreviations for museums are as follows: BMNH (British Museum of Natural History, London); HNHM (Hungarian Natural History Museum, Budapest); UZMH (Universitets Zoologiska Museum, Helsinki); ZSM (Zoologische Staatssammlung, Munich).

atricolor Champion (*Epicauta*). Lectotype: ♂, "Oaxaca, Mexico/Salle Coll./"; (BMNH). Paralectotypes: 5 (BMNH).

auricomans Champion (*Epicauta*). Lectotype: ♂, "Oaxaca, Mexico/Hoege/"; (BMNH). Paralectotypes: 4♂, 2♀ (BMNH). The specimen chosen as lectotype was figured by Champion (1892: Table 19, Fig. 24). This individual is abnormal in that the hindtibiae are abruptly and strongly bowed.

basimacula Haag-Rutenberg (*Lytta*). Lectotype: ♂, "Mexico/Samml. Haag-Rutenberg/"; (ZSM). Paralectotypes: 1♀ (ZSM), 1♂ (UZMH).

carmelita Haag-Rutenberg (*Lytta*). Lectotype: ♂, "N. Grenada/F. Bates/typ. Haag/"; (BMNH). Paralectotypes: 1♂ (HNHM), 3♀ (ZSM), 1♀ (UZMH).

cinctipennis Chevrolat (*Lytta*). Lectotype: ♂, "Mexico, Mineral del Zimapan/Sommer/"; (UZMH). Paralectotype: 1♀ (UZMH).

curvicornis Haag-Rutenberg (*Lytta*). Lectotype: ♂, "Mexico/F. Bates/ typ. Haag./"; (BMNH). Paralectotype: 1♀ (BMNH). I have examined 13 additional specimens from UZMH which are questionably from the original series. At least 4 of these represent species other than *curvicornis*.

emarginata Champion (*Epicauta*). Lectotype: ♂, "San Isidro, Mexico, Höge/"; (BMNH). Paralectotypes: 3♀ (BMNH); 1♀ (HNHM).

leucocoma Champion (*Epicauta*). Lectotype: ♀, "Tepanistalabuaca, Mexico, Salle Coll./"; (BMNH). Paralectotypes: 2♀ (BMNH). The lectotype was figured by Champion (1892: Table 19, Fig. 23); it is labeled a male in error).

neglecta Haag-Rutenberg (*Lytta*). Lectotype: ♀, "Mex./F. Bates/Typ. Haag/"; (BMNH). Paralectotypes: 1♂ (HNHM); 1♀ (ZSM). As indicated, the original series of *E. neglecta* is mixed. The lectotype and male paralectotype are assignable to *E. stigmata*. The female paralectotype represents *E. mixta*.

singularis Champion (*Epicauta*). Lectotype: ♂, "Monterey, Nuevo Leon, Höge/"; (BMNH). Paralectotypes: 4♂, 1♀ (BMNH); 1♂ (HNHM).

subvittata Haag-Rutenberg (*Lytta*). Lectotype: ♂, "Mexiko/Coll. Blny./"; (UZMH). Paralectotypes: 1♂ (UZMH); 2♀ (BMNH). Five other specimens in UZMH also may represent part of the original series. *Epicauta subvittata* has long been considered a junior synonym of *E. rufipedes* (Champion, 1892).

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LITERATURE CITED

Champion, G. C. 1891–93. Family Meloidae. *In* Godman, F. D. and O. Salvin, Biologia Centrali-Americana, Coleoptera, 4(2): 364–450, 462–464.

Chevrolat, L. A. 1834–35. Coléoptères du Mexique, Fasc. 3, 4. Strasbourg.

Dillon, L. 1952. The Meloidae (Coleoptera) of Texas. Am. Midl. Nat. 48: 330–420.

Dugès, E. 1870. Descripcíon de algunos Meloideos indígenas. Naturaleza 1: 125–128, 157–171.

———. 1889. Sinopsis de los Meloideos de la República mexicana. An. Mus. Michoacano 2: 34–40, 49–114.

Fall, H. C. 1907. Descriptions of new species, pp. 218–272. *In* Fall, H. C. and T. D. A. Cockerell, The Coleoptera of New Mexico. Trans. Am. Entomol. Soc. 33: 145–272.

Haag-Rutenberg, J. G. 1880. Beiträge zur Kenntniss der Canthariden. Dtsch. Entomol. Z. 24: 17–90.

Horn, G. H. 1885. Studies among The Meloidae. Trans. Am. Entomol. Soc. 12: 107–116.

LeConte, J. L. 1853. Synopsis of The Meloides of the United States. Proc. Acad. Nat. Sci. Philad. 6: 328–350.

Selander, R. B. and J. M. Mathieu. 1969. Ecology, behavior and adult anatomy of The Albida Group of the genus *Epicauta* (Coleoptera: Meloidae). Ill. Biol. Monogr. 41: 1–168.

Werner, F. G. 1944. Some new North American species of *Epicauta* (Coleoptera: Meloidae). Psyche (Camb. Mass.) 50(1943): 65–73.

———. 1945. A revision of the genus *Epicauta* in America north of Mexico. Bull. Mus. Comp. Zool. 95: 421–517.

———. 1949. Additions to *Epicauta*, with new synonymy and a change of names (Coleoptera: Meloidae). Psyche (Camb. Mass.) 56: 93–111.

———. 1954. A review of the subgenus *Gnathospasta* of the genus *Epicauta* (Meloidae). Coleopt. Bull. 8: 25–27.

———. 1958. Studies in the genus *Epicauta* of the North American Continent (Meloidae) II. The Uniforma-Group. Coleopt. Bull. 12: 1–19.

Werner, F. G., W. R. Enns, and F. H. Parker. 1966. The Meloidae of Arizona. Univ. Ariz. Agric. Exp. Stn. Tech. Bull. 175, 96 pp.

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NOTE

Silphids Attracted to Mammal Carrion at Cheltenham, Maryland (Coleoptera: Silphidae)

Several field experiments dealing with carrion beetles (Silphidae) were conducted from 2 June 1981 to 3 August 1981 at Cheltenham, Prince Georges Co., Maryland. The work was done on the reservation where the Naval Communication Unit is located. The reservation's 220 ha contain a variety of natural habitats such as marsh, old field, mature deciduous woodland, mature coniferous woodland, and young mixed woodland. The most extensive habitat is the latter.

Four traps (4.21 cans covered by 1.27 cm mesh hardware cloth and a rain cover 5 cm above the can opening) were suspended 45 cm above the ground. Each of these cans was suspended from a crosspiece between 2 stakes in the young woodland habitat. Two similar traps were situated in each of the following habitats: Mature coniferous woodland, marsh, and old field. No trap was closer than 75 m to a neighboring trap. Each trap was baited with a whole fetal pig weighing about 380 g and the carrion was left to decompose for 7 days. Traps were usually examined on days 1, 2, 3, 4, and 7 after having been set. Carrion beetles were removed, identified, and the data recorded for each trap.

A total of 300 trap collections was made during the study and a total of 1873 carrion beetles, representing 8 species, was taken. The species, the number of each species collected, the percentage of all silphids this represents, and rank order for each species are in Table 1.

It is clear from this data that *Silpha americana* is the dominant silphid species collected since it accounted for well over half of all Silphidae taken.

Table 1.

Species	Number Collected	% of Total	Rank
Silpha americana L.	1027	54.83	1
S. noveboracensis Forster	318	16.98	2
S. inaequalis F.	253	13.51	3
Nicrophorus tomentosus Weber	139	7.42	4
N. orbicollis Say	109	5.82	5
Necrodes surinamensis F.	24	1.28	6
Nicrophorus pustulatus Herschel	2	0.11	7
N. marginatus F.	1	0.05	8
Total	1873	100.00	

Silpha noveboracensis is a very poor second. In previous studies in New Jersey, Shubeck has found that *Silpha noveboracensis* is clearly the dominant species through June and July, and *S. americana* is second or third in abundance (Shubeck et al. 1977. The Wm. L. Hutcheson Memorial Forest Bull. 4(1): 12–17; Shubeck et al. 1981. Entomol. News 92(1): 7–16).

The 8 species of Silphidae collected in Maryland during this study are the same 8 silphid species that have been taken by Shubeck during the last 21 years of carrion beetle studies in New Jersey. Continued field studies may reveal that additional "common" silphid species (according to previous literature), are, in fact, no longer common in New Jersey and Maryland.

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NOTE

The Habits and Appearance of a Rare Mealybug, *Eurycoccus blanchardii* (King and Cockerell) (Homoptera: Coccoidea: Pseudococcidae)

Between 1897 when *Eurycoccus blanchardii* (King and Cockerell) was described and the present time, there have been only two recorded collections of this species and only a brief mention of a host or the feeding habits and appearance of the insect in life. It therefore seems desirable to record its rediscovery in what may have been an unusual location.

On 23 June 1968 while digging up daffodil bulbs in Silver Spring, Maryland, I found a husked hickory nut (*Carya* sp.) approximately 6″ below the surface of the soil. The nut was cracked open about $^1/_{16}$″, and it had a root sprout about 6″ long that extended deeper into the soil. There were 20 mealybugs inside the nut next to the shell, a most unusual location for mealybugs as far as known, and there were also 2 mealybugs on the root about 2″ below the nut. Some of the mealybugs inside the nut appeared to be feeding on the sprouting kernel. The mealybugs were attended by ants which escaped before I could get a container to place them in. Although I have dug in the same plot annually since 1968, I have not found the mealybug again.

The mealybugs were a dull, but almost glistening white owing to the waxy pulverulence that covered them. Underneath the waxy secretion the bodies were pinkish red instead of reddish purple as described by King and Cockerell for the original example of *blanchardii*.

The specimens were identified by the late H. L. McKenzie of the University of California at Davis.

An annotated list of all previous articles known to me that have mentioned *blanchardii* is given as an aid to persons who may encounter this mealybug.

King and Cockerell. 1897. Can. Entomol. 29: 92–93. *Ripersia blanchardii* described from "Haverhill, Mass., October 4th, 1896, in a nest of *Lasius claviger,* Rog., under a stone with a small herd of another species; only one found, not feeding."

Tinsley. 1899. Can. Entomol. 31: 46. Noted that the type-specimen had malformed antennae.

King. 1899. Can. Entomol. 31: 111. Stated "Large and not often met with . . ."

Lindinger. 1908 (1907). Berl. Entomol. Z. 52: 90. Changed the spelling to *blanchardi.*

MacGillivray. 1921. The Coccidae, p. 141. Listed as a species described in *Ripersia.*

Britton. 1923. Conn. State Geol. and Nat. Hist. Surv. Bull. 34: 382. Indicated that the species might be found in Connecticut because it was known in Massachusetts.

Trimble. 1928. Entomol. News 39: 44. Recorded the species "on grass roots in ants' nest" in Pennsylvania. Through the courtesy of G. B. Sleesman, formerly of the Department of Agriculture, Harrisburg, Pennsylvania, I have been able to examine specimens that may be the ones Trimble listed. The data with these specimens are "Rip. blanchardii?, F 108, under a stone attended by ants, Rockville, Pa., 4-16-22, A. B. Champlain." Unfortunately the specimens are in such poor condition that I cannot determine whether they are *blanchardii.* Other Trimble specimens labeled "Rip. minima T & K? on grass roots, in ant nest, Rockville, Pa., 2-15-21, coll. F. M. Trimble" are also very poor mounts, but these insects definitely are not *blanchardii.* These two lots are the only ones found in the Trimble collection that might be the one he recorded.

Ferris. 1953. Atlas of the Scale Insects of North America 6: 349–350. Ferris redescribed and illustrated *blanchardii* and transferred it to *Eurycoccus* Ferris 1950 though stating that it was not typical of the genus.

Williams. 1958. Proc. R. Entomol. Soc. Lond., Ser. B., Taxonomy 27(1–2): 22–24. Mentioned similarity of his new species to *blanchardii.*

Sailer. 1968. USDA, Coop. Econ. Insect Rep. 18(36): 866. Recorded my collection as new for Maryland.

Balachowsky and Ferrero. 1969. Bull. Inst. Fondam. Afr. Noire, Ser. A, Sci. Nat. 31: 138. Listed *blanchardii* as a species of *Eurycoccus.*

Brooks. 1972. J. Aust. Entomol. Soc. 11: 129. Listed *blanchardii* as a species of *Eurycoccus.*

Louise M. Russell, *Cooperating Scientist, Systematic Entomology Laboratory, IIBIII, Agricultural Research Service, USDA, Beltsville Agricultural Research Center, Beltsville, Maryland 20705.*

PROC. ENTOMOL. SOC. WASH.
84(2), 1982, p. 412

BOOK REVIEW

The Plant Protection Discipline, Problems and Possible Developmental Strategies. By W. H. Sill, Jr. Allanheld, Osmun and Co.; distr. John Wiley and Sons, New York. 190 pp. 1979. Cost: $25.00.

This hardcover book provides an interesting, wide-ranging discussion of the practical applications and philosophical foundations of plant protection. Topics include world food losses due to pests; complexity of agroecosystems; interdisciplinary research and coordination needed; integrated pest management; comparison of plant protection in developed and developing nations; economics of crop production; viewpoints of administrators and research scientists; public relations problems; low prestige of agriculture as a profession; training of extension agents and other crop protection and crop production experts; academic training; possible organizational strategies; legislation; and regulation of pesticides with certification of applicators, resembling the regulation of pharmaceuticals and pharmacists. Useful and explicit definitions of terms commonly in the literature are provided, the concepts and nomenclature defining plant protection are discussed, and numerous authorities are extensively quoted. The daunting complexity of understanding and managing the many interacting and changing components that comprise agroecosystems are correctly stressed. The author emphasizes that, contrary to the viewpoint of many city dwellers, agriculture cannot be performed by the uneducated peasants, but instead is rapidly evolving into what must be the most complex and challenging of all human endeavors, if world food production is to be adequate.

Although this book is addressed primarily to those concerned with plant protection, there is much of interest regarding crop production, general ecology, and sociology as well. It is well written, thoughtful, interesting to read, and should be available to agricultural planners, research scientists, and extension workers.

S. W. T. Batra, *Research Entomologist, Beneficial Insect Introduction Laboratory, IIBIII, Agricultural Research Service, USDA, Beltsville, Maryland 20705.*

PROC. ENTOMOL. SOC. WASH.
84(2), 1982, p. 413

BOOK REVIEW

Systematics of the Colletidae Based on Mature Larvae with Phenetic Analysis of Apoid Larvae (Hymenoptera: Apoidea). By R. J. McGinley. University of California Publications in Entomology, Vol. 91, 307 pp. 1981. Cost: $14.50.

The colletid bees are generally regarded to be the ancestors of the bees (Apoidea), based on the morphological similarity of adults to certain sphecoid wasps and the relict distribution of colletids, with speciation principally in South America and Australia. As there are over 20,000 species of bees worldwide, on which most higher plants depend for pollination (including about 20 billion dollars' worth of crops), the origin and evolution of the bees are of considerable basic scientific and agricultural significance.

This volume takes a novel and difficult approach to assess the evolutionary relationships among colletid subfamilies and genera, and their possible relationships to other bee families, because it is based on the relatively scant and indistinct morphological characters of the larvae. Numerical taxonomy was used to generate a cladistic analysis, and larval information did not support colletid monophyly. This conclusion is supported by the recent findings of this reviewer and colleagues (unpublished) that the secreted nest membrane in Colletidae consists of two chemically unrelated types; in Colletinae, it is a polyester derived from lactones in the Dufour's gland (similar to Halictidae), and, in Hylaeinae, it is a nest membrane composed of silk secreted by salivary glands (similar to silk of pemphredonine wasps). The bifid or blunt glossa of Colletidae may thus be only the result of convergent evolution in at least two groups that use the glossa for applying a secreted nest membrane, and therefore should not be considered as the definitive family characteristic.

This well written and amply illustrated paperback publication includes descriptions of, and a key to, known mature colletid larvae; a phenogram; partial taxometric maps; similarity matrix; and ranked nearest-neighbor listing. A phenogram and nearest-neighbor diagram for 96 apoid taxa indicates 11 major phenetic groupings based on larvae, not all of them corresponding to existing taxonomic groups based on external morphology of the adults. I recommend this book to institutional libraries, hymenopterists, numerical taxonomists, and those interested in the evolution of the bees.

S. W. T. Batra, *Research Entomologist, Beneficial Insect Introduction Laboratory, IIBIII, Agricultural Research Service, USDA, Beltsville, Maryland 20705.*

SUMMARY REPORTS OF SOCIETY OFFICERS FOR 1981

TREASURER
(1 November 1980 to 31 October 1981)

Summary	General Fund	Special Publication Fund	Totals
On hand, 1 November 1980	21,462.57	33,133.73	54,596.30
Total receipts	38,434.76	5,857.00	44,291.76
Total disbursements	42,381.66	8,145.05	50,526.71
On hand, 31 October 1981	17,515.67	30,845.68	48,361.35

EDITOR
(Calendar Year 1981)

A total of 139 manuscripts were received and processed from November 1, 1980 to October 31, 1981. Four numbers of the *Proceedings* were published in 1981. The 824 pages represented 81 scientific articles, 13 scientific notes, 8 book reviews, 2 obituaries, 5 announcements, and minutes for 12 Society meetings. Reports for officers for 1980, information for contributors, table of contents for volume 83, index to new taxa for volume 83, and PS Form 3526 were also published. This is the largest volume published by the Society.

Editorial charges were waived for 8 articles totaling 54 pages. Full editorial charges were paid for immediate publication of 6 articles totaling 65 pages and one article of 4 pages by non-members. Ten lengthy articles included full editorial charges for 58 pages.

In September, the Society published *Memoir* Number 9, *The Flower Flies of the West Indies* by F. Christian Thompson. The 200 page *Memoir* is available from the Society at a cost of $10.00.

The Society covered expenses for the Editor to attend the Editorial Workshop held at Allen Press, Inc., Lawrence, Kansas, October 15–16, 1981. Representatives from 20 scientific journals attended. The session included a tour of the Allen Press plant and seminars on costs of production, scientific illustrations, style of publications, new developments from the U.S. Postal Service, marketing of scholarly publications, and the librarian's view of scholarly journals.

Publications Committee: E. Eric Grissell, John M. Kingsolver, Wayne N. Mathis, George C. Steyskal, Thomas E. Wallenmaier, and David R. Smith (*Editor*).

PROC. ENTOMOL. SOC. WASH.
84(2), 1982, pp. 415–420

SOCIETY MEETINGS

880th Regular Meeting—October 1, 1981

The 880th Regular Meeting of the Entomological Society of Washington was called to order by President Jack E. Lipes at 8:00 PM, October 1, 1981, in the Naturalist Center, National Museum of Natural History. Twenty-one members and two guests attended.

Minutes of both the 878th and 879th meetings were read and approved.

Membership Chairman Joyce Utmar read the names of fifteen new members:

Nancy J. Agafitei, St. Charles, Illinois.
Wesley Bicha, Logansport, Indiana.
D. Christopher Darling, Department of Entomology, Cornell University, Ithaca, New York.
Andrew G. Gerberich, Arlington, Virginia.
Lester Paul Gibson, Plain City, Ohio.
Roger H. Grothaus, Columbia, Maryland.
Akey C. F. Hung, Insect Identification and Beneficial Insect Introduction Institute, USDA, Beltsville, Maryland
Adriean J. Mayor, Riverside, California.
Gary L. Miller, Department of Entomology and Plant Pathology, University of Tennessee, Knoxville, Tennessee.
D. Muraleedharan, Department of Zoology, University of Kerala, Kerala, India.
Terry Prewitt Nuhn, Arlington, Virginia.
Jim Pakaluk, Department of Entomology, Cornell University, Ithaca, New York.
Sharon Rose, Department of Biology, Montana State University, Bozeman, Montana.
Akihiko Shinohara, College of Agriculture, University of Osaka Prefecture, Sakai, Osaka, Japan.
M. A. Tidwell, Department of Entomology, The Citadel, Charleston, South Carolina.

President Elect Margaret Collins announced that there was an omission of acknowledgment of the contribution of the consulting company of Mr. John W. Kennedy on the program of the annual banquet, and she stated that a letter of apology for the oversight had been sent to him. President Lipes announced the formation of an Auditing Committee and a Nominating Committee to propose names as candidates for Society officers for 1982.

The speaker for the evening was Dr. Jeffrey Aldrich of the Insect Physiology Laboratory, USDA, in Beltsville, who presented a talk with slides, entitled "Chemical Ecology of the Hemiptera: Exocrinology and Endocrinology." His talk discussed the phylogeny of the Hemiptera in the light of the chemical structures of allomones and pheromones and described some of the research being conducted to evaluate the behavioral roles of these chemicals.

Notes and Exhibitions

Editor David R. Smith displayed the latest issue of the Society's *Memoir* series, *Flower Flies of the West Indies* by F. Christian Thompson.

President Lipes passed around correspondence of historical interest to the Society, consisting of letters between the Department of Entomology, The University of Connecticut, and Dr. E. A. Back regarding the Back Collection.

Special acknowledgment was given to Dr. Curtis Sabrosky, recently retired from the Systematic Entomology Laboratory, USDA, as recipient of the L. O. Howard Award at the Eastern Branch meetings of the Entomological Society of America.

President Lipes reported on the deaths of Dr. Bennet Porter, 89, former head of the Bureau of Entomology and Plant Quarantine at Beltsville, and Dr. Lowd E. Goodhue, inventor of the insecticide aerosol.

The meeting was adjourned at 9:25 PM for cookies and cider prepared by Mrs. Helen Sollers-Riedel.

David A. Nickle, *Recording Secretary*

881st Regular Meeting—November 5, 1981

The 881st Regular Meeting of the Entomological Society of Washington was called to order by President Jack E. Lipes at 8:00 PM on November 5, 1981 in the Naturalist Center of the National Museum of Natural History. Thirty-three members and seven guests attended.

Minutes of the previous meeting were read and approved.

Membership Chairman Joyce Utmar read the names of three new members:

William C. Scharf, Northwestern Michigan College, Division of Science and Mathematics, Traverse City, Michigan.
Kenneth W. Stewart, Department of Biological Sciences, North Texas State University, Denton, Texas.
Robert Wharton, Department of Entomology, Texas A&M University, College Station, Texas.

President Lipes announced the nominations of the following individuals for officers of the coming year. These names were submitted for consideration by the Nominating Committee, consisting of Drs. Raymond Gagné, Neal Morgan, and Ivan Rainwater.

President-elect, Dr. Manya B. Stoetzel
Recording Secretary, Dr. Thomas E. Wallenmaier
Corresponding Secretary, Dr. Ralph E. Harbach
Treasurer, Dr. F. Christian Thompson
Editor, Dr. David R. Smith
Membership Chairman, Ms. Joyce A. Utmar
Program Chairman, Dr. Jay C. Shaffer
Custodian, Dr. John F. Carroll
Hospitality Chairman, Mrs. Helen Sollers-Riedel

President Lipes opened the floor for other names to be submitted, but no entries were made.

The speaker for the evening was Dr. Ron Goor, National Heart, Lung and Blood Institute, NIH, who presented a colorful slide talk entitled "Shooting Insects in the Wild." The talk focused on insect photography, and suggestions were presented for successful close-up photographs and slides of insects.

NOTES AND EXHIBITIONS

Editor David R. Smith passed around the Entomological Society of Washington *Memoir* No. 9, *Flower Flies of the West Indies*, by F. Christian Thompson. He also described his trip to Allen Press, Inc., Lawrence, Kansas, to attend an editor's workshop presented by Allen Press, the printer of the Society's publications.

Mr. Ed Saugstad presented a book published in 1851, *Episodes of Insect Life by Acheta domestica,* M. E. S., dedicated to William Kirby, William Spence, and Edward Forbes. It consists of essays on the habits and life cycles of common insects.

Dr. J. H. Fales passed around the program by Sigma Xi of Towson State University of the Symposium of Threatened and Endangered Plants and Animals of Maryland.

Dr. Dee Wilder showed slides of dolichopodid flies collected in California. She was especially interested in a fly, *Tachytrechus flabellifer* Osten Sacken, in which males have a conspicuous silvery band extending from an elongated clypeus across the thorax. Females lack this band, and it is presumed to attract females as part of a pair formation strategy.

Dr. Manya Stoetzel showed slides of northern Arizona and the retired Systematic Entomology Laboratory staff members Dr. Barney Burks and Mrs. Kellie O'Neill Burks.

Dr. Ashley B. Gurney mentioned that Dr. Frederick Poos celebrated his 90th birthday and that Mr. Oscar Cartwright was in the hospital with heart problems.

Visitors were introduced, and the meeting was adjourned at 9:35 PM for refreshments.

David A. Nickle, *Recording Secretary*

882nd Regular Meeting—December 10, 1981

The 882nd Regular Meeting of the Entomological Society of Washington was called to order by President Jack E. Lipes at 8:00 PM on December 10, 1981 in the Naturalist Center, National Museum of Natural History. Thirty-four members and 11 guests attended.

Minutes of the previous meeting were read and approved.

Membership Chairman Joyce Utmar read the names of the following new members:

Božidar Ćurčić, Institute of Zoology, Faculty of Science, Studentski trg 16, 11000 Beograd, Yugoslavia.

Steve Marshall, Department of Environmental Biology, University of Guelph, Guelph, Ontario.

John, W. Neal, Jr., USDA, Beltsville Agricultural Research Center, Beltsville, Maryland.

Paul P. Shubeck, Department of Biology, Montclair State College, Upper Montclair, New Jersey.

Donald W. Webb, Illinois Natural History Survey, 607 E. Peabody, Champaign, Illinois.

Corresponding Secretary Mignon Davis reported that the current membership of the Society was 532 with subscriptions totalling 330.

A motion by Dr. Raymond Gagné to vote *in toto* for the nominees for offices in 1982 was passed. The attending members voted unanimously in favor of electing all nominees.

Treasurer F. C. Thompson presented a report of the financial condition of the Society. He pointed out that although the assets as of October 31, 1981 were $17,515.67 (General Fund) and $30,845.68 (Special Publications Fund), both Funds are down from last year. He recommended a membership dues increase of $5.00 (from $8 to $13) and a change in Article 4, Section 1 of the Constitution to read "thirteen" instead of "eight."

Editor Smith reported that 104 articles totalling 824 pages had been published in the Proceedings in 1981, making this volume the largest in the Society's history.

The speakers for the evening were Drs. Lloyd Knutson and Robert D.

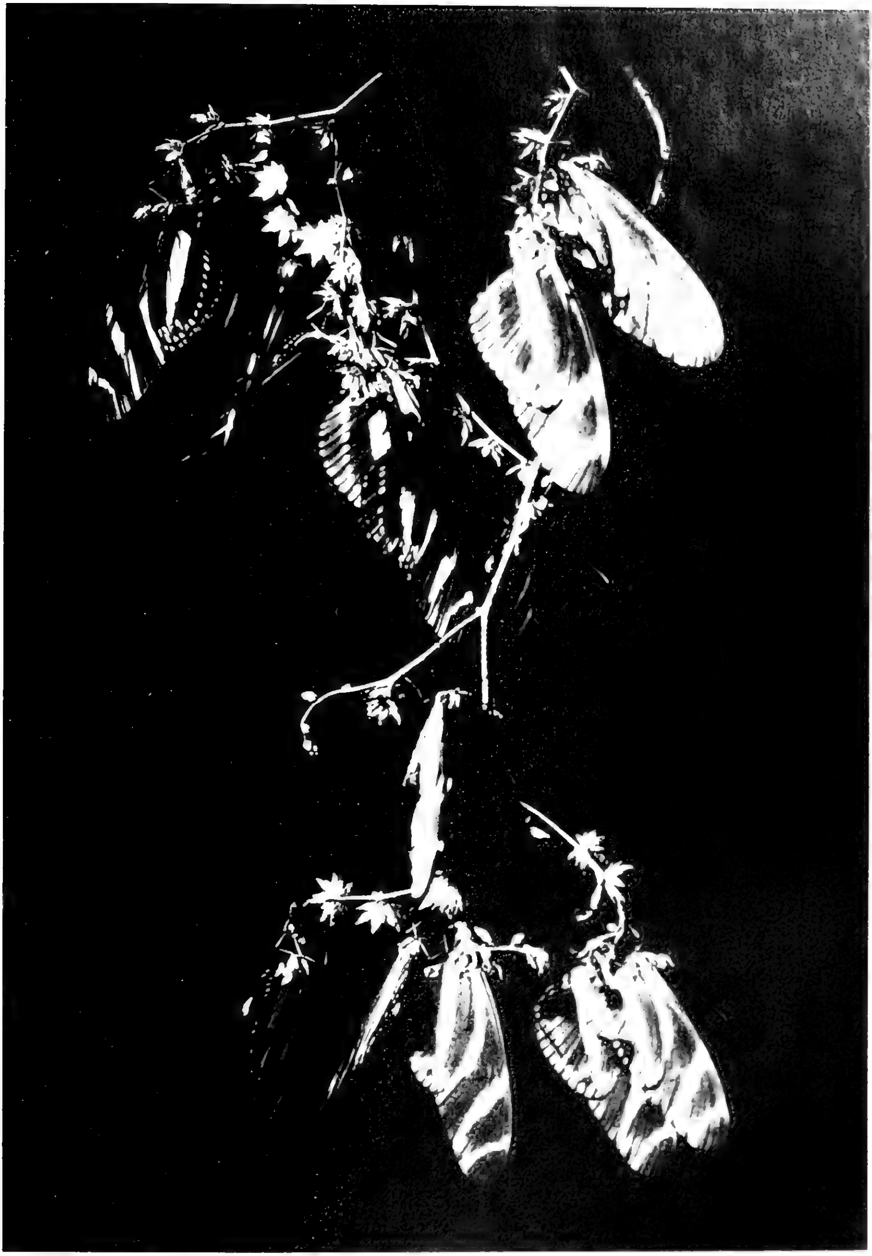

Fig. 1. Zebra butterfly, the correct resting position.

Gordon, IIBIII, USDA, who together presented a talk entitled, "Entomology in China—from Taxonomic and Biological Control Viewpoints with Comments on Opportunities for and Difficulties in Cooperation." Dr. Knutson outlined the recent history of the broadening cooperative research activities between the United States and the People's Republic of China in systematics and biological control. Dr. Gordon presented slides of the recent trip to China which he and Dr. Knutson had made to explore research potentials in China.

Notes and Exhibitions

Dr. Ed Barrows passed around a box of instant rice containing a dead specimen of the Southern Brown Cockroach, *Periplaneta brunnea* Burmeister, which had been packaged with the rice.

To inspire the spirit of Christmas through a presentation of the traditional colors of red and green, Dr. David Nickle displayed a living bright pink katydid, *Amblycorypha floridana* Rehn and Hebard, on a branch of American holly.

Mrs. Mignon Davis circulated the October issue of *The Naturalist* (formerly *The Trinidad Naturalist*) with a cover photograph of several specimens of *Heliconius charitonius simulator* Roeber. Commonly called the zebra butterfly, it is the only species with parallel black and white stripes. The same individuals return nightly to the same branch of certain trees for several weeks. Zebra butterflies do not rest standing upright but hang from the branch (Fig. 1). The cover photograph was printed upside down. Mrs. Davis discovered and assisted in photographing these butterflies just after dusk on a road in a Jamaican plantation near Runaway Bay.

Dr. Thompson showed volume 2 of *Myia, Charles Howard Curran,* a catalog of the entomological taxa of Curran and his bibliography. Later, Dr. Thompson announced the death of Dr. Charles P. Alexander, dipterist and author of more than 1000 papers, primarily on crane flies of the world. His announcement was accompanied by slides of Dr. Alexander at his home in Amherst, Massachusetts.

President Lipes presented letters of appreciation to officers M. Davis, S. Nakahara, and D. Nickle, and to Mrs. Helen Sollers-Riedel and Dr. Donald Anderson for their special services to the Society. He then read a letter he had written to the Selection Committee for Outstanding Scientists, ARPE, in support of the Award in Category 6 (Systematics and Morphology) for Dr. Richard H. Foote, Systematic Entomology Laboratory, USDA.

Visitors were introduced, and the meeting was adjourned at 9:35 PM for cookies and Holiday punch.

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 *Dermatophagoides*, 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 *Anastrepha* (Diptera: Tephritidae), by George C. Steyskal	1.50
Taxonomic Studies on Fruit Flies of the Genus *Urophora* (Diptera: Tephritidae), by George C. Steyskal	2.00

Memoirs of the Entomological Society of Washington

No. 1.	The North American Bees of the Genus *Osmia*, by Grace Sandhouse. 1939	$15.00
No. 2.	A Classification of Larvae and Adults of the Genus *Phyllophaga*, by Adam G. Boving. 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 Hirosi Takahasi. 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 *Palpomyia* Meigen (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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of the
ENTOMOLOGICAL SOCIETY of WASHINGTON

1884

DEPARTMENT OF ENTOMOLOGY
SMITHSONIAN INSTITUTION
WASHINGTON, D.C. 20560

PUBLISHED QUARTERLY

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THE
ENTOMOLOGICAL SOCIETY
OF WASHINGTON

ORGANIZED MARCH 12, 1884

All correspondence concerning Society business should be mailed to the appropriate officer at the following address: Entomological Society of Washington, ℅ Department of Entomology, Smithsonian Institution, Washington, D.C. 20560.

MEETINGS.—Regular meetings of the Society are held in the Ecology Theater, Natural History Building, Smithsonian Institution, on the first Thursday of each month from October to June, inclusive, at 8 P.M. Minutes of meetings are published regularly in the *Proceedings*.

MEMBERSHIP.—Members shall be persons who have demonstrated interest in the science of entomology. Annual dues for members are $10.00 (U.S. currency) of which $9.00 is for a subscription to the Proceedings of the Entomological Society of Washington for one year.

PROCEEDINGS.—Published quarterly beginning with January by the Society at Washington, D.C. Members in good standing receive the Proceedings of the Entomological Society of Washington. Nonmember subscriptions are $18.00 per year, domestic, and $20.00 per year, foreign (U.S. currency), payable in advance. All remittances should be made payable to *The Entomological Society of Washington*.

The Society does not exchange its publications for those of other societies.

Please see p. 183 of the January 1981 issue regarding preparation of manuscripts.

STATEMENT OF OWNERSHIP

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DESCRIPTION OF A NEW SPECIES OF *NOCTICANACE* MALLOCH (DIPTERA: CANACIDAE) FROM SRI LANKA WITH NOTES ON TWO RELATED SPECIES

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Abstract.—*Nocticanace* ***taprobane*** from Sri Lanka is described and compared with two closely related species, *N. mahensis* (Lamb) and *N. sinensis* Delfinado. Appropriate illustrations are provided.

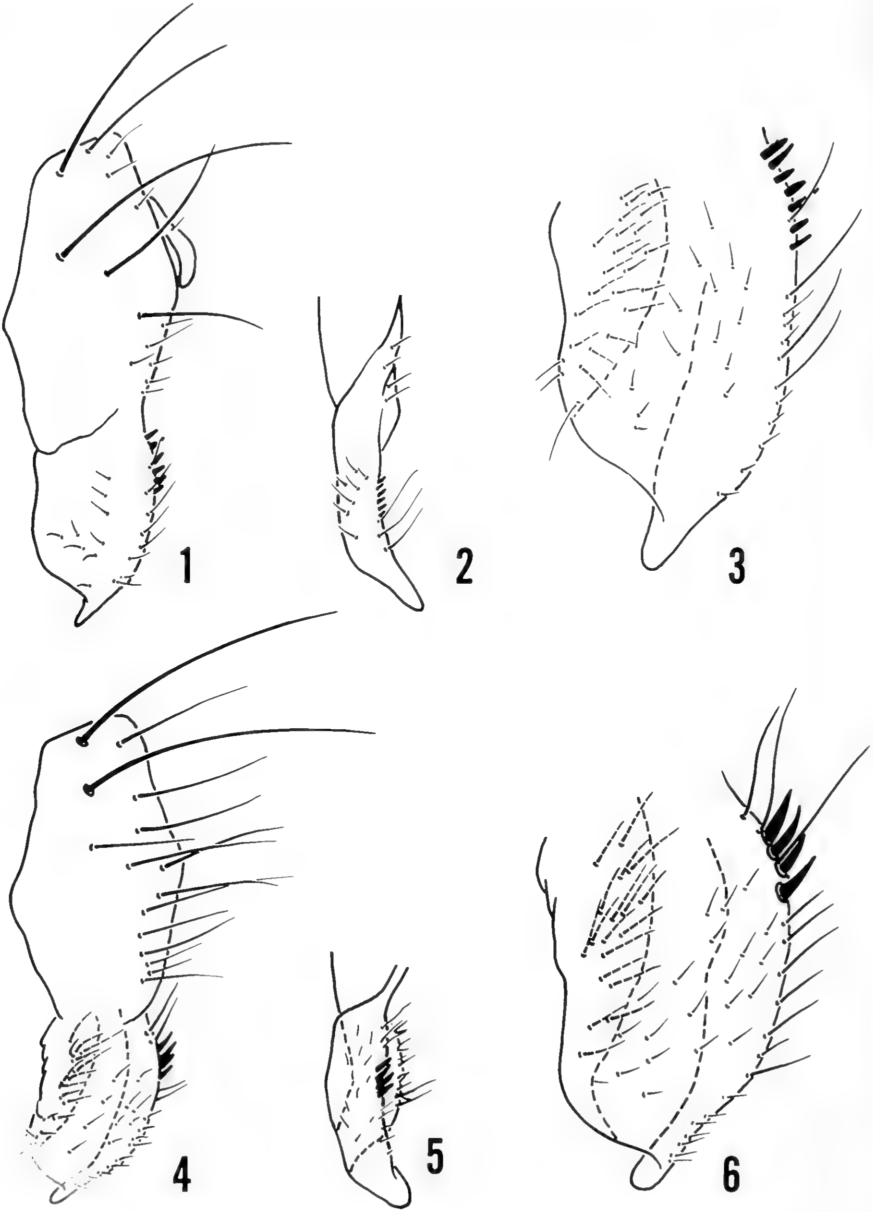
Based on specimens collected by the Lund University Ceylon Expedition in 1962, Delfinado (1975) reviewed the beach fly fauna of Sri Lanka (Ceylon). Delfinado described two new species, each in a separate genus, *Chaetocanace brincki* and *Xanthocanace zelanica*, and included notes on a third genus and species, *Procanace grisescens* Hendel. During a collecting trip to Sri Lanka in 1980, I collected specimens of a fourth genus, *Nocticanace* Malloch, all of which are apparently conspecific and represent a new species. This species is described herein. Notes and illustrations of two closely related species, *N. mahensis* (Lamb) and *N. sinensis* Delfinado, are included for comparative purposes.

Nocticanace taprobane Mathis, New Species

Figs. 1–3

Diagnostic description.—This species belongs to a species-group of *Nocticanace* which lacks an anterior notopleural bristle and has the apical scutellar bristles anaclinate. Within that group, it is distinguished from related congeners, particularly *N. mahensis* and *N. sinensis*, by the following characters, mostly from the male terminalia: Small to moderately small beach flies, length 1.65 to 2.31 mm.

Male terminalia (Figs. 1–3) as follows: Surstylus a single, ventrally projected lobe, moderately wide, tapered abruptly ventrally to form a moderately long, slender, ventral process, posterior margin with approximately 6 short, stout setae.



Figs. 1–3. *Nocticanace taprobane*. 1, External male terminalia, lateral view. 2, Surstylus, posterior view. 3, Surstylus, lateral view. Figs. 4–6. *N. mahensis*. 4, External male terminalia, lateral view. 5, Surstylus, posterior view. 6, Surstylus, lateral view.

Type-material.—Holotype ♂ is labeled "SRI LANKA: Gal[le]. Dist[rict]. Mirigama 26 April 1980/Collectors: W. N. Mathis[,] T. Wijesinhe[,] L. Jayawickrema." Allotype and 28 paratypes (11 ♂, 17 ♀; USNM) bear the same label data as the holotype. Other paratypes are as follows: SRI LANKA. Trincomalee District: Nilaveli (5 km N) 3 May 1980, W. N. Mathis, T. Wijesinhe, L. Jayawickrema (2 ♂, 1 ♀; USNM). Hambamtota District: Kirinda, 25 Apr 1980, W. N. Mathis, T. Wijesinhe, L. Jayawickrema (9 ♂, 18 ♀; USNM). The holotype is double mounted (minute nadel in plastic block), is in excellent condition, and is in the Smithsonian Institution, Washington, D.C., USNM 100224.

Remarks.—This species and *N. mahensis* are very closely related, as evidenced by the similar conformation of the male terminalia of both species, and I can distinguish between them by the shape of the apical process of the surstylus, which is more slender, and by the number and size of the stout setae along the posterior margin of the surstylus.

The specific epithet, *taprobane*, is the classical Greek name for Sri Lanka and is a noun in apposition.

Nocticanace mahensis (Lamb)

Figs. 4–6

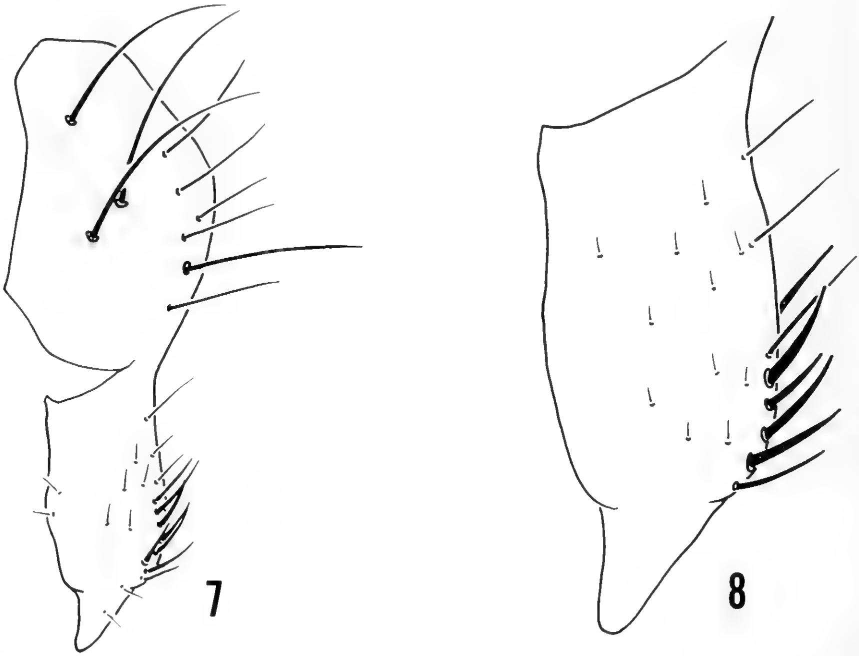
Canace mahensis Lamb, 1912: 328.
Nocticanace mahensis: Wirth, 1951: 274.

Type-material.—Holotype ♀ is labeled "Type H. T. [disc with red border]/Seychelles Is[land]. Prof. J. S. Gardiner. 1914-537/Seaweed [handwritten in pencil]/TYPE Canace mahensis. Lamb _ [??, I cannot decipher what is written after "Lamb"; "TYPE" black on blue, printed; otherwise label black on white, handwritten]." The holotype is double mounted (minute nadel in cork block; block has "107" handwritten on top), is in good condition, and is in the British Museum (Natural History), London.

Remarks.—The illustrations of the male terminalia are from a topotypical specimen that was compared with the female holotype.

This species is apparently closely related to *N. sinensis* and *N. taprobane*, as evidenced by the similar shape of the surstylus in all three species. When viewed from slightly different angles, their surstyli can be positioned to appear to be virtually identical. From a direct lateral view, however, there are consistent differences, and I can only conclude that three species are represented. Externally all three species are inseparable.

Male terminalia (Figs. 4–6) are as follows: Surstylus generally comparatively wide, narrowed abruptly ventrally to form rather narrow, short ventral process; ventral process moderately tapered, especially in posterior view; posterior margin with 3–5 short, stout setae on dorsal half of surstylus.



Figs. 7, 8. *Nocticanace sinensis*. 7, External male terminalia, lateral view. 8, Surstylus, lateral view.

Nocticanace sinensis **Delfinado**
Figs. 7, 8

Nocticanace sinensis Delfinado, 1971: 120.

Type-material.—Holotype ♀ is labeled "HONG KONG: N. T. Sai Kung Station 27. I. 1965/W. J. Voss & Hui Wai Ming Light Trap BISHOP MUS./♀ [handwritten in pencil]/HOLOTYPE ♀ Nocticanace sinensis Md. [Mercedes Delfinado; handwritten, black on pink]." The holotype is double mounted (glued to a paper point), is in poor condition (the body is covered with lepidopteran scales, several legs and setae are missing), and the abdomen has been removed (the terminalia and other structures of the abdomen are slide mounted). The holotype is deposited in the B. P. Bishop Museum, Honolulu, Hawaii.

Remarks.—This species is evidently closely allied to *N. mahensis*, as the shape of the surstylus of both species is very similar, although consistently differs (Figs. 7, 8) as follows: Surstylus generally more slender; ventral projection long, somewhat triangular, with distinct taper; posterior margin with several long stout setae, especially on ventral half.

ACKNOWLEDGMENTS

I thank Brian H. Cogan, British Museum (Natural History), and Neil Evenhuis, B. P. Bishop Museum, for permitting me to examine the holotypes of *N. mahensis* and *N. sinensis*, respectively. I am also grateful to Willis W. Wirth, Systematic Entomology Laboratory, USDA, for reviewing a draft of the manuscript, to S. Dillon Ripley, Secretary of the Smithsonian Institution, for support to conduct fieldwork through a Fluid Research Grant, and to Karl V. Krombein, Department of Entomology, Smithsonian Institution, for encouraging my work on the dipteran fauna of Sri Lanka and for making arrangements for my fieldwork in Sri Lanka.

LITERATURE CITED

Delfinado, M. D. 1971. New species of shore flies from Hong Kong and Taiwan (Diptera: Canaceidae). Orient. Insects 5(1): 117–124.

———. 1975. Diptera: Canaceidae from Ceylon. Pp. 221–223. *In* Reports from the Lund University Ceylon Expedition in 1962, Vol. II. Entomol. Scand. Suppl. 4.

Lamb, C. G. 1912. The Percy Sladen Trust Expedition to the Indian Ocean in 1905, under the Leadership of Mr. J. Stanley Gardiner, M. A. Vol. IV. No. XIX. Diptera: Lonchaeidae, Sapromyzidae, Ephydridae, Chloropidae, Agromyzidae. Trans. Linn. Soc. Lond. (2) 15: 303–3458.

Wirth, W. W. 1951. A revision of the Dipterous Family Canaceidae. Occas. Pap. Bernice Pauahi Bishop Mus. 20(14): 245–275.

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TETRASTICHUS CECIDOBROTER (HYMENOPTERA: EULOPHIDAE), A NEW PHYTOPHAGOUS SPECIES DEVELOPING WITHIN THE GALLS OF *ASPHONDYLIA* (DIPTERA: CECIDOMYIIDAE) ON *ATRIPLEX* (CHENOPODIACEAE) IN SOUTHERN CALIFORNIA

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Abstract.—Tetrastichus **cecidobroter,** new species, is described and illustrated. Its larvae are phytophagous gall-formers within cecidomyiid galls in *Atriplex* spp. in the southwestern United States. This species is the third phytophagous *Tetrastichus* known.

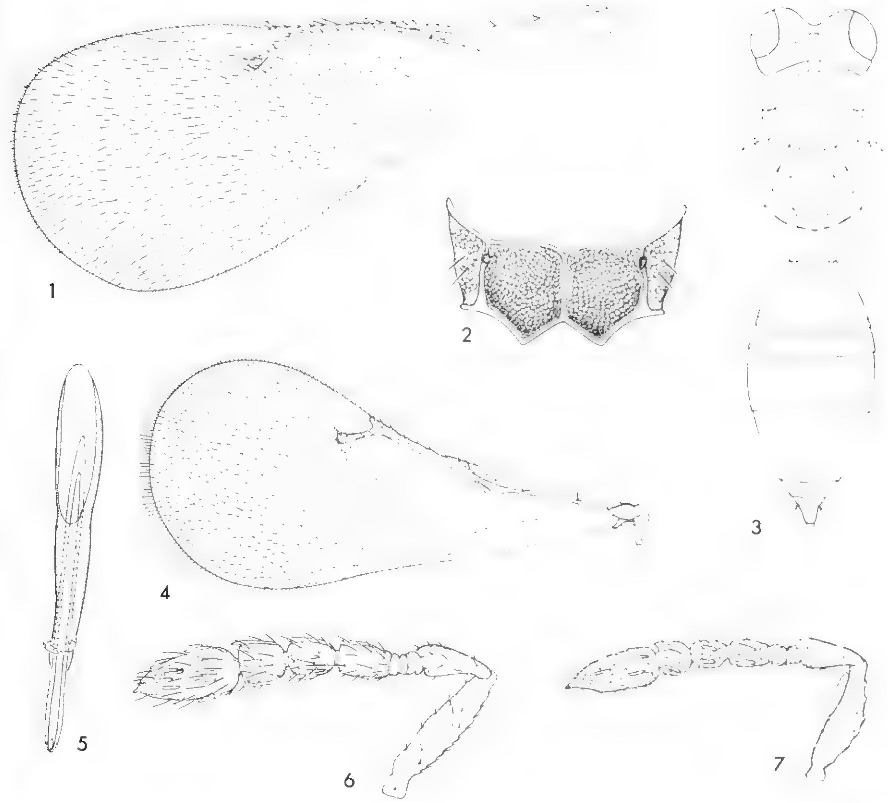
Ecological studies by one of us (BAH) on the gall fauna of *Atriplex* spp. in southern California have revealed an undescribed species of *Tetrastichus* which develops on modified plant tissue in galls caused by species of the *Asphondylia atriplicis* Cockerell complex. The novel biology of this wasp will be presented elsewhere. The purpose of this paper is to make a name available for this species. Descriptive terminology is principally after Graham (1961).

Tetrastichus cecidobroter Gordh and Hawkins, NEW SPECIES

Figs. 1–7

Female.—Holotype 2.7 mm long; body black with very faint and limited bluish tinge in certain plays of light; antennal scape and pedicel tan, flagellum dusky; coxae black, femora similarly dark colored except apices pale; tibiae dusky mesad, basal and distal portions tan; pretarsi dusky, tarsomeres I–III nearly white; wings hyaline with bluish tinge in certain plays of light.

Head: Slightly wider than mesosoma, in dorsal aspect with weak irregular, transverse reticulate sculpture and scattered pale setae; frontovertex about 0.5× as wide as head; ocelli forming a strongly obtuse triangle surrounded by a superficial line of weakness. Head in dorsal aspect with scrobal impression broad and shallow, medially with 2 superficial lines of weakness diverging dorsad and terminating near median ocellus; paraocular area slightly more pubescent than vertex; toruli just dorsad of imaginary trans-



Figs. 1–7. *Tetrastichus cecidobroter*. 1, Female forewing. 2, Female propodeum. 3, Female habitus, dorsal aspect. 4, Male forewing. 5, Male genitalia. 6, Female antenna. 7, Male antenna.

verse line projecting between ventral margins of compound eyes; ventral margin of clypeus without tooth-like projections; area between ventral margin of clypeus and toruli moderately setose. Malar space about 0.7× as long as compound eye; malar sulcus well defined, complete. Antenna as illustrated (Fig. 6).

Mesosoma: Rather robust (Fig. 3); pronotum with posterior margin strongly arched, anterior face weakly striate or transversely reticulate, lateral face more boldly reticulate; posterior margin with a line of inconspicuous setae, lateral face with several pale setae. Middle lobe of mesoscutum boldly reticulate, without median line, with 5–8 inconspicuous adnotaular setae forming an irregular line (forming 2 irregular lines when 8 setae are present); lateral lobe of mesoscutum with sculpture less distinct (weakly, irregularly reticulate), and setal number 3–6. Scutellum weakly and minutely longitudinally reticulate, with 2 inconspicuous setae laterad of each submedian longitudinal line, the cephalad setae just anterior of imaginary transverse line bisecting scutellum. Dorsellum minutely and weakly reticulate. Prepectus and mesepisternum boldly reticulate; anterior 0.6 of mesepimeron smooth and polished, posterior 0.4 boldly reticulate. Propodeum (Fig. 2) reticulate (usually boldly), with complete median carina and postspiracular carina; callus with 2 rather long, pale setae, sculpture less conspicuous. Hindcoxa boldly reticulate. Forewing as illustrated (Fig. 1), submarginal vein with 2 widely separated dorsal setae. Apex of hindwing not acute.

Metasoma: Conic-ovate, 1.6× as long as mesosoma; Tergum I smooth-polished, with 2 setae laterad; T II mostly concealed, but similarly smooth-polished and with 2 setae laterad; T III finely reticulate and with several setae laterad; T IV–VI finely reticulate and densely setose; epipygium densely setose; ovipositor and gonostyli slightly exserted.

Male.—Similar to female in habitus, coloration, sculpture, and chaetotaxy. Differing in smaller size, antennal segmentation and shape (Fig. 7), wing shape (Fig. 4), and genitalia (Fig. 5). Also more variation in coloration of tibiae (frequently very faintly dusky, nearly tan), and a third seta may be on the propodeal callus.

Material examined.—Holotype: ♀, California, Riverside Co., Palm Desert; 4/XI/1979; ex stem gall on *Atriplex canescens*; B. A. Hawkins, Collector. Paratypes: Palm Desert, 6 ♀, 3 ♂, 10/II/1979; 1 ♀, 3/III/1979; 4 ♀, 2 ♂, 22/VII/1979; 8 ♀, 5 ♂, 29/VII/1979; 1 ♀, 12/VIII/1979; 5 ♀, 2 ♂, 4/XI/1979. California, Riverside Co., nr. Valle Vista, 1 ♀, 11/V/1980; 15 ♀, 8 ♂, 15/VII/1979; 3 ♀, 2 ♂, 23/VII/1979; 4 ♂, 13/VIII/1979; 2 ♀, 20/VIII/1979; 2 ♀, 2 ♂, 27/VIII/1979; 1 ♀, 21/X/1979. California, Riverside Co., nr. Thermal, 3 ♀, 11/V/1980. All material collected and reared from cecidomyiid galls on *Atriplex canescens* by B. A. Hawkins.

Holotype, 5 ♀ and 4 ♂ paratypes deposited in the National Museum of Natural History, Smithsonian Institution, Washington, D.C. Remaining paratypes deposited in the Division of Biological Control, University of California, Riverside.

Etymology.—Cecido (Greek = gall), broter (Greek = eater).

Discussion.—In the most recent revision of the Nearctic *Tetrastichus* (Burks, 1943), *T. cecidobroter* runs to *T. cormus* Burks. The new species differs from *T. cormus* in that the head and thorax are not minutely shagreened, the toruli are located higher on the head, the submarginal vein bears only two dorsal setae, part of the thoracic pleuron is polished, and the propodeum lacks short anterolateral carinae. Burks (1963) subsequently described ten additional species of *Tetrastichus* from material taken in North America. *Tetrastichus cecidobroter* displays no affinity with any of these species.

Phytophagy has apparently evolved several times in the Chalcidoidea (see Gahan, 1922), but it is relatively uncommon in the Eulophidae. Only two species of *Tetrastichus* other than *T. cecidobroter* are known to be phytophagous. Ishii (1931) described *T. ardisiae* from material taken on *Ardisia japonica* (Thunb.) (Myrsinaceae) and reported that the portion of the shoot in which *T. ardisiae* developed "swells to some extent." Both *T. ardisiae* and *T. cecidobroter* are similar in having four ring segments in the female antenna. They differ in that the median ocellus of *T. cecidobroter* is not within the scrobal impression, the ventral margin of the clypeus is not toothed, the mesoscutum lacks a median groove, and the submarginal vein does not bear seven dorsal setae.

A more convincing case of phytophagy in *Tetrastichus* has been discussed by Teitelbaum and Black (1957) who report that a species "near *venustus*" develops on sweet clover (*Melilotus alba* Desc. and *M. officinalis* (L.) Lam.). This species has remained undescribed. Burks regarded it as morphologically indistinguishable from *T. venustus* Gahan, although the phytophagous form is thelytokous. Nikolskaya (1933) regarded *venustus* as a junior synonym of the well-known European species *T. brevicornis* (Panzer), but this synonymy has not been accepted in more recent catalogs (Domenichini, 1966; Burks, 1979).

LITERATURE CITED

Burks, B. D. 1943. The North American parasitic wasps of the genus *Tetrastichus*—A contribution to biological control of insect pests. Proc. U.S. Natl. Mus. 93: 505–608.

———. 1963. Ten new reared species of *Tetrastichus* (Hymenoptera, Eulophidae). Proc. Biol. Soc. Wash. 76: 47–58.

———. 1979. Family Eulophidae. Pp. 967–1022. *In* Krombein, K.V. et al., Catalog of Hymenoptera in America North of Mexico, Vol. 1. Smithsonian Institution Press, Washington, D.C.

Domenichini, G. 1966. Index of Palearctic Tetrastichinae. Le Francois, Paris, 101 pp.

Gahan, A. B. 1922. A list of phytophagous Chalcidoidea with descriptions of two new species. Proc. Entomol. Soc. Wash. 24: 33–58.

Graham, M. W. R. de V. 1961. A new species of *Tetrastichus* Walker (Hymenoptera: Eulophidae) from Britain. Entomol. Gaz. 25: 106–110.

Ishii, T. 1931. Notes on the phytophagous habit of some chalcidoids, with descriptions of two new species. Kontyû 5: 132–138.

Nikolskaya, M. N. 1933. A new species of seed-infesting chalcid-fly, *Eurytoma onobrychidis*, sp. n. (Chalcididae) on *Onobrychis sativa*, and its parasites. [In Russian.] Rev. Entomol. URSS 25: 119–133.

Teitelbaum, S. S. and L. M. Black. 1957. The effect of a phytophagous species of *Tetrastichus*, new to the United Staes, on sweet clover infected with tumor-wound virus. Phytopathology 44: 548–550.

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84(3), 1982, pp. 430–439

ABUNDANCE AND DISTRIBUTION OF THE SEVENTEEN-YEAR PERIODICAL CICADA, *MAGICICADA SEPTENDECIM* (LINNAEUS) (HEMIPTERA: CICADIDAE—BROOD II), IN CONNECTICUT

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Abstract.—Mean density of *Magicicada septendecim* (Linnaeus), based on number of emergence holes, ranged from 2.3 to 14.3 cicadas/m² under apple trees and from 2.2 to 8.0 cicadas/m² under forest trees at three sites. Density along transects through these sites showed a slight or large buildup near the orchard and forest margin at two sites. Emergence holes occurred at 70/72 (97.2%) of sampling stations despite variation in forest characteristics. Connecticut populations of *M. septendecim* in Brood II occurred only in the central part of the state. Examination of 75 sites known to have had cicada populations in 1945 indicated that four (5.3%) of the populations disappeared due to human disturbance.

Early surveys conducted by Riley (1885) and Marlatt (1907) indicated that Brood II and XI of the 17-year periodical cicada, *Magicicada septendecim* (Linnaeus), occurred in Connecticut. Brood XI last emerged in 1954 and is now apparently extinct (Manter, 1974). By contrast, adults of Brood II appeared at many sites in central Connecticut during their scheduled emergence in 1962 (Leonard, 1964). These adults successfully reproduced as Maier (1980) found nymphs in several Connecticut apple orchards and forests in 1978–9.

Marlatt (1907) reported Brood II in five of eight Connecticut counties, but Britton (1911) found it in only three counties. Accuracy of these surveys is unknown because both authors relied heavily upon observations of others and deposited few specimens in collections. The more detailed study of Britton (1911) showed that *M. septendecim* was largely restricted to the Connecticut Valley in central Connecticut. Britton (1911) made casual observations on density but provided no quantitative data.

This study was conducted (1) to determine density of cicadas in selected apple orchards and forests in Connecticut, (2) to characterize forests inhabited by cicadas, (3) to provide detailed distributional records, and (4) to report the fate of 75 populations recorded in 1945. Hopefully, this paper will furnish basic data necessary for future comparative studies.

MATERIALS AND METHODS

Density at Guilford, Middlefield, and Southington, Connecticut was measured in mid-July by counting nymphal emergence holes at sampling points along two parallel, east-west transects/site that were separated by 100 m. Each transect extended from the center of an apple orchard to approximately the center of an adjacent forest. Samples were taken at approximately 10 m intervals in orchards and forests for a distance of 110 m into each habitat. No sampling was done in the 25 m wide treeless and shrubless zone that separated orchard and forest. At each sampling point (=each apple tree in a row), two 1 m^2 quadrats located 0.25 m to each side of the transect were inspected for holes (n = 48 quadrats/transect, 24 in each habitat). To characterize the forest, all trees (≥7.5 cm in diameter) within 5 m of each sampling point were identified, their diameter at a height of 1.3 m was measured, and total basal area of each species was calculated.

When density/hectare (ha) was estimated, all area under the continuous forest canopy was assumed to have been inhabited by nymphs. In the orchard only soil under the canopy of apple trees was considered to have been occupied as few or no nymphs emerged between trees. Thus, estimates of number/ha in orchards were calculated using mean number/m^2 (given in Table 1) for the area under the canopies and 0 for the area outside the canopies.

Distribution of *M. septendecim* in Brood II was determined by collecting adults, nymphs, or nymphal exuviae or by hearing adult singing and finding exuviae. Although inspections were made in every county in Connecticut, they were concentrated in the Connecticut Valley where *M. septendecim* in Brood II was previously reported (Maier, 1980, and references therein). In addition, all reports of cicada activity filed by fruit growers (i.e. positive responses to questionnaires), newspersons, and other citizens in 1979 were investigated; and most sites known to have had cicadas in 1945 (unpublished data) were examined. Specimens collected in the survey were deposited in the insect collection housed in the Department of Entomology at the Connecticut Agricultural Experiment Station, New Haven.

RESULTS AND DISCUSSION

ABUNDANCE AND DISTRIBUTION

Although density in sampled areas was higher in the orchard than in the forest at Guilford and Southington, the estimated density/ha was higher in forests at all three sites (Table 1). Forsythe (1976) and Maier (1980) found

Table 1. Density of *Magicicada septendecim* (Brood II) in apple orchards and adjacent forests in Connecticut during 1979.

	Orchard[a]			Forest		
Sampling Site	Mean Number/m² (n = 48)	Range	Estimated Number/ha[b]	Mean Number/m² (n = 48)	Range	Estimated Number/ha[b]
Guilford	5.0	0–16	14,746	2.2	0–11	22,000
Middlefield	2.3	0–9	8,335	6.1	0–41	61,000
Southington	14.3	3–57	57,367	8.0	0–31	80,000

[a] Variety, age, canopy diameter, and spacing were as follows: Guilford—McIntosh and Red Delicious, 45 years, 6.2 m, 10.7 × 12.2 m; Middlefield—Stayman, 35 years, 7.0 m, 9.8 × 8.5 m; Southington—Baldwin, 45 years, 7.0 m, 9.8 × 9.8 m.

[b] See Materials and Methods for explanation of calculations.

a similar pattern in overall abundance. Densities recorded in this and my previous study (Maier, 1980) were well below 386 nymphs/yd² (=462 nymphs/m²) reported by Leonard (1964) for one sample in a Connecticut orchard in 1962. Estimates of abundance at my study sites fell at the lower end of ranges reported for other *Magicicada* populations which consisted of one or more species (e.g. Dybas and Davis, 1962, and references therein; Forsythe, 1976).

The density profile along transects differed between sites (Fig. 1). No clear pattern existed at Guilford; however, at Middlefield and Southington density in the orchard, forest, or both tended to be higher near the edge. Density showed no consistent relationship with elevation which fluctuated less than 6 m along any one transect. Soil moisture, previous oviposition activity of females, and human disturbance (which was highest at Guilford and Middlefield) probably contributed in forming the density pattern. For example, at Middlefield density in the forest was low in wet or submerged soils which were located between 10 and 40 m along transect 1 and between 10 and 20 m along transect 2. A very distinct pattern, i.e. higher density near margins, emerged at Southington where disturbances other than insecticide applications between 1962 and 1978 were minimal.

Abundance pattern at Southington (Fig. 1) typifies that in many upland areas. Females apparently oviposit preferentially in many species of young or at least sunlit trees (Lloyd and White, 1976; White, 1980), which abound along the forest border at Southington and other locations. At Southington adults readily fly from forest to orchard or vice versa (Maier, 1982). Thus, high density along forest margins should influence the development of density profiles in adjacent apple orchards. Density in orchards and forests can be expected to decline as the distance from the edge of the forest increases.

Magicicada septendecim inhabited forests that usually resembled one another in species composition but varied in the structure of dominance

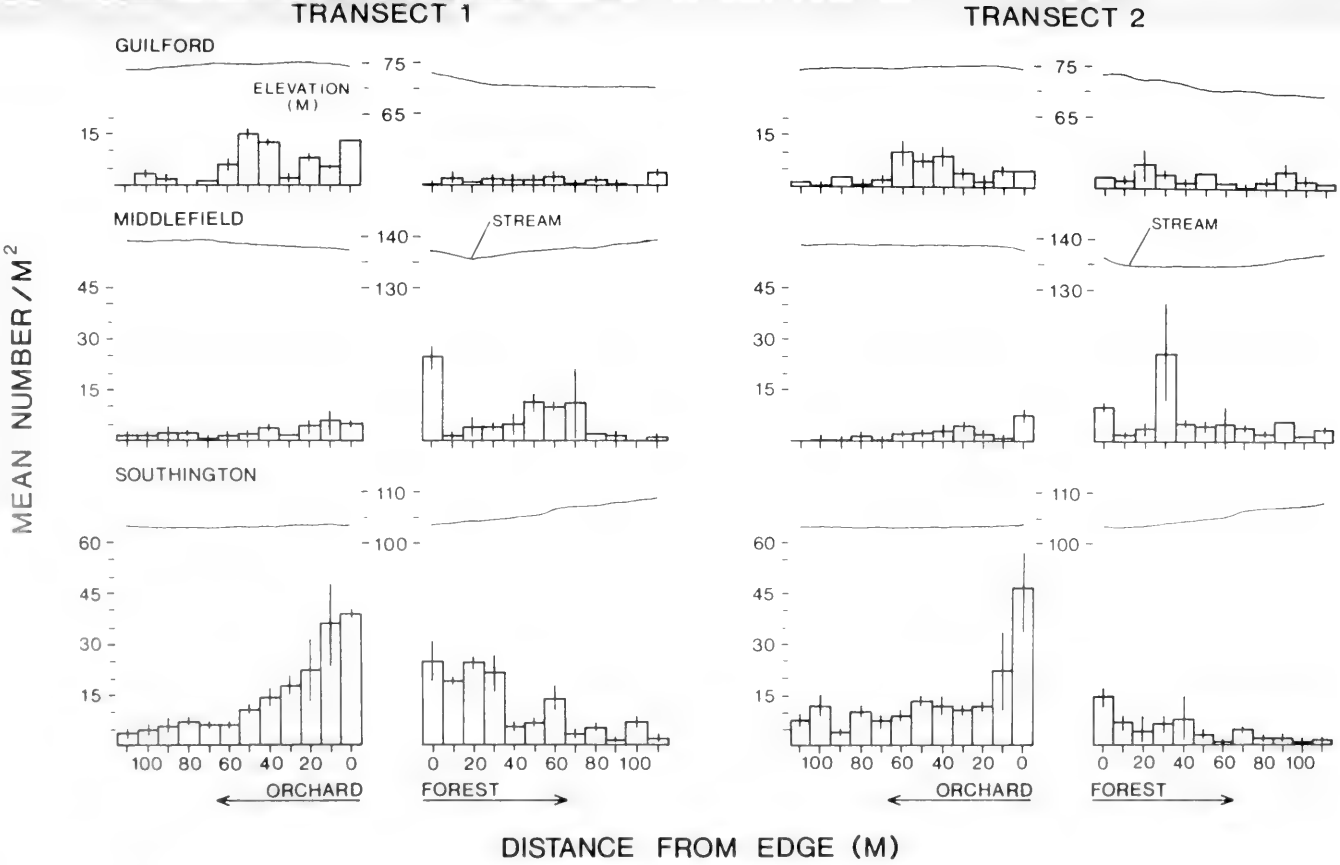

Fig. 1. Mean density of *Magicicada septendecim* emergence holes along two transects through each of three sites in central Connecticut. The two density measurements for variable paired samples are indicated by the end points of the vertical line drawn through the top of a hollow bar. Elevation above sea level is given at the top of each graph. Location of sites is indicated in Fig. 2.

Table 2. Characteristics of Connecticut forests inhabited by *Magicicada septendecim* (Brood II). Basal area is the cross-sectional area of trees in all sampling plots along one transect. Locations and transects are those in Fig. 1.

	Guilford—Transect 1			Guilford—Transect 2			Middlefield—Transect 1		
Tree Species	Number of Trees	% of Total Number of Trees	% of Total Basal Area (=33,330 cm²)	Number of Trees	% of Total Number of Trees	% of Total Basal Area (=37,363 cm²)	Number of Trees	% of Total Number of Trees	% of Total Basal Area (=24,667 cm²)
Acer rubrum L.	6	7.7	7.7	1	1.1	0.8	21	16.3	11.9
A. saccharum Marsh.	3	3.8	6.6	18	19.4	13.5	10	7.8	5.5
Betula alleghaniensis Britton							6	4.7	5.6
B. lenta L.	6	7.7	5.1	6	6.5	8.2	1	0.8	0.3
Carpinus caroliniana Walt.	4	5.1	0.9				1	0.8	0.2
Carya cordiformis (Wang.) K. Koch	1	1.3	0.5						
C. glabra (Mill.) Sweet	7	9.0	24.6	5	5.4	5.5	10	7.8	12.1
C. ovata (Mill.) K. Koch	6	7.7	16.5	2	2.2	2.2	3	2.3	1.8
C. tomentosa Nutt.				2	2.2	1.3			
Cornus florida L.	22	28.2	6.2	19	20.4	4.3	2	1.6	0.6
Fagus grandifolia Ehrh.				5	5.4	1.9	9	7.0	8.0
Fraxinus americana L.	10	12.8	11.0	2	2.2	2.1	17	13.2	13.3
Liriodendron tulipifera L.				12	12.9	31.5	1	0.8	1.7
Ostrya virginiana (Mill.) K. Koch	3	3.8	3.5	9	9.7	2.6	2	1.6	0.4
Prunus serotina Ehrh.							1	0.8	0.8
Quercus alba L.	2	2.6	3.7	7	7.5	19.4	5	3.9	4.6
Q. prinus L.									
Q. rubra L.							14	10.9	17.4
Q. velutina Lam.	3	3.8	7.5	2	2.2	5.1	7	5.4	3.5
Sassafras albidum (Nutt.) Nees							4	3.1	4.0
Tsuga canadensis (L.) Carr.	1	1.3	4.2	2	2.2	0.6	14	10.9	8.1
Ulmus americana L.	4	5.1	2.0	1	1.1	1.1	1	0.8	0.2
Total	78			93			129		

hierarchies (Table 2). Tree species at the same site sometimes changed markedly along a transect and differed in prevalence and size in two transects. Nonetheless, nymphs emerged at 70/72 (97.2%) of sampling stations represented in Fig. 1. In five of six transects oaks and hickories accounted for [illegible].5–54.2% of total basal area (Table 2). In the other (Middlefield, transect 2), white ash, red and sugar maple, and tuliptree represented 76.8% of total basal area as compared to only 0.2% for oak and 0.0% for hickory. A species of oak had the greatest basal area in three transects and pignut hickory, sugar maple, and tuliptree in one each. Variation in species composition and basal area was probably influenced especially by plant disease

Table 2. Continued.

Tree Species	Middlefield—Transect 2			Southington—Transect 1			Southington—Transect 2		
	Number of Trees	% of Total Number of Trees	% of Total Basal Area (=22,952 cm^2)	Number of Trees	% of Total Number of Trees	% of Total Basal Area (=27,208 cm^2)	Number of Trees	% of Total Number of Trees	% of Total Basal Area (=39,162 cm^2)
Acer rubrum L.	14	13.2	20.8	12	11.7	5.8	5	5.0	1.5
A. saccharum Marsh.	34	32.1	25.0	9	8.7	10.4	13	12.9	6.2
Betula alleghaniensis Britton									
B. lenta L.	2	1.9	3.2	20	19.4	12.3	11	10.9	8.1
Carpinus caroliniana Walt.	9	8.5	4.5				1	1.0	0.2
Carya cordiformis (Wang.) K. Koch							1	1.0	0.1
C. glabra (Mill.) Sweet				2	1.9	3.1	4	4.0	5.0
C. ovata (Mill.) K. Koch									
C. tomentosa Nutt.							2	2.0	2.6
Cornus florida L.	1	0.9	0.2	31	30.1	7.9	26	25.7	3.9
Fagus grandifolia Ehrh.							2	2.0	0.6
Fraxinus americana L.	16	15.1	16.2				11	10.9	4.7
Liriodendron tulipifera L.	6	5.7	14.8	6	5.8	11.8	8	7.9	19.9
Ostrya virginiana (Mill.) K. Koch	14	13.2	8.9	5	4.9	1.9	2	2.0	0.3
Prunus serotina Ehrh.									
Quercus alba L.				1	1.0	4.2	2	2.0	6.6
Q. prinus L.				13	12.6	22.8	4	4.0	3.0
Q. rubra L.				4	3.9	19.9	6	5.9	31.0
Q. velutina Lam.	1	0.9	0.2				2	2.0	5.9
Sassafras albidum (Nutt.) Nees	1	0.9	0.7				1	1.0	0.3
Tsuga canadensis (L.) Carr.	4	3.8	1.6						
Ulmus americana L.	4	3.8	3.9						
Total	106			103			101		

(e.g. Maier, 1980), soil chemistry and moisture, and various human disturbances. In the last century, partial clearing of land or selective logging occurred at all these sites. Nevertheless, cicadas survived probably because some trees were left standing after every disturbance.

Periodical cicadas in Brood II occurred in orchards and disturbed forests in central Connecticut (Fig. 2). Most populations inhabited upland forests that were protected from extensive disturbance by their location on rocky soil near basalt ridges, policy of owners, or both. Absence of cicadas in floodplains in Connecticut should not lend support to arguments on interspecific competition and host preference of cicadas (Dybas and Lloyd, 1974;

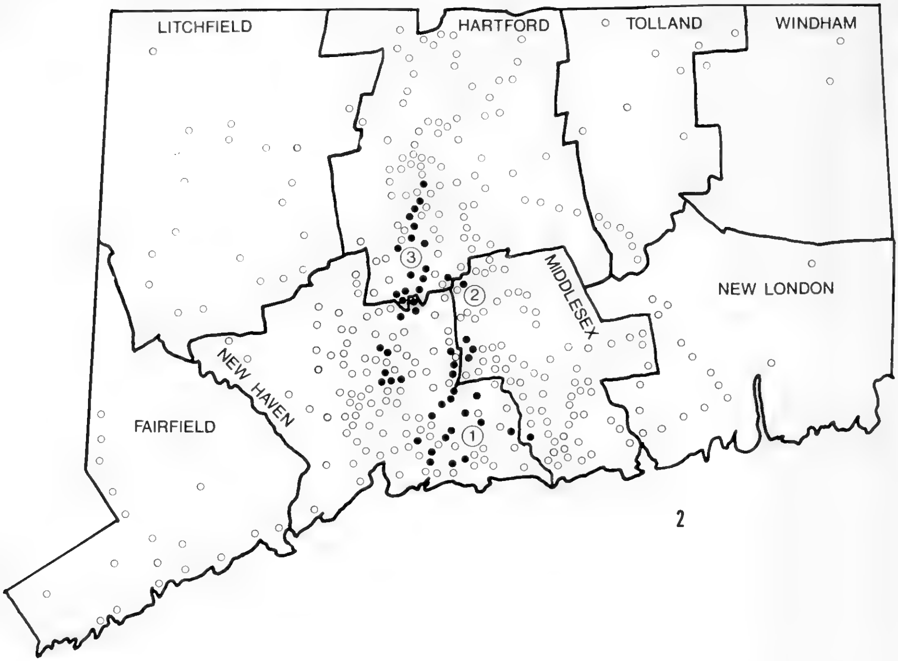

Fig. 2. Distribution of *Magicicada septendecim* (Brood II) in Connecticut during 1978–9). Records from 1978 are extracted from Maier (1980). Numbers 1, 2, and 3 represent sites at Guilford, Middlefield, and Southington, respectively, which were sampled to obtain data in Tables 1, 2, and Fig. 1. Solid and hollow circles indicate presence and absence, respectively. Sampling sites separated by <1 km are represented by the same symbol. Lines delimit counties.

White, 1980). Original floodplain forest was destroyed to provide farmland, and now only small remnants of second-growth floodplain forest remain (Dowhan and Craig, 1976). Nearly all sizeable second-growth floodplain forests lie outside the present distributional range of *M. septendecim*.

Distributional range of Brood II (Fig. 2), the only extant brood in Connecticut (Manter, 1974), resembled that outlined in 1911 (Britton, 1911). Previously, Marlatt (1907) reported that *M. septendecim* in Brood II also occurred in the two western-most counties. Unfortunately, the validity of Marlatt's (1907) records cannot be determined because they were apparently based on correspondence and previously published literature (Riley, 1885), not on specimens.

I visited 75 sites known to have had cicadas in 1945 (unpublished data) and found them absent at four (5.3%). These populations had been eliminated by suburban housing developments (three sites) and by construction of an interstate highway (one site). Britton (1911) listed 13 large populations of *M. septendecim*, and of these two (15.4%) were extinct and two were relatively small. The smallest population occurred in an oak-hickory forest at the northernmost positive site represented in Fig. 2. On June 6, I heard only three singing males and collected one nymphal exuviae during a 2-hour search at midday. Populations located on protected lands, especially those located in parks and forests owned by the state and in forests controlled by water companies, will probably thrive in the foreseeable future. However, those on lands suitable for development will probably decline unless human disturbance is curbed.

COLLECTION DATA

Precise distribution records for *M. septendecim* of Brood II are given below. These data are for adults unless noted otherwise. Abbreviations for roads are: C = Connecticut State highway; I = interstate highway; and US = United States highway.

HARTFORD CO.: Berlin, 1.8 km NW jct. C-71 and C-364, 17 June 1979; Berlin 3.0 km SW jct. C-71 and C-364, 23 May 1979, nymphs; Berlin, 3.0 km ENE jct. C-66 and C-120, 23 May 1979, nymph; Berlin, Lamentation Mt., 3.7 km ESE jct. C-71 and C-364, 4 June 1979; Farmington, 3.2 km NE jct. C-4 and C-10, 6 June 1979, nymphal exuviae and adult singing; Farmington, 1.9 km E jct. US-6 and C-10, 12 June 1979, nymphal exuviae and adults chorusing; Farmington, Rattlesnake Mt., 0.9 km SE jct. US-6 and C-10, 16 June 1979; Farmington, 1.4 km S jct. US-6 and C-10, 16 June 1979; New Britain, 2.4 km W jct. C-71A and C-72, 12 June 1979; Plainville, 2.8 km ENE jct. C-10 and C-72, 12 June 1979; Plainville, 2.5 km SE jct. C-10 and C-72, 19 June 1979; Southington, 3.0 km ENE jct. I-84 and C-10, 12 June 1979; Southington, 2.8 km E jct. I-84 and C-10, 17 June 1979; Southington, 2.7 km E jct. I-84 and C-10, 20 Nov. 1978, nymphs; Southington, 3.3 km ESE jct. I-84 and C-10, 23 May–22 June 1979, nymphs and adults in emergence traps; Southington, 2.8 km W jct. C-71 and C-364, 17 June 1979; Southington, 0.8 km N jct. C-66 and C-120, 4 June 1979; Southington, 0.9 km WNW jct. C-66 and C-120, 4 June 1979; Southington, 1.2 km SSE jct. C-66 and C-120, 14 June 1979.

MIDDLESEX CO.: Durham, 3.6 km WNW jct. C-17 and C-68, 2 Oct. 1978, nymphs; Durham, 4.4 km W jct. C-17 and C-68, 5 June 1979; Killingworth, 4.0 km SW jct. C-80 and C-81, 17 June 1979; Middlefield, 1.4 km SW jct. C-147 and C-157, 12 Oct. 1978, nymphs; Middlefield, 3.8 km WNW jct. C-17 and C-68, 5 June 1979; Middletown, 2.5 km W of Westfield, nr. E. Bradley Brook, 20 Oct. 1978, nymphs; Middletown, 0.6 km N jct. C-66 and C-217, 7 June 1979.

NEW HAVEN CO.: Branford, 1.6 km ESE jct. C-80 and C-100, 22 May

1979, nymphs; Branford, 2.6 km SE jct. C-80 and C-100, 13 June 1979, nymphal exuviae; Branford, 0.9 km S jct. US-1 and C-22, 13 June 1979; Cheshire, 2.0 km S jct. C-66 and C-120, 6 June 1979; Cheshire, 2.2 km SSE jct. C-10 and C-70, 13 Oct. 1978, nymphs; Cheshire, 2.5 km S jct. C-10 and C-70, 13 Oct. 1978; East Haven, 1.5 km N jct. C-80 and C-100, 1 June 1979; Hamden, 5.7 km NNW jct. C-15 and C-22, 6 June 1979; Hamden, 4.8 km NNW jct. C-15 and C-22, 6 June 1979; Hamden, Sleeping Giant St. Pk., 4.9 km N jct. C-15 and C-22, 6 June 1979; Hamden, Sleeping Giant St. Pk., 4.9 km NNE jct. C-15 and C-22, 6 June 1979; Hamden, Sleeping Giant St. Pk., 4.3 km NNE jct. C-15 and C-22, 6 June 1979; Hamden, 3.1 km NW jct. C-15 and C-22, 20 June 1979, nymphal exuviae and adult singing; Guilford, 6.4 km NNE jct. C-77 and C-80, 13 June 1979; Guilford, 2.3 km NNW jct. C-77 and C-80, 2 Oct. 1978, nymphs; Guilford, 2.5 km NE jct. US-1 and C-22, 18 Oct. 1978, nymphs; Guilford, 0.8 km SSE jct. US-1 and C-22, 13 June 1979; Madison, 2.0 km SSE jct. C-79 and C-80, 13 June 1979; Meriden, East Peak of Hanging Hills, 1.4 km E jct. C-66 and C-120, 3 Oct. 1978, nymphs; Meriden, Hubbard Pk., 1.7 km ESE jct. C-66 and C-120, 3 Oct. 1978, nymphs; N. Branford, 3.6 km ENE jct. C-17 and C-22, 26 May 1979, nymphs; N. Branford, 2.3 km SSW jct. C-17 and C-22, 25 May 1979; N. Branford, 2.6 km SSW jct. C-17 and C-22, 4 Oct. 1978, nymphs; N. Branford, 3.3 km SSW jct. C-17 and C-22, 23 May 1979, nymph; N. Branford, 3.1 WNW jct. C-77 and C-80, 21 May 1979; N. Branford, 1.0 km N jct. C-80 and C-139, 23 May 1979, nymphs; Wallingford, 1.3 km SE jct. I-91 and C-68, 5 June 1979; Wallingford, 3.1 km E of E. Wallingford, 5 June 1979; Wallingford, 3.2 km E of E. Wallingford, 7 Dec. 1978, nymphs.

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LITERATURE CITED

Britton, W. E. 1911. The periodical cicada or seventeen year locust in Connecticut in 1911. Conn. Agric. Exp. Stn. Ann. Rep. 35: 296–305.

Dowhan, J. J. and R. J. Craig. 1976. Rare and endangered species of Connecticut and their habitats. Conn. State Geol. Nat. Hist. Surv., Rep. Investigations No. 6, 137 pp.

Dybas, H. S. and D. D. Davis. 1962. A population census of seventeen-year periodical cicadas (Homoptera: Cicadidae: *Magicicada*). Ecology 43: 432–444.

Dybas, H. S. and M. Lloyd. 1974. The habitats of 17-year periodical cicadas (Homoptera: Cicadidae: *Magicicada* spp.). Ecol. Monogr. 44: 279–324.

Forsythe, H. Y., Jr. 1976. Estimating nymphal populations of 17-year cicadas in eastern Ohio, 1968. Ohio J. Sci. 76: 95–96.

Leonard, D. E. 1964. Biology and ecology of *Magicicada septendecim* (L.) (Hemiptera: Cicadidae). J. N. Y. Entomol. Soc. 72: 19–23.

Lloyd, M. and J. White. 1976. On the oviposition habits of 13-year versus 17-year periodical cicadas of the same species. J. N. Y. Entomol. Soc. 84: 148–155.

Maier, C. T. 1980. A mole's-eye view of seventeen-year periodical cicada nymphs, *Magicicada septendecim* (Hemiptera: Homoptera: Cicadidae). Ann. Entomol. Soc. Am. 73: 147–152.

———. 1982. Observations on the seventeen-year-periodical cicada, *Magicicada septendecim* (Hemiptera: Homoptera: Cicadidae), in Connecticut. Ann. Entomol. Soc. Am. 75: 14–23.

Manter, J. A. 1974. Brood XI of the periodical cicada seems doomed, pp. 100–101. *In* Beard, R. L., ed., 25th Anniversary Memoirs, Conn. Entomol. Soc., The Conn. Entomol. Soc., New Haven.

Marlatt, C. L. 1907. The periodical cicada. U.S. Dep. Agric. Bur. Entomol. Bull. 71: 1–181.

Riley, C. V. 1885. The periodical cicada. U.S. Dep. Agric. Div. Entomol. Bull. 8: 1–46.

White, J. 1980. Resource partitioning by ovipositing cicadas. Am. Nat. 115: 1–28.

PROC. ENTOMOL. SOC. WASH.
84(3), 1982, pp. 440–447

THREE NEW SPECIES OF *SERROMYIA* (DIPTERA: CERATOPOGONIDAE) FROM SRI LANKA, WITH NEW RECORDS AND A KEY TO THE ORIENTAL AND AUSTRALASIAN SPECIES

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Abstract.—Three new species of *Serromyia* are described from Sri Lanka: ***heveli, maculipennis,*** and ***punctata.*** A key is given for separation of the six known Oriental and Australasian species of the genus. New Oriental records are *S. esakii* Tokunaga from the Philippines and Sabah, and *S. pendleburyi* Macfie from Vietnam. Notes are given on the hitherto unknown female of *S. pendleburyi.*

The genus *Serromyia* Meigen is well represented in the Northern Hemisphere with about two dozen species known from the temperate Holarctic Region (Wirth et al., 1974). It extends into the African continent with five species (de Meillon and Wirth, 1981), but elsewhere it is absent or poorly represented. No species have been reported from the Neotropical Region (Wirth, 1974), only two from the Australasian Region (Debenham, 1970), and only one heretofore described Oriental species (Wirth, 1973). The purpose of this study is to report three new species from Sri Lanka, to describe the hitherto unknown female of *S. pendleburyi* Macfie (1934) from Vietnam, and to report new records of *S. esakii* Tokunaga (1940) from Southeast Asia.

In this manuscript the first values given are those of the holotype followed by the range of variation of the paratypes in parenthesis. The methods of measurements and ratios used are those of Debenham (1970).

The authors are indebted to Karl V. Krombein, Director of the Smithsonian Ceylonese Insect Project, for specimens used in this study, and to Molly Ryan for illustrations used in this paper. USNM indicates the National Museum of Natural History, Smithsonian Institution, Washington, D.C.

KEY TO THE ORIENTAL AND AUSTRALASIAN SPECIES OF *SERROMYIA*

1. Hindfemur and hindtibia dark brown, unbanded; mesonotum dark brown 2
– Hindfemur and hindtibia yellowish with brown bands or other markings; mesonotum yellowish, at least on sides 3
2. Large species, wing 2.2–2.6 mm long; female hindfemur armed ventrally with about 40 strong black spines in at least 3 series; costa long, costal ratio 0.75; male 9th tergum long and slender distally; halter infuscated .... *pendleburyi* Macfie
– Smaller species, wing 1.0 mm long; female hindfemur armed ventrally with 20 strong spines in 2 series; costa shorter, costal ratio 0.69 in female, 0.60 in male; male 9th tergum short and bluntly rounded distally; halter pale .... *reyei* Debenham
3. Wing with small black spot midway in anal cell (mesonotum and legs yellowish with numerous small brown punctations at the setal bases; fore- and midfemora and tibiae with narrow brown bases, hindfemur with narrow brown base and broad brown apical band, hindtibia brown on bent basal knee portion, with broad subbasal and narrow apical brown bands; spermathecae pale yellowish; halter slightly infuscated, posterior side of knob whitish) .. *maculipennis*, new species
– Wing without small black spot midway in anal cell on vein 1A 4
4. Legs yellowish, apices of tibiae brownish, hindtibia brown at base, hind femur brown, only moderately swollen and bearing 20 strong ventral spines; halter slightly infuscated; spermathecae pale brown; costal ratio 0.75 .... *esakii* Tokunaga
– Legs with prominent dark brown bands or punctations; hindfemur markedly swollen and bearing 20–28 strong ventral spines; costal ratio about 0.70 5
5. Mesonotum and legs yellow, with prominent brown punctations at setal bases; apices of tibiae narrowly brown; hindfemur with subapical and tibia with subbasal, narrow brown bands; spermathecae pale yellowish .... *punctata*, new species
– Mesonotum brown in broad midportion; fore- and midlegs pale brownish; hindfemur dark brown with broad yellow band in midportion; hindtibia dark brown proximally, yellow on distal ⅓; spermathecae dark brown .... *heveli*, new species

Serromyia esakii Tokunaga

Serromyia esakii Tokunaga, 1940: 218 (♀; Caroline Islands; fig. wing, antenna); Tokunaga and Murachi, 1959: 402 (♂, ♀; Caroline Islands, fig. male palpus, genitalia).

Distribution.—Caroline Islands, Philippines, Sabah.

New records.—PHILIPPINES: Balabac, Dalawan Bay, 9 Oct. 1961, at mercury light, Noona Dan Exped., 1 ♀. SABAH: Labuan I., Borneo, Sept.–Oct., 1948, March 1950, D. H. Colless, at light, 1 ♂, 1 ♀; March 1952; sweeping, 1 ♀.

Serromyia pendleburyi Macfie

Serromyia pendleburyi Macfie, 1934: 280 (♂; Malaysia; fig. genitalia); Debenham, 1970: 165 (compared with *C. reyei*).

Distribution.—Malaysia, Vietnam.

New record.—Vietnam, Dalat, 26–27 Sept. 1960, J. L. Gressitt, 2 ♀.

Notes.—The female of this species has not been described before. The Vietnam females have the wing length 2.2 mm; costal ratio 0.75; hindfemur with 40 ventral spines in at least 3 series, hindclaw 1.28× as long as 5th tarsomere, the short, slender basal barb only 0.15× as long as claw. This species resembles the Northern Hemisphere species in its large size and uniformly dark brown color with only the tarsi and the four anterior legs yellowish.

Serromyia heveli Giles and Wirth, New Species

Fig. 1

Female holotype.—Wing length 1.07 mm, breadth 0.43 mm.

Head: Yellowish brown, setae long and strong. Eyes bare, separated by distance equal to 3 facets. Antenna (Fig. 1a) pale, apices of segments 3–10 light brown, segments 11–15 darker brown; verticils well developed on all segments; lengths of flagellar segments in proportion of 36-21-24-26-28-28-30-30-42-40-50-52-66, antennal ratio 1.12. Palpus (Fig. 1b) pale; 3rd segment moderately swollen from base with long capitate sensilla irregularly clumped on distal ⅓; palpal ratio 2.36. Proboscis brown, moderately long, P/H ratio 0.56; mandibular teeth 9 (8), large and coarse.

Thorax: Yellowish; scutum dark brownish mesally, yellowish on sides; pleuron yellowish with brown blotches dorsad, ventral areas darker brown; thorax with strong setae, scutellar setae slightly longer than hindclaw. Legs (Fig. 1d–f) brownish; fore- and midtrochanters yellowish, hindcoxa yellowish subdorsally, hindtrochanter dark brownish; forefemur and tibia yellowish brown; midfemur with dark brownish base, distal ⅔ and tibia pale brown; hindfemur yellowish brown, basal ⅓ dark brown except for small yellowish area at junction of trochanter, distal ¹/₅ dark brown; hindtibia yellowish brown, basal ⅔ dark brown. Hindfemur swollen, measuring 0.63 by 0.14 mm, bearing 20 (21) strong ventral spines, the basal one weaker and lighter in color; hindtibia arcuate, with comb of 6 (8) spines. Tarsi pale; hindtarsal ratio 2.03; fore- and midleg with claws small and equal, each with well-developed teeth, ratio of length of claw to 5th tarsomere on 1st leg

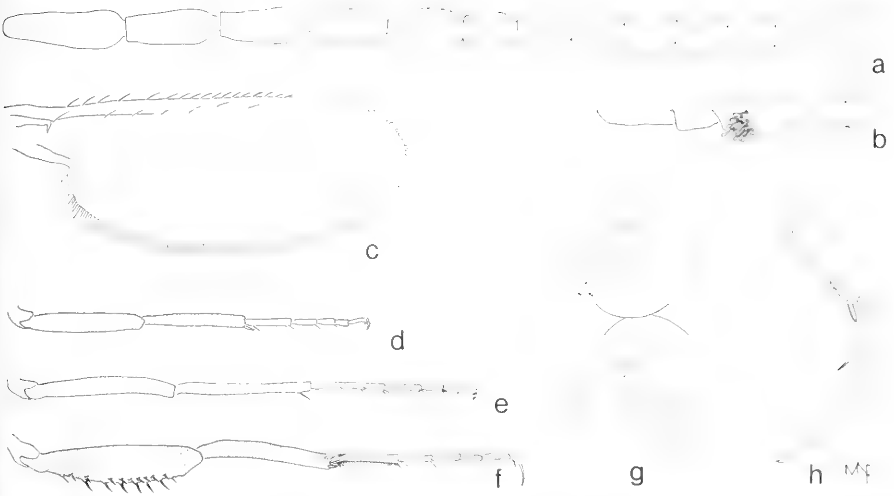

Fig. 1. *Serromyia heveli*, ♀ holotype. a, Antenna. b, Palpus. C, Wing. d, Foreleg. e, Midleg. f, Hindleg. g, Spermathecae. h, 5th tarsomere and claw of hindleg.

0.45, on 2nd leg 0.50, hindleg with single claw (Fig. 1h) 1.10 as long as 5th tarsomere and with fine basal tooth 0.29 the length of claw.

Wing (Fig. 1c): Milky white, with fine microtrichia; base of veins Rs and 1A brownish; 1st and 2nd radial cells slightly yellowish; 22 short setae along costa to tip of 2nd radial cell, 7 on radius; vein R4+5 obliquely meeting costa; radial cells with lumens poorly developed; 1st and 2nd radial cells respectively 0.122 by 0.019 mm and 0.169 by 0.026 mm; vein M2 obsolescent only a short distance at base; cell M4 extending from level of base of r-rm crossvein to a level past tip of 2nd radial cell; costal ratio 0.66. Halter yellowish.

Abdomen: Yellowish with faint segmental dark bands, terminal segments brownish. Spermathecae (Fig. 1g) 2, dark brown with minute hyaline perforations; slightly unequal, measuring 0.094 by 0.055 mm and 0.087 by 0.062 mm; necks arising obliquely, long and tapering; rudimentary spermatheca present.

Male.—Unknown.

Distribution.—Sri Lanka.

Type.—On slide in phenol balsam. Holotype ♀, Sri Lanka, Mannar District, 4 mi NW Mannar, UV light, 100 ft, 3 Nov. 1976, coll. Hevel et al. (Type no. 76579, USNM).

Discussion.—This species is named for Gary F. Hevel of the Smithsonian Institution in appreciation of his interest and assistance in the collection of Sri Lanka Ceratopogonidae.

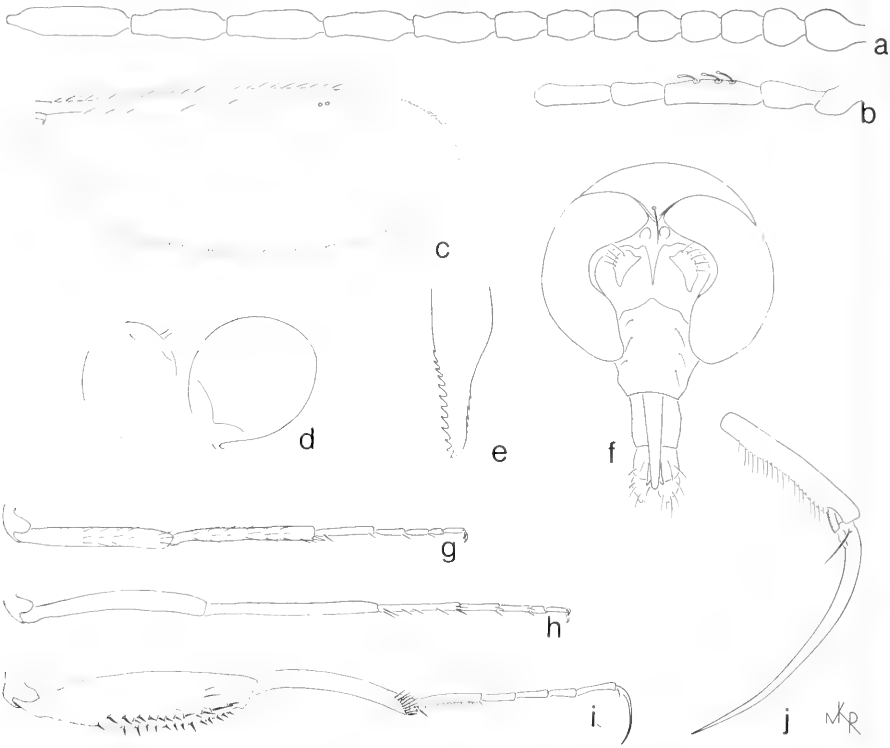

Fig. 2. *Serromyia maculipennis*, ♀ holotype. a, Antenna. b, Palpus. c, Wing. d, Spermathecae. e, Mandible. f, Head, anterior view. g, Foreleg. h, Midleg. i, Hindleg. j, 5th tarsomere and claw of hindleg.

Serromyia maculipennis Giles and Wirth, New Species

Fig. 2

Female holotype.—Wing length 1.44 (1.34–1.66, $n = 7$) mm; breadth 0.58 (0.51–0.60, $n = 7$) mm.

Head: Yellowish with brown dots at setal bases. Eyes (Fig. 2f) bare, separated by a distance equal to 2 facets. Antennal segments 3–10 stramineous, 11–15 pale brown, verticils well developed on all segments; flagellar segments (Fig. 2a) with lengths in proportion of 42-34-34-32-34-32-34-36-59-62-[illegible]-74-94, antennal ratio 1.38 (1.20–1.38, $n = 4$) mm. Palpus (Fig. 2b) pale yellow, [illegible] base of 2nd, and tip of 5th segments darkest; lengths of segments in proportion of 20-47-74-40-60; 3rd segment cylindrical with sensilla scattered on surface, palpal ratio 3.70 (3.40–4.44, $n = 7$). Proboscis brown, moderately long, P/H ratio 0.57 (0.51–0.65, $n = 7$); mandibular teeth (Fig. 2e) 11 (10–13, $n = 7$), large and coarse.

Thorax: Yellowish, with brown setal bases; a broad median brown band extending the length of mesonotum, extending ventrad to meet pleuron between anterior spiracle and wing base; pleuron with brown splotches. Legs (Fig. 2g–i) yellowish with brown setal bases; fore- and midcoxae and trochanters with brown streaks, hind ones dark brown; femora and tibiae with setal punctations tending to form transverse bands; fore- and midfemora with basal and apical brown bands, hindfemur with basal and subapical brown bands; tibiae with apical brown bands; mid- and hindtibiae with subbasal brown bands; hindfemur swollen, measuring 0.09 by 0.21 mm, bearing 28 (26–34, $n = 7$) strong ventral spines; hindtibia arcuate, with comb of 10 (10–12, $n = 7$) spines; tarsi yellowish; hindtarsal ratio 2.13; fore- and midlegs with claws subequal and simple, empodium small; ratio of length of claw to 5th tarsomere on first leg 0.44, on 2nd leg 0.47; hindleg with single striated claw (Fig. 2j) 1.55 as long as 5th tarsomere, and with fine basal tooth 0.16 the length of claw.

Wing (Fig. 2c): Hyaline, with fine whitish microtrichia; subcosta, radius, and M1+2 strong, yellowish, tip of vein R4+5 darker; large setae numerous the length of costa to end of 2nd radial cell, 7 setae scattered along radius; 1st radial cell measuring 0.197 by 0.035 mm, 2nd radial cell 0.254 by 0.054 mm with tip quadrate; vein M2 interrupted at base; cell M4 extending from level of a line ½ the length of r-m crossvein proximad of the crossvein distally to the level of end of 2nd radial cell; a spot on vein 1A at midlength of anal cell composed of densely packed long microtrichia, the spot brownish with a small green area iridescent in some lights; costal ratio 0.70 (0.68–0.72, $n = 7$). Halter pale brownish, posterior portion of knob white.

Abdomen: Yellowish, setal bases and terga brown, posterior segments tending to darken; spermathecae (Fig. 2d) pale brownish, 2, ovoid with short, slender, oblique necks; unequal, measuring 0.166 by 0.123 mm and 0.129 by 0.104 mm.

Male.—Unknown.

Distribution.—Sri Lanka.

Types.—All on slides in phenol balsam. Holotype ♀ Sri Lanka, Jaffna District, Chundikkulam Sanctuary, 25 ft, UV light, 7 Nov. 1976, coll. G. F. Hevel, R. E. Deitz IV, S. Karunaratne, and D. W. Balasooriya (Type no. 76580, USNM). Paratypes, 26 ♀, same data as holotype. Holotype and 24 paratypes deposited in USNM; one paratype will be deposited in the Colombo National Museum, Colombo, Sri Lanka, and another in the National Museum at the University of Sri Lanka at Peradeniya. Paratype ♀, Sri Lanka, Mannar District, 4 mi NW Mannar, UV light, 100 ft, 3 Nov. 1976, coll. Hevel et al. (deposited in USNM).

Discussion.—*Serromyia maculipennis* derives its name from the prominent dark spot in the anal cell. It can readily be identified since all others in this genus have clear wings.

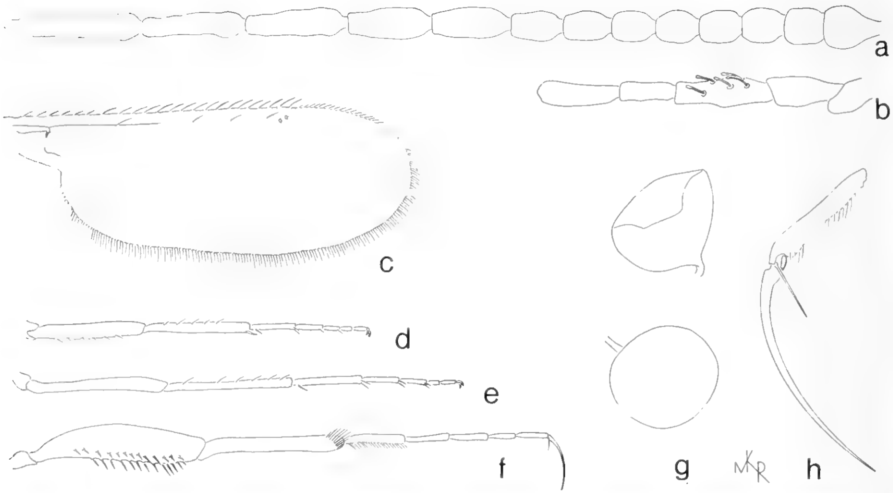

Fig. 3. *Serromyia punctata,* ♀ holotype. a, Antenna. b, Palpus. c, Wing. d, Foreleg. e, Midleg. f, Hindleg. g, Spermathecae. h, 5th tarsomere and claw of hindleg.

Serromyia punctata Giles and Wirth, New Species

Fig. 3

Female holotype.—Wing length 1.20, breadth 0.48 mm.

Head: Yellowish brown. Eyes bare, contiguous for a distance equal to 1 facet. Antenna (Fig. 3a) with segments 3–10 pale yellow, 11–15 becoming progressively darker brown; length of flagellar segments in proportion of 34-26-26-26-28-26-28-30-46-48-58-60–71, antennal ratio 1.26. Palpus (Fig. 3b) pale, segments 1 and 5 brownish; lengths of segments in proportion of 11-29-50-29-36, 3rd segment slightly swollen from base, with long capitate sensilla scattered on surface; palpal ratio 3.1. Proboscis brown, moderately long, P/H ratio 0.63; mandibular teeth 12 (13), large and coarse.

Thorax: Yellowish with brown setal bases; pleuron with brown blotches. Legs (Fig. 3d–f) yellowish with brown setal bases; foreleg with coxa brown, trochanter yellowish, femur with faint brownish basal band, small brown blotches on flexor surface, tibia with small brown blotches on extensor surface and narrow apical brown band; midleg with coxa and trochanter light brown, femur with narrow base brown, tibia with small brown blotches on extensor surface and narrow apical brown band; hindleg with coxa brown on distal 1/2, trochanter brown, femur with irregular brown basal area, narrow brown supapical band and irregular brown splotches throughout, tibia with irregular brown areas distally, brown subbasal band, and brown blotches on extensor surface; hindfemur swollen, measuring 0.69 by 0.16 mm, bearing 27 (28) strong ventral spines; hindtibia arcuate, with 9 spines in tibial comb. Tarsi yellowish; hindtarsal ratio 1.37; fore- and midlegs with claws small and equal, empodium small; ratio of length of claw to 5th tarsomere 0.45 on foreleg, 0.40 on midleg; hindleg with single striated claw (Fig. 3h) 1.72× as long as 5th tarsomere, with fine basal tooth (paratype—tooth 0.25× as long as claw).

Wing (Fig. 3c): Milky white, with fine microtrichia; base of radius, and 1A, and tip of vein R4+5 dirty yellowish, costa, M1+2, r-m crossvein and distal ½ of Rs yellowish; 30 short setae scattered the length of costa to tip of 2nd radial cell, only 3 setae on radius; vein R4+5 with beadlike swelling distally; 1st and 2nd radial cells measuring respectively 0.080 by 0.024 mm and 0.221 by 0.038 mm; tip of 2nd radial cell quadrate; costal ratio 0.68; cell M4 extending from level of base of r-m crossvein to a level opposite tip of 2nd radial cell. Halter pale brownish.

Abdomen: Pale yellowish; a pair of brownish spots on each tergum. Spermathecae (Fig. 3g) 2, pale yellowish scarcely discernible; oval with short slender necks; unequal, measuring 0.156 by 0.104 mm and 0.115 by 0.071 mm.

Male.—Unknown.

Distribution.—Sri Lanka.

Types.—All on slides in phenol balsam. Holotype ♀, Sri Lanka, Puttalam District, Wilpattu National Park, 14–15 Feb. 1979, coll. K. V. Krombein, T. Wijesinhe, S. Siriwardane, and T. Gunawardane (Type no. 76581, USNM). Paratype ♀, Sri Lanka, Jaffna District, Chundikkulam Sanctuary, 25 ft. UV light, 7 Nov. 1976, coll. G. F. Hevel, R. E. Deitz IV, S. Karunaratne, and D. W. Balasooriya (USNM).

LITERATURE CITED

Debenham, M. L. 1970. Australasian Ceratopognidae (Diptera, Nematocera). Part XIV: The genus *Serromyia* Meigen. Proc. Linn. Soc. N.S.W. 94: 160–165.

Macfie, J. W. W. 1934. Report on a collection of Ceratopogonidae from Malaya. Ann. Trop. Med. Parasitol. 28: 279–293.

Meillon, B. de and W. W. Wirth. 1981. Subsaharan Ceratopogonidae (Diptera) VII. The biting midges of the Kruger National Park, South Africa, exclusive of the genus *Culicoides*. Ann. Natal Mus. 24: 563–601.

Tokunaga, M. 1940. Ceratopogonidae and Chironomidae from the Micronesian Islands. Philipp. J. Sci. 71: 205–226.

Tokunaga, M. and E. K. Murachi. 1959. Diptera: Ceratopogonidae. Insects Micronesia 12: 103–434.

Wirth, W. W. 1973. Family Ceratopogonidae (Heleidae). Pp. 346–388. *In* Delfinado, M. D. and D. E. Hardy, eds., A Catalog of the Diptera of the Oriental Region. Vol. 1. Univ. Press of Hawaii, Honolulu. 618 pp.

———. 1974. Family Ceratopogonidae. A Catalogue of the Diptera of the Americas south of the United States, Vol. 14. São Paulo, Brazil. 89 pp.

Wirth, W. W., N. C. Ratanaworabhan, and F. S. Blanton. 1974. Synopsis of the genera of Ceratopogonidae (Diptera). Ann. Parasitol. 49: 595–613.

PROC. ENTOMOL. SOC. WASH.
84(3), 1982, pp. 448–460

EGG MORTALITY IN THE EASTERN TENT CATERPILLAR, *MALACOSOMA AMERICANUM* (LEPIDOPTERA: LASIOCAMPIDAE): THE ROLE OF ACCESSORY GLAND SECRETIONS AND EGG MASS SHAPE

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Abstract.—Four species of hymenopteran parasitoids were reared from egg masses of the eastern tent caterpillar, *Malacosoma americanum* (F.) (Lepidoptera: Lasiocampidae) in New York State: *Telenomus clisiocampae* Riley (Scelionidae), *Tetrastichus malacosomae* Girault (Eulophidae), *Ooencyrtus clisiocampae* (Ashmead) (Encyrtidae), and *Ablerus clisiocampae* (Ashmead) (Aphelinidae). Three classes of host eggs were distinguished, exposed eggs, eggs covered with spumaline on the margin of the mass, and eggs covered with spumaline in the interior portion of the mass. Parasitism rates of exposed (27%) and covered marginal eggs (23%) were significantly greater than covered interior eggs (1%). Inviability was greater in exposed and covered marginal eggs relative to interior eggs. An analysis of relationships within *Malacosoma* indicates that frothy spumaline is an evolutionarily labile trait and has undergone either multiple elaborations or parallel reductions. The hypothesis that frothy spumaline has evolved convergently in *Malacosoma* species as a response to hymenopteran egg parasitoids is discussed.

Egg parasitoids (primarily of the hymenopteran superfamilies Chalcidoidea and Proctotrupoidea) are one of the most important biological factors affecting the survival of many species of Lepidoptera and Hemiptera. Their influence is not as widely appreciated as that of larval, nymphal, and pupal parasitoids, in large part because of the difficulty in sampling egg populations. Where data are available, commonly more than 50% of the eggs are parasitized (Anderson, 1976). Such high rates indicate strong selective pressures on the host to reduce loss, for example, by elimination of the cues used by parasitoids to locate the eggs, or to provide the eggs with a means of protection if they are found.

The oviposition behavior of species in the genus *Malacosoma* Hübner

(Lepidoptera: Lasiocampidae) is particularly interesting with regard to egg parasitism. The European pest species *M. neustria* (L.) is typical of all Old World species of the genus. It lays its eggs in a single-layered exposed mass on twigs; a typical mass contains 140–200 eggs (Schwenke, 1978). In these masses parasitism rates of 40% have been recorded (Romanova and Lozinskij, 1958).

In contrast parasitism rates in New World *Malacosoma* have never been found to exceed 15% and are usually much lower (Anderson, 1976; Witter and Kulman, 1972). All New World species except *M. tigris* (Dyar) cover their egg masses with a foamy, accessory gland secretion known as spumaline. Hodson (1939) noted that egg parasitism of *M. disstria* Hübner is concentrated in eggs along the margin of the mass and suggested that this was due to the incomplete covering of spumaline in this area. Other authors have anecdotally referred to prevention of parasitism as the function of spumaline (e.g. Stehr and Cook, 1968; Wellington, 1965; Witter and Kulman, 1979). Prentice (1953) reported that *M. disstria* eggs covered with spumaline were less heavily parasitized (2.3%) than those exposed (60.9% in partially covered masses; 72.5% in completely exposed masses). He cited only these percentages and gave none of the information necessary to evaluate his conclusion (e.g., sample size, variation). The function of spumaline therefore merits further investigation.

In this paper we present natural history information on the egg parasitoids associated with *Malacosoma americanum* (F.). We compare parasitism and inviability rates of eggs as functions of both position within the mass and spumaline covering. We discuss the possible role of egg parasitoids in the evolution of oviposition behavior in the genus *Malacosoma*.

METHODS AND MATERIALS

Egg masses of *Malacosoma americanum* were collected in the spring of 1980 prior to the hatching of caterpillars. A total of 90 egg masses were collected from four localities in central and western New York State (Ithaca, Beebe Lake, Tompkins Co., $n = 17$ egg masses; Ithaca, Cascadilla Creek, Tompkins Co., $n = 30$; Texas Hollow Wildflower Preserve, Schuyler Co., $n = 28$; and Dunkirk, Chautauqua Co., $n = 15$). Egg masses were then scored as either completely covered with spumaline or as having some exposed eggs. All exposed eggs were marked with paint to allow recognition after caterpillar emergence.

Egg masses were maintained at 21°C, 63% relative humidity, and 12/12 hour photoperiod until after the hatching of caterpillars and parasitoids. Unhatched eggs were then examined to determine both parasitism and inviability rates.

Data collected from each parasitized egg consisted of identity of parasitoid, date of emergence, position in the egg mass, and whether or not it was

Table 1. Composition of egg parasite fauna on *Malacosoma americanum* from 4 localities in New York. [% composition and (number of individuals). Total: 937 parasitoids.]

Locality (*n* = egg masses)	*Tetrastichus malacosomae*	*Telenomus clisiocampae*	*Ooencyrtus clisiocampae*	*Ablerus clisiocampae*
Dunkirk (*n* = 13)	.541 (92)	.159 (27)	.294 (50)	.006 (1)
Beebe Lake (*n* = 15)	.900 (226)	.068 (17)	.028 (7)	.004 (1)
Cascadilla Ck. (*n* = 26)	.761 (124)	.147 (24)	.080 (13)	.012 (2)
Texas Hollow (*n* = 22)	.926 (327)	.065 (23)	.008 (3)	—
Totals	.821 (769)	.097 (91)	.078 (73)	.004 (4)

covered with spumaline. Four species of hymenopteran egg parasitoids were encountered in this study: *Ablerus clisiocampae* (Ashmead) (Aphelinidae) which appeared first, followed, in order of emergence, by *Telenomus clisiocampae* Riley (Scelionidae), *Ooencyrtus clisiocampae* (Ashmead) (Encyrtidae), and *Tetrastichus malacosomae* Girault (Eulophidae). Vouchers of specimens are deposited in the Cornell University Insect Collection, lot no. 1107. Locations of parasitized host eggs in the mass were scored as exposed, not covered with a layer of frothy spumaline; covered marginal, on the perimeter of the egg mass or next to an exposed egg; or covered interior, and ranked according to the number of eggs by which it was separated from the margin. Another source of egg mortality was the failure to produce either a caterpillar or a parasitoid wasp. These were termed inviable eggs, and their positions within the egg mass were also recorded. Ten egg masses were then randomly chosen for a detailed analysis of parasitism rate, inviability rate, and the distribution of parasitized eggs in the egg mass.

A weakness in previous studies on egg parasitoids has been the failure to separate eggs that do not hatch from those that produce parasitoids. Previous investigators simply counted and identified the parasitoids and estimated the size of the egg mass (e.g. Hodson, 1941; Romanova and Lozinskij, 1958). This procedure does not allow assessment of the relative contributions of parasitism and inviability to mortality.

Our procedure determined the fate of each egg along with its position and the distribution of spumaline on the egg mass. Parasitoid identity was established by the distinctive shape and color of the meconium of each species. *Telenomus clisiocampae* produces a yellowish-green amorphous meconium; *Tetrastichus malacosomae* deposits large dark green, ovoid pel-

Table 2. Distribution of parasitized and inviable eggs in ten egg masses of *M. americanum*. (Exp = exposed eggs; Marg = marginal eggs; Int = interior eggs; as defined in text.)

Egg Mass	No. Egg	No. Exp	No. Marg	No. Int	Parasitism Rate			Inviability Rate		
					Exp	Marg	Int	Exp	Marg	Int
cc19	145	3	43	99	0	.209	0	.33	0	0
cc18	339	2	65	272	0	.123	.004	.500	.062	.004
cc12	387	3	39	345	.333	.462	.020	.667	.077	.009
cc11	290	18	77	195	0	.169	0	.278	.208	.031
cc4	120	3	43	74	0	0	0	0	.046	.027
th29	272	31	81	160	.452	.272	0	.258	.062	0
th21	339	36	56	247	.361	.232	.012	.056	.089	.004
th9	216	18	45	153	.333	.333	0	.167	.044	.007
th8	203	8	51	144	.750	.275	.062	.250	.137	.076
bl12	274	4	64	206	.500	.172	.005	0	0	0
Mean	258.5	12.6	56.4	189.5	.272	.225	.010	.251	.073	.016
SD	86.82	12.6	14.8	81.9	.263	.125	.019	.214	.062	.024

lets; *Ooencyrtus clisiocampae* and *Ablerus clisiocampae* both produce small black pellets. The latter two species were distinguishable because their emergence periods did not overlap. Successful development of the caterpillar was determined by a completely empty opened egg (chorion), with neither yolk nor meconium, or by the presence of the caterpillar within unhatched eggs. The ten egg masses contained at least one viable exposed egg. We used *t*-tests to compare the mean differences in parasitism and inviability rates in the ten egg masses for all three pairwise combinations of egg location (exposed versus interior, exposed versus marginal, marginal versus interior).

RESULTS

Malacosoma americanum populations have been relatively large in the study sites in the three years preceding this study (1976–1979), and a high proportion of the egg masses were parasitized (89%). Interlocality variation in the proportion of masses parasitized varied from 100% at Texas Hollow to 76% at Cascadilla Creek. Exposed eggs occurred in 64% of the 76 egg masses, with the number of exposed eggs usually quite low (mean = 13, SD = 10).

Table 1 documents the composition of the egg parasitoid fauna of *M. americanum* in the four upstate New York localities; *Tetrastichus* is clearly the most abundant egg parasitoid. The same rank order of these four parasitoids was found in a study conducted in Ithaca, New York, in 1924 (Liu, 1926), but in that study *Telenomus* was a much more important mortality

Table 3. Comparison of the distribution of the 3 most common species of parasitoids within egg masses of *M. americanum*. The χ^2 values test the null hypothesis of equal numbers of parasitoids in marginal and interior eggs classes. Note that the number of eggs in the two classes are not equal (Table 2). [% of occurrences, (number of individuals).]

Species	Marginal Eggs	Interior Eggs	χ^2
Tetrastichus malacosomae	.730 (492)	.270 (182)	75.27[a]
Telenomus clisiocampae	.518 (56)	.482 (52)	.074 n.s.
Ooencyrtus clisiocampae	.427 (32)	.573 (43)	.811 n.s.

[a] Significant at $P = .001$; n.s.: $P > .25$.

factor (30% of reared wasps versus 10%). Parasitoid abundance varies on a regional basis; parasitism by *Ooencyrtus* ranged over an order of magnitude in this study alone.

Table 2 summarizes the results of the detailed analysis of ten egg masses. Parasitism rates are significantly higher in exposed than interior eggs ($t = 4.69$, 9 *df*, $P < .001$), and significantly higher in marginal than interior eggs ($t = 8.02$, 9 *df*, $P < .0005$). Exposed and marginal eggs do not differ significantly in parasitism rate ($t = .950$, 9 *df*, $P > .10$).

Inviability rates were significantly higher in exposed than marginal eggs ($t = 3.75$, 9 *df*, $P < .01$), higher in marginal than interior eggs ($t = 4.94$, 9 *df*, $P < .0005$) and higher in exposed than interior eggs ($t = 4.84$, 9 *df*, $P < .0005$).

The distribution of the three most common species of parasitoid within the egg mass was also compared ($n = 90$ egg masses). Table 3 summarizes the results. *Telenomus* and *Ooencyrtus* were equally common in the interior and marginal egg classes. *Tetrastichus* is more closely associated with the egg mass margin (73%) and this distribution is significantly different from that of both *Ooencyrtus* ($\chi^2 = 28.9$, $P < .001$) and *Telenomus* ($\chi^2 = 20.0$, $P < .001$).

DISCUSSION

In *Malacosoma americanum* egg survival is strongly correlated with the relative position in the egg mass and with the covering of frothy spumaline. Exposed eggs, i.e. those without a spumaline covering, average 27% parasitism and 25% inviability rates. The most vulnerable position within the covered portion of the egg mass is along its perimeter (23% parasitism, 7% inviability). The same general trends appear to be true for *M. disstria*. Clearly, the best oviposition strategy for a female of *Malacosoma* is to cover all eggs with spumaline and to minimize the number of marginal eggs in the mass.

The number of marginal eggs can be changed by altering the shape of the

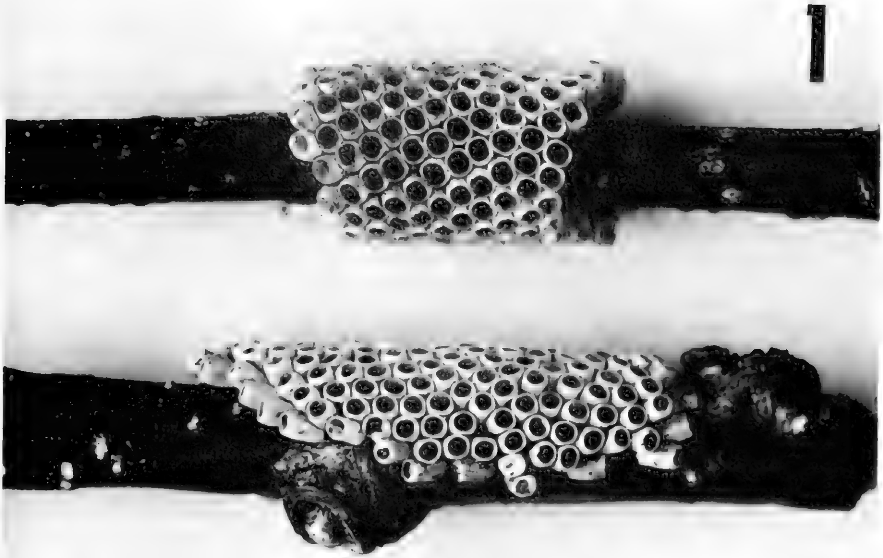

Fig. 1. Egg masses of *M. americanum* (bottom) and *M. disstria* (top). *M. americanum* has a clasping egg mass; *M. disstria* has a helical egg mass. Note the deviation of the marginal eggs of *M. americanum* from the vertical orientation.

egg mass. Two general egg mass shapes are found in *Malacosoma*, clasping (found in *americanum*, *californicum* (Packard), and *incurvum* (Hy. Edwards) and helical (all other species). These terms refer to the final shape of the mass and are a result of differences in oviposition behavior. According to Stehr and Cook (1968), in all species the female oviposits with the longitidunal axis of the body perpendicular to the twig. She swings her abdomen from side to side, laying eggs in a single row, and then moves forward and around the twig. The difference in shape between the two kinds of masses results from varying numbers of eggs laid in each row. Those species forming a helical mass lay only three to four eggs before moving around the twig. The female completely circles the twig several times and packs the eggs as tightly together as possible. The resulting egg mass is roughly cylindrical. The clasping species lay a row of ten to fifteen eggs. As the female oviposits she moves around the twig, but generally does not move far along its longitudinal axis. The egg mass is usually saddle-shaped, occasionally completely encircling the twig and sometimes even overlapping upon itself (Fig. 1).

The type of egg mass will determine the proportion of eggs placed in the vulnerable marginal row. Assume that the eggs are cubic in shape with unit length (u) for each side and unit area for each face. Assume also that the clasping mass has a circular outline so as to minimize the number of marginal eggs in the egg mass (note, an elliptical egg mass will have an even greater number of marginal eggs). Consider a circular clasping egg mass of 260 eggs (the average for *M. americanum,* see below) laid so that the mass completely encircles the twig, but does not overlap itself. The twig would have a circumference of 18.2 eggs, the diameter of the egg mass ($\pi r^2 = 260\text{u}$, $r = 9.097\text{u}$, $d = 2r = 18.2\text{u}$). This egg mass would have 57 marginal eggs along the circumference of the mass (circumference $= 2\,\pi r = 2\pi\ 9.09\text{u} = 57.7\text{u}$), and 22% of the total eggs would be marginal. A helical egg mass laid as a perfect cylinder would have two circles of marginal eggs, one at each end of the egg mass. If laid on the same diameter twig, 18.2u, there would be a total of 36 marginal eggs, with 14% of the total eggs on the margin. Clearly, the optimal egg mass shape, the one minimizing the number of vulnerable marginal eggs, is the helical (cylindrical) egg mass.

Considerations of the phylogeny of *Malacosoma* (see below) indicate that the clasping egg mass is derived (apomorphic) and the helical mass ancestral (plesiomorphic). How can we explain the evolution of this change in oviposition behavior, considering the relatively high marginal mortality rates and assuming the presence of frothy spumaline?

One possibility is that we have overestimated the vulnerability of some of the marginal eggs in clasping egg masses. In those cases in which the lateral edges of the mass are closely approximated and the space between them filled with spumaline, eggs that by our definition are marginal are probably as well protected as interior eggs. If egg masses are laid on very small twigs the clasping egg mass may completely encircle the twig. The last laid row(s) are then laid atop the first laid row(s). In the instances in which we found overlapping eggs, those in the lower layer were rarely parasitized (1%, $n = 76$ eggs). Nevertheless, in the majority of masses the eggs do not encircle the twig (81%, $n = 63$).

We have also observed that the long axes of the marginal eggs of *M. americanum* are usually slanted both away from the perpendicular and away from the center of the mass, sometimes to the extent that the eggs are lying parallel to the twig. This is in contrast to the eggs of *disstria* which are almost always parallel to one another and each perpendicular to the surface of the twig (Fig. 1). This slanting effect increases the distance of the second row of eggs from the edge of the spumaline layer and should result in a lower parasitism rate of the interior eggs. The second and third row parasitism rates cited by Hodson (1939) for *disstria* are indeed greater than those we have found for *americanum* (Fig. 2).

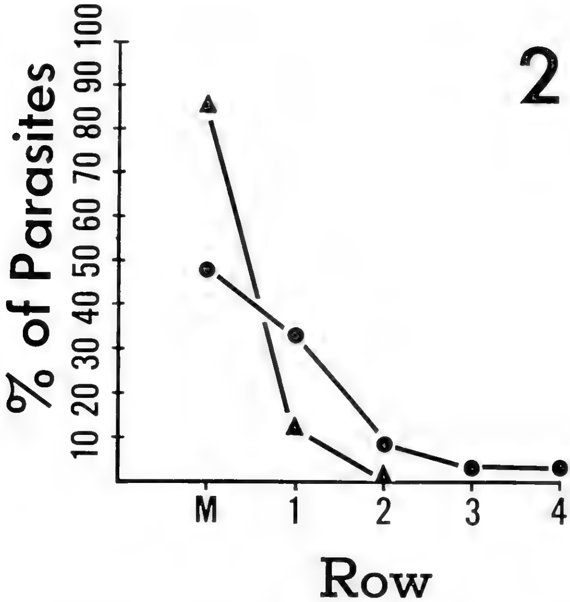

Fig. 2. Distribution of parasites by row. *Malacosoma americanum* (●) [present study, *n* = 10 egg masses] and *M. disstria* (▲) [from Hodson, 1939, *n* = 52 egg masses].

The egg masses of *M. americanum* generally contain many more eggs (mean = 259, SD = 76.8, *n* = 13 egg masses) than those of either *disstria* (mean = 155 eggs; Hodson, 1941) or *neustria* (140–200 eggs; Schwenke, 1978). The clasping mode of oviposition may be necessary if the female is to carry and lay a large number of eggs. A large egg mass, in turn, may be needed to provide a large number of caterpillars, either for the construction of large permanent tents (lacking in *disstria*), or for communal foraging. Finally, a clasping egg mass may enable the female to oviposit on large diameter twigs or even low on tree trunks normally covered by winter snows. The latter is apparently common in the northern Great Lakes region, but is very rare in New York State. A comparison of the low temperature survival rates of pharate larvae of *americanum* and *disstria* may, in fact, provide the key for understanding the evolution of this egg mass shape.

There are interesting differences in the relative abundances of the parasitoid species of *M. americanum* and *disstria*. Species of *Tetrastichus*, *Ooencyrtus*, and *Telenomus* are the most abundant egg parasitoids of both species. In our study of *M. americanum* 80% of the parasitoids were *Tetrastichus malacosomae*, and over 70% of these individuals were reared from marginal eggs (Table 3). In *M. disstria*, parasitism is primarily due to

Ooencyrtus clisiocampae and *Telenomus clisiocampae* which occur in equal numbers and account for 80% of the total parasitism with only 20% mortality due to *Tetrastichus silvaticus* Gahan (Hodson, 1939). In *M. americanum, Ooencyrtus clisiocampae* and *Telenomus clisiocampae* show no preference for the marginal egg class (Table 3). The more even distribution of parasitized eggs in *M. disstria* may reflect the relative importance of these two parasitoids. The predominance of *T. malacosomae* in *M. americanum* may be a reflection of the preference for marginal eggs by this species and the greater numbers in this egg class due to the clasping mode of oviposition.

All species of *Malacosoma* deposit a glandular secretion with each egg (Stehr and Cook, 1968). Hodson and Weinman (1945) coined the term "spumaline" to refer to these glandular materials, regardless of the final form. In many species the spumaline is elaborated into a frothy material which covers the eggs, referred to here as frothy spumaline. This type of spumaline is found in all New World species except *M. tigris.*

Two hypotheses have been proposed for the adaptive significance of frothy spumaline: (1) Reduction of egg parasitism (Hodson, 1939) and (2) resistance to desiccation (Hodson and Weinman, 1945). The data of Hodson and Weinman for *M. disstria* agree with ours for *M. americanum*: inviability rates are significantly higher in exposed eggs than those covered with frothy spumaline. However, if spumaline elaboration is primarily a response to desiccation, then one must explain the resistance to desiccation in the arid-land species *M. tigris* and in all Old World species.

The high parasitism rates in exposed eggs (27%) versus internal eggs (1%) suggests that frothy spumaline is a deterrent to egg parasitoids. However, it is not completely effective in eliminating parasitism in eggs along the margin of the mass in either *M. americanum* or *disstria*. This is not a result of a more ragged covering near the margin as was suggested by Hodson (1939). All eggs scored as marginal in our study were completely covered with a frothy spumaline. In both species over 90% of the parasitized eggs were found in the outside two rows. This strongly suggests that the spumaline does not function as a repellent to parasitic Hymenoptera; rather it acts as a physical barrier separating the wasps from potential hosts.

The distribution of frothy spumaline in species of *Malacosoma* can provide ecological insights only in the context of the phylogeny of the genus. The phylogenetic relationships of *Malacosoma* have not been resolved, but Stehr and Cook (1968) present morphological, ecological and behavioral data that establish the following groups as monophyletic (Table 4): *tigris* + *constrictum*, *neustria* + *disstria*, and *americanum* + *incurvum* + *californicum*. The possible relationships among these three groups are illustrated in Fig. 3. Alternative A is suggested by the distribution of character 10, but we prefer to consider the relationships of these three groups as unresolved pending detailed studies. Species with frothy spuma-

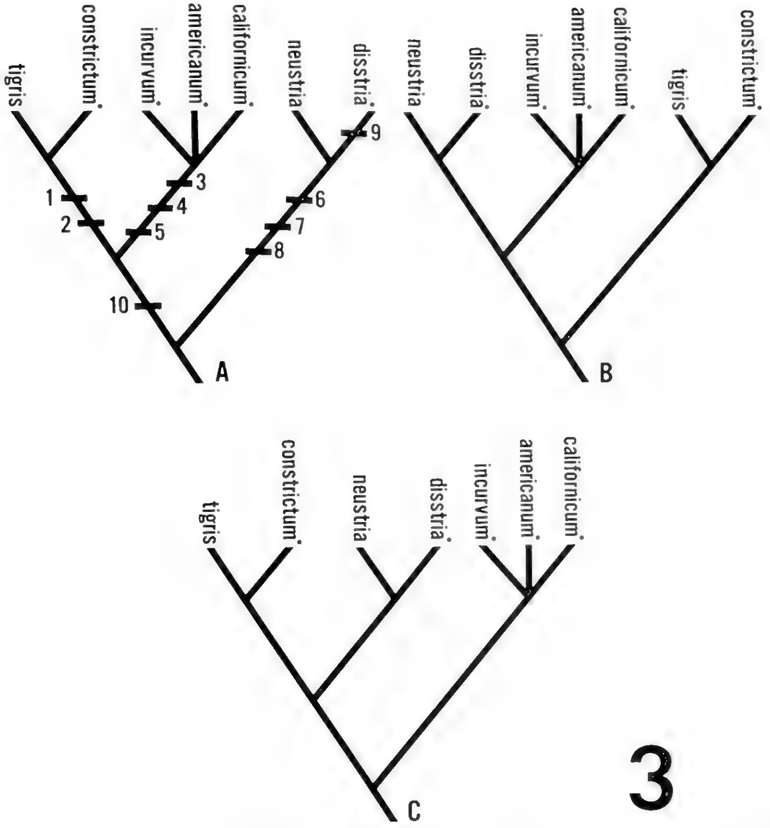

Fig. 3. Three possible cladograms of *Malacosoma* species-groups, with species with a frothy spumaline indicated (*). Numbers refer to characters in Table 4. [See text for discussion.]

line are indicated (*) and appear in each of the three groups. No other members of the genus have frothy spumaline. There are two equally parsimonious interpretations of the pattern of spumaline elaboration for all cladograms in Fig. 3, either frothy spumaline evolved in the common ancestor of all seven species, and was subsequently lost in *neustria* and *tigris*, or frothy spumaline was independently developed three times, in the ancestor of *americanum* + *californicum* + *incurvum*, in *disstria* and in *constrictum*.

Either interpretation establishes that frothy spumaline is an evolutionarily labile character, with either convergences or parallel reductions. We favor the view that a frothy spumaline has evolved independently at least three times for the following reasons:

1. The loss of frothy spumaline in *M. neustria* would result in a substantial

Table 4. Character states of *Malacosoma* species. Polarity determined by considering the European species, *M. franconicum* Esper, *castrensis* (L.), *alpicola* (Staudinger) as the outgroup. Data derived from Stehr and Cook, 1968.

Character No.	Ancestral	Derived
1	Large, permanent tents	Small tents, used only during moulting
2	Feed on many plants	Restricted to oaks
3	Helical egg mass	Clasping egg mass
4	Upper posterior corner of ovipositor valves not produced, rounded or angulate in lateral view	Upper posterior corner of ovipositor valves produced as flattened lobes, strongly angled in lateral view
5	Upper posterior corner of ovipositor valve rounded or only slightly produced	Upper posterior corner of ovipositor valve strongly produced
6	Male epiphysis of foreleg small or absent	Male epiphysis large and sickle-shaped
7	Larval setal group L2 with 3 setae	Setal group L2 with 2 setae
8	Larval setal group D1 with 5 setae	Setal group D1 with 4 setae
9	Large, permanent tents	Tent absent
10	Rear margin of male 7th sternum strongly and coarsely serrate	Rear margin of male 7th sternum sinuous, smooth or slightly denticulate

increase in mortality due to parasitism, from the 5–10% loss in species with frothy spumaline (7.0% in this study) to the level of 20–40% observable today (Tadic, 1965; Romanova and Lozinskij, 1958). We can conceive of no selective advantage to the elimination of the spumaline coating that could offset such an increase in egg mortality.

2. The evolution of the clasping egg mass in the *americanum* group presents a dilemna only if frothy spumaline occurred either simultaneously or before the change in egg mass shape. No selective disadvantage due to marginal egg parasitism would obtain in shifting from a helical to the clasping egg mass if spumaline was not present; all eggs are equally vulnerable. For the clasping egg mass to precede spumaline elaboration in the *americanum* group requires that spumaline evolved convergently at least three times.

3. Frothy spumaline requires only a modification of existing accessory gland secretions, primarily by the incorporation of bubbles. It is noteworthy that the accessory glands of *M. tigris*, which has unmodified spumaline, produce as much material as other New World species (Stehr and Cook, 1968).

On the basis of these observations we feel that a frothy spumaline covering was not lost in *neustria* and *tigris,* but was evolved independently in *disstria, constrictum* and the *americanum* species group as a mechanism to decrease egg parasitism. Parasitoids have been linked several times to the evolution of parental guarding of eggs by the host species (see, e.g. Eberhard, 1975; Odhiambo, 1959; Ralston, 1977). We expect that further studies on the evolution of mating and oviposition behavior of hosts will continue to demonstrate the influential role played by chalcidoid and proctotrupoid egg parasitoids.

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LITERATURE CITED

Anderson, J. F. 1976. Egg parasitoids of forest defoliating Lepidoptera. Pp. 233–249. *In* Anderson, J. F. and H. K. Kaya, eds., Perspectives in Forest Entomology, Academic Press, New York.

Eberhard, W. G. 1975. The ecology and behavior of a subsocial pentatomid bug and two scelionid wasps: Strategy and counterstrategy in a host and its parasites. Smithson. Contrib. Zool. 205, 39 pp.

Hodson, A. C. 1939. Biological notes on the egg parasites of *Malacosoma disstria* Hbn. Ann. Entomol. Soc. Am. 32: 131–136.

———. 1941. An ecological study of the forest tent caterpillar, *Malacosoma disstria* Hbn., in Northern Minnesota. Minn. Agric. Exp. Stn. Tech. Bull. 148, 55 pp.

Hodson, A. C. and C. J. Weinman. 1945. Factors affecting recovery from diapause and hatching of eggs of the forest tent caterpillar *Malacosoma disstria* Hbn. Minn. Agric. Exp. Stn. Tech. Bull. 170, 31 pp.

Liu, C. L. 1926. On some factors of natural control of the eastern tent caterpillar (*Malacosoma americana* Harris), with notes on the biology of the host. Ph.D. thesis, Cornell University, Ithaca, New York.

Odhiambo, T. R. 1959. An account of parental care in *Rhinocoris albopilosus* Signoret (Hemiptera—Heteroptera: Reduviidae), with notes on its life history. Proc. R. Entomol. Soc. Lond. (A) 34: 175–185.

Prentice, R. M. 1953. Egg parasitism of forest tent caterpillar. Can. Dept. For. Bi-mon. Prog. Rep. 9(4): 2.

Ralston, J. S. 1977. Egg guarding by male assassin bugs of the genus *Zelus* (Hemiptera: Reduviidae). Psyche (Camb. Mass.) 84: 103–107.

Romanova, Y. S. and V. A. Lozinskij. 1958. Experiments on the practical use of egg parasites of *Malacosoma neustria* in forest conditions. Zool. Zh. 37: 542–547.

Schwenke, W. 1978. Familienreihe Bombycoidea. Pp. 421–445. *In* Schwenke, W., ed., Die Forstschadlinge Europas, Vol. 3. Schmetterlinge.

Stehr, F. W. and E. F. Cook. 1968. A revision of the genus *Malacosoma* Hübner in North America (Lepidoptera: Lasiocampidae): systematics, biology, immatures, and parasites. U.S. Natl. Mus. Bull. 276, 321 pp.

Tadić, M. D. 1965. *Telenomus terebrans* Ratz., parasite des oeufs du bombyx a livree (*Ma-*

lacosoma neustria L.). Pp. 568–569. *In* Freeman, P., ed., Proc. XIIth Int. Congr. Entomol., Royal Entomological Society, London.

Wellington, W. G. 1965. Some maternal influences on progeny quality in the western tent caterpillar, *Malacosoma pluviale* (Dyar). Can. Entomol. 97: 1–14.

Witter, J. A. and H. M. Kulman. 1972. A review of the parasites and predators of tent caterpillars (*Malacosoma* spp.) in North America. Minn. Agric. Exp. Stn. Bull. 289, 48 pp.

———. 1979. The parasite complex of the forest tent caterpillar in northern Minnesota. Environ. Entomol. 8: 723–731.

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THE BIONOMICS OF TWO SPECIES OF *HYDROCHARA* (COLEOPTERA: HYDROPHILIDAE) WITH DESCRIPTIONS OF THEIR LARVAE

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Abstract.—The habitat, periods of larval and adult occurrence, and possible larval food sources are described for two species of *Hydrochara*. Larvae and adults of *Hydrochara occulta* (d'Orchymont) were found to inhabit *Spartina patens* (Ait.) Muhl. salt marshes, while *Hydrochara soror* Smetana larvae and adults were found in a variety of non-salt marsh habitats. In addition the larvae of the two species are described.

In his world revision of the *Hydrochara*, Smetana (1980) states that the larvae of only three species (*Hydrochara caraboides* (Linnaeus), *H. affinis* (Sharp), and *H. obtusata* (d'Orchymont)) are known. Of these only one, *H. obtusata*, is found in the Nearctic Region. The larva of this species has been discussed by several individuals (Bowditch, 1884; Wickham, 1895; Richmond, 1920; Wilson, 1923; Bertrand, 1972), and Richmond (1920) presented an extensive discussion of larval life history for *H. obtusata*.

During recent studies on the aquatic insects of Parramore Island, a barrier island on the Virginia eastern shore, two species of *Hydrochara* were found to maintain breeding populations. The larvae of these two species (*H. occulta* (d'Orchymont) and *Hydrochara soror* Smetana) and their habitats are described.

The larvae of the two species were not reared; however, larvae were collected in association with adults, and there appears to be little or no 'cross contamination' of habitat by these two species. Adults were never collected outside of their preferred habitat on Parramore Island, and *H. occulta* was not collected from the Dismal Swamp. While rearing is the preferred method of associating larvae with adults, the habitat distinctions appear to be clear-cut enough in this case to warrant the association.

Hydrochara soror Smetana

BIONOMICS

Larvae and adults of this species were found in freshwater woodland pools and were not as abundant on the island as *H. occulta*. *Hydrochara* *soror* was also found in abundance in other woodland habitats in the tidewater area, and larvae and adults of this species have been collected routinely from open, woodland pools in the Dismal Swamp, Virginia.

Adults have been collected during all seasons of the year, but they were most abundant from late spring to fall. First-instar larvae have been collected as early as mid-April and mature third-instar larvae have been collected as late as mid-July. Adults are most abundant in heavily shaded woodland pools and backwaters, and larvae have been collected under these conditions on Parramore Island. In the Dismal Swamp, larvae are much more abundant in large, open temporary pools which form in relatively unshaded areas (old field or burn areas). There the larvae are usually associated with clumps of grass or other vegetation with stems hanging in the water. The rarity of the larvae in woodland pools may be an artifact of sampling since it is very difficult to separate larvae from detritus which is invariably associated with woodland pool habitats.

On Parramore Island the woodland pools contain few potential food species of macroinvertebrates other than *Gammarus* sp., *Anopheles* sp., Chironomidae, and larvae of several aquatic Coleoptera including *Hydroporus signatus youngi* Gordon, *Agabus punctatus* Melsheimer, and Helodidae. In the Dismal Swamp a wide variety of macroinvertebrates and amphibian larvae is available as potential prey, including the larvae of over 20 species of aquatic Coleoptera.

Larval Description

Last-instar larva.—Overall length 25.0 mm, greatest width of pronotum 3.5 mm. Body, except head and prothorax, dirty brown, slightly lighter beneath, especially on thoracic and 1st abdominal segments.

Head as in Fig. 1. Greatest width of head capsule 3.4 mm. Length 2.3 mm from labroclypeus to occipital foramen; almost rectangular, slightly tapering from base of mandibles to posterior edge. Labroclypeus slightly asymmetrical, right side with teeth projecting slightly anteriorly. Side of labroclypeus with 2 small teeth (not counting tooth at apex). Teeth partially fused in some specimens, particularly on right side, and rarely labroclypeus appears almost semicircular with no distinct teeth. Apex of labroclypeus broadly flattened, slightly concave and indistinctly crenulate, with a slight projection at each end which might be interpreted as a 3rd tooth. Anterolateral projections of epistoma slightly produced, not attaining level of anterior edge of labroclypeus; with 4 or 5 indistinct crenulations.

Ocellar area with 6 ocelli arranged in an ellipse with anterior ocellus larger and subtriangular. Antenna with 1st segment almost 4× as long as 2nd and 3rd together. First antennal segment with inner margin slightly concave; with about 50 strong setae on inner margin which vary in length from ¼ to 1¾ the width of 1st antennal segment. Outer margin with about 20 irregularly

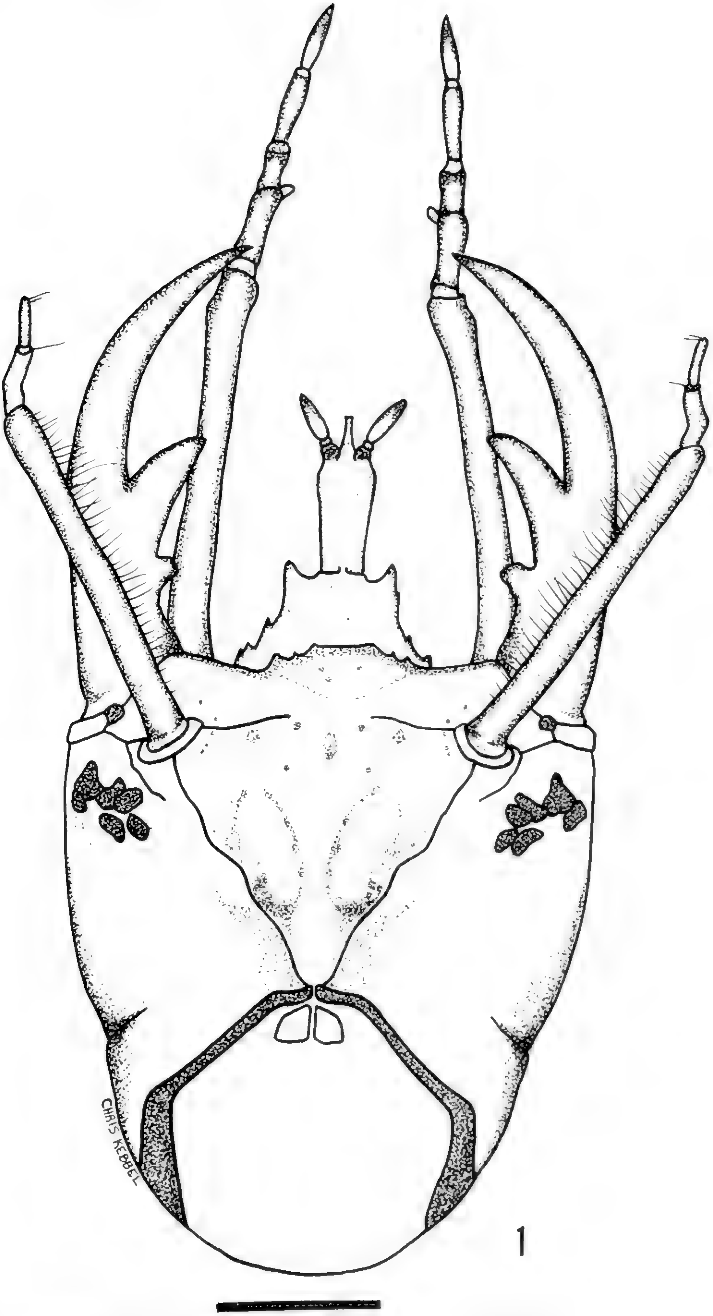

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Fig. 1. Head (dorsal view) of *Hydrochara soror*. Line indicates 1.0 mm.

placed, weak setae. Second segment narrower than 1st, slightly curved, with a sensory pit on outer margin at midpoint and a light seta (which is almost as long as last antennal segment) on inner margin at apex. Third segment about half as long as 2nd and about half as wide, with 2 setae on inner margin at apex.

Mandibles large, long and tapering, roughly symmetrical, each with a large median tooth and a smaller, blunt submedian tooth. Teeth of left mandible slightly broader and thicker than right.

Maxillary stipe long and slender, almost as long as mandible, with several irregularly placed weak setae. Palpifer much shorter, less than ¹/₅ as long as stipes, with 1 or 2 setae on outer edge anteriorly and a short appendage on inner edge anteriorly. Appendage with a long terminal bristle. Palpus 3 segmented, with 1st segment slightly more than half as long as 2nd. Third segment slightly longer than 2nd, tapering at distal ⅓ to a rounded tip, with a single seta located basally.

Labrum projecting beyond tip of median mandibular tooth. Mentum (including ligula) and submentum about equal in length. Submentum (best viewed dorsally) roughly pentagonal, with 2 sharp strong denticles distally flanking base of mentum and with 4 smaller denticles on sloping sides. The anterior most of these 4 denticles is extremely minute. Mentum subquadrangular, with ligula produced, 2× as long as 1st palpal segment. Labial palpi 2 segmented, 1st segment short, 2nd segment long and slender, 4× as long as 1st.

Pronotum broader than long, sloping laterally, broadly margined, with sagittal line prominent. Sclerotized portion of mesonotum and metanotum reduced to subtriangular sclerites, broader anteriorly, tapering posteriorly with a small transverse sclerite at tip of each triangle. Metanotal sclerites smaller than mesonotal sclerites. Prosternal sclerite large. Mesosternum and metasternum without sclerites.

Legs of similar morphology, 4 segmented, widely separated. Coxae, trochanters, femora, tibiotarsi and claws 1.6, 0.6, 2.0, 1.3, and 0.5 mm in length respectively. Coxae, trochanters and femora with a fringe of fine hairs on upper and lower surfaces. Tibiotarsi with a fringe of stouter hairs on lower surface and with a single large seta on upper inner face at basal ⅓ and 1 stout seta at apex. Claws single, gently curved with 2 stout setae in basal ½.

Abdomen with 8 distinct segments. Segments 9 and 10 reduced. Segment 1 with a pair of small sclerites dorsolaterally at anterior margin. Segments 1–7 secondarily divided by transverse folds; 2nd fold of each segment bearing 4 setose tubercles. Epipleurite and hypopleurite of each segment (1–7) with a short setose tubercle and the epipleurite with a long setose filament.

Eighth tergum, representing the dorsal valve of stigmatic atrium, bears a

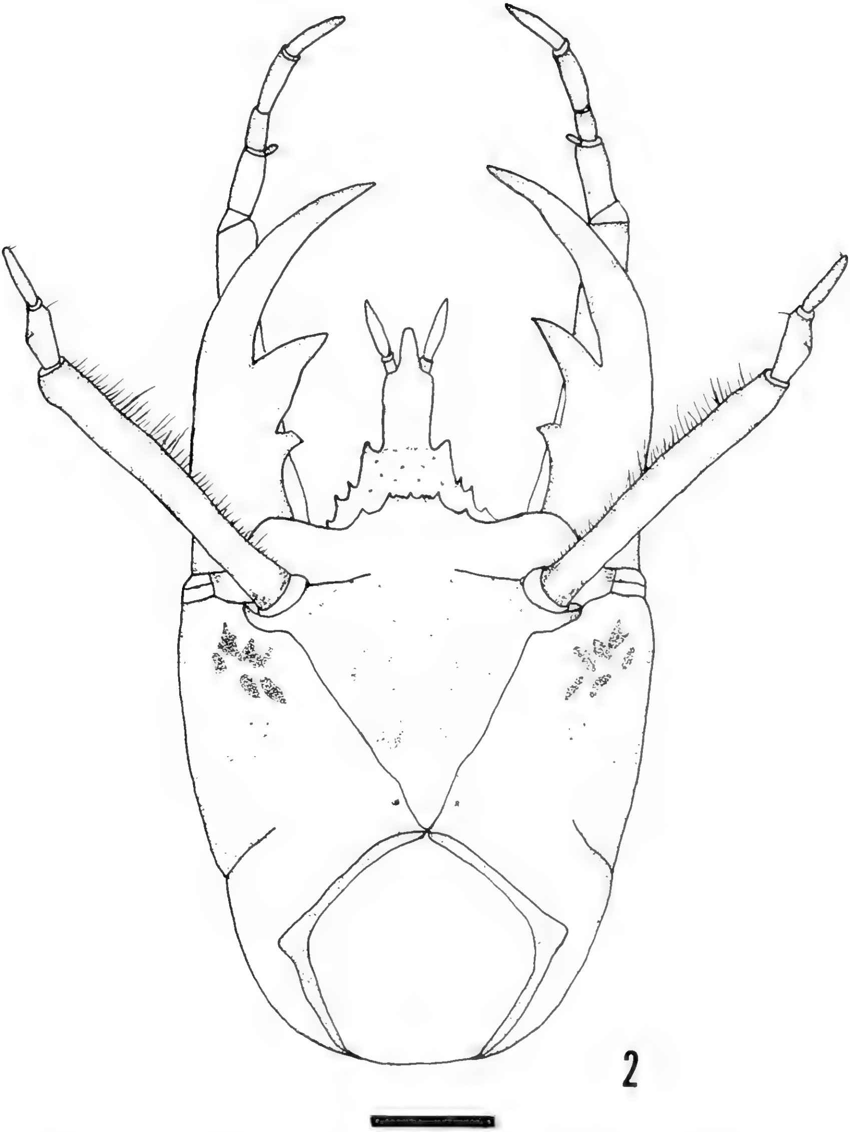

Fig. 2. Head (dorsal view) of *Hydrochara occulta*. Line indicates 1.0 mm.

quadrate sclerotized plate which is usually entire but occasionally projects weakly distally and is rarely notched posteromedially so that rear margin appears bidentate; posterior margin of stigmatic atrium with 6 distinct lobes. Mesocercus prominent and sclerotized, bearing 2 long and 1 short setae;

paracerci less distinctly sclerotized, bearing 2 terminal setae. Posteroventral gill-like appendages as long as the stigmatic atrium (ventromedially).

***Hydrochara occulta* (d'Orchymont)**

BIONOMICS

Adults of this species were found in the low salinity (2 to 12 ppt) *Spartina patens* (Ait.) Muhl. marshes on Parramore Island. They were most frequently encountered in deep (½ to 1 m), detritus filled sloughs which were heavily shaded with shrubs. Adults were collected during all seasons of the year but were most abundant during late summer and fall.

Larvae were also found in the *Spartina patens* marshes and were usually found clinging to the mat of *S. patens* stems which hang in the water at the margins of the pools. First- and second-instar larvae were collected in late May and mature third-instar larvae were collected as late as mid-July. In the laboratory larvae fed on anything small enough for them to subdue, including mosquito larvae, damselfly larvae, isopods, amphipods, small fish, and amphibian larvae. They rejected hard bodied insects such as adult beetles and some hemipterans. In the field, food available included *Gammarus* sp. and small fish (*Fundulus heteroclitus* (Linnaeus) and *Cyprinodon variegatus* Lacépède) as well as a variety of smaller crustaceans and insects. Other aquatic Coleoptera found in association with this species were the Dytiscidae, *Hygrotus impressopunctatus* (Schaller), *Liodessus affinis* (Say), and *Thermonectus basillaris* (Harris), and the Hydrophilidae *Tropisternus quadristriatus* Horn, *Enochrus hamiltoni* (Horn), and *Berosus fraternus* LeConte. In addition Helodidae larvae were also abundant.

LARVAL DESCRIPTION

Last-instar larva.—Similar to *H. soror*; differing in shape of labroclypeus (Fig. 2) which has a large distinct tooth on side and anterior margin appearing tridentate with middle tooth reduced. Gill-like posteroventral appendages of stigmatic atrium reduced, shorter than ventromedian length of stigmatic atrium. In addition *H. occulta* usually are lighter than *H. soror,* being straw yellow rather than brown.

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LITERATURE CITED

Bertrand, H. 1972. Larves et nymphes des coléoptères aquatiques du globe. Paris. 804 pp.

Bowditch, F. C. 1884. *Hydrocharis obtusatus*. J. Boston Zool. Soc. 3: 1–6.

Richmond, E. A. 1920. Studies on the biology of the aquatic Hydrophilidae. Bull. Am. Mus. Nat. Hist. 42: 1–94.

Smetana, A. 1980. Revision of the genus *Hydrochara* Berth. (Coleoptera: Hydrophilidae). Mem. Entomol. Soc. Can. 111: 1–100.

Wickham, H. F. 1895. On the larvae of *Hydrocharis obtusatus* and *Silpha surinamensis*. Entomol. News 6: 168–171.

Wilson, C. B. 1923. Life history of the water scavenger beetle *Hydrous (Hydrophilus) triangularis*, and its economic relation to fish breeding. Bull. U.S. Bur. Fisheries 39: 9–38.

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SMITTIA LASIOPS (MALLOCH): A REDESCRIPTION OF THE ADULTS WITH A DESCRIPTION OF THE IMMATURE STAGES (DIPTERA: CHIRONOMIDAE)

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Abstract.—The adults of *Smittia lasiops* (Malloch) are redescribed, with a description of the immature stages. The terrestrial nature of the immature stages is discussed.

Malloch (1915) described the adults of *Smittia lasiops* (as *Camptocladius lasiops*) from adults collected around garbage at a home in Urbana, Illinois. The place of occurrence of the adults indicated to Malloch that the larva was terrestrial. During an investigation of the bionomics of the northern and western corn rootworms by the Section of Economic Entomology, Illinois Natural History Survey, numerous larvae of a terrestrial chironomid were collected from soil samples taken in an experimental corn plot on the University of Illinois South Farm area at the south edge of Urbana. Soil samples collected for egg counts of corn rootworms had been washed and separated using an apparatus (Shaw et al., 1976) that would process a pint of soil in 3–4 minutes. Using this apparatus, I recovered numerous live chironomid larvae from subsequent soil samples taken in the experimental corn plots. Larvae were also collected on the roots of corn plants, although there was no evidence of damage to the roots. Several larvae were reared, and I identified the adults as *Smittia lasiops*.

Malloch's description of the male and female of *Smittia lasiops* was very general. Sublette (1967, 1970) added to the description of *Smittia lasiops* in his review of the type-specimens of the Chironomidae in the collections of the Illinois Natural History Survey and the Canadian National Collection. In his examination of the lectotype male (Frison, 1927), lectoallotype, and paratypes at the Illinois Natural History Survey, Sublette mounted only the male terminalia on slides, and based the remainder of his description on pinned material. In my examination of slide material of the reared adults and a slide preparation of the lectotype, I found some variation from Sublette's description, in addition to certain undescribed features of the adults.

With the discovery of the immature stages, the determination of their terrestrial nature, and because of the incomplete earlier description of the adults, I feel it is appropriate to redescribe the adults and to describe the immature stages. No comparison is made at this time between other eastern species of *Smittia*.

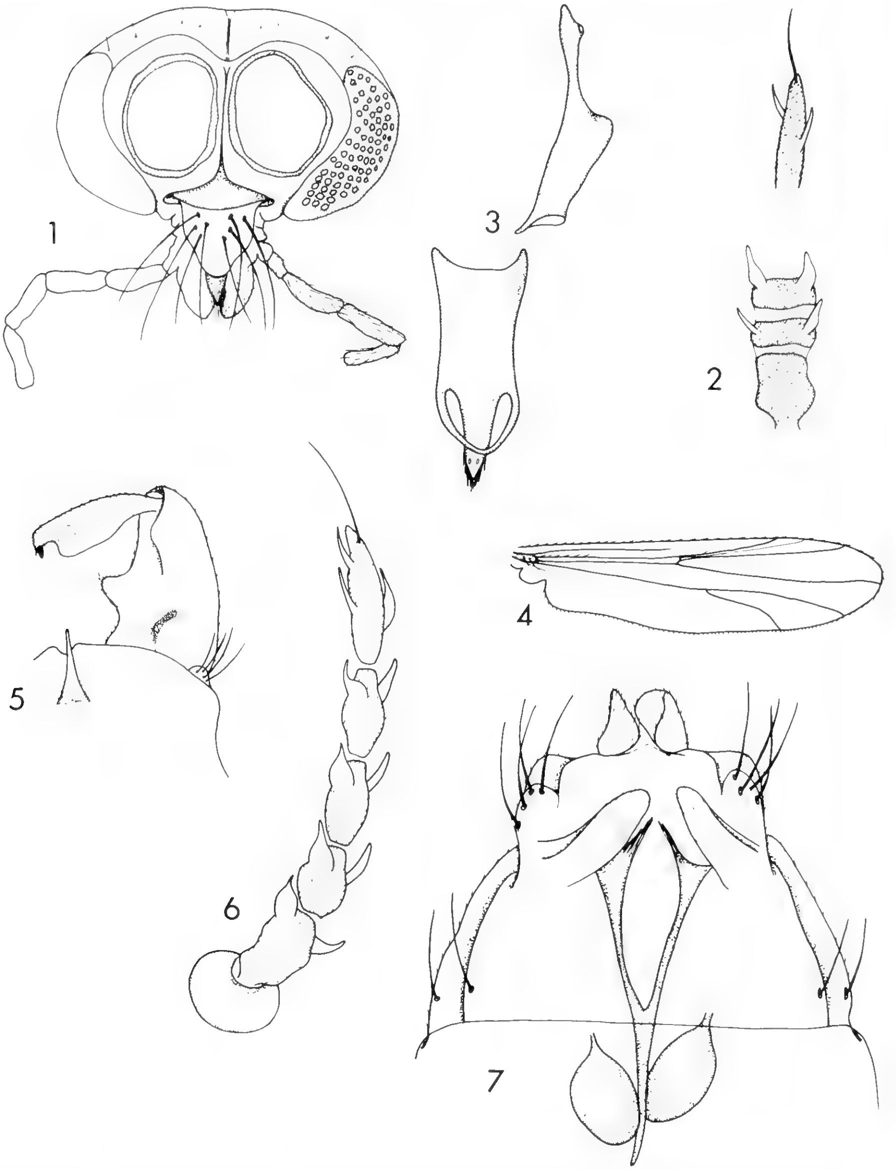
The terminology and abbreviations follow that of Saether (1980). All measurements are given in millimeters, with the range and mean.

Smittia lasiops (Malloch)

Male.—Length 2.17–2.51, 2.41 ± 0.10 ($N = 10$). Head (Fig. 1) dark brown, expanded laterally. Eyes dark brown; dichoptic; facets of equal size; covered with short fine setae; dorsal separation between eyes 1.63× ventral distance. Coronal triangle reduced, narrowed anteriorly, 1.1–1.7, 1.4× longer than wide; coronal setae absent. Antenna dark brown; scape flattened, ring-shaped, 1.2–1.4, 1.3× longer than wide; pedicel globose, macrosetae absent, 1.4–2.2, 1.9× wider than long; flagellomeres plumose, flagellomeres 2, 3, and 13 (Fig. 2) with 2 flat hyaline lateral blades, flagellomere 13 with distinct apical seta, flagellomere lengths: 0.048–0.054, 0.052; 0.018–0.024, 0.021; 0.021–0.027, 0.024; 0.018–0.024, 0.021; 0.018–0.024, 0.020; 0.018–0.024, 0.020; 0.018–0.024, 0.020; 0.018–0.024, 0.020; 0.018–0.024, 0.021; 0.021–0.024, 0.022; 0.018–0.024, 0.022; 0.021–0.024, 0.022; 0.540–0.600, 0.578; AR 1.87–2.16, 2.03. Clypeus dark brown, broad, ventral ⅓ tapered to broad point; clypeal setae 6–8, 7, dark brown, elongate. Maxillary palps membranous, pale brown, cylindrical, length of palpal segments: 0.016–0.030, 0.023; 0.037–0.051, 0.043; 0.076–0.092, 0.085; 0.069–0.092, 0.097; 0.085–0.099, 0.091; setae dark brown, elongate, scattered. Inner vertical setae 0–2, 1; outer vertical setae 0–4, 2; frontal setae absent; postorbital setae 0–3, 1. Cibarial pump (Fig. 3) elongate, tapered ventrally, apex acute, 0.145–0.170, 0.159 long, 0.048–0.074, 0.060 wide, 2.2–3.2, 2.7× longer than wide. Tentorium (Fig. 3) 0.127–0.150, 0.141 long.

Thorax dark brown, subshiny; vittae indistinct. Antepronotum in lateral view narrow, elongate, expanded ventrally; in dorsal view median fissure contiguous; antepronotal setae absent. Acrostichial setae absent; dorsocentrals 5–12, 8; prealar setae 2–6, 4. Pleura pale brown, anepisternal and katepisternal setae absent. Halter pale yellowish brown to pale brown. Scutellum dark brown, subshiny, rounded posteriorly; scutellar setae 6–7, 6 in single transverse row.

Wing (Fig. 4) length (from arculus) 1.47–1.79, 1.68; 3.6× longer than wide. Membrane hyaline; microtrichia absent; brachiolar setae 1–2, 1; basal half of radius with 4–6, 5 setae; R_1 with 1 seta; veins pale yellowish brown. Costa ending anterior to apex of wing, distinctly distad to apex of R_{4+5}. R_{2+3} reaches costa 0.49–0.55, 0.53 of way between R, and R_{4+5}. Squama glabrous. WR 1.2–1.3, 1.3.



Figs. 1–7. *Smittia lasiops*. 1, Head. 2, Male flagellomeres 1–3, apex of flagellomere 13. 3, Cibarial pump and tentorium. 4, Male wing. 5, Male terminalia. 6, Female antenna. 7, Female terminalia.

Legs pale brown, concolor, linear. Tibial spur on foreleg 0.046–0.051, 0.048. Inner tibial spur on midleg 0.012–0.018, 0.015, outer tibial spur 0.018–0.028, 0.022. Inner tibial spur on hindleg 0.009–0.023, 0.015, outer tibial spur 0.041–0.054, 0.048. Empodium filiform, pale yellow. Pulvilli reduced, indistinct. Apical claws on tarsomere 5 fuscus, paired, simple. Lengths (in mm) and proportions of legs:

	fe	ti	ta_1
P_1	0.536–0.643, 0.604	0.673–0.826, 0.760	0.352–0.444, 0.393
P_2	0.612–0.689, 0.656	0.536–0.719, 0.635	0.245–0.321, 0.292
P_3	0.627–0.719, 0.689	0.673–0.796, 0.736	0.352–0.459, 0.424
	ta_2	ta_3	ta_4
P_1	0.199–0.245, 0.226	0.138–0.168, 0.158	0.077–0.107, 0.096
P_2	0.153–0.184, 0.166	0.107–0.138, 0.119	0.061–0.077, 0.075
P_3	0.184–0.245, 0.226	0.168–0.184, 0.177	0.077–0.092, 0.090
	ta_5	LR	BV
P_1	0.046–0.092, 0.081	0.46–0.57, 0.52	2.90–4.04, 3.23
P_2	0.061–0.077, 0.073	0.40–0.54, 0.46	3.62–3.74, 3.65
P_3	0.077–0.092, 0.086	0.52–0.62, 0.57	3.24–3.41, 3.26
	SV		
P_1	3.13–3.81, 3.48		
P_2	4.02–4.90, 4.40		
P_3	3.21–3.71, 3.40		

Abdomen and terminalia (Fig. 5) dark brown; setae dark brown to fuscus, elongate, scattered. Anal point distinct, acute. Gonostylus broad, reflexed, apex truncate, length 0.08–0.10, 0.095; apical tooth thick, length 0.01. HR 1.7–1.9, 1.75.

Female.—Coronal triangle indistinct. Antenna (Fig. 6); scape 0.06–0.10, 0.08 long, 0.05–0.07, 0.06 wide, 1.1–1.6, 1.3× longer than wide; pedicel 0.06–0.07, 0.062 long, 0.07–0.08, 0.072 wide, 1.0–1.3, 1.2× wider than long; flagellomeres pilose, flagellomeres 1–5 with 2 broad hyaline blades, lengths 0.078–0.090, 0.084, flagellomere lengths: 0.066–0.072, 0.067; 0.048–0.060, 0.053; 0.060–0.072, 0.062; 0.060–0.072, 0.062; 0.090–0.114, 0.097. Clypeal setae 6–13, 8. Maxillary palpal lengths: 0.018–0.024, 0.023; 0.024–0.042, 0.032; 0.060–0.078, 0.067; 0.072–0.084, 0.076; 0.066–0.096, 0.079; setae pale brown. Inner vertical setae 2; outer vertical setae 1–2, 2; postorbital setae absent. Cibarial pump 0.108–0.162, 0.140 long, 0.054–0.066, 0.060 wide, 1.8–2.6, 2.3× longer than wide. Tentorium 0.108–0.138, 0.128 long.

Antepronotal setae 3–4, 4; dorsocentrals 9–12, 11; prealars 3–4, 4; scutellar setae 5–7, 6.

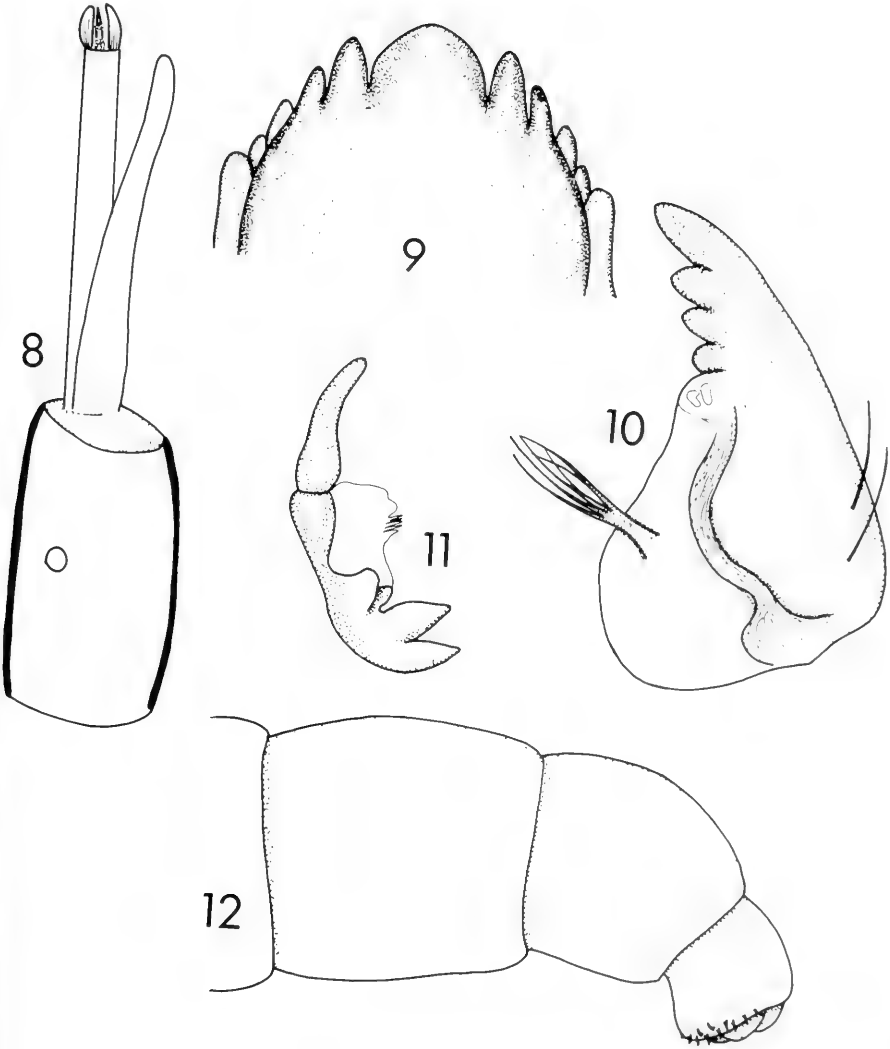
Wing length 1.42–1.64, 1.53, 2.7–3.7, 2.9× longer than wide. Brachiolar setae 2; setae on basal half of radius 10–13, 11; setae on R_1 7–8, 8; setae on R_{4+5} 13–18, 16. R_{2+3} lies alongside of R_1, almost fused. VR 1.2–1.3, 1.26.

Length of tibial spur on foreleg 0.018–0.037, 0.029; length of inner spur on midleg 0.009–0.018, 0.014, outer spur 0.018–0.025, 0.022; length of inner spur on hindleg 0.012–0.016, 0.014, outer spur 0.051–0.046, 0.045. Lengths (in mm) and proportions of legs:

	Fe	Ti	Ta_1	Ta_2	Ta_3	Ta_4	Ta_5	LR	BV	SV
P_1	0.413–0.536, 0.477	0.536–0.658, 0.594	0.260–0.306, 0.288	0.122–0.184, 0.165	0.107–0.199, 0.135	0.077–0.077, 0.077	0.061–0.077, 0.064	0.4–0.5, 0.48	2.6–3.3, 3.1	3.5–3.9, 3.7
P_2	0.474–0.612, 0.536	0.520–0.627, 0.557	0.214–0.275, 0.236	0.107–0.138, 0.125	0.092–0.168, 0.113	0.061–0.077, 0.064	0.046–0.061, 0.058	0.4–0.4, 0.40	3.0–4.0, 3.6	4.4–4.8, 4.6
P_3	0.581–0.643, 0.600	0.551–0.719, 0.624	0.321–0.428, 0.361	0.153–0.199, 0.174	0.138–0.168, 0.147	0.061–0.077, 0.071	0.061–0.077, 0.071	0.6–0.6, 0.60	3.2–4.0, 3.5	3.2–3.5, 3.4

Abdomen and terminalia (Fig. 7) pale brown. gonopophysis VIII membranous, oblong. Gonocoxite IX with 4 setae. Rami of gonapophysis IX 0.207–0.248, 0.228 long. Cerci reduced, length 0.048–0.060, 0.054. Spermatheca oval, dark brown, length 0.081, width 0.044–0.048, 0.046, 1.8× longer than wide.

Pupa.—Length 2.4–3.0, 2.7 ($N = 3$). Exuvium pale yellow. Thoracic horn and cephalic tubercle absent. Precorneal setae 1–3 in short arc. Median antepronotal setae 1. Dorsocentral, metanotal, prealar, supraalar, postorbital, and vertical setae absent. Wing sheath broad, apex rounded, nose and pearl row absent. Tergum I with fine spinules scattered across anterior half. Terga II–VIII with fine spinules across each entire tergum, generally coarser anteriorly on each tergum. Lateral and dorsal setae absent. Pedes spurii B



Figs. 8–12. *Smittia lasiops*, larva. 8, Antenna. 9, Mentum. 10, Mandible. 11, Premandible. 12, Abdominal segments 7–9.

and posterolateral tubercle on tergum VIII absent. Anal lobe without macrosetae or fringe of natatory setae.

Larva.—Head capsule dark yellow, body pale white. Length 4.2–4.6, 4.3 + 0.07 (*N* = 5). Head capsule length 0.306–0.360, 0.322, width 0.246–

0.276, 0.263, 1.2× longer than wide. Postoccipital margin broadly rounded anteriorly, extending anteriorly 0.108–0.138, 0.121 from posterior margin of head. Antenna (Fig. 8), length of segments: 0.028–0.035, 0.031; 0.037–0.041, 0.039; 0.001; 0.002, AR = 0.74; width of basal segment 0.018, 1.6–1.9, 1.7× longer than wide, 0.7–0.9, 0.8× length of 2nd segment; distance from base to annular organ 0.012–0.018, 0.015; length of antennal blade 0.032–0.044, 0.039; lauterborn organs reduced at apex of 2nd segment, extend to apex of antennal segment 4. Mentum (Fig. 9), length 0.053–0.067, 0.061, width 0.104–0.113, 0.107, 1.6–2.0, 1.8× wider than long; anterior convex, median tooth broad, simple, 5 pairs of lateral teeth, descending in height from median tooth. Ventromental plate and setae absent. Mandible (Fig. 10) length 0.104–0.110, 0.107; width 0.053–0.064, 0.057; 1.7–2.0, 1.9× longer than wide; outer lateral broadly rounded, not crenulate; mediolateral margin smooth; apical tooth 0.5–0.6, 0.55× combined width of lateral teeth; setae subdentalis indistinct; setae interna reduced, branched; lateral setae 2. Premandible (Fig. 11) bifid, length 0.053–0.064, 0.059; inner blade 1.0–1.5, 1.3× basal width of outer blade; premandibular brush absent. Setulae I dentate. Fore prolegs reduced, fused medially, claws simple. Procerci and posterior prolegs absent (Fig. 12). Anal gills reduced, 2 pairs, rounded apically. Posterior margin of abdominal segment 9 (Fig. 12) with numerous coarse, simple spinules.

LITERATURE CITED

Frison, T. H. 1927. A list of the insect types in the collections of the Illinois State Natural History Survey and the University of Illinois. Ill. Nat. Hist. Surv. Bull. 16: 137–309.

Malloch, J. R. 1915. The Chironomidae, or midges, of Illinois, with particular reference to the species occurring in the Illinois River. Ill. State Lab. Nat. Hist. Bull. 10: 275–543.

Saether, O. A. 1980. Glossary of chironomid morphology terminology. (Diptera: Chironomidae). Entomol. Scand. Suppl. 14: 1–51.

Shaw, J. T., R. O. Ellis, and W. H. Luckmann. 1976. Apparatus and procedure for extracting corn rootworm eggs from soil. Ill. Nat. Hist. Surv. Biol. Notes 96: 1–4.

Sublette, J. E. 1967. Type specimens of Chironomidae (Diptera) in the Canadian National Collections, Ottawa. J. Kans. Entomol. Soc. 40: 290–331.

———. 1970. Type specimens of Chironomidae (Diptera) in the Illinois Natural History Survey collection, Urbana. J. Kans. Entomol. Soc. 43: 44–95.

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A REVIEW OF THE GENUS *CHAETOCOELUS* LeCONTE (COLEOPTERA: MALACHIIDAE)

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Abstract.—*Chaetocoelus* LeConte and *C. setosus* LeConte are redescribed. *Chaetocoelus* is characterized by the presence in the male of a pectinate comb of stout, black teeth on the anterior margin of segment I of the protarsus. This character, not mentioned in the original description, places the genus in the subfamily Carphurinae. *Chaetocoelus* is closely related to *Carphuroides* Champion from which it differs primarily by the greatly reduced female elytra, a character of dubious generic value. Formal synonymy is not currently recommended; however, *C. setosus* should be considered in any revision of the genus *Carphuroides*. A lectotype is designated for *C. setosus*.

The monotypic genus *Chaetocoelus* was described by LeConte in 1880. The genus was briefly characterized by the brachyelytrous female, and the presence in both sexes of long, stiff bristles at the sides of the abdomen. Marshall (1954), relying on LeConte's description, placed *Chaetocoelus* in the subfamily Malachiinae. Recently I was able to examine the type-series of *Chaetocoelus setosus* and discovered several characters not mentioned by LeConte in his original description. The most important of these, the presence of a pectinate comb of stout, black teeth on the anterior margin of segment I of the male protarsus, suggests that *Chaetocoelus* belongs in the subfamily Carphurinae. Redescriptions of *Chaetocoelus* and *C. setosus* and a discussion of the taxonomic placement of the genus are given below.

Genus *Chaetocoelus* LeConte

Chaetocoelus LeConte, 1880: 194 [Type-species: *Chaetocoelus setosus* LeConte; fixed by monotypy]; LeConte and Horn, 1883: 214; Marshall, 1948: 125, 1954: 75; Wittmer, 1961: 612.

Description.—Small, graciliform. Surface shining. Yellow brown to reddish brown. Pubescence conspicuous; long erect setae on head, pronotum, elytra, and abdomen.

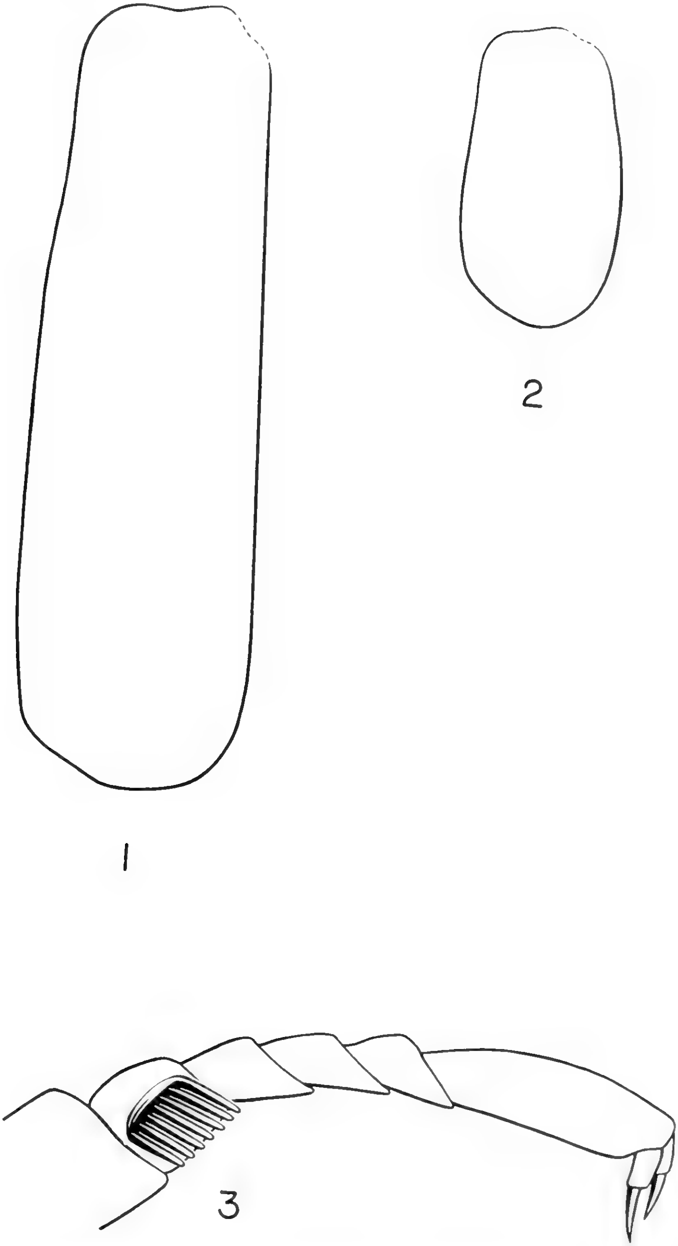
Head short, frons slightly impressed. Clypeus short, appearing entirely membranous; epistomal suture tangential to antennal sockets. Antenna 11-segmented, submoniliform to subserrate.

Pronotum quadrate, as wide as head, apex not produced; anterior angles variable; sides slightly and evenly produced; posterior angles broadly rounded, not reflexed; disc smooth, lacking sulci or other impressions. Elytra varying in length, fully developed in male, greatly reduced in female; apex unmodified in both sexes. Wings present, fully developed in male, reduced to small pads in female. Tarsi 5-segmented in both sexes; segment I of male protarsus with a pectinate comb of stout, black teeth on anterior margin; segments II–IV of both sexes narrow, rounded at apex, not bilobed.

Abdominal sterna completely sclerotized medially; terminal abdominal sternum broadly rounded in both sexes; pygidium truncate in male, broadly rounded in female. Aedeagus of male genitalia with median lobe elongate, bluntly bilobed apically (dorsal aspect); internal sac armed with large acute spines.

Remarks.—The family Malachiidae has been divided into two subfamilies, the Carphurinae and Malachiinae (Champion, 1923; Evers, 1968). The Carphurinae are characterized by the presence of a pectinate comb of stout, black teeth on the anterior margin of segment I of the male protarsus, the presence of eight small pairs of eversible vesicles (one between head and prothorax, one on metepimeron, and one each on the lateral margins of abdominal sterna I–VI), the presence of seven visible abdominal sterna, and the bilobed apex of the median lobe of the aedeagus. The Malachiinae are characterized by the absence of a comb on segment I of the male protarsus, the presence of two large pairs of eversible vesicles (one between head and prothorax and one between metasternum and first abdominal sternum), the presence of six visible abdominal sterna, and the simple apex of the median lobe of the aedeagus. The presence of a tarsal comb on segment I of the male protarsus, a character overlooked by LeConte in his description of *Chaetocoelus*, as well as concurrence of other characters mentioned above, places the genus in the subfamily Carphurinae.

Chaetocoelus, with the exception of a specimen from Ceralbo Island in the Gulf of California identified by Marshall (1951) as *Carphuroides atratulus* (Gorham), is the only genus of Carphurinae known from North America. It appears to be most closely related to the genus *Carphuroides* Champion (1923). In both taxa tarsal segments II–IV are narrow and rounded at the apex rather than broad and more or less bilobed as they are in most other carphurine genera, and the pronotum is unmodified, without sulci or other impressions. Males of *Chaetocoelus* cannot be distinguished from males of *Carphuroides* by any character or combination of characters. Females differ only in that those of *Chaetocoelus* are brachyelytrous and brachypterous while females of *Carphuroides* tend to have the elytra and wings



Figs. 1–3. *Chaetocoelus setosus*. 1, Male elytron, dorsal aspect. 2, Female elytron, dorsal aspect. 3, Male protarsus, anterior aspect.

fully developed. These characters have not often been used as a basis for characterizing genera of Malachiidae, and in some (*Endeodes* and *Attalusinus*) there is considerable interspecific variation with respect to the length of the elytra and the development of the wings. This suggests that the two taxa may be congeneric. However, *Carphuroides* is a large, widely distributed genus, and, until its numerous species can be studied along with *Chaetocoelus setosus* in the context of a generic revision, formal synonymy is not recommended.

Chaetocoelus setosus LeConte

Figs. 1–3

Chaetocoelus setosus LeConte, 1880: 194 [Lectotype, ♂, herein designated from Columbus, Texas, in the Museum of Comparative Zoology, Harvard University, Cambridge, Mass. (Type No. 3465, examined)]; LeConte and Horn, 1883: 214; Marshall, 1948: 125.

Description.—Length 1.8 mm, male; 0.8–1.1 mm, female (measured from anterior margin of pronotum to apex of elytra). Pale yellow brown to dark reddish brown; elytra yellow brown, apex darker in female. Pubescence conspicuous; long, erect, tan to reddish-brown setae on head, pronotum, elytra, and abdomen; lateral margins of abdomen with some setae 1.5× as long as eye or shorter in male, and 4 to 5× as long as eye or longer in female.

Head 1.6, male; 1.3–1.4, female, as wide as interocular distance; frons, interocular margins, and much of vertex with finely sculptured ridges; ridges transverse on vertex, and more or less longitudinal on interocular margins and frons; median apex of vertex smooth, finely, sparsely punctate. Antenna short, stout, barely surpassing elytral humeri in male, shorter in female; segments III–X subserrate in male, submoniliform in female; VII 0.8–1.0 as long as wide. Eyes coarsely faceted in both sexes; male eyes nearly twice as large as female eyes.

Pronotum 0.78, male; 0.80–0.85, female, as long as wide; anterior angles truncate in male, broadly rounded in female; lateral margins diverging from base in male, widest at apical angles; lateral margins subparallel in female, widest near middle. Elytra of male (Fig. 1) long, sutural margin entire, 4 abdominal terga exposed; female elytra (Fig. 2) short, sutural margin divergent apically, 7 abdominal terga exposed.

Tarsal comb (Fig. 3) on segment I of male protarsus with 7 teeth.

Abdomen wider than elytra in female; segments II and III widest, IV to VII tapering to apex. Aedeagus of male genitalia with a pair of long sharp spines at apex of internal sac.

Geographic distribution.—Southeastern North America from Florida west to Texas.

Specimens examined.—FLORIDA: 4 ♀ Punta Gorda, II.7/10.40. TEXAS: 1 ♂, 2 ♀ Columbus, 1–17 June.

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LITERATURE CITED

Champion, G. C. 1923. A revision of the Malayan and Indian species of the melyrid subfamily Carphurinae. Ann. Mag. Natl. Hist. (9) 12: 1–54.

Evers, A. M. J. 1968. Carphurinae oder Carphuridae. Entomol. Bl. Biol. Syst. Kaefer 64: 17–27.

LeConte, J. 1880. Short studies of North American Coleoptera. Trans. Am. Entomol. Soc. 8: 194.

LeConte, J. and G. Horn. 1883. Classification of the Coleoptera of North America. Smithson. Misc. Collect. 264: 169–348.

Marshall, M. Y. 1948. Studies in the Malachiidae II. Entomol. Am. 28: 113–144.

———. 1951. Studies in the Malachiidae III. Proc. Calif. Acad. Sci. 27(4): 77–132.

———. 1954. A Key to the world genera of Malachiidae. Coleopt. Bull. 8(5&6): 59–82.

Wittmer, W. 1961. Malachiinae, Fasc. 67, p. 612. *In* Arnett, R. H., The Beetles of the United States (a manual for identification). Catholic University of America Press, Washington, D.C. 1112 pp.

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SIX NEW SPECIES OF NEOTROPICAL ARADIDAE (HEMIPTERA)

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Abstract.—Six new taxa are proposed, *Aneurus* ***aterrimus,*** n. sp. (Costa Rica), *A.* ***brailovskyi,*** n. sp. (Mexico), *Mezira* ***guanacastensis,*** n. sp. (Costa Rica), *M.* ***hondurensis,*** n. sp. (Honduras), *M.* ***proxima,*** n. sp. (Peru), and *Notapictinus* ***piliger,*** n. sp. (Colombia).

By the kind offices of Dr. Harry Brailovsky, Instituto de Biologia, Universidad Nacional Autonoma de Mexico, Mexico 20, Mexico, and Dr. John A. Chemsak, University of California, Berkeley, I had the privilege of studying Neotropical Aradidae under their care, for which I express my sincere gratitude.

Among these Aradidae six species were new and are described in this paper. Of particular interest is a species of *Notapictinus* Usinger and Matsuda, 1959, whose body, antennae and legs are covered with stiff, erect bristles, the first case of such pilosity in this genus.

All measurements in this paper were taken with micromillimeter eyepiece, 25 units = 1 mm. In ratios, the first figure represents the length and the second the width of measured portion.

Subfamily ANEURINAE

Genus *Aneurus* Curtis, 1825

Aneurus brailovskyi **Kormilev, New Species**

Figs. 1–3

Female.—Elongate ovate; head and pronotum partially granulate; looks scabrous.

Head: Almost as long as its width across eyes (15.5:16.0); anterior process rounded anteriorly, not reaching tip of antennal segment I; antenniferous tubercles truncate anteriorly; postocular blunt, reaching outer border of eyes. Eyes semiglobose, moderately protruding. Vertex transversely striate.

Antenna strong; antennal segment I barrel-shaped; II subobovate; III tapering toward base; IV fusiform; relative length of antennal segments I to IV are: 5.0:5.0:5.5:11.5. Labium reaching line connecting hind borders of eyes.

Pronotum: Less than ½ as long as its maximum width (15:35); collar sinuate anteriorly; anterior borders rounded and produced forward beyond collar; lateral notch slightly sinuate; lateral borders of hind lobe parallel; hind border sinuate medially. Fore disc granulate and with 4 (2+2) curved callosities; hind disc transversely striate and with 2 (1+1) transverse callosities.

Scutellum: Semicircular, shorter than its basal width (15:23); basal ⅓ of disc with rough longitudinal striation, surrounded with concentrical striation.

Hemelytra: Reaching hind border of tergum VI; corium reaching basal ⅓ of scutellum.

Abdomen: Ovate, longer than its maximum width across segment IV (70:52); posteroexterior angles of connexiva barely protruding; paratergites very short, not reaching tip of segment IX; the latter truncate posteriorly. Spiracles II, VI, and VII lateral and visible from above; III to V ventral, equidistant from border; VIII terminal. Sublateral fold reaches hind border of sternum VI.

Posterior lobe of propleuron swollen and granulate, visible from above.

Male.—Similar to female, but smaller; paratergites small, reaching tip of rounded, posteriorly, small hypopygium.

Measurements.—head 15.0:15.5; relative length of antennal segments I to IV are: 5:5:5:11; pronotum 14:31; scutellum 15:20; abdomen 59:48; hypopygium 3:5.

Color.—Yellow brown (♂) to dark brown (♀)

Total length.—♀—4.68, ♂—4.20; width of pronotum: ♀—1.40, ♂—1.24; width of abdomen: ♀—2.08, ♂—1.92 mm.

Holotype.—♀, Mexico, Vera Cruz, Las Cabañas; 10.VII.1972, H. Brailovsky leg.; deposited at the Instituto de Biologia, UNAM, Mexico 20, Mexico.

Allotype—♂, collected with holotype; same collection.

Paratypes.—1 ♀, 1 ♂ (without head), collected with holotype; same collection and Kormilev collection.

Remarks.—*Aneurus brailovskyi* is closely related to *A. arizonensis* Picchi, 1977, and runs to it in Picchi's key, but may be separated from it by the following: Anterior process of head not reaching tip of antennal segment I (produced beyond tip in *A. arizonensis*); postocular tubercles only reaching, or barely protruding, beyond outer border of eyes (distinctly protruding in *A. arizonensis*); hind lobe of propleuron more swollen and visible from above (less swollen and not visible from above in *A. arizonensis*); and ratio between length of antennae and width of head across eyes is 1.635 (1.535 in *A. arizonensis*).

The holotype was compared with a paratype of *A. arizonensis* from the collections of the American Museum of Natural History, New York, N.Y.

It is a pleasure to dedicate this species to its collector Dr. Harry Brailovsky, Instituto de Biologia, UNAM, Mexico, Mexico.

***Aneurus aterrimus* Kormilev, New Species**

Figs. 4–6

Male.—Elongate with subparallel sides; head, pronotum, scutellum and connexivum partially, finely granulate.

Head: Longer than its width across eyes 16.0:15.5; anterior process rounded anteriorly; genae short, by far not reaching tip of clypeus; almost reaching tip of antennal segment I. Antenniferous tubercles truncate anteriorly, acute anterolaterally. Postocular tubercles blunt, not reaching outer border of eyes. Eyes semiglobose, protruding. Vertex with 2 (1+1) large, ovate infraocular callosities. Antenna strong; antennal segment I elongate obovate, II obovate, III tapering toward base, IV fusiform; relative length of antennal segments I to IV are: 5.5:4.5:5.0:10.0; ratio length of antenna: width of head across eyes as 1.61:1.00. Labium reaching line connecting hind borders of eyes.

Pronotum: Half as long as its maximum width (16:33); collar sinuate anteriorly; anterolateral angles rounded, neither produced forward, nor sideways. Lateral notch forming obtuse angle; lateral borders of hind lobe subparallel, slightly rounded; hind border slightly sinuate medially. Fore disc with 2 (1+1) larger callosities and 4 (2+2) smaller laterad of them; hind disc finely granulate.

Scutellum: Semicircular, shorter than its basal width (15:22); disc densely granulate on basal ⅓, less densely around basal ⅓.

Hemelytra: Almost reaching hind border of tergum VII; corium reaching basal ⅓ of scutellum.

Abdomen: Elongate, with slightly rounded sides; longer than its maximum width across segment IV (61:41); posteroexterior angles of connexiva not protruding. Paratergites short, rounded posteriorly, reaching tip of a small hypopygium, which is shorter than its maximum width (3.0:5.5). Spiracles II, VI and VII lateral and visible from above; III to V sublateral, placed on sublateral fold; VIII terminal. Sublateral fold extends from III to hind border of VI.

Female.—Similar to male, but larger; paratergites very short, rounded posteriorly, reaching tip of truncate segment IX.

Measurements.—Head 16.0:15.5; relative length of antennal segments I to IV are: 6:5:5:11; pronotum 19:36; scutellum 15:23; abdomen across segment IV (67:44); width of tergum VIII, 14.

Color.—Black; base of membrane dark brown. On some specimens pronotum laterad of collar yellow brown.

Total length.—♂—4.40, ♀—4.72 mm; width of pronotum: ♂—1.32, ♀—1.44 mm; width of abdomen: ♂—1.64, ♀—1.76 mm.

Holotype.—♂, Costa Rica, Monte Verde, Ponta Arenas; 9.II.1981, H. Brailovsky leg., deposited at the Instituto de Biologia, UNAM, Mexico 20, Mexico.

Allotype.—♀, Same locality and date; E. Barrera leg.; same collection.

Paratypes.—3 ♂, 2 ♀, same locality and date, H. Brailovsky leg.; 3 ♂, 2 ♀, same locality and date, E. Barrera leg. Same collection and Kormilev collection.

Remarks.—*Aneurus aterrimus* runs to *A. slateri* Picchi, 1977, in Picchi's key but may be separated from it by: Head slightly longer than its width across eyes; antennal segment III tapering toward base, not fusiform; larger size; and different color, black.

Subfamily MEZIRINAE

Genus *Notapictinus* Usinger and Matsuda, 1949

***Notapictinus piliger* Kormilev, New Species**

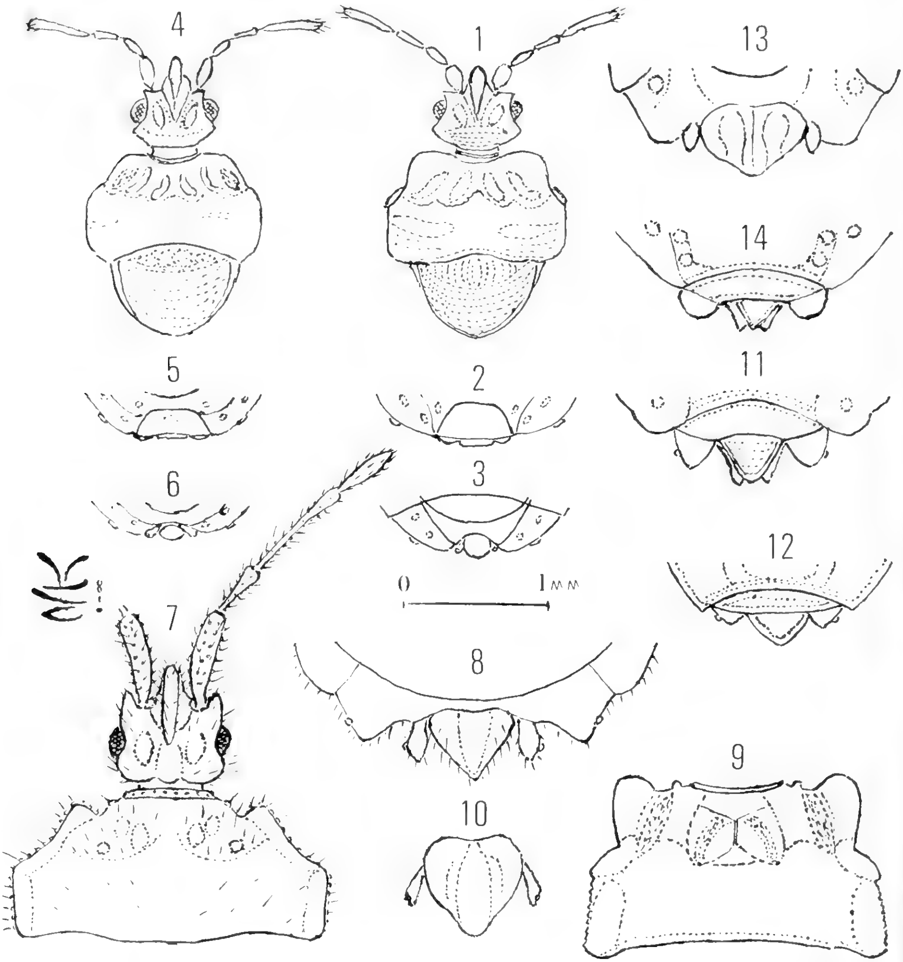
Figs 7, 8

Male.—Elongate ovate; body, particularly on the borders, antennae and legs, covered with stiff, erect bristles.

Head: Shorter than its width across eyes (21.0:22.5); anterior process with parallel sides, rounded anteriorly, reaching basal ¼ of antennal segment I. Antenniferous tubercles short, blunt, with parallel outer borders. Postocular borders rounded and granulate. Eyes moderately convex, shorter than preocular portion (5:7). Vertex moderately convex, granulate. Antennae long and thin, more than 2½× as long as width of head across eyes (2.69:1.00); relative length of antennal segments I to IV are: 16.0:11.0:21.0:12.5. Labium not reaching hind border of labial groove, which is open posteriorly.

Pronotum: Less than ½ as long as its maximum width (27:58); collar truncate anteriorly, granulate. Anterolateral angles rounded and produced forward, reaching hind border of collar. Fore border between collar and anterolateral angles sinuate and with a cluster of granules in the middle. Lateral borders of fore lobe and hind lobe in front of humeri expanded and crenate. Lateral borders of hind lobe roughly granulate. Hind border twice (1+1) sinuate laterad of scutellum. Fore disc with 2 (1+1) flat callosities, granulate between and laterad of them. Hind disc irregularly granulate.

Scutellum: Crushed by pin.



Figs. 1–3. *Aneurus brailovskyi*. 1, Head, pronotum, and scutellum, ♀. 2, Tip of abdomen from above, ♀. 3, Tip of abdomen from above, ♂. Figs. 4–6. *A. aterrimus*. 4, Head, pronotum, and scutellum, ♀. 5, Tip of abdomen from above, ♀. 6, Tip of abdomen from above, ♂. Figs. 7, 8. *Notapictinus piliger*, ♂. 7, Head and pronotum. 8, Tip of abdomen from above. Figs. 9–11. *Mezira hondurensis*. 9, Pronotum, ♂. 10, Hypopygium and paratergites, ♂. 11, Tip of abdomen from above, ♀. Fig. 12. *M. proxima*, ♀, tip of abdomen from above. Figs. 13, 14. *M. guanacastensis*. 13, Tip of abdomen from above, ♂. 14, Tip of abdomen from above, ♀.

Hemelytra: Reaching hind border of tergum VII; corium reaching hind border of connexivum II; its basolateral border straight, slightly expanded and granulate; apical angle acute and produced backward; apical border sinuate. Membrane with anastomosed veins.

Abdomen: Ovate, longer than its maximum width across segment V (90:70); posteroexterior angles of connexiva II to IV not protruding; V slightly produced, rounded; VI more protruding, rounded; exterior border between VI and VII sinuate; VII rounded, forming subangular lobe. Paratergites clavate, reaching ⅔ of hypopygium; the latter pointed posteriorly and with a stout median ridge, almost reaching tip of disc. Spiracles II to V ventral, placed far from border; VI sublateral, but not visible from above; VII and VIII lateral and visible from above. Sterna III to VI with swollen hind border.

Legs: Unarmed.

Color.—Reddish brown; connexiva with pale yellow spots; hypopygium dark brown; antenna and legs yellow brown.

Total length.—6.72 mm; width of pronotum 2.32 mm; width of abdomen 2.80 mm.

Holotype.—♂, Colombia, Ville de Cauca, 4 km NW San Antonio, 6500′; A.H. Miller leg. 1.XI.1958. Deposited at the California Academy of Sciences, San Francisco, California.

Remarks.—*Notapictinus piliger* runs to *N. quadraticeps* (Champion), 1898, in my key (Kormilev, 1967: 7) but may be separated at once by the long, erect bristles on the body, antennae, and legs.

Genus *Mezira* Amyot and Serville, 1843

***Mezira hondurensis* Kormilev, New Species**

Figs. 9—11

Male.—Elongate ovate, partially covered with short, golden, curled hairs; connexivum tricolored, ferrugineous, yellow, and black.

Head: As long as its width across eyes (24:24); anterior process with parallel sides, incised anteriorly, reaching ½ of antennal segment I; antenniferous tubercles acute and slightly divaricating; postocular small, not reaching outer border of eyes. Eyes large, strongly protruding. Vertex with M-shaped rows of granules. Antennae moderately strong, twice as long as width of head across eyes (49:24); relative length of antennal segments I to IV are: 13:11:15:10. Labium reaching hind border of labial groove, which is closed posteriorly.

Pronotum: Short and wide (28:54); collar sinuate anteriorly, granulate; anterolateral angles produced forward as rounded lobes as far as collar; lateral notch forming an obtuse angle; lateral borders of hind lobe parallel, rounded and strongly converging anteriorly; hind border twice sinuate. Fore disc with 4 (2+2) ridges; hind disc granulate.

Scutellum: Shorter than its basal width (25:30); all borders carinate, lateral sinuate before apex, tip rounded. Disc with 2 (1+1) transverse, naked elevations along basal border; median ridge narrow.

Hemelytra: Reaching hind border of tergum VI; corium reaching ½ of connexivum III, its basolateral border slightly sinuate and reflexed, apical border sinuate interiorly, rounded exteriorly; apical angle rounded.

Abdomen: Ovate, longer than its maximum width across segment IV (89:67); lateral borders rounded; posteroexterior angles of connexiva II to VI slightly protruding, VII rounded. Paratergites clavate, reaching ⅔ of hypopygium; the latter cordate, median ridge reaching tip of disc. Spiracles II to VII ventral, placed far from border, VIII lateral and visible from above.

Female.—Similar to male, but slightly larger. Paratergites large, rounded posteriorly, reaching ½ of incised posteriorly segment IX.

Measurements.—Head 25:25; relative length of antennal segments I to IV are: 13:11:15:10; pronotum 28:55; scutellum 25:32; abdomen 95:69; width of tergum VIII, 29.

Color.—Ferrugineous; connexivum with yellow round spots and anterior ¼ of exterior border; posterior ¾ of exterior border is black.

Total length.—♂—6.76, ♀—7.00 mm; width of pronotum: ♂—2.16, ♀—2.20 mm; width of abdomen: ♂—2.68, ♀—2.76 mm.

Holotype.—♂, Honduras, 10 km N Siguatepeque; 20.VIII.1978, J.A. Chemsak, E.G. & J.M. Linsley leg. Deposited at the California Academy of Sciences, San Francisco.

Allotype.—♀, collected with holotype; same collection.

Paratypes.—♂, 2 ♀, collected with holotype; same collection and Kormilev collection.

Remarks.—*Mezira hondurensis* is related to *M. hyperlobata* Kormilev, 1962, from Brasil, but the head is as long as the width across the eyes; the anterolateral lobes of the pronotum are directed more forward and only reach level of the collar; the lateral notch of the pronotum is obtuse; and the (♀) paratergites are large, reaching ½ length of segment IX.

Mezira proxima Kormilev, New Species

Fig. 12

Female.—Elongate ovate, abdomen with subparallel sides; prosternum, propleura and venter laterally, with thin layer of white incrustation. Pilosity short and curled.

Head: Shorter than its width across eyes (21.0:23.5); anterior process rounded and slightly incised anteriorly, genae contiguous in front of clypeus, reaching ⅔ of antennal segment I; antenniferous tubercles wide, acute, divaricating; postocular dentiform, reaching or almost reaching, outer border of eyes. The latter large, protruding. Vertex with V-form rows of granules. Antennae moderately stout, less than 1½× as long as width of head across eyes (32.5:23.5); relative length of antennal segments I to IV are: 10.0:7.0:8.0:7.5. Labium not reaching hind border of labial groove, which is closed posteriorly.

Pronotum: Less than ½ as long as its maximum width (22:48); collar slightly sinuate anteriorly and granulate; anterolateral angles rounded, crenulate and slightly expanded; lateral notch shallow; lateral borders of hind lobe parallel, converging anteriorly; hind border sinuate medially. Fore disc with 4 (2+2) oblique ridges; hind disc granulate.

Scutellum: Shorter than its basal width (20:25); disc crushed by pin.

Hemelytra: Reaching hind border of tergum VI; corium reaching ½ of connexivum III; its hind border rounded, apical angle also rounded.

Abdomen: Longer than its maximum width (80:54); lateral borders subparallel from II to V, then converging in arquate line; connexiva II and III semifused together; posteroexterior angles of connexiva not protruding; paratergites subangular, rounded posteriorly, reaching ½ of rounded posteriorly segment IX. Spiracles II to VI ventral, placed far from border; VII also ventral, placed nearer to border; VIII lateral and visible from above.

Legs: Unarmed; femora and tibiae roughly granulate.

Color.—Testaceous; membrane infuscate, white at base.

Total length.—5.80 mm; width of pronotum 1.92 mm; width of abdomen 2.16 mm.

Holotype.—♀, Peru, Loromayo, 4–10.IX.1962, L.E. Peña leg. Deposited at the California Academy of Sciences, San Francisco.

Remarks.—*Mezira proxima* is closely related to *M. paraensis* Kormilev and Hess, 1979, but is larger; the labium is relatively shorter, not reaching the hind border of the labial groove; the basolateral border of the corium is straight; spiracle VII is placed near the margin; and the ventral side of the body is partially incrusted.

Mezira guanacastensis Kormilev, New Species

Figs 13, 14

Male.—Closely related to *Mezira neotropicalis* (Champion), 1898, but smaller; antennae relatively shorter, only 1.52× as long as width of head across eyes (2× in *M. neotropicalis*); antennal segment III relatively shorter, only slightly longer than I and only by ⅓ longer than IV (much longer than I (23:18) and almost twice as long as IV (23:13) in *M. neotropicalis*); antenniferous tubercles relatively shorter and not so pointed as in *M. neotropicalis*. Hypopygium relatively wider, ratio length:width as 13:18 (13:16 in *M. neotropicalis*). Paratergites (♀) relatively shorter, reaching ½ of segment IX (almost reaching tip of IX in *M. neotropicalis*).

Measurements.—Head: ♂—22:24, ♀—23:25; relative length of antennal segments I to IV are: ♂—10.0:8.0:11.0:7.5, ♀—11:8:12:8; pronotum: ♂—25:49, ♀—26:50; scutellum: ♂—18:26, ♀—18:28; abdomen: ♂—73:56, ♀—88:62; hypopygium 13:20; width of tergum VIII (♀), 27.

Paratergites.—(♂) clavate, reaching slightly beyond ½ of hypopygium; the latter cordate, shorter than its maximum width. Rounded posteriorly in female reaching ½ of segment IX. Spiracles II to VII ventral, placed far from border; VIII ventral, placed near border.

Color.—Ferrugineous, membrane black.

Total length.—♂—5.64, ♀—6.20 mm; width of protnotum: ♂—1.96, ♀—2.04 mm; width of abdomen: ♂—2.24, ♀—2.48 mm.

Holotype.—♂, Costa Rica, Guanacaste Prov., Comelco Areal, 5 km W Bagaces; under bark; 28.IX.1973, P. A. Opler leg. Deposited at the California Academy of Sciences, San Francisco.

Allotype.—♀, collected with holotype; same collection.

Paratypes.—5 ♂, collected with holotype; same collection and Kormilev collection.

ACKNOWLEDGMENT

I express my sincere thanks to L. Jessop, Department of Entomology, British Museum (Natural History), London, who kindly examined the types of *Mezira neotropicalis* (Champion), 1898, and made drawings of the genital segments.

LITERATURE CITED

Champion, G. C. 1898. Biologia Centrali-Americana. London. Heteroptera 2: 65–117, 3 pls.

Kormilev, N. A. 1962. Notes on Aradidae in the Naturhistoriska Riksmuseum, Stockholm (Hemiptera-Heteroptera). Ark. Zool. (2) 15(14): 255–273, 2 pls.

———. 1967. On some Aradidae from Brasil, Argentina and Laos; (Hemiptera-Heteroptera). Opusc. Zool. (Munich) 100: 1–10.

Kormilev, N. A. and E. Heiss. 1979. Four new species and lectotype designation of some neotropical Aradidae (Insecta, Heteroptera). Entomol. Arb. Mus. G. Frey Tutzing bei Muench. 28: 93–118, 34 figs.

Picchi, V. D. 1977. A systematic review of the genus *Aneurus* of North and Middle America and the West Indies (Hemiptera: Aradidae). Quaest. Entomol. 13: 255–308, 233 figs, IX maps.

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84(3), 1982, pp. 489–494

TWO NEW SPECIES OF *ESENBECKIA* (DIPTERA: TABANIDAE) FROM MEXICO[1,2]

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Abstract.—Two new species of *Esenbeckia* from Mexico are described and figured, *E.* (*Ricardoa*) ***biclausa***, n. sp., from Hidalgo State is compared to *E.* (*R.*) *scionodes* Philip, and *E.* (*Esenbeckia*) ***hirsutipalpus***, n. sp., from Nuevo Leon State is compared to *E.* (*E.*) *illota* (Williston).

The genus *Esenbeckia* Rondani with its four subgenera is an entirely American group of relatively primitive Pangoniini. The genus as a whole ranges from Argentina to southern United States, but the subgenera, except *Esenbeckia* itself, have more restricted ranges. Philip (1978) has recently reviewed, with keys to both sexes, the Mexican species, most of which belong to the subgenus *Ricardoa* Enderlein, a group which does not range south of Panama. Fairchild and Wilkerson (1981) give a detailed review of the subgenus *Proboscoides* Philip and have nearly completed a similar treatment of the nominate subgenus. The remaining subgenus, *Palassomyia* Fairchild contains but one peculiar Chilean species. Very little is known of the early stages or habits of any of the species. For the most part they seem to be rare and local; many are haematophagous, especially in the subgenus *Esenbeckia* and probably *Proboscoides*, while those in *Ricardoa* are often taken feeding on flowers. Philip's paper contains references to the pertinent literature, but is without figures, though most of the species have been figured by him or others in earlier publications.

The two species described here are peculiar in several ways and form interesting additions to the Mexican fauna. *Esenbeckia* (*Ricardoa*) *biclausa* is apparently close to *E.* (*R.*) *scionodes* Philip, having the same, hitherto

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unique, *Scione*-like venation, while males of *E.* (*Esenbeckia*) *hirsutipalpus* were reported by Philip (1978) as possibly the first records of *E.* (*E.*) *illota* from Mexico. The female collected by H. V. Weems, Jr., shows little similarity to *E. illota*, except for general coloration, but seems surely correctly associated with the sympatric males.

Esenbeckia* (*Ricardoa*) *biclausa **Wilkerson and Fairchild, New Species**

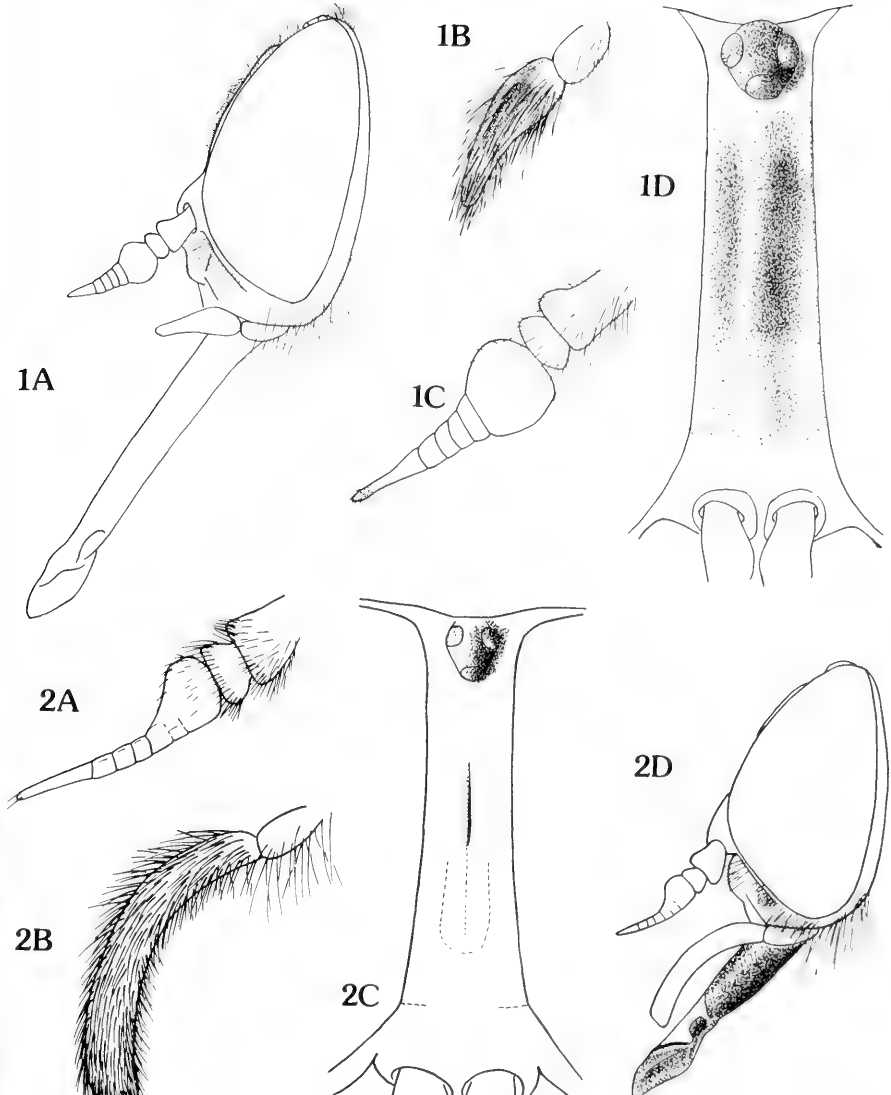
Figs. 1A–D

A blackish, yellow-haired, medium-sized, robust, beelike fly with an orange antennal flagellum, and short, wholly hairy, pointed palpi. Legs bicolored, femora blackish, tibiae yellow. Wings unpatterned but veins margined brown, 1st and 4th posterior cells closed and fork of 3rd vein with an appendix.

Female.—Length 12.5 mm; of wing 11.5 mm. Head structures as figured. Frons blackish in ground color, covered with gray pollinosity which is densest on the lower ¼. Frontal hairs as figured, all pale lemon yellow. Callus absent but a median raised ridge present. Ocellar tubercle prominent and black, bearing 3 reddish-brown ocelli. Subcallus, genae, and frontoclypeus blackish in ground color covered with dense gray pollinosity. Area around antennal sockets yellowish-brown pollinose. Oculogenal hairs pale lemon yellow. Beard of dense, pale lemon-yellow hairs. Antennal segments 1 and 2 yellowish brown in ground color, sparsely pale grayish-yellow pollinose with pale lemon-yellow hairs. Segment 3 orange, dusky at apex of last annulus. Palpal segment 1 blackish in ground color, pale yellow pollinose; segment 2 dark reddish brown which shows through thin yellowish pollinosity and shiny, pale yellow, bristle-like hairs. Second segment with deep groove on outer aspect. Proboscis wholly sclerotized, black, surface shiny but rough.

Mesonotum and scutellum black in ground color with dark gray pollinosity and quite dense, long, pale lemon-yellow hairs. Tufts of hairs at wing base and in front of scutellum whitish yellow. Ground color of pleura and coxae dark reddish brown with dark gray pollinosity and dense, long, pale lemon-yellow hairs. Femoral ground color dark reddish brown, yellowish brown at apical tips. Femora grayish pollinose with long, pale lemon-yellow hairs. Tarsi and apical tips of tibiae brown with pale lemon-yellow hairs. Tibiae yellow with pale lemon-yellow hairs. Basicosta bluntly pointed and blackish. Wings hyaline except for yellowish line along leading edge, especially in costal, subcostal, and 1st basal cells. All veins brown and brown margined. First and 4th posterior cells closed, fork of 3rd appendiculate. Halter reddish brown, dusky at tip of and base of knob.

Abdomen very dark shiny brown except for 1st segment which is dark gray pollinose. Setal vestiture of quite dense, pale lemon-yellow hairs which



Figs. 1A–D. *Esenbeckia* (*Ricardoa*) *biclausa*. 1A, Head, side view. 1B, Palp. 1C, Antenna. 1D, Frons. Figs. 2A–D. *Esenbeckia* (*Esenbeckia*) *hirsutipalpus*. 2A, Antenna. 2B, Palp. 2C, Frons. 2D, Head, side view.

are most numerous along segmental borders. Yellow color along borders accentuated by narrow strips of underlying pale yellow integumental color. Abdomen below as above but with hairs slightly longer and more numberous.

Male.—Length 15 mm; of wing 13 mm. Eyes contiguous. Ocellar tubercle at vertex prominent, bearing 3 distinct reddish-brown ocelli. Antennal flagellae missing. Palpi as female but slightly longer and curved. Proboscis more slender than female. Thorax, legs, and wings as female but hairs longer and more numerous and pollinosity with yellowish hue. Abdominal hairs as female but longer and more numerous both above and below. Ground color blackish on 1st tergum, middle ⅓ of the 2nd and 3rd, and on all but apical borders of remaining terga. Lateral portions of terga 2 and 3 and apical borders of following segments reddish yellow. All segments grayish-yellow pollinose. Abdomen below as above but sternum 3 with lateral reddish-yellow areas.

Type material.—Holotype, ♀, Mexico, Hidalgo, Tepeapulco, 1-IX-1974, G. Bohart and W. Hanson coll. Allotype, ♂, Mexico, Hidalgo, Tepeapulco, 18-IX-1974, G. Bohart and W. Hanson coll. To be deposited in Florida State Collection of Arthropods (F.S.C.A.)

Discussion.—*Esenbeckia scionodes* Philip is apparently sympatric with and closely allied to *E. biclausa,* n. sp.; however, *biclausa* is more robust and lacks the lateral reddish areas on the first two abdominal terga. It also has shorter palpi which are blackish, with long pale yellow hairs, not orange with black hairs. The first annulus (basal plate) of the flagellum is also much wider than in *scionodes,* being half again as wide as the scape. In other respects, including leg coloration, overall body vestiture and coloration, and closure of the fourth posterior cell, the two species are quite close.

We place it in the subgenus *Ricardoa* on the basis of the short grooved palpi and the slender proboscis even though it, like *E.* (*Ricardoa*) *scionodes,* does have oculongenal hairs.

All specimens of the type-series of *E. scionodes* Philip do not have a completely closed 4th posterior cell. Of the 19 specimens, 7 were strongly narrowed and 3 "variously more opened" (Philip, 1973). One might expect this same variability in a larger series of *E. biclausa.*

Esenbeckia (*R.*) *incisuralis* (Say) is also a robust, yellow-haired, beelike species with darkened femora. The palpi of *E. incisuralis* are longer with a bare median groove, not short and wholly hairy; the antennal basal plate is narrower than *E. biclausa* and the 4th posterior cell is always open.

Esenbeckia (*Esenbeckia*) *hirsutipalpus* Wilkerson and Fairchild, New Species

Figs. 2A–D

Esenbeckia illota: Philip 1978:350. In part, 2 ♂ reported from Nuevo Leon.

A medium-sized yellowish-brown species lacking a distinct callus, but with sabre-shaped palpi covered completely with long brown hairs; proboscis about equal to head height; pale fore- and midtibiae, and smoky brown wings. Abdomen brown, 1st segment contrastingly pale translucent yellowish white.

Female.—Length 14 mm; of wing 14.5 mm. Head structures as figured. Frons yellowish-brown pollinose, bearing on its lower ½ a slight depression with a barely evident median ridge which extends upward into a small slightly denuded callus. Tubercle at vertex raised and bearing 3 dark red ocelli. Subcallus, genae, and frontoclypeus with brownish integument and yellowish-brown pollinosity; beard and other facial hairs dark brown. Antennal pedicel and scape yellowish-brown pollinose, flagellum pale yellow orange; antennal hairs dark brown. Palpi dark yellowish brown, densely covered with long dark brown hairs. Proboscis shiny brown.

Integument of mesonotum, scutellum, pleura, and coxae brown; yellowish-brown pollinose. Setal vestiture of numerous brown hairs, longer laterally, on scutellum and pleura. Hairs of thorax nearest head pale, yellowish. Femora and hindtibia and tarsus brown and brown haired; hindfemur slightly darker. Fore- and midtibiae and tarsi pale yellowish brown and short yellow haired. Halter yellowish brown. Wings with brownish tinge, darker in costal, subcostal, 1st basal, and base of marginal cells. Wing venation normal for genus.

Abdomen above brown and brown haired with 1st tergum translucent pale yellowish white and pale yellowish-brown haired. Extreme lateral borders of terga 2–7 blackish; posterior borders of terga 3–7 darkened. Below as above but without lateral darkening and with posterior borders of sterna 2–6 dark.

Male.—Length 13 mm; of wing 13 mm. Similar to female but paler overall. Head, thoracic, and leg hairs long, pale yellowish brown; those of 1st abdominal tergum pale yellow, remaining abdominal hairs pale brown. Eyes contiguous, a distinct raised tubercle bearing 3 ocelli at vertex. Palpi similar to female, but shorter, slender, and curved. Palpal hairs numerous, long, and reddish brown. Proboscis short, little more than ½ head height, only ⅓ again as long as palp. Abdomen as female, segment 1 pale yellow translucent, lateral borders on terga 2–7 darkened.

Type material.—Holotype, ♀, Mexico, Nuevo Leon, Chipinque Mesa, 18-VI-1976, H. V. Weems coll. To be deposited in F.S.C.A. Allotype, ♂, Mexico, V. deSantiago, N. L. (Nuevo Leon), H. Hedderich coll. Cornelius B. Philip collection in California Academy of Sciences San Francisco (C.A.S.). Determined as *Esenbeckia* sp. nr. *illota* by C. B. Philip, 1957. Paratype, ♂, Mexico, Apodaca, N.L., A. Salazar coll., in collection C. B. Philip in C.A.S. determined as *E. illota* in 1954 and *E.* sp. nr. *illota* in 1957 by C. B. Philip.

Discussion.—*Esenbeckia hirsutipalpus* is similar to *E. illota* (Williston) in that both are medium sized straw-colored to brown species with smoky brown wings and the first abdominal segment translucent horn colored. The palpi of the two are strikingly different in both sexes; however, those of *hirsutipalpus* are wholly long haired, and those of *illota* are short haired and mostly bare on the outer aspect. In addition, *hirsutipalpus* has a stouter and much shorter proboscis, and lacks a distinct shiny frontal callus.

LITERATURE CITED

Fairchild, G. B. and R. C. Wilkerson. 1981. New species of *Esenbeckia* (*Proboscoides*) (Diptera: Tabanidae) with a key to the subgenus. Fla. Entomol. 64(1): 158–175.

Philip, C. B. 1973. New North American Tabanidae (Diptera). XX. Six new species of *Esenbeckia* subgenus *Ricardoa* from Mexico. Ann. Entomol. Soc. Am. 66(5): 1141–1145.

———. 1978. New North American Tabanidae (Insecta: Diptera). XXIV. Further comments on certain Pangoniinae in Mexico with special reference to *Esenbeckia*. Proc. Calif. Acad. Sci. (4) 41(14): 245–356.

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84(3), 1982, pp. 495–508

AN ANNOTATED CHECKLIST OF THE CADDISFLIES (TRICHOPTERA) OF MISSISSIPPI AND SOUTHEASTERN LOUISIANA. PART I: INTRODUCTION AND HYDROPSYCHOIDEA

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Abstract.—Distributional records for 46 species of caddisflies in the superfamily Hydropsychoidea (Hydropsychidae, Philopotamidae, Polycentropodidae, and Psychomyiidae) are presented, and the seasonal distribution of each is indicated. Annotations for many species include habitat notes. Of the species reported, 38 represent new state records for Mississippi, and 18 are new records for Louisiana.

Faunal lists of caddisfly species have been prepared for several of the states in the southeastern United States. Studies conducted in Arkansas (Unzicker et al., 1970), Florida (Blickle, 1962), Kentucky (Resh, 1975), North and South Carolina (Morse, 1970; Morse et al., 1980; Unzicker et al., *in press*), Tennessee (Etnier and Schuster, 1979), Texas (Edwards, 1973), and Virginia (Parker and Voshell, 1981) have provided preliminary to fairly complete checklists. Although more than 450 species have been reported from the southeast (Morse, personal communication), the caddisfly faunas of the gulf coastal states (Texas, Louisiana, Mississippi, Alabama, and Florida) and of Georgia are virtually unknown and records available from these states are few and scattered. Only 10 species have been reported from Mississippi and only 14 from Louisiana.

The following list represents a compilation of two separate surveys. Holzenthal (1980) recently completed a study of the caddisflies of the southern third of Mississippi and the southeastern "Florida" parishes of Louisiana, and Lago and Harris have been conducting a general survey of the Trichoptera of Mississippi since 1977. The information we have accumulated will be presented in three parts, each covering one of the three trichopteran superfamilies, the Hydropsychoidea, Rhyacophiloidea, and Limnephiloidea (Ross, 1967).

General Physiography of the Study Area

Both Mississippi and Louisiana lie in the Nearctic Coastal Plain Physiographic Province with only the extreme northeastern corner of Mississippi belonging to the Interior Low Plateau Province. This latter area is small and the state is usually considered entirely Coastal Plain (e.g. Berner, 1977). Lowe (1919) divided Mississippi into ten physiographic regions differing in soil types and natural vegetation. These regions can be generally grouped into four areas containing fairly distinct aquatic habitat types (Stanford, 1980). The areas, as shown in Figure 1, are the Tennessee River Hills (TRH), the North Central Plateau (NCP), the Yazoo Delta (YD), and the Coastal Plain (CP). The TRH area presents the roughest terrain in the state and is characterized by swift, clear streams with rocky-sandy bottoms. The NCP region has sandy or silty streams and many man-made lakes with mud or leaf-littered bottoms. Gravel-bottomed streams are occasionally encountered throughout the area. West of this lies the YD area which is characterized by meandering bayous, ox-bow lakes and small silt-bottomed streams. Most of the southern half of Mississippi and the portion of Louisiana included in the study area (the southeastern "Florida" parishes) is CP. Streams and rivers here have sand and gravel bottoms, and streams stained with tannic acid (black water) are ubiquitous.

List of Collection Sites

Figure 1 shows the distribution of 132 localities in the study area from which specimens were obtained. The following list will serve as an index to collecting sites for the three parts of our checklist and will not be repeated in subsequent parts.

Tennessee River Hills

Tishomingo County
  1. Iuka.
  2. Tishomingo State Park.
Monroe County
  3. Hamilton.
Lowndes County
  4. Columbus.

North Central Plateau

Marshall County
  5. 4 mi. N Holly Springs (T3S-R3W-Sec. 13).

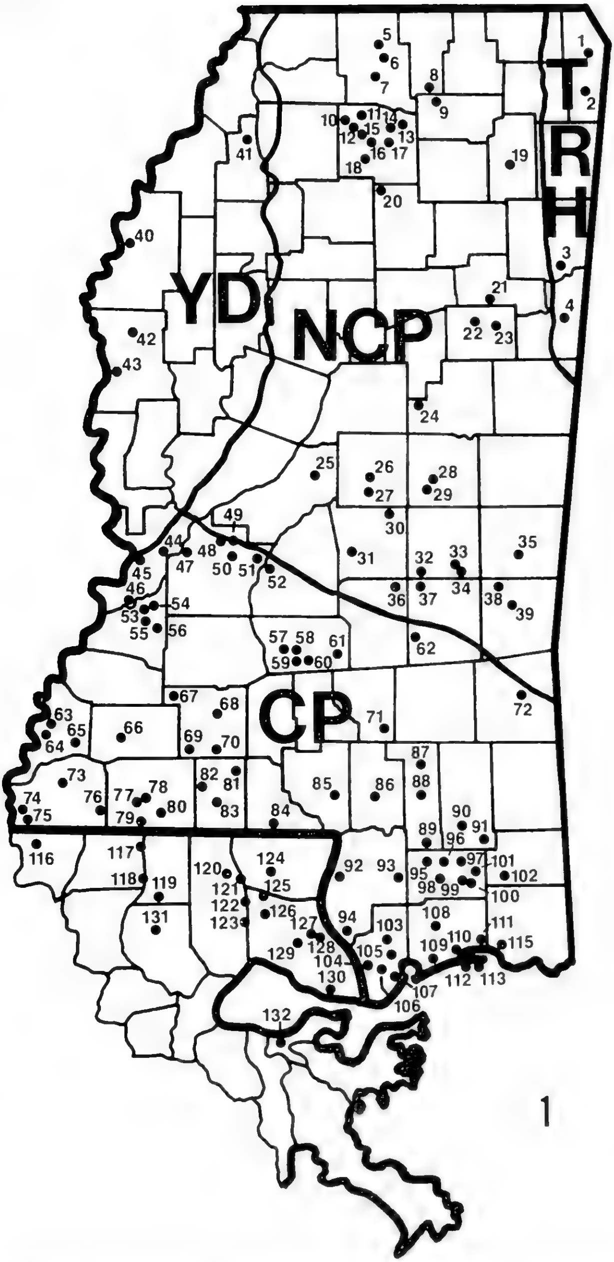

Fig. 1. Collecting sites and major physiographic regions of the study area. CP—Coastal Plain; NCP—North Central Plateau; TRH—Tennessee River Hills; YD—Yazoo Delta.

6. Holly Springs.
7. Wall Doxey State Park, Spring Lake.

Benton County
8. Hickory Flat.

Union County
9. 8.5 mi NW New Albany (T6S-R2E-Sec. 5).

Lafayette County
10. 11 mi. NW Oxford, Sardis Lake.
11. 4.5 mi. SW Abbeville, Dunlap Branch.
12. 4 mi. NW Oxford, Cataraci Branch.
13. 11 mi. NE Oxford, Puskus Lake.
14. 8 mi. NE Oxford, Bay Springs Branch.
15. 3 mi. NW Oxford, Davidson Creek.
16. Oxford.
17. 6 mi. E Oxford, Hopewell Lake.
18. 6 mi. S Oxford, Morris Creek.

Lee County
19. Tupelo.

Calhoun County
20. 13 mi. NW Bruce (T11S-R2W-Sec. 25).

Clay County
21. Cedar Bluff.

Oktibbeha County
22. Adaton.
23. State College (Mississippi State University).

Winston County
24. 13 mi. W Louisville, Branch of Labutcha Creek.

Madison County
25. 10 mi. NE Canton, Dry Creek.

Leake County
26. Carthage.
27. 5 mi. S Carthage, Pearl River.

Neshoba County
28. 1.5 mi. N Dixon.
29. 7 mi. SW Philadelphia.

Scott County
30. Golden Memorial State Park.
31. Roosevelt State Park.

Newton County
32. Roberts.
33. 4.5 mi. E Newton, small pond.
34. 6 mi. SE Newton, Falema Creek.

Lauderdale County
  35. Meridian.
Smith County
  36. 1 mi. W Lake Marathon, Branch of Ichusa Creek.
Jasper County
  37. 6 mi. NW Montrose, Cedar Creek.
Clarke County
  38. 3 mi. N Enterprise, Chunky Creek.
  39. Clarke Co. State Park, Moore Mill Creek.

Yazoo Delta

Bolviar County
  40. 2 mi. W Rosedale, Mississippi River.
Quitman County
  41. 2 mi. S Sledge, Flagg Lake.
Washington County
  42. Stoneville.
  43. Wayside.

Coastal Plain
Mississippi

Warren County
  44. Bovina.
  45. Vicksburg.
  46. 6 mi. S Yokena (T13N-R3E-Sec. 30).
Hinds County
  47. Big Black River × Interstate 20.
  48. 4.5 mi. NW Clinton.
  49. 4 mi. N Clinton, Bogue Chitto Creek.
  50. Clinton.
  51. Jackson.
Rankin County
  52. Pearl.
Claiborne County
  53. Rocky Springs.
  54. Little Sand Creek, nr Rocky Springs (Natchez Trace Parkway).
  55. 3 mi. S Rocky Springs, Owens Creek.
  56. Bayou Pierre at Carlisle.
Simpson County
  57. 2 mi. W Pinola, Strong River × Hwy 28.
  58. Westville Creek × Hwy 43, nr Pinola.
  59. 2 mi. SE Pinola, Tanyard Creek × Hwy 28.
  60. 4 mi. SE Pinola, Mill Creek × Hwy 472.

61. 3 mi. E Magee, Ocatoma Creek × Hwy 28.
Jasper Co.
62. 2.5 mi. E Bay Springs, Tallahoma Creek × Hwy 528.
Adams County
63. Natchez.
64. 5 mi. S Natchez.
65. Homochitto National Forest, Sandy Creek.
Franklin County
66. 7 mil. SW Meadville, Clear Springs Lake.
Lincoln County
67. 4 mi. W Caseyville, Homochitto River × Hwy 550.
68. Brookhaven.
69. E Fork Amite River × Hwy 98, nr Auburn.
70. 7 mi. N Summit on Interstate 55.
Covington County
71. Okatoma Creek × Hwy 598, nr Sanford.
Wayne County
72. Waynesboro.
Wilkinson County
73. Buffalo River × Hwy 61.
74. Fort Adams.
75. 1 mi. SW Pond, Clark Creek.
76. Centerville.
Amite County
77. 3 mi. SW Liberty, W Fork Amite River × Hwy 48.
78. Wagoner Creek × Hwy 48, nr Liberty.
79. 9 mi. S Liberty, E Fork Amite River.
80. 9 mi. SSW Liberty, W Fork Amite River.
Pike County
81. .5 mi. W Pricedale, Topisaw Creek × Hwy 44.
82. Percy Quinn State Park, Percy Quinn Lake.
83. 3 mi. S Magnolia, Tangipahoa River.
Walthall County
84. 5 mi. SE Lexie, Bogue Chitto River.
Marion County
85. Lake Columbia.
Lamar County
86. 5 mi. N Baxterville, Half-Moon Creek.
Forrest County
87. Hattiesburg.
88. Paul B. Johnson State Park.
89. 9.5 mi. S Brooklyn.

Perry County
  90. 1 mi. E Janice, Cypress Creek × Hwy 29.
  91. Leaf River Game Mang. Area.
Pearl River County
  92. 5 mi. S Crossroads, Chinquapin Creek × Hwy 43.
  93. 1 mi. SW Silver Run, Wolf River.
  94. Picayune.
Stone County
  95. 5 mi. W Wiggins, Red Creek × Hwy 26.
  96. Wiggins.
  97. 5 mi. E Wiggins, Flint Creek × Hwy 26.
  98. Perkinston.
  99. 13 mi. SW Wiggins, Sandy Creek.
  100. University of Mississippi forest lands, headquarters.
  101. Red Creek × Hwy 15.
George County
  102. 7 mi. S Benndale.
Hancock County
  103. 4 mi. NW Kiln, Orphan Creek × Hwy 43.
  104. NASA Missile Testing Facility.
  105. Bayou LaTerre.
  106. 6 mi. WNW Waveland.
  107. Bay St. Louis.
Harrison County
  108. 2 mi. N Lyman, Little Biloxi River.
  109. Long Beach.
  110. Handsboro.
  111. D'Iberville.
  112. Biloxi.
  113. Keesler Air Force Base.
  114. Big Biloxi River (exact locality unknown).
Jackson County
  115. Ocean Springs.

Louisiana

West Feliciana Parish
  116. 2 mi. NNW Weyanoke, Little Bayou Sara × Hwy 66.
East Feliciana Parish
  117. 4.5 mi. NNE Felixville, confluence of E and W Forks Amite River.
  118. 10 mi. E Clinton, confluence of E and W Prongs Amite River.
St. Helena Parish
  119. 3 mi. S Pine Grove, Claiborne Branch × Hwy 449.

Tangipahoa Parish
120. 2.5 mi. E Holton, Chappepeela Creek × Hwy 16.
121. 6 mi. E Holton, Tchefuncte River × Hwy 16.
122. 8 mi. NW Folsom, Tchefuncte River × Parish Rd 19.
123. 4.5 mi. W Folsom, Tchefuncte River × Hwy 40.
Washington Parish
124. 11 mi. N Folsom, Bonner Creek × Hwy 25.
St. Tammany Parish
125. 6 mi. N Folsom, Bogue Falaya River × Hwy 25.
126. 1 mi. S Folsom, Morgan Branch Bogue Falaya River × Hwy 25.
127. Talisheek Creek × Hwy 435, nr Talisheek.
128. Talisheek Creek × Hwy 41, E of Talisheek.
129. 4.5 mi. E Abita Springs, Abita Creek × Hwy 435.
130. Slidell, barrow pit at Hwy 433.
Livingston Parish
131. Hornsby Creek × Hwy 1025, .5 mi. E of Hwy 49.
Orleans Parish
132. Biological Sciences Annex, University of New Orleans.

List of Species

The Hydropsychoidea are represented in the study area by 46 species in 15 genera and four families. In the following list those records obtained from literature sources are indicated by the citation. Since most of the species have rather broad temporal distributions, a range of collection dates is presented when more than three dates are involved. Widely disjunct collection dates are also indicated. Voucher specimens have been deposited in collections at the University of Mississippi, Clemson University, and Louisiana State University.

Philopotamidae

Chimarra aterrima Hagen. Sites 2, 70. 5 April and 8 Sept. Rare in our collections. Several specimens were collected near a small, swift, rocky stream.

Chimarra feria Ross. Sites 6, 55, 70. 20 March–2 June. Uncommon.

Chimarra florida Ross. Sites 54, 86, 97, 99, 100, 107, 108, 110, 120, 123, 125, 126, 127, 129, 131. 28 March–5 June, 18 Sept. and 17 Oct. Locally abundant in small to medium black water streams in the CP. The widely disjunct collection dates may indicate two cohorts per year for this species in the study area.

Chimarra obscura (Walker). Sites 14, 16, 57, 58, 59, 66, 67, 101. 4 May–26 Sept. Although Ross (1944) stated that this species frequents rapid, clear streams, several of the adults we have collected came from light traps near small spring-fed lakes. Not common.

Chimarra socia Hagen–*C. moselyi* Denning "complex." Sites 2, 16, 25, 26, 56, 57, 58, 59, 61, 79, 80, 81, 83, 84, 93, 95, 97, 99, 100, 101, 102, 117, 118, 120, 126, 129. 11 April–29 Sept. It seems that this complex is represented in the study area by two or three variable species, or perhaps a complex of described and undescribed species. Many more specimens will need to be studied in order to understand the variation presented by this series. This group is widespread and common throughout the CP, and specimens were collected along slowly flowing, as well as rapid, streams.

Wormaldia moesta (Banks). Sites 16, 17, 100. 10 April–14 June. Rare in our collections.

Psychomyiidae

Lype diversa (Banks). Sites 25, 36, 60, 80, 83, 90, 121, 122, 123, 124, 125, 127. 20 March–10 June, 15 Sept. and 17 Oct. The spring and fall collection dates for this CP species indicate it may be bivoltine in the study area.

Polycentropodidae

Cernotina calcea Ross. Sites 57, 62, 67, 69, 71, 80, 83, 106, 119, 120, 131. 23 May–18 Sept. Specimens of *C. calcea* were not encountered in large numbers, but the species is widespread in the CP.

Cernotina spicata Ross. Sites 7, 25, 31, 66, 71, 86, 100. 6 May–26 May, 30 Aug.–9 Sept. Less common than *C. calcea,* but considerably more widespread in the study area. The split collection dates suggest a bivoltine life cycle here. Specimens were collected near spring-fed lakes, a swift blackwater river and small sand bottom creeks, confirming the wide variety of habitats noted for this species by Hudson et al. (1981).

Cyrnellus fraternus (Banks). Sites 5, 7, 10, 11, 14, 16, 23, 28, 40, 41, 49, 82, 85, 86, 87, 106, 126, 129. 21 April–26 Sept. Widespread and common; specimens were collected from a wide variety of aquatic habitats in the study area.

Neureclipsis crepuscularis (Walker). Sites 16, 24, 25, 40, 42, 44, 47, 48, 52, 57, 73, 79, 83, 86, 87, 120, 125. 6 May–10 Sept. Widespread and common. In the study area, capture nets of larvae were observed on the tops of submerged logs, on firm gravel substrate and on *Vallisneria* leaves in moderate current.

Neureclipsis melco Ross. Site 128. 4 June. This is a black-water, coastal plain endemic, and was previously known from Georgia and South Carolina. It is not common here.

Nyctiophylax affinis (Banks) Sites 6, 7, 14, 15, 16, 21, 29, 32, 40, 41, 50, 62, 100, 119, 120. 21 April–6 July, 9 Sept., 27 Sept. Widely distributed and fairly common. Specimens were collected near tiny streams, the Mississippi River and several spring-fed lakes. Morse (1972) reported this species from Mississippi, but gave no specific locality.

Nyctiophylax banksi Morse. Sites 101, 102, 108. 24 and 25 May. Rare in our collections. Specimens were collected near a large, swift black-water river, a smaller sand bottomed creek and a marshy area where little water flow was discernable.

Nyctiophylax celta Denning. Sites 57, 97. 7 June, 20 June. Rare in our collections.

Nyctiophylax denningi Morse. Sites 2, 57. 20 June, 21 July, 8 Sept. This species was previously known from the southern Appalachians (Morse, 1972); consequently, the record from the TRH area was not unexpected. However, the Simpson County record (CP) represents an interesting range extension.

Phylocentropus carolinus Carpenter. Sites 60, 77, 78, 86, 95, 121, 126. 20 April–July, 17 October. Uncommon and apparently restricted to the CP here. Several specimens were collected along black-water streams.

Phylocentropus lucidus (Hagen). Sites 2, 16, 83. 4 June, 10 June, 8 Sept. More widely distributed but less common than *P. carolinus* in the study area.

Phylocentropus placidus (Banks). Sites 14, 17, 23, 60, 61, 62, 71, 79, 81, 83, 119, 120, 122, 124, 127, 129, 131. 21 March–17 October. This is the most common species of *Phylocentropus* in the study area.

Polycentropus blicklei Ross and Yamamota. Sites 7, 88. 29 March, 21 May. The Marshall County record (21 May 1957) was reported by Ross and Yamamoto (1965). They had one male from Mississippi which was designated a paratype, and they felt that the Mississippi record represented a relict population. A male from Forrest County represents the only other specimen known from the study area.

Polycentropus centralis Banks. Site 53. 18 April. Only one specimen has been collected here.

Polycentropus cinereus Hagen. Sites 103, 128. 26 May, 1 October. Rare in our collections.

Polycentropus clinei (Milne). Site 100. 10 April, 15 April. Rare in our collections.

Polycentropus confusus Hagen. Sites 81, 86, 97. 20 April, 7 June, 29 Sept. Most specimens were collected near swift black-water creeks.

Polycentropus crassicornis Walker. Sites 4, 16, 19, 23, 24, 36, 41, 53, 63, 86, 112, 115. 2 April–15 June. The most widely distributed and common species of *Polycentropus* in the study area. Collected from a variety of aquatic habitats, including swift black-water rivers and small streams.

Hydropsychidae

Cheumatopsyche burksi Ross. Sites 2, 11, 12, 14, 15, 17, 20, 21, 23, 25, 36, 40, 41, 44, 45, 49, 50, 51, 52, 59, 63, 64, 65, 66, 73, 83, 100. 28 March–10 October. Common in all regions of Mississippi, but no specimens were collected in the "Florida" parishes of Louisiana. The extreme diversity of habitat types from which specimens were collected indicates that the species is tolerant of a wide range of environmental conditions.

Cheumatopsyche geora Denning. Sites 2, 66. 28 May, 22 July. Rare in our collections. All specimens were collected near streams where they entered small impoundments. These represent the western-most records for *C. geora*.

Cheumatopsyche pasella Ross. Sites 2, 5, 16, 23, 25, 26, 29, 33, 35, 38, 40, 44, 47, 49, 51, 52, 56, 57, 59, 60, 62, 65, 69, 80, 81, 83, 84, 87, 91, 92, 93, 99, 100, 101, 103, 117, 119, 120, 122, 123, 125, 126, 129, 131. 1 April–19 Sept. Reported from Site 23 by Gordon (1974). Abundant throughout the study area. Shows about the same habitat specificity as *C. burksi*.

Cheumatopsyche petersi Ross, Morse and Gordon. Site 108. 25 May. Previously known only from Florida. About 20 specimens were collected from this site near a small sandy-bottomed river.

Cheumatopsyche pettiti (Banks). Sites 4, 7, 10, 11, 12, 14, 16, 17, 18, 19, 20, 21, 23, 24, 25, 32, 33, 34, 36, 37, 44, 49, 50, 51, 52, 59, 63, 65, 66, 70, 73, 75, 86, 91, 92, 99, 100, 103, 108, 112, 116, 119, 124, 131. 28 March–28 October. Widely distributed and abundant, but apparently absent from the YD area. Perhaps the larvae of *C. pettiti* are not as tolerant as those of *C. burksi* and *C. pasella* to the relatively warm water, silty conditions present in the streams of that region.

Cheumatopsyche pinaca Ross. Sites 2, 12, 14, 16, 18, 86, 87, 100, 120, 125, 127. 20 March–17 October. Widely distributed but uncommon. Collected from a variety of aquatic habitats, but most commonly from small black-water streams.

Cheumatopsyche sordida (Hagen). 16, 21, 23, 49, 57, 59, 65, 66, 67, 71, 73, 81, 84, 86, 87, 90, 93, 102, 108, 114, 116. 23 May–20 October. This is the only common species of *Cheumatopsyche* in the study area which seems to be restricted to the CP. We have only three records north of that area. In light of its known distribution, widespread east of the Mississippi River, the virtual absence of *C. sordida* from the northern half of the study area is somewhat puzzling.

Cheumatopsyche virginica Denning. Sites 100, 125. 1 April–24 May. Known previously from the Atlantic Coastal states (Gordon, 1974). Rare in our collections.

Diplectrona modesta Banks. Sites 2, 16, 66, 72, 75, 86, 100. 7 April–8 Sept. Widespread but uncommonly encountered in the study area. Specimens were collected near spring-fed lakes, black-water streams and small, clear rocky streams.

Hydropsyche alvata Denning. Sites 2, 26, 51, 59, 73, 77, 79, 83, 91, 93, 95, 97, 99, 100, 101, 102, 103, 120, 127, 128, 129. 20 March, 30 April–8 Sept. Denning (1949) described this species from specimens collected in Jackson, Mississippi. Principally a coastal plain species in the study area. Specimens are seldom encountered in large numbers, but on one occasion (Site 101, 24 May) several hundred were collected at a blacklight in 45 minutes. Most specimens were obtained from medium to large rivers.

Hydropsyche betteni Ross. Sites 2, 16, 18, 20, 59, 73, 75, 124. 7 April–8 Sept. Widely distributed but not common. Most specimens were collected near small or medium streams with sand or gravel bottoms.

Hydropsyche ellisoma Ross. Sites 124, 125. 28 March, 1 April. Previously known from the type locality and vicinity in Georgia, and South Carolina (Morse et al., 1980). This species appears to be associated with spring-fed black-water streams of the CP.

Hydropsyche mississippiensis Flint. Sites 7, 11, 16, 25, 26, 30, 58, 59, 65, 67, 69, 71, 72, 73, 77, 78, 81, 82, 83, 86, 90, 93, 95, 97, 100, 101, 102, 103, 108, 120, 122, 123. 8 May–9 Sept. Flint (1972) described this species from Wayne County, Mississippi (Site 72). Schuster and Etnier (1978) examined larvae of *H. mississippiensis* from Jones County, Mississippi. Fairly common in the CP near streams of various types, also collected around small spring-fed lakes. Often collected with *H. alvata*.

Hydropsyche orris Ross. Sites 4, 5, 6, 7, 11, 16, 17, 19, 21, 23, 26, 32, 35, 38, 40, 41, 43, 44, 45, 47, 48, 49, 50, 51, 52, 53, 56, 60, 62, 63, 64, 65, 66, 67, 69, 73, 74, 77, 78, 79, 81, 82, 83, 84, 87, 92, 95, 100, 110, 113, 116, 120, 127, 129. 8 April–16 October. Schuster and Etnier (1978) reported *H. orris* from our study area (St. Tammany and East Baton Rouge parishes, Louisiana). This is our most common species of *Hydropsyche* and is found throughout the study area. It is particularly abundant along the Mississippi River and near the large reservoirs of the NCP.

Hydropsyche phalerata Hagen. Sites 38, 84. 16 June, 13 October. Rare in our collections, only two specimens were taken.

Hydropsyche rossi Flint, Voshell, and Parker. Sites 2, 5, 7, 10, 11, 13, 14, 16, 17, 18, 23, 24, 25, 26, 36, 41, 43, 44, 45, 46, 48, 49, 50, 51, 52, 56, 57, 59, 60, 65, 79, 83, 86, 90, 92, 114, 116, 120, 127, 128. 11 March–24 October. The holotype of *H. rossi* is from Hattiesburg, Forrest County, Mississippi and was described by Flint et al. (1979). Paratypes are listed from various locations in Mississippi and Louisiana as well as several other states. This species is almost as widely distributed in the study area as *H. orris*, however *H. rossi* is rarely encountered in the YD, an area where *orris* abounds. Throughout the rest of the study area the two species are commonly collected together, but *H. rossi* is usually much less common.

Hydropsyche simulans Ross. Site 4. 16 April. Considered a Central States species by Ross (1944), *H. simulans* is known from the study area by one male specimen (det. O. S. Flint, Jr.).

Macronema carolina Banks. Sites 2, 3, 16, 23, 31, 32, 35, 51, 56, 57, 59, 62, 65, 67, 69, 71, 75, 77, 78, 81, 82, 83, 84, 86, 87, 92, 94, 95, 96, 97, 99, 101, 102, 103, 104, 106, 108, 112, 114, 117, 119, 121, 128, 129, 130. 7 April–23 October. Ross (1944) recorded *M. carolina* from Louisiana without specific locality data. This species is not found in the YD, but is widely distributed throughout the rest of the study area, and is abundant in the CP. Specimens were collected near a wide variety of aquatic habitats, including springs, small streams, and impoundments.

Macronema transversa (Walker). Site 57. 20 June. This record is based on two female specimens (det. D. G. Denning). The species was previously known only from Georgia and Indiana.

Potamyia flava (Hagen). Sites 4, 5, 6, 8, 15, 16, 17, 19, 21, 23, 32, 40, 41, 44, 45, 49, 50, 51, 52, 57, 62, 65, 75, 79, 81, 83, 87, 110. 7 April–15 October. Very common along larger rivers, and particularly abundant along the Mississippi River.

Symphitopsyche sparna (Ross). Sites 2, 57, 65, 66, 71, 79, 80, 81, 83, 84, 87, 88. 29 March–29 Sept. This uncommon species seems to be restricted to the CP in the study area. We collected specimens near a variety of aquatic habitats, including small sandy bottomed streams, spring-fed impoundments, and black-water rivers.

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In addition to the specimens collected during the surveys mentioned above, many records were obtained from Bryant Mather who has collected in various portions of Mississippi for many years. These records were of great value in defining the distribution of each species in the state, and we wish to thank Mr. Mather for making them available to us.

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LITERATURE CITED

Berner, L. 1977. Distributional patterns of southeastern mayflies (Ephemeroptera). Bull. Fla. State Mus. Biol. Soc. 22: 1–56.

Blickle, R. L. 1962. Hydroptilidae (Trichoptera) of Florida. Fla. Entomol. 45: 153–155.

Denning, D. G. 1949. New species of Nearctic caddis flies. Bull. Brooklyn Entomol. Soc. 44: 37–48.

Edwards, S. W. 1973. Texas caddisflies. Tex. J. Sci. 24: 491–516.

Etnier, D. A. and G. A. Schuster. 1979. An annotated list of Trichoptera (caddisflies) of Tennessee. J. Tenn. Acad. Sci. 54: 15–22.

Flint, O. S., Jr. 1972. Three new caddisflies from the southeastern United States. J. Ga. Entomol. Soc. 7: 79–82.

Flint, O. S., Jr., J. R. Voshell, Jr., and C. R. Parker. 1979. The *Hydropsyche scalaris* group in Virginia, with the description of two new species (Trichoptera: Hydropsychidae). Proc. Biol. Soc. Wash. 92: 837–862.

Gordon, A. E. 1974. A synopsis and phylogenetic outline of the Nearctic members of *Cheumatopsyche*. Proc. Acad. Nat. Sci. Phila. 129: 117–160.

Holzenthal, R. W. 1980. A survey of the caddisflies (Insecta: Trichoptera) of southeastern Louisiana and southern Mississippi. MS thesis, Univ. of New Orleans. 75 pp.

Hudson, P. L., J. C. Morse, and J. R. Voshell, Jr. 1981. The larva and pupa of *Cernotina spicata* (Trichoptera: Polycentropodidae). Ann. Entomol. Soc. Am. 74: 516–519.

Lowe, E. N. 1919. Mississippi: its geology, geography, soils and minerals resources. Miss. State Geol. Surv. Bull. 14: 1–345.

Morse, J. C. 1970. Caddisflies, or Trichoptera, from northwestern South Carolina. MS thesis, Clemson Univ. 56 pp.

———. 1972. The genus *Nyctiophylax* in North America. J. Kans. Entomol. Soc. 45: 172–181.

Morse, J. C., J. W. Chapin, D. D. Herlong, and R. S. Harvey. 1980. Aquatic insects of Upper Three Runs Creek, Savannah River Plant, South Carolina. Part 1: Orders other than Diptera. J. Ga. Entomol. Soc. 15: 73–101.

Parker, C. R. and J. R. Voshell, Jr. 1981. A preliminary checklist of the caddisflies (Trichoptera) of Virginia. J. Ga. Entomol. Soc. 16: 1–7.

Resh, V. H. 1975. A distributional study of the caddisflies of Kentucky. Trans. Ky. Acad. Sci. 36: 6–16.

Ross, H. H. 1944. The caddisflies, or Trichoptera, of Illinois. Ill. Nat. Hist. Sur. Bull. 23(1): 1–326.

———. 1967. The evolution and past dispersal of the Trichoptera. Annu. Rev. Entomol. 12: 169–206.

Ross, H. H. and T. Yamamoto. 1965. New species of the caddisfly genus *Polycentropus* from eastern North America (Trichoptera, Psychomyiidae). Proc. Biol. Soc. Wash. 78: 241–245.

Schuster, G. A. and D. A. Etnier. 1978. A manual for the identification of the larvae of the caddisfly genera *Hydropsyche* Pictet and *Symphitopsyche* Ulmer in Eastern and Central North America (Trichoptera: Hydropsychidae) U.S. Environ. Prot. Agency Rep. 600/4-78-060. 128 pp.

Stanford, D. F. 1980. The immature dragonflies (Odonata: Anisoptera) of north Mississippi. MS thesis, Univ. of Mississippi. 98 pp.

Unzicker, J. D., L. Aggus, and L. O. Warren. 1970. A preliminary list of the Arkansas Trichoptera. J. Ga. Entomol. Soc. 5: 167–174.

Unzicker, J. D., V. H. Resh, and J. C. Morse. *In press*. Trichoptera, Chapter 9. *In* Brigham, A. R., W. U. Brigham, and A. Gnilka, eds., Aquatic Insects and Oligochaetes of North and South Carolina. Midwest Aquatic Enterprises, Mahomet, Ill.

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AN ANNOTATED CHECKLIST OF THE CADDISFLIES (TRICHOPTERA) OF MISSISSIPPI AND SOUTHEASTERN LOUISIANA. PART II: RHYACOPHILOIDEA

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Abstract.—Distributional records for 30 species of caddisflies in the superfamily Rhyacophiloidea (Glossosomatidae, Hydroptilidae, Rhyacophilidae) are presented, and the seasonal occurrence of each is indicated. Annotations include information on species habitat and relative abundance. All 26 of the species reported from Mississippi are new state records, and all but eight species are newly recorded from Louisiana.

This paper is the second of a three part series dealing with the Trichoptera of Mississippi and southeastern Louisiana. Representatives of all three families in the superfamily Rhyacophiloidea were collected during the surveys, but only members of the Hydroptilidae were common and represented by more than a single species. This superfamily was more poorly represented than the Hydropsychoidea of Part I and the Limnephilodea of Part III in the study area.

List of Species

The Rhyacophiloidea were represented in the study area by 30 species in eight genera and three families. Of the reported 30 species, 28 belong to the Hydroptilidae and one each to the Rhyacophilidae and Glossosomatidae. Only eight species, all hydroptilids, were previously reported from the study area: *Hydroptila waubesiana* Betten, *Neotrichia minutisimella* (Chambers), *Oxyethira glasa* Ross, *O. verna* Ross, and *O. zeronia* Ross (as *O. walteri*)

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by Denning (1947a); *Orthotrichia cristata* Morton by Denning (1947b); *Oxyethira janella* Denning by Denning (1948); and *Orthotrichia aegerfasciella* (Chambers) (as *O. americana* Banks) by Kingsolver and Ross (1961).

Collecting sites and seasonal occurrence designations in the following list follow that outlined in Part I. Since most of these species, particularly within the Hydroptilidae, have poorly known distributions, those with significant range extensions are indicated.

Glossosomatidae

Protoptila lega Ross. Sites 35, 57, 71, 80, 81. 23 May–13 Oct. Locally common. Collected along fast, clear streams with sand-gravel substrates. At several of the localities aquatic mosses and algae were encrusted on the rocks of the rapids.

Hydroptilidae

Hydroptila armata Ross. Sites 24, 60. 27 March, 8 May. Uncommon. Collected near swift, sand-bottom streams.

Hydroptila berneri Ross. Site 127. 20 March. A single specimen was collected along a small blackwater stream.

Hydroptila grandiosa Ross. Sites 60, 61. 7 Feb., 11 April. Rare. Collected along small, spring-fed streams. Primarily known from the northeastern and northcentral United States (Blickle, 1979).

Hydroptila gunda Milne. Sites 57, 61, 67. 11 April, 20 June, 1 Aug. Uncommon. Collected along Coastal Plain (CP) streams with moderately fast flow and sand-gravel bottoms.

Hydroptila hamata Morton. Sites 34, 60, 125. 30 Jan., 7 Feb., 1 April, 10 May. Occasional but probably widespread in study area. Collected along a variety of streams.

Hydroptila molsonae Blickle. Sites 99, 127. 20 March, 22 May. Uncommon. Collected along CP blackwater streams with abundant vegetation. Only known previously from the type-locality in Florida (Blickle, 1962).

Hydroptila n. sp. Sites 2, 38, 67, 71, 80, 81. 8 Sept., 1 Aug.–13 Oct. Common. Widely distributed in study area, usually occurring near clear, cool, fast-flowing streams. This species is being described by the junior author (RWH).

Hydroptila novicola Blickle and Morse. Site 97. 7 June. Uncommon. Collected near a small, sand-bottom blackwater stream. Beds of *Vallisneria* were abundant in stream. Primarily known from the northeastern United States (Blickle, 1979).

Hydroptila quinola Ross. Sites 24, 37, 60, 83, 86, 97, 103. 7 Feb., 7–28 May, 10 June. Common. Widely distributed in study area occurring along a variety of streams.

Hydroptila remita Blickle and Morse. Sites 37, 61, 120, 127. 11 April, 7–31 May, 17 Oct. Occasional. Collected near slow- to moderate-flowing streams primarily on the CP.

Hydroptila strepha Ross. Site 97. 7 June. Uncommon. Collected with *H. novicola*. Previously known only from northeastern United States (Blickle, 1979).

Hydroptila tusculum Ross. Sites 83, 122, 129. 9 April, 5–10 June. Uncommon. Associated with small, spring-fed blackwater streams. Previously only known from the type locality in Tennessee (Ross, 1947).

Hydroptila waubesiana Betten. Sites 51, 79, 86. 23 May, 9 June, 23 June. Uncommon. This widespread eastern species was collected near clear, fast-flowing streams with sand-gravel substrates.

Mayatrichia ayama Mosely. Sites 95, 97. 7 June. Locally common. This widespread North American species was collected near small, moderately flowing blackwater streams with sand substrates.

Neotrichia minutisimella (Chambers). Site 40. 23 Aug., 10 Oct. Locally common. Collected along the Mississippi River.

Neotrichia vibrans Ross. Sites 71, 95. 7 June, 30 Aug. Locally common. Collected along small blackwater streams with moderate flow and sand-gravel bottoms.

Ochrotrichia tarsalis (Hagen). Sites 2, 57, 67, 116. 20 June–20 Oct. Common. Collected near clear, fast-flowing streams with sand-gravel bottoms. This species as well as the two preceding are fairly widespread in the eastern United States (Blickle, 1979).

Orthotrichia aegerfasciella (Chambers). Sites 2, 16, 24, 25, 37, 40, 41, 49, 66, 71, 103, 126, 129, 131. 25 April–5 June, 16 July, 30 Aug–10 Oct. Common. Widely distributed in study area associated with a variety of streams and lakes.

Orthotrichia cristata Morton. Sites 31, 66. 28 May, 31 Aug. Uncommon. Collected near spring-fed, sand-bottom lakes. As with *O. aegerfasciella*, this is a widespread eastern species (Blickle, 1979).

Orthotrichia curta Kingsolver and Ross. Site 129. 5 June. Rare. Collected near a small, spring-fed blackwater stream with little flow. Previously only known from the type-locality in Florida (Blickle, 1962).

Orthotrichia dentata Kingsolver and Ross. Site 103. 26 May. A single specimen was collected along a large, swift-flowing blackwater stream of the CP. Previously only known from the type-locality in Florida (Blickle, 1962).

Oxyethira glasa (Ross). Sites 86, 99, 102, 129. 22 May–5 June. Locally common. Collected primarily along small, slow-moving blackwater streams of the lower CP.

Oxyethira janella Denning. Sites 71, 106, 129. 26 May, 5 June, 30 Aug.

Locally common. Collected from the CP near blackwater streams of various sizes and flow regimes.

Oxyethira novasota Ross. Sites 28, 37, 61, 83, 86, 129. 11 April, 7–23 May, 5–10 June. Locally common. Widespread in study area occurring along a variety of streams.

Oxyethira pallida (Banks). Sites 25, 106, 129. 6 May, 26 May, 5 June. Locally common. This widespread North American species was collected from both clear and blackwater streams of varying size and flow regimes.

Oxyethira sininsigne Kelley. Site 129. 5 June. Rare. Collected along a small, spring-fed blackwater stream with little flow.

Oxyethira verna Ross. Site 132. 14 May. Locally common.

Oxyethira zeronia Ross. Sites 31, 99, 102. 22–24 May, 31 Aug. Locally common. This widespread eastern species was associated with a variety of aquatic habitats including a lake, a marsh, and a swift-flowing, sand-bottom stream.

Rhyacophilidae

Rhyacophila glaberrima Ulmer. Site 2. 8 Sept. Rare. This primarily northern species was collected along a small, fast-flowing stream with rocky bottom in the Tennessee River Hills (TRH) region.

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LITERATURE CITED

Blickle, R. L. 1962. Hydroptilidae (Trichoptera) of Florida. Fla. Entomol. 45: 153–155.

———. 1979. Hydroptilidae (Trichoptera) of America north of Mexico. N. H. Agric. Exp. Stn. Bull. 509: 1–97.

Denning, D. G. 1947a. Hydroptilidae (Trichoptera) from southern United States. Can. Entomol. 79: 12–20.

———. 1947b. New species and records of North American Hydroptilidae (Trichoptera). Psyche (Camb. Mass.) 54: 170–177.

———. 1948. New species of Trichoptera. Ann. Entomol. Soc. Am. 41: 397–401.

Kingsolver, J. M. and H. H. Ross. 1961. New species of nearctic *Orthotrichia* (Hydroptilidae, Trichoptera). Ill. St. Acad. Sci. Trans. 54: 28–33.

Ross, H. H. 1947. Descriptions and records of North American Trichoptera, with synoptic notes. Trans. Am. Entomol. Soc. 73: 125–168.

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AN ANNOTATED CHECKLIST OF THE CADDISFLIES (TRICHOPTERA) OF MISSISSIPPI AND SOUTHEASTERN LOUISIANA. PART III: LIMNEPHILOIDEA AND CONCLUSIONS[1]

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Abstract.—Distributional records for 63 species of caddisflies in the superfamily Limnephiloidea (Phryganeidae, Brachycentridae, Limnephilidae, Lepidostomatidae, Sericostomatidae, Odontoceridae, Molannidae, Helicopsychidae, Calamoceratidae, Leptoceridae) from Mississippi and southeastern Louisiana are presented and seasonal occurrence of each is indicated. Annotations for many species include notes on habitat and relative abundance. Of the species reported, 58 represent new state records for Mississippi and 60 are newly recorded from Louisiana. Faunal composition and distribution of the order in the study area are discussed.

This is the third and final contribution in a three part series on the caddisflies of Mississippi and southeastern Louisiana. In this section records are presented for 63 species in 22 genera from the families Phryganeidae, Brachycentridae, Limnephilidae, Lepidostomatidae, Sericostomatidae, Odontoceridae, Molannidae, Helicopsychidae, Calamoceratidae, and Leptoceridae. Sixty-two percent of the species reported belong to the Leptoceridae.

Literature records of Limnephiloidea from Mississippi and Louisiana are very few and scattered, and include the following: Hagen (1861) described *Platycentropus amicus* (as *Hallesus*) from New Orleans, Louisiana; Ross

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[2] Address reprint requests to junior author (PKL).

(1962) described *Agarodes stannardi* (as *Sericostoma*) from Marshall Co., Mississippi; Flint (1972) described the male of *Ironoquia kaskaskia* (Ross) (as *I. brysoni*) from Oktibbeha Co., Mississippi; Ross and Scott (1974) described *Agarodes libalis* from Jackson Parish, Louisiana; and Haddock (1977) recorded *Nectopsyche spiloma* (Ross) from Louisiana and Mississippi and *N. candida* (Hagen) and *N. pavida* (Hagen) from Mississippi.

Additional records indicated in the text were obtained from the Louisiana State University Collection (LSUC). Collection site numbers correspond to those listed in Part I.

List of Species

Phryganeidae

Agrypnia vestita (Walker). Sites 2, 9, 10, 13, 14, 16, 19, 22, 23, 44, 90, 100. 7 Apr.–12 July, 11 Sept.–24 Oct. Fairly common in the northern half of the study area.

Ptilostomis ocellifera (Walker). Sites 3, 16. 16 June, 2 July, 26 July. Uncommon.

Ptilostomis postica (Walker). Sites 3, 4, 16, 18, 19, 23, 26, 85, 104. Additional record from Baton Rouge, East Baton Rouge Parish, LA (LSUC). 16 Apr.–14 July, 27 Aug.–27 Sept. Collected near rocky streams, muddy ponds and sand-bottomed reservoirs. Widespread but not common.

Brachycentridae

Brachycentrus numerosus (Say). Larvae collected from sites 81, 123, 125. Adult records from Magnolia, Plaquemines Parish, LA, 28 Feb., (LSUC). This species is fairly common and widespread in the CP. Larvae were collected from submerged logs and aquatic vegetation in strong currents of clear, fast flowing streams. This was the earliest emerging caddisfly in the study area.

Micrasema wataga Ross. Sites 71, 92, 97, 108, 120. 25 May–30 Aug. Widespread in the CP but not common. Most often collected near clear, cool, blackwater streams having abundant aquatic vegetation.

Limnephilidae

Ironoquia kaskaskia (Ross). Site 23. Additional record from Fluker, Tangipahoa Parish, LA (LSUC). 14 Oct.–7 Nov. Rare.

Ironoquia punctatissima (Walker). Sites 6, 7, 10, 11, 13, 16, 19, 23, 44, 116. 9 Sept.–8 Nov. Widespread but not common. Collected along a wide variety of aquatic habitats.

Limnephilus prob. *submonilifer* Walker. Site 7. A single small larva was collected in May. Our identification is tentative until we can associate it with adults. *L. submonilifer* is the only *Limnephilus* recorded from the neighboring states of Arkansas (Unzicker et al., 1970) and Tennessee (Etnier and Schuster, 1979). The larva was described by Flint (1960).

Platycentropus amicus (Hagen). The female holotype is from New Orleans. Ross (1938) described the male (as *P. plectrus*) from Michigan and Wisconsin. This rare species has not been collected from the study area since Hagen's time.

Platycentropus radiatus (Say). Based on a single male from Moss Point, Hancock Co., Miss. 26 May.

Pycnopsyche indiana (Ross). Site 127. 17 Oct. Rare. Collected from a small, spring-fed, black-water stream.

Pycnopsyche lepida (Hagen). Site 23. 22 Oct.–28 Oct.

Pycnopsyche luculenta (Betten). Sites 11, 14, 16, 17. 1 Oct.–30 Oct. Collected along small streams, ponds and bogs.

Pycnopsyche scabripennis (Rambur). Sites 10, 11, 13, 14, 17, 44, 103, 127. 1 Oct.–30 Oct. The most common and widespread *Pycnopsyche* in the study area, the majority of specimens were collected near small reservoirs.

Lepidostomatidae

Lepidostoma sp. Site 7. Based on larvae collected in May.

Sericostomatidae

Agarodes crassicornis (Walker). Sites 16, 21, 86, 89, 93, 96, 97, 98, 100, 102, 108, 114. 18 May–30 June. Fairly common. Associated with cool streams and springs.

Agarodes libalis Ross and Scott. Sites 86, 108, 120, 128. 23 May–4 June. This CP endemic has a narrow emergence period in the spring of the year and was always associated with spring-fed, black-water streams.

Agarodes stannardi (Ross). Sites 7, 16. 16 May, 21 May, 30 May. This rare species is known only from the type-locality and vicinity and is associated with cool, sandy springs.

Odontoceridae

Psilotreta rufa Hagen. Sites 1, 7, 17. 16 May, 21 May, 28 May. Not common. Limited to cool, rocky springs. Previously known only from the Northeast (Ross, 1944).

Molannidae

Molanna blenda Sibley. Sites 7, 16, 124. 28 March–12 June. Larvae and adults were collected from springs.

Molanna tryphena Betten. Sites 70, 127, 128. 21 March, 29 March, 4 June. Associated with CP black-water streams. Larvae were very common at sites 127 and 128.

Molanna ulmerina Navas. Sites 87, 125. 1 April, 25 Sept. Rare. The collection of adults in September suggest that this species may have two generations per year in the study area.

Helicopsychidae

Helicopsyche borealis (Hagen). Sites 38, 57, 58. 20 June, 22 Sept., 13 Oct. In Mississippi larvae were collected in shallow, gravel expanses of clear, well aerated streams.

Calamoceratidae

Anisocentropus pyraloides (Walker). Sites 39, 59, 60, 86, 97. 19 April–7 June. Collected near small, cool, black-water streams.

Leptoceridae

Ceraclea cancellata (Betten). Sites 33, 114. 17 April, 10 May.

Ceraclea diluta (Hagen). Site 100. 6 April. Collected near a shallow, sand-bottomed pond.

Ceraclea flava (Banks). Sites 40, 44, 59, 63, 65, 73, 80, 83, 102. 23 May–20 June. Usually associated with large, slow moving rivers.

Ceraclea maculata (Banks). Sites 2, 5, 7, 10, 11, 16, 17, 20, 23, 25, 26, 32, 33, 34, 37, 40, 44, 45, 51, 52, 56, 57, 58, 59, 62, 65, 67, 69, 73, 80, 83, 86, 91, 92, 93, 95, 97, 100, 101, 106, 108, 117, 119, 121, 122, 126, 127, 129. 9 April–17 Oct. The most common and widespread *Ceraclea* in the study area. Collected along a wide diversity of aquatic habitats.

Ceraclea nepha (Ross). Sites 2, 11, 16, 19, 23, 25, 45, 59, 86. 18 April–27 Oct. Collected from a variety of habitats in the study area. Previously known from the central states (Morse, 1975).

Ceraclea ophiodera (Ross). Sites 16, 40, 47, 58, 71, 79, 80, 83, 84, 97, 101, 117, 120. 23 May–22 Sept. Widespread and common in the southern half of the study area.

Ceraclea protonepha Morse and Ross. Sites 2, 11, 16, 24, 25, 28, 34, 66, 86. 19 April–27 June. Specimens were commonly collected near small, sandy streams.

Ceraclea resurgens (Walker). Sites 122, 124, 125. 28 March, 1 April, 9 April. This obligate sponge feeder was always associated with medium-sized, black-water streams. Adult emergence period was very brief.

Ceraclea slossonae (Banks). Site 51. 27 May.

Ceraclea spongillovorax (Resh). Sites 7, 118, 128. 6 Aug., 18 Sept., 1 Oct. Several specimens were collected near a small, spring-fed reservoir.

Ceraclea tarsipunctata (Vorhies). Sites 5, 6, 7, 15, 16, 19, 23, 26, 28, 29, 32, 33, 36, 44, 49, 51, 59, 63, 73, 80, 85, 88, 93, 100, 115, 132. 29 March–11 Nov. Widespread and common across the study area. There is probably more than a single generation per year for this species in our area.

Ceraclea transversa (Hagen). Sites 28, 84. 9 May, 16 June. Collected from small, sandy streams. Rarely encountered.

Leptocerus americanus (Banks). Sites 16, 24, 25, 32, 44, 51, 52, 66, 110, 120, 126. 19 April–31 May. Usually associated with streams and ponds having abundant beds of aquatic vegetation, especially *Ceratophyllum*.

Nectopsyche albida (Walker). Sites 16, 19, 23, 32. 8 May–17 June.

Nectopsyche candida (Hagen). Sites 2, 7, 16, 17, 23, 40, 43, 44, 45, 51, 52, 56, 67, 80, 81, 87, 90, 92, 100, 103, 105, 112, 114, 115, 116, 119, 120, 126, 127, 129, 131. 17 April–20 Oct. Widespread and common.

Nectopsyche exquisita (Walker). Sites 2, 16, 35, 38, 49, 57, 59, 71, 73, 87, 91, 110. 21 May–13 Oct. As widespread but somewhat less common than *N. candida* in the study area.

Nectopsyche pavida (Hagen). Sites 2, 51, 57, 58, 61, 62, 67, 80, 81, 90, 92, 119. 11 April–29 Sept. Collected mostly near CP streams.

Nectopsyche spiloma (Ross). Site 51. 7 July.

Oecetis avara (Banks). Sites 83, 84, 87. 10 June, 16 June, 10 Sept., 20 Sept. Rarely encountered.

Oecetis cinerascens (Hagen). Sites 2, 8, 10, 16, 20, 25, 30, 31, 32, 35, 37, 44, 50, 51, 52, 65, 66, 73, 87, 114, 126, 132. 11 April–8 Oct. Collected near small reservoirs and a variety of stream types throughout the study area.

Oecetis daytona Ross. Sites 91, 102. 24 May, 5 Aug. An apparent CP endemic. Previously known only from the type-locality in Florida (Ross, 1947).

Oecetis ditissa Ross. Sites 2, 5, 11, 13, 16, 24, 25, 28, 34, 40, 49, 62, 63, 83, 84, 85, 86, 100, 127, 128. 15 April–17 Oct. Widespread and common.

Oecetis georgia Ross. Sites 118, 127. 6 Aug.–17 Oct. A rare CP endemic. Collected only along spring-fed, black-water streams. Known previously from Georgia (Ross, 1941).

Oecetis inconspicua (Walker). Sites 2, 4, 9, 10, 11, 13, 14, 16, 17, 18, 19, 20, 21, 23, 24, 25, 26, 28, 30, 31, 32, 33, 35, 36, 40, 43, 44, 49, 50, 51, 59, 62, 63, 65, 66, 68, 69, 71, 73, 79, 80, 81, 82, 83, 84, 85, 86, 87, 88, 90, 92, 93, 99, 100, 102, 103, 107, 109, 110, 111, 112, 114, 115, 116, 120, 125, 126, 127, 128, 129, 131, 132. 15 March–21 Nov. One of the most common caddisflies occurring in the study area.

Oecetis nocturna Ross. Sites 2, 24, 26, 34, 83, 114, 127. 8 May–17 Oct. Taken from a variety of habitats including reservoirs and small, sandy streams.

Oecetis osteni Milne. Sites 7, 16, 28, 37, 56, 62, 66, 69, 71, 90, 92, 93, 95, 97, 100, 101, 102, 103, 126, 129, 131. 5 April–18 Oct. Although widespread, this species was more common in the CP.

Oecetis persimilis (Banks). Sites 2, 14, 28, 34, 52, 61, 77, 79, 83, 84, 91, 92, 97, 122, 126. 9 April–13 Oct. The distribution and abundance of this species in the study area is similar to those of *O. osteni*.

Oecetis sphyra Ross. Sites 60, 67, 78, 80, 81, 83, 90, 93, 95, 97, 103, 117, 120, 127, 128. 23 May–18 Oct. Limited in distribution to the CP.

Setodes dixiensis Holzenthal. Sites 61, 79, 80, 117, 118. 11 April–6 Aug. Associated with cool, clear, fast flowing, medium-sized streams in the CP.

Triaenodes abus Milne. Sites 19, 34, 122. 9 April, 10 May, 12 May. Collected near small, sandy streams. Most members of this genus were rare in our area and records for many species represent rather significant range extensions.

Triaenodes flavescens Banks. Sites 38, 87. 19 Sept.–13 Oct.

Triaenodes ignitus (Walker). Sites 16, 18, 29, 51, 57, 60, 69, 79, 80, 84, 97, 101, 103, 122, 127, 128. 9 April–28 July, 17 Oct. Common and taken along a variety of aquatic habitats but never in large numbers.

Triaenodes inflexus Morse. Site 16. 14 June. Very rare. Our specimens were collected rather far from water. Previously known only from South Carolina (Morse, 1971; Morse et al., 1980).

Triaenodes marginatus Sibley. Sites 11, 14. 3 May, 30 May, 17 July. A widespread eastern species. Specimens were collected near a shallow, sandy stream and a muddy stream.

Triaenodes melacus Ross. Sites 28, 30. 8 May, 9 May. Collected along a small stream and a sand bottomed reservoir. Previously known only from Illinois (Ross, 1947).

Triaenodes nox Ross. Site 29. 9 May. These specimens were collected near a small farm pond. Very rare.

Triaenodes ochraceus (Betten and Mosely). Sites 24, 29, 34, 86, 100. 19 April–18 May. Rare. Formerly known only from Burke Co., Georgia and Aiken Co., South Carolina (Morse et al., 1980). Our specimens were collected near small, sandy streams and small ponds.

Triaenodes pernus Ross. Sites 11, 14, 29, 69, 92, 129, 131. 9 May–17 July, 18 Sept. Fairly common near small to medium-sized sandy streams.

Triaenodes smithi Ross. Sites 14, 33, 44, 79. 10 May–23 June. Reported previously from Illinois (Ross, 1959). We collected specimens in an area of spring-fed ponds, and near small sandy streams.

CONCLUSIONS

In our three part checklist we recorded a total of 139 species of caddisflies from 43 genera and 17 families from Mississippi and southeastern Louisiana. Most of the more than 450 species of Southeastern caddisflies occur in areas of high topographic relief, particularly in the southern Appalachian region, where lotic habitats include large, meandering rivers, torrential mountain streams, cool springs and seeps. The majority of streams in the study area have sand and gravel bottoms, low gradients and warm waters. These conditions result in fewer microhabitats available to many species and limit the occurrence of cool-adapted species. It is not surprising then that the families Leptoceridae, Hydropsychidae, Hydroptilidae, and Polycentropodidae accounted for 76% of the species reported (28%, 20%, 15% and 13% respectively). Species in these families, especially the Leptoceridae, are noted for their ability to exploit warm water habitats (Wiggins, 1977). This factor in large part accounts for the high numbers of species from these four families in our area.

The generally cool-adapted families Philopotamidae, Psychomyiidae, Glossosomatidae, Phryganeidae, Brachycentridae, and Limnephilidae were represented by species in genera with members secondarily adapted to warm waters, e.g. *Chimarra, Lype, Protoptila, Agrypnia, Ptilostomis, Brachycentrus, Micrasema, Ironoquia,* and *Pycnopsyche* (Wiggins, 1977). Species from other cool-adapted families, including *Rhyacophila glaberrima* (Rhyacophilidae), *Psilotreta rufa* (Odontoceridae), and *Lepidostoma* sp. (Lepidostomatidae) were restricted to the extreme northern part of the NCP or the TRH where cooler streams are more frequent. Species in the Sericostomatidae, Molannidae, and Calamoceratidae were almost always associated with cool springs and spring-fed streams, especially in the CP.

Approximately 35 southeastern caddisfly species appear to be restricted in distribution to the Gulf and Atlantic Coastal Plains where they usually are associated with black-water streams. Morse et al. (1980) recorded many of these species and Ross and Scott (1974) and Kelley and Morse (1982) noted the endemicity of several species of *Agarodes* and *Oxyethira*, respectively, to this region of North America. In the study area these coastal plain endemics included, *Chimarra florida, Neureclipsis melco, Cheumatopsyche petersi, Cheumatopsyche virginica, Hydropsyche elissoma, Hydroptila molsonae, Orthotrichia curta, Orthotrichia dentata, Oxyethira janella, Oxyethira novasota, Oxyethira sininsigne, Agarodes libalis, Oecetis daytona, Oecetis georgia,* and *Setodes dixiensis*.

A few typically northern species were collected only from the northern half of the NCP an the TRH and included *Hydropsyche simulans, Rhyacophila glaberrima, Ptilostomis ocellifera, Limnephilus* prob. *submonilifer, Pycnopsyche lepida, Pycnopsyche luculenta, Lepidostoma* sp., *Psilotreta rufa,* and *Triaenodes marginatus*.

Only *Neotrichia minutisimella*, a widespread eastern species, was restricted to the YD, where it was collected along the Mississippi River.

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LITERATURE CITED

Etnier, D. A. and G. A. Schuster. 1979. An annotated list of Trichoptera (Caddisflies) of Tennessee. J. Tenn. Acad. Sci. 54: 15–22.

Flint, O. S., Jr. 1960. Taxonomy and biology of Nearctic limnephilid larvae (Trichoptera), with special reference to species in eastern United States. Entomol. Am. 40: 1–117.

———. 1972. Three new caddisflies from the southeastern United States. J. Ga. Entomol. Soc. 7: 79–82.

Haddock, J. D. 1977. The biosystematics of the caddis fly genus *Nectopsyche* in North America with emphasis on the aquatic stages. Am. Midl. Nat. 98: 382–421.

Hagen, H. A. 1861. Synopsis of the Neuroptera of North America, with a list of the South American species. Smithson. Misc. Collect., 347 pp.

Kelley, R. W. and J. C. Morse. 1982. A key to females of the genus *Oxyethira* (Trichoptera: Hydroptilidae) from the southern United States. Proc. Entomol. Soc. Wash. 84: 256–269.

Morse, J. C. 1971. New caddisflies (Trichoptera) from the southeastern United States. J. Ga. Entomol. Soc. 6: 77–84.

———. 1975. A phylogeny and revision of the caddisfly genus *Ceraclea* (Trichoptera, Leptoceridae). Contrib. Am. Entomol. Inst. (Ann Arbor) 11: 1–97.

Morse, J. C., J. W. Chapin, D. D. Herlong, and R. S. Harvey. 1980. Aquatic insects of Upper Three Runs Creek, Savannah River Plant, South Carolina. Part I: Orders other than Diptera. J. Ga. Entomol. Soc. 15: 73–101.

Ross, H. H. 1938. Descriptions of Nearctic caddis flies (Trichoptera) with special reference to the Illinois species. Ill. Nat. Hist. Surv. Bull. 21: 101–183.

———. 1941. Descriptions and records of North American Trichoptera. Trans. Am. Entomol. Soc. 67: 35–126.

———. 1944. The caddis flies, or Trichoptera, of Illinois. Ill. Nat. Hist. Surv. Bull. 23: 1–326.

———. 1947. Descriptions and records of North American Trichoptera, with synoptic notes. Trans. Am. Entomol. Soc. 73: 125–168.

———. 1959. The relationships of three new species of *Triaenodes* from Illinois and Florida. Entomol. News 70: 39–45.

———. 1962. Three new species of Trichoptera from eastern North America. Entomol. News 73: 129–133.

Ross, H. H. and D. C. Scott. 1974. A review of the caddisfly genus *Agarodes*, with descriptions of new species (Trichoptera: Sericostomatidae). J. Ga. Entomol. Soc. 9: 147–155.

Unzicker, J. D., L. Aggus, and L. O. Warren. 1970. A preliminary list of the Arkansas Trichoptera. J. Ga. Entomol. Soc. 5: 167–174.

Wiggins, G. B. 1977. Larvae of the North American caddisfly genera (Trichoptera). Univ. of Toronto Press, Toronto. 401 pp.

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A DESCRIPTION OF THE LARVA OF *DIXELLA NOVA* (WALKER) (DIPTERA:DIXIDAE)[1]

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Abstract.—The mature fourth instar of *Dixella nova* (Walker) is described and illustrated. Terms applied to larval dixid structures by authors of earlier descriptions are synonymized with those used in this paper.

All 44 species of Dixidae known to occur in the Nearctic Region have been described in the imaginal stage (Peters and Cook, 1966; Peters and Barbosa, 1970; Peters, 1981b). Knowledge of immature stages is sparse; only nine species have been described or illustrated (Johannsen, 1903, 1933; Nowell, 1951; Peters and Barbosa, 1970; Smith, 1928).

Adult dixids spend the majority of their time concealed in habitats along the edges of water dominated by overhanging vegetation. Hence, they are seldom taken by the general collector. However, adult males form swarms in late afternoon and evening along the water's edge and can be collected by wading along the shore.

Although a few immature dixids may be found in broad spectrum collections gathered for environmental impact statements, they are seldom collected except by specialized techniques. The pupa is attached to emergent vegetation or rocks above the waterline. The larva rests at the waterline with its body in an inverted U position so that only its head and caudal respiratory apparatus is in the meniscus. Thus, aquatic netting or use of dippers seldom catch immature dixids. However, larvae in lotic waters undergo diel drifting (Waters, 1962) and are caught by drift sampling techniques. Both lentic and lotic forms may be washed into an aquatic net from their positions on emergent objects and the water's edge. If the net is emp-

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tied into a white pan full of water, the larvae soon swim to the surface and may be picked out.

At present, the only way most larvae can be identified to species is by rearing to the adult stage and then identifying them. However, most specimens are preserved as they are caught and are thereby not identifiable to species except by comparison with the few published larval descriptions. Here too, a problem is encountered because of the diverse terminology used for the morphological structures employed in the specific descriptions.

The purpose of this paper is twofold. The first objective is to stabilize the terminology so that workers can use the previous larval descriptions with some confidence that the structures being compared between articles are the same. The second objective is to describe the mature larva of *Dixella nova* (Walker) and to illustrate the structures that are of value in comparing it to previously known larvae. The complete chaetotaxy is not presented here, but it will be covered in a future paper comparing all the known larval dixids from the Nearctic Region.

Description of the Mature Fourth Instar of *Dixella nova* (Walker)

Figs. 1, 2, 3

Length 2.8–3.4 mm ($N = 10$). Head and caudal respiratory apparatus medium brown, heavily sclerotized. Body cylindrical, predominantly slate gray, including thoracic segments and abdominal segment 8. Abdominal segments 1–7 countershaded, with venter lighter gray. Mesothorax with 2 paired subcircular non-pigmented areas, one on each pleural area with a second contiguous to it toward the venter. Metathorax with single non-pigmented subcircular area on each side, slightly smaller than those of mesothorax.

Head as in Fig. 3A. Eye posterior to and slightly below insertion of antenna, with heavy sclerotization of head capsule around dorsoanterior margin but very lightly sclerotized immediately below and behind eye, becoming heavily sclerotized just anterior to seta 10 (following system of Belkin et al., 1970). Seta 1 as long as mouth brushes but of greater diameter, moderately sinusoidal, blunt-ended. Seta 3 shorter than mouth brushes, flattened, pointed, widest in middle. Antenna with numerous pointed terminal sensilla. A very lightly sclerotized, pear-shaped sensillum located in depression bounded by ring of pointed terminal sensilla. This sensillum often destroyed in permanently mounted specimens (see insert in Fig. 3C).

Mandible as in Fig. 3A. Dorsal tooth between mandibular brush and seta 2. Mandibular brush tapering from long distal hair, shortest basally. Two prominent, heavily sclerotized ventral teeth, the distal one largest. A row of accessory teeth between inner ventral tooth and articulation. An elongate tuft of branched, slender hairs forms the mandibular sweeper, arising from basal edge of accessory tooth ridge, at 90° angle to row of accessory teeth

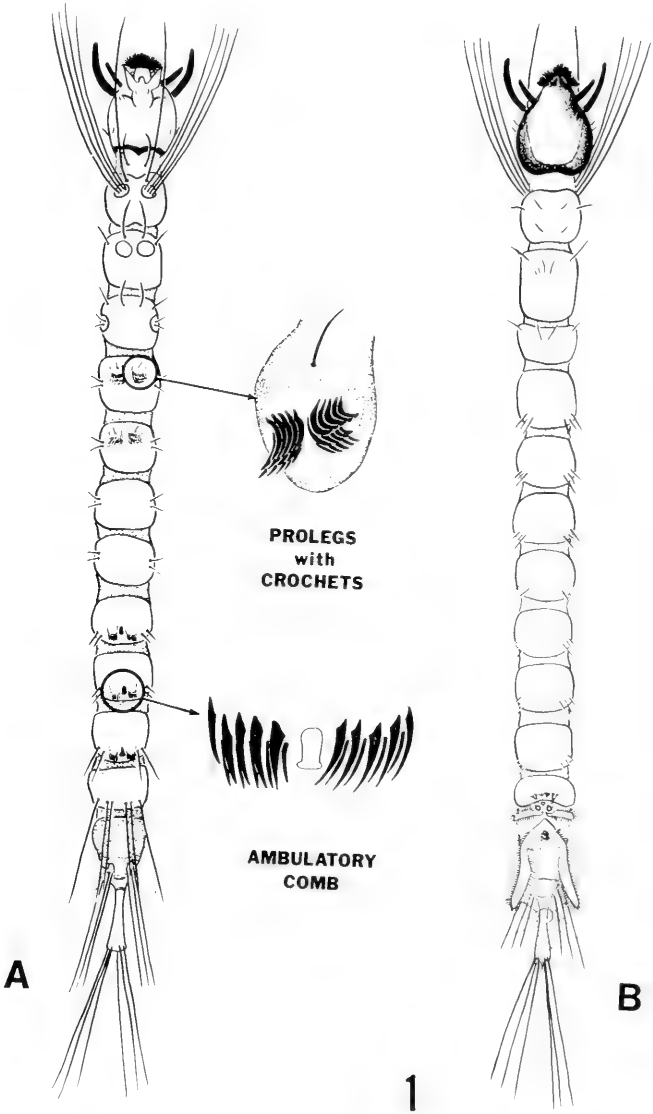

Fig. 1. Mature fourth-instar of *Dixella nova*. A, Ventral view. B, Dorsal view.

(see insert of Fig. 3A). Lateral seta prominent. Maxilla as in Fig. 3A. Palp antenniform.

Anterior ventral setae of prothorax prominent, extending beyond mouth brushes of head, arranged as 1-1-4-1-1-4-1-1. Each group of 4 share a common sclerotized base.

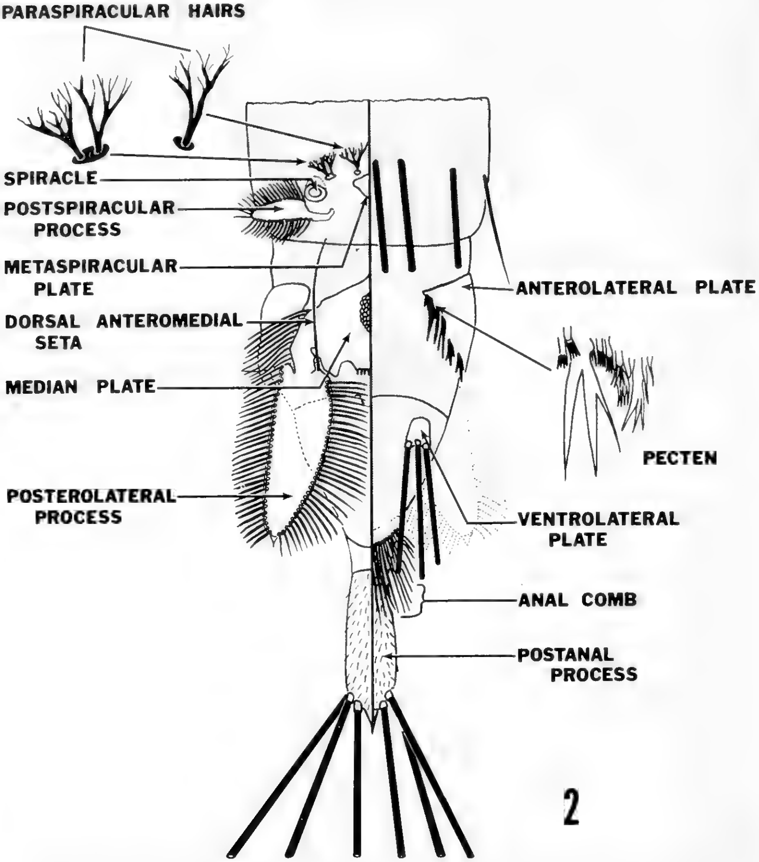

Fig. 2. Posterior abdominal structures of *Dixella nova* larva, slightly distended; left half dorsal, right half ventral.

Venter of abdominal segments 1 and 2 each with a pair of prolegs, tipped with anteriorly directed, uniordinal, triserial crochets (see insert, Fig. 1A). Base of prolegs slate gray, lighter distally. Segments 5–7 with ambulatory comb (see insert, Fig. 1A). Medial plate of comb subrectangular, posterolateral corners expanded. Spines of comb in 2 distinct rows, the smaller slightly appressed to surface of segment, the stouter row at a less acute angle to body surface.

Segment 8 simple ventrally, with row of 8 long stout setae. Dorsally a row of multiple-branched paraspiracular setae arise from 4 bases, lateral bases with 2 setae each, medial bases with 1 seta each. Metaspiracular plate located medially between spiracles; subtriangular, with apex directed pos-

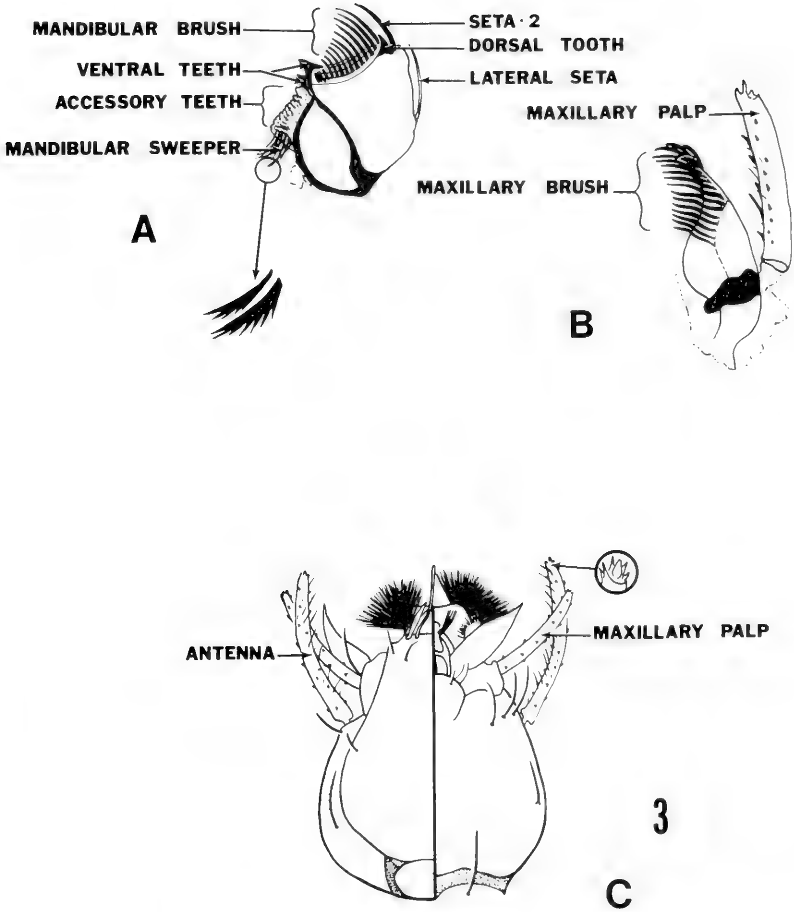

Fig. 3. *Dixella nova*. A, Left mandible, ventral view. B, Left maxilla, ventral view. C, Head, left half dorsal, right half ventral.

teriorly, center of plate elevated into a slight, blunt peak. Posterior to each spiracle is a laterally projecting, dorsoventrally flattened postspiracular process fringed with articulated setae.

Segment 9 with paired anterolateral plates bearing a complex pecten on the posterior margin; pecten of many small quadriradiate processes and a single large triradiate spine near the most ventral apex (see insert, Fig. 2). On dorsum a large median plate with slight sculpturing along mid-dorsal area in center of plate. Sculpturing formed by a contiguous group of elongate ovoids. Posterior medial margin of median plate with irregular row of very short complex, multiple-branched spines. Median plate extends into a pair of dorsoventrally flattened posterolateral processes fringed with articulated setae. Each process terminates posteriorly in a spine directly beneath the fringe. At base of each posterolateral process is a small dorsally projecting tubercle bearing a long, dorsal anteromedial seta.

Segment 10 conical; sclerotized dorsally; venter lightly sclerotized, bearing a pair of heavily sclerotized subtriangular ventrolateral plates, each with 3 very long posteriorly projecting setae. Just anterior to anus is a ventral anal comb of stout posteriorly projecting spines. Anterior to anal comb is an area of shorter delicate aculeae extending from one side of the segment ventrally to the opposite side. Behind anus, postanal process is entirely sclerotized with a sharp break in sclerotization at its narrowest diameter. Expanded and sparsely covered with moderately long microtrichia posterior to break. Caudal tip bears a posteriorly projecting spine on dorsum. Three pairs of long posteriorly projecting setae at caudal end. One pair projects dorsoposteriorly, another dorsolaterally, the 3rd posteroventrally.

TERMINOLOGY

Terms previous authors have used for morphological structures in descriptions of larval dixids vary widely. The only attempts to standardize terminology have been by Belkin (1962, 1968) when he interpreted dixid morphology considering them to be a subfamily of the Culicidae. He synonymized much of dixid morphology with that used for anopheline mosquitoes.

The terminology I apply to the larval head and mouthparts follows that of Harbach and Knight (1980) for mosquitoes. However, I have not attempted to use culicid terminology for the caudal and respiratory complex of dixids since homologies are not certain. This is not surprising in light of the morphological (Rohdendorf, 1964) and cytogentic (Frizzi et al., 1966) evidence accumulating to support the separation of Dixidae from the Culicidae.

The following is a list of published names, by author, for those structures described and illustrated in the *D. nova* description above. Each author's name appears only if the structure was assigned a name in the listed reference.

Paraspiracular hairs or setae (=prespiracular hairs of Nowell, 1951, Smith, 1928).

Postspiracular process (=anterolateral lobes of Belkin, 1962, Contini, 1965; =spiracular valves, plates, or appendages of Edwards, 1932, Smith, 1928, Tonnoir, 1921–3, Brindle, 1963, Disney, 1975; =ear-shaped lobes of Nowell, 1951; =Seitenklappe of Martini, 1929).

Metaspiracular plate (=anterior median lobe of Belkin, 1962; =posterior median plate of Contini, 1965; =chordate chitinized area of Smith, 1928; =median plate of Peters, 1981a; =interspiracular disc of Disney, 1975).

Median plate (=median plate of Belkin, 1962, Contini, 1965; =basal plate of Brindle, 1963, Disney, 1975; =Mittelstück of Martini, 1929).

Posterolateral process (=posterolateral lobes of Belkin, 1962, Contini, 1965; =lateral plates of Tonnoir, 1921–3, Smith, 1928; =posterior articulated paddle of Nowell, 1951; =posterior appendage of Brindle, 1963; =ciliated lateral lobe of Johannsen, 1933; =large posterior valves of Edwards, 1932; =Seitenklappe of Hennig, 1950; =Hinterklappe of Martini, 1929; =posterior paddle of lateral plate of Disney, 1975).

Anterolateral plate with pecten (=pecten of Belkin, 1962, Johannsen, 1903, Martini, 1929, Smith, 1928; =pectinate comb of Nowell, 1951).

Ventrolateral plate (=Lateralplatte of Hennig, 1950; =Subventralplatte of Martini, 1929).

Anal comb (=supraanal spicules of Belkin, 1962; =guards for gill chamber of Smith, 1928).

Postanal process (=tail-process of Johannsen, 1933, Edwards, 1932; =caudal appendage of Tonnoir, 1921–3, Contini, 1965, Disney, 1975; =cap of Nowell, 1951; =Schwanzfortsatz of Martini, 1929, Hennig, 1950; =anal appendage of Brindle, 1963; =cylindrical caudal process of Belkin, 1962).

Ambulatory comb (=ambulacral plate of Nowell, 1951; =sclerotized pectinate plate of Johannsen, 1933; =locomotory plate of Contini, 1965; =spiney plate of Smith, 1928; =rows of spines of Belkin, 1962; =short, hook-like spines of Brindle, 1963; =plate set with rows of hooks of Edwards, 1932; =Fusstummel of Hennig, 1950; =ambulacral comb of Belkin, 1968; =ventral comb of Disney, 1975).

Prolegs with crochets (=pseudopods of Edwards, 1932, Contini, 1965; =pseudopods with spines, hooks, or claws of Nowell, 1951, Brindle, 1963, Smith, 1928; =prolegs of Johannsen, 1933; =prolegs with curved spines of Belkin, 1962; =Kriechwulste of Hennig, 1950).

LITERATURE CITED

Belkin, J. N. 1962. The Mosquitoes of the South Pacific. Univ. of Calif., Press, Berkeley. 2 vols. 608 pp., 412 pls.

———. 1968. Mosquito studies (Diptera, Culicidae) VII. The culicidae of New Zealand. Contrib. Am. Entomol. Inst. (Ann Arbor) 3: 1–182.

Belkin, J. N., S. J. Heinemann, and W. A. Page. 1970. Mosquito studies (Diptera, Culicidae) XXI. The culicidae of Jamaica. Contrib. Am. Entomol. Inst. (Ann Arbor) 6: 1–458.

Brindle, A. 1963. Taxonomic notes on the larvae of British Diptera. Entomologist (Lond.) 96: 237–243.

Contini, C. 1965. I Dixidae della Sardegna. Nuovi reperti e descrizione di *Palaeodixa frizzii* N. Gen. N. Sp. Mem. Soc. Entomol. Ital. 44: 95–108, 6 pls.

Disney, R. H. L. 1975. A key to the British dixidae. Freshw. Biol. Assoc. Sci. Publ. No. 31, 78 pp.

Edwards, F. W. 1932. Family Culicidae. *In* Wytsman, P., ed., Genera Insectorum Fasc. 194, pp. 8–15.

Frizzi, G., C. Contini, and M. Mameli. 1966. Ulteriori richerche citogenetiche sui *Dixidae* della Sardegna. Atti Assoc. Genet. Ital. Pavia XI: 286–291.

Harbach, R. E. and K. L. Knight. 1980. Taxonomists' Glossary of Mosquito Anatomy. Plexus Publ. Co., Marlton, N.J. 413 pp.

Hennig, W. 1950. Die Larvenformen der Dipteren. Teil 2, pp. 66–67.

Johannsen, O. A. 1903. Aquatic nematocerous Diptera. N.Y. State Mus. Bull. 68: 429–432.

———. 1933. Aquatic Diptera, Part I. Nemosera exclusive of Chironomidae and Ceratopogonidae. Cornell Univ. Agric. Exp. Stn. Mem. 164: 35–37.

Martini, E. 1929. Subfamilie Dixidae. Pp. 20–43. *In* Lindner, E., Die Fliegen der Palaearktischen region Lief 33, Culicidae.

Nowell, W. R. 1951. The dipterous family Dixidae in western North America. Microentomology 16: 187–270.

Peters, T. M. 1981a. Family Dixidae. *In* McAlpine, J. F., B. V. Peterson, G. E. Shewell, H. J. Teskey, J. R. Vockeroth, and D. M. Wood, Manual of Nearctic Diptera. Vol. I. Res. Branch, Agric. Can., Monogr. No. 27. 674 pp.

———. 1981b. A new Nearctic *Dixa* (Diptera:Dixidae). Proc. Entomol. Soc. Wash. 83: 516–519.

Peters, T. M. and P. Barbosa. 1970. A new Nearctic species of Dixinae (Culicidae:Diptera). Entomol. News 81: 11–17.

Peters, T. M. and E. F. Cook. 1966. The Nearctic Dixidae. Misc. Publ. Entomol. Soc. Am. 5: 231–278.

Rohdendorf, B. 1964. The Historical Development of Diptera. Tr. Paleontol. Inst. Akad. Nauk USSR, Vol. 100 (English translation, Univ. of Alberta Press, Edmonton. 360 pp.)

Smith, F. K. 1928. Larval characters of genus *Dixa*. J. N.Y. Entomol. Soc. 36: 263–286.

Tonnoir, A. L. 1921–1923. Australian Dixidae. Pap. Proc. R. Soc. Tasmania, pp. 58–71.

Waters, T. F. 1962. Diurnal periodicity in the drift of stream invertebrates. Ecology 43: 316–320.

PROC. ENTOMOL. SOC. WASH.
84(3), 1982, pp. 529–534

NOMENCLATURAL NOTES ON *POLYNEMA* (HYMENOPTERA: MYMARIDAE), WITH DESCRIPTION OF A NEW SPECIES[1]

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Abstract.—Polynema **ema,** new species, a parasite of the lily planthopper, (*Megamelus davisi* Van Duzee), is described and illustrated. *Psilus ciliatus* Say, previously reported as a *Polynema* and believed to be the parasite of the lily planthopper, is a *nomen dubium*. *Polynema ciliatum* Perkins is considered a valid species and not a homonym of *ciliatus* Say.

In attempting to identify a species of *Polynema* parasitic upon eggs of the lily planthopper (*Megamelus davisi* Van Duzee), we noticed that the name *Polynema ciliata* (Say) had been used by Zimmerman (1948) for the parasite of this planthopper. We found also that Perkins (1910) had described a *Polynema ciliata,* thus creating an apparent homonym. After studying the literature and available specimens, however, we believe that Say's *ciliatus* is not recognizable to genus, that Perkins' *ciliata* is not a homonym, and that the parasite of the lily planthopper is an undescribed species. We take this opportunity to clarify the nomenclature of *P. ciliata* (Say) (of authors) and to describe the incorrectly named parasite of the lily planthopper.

Morphological terminology used here is that of DeBauche (1948), except for face height, which is the distance from the oral cavity to the median carina. The abbreviation LMC is used for the length of the longest marginal cilia of the forewing. Measurements of body length, ratios of body regions, etc., were made dorsally along the midline. Wings, antennae, and legs were measured in their extended form. Measurements were made with the aid of both a compound (100× and 160×) and a dissecting microscope (ca. 60×). Ranges and means were calculated from a random sample of 15 individuals from the type-series.

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Psilus ciliatus Say, *nomen dubium*

Psilus ciliatus Say 1828: 80.
Galesus ciliatus: Ashmead 1887: 195 (list).
Diapria ciliatus: Cresson 1887: 251 (list); Ashmead 1893: 428 (list, probably a mymarid); Dalla Torre 1898: 436 (list); Kieffer 1916: 76 (repeat of orig. desc. in German).
Trichopria ciliata: Kieffer 1911: 64 (list).
Polynema ciliatum: Peck 1951: 417 (n. comb.).

Psilus ciliatus Say has a long history of varied placement in two different superfamilies of Hymenoptera (Proctotrupoidea and Chalcidoidea). Most of the citations of this species are mere listings, and it is probable that none of the authors except Say ever saw the type-specimen. This specimen is lost, and based upon Say's original description it is not possible to assign *ciliatus* to a genus. For this reason we do not accept Peck's placement (1951) of *ciliatus* as a *Polynema*. Because there is no way positively to associate Say's description with a known genus or species, we relegate *ciliatus* to the status of a *nomen dubium*. However, we agree with Ashmead (1893) and Peck (1951) that *ciliatus* is probably a mymarid on the basis of the enlarged antennal club and ciliate wing margins.

We do not know how or why the name *ciliata* (Say) of authors became applied to the *Polynema* that attacks *Megamelus davisi* Van Duzee (Van Duzee, 1896: 18; Zimmerman, 1948: 248). There is no reason to associate this parasite with the name *ciliata*, because, with its extremely long ovipositor, it is quite distinct among all *Polynema*. On the basis of the "oblong oval acute club" as described by Say, his specimen would have been a female, and he certainly would have mentioned the ovipositor if it were prominent. Say mentioned no host, so that host-association is not possible.

Polynema ema Schauff and Grissell, New Species

Figs. 1–3

Cosmocoma ciliata (Say): Van Duzee, 1896: 18 (misidentification).
Polynema ciliata (Say): Zimmerman, 1948: 248 (misidentification).
Polynema ciliata (Say): Wilson and McPherson, 1981: 346 (misidentification).

Holotype female.—Length 0.63 mm excluding ovipositor (0.60–0.66, $\bar{x}$ = 0.64). Ratio head:thorax:abdomen:ovipositor 8:19:20:30. Head, thorax (except pronotum), and abdomen brown; funicle segments, club, last tarsal segment of legs lighter brown; scape, pedicel, prothorax, legs, petiole yellow. Head slightly wider than thorax (12:10), vertex alutaceous; median, frontal supraorbital carinae complete, occipital suture reaching foramen; posterior ocelli placed at junction of supraorbital carina and occipital suture; POL: OOL 7:1; frontal grooves converging below toruli, ending on either side of

Fig. 1. *Polynema ema*, female, habitus.

clypeus, interocular distance:face height 5:7; torulus removed ca. 1 diameter from median carina, laterally against frontal carinae; antennal ratio (Fig. 2) beginning with scape 33:19:8:21:15:12:11:12:36; club with 7 sensory ridges; ratio pronotum:scutum:scutellum:propodeum 5:5:5:4. Pronotum alutaceous, becoming coriaceous laterally, divided medially, each side with 5 setae on anterior margin, 3 setae at posterior margin, posterior ½ of prosternum divided medially, scutum alutaceous, notauli interrupted by large fovea in anterior $^1/_5$; scutellum alutaceous (weaker than scutum), placoid sensilla removed ca. 3 diameters from anterior margin, separated ca. 5 diameters, transverse row of foveae in posterior $^1/_5$; propodeum smooth, descending, median carina broken, ending in a tooth above petiolar insertion (viewed laterally), with a seta posterolaterally above hindcoxa; forewing (Fig. 1) length 0.82 mm (0.82–0.88, $\bar{x} = 0.84$), width 0.13 mm (0.12–0.14, $\bar{x} = 0.13$), LMC 0.20 mm (0.18–0.20, $\bar{x} = 0.19$); hindwing length 0.72 mm (0.67–0.75, $\bar{x} = 0.71$), width 0.02 mm (0.019–0.024, $\bar{x} = 0.20$); petiole 2× as long as wide, produced into a tooth ventrally, (Fig. 3); ratio femur:tibia:tarsi as follows: foreleg 11:11:13, midleg 10:14:17, hindleg 12:16:22, coxa with small group of setae on inner surface, hindbasitarsus 4× as long as tarsomere 2. Abdomen ovate elliptic, length 0.30 mm (0.30–0.41, $\bar{x} = 0.36$), faintly striate dorsally; ovipositor exserted 0.45 mm (0.35–0.50, $\bar{x} = 0.42$).

Allotype male.—Length 0.67 mm (0.60–0.75, $\bar{x} = 0.66$). Similar to female except the following: antennal ratio beginning with scape 30:22:25:26:28:27:29:28:28:27:27:26:26; petiole not produced into a tooth ventrally; abdomen ovate, length 0.22 mm (0.18–0.25, $\bar{x} = 0.22$)

Types.—Holotype ♀ on point (antenna and wings on slide) with data as follows: "Ill., Jackson Co., 3 mi. N. of Pomona, Etherton Pond, 25 Aug., 1979, S. W. Wilson, ex. eggs of *Megamelus davisi* on *Nuphar advena*." Deposited in the National Museum of Natural History, Smithsonian Institution, Washington, D.C., Type No. 100015. Allotype and paratypes (22 ♂ and 36 ♀) with same data as above. Paratypes deposited in the British Museum (Natural History), London, Canadian National Collection, Ottawa, and National Museum of Natural History.

Other specimens.—Two ♂ and 4 ♀ from Honolulu, Hawaii, reared from the lily planthopper, E. C. Zimmerman collector (date unknown, probably 1945); 2 ♀, Md., Prince Georges Co., Laurel, Patuxent Wildlife Research Center, 25 June, 1980, L. Masner, pan trap in pondside vegetation.

Variation.—Quantitative estimates of variation are given in the species description. Color varied between series of specimens and between specimens of the same series. The specimens from Hawaii are nearly uniformly dark brown, with the legs, pronotum, scape, and pedicel light brown. Most specimens in the type-series are similar to the holotype. However, a few females are lighter in color with the yellow faded to very light yellow (coxae occasionally nearly white), and males may have the abdomen very dark brown or black mesad. The occipital suture does not reach the foramen in some specimens, ending only slightly past the lateral ocellus. The structure of the median propodeal carina is very difficult to see in this species both

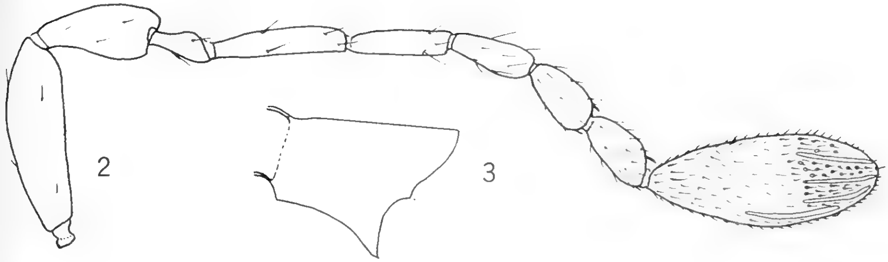

Fig. 2, 3. *Polynema ema,* female. 2, Antenna, lateral view. 3, Petiole, lateral view.

in slide-mounted and pointed specimens. Scanning electron micrographs show the area to be slightly sunken and composed of irregular broken carina that forms a keel posteriorly. When viewed laterally under the compound microscope, this area appears as a raised "tooth" above the petiolar insertion.

Diagnosis.—Females of this species are distinct from other *Polynema* by virtue of the long slender forewing (6 times as long as broad), the ovipositor exserted the length of the abdomen or more, and the presence of the ventral tooth on the abdominal petiole. Female *Polynema* normally have the forewing only 3 or 4 times as long as broad, the abdominal petiole without a ventral tooth, and the ovipositor not exserted. Males of *Polynema* (as with most mymarids) are more difficult to separate; however, the narrow forewing may be used to distinguish this species.

Remarks.—*Polynema ema* probably will be found to occur throughout the range of its host, *Megamelus davisi.* In the continental United States, *M. davisi* is known throughout the eastern states and west as far as Kansas (Metcalf, 1943; Beamer, 1955). Van Duzee (1896: 18) was the first to associate *P. ema* with *Megamelus* in Michigan. Wilson and McPherson (1981: 346) recently made brief mention of this parasite in relation to its host in Illinois. According to Zimmerman (1948: 248), *Polynema ema* [reported as *ciliata* (Say)] was "brought to Honolulu from Michigan in 1941 by Fullaway and it quickly established itself on local leafhopper colonies" of *Megamelus davisi* (reported as *angulatus* Osborn, a synonym of *davisi*).

Etymology.—The species epithet is an euphonius combination of arbitrary letters.

Polynema ciliatum Perkins

Polynema ciliata Perkins, 1910: 666.

As previously mentioned, we do not accept the placement of *ciliatus* Say as a *Polynema*. Therefore, Perkins' *ciliatum* is not a homonym, and having seen the type, we consider it a valid species. It is known only from Oahu, Hawaiian Islands.

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We thank S. W. Wilson (California State University, Chico) for providing specimens of the new species, J. P. Kramer (Systematic Entomology Laboratory, IIBIII, USDA, Washington, D.C.) for providing information about its host, G. M. Nishida (B. P. Bishop Museum, Honolulu, Hawaii) for loaning us the type-specimen of *Polynema ciliata* Perkins, Linda Heath Lawrence for the habitus drawing, and Phyllis W. Iglehart for typing the manuscript.

LITERATURE CITED

Ashmead, W. H. 1887. Studies of the North American Proctotupidae with descriptions of new species from Florida. Can. Entomol. 19: 192–198.

———. 1893. A monograph of North American Proctotrypidae. Bull. U.S. Natl. Mus. 45: 1–472.

Beamer, R. H. 1955. A revision of the genus *Megamelus* in America North of Mexico. J. Kans. Entomol. Soc. 28: 29–46.

Cresson, E. T. 1887. Synopsis of the families and genera of the Hymenoptera of America North of Mexico together with a catalogue of the described species and bibliography. Trans. Am. Entomol. Soc. Suppl. 1887: 155–350.

Dalla Torre, C. G. 1898. Catalogus Hymenopterorum hucusque descriptorum systematicus et synonymicus 5. Chalcididae et Proctotrupidae, Leipzig. 598 pp.

DeBauche, H. R. 1948. Étude sur les Mymarommidae et les Mymaridae de la Belgique (Hymenoptera:Chalcidoidea). Mem. Mus. Hist. Nat. Belg. 108: 1–248.

Kieffer, J. J. 1911. Hymenoptera Fam. Diapriidae. *In* Wytsman, P., ed., Genera Insectorum 124. 75 pp.

———. 1916. Diapriidae. Das Tierreiche 44, 627 pp.

Metcalf, Z. P. 1943. General catalog of the Hemiptera. Fascicle IV. Fulgoroidea Pt. 3. Araeopidae (Delphacidae). Smith College, Mass. 552 pp.

Peck, O. 1951. Chalcidoidea, pp. 410–594. *In* Muesebeck, C. F. W., et al., eds., Hymenoptera of America North of Mexico, Synoptic Catalog. U.S. Dep. Agric. Agric. Monogr. 2.

Perkins, R. C. L. 1910. Supplement (by R. C. L. Perkins) to Hymenoptera. Fauna Hawaiiensis Hym. Suppl. 2: 600–686.

Say. T. 1828. A description of some new species of Hymenoptera of the United States. Contrib. Maclurian Lyceum Phil. 1: 67–83.

Van Duzee, E. P. 1896. Pests of House and Ornamental Plants. Mich. Agric. Exp. Stn., Spec. Bull. No. 2, 43 pp.

Wilson, S. W. and J. E. McPherson. 1981. Life history of *Megamelus davisi* with descriptions of immature stages. Ann. Entomol. Soc. Am. 74: 345–350.

Zimmerman, E. C. 1948. Insects of Hawaii. Vol. 4. University of Hawaii Press, Honolulu. 268 pp.

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CHROMOSOME STUDY IN MALES OF NEARCTIC SPECIES OF *GERRIS* FABRICIUS AND *LIMNOPORUS* STÅL (HEMIPTERA: HETEROPTERA: GERRIDAE)

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Abstract.—Chromosome study of males of some Nearctic species of Gerridae of the genera *Gerris* and *Limnoporus* reveals that contrary to what has been reported for Palearctic species, the mechanism of sex determination varies among subgroups. Consistently absent are m chromosomes, and kinetochore activity is restricted to the terminal ends of chromosomes during meiosis.

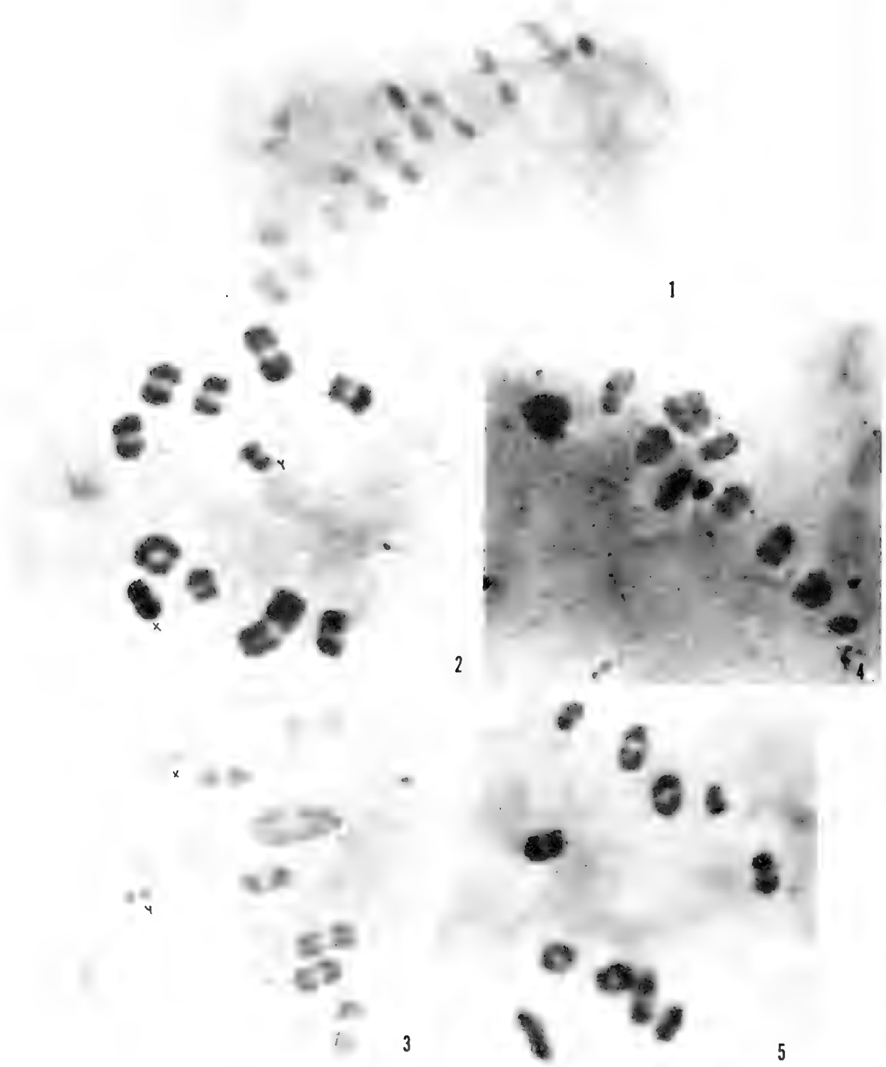
Although diploid and/or haploid numbers have been reported for 15 species of Gerridae (Hemiptera: Heteroptera) (see summary, Ueshima, 1979), results for only one Nearctic species have been reported. Montgomery (1901) reported a haploid number of 10A + XO for *Gerris marginatus* Say (as *Limnotrechus marginatus*). Unfortunately, in 1901 at least three species were included under the binomen *G. marginatus* and the nomenclature was not clarified until 1934 by Drake and Harris.

We have undertaken a study of chromosome number and structure in the Gerridae because we believe, as do Ueshima and Ashlock (1980), that chromosome morphology may be useful in the phylogenetic reconstruction of the families of aquatic and semiaquatic Heteroptera. We also anticipate that chromosomal rearrangements may be correlated with change in wing form within populations of wing polymorphic species.

We have looked at representatives of Nearctic *Gerris* (*Gerris*), *G.* (*Aquarius*), and *Limnoporus* (until 1975, Andersen, *G.* (*Limnoporus*)) and we report here our results for these groups. We compare the results to those that have been reported for Palearctic species of the same genera and subgenera.

MATERIALS AND METHODS

Gerris (*A.*) *remigis* (Say) was collected at Aguirre Springs, N.M., *G.* (*G.*) *buenoi* Kirkaldy and *L. dissortis* Drake and Harris were collected near



Figs. 1–5. Metaphase I, photographed at ca. 6400×. 1, *Gerris* (*Aquarius*) *remigis*, early metaphase I. 2, *G.* (*Gerris*) *alacris*. 3, *G.* (*G.*) *comatus*. 4, *G.* (*G.*) *buenoi*. 5, *Limnoporus dissortis*.

Minneapolis, Minn., *G.* (*G.*) *alacris* Hussey and *G.* (*G.*) *comatus* Drake and Hottes were collected at Presque Isle State Park, Pa., and *G.* (*G.*) *marginatus* and *G.* (*G.*) *insperatus* Drake and Hottes were collected in Washington, D.C. All species were lab-reared under a 14L:10D photoperiod using techniques that have been described elsewhere (Calabrese, 1974, 1979). Spermatogenic (meiotic) tissue was obtained from males approximately 24 hours after they had molted to the fifth instar. Such males, we discovered, showed the greatest number of metaphase I figures.

Testes were fixed (15 ml glacial acetic acid, 45 ml absolute ethanol, 5 ml acetone) for 2–3 minutes. Each testis was divided and each follicle placed on a slide with a drop of lacto-proprio orcein stain for at least 3–5 minutes. A standard squash was made. Slides were sealed in temporary mounts and scanned for figures at 40×. Numerous preparations were made and scanned for each species. Metaphase I figures were photographed at about 6400× under oil on a Zeiss compound microscope with a Wetzler large format camera attachment.

RESULTS

All results were consistent for the minimum of five representatives examined per species.

Gerris (*Aquarius*) *remigis* (Fig. 1) exhibits a diploid number of 22, and the male is XO.

Four of the *Gerris* species examined exhibit an XY sex determination mechanism in the male and a diploid number of 20 (Figs. 2, 3; *G. insperatus* and *G. marginatus* not shown). However, *G.* (*G.*) *buenoi*, although it exhibits a diploid number of 20, shows an XO sex determination mechanism (Fig. 4).

Limnoporus dissortis exhibits a diploid number of 22 and what appears to be a XO, sex determination mechanism in the male (Fig. 5).

No m chromosomes are visible in any of the species studied (Figs. 1–5; *G. insperatus* and *G. marginatus* not shown). Kinetochores are restricted to the ends of meiotic chromosomes in all species studied (examples, Figs. 1–5).

DISCUSSION

Ueshima (1979) suggested that the Gerridae do not have m chromosomes and that kinetochores are found only at the terminals of chromosomes during meiosis. The results of our studies to date support those suggestions. However, we do not agree with Ueshima (1979) that the XO system is the universal mode of sex determination among the Gerridae. In four of the *Gerris* (*Gerris*) species we studied the male is heterogametic, but it shows an XY system. In one *G.* (*Gerris*) species (*G. buenoi*) and in *G.* (*Aquarius*) *remigis* and *Limnoporus dissortis* the mode of sex determination appears to be XO, male heterogametic. It is notable that in a reanalysis of the cytogenetics of *G.* (*Aquarius*) *paludum*, a Palearctic species, (Takenouchi and Muramoto, 1968) it has been shown that the sex determination mechanism is XY and not XO as had been reported earlier (Wilke, 1913).

The results of the study to date suggest that there is no consistency within genera and subgenera in terms of sex determination mechanism. Differences in chromosome morphology and the cytogenetic characters discussed herein may prove to be useful characters in a further test of the existing phylogenetic reconstruction for the Gerridae (Calabrese, 1980), when more species are studied (compare Figs. 1–5).

ACKNOWLEDGMENTS

We are very grateful to Donald Bennett, University of Connecticut, who took the time to collect gerrid specimens for us in Minnesota and the care to send them to us as live specimens.

LITERATURE CITED

Andersen, N. M. 1975. The *Limnogonus* and *Neogerris* of the Old World with character analysis and a reclassification of the Gerridae (Hemiptera: Gerridae). Entomol. Scand. Suppl. 7, 96 pp.

Calabrese, D. M. 1974. Keys to the adults and nymphs of the species of *Gerris* Fabricius occurring in Connecticut. Mem. Conn. Entomol. Soc. 1974, pp. 227–266.

———. 1979. Pterygomorphism in ten Nearctic species of *Gerris* F. Am. Midl. Nat. 101: 61–68.

———. 1980. The zoogeography and a cladistic analysis of the Gerridae. Misc. Publ. Entomol. Soc. Am. 11(5): 1–119.

Drake, C. J. and H. M. Harris. 1934. The Gerrinae of the Western Hemisphere (Hemiptera). Ann. Carnegie Mus. 23: 179–240.

Montgomery, T. H. 1901. Further studies on the chromosomes of the Hemiptera-Heteroptera. Proc. Acad. Nat. Sci. Phila. 53: 261–271.

Takenouchi, Y. and N. Muramoto. 1968. A survey of the chromosomes in twenty species of Heteroptera insects. (in Japanese). J. Hokkaido Univ. Educ. Sect. II B 19: 1–19.

Ueshima, N. 1979. Animal Cytogenetics. vol. 3 Insecta 6. Hemiptera II, Heteroptera. Gebrüder Borntraeger, Stuttgart. 117 pp.

Ueshima, N. and P. D. Ashlock. 1980. Cytotaxonomy of the Lygaeidae (Hemiptera-Heteroptera). Univ. Kans. Sci. Bull. 51: 717–801.

Wilke, G. 1913. Chromatinreifung und Mitochondrienkörper in der Spermatogenese von *Hydrometra paludum* Fab. Arch. Zellf. 10: 203–236.

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84(3), 1982, pp. 539–546

A NEW SPECIES OF BITING MIDGE OF THE GENUS *ALLUAUDOMYIA* KIEFFER (DIPTERA: CERATOPOGONIDAE) FROM THE SOUTHEASTERN UNITED STATES[1]

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Abstract.—*Alluaudomyia* ***variegata,*** a new species of biting midge from the southeastern United States, is described and illustrated, and the known biology is discussed. This species is believed to be a member of the Maculipennis Group and is most closely related to the widespread Nearctic species *A. needhami* Thomsen.

The worldwide genus *Alluaudomyia* Kieffer is comprised of relatively small, often strikingly marked biting midges. Only eight species have thus far been reported for the Nearctic Region (Wirth, 1952a; Williams, 1956). During a study of the Ceratopogonidae of Alabama, males and females of a previously undescribed species of *Alluaudomyia* were taken in light traps at localities in central and northern Alabama. Additional specimens obtained from the National Museum of Natural History, Smithsonian Institution, Washington, D.C., extend the known distribution of this species to encompass the Gulf Coast states of the United States.

For an explanation of the general morphology and terminology of the ceratopogonids see Wirth (1952b). The descriptions are based on specimens slide-mounted in balsam or Hoyer's medium; measurements were obtained with the aid of a calibrated ocular micrometer in the eyepiece of a Zeiss phase-contrast microscope. The wing length is measured from the basal

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arculus to the wing tip; costal length (costal ratio) is obtained by dividing the length of the costa by the wing length. Antennal ratio is determined by the combined lengths of the 5 distal flagellomeres divided by the combined lengths of the preceding 8 flagellomeres. The hindtarsal ratio is obtained by dividing the length of the hindbasitarsus by the length of the second tarsomere. Proportions given for antennal flagellomeres and for palpal segments refer to the relative lengths as units in an ocular micrometer and not as absolute measurements. Variation is given by the mean, followed by the minimum-maximum values and sample size.

All types and other material examined are slide-mounted except where noted. Types are deposited in the National Museum of Natural History, Smithsonian Institution, Washington, D.C. (USNM); paratypes will be deposited in the British Museum (Natural History), London (BM); California Academy of Sciences, San Francisco (CAS); Florida State Collection of Arthropods, Gainesville (FSCA); and the Auburn University Entomological Museum (AU). All other material examined is deposited in the National Museum of Natural History, Washington, D.C.

Alluaudomyia variegata Glick and Mullen, New Species

Figs. 1, 2

Alluaudomyia needhami Thomsen; Snow et al., 1957: 21 (in part, misidentification; reared ♂).

Diagnosis.—A small brownish species; wing markings extensive with dark streaks distally on the veins, membrane between the veins with a varying amount of infuscation. Female with 1 large, ovoid spermatheca. Male 9th tergum with long, slender apicolateral processes; aedeagus with stout, blunt tip; distal portion of paramere laterally recurved terminating in a ventrally bent, pointed apex.

Female.—Wing length 1.26 (0.98–1.52) mm ($n = 15$).

Head: Brown; occiput white with a midbasal brownish triangulate spot. Eyes medially contiguous for a short distance, bare. Antenna (Fig. 1a) with flagellomeres in proportion of 9-6-6-7-7-8-8-8-10-10-12-11-14; antennal ratio 0.94 (0.87–1.01, $n = 14$); proximal flagellomeres relatively short and somewhat tapering distally; distal flagellomeres slender; apices of flagellomeres 3–10 pale. Palpal segments (Fig. 1c) short, in proportion of 5-7-8-5-8; segment 3 with a small, round, distal sensory pit with several elongate hyaline sensilla; 1st, 2nd, and base of 3rd segments pale. Mandible (Fig. 1j) with 18 (17–19, $n = 10$) teeth on inner margin, outer margin with 3–5 widely spaced minute teeth.

Thorax: Brown; mesonotum with numerous, small, dark brown spots; humeri and lateral margins of mesonotum whitish; prescutellum with a median pair of whitish spots and 2 long median setae; scutellum white with a

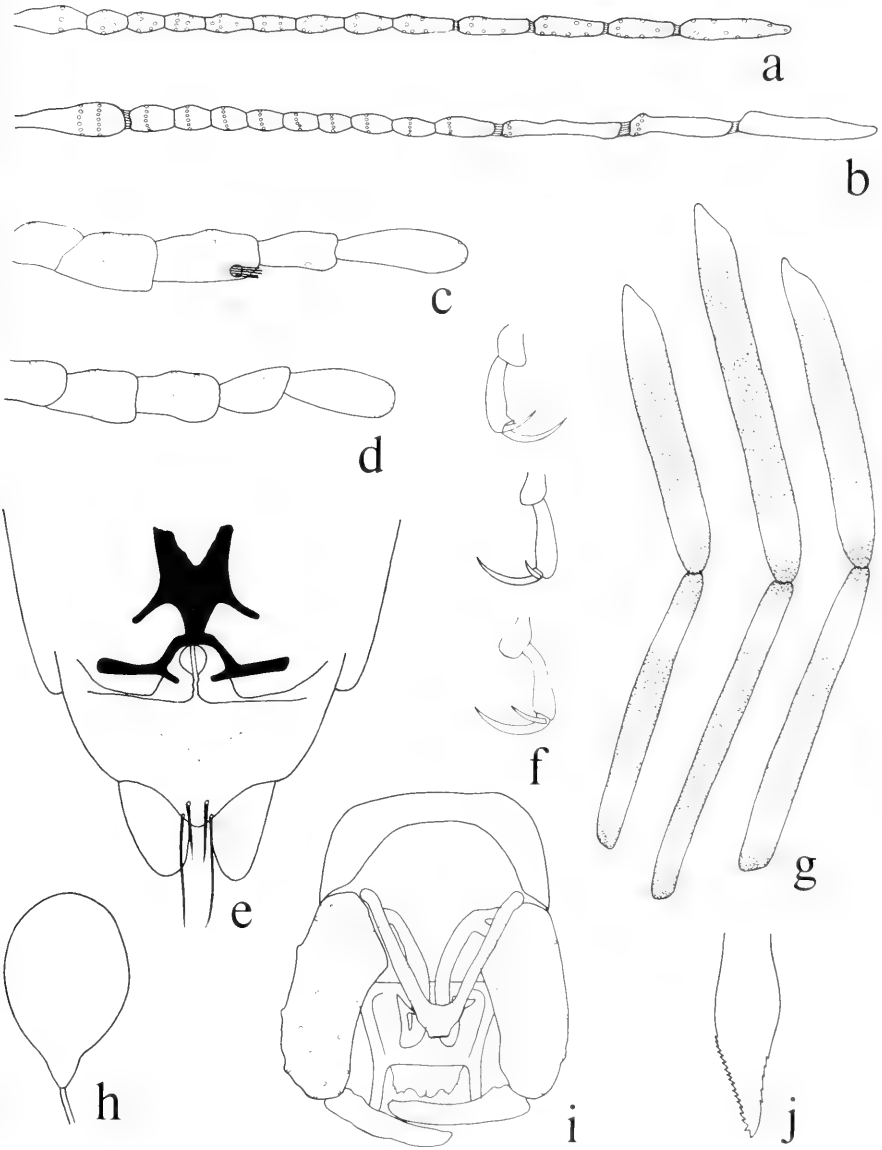

Fig. 1. *Alluaudomyia variegata*. a, c, e–h, j, Female. b, d, i, Male. a, b, Antenna. c, d, Palpus. e, Genital sclerotization. f, Fifth tarsomeres and claws of (top to bottom) fore-, mid-, and hindlegs. g, Femora and tibiae of (left to right) fore-, mid-, and hindlegs. h, Spermatheca. i, Genitalia. j, Mandible.

thin median brown band and with 6 long setae; postscutellum and pleuron brown.

Legs (Fig. 1g): Brown, femora pale basally, with subapical pale rings; tibiae with subbasal and subapical pale rings, broader on hindtibia; tarsi pale, darker at apices, hindbasitarsus brownish; hindtibial comb with 6–7 spines; hindtarsal ratio 2.9 (2.7–3.3, $n = 14$). Tarsal claw (Fig. 1f) long and slender, unequal on all legs.

Wing (Figs. 2a, b): With 6 conspicuous dark spots as follows: 1 large irregular marking proximal to r-m crossvein; a smaller spot just caudad of latter spot; 1 large spot just below apex of radial cell; 1 large elongate spot near base of vein M2; a moderately small spot on anterior wing margin just distad of junction of costa and R1; and a small spot at tip of anal vein. Wing with prominent dark streaks over apices of veins R1 and Rs, midportion and apex of M1, apices of M2 and M3+4, middle of cubitus, and over mediocubital fork to apex of Cu1; small amount of infuscation just distad of basal arculus between bases of radius and cubitus, and on anterior wing margin in costal cell; a varying amount of dark infuscation on the membrane between the veins in distal portion of cells R5 and M2, and extensively in M1, M4, and anal cells (often weakly infuscated in larger individuals, Fig. 2b); costa extending to 0.73 (0.68–0.77, $n = 15$) of wing length. Halter stem and base of knob whitish, dark apically.

Abdomen: Brown; apices of terga with white bands, 7th and 8th terga almost entirely whitish. Genital sclerotization (Fig. 1e) as figured. One large ovoid spermatheca (Fig. 1h) 0.116 × 0.075 mm, with short, tapering, sclerotized neck.

Male.—Similar to female with the usual sexual differences. Antenna (Fig. 1b) with apex of flagellomere 12 and all of 13–15 brownish; scutellum with 4 long setae; dark streaks on wing veins more prominent and extensive than in female, with spot absent on anterior margin of wing distad of junction of costa and R1. Genitalia (Fig. 1i) with sternum 9 relatively short, with a broad, deep, caudomedian emargination, caudal membrane spiculate; tergum 9 elongate with moderately tapering sides and long, slender apicolateral processes. Basistyle moderately long, dististyle nearly straight with stout, blunt apex. Aedeagus heavily sclerotized, with a deep basal arch; basal arms slender and nearly straight, with a small flange at base; distomedian process short and stout with blunt, ventrally bent tip. Paramere with short basal arm and a short, anterolaterally directed basal lobe; stem moderately slender with a slight bend mesally, expanded distally and laterally recurved into a short, slender appendage terminating in a ventrally bent, pointed apex.

Distribution.—Southeastern United States, from extreme eastern Texas to Florida, and north to Tennessee.

Types.—Holotype ♂, allotype ♀, Alabama: Lee Co., Chewacla State

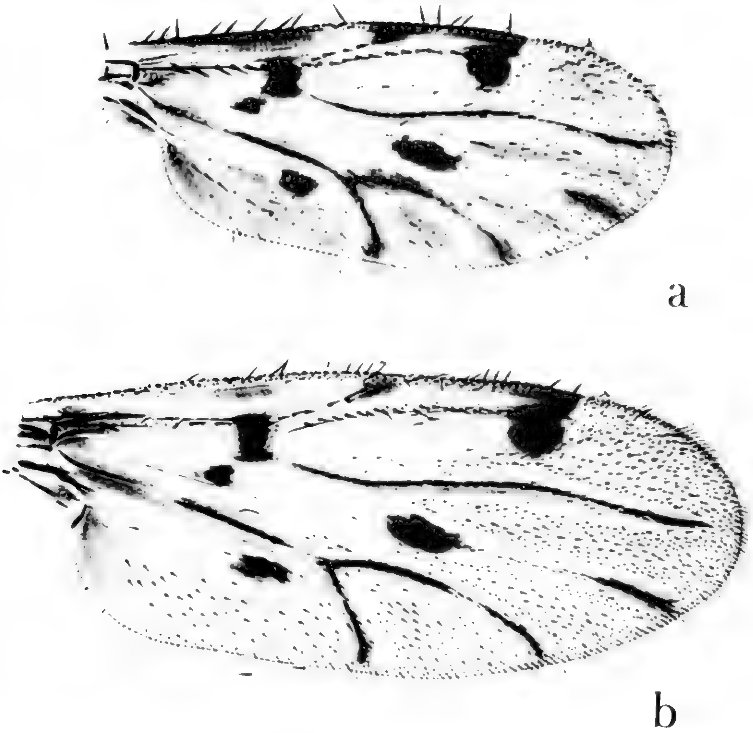

Fig. 2. *Alluaudomyia variegata*. a, b, Female wing, showing range of infuscation on the membrane between the veins.

Park, near Chewacla Pond, J. I. Glick, light trap, 10–11 June 1977 (USNM type no. 76104). Paratypes, 35 ♂, 25 ♀, as follows. ALABAMA: Dallas Co., Marion Junction, Alabama Agricultural Experiment Station (Black Belt Substation), J. I. Glick, light trap, 21–23 May 1978, 1 ♂ (AU); same data, 26–27 May 1978, 1 ♀ (CAS); same data, 31 May–2 June 1978, 1 ♀ (AU); same data, 9–12 June 1978, 1 ♀ (AU); same data, 22–24 June 1978, 1 ♂ (USNM); same locality, M. Lame, reared, 2 May 1979, 1 ♂ (AU); Lauderdale Co., Florence, Collier Slough, near Tennessee River, J. I. Glick, light trap, 21–24 July 1978, 1 ♂ (AU); Lee Co., Chewacla State Park, near Chewacla Pond, J. I. Glick, light trap, 18–19 April 1977, 2 ♀ (AU); same data, 11–17 May 1977, 1 ♀ (AU); same data, 2–8 June 1977, 4 ♂, 5 ♀ (4 ♂, 4 ♀ in alcohol) (AU); same data, 9 June 1977, 2 ♂, 2 ♀ (FSCA); same data, 14 June 1977, 1 ♀ (AU); same data, 22 June 1977, 2 ♂ (AU); same data, 29 June 1977, 1 ♂ (AU); same data, 4 Aug 1977, 1 ♂ (AU); same data, 25 Aug 1977, 1 ♂ (AU), 1 ♀ (USNM); same data, 18–23 July 1978, 1 ♀ (USNM);

same data, 21 Aug 1978, 1 ♂, 1 ♀ (BM); same data, 26 Sept–1 Oct 1978, 4 ♂ (AU); same data, 10–15 Oct 1978, 1 ♂ (CAS); same data, 24–29 Oct 1978, 9 ♂, 2 ♀ (AU), 2 ♂ (USNM); same data, 30–31 Oct 1978, 1 ♂ (AU); same data, 1–6 Nov 1978, 1 ♂ (AU); Loachapoka, Loachapoka Hunt Club, J. I. Glick and B. Buxton, light trap, 27–29 May 1977, 1 ♀ (AU); Morgan Co., Decatur, Wheeler National Wildlife Refuge, J. I. Glick, light trap, 8–10 May 1978, 1 ♀ (USNM); same data, 11–14 May 1978, 1 ♀ (AU); same data, 19–21 May 1978, 1 ♀ (AU); same data, 22–25 May 1978, 1 ♂, 1 ♀ (USNM); same data, 26–29 May 1978, 1 ♀ (AU).

Other specimens examined.—42 ♂, 6 ♀ (USNM) as follows. FLORIDA: Alachua Co., Gainesville, W. W. Smith, light trap, 10 April 1965, 1 ♂; same locality, W. W. Wirth, light trap, 20 April 1967, 1 ♂; same locality, F. S. Blanton, light trap, 8 May 1967, 1 ♂; Hawthorne, F. S. Blanton, light trap, 27 April 1968, 1 ♀; Baker Co., Glen St. Mary, F. S. Blanton, light trap, May 1971, 1 ♀; Gulf Co., Wewahitchka, State Board of Health, light trap, May 1961, 1 ♂; same data, July 1961, 1 ♂; same data, Aug 1961, 1 ♂; same data, Oct 1961, 1 ♂; Holmes Co., Bonifant, State Board of Health, light trap, June 1961, 1 ♂; same data, Sept 1961, 1 ♀; same data, Oct 1961, 1 ♂; Jackson Co., Florida Caverns State Park, W. W. Wirth, light trap, 26 May 1973, 1 ♀; Sneads, State Board of Health, light trap, 6 April 1954, 1 ♂; same data, March 1955, 1 ♂; same data, 31 May 1955, 1 ♂; Jefferson Co., Monticello, W. H. Whitcomb, light trap, May 1969, 1 ♂, 1 ♀; Leon Co., 3 mi N. of Tallahassee, F. S. Blanton, light trap, May 1970, 1 ♀; Liberty Co., Torreya State Park, F. S. Blanton, light trap, 27 April 1958, 1 ♂; same data, May 1971, 1 ♂; same locality, H. V. Weems Jr., light trap, 20 May 1966, 2 ♂; same locality, W. W. Wirth, light trap, 22 April 1967, 1 ♂. LOUISIANA: St. Tammany Parrish, Pearl River, K. T. Khalaf, light trap, April 1966, 16 ♂; Slidell, K. T. Khalaf, light trap, July 1966, 1 ♂. MISSISSIPPI: Hancock Co., Gainesville, K. T. Khalaf, light trap, April 1966, 1 ♂; Harrison Co., K. T. Khalaf, light trap, May 1966, 4 ♂. TENNESSEE: Polk Co., Copperhill, Ocoee Reservoir, E. Pickard and W. Snow, reared from pupa, 26 Aug 1954, 1 ♂. TEXAS: Jasper Co., Jasper, R. E. Woodruff, light trap, 2 Aug 1968, 1 ♂.

Biology.—Snow et al. (1957) reported rearing a single pupa of *A. variegata* to the adult (misidentified by Wirth as *Alluaudomyia needhami* Thomsen). The pupa was collected in late August from a small pool on an island in Ocoee Reservoir, Copperhill, Tennessee; the pool was overgrown with prickly stem smartweed (*Polygonum sagittatum* Linnaeus) and black willow (*Salix nigra* Marsh). During the current study, an adult male was reared in early May from a substrate sample of wet mud and decomposing leaves taken from the margin of a small pasture pond at the Alabama Agricultural Experiment Station (Black Belt Substation), Marion Junction, Alabama. Other Nearctic species of *Alluaudomyia* including *A. bella* (Coquillett), *A.*

needhami, and *A. paraspina* Wirth share a similar larval habitat (Thomsen, 1937; Williams, 1953; Grogan and Messersmith, 1976).

Adults of *A. variegata* have been collected in light traps from March through November, with the greatest numbers being taken during April and May. In east-central Alabama two activity peaks were noted, the first from May through June and a second in October.

Discussion.—Wirth and Delfinado (1964) proposed five "natural" groups for the genus *Alluaudomyia* in which they placed 79 of the 99 then known species. We are placing *A. variegata* in the large and diverse Maculipennis Group, the adults of which are characterized by the following combination of group characters: (1) wing with at least two conspicuous spots, one proximal to the r-m crossvein and one at the apex of the costa; (2) the distal portions of the wing veins often with dark streaks, and often with prominent spots present in the cells between the veins near the wing margin; (3) legs usually dark with narrow pale rings; (4) antennae dark with narrow basal pale rings on flagellomeres 3–10; (5) tarsal claws usually unequal on all legs; and (6) one spermatheca present, without diverticulum. The Nearctic species *A. variegata*, *A. megaparamera* Williams, and *A. needhami* are members of the Maculipennis Group which lack distal spots in the wing cells. *Alluaudomyia variegata* most closely resembles *A. needhami*, but can be easily separated by its distinctive wing markings with infuscation on the membrane between the veins, differences in the shape of the female genital sclerotization, and by the unusual shape of the male parameres. *Alluaudomyia megaparamera* is a smaller species with more reduced wing markings, a yellowish thorax and abdomen, and extensive pale markings on the legs.

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LITERATURE CITED

Grogan, W. L., Jr. and D. H. Messersmith. 1976. The immature stages of *Alluaudomyia paraspina* (Diptera: Ceratopogonidae) Wirth with notes on its biology. Ann. Entomol. Soc. Am. 69: 687–690.

Snow, W. E., E. Pickard, and J. B. Moore. 1957. The Heleidae of the Tennessee River Basin. J. Tenn. Acad. Sci. 32: 18–36.

Thomsen, L. C. 1937. Aquatic Diptera. Part V. Ceratopogonidae. Cornell Univ. Agric. Exp. Stn. Mem. 210: 57–80.

Williams, R. W. 1953. Notes on the bionomics of the *Alluaudomyia* of Baker County, Georgia. I. Observations and breeding habits of *bella* and *needhami* (Diptera, Heleidae). Proc. Entomol. Soc. Wash. 55: 283–285.

———. 1956. Two new species of *Alluaudomyia* from Cheboygan County, Michigan, with a note on the synonomy of *parva* and *downesi* (Diptera, Heleidae). Proc. Entomol. Soc. Wash. 58: 327–331.

Wirth, W. W. 1952a. The genus *Alluaudomyia* Kieffer in North America (Diptera, Heleidae). Ann. Entomol. Soc. Am. 45: 423–434.

———. 1952b. The Heleidae of California. Univ. Calif. Publ. Entomol. 9: 95–266.

Wirth, W. W. and M. D. Delfinado. 1964. Revision of the Oriental species of *Alluaudomyia* Kieffer (Diptera, Ceratopogonidae). Pac. Insects 6: 599–648.

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LYCHNUCHOIDES FRAPPENDA FROM CENTRAL MEXICO JOINS *LUNUS* AND *ZWEIFELI* IN A *LUNUS* GROUP OF *ATRYTONOPSIS* (LEPIDOPTERA: HESPERIIDAE: HESPERIINAE)

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Abstract.—Lychnuchoides frappenda, described by Dyar from two females in 1920, is actually a species of *Atrytonopsis* (new combination) unusual in having a broad semihyaline band that boldly disrupts the dark primary from midcosta to tornus. Despite its distinctive facies, *frappenda* clusters tightly with *A. lunus* and *A. zweifeli* in what appears, from limited locality data, to be a superspecies occurring discontinuously at middle elevations in woodland and scrub from southeastern Arizona to central Mexico. This "*lunus* group" is defined on the basis of size (it includes the largest species of *Atrytonopsis*), antenna (the apiculus is long and the nudum averages 13 segments), male stigma (absent!), facies (primary always with a strong cell spot and with the spot in space 1b *under* the spot in space 2; secondary rarely with any dorsal spots), male and female genitalia (figured), temporal distribution (the flight period of *lunus,* mostly from mid-July to mid-August, is unique among species of *Atrytonopsis* in the United States), and spatial distribution (mapped). Facies provides the best characters for distinguishing species within the *lunus* group. This study was carried out in the context of a review of the entire genus *Atrytonopsis,* with special attention to male and female genitalia and to variation in characters generally.

Dyar (1920: 187) so badly placed his new species *frappenda,* in *Lychnuchoides* Godman (1901: 612), that its proper position, in *Atrytonopsis* Godman (1900: 497) (**NEW COMBINATION**), has escaped notice for sixty years. Dyar missexed the type, though not the paratype, of *frappenda*–both are female. He misspelled the name of the genus to which he banished *frappenda*–as *Lychnucoides* rather than *Lychnuchoides* (a misspelling that some later workers have repeated).

Dyar's original description dealt only with expanse and appearance of the wings. It included no illustrations. Had Dyar looked critically and comparatively at facies or, better, beyond facies to some of the morphology Godman used in defining *Lychnuchoides,* he could never have put *frappenda* there. The excuse for doing so is crude similarity: a broad semihyaline band cuts obliquely across the middle of a brown primary from midcosta almost to the tornus both in true species of *Lychnuchoides—saptine* (Godman and Salvin) and *ozias* (Hewitson)—and in *frappenda* (cf. Figs. 1–5 for this and other aspects of facies discussed below). This conspicuous band, which is rich yellow in *Lychnuchoides,* was described by Dyar as "light yellow" in *frappenda* but is better dubbed creamy white. The spots that form it are not shaped in *frappenda* as they are in true species of *Lychnuchoides.* Moreover, in *frappenda,* a spot in space 3 of the primary does not quite fill the tip of the angle between the bases of veins 3 and 4 to become an integral part of the band as it does in *Lychnuchoides.* Still other features of facies fail to jibe: subapical spots occur in spaces 6, 7, and 8 of the primary in *frappenda,* and in all other species of *Atrytonopsis,* but not in *Lychnuchoides*; complex ventral wing patterns in shades of gray and rust in *Lychnuchoides* have no counterpart in *frappenda,* whose ventral secondary closely resembles that of the other species of *Atrytonopsis* that usually lack spots on the dorsal secondary, except for *loammi* (Whitney). Most important, *frappenda* fits smoothly into *Atrytonopsis,* but grossly distorts *Lychnuchoides,* on many major morphological counts involving wing shape and venation, antennae, palpi, vestiture and spination of legs, and genitalia. Many of these differences were set down by Godman when he originally characterized *Atrytonopsis* and *Lychnuchoides* two decades before Dyar described *frappenda.*

With spots in spaces 1b, 2, and the cell enlarged and aligned to form a conspicuous band bisecting the primary, *frappenda* at first looks bizarre in *Atrytonopsis.* Semideparture from the *Atrytonopsis* image no doubt conspired with Dyar's misclassification so that, over the years, neither the segregated type of *frappenda* nor the paratype filed with true species of *Lychnuchoides* (both in USNM) registered correctly with skippermen who saw them.

Hoffmann (1941: 282) listed *Lychnuchoides frappenda* for Mexico, and Evans (1955: 253) included *frappenda* in his key to species of *Lychnuchoides* (misspelled *Lychnucoides* but corrected in separate "Addenda and Corrigenda"); Evans never saw an example of it. Most recently, Okano (1981: 31) retained *Lychnuchoides* (misspelled *Lychnucoides*) in his list of hesperiid genera occurring in Mexico. This he did strictly on account of *frappenda,* for *L. saptine* (long known from Guatemala) has yet to be recorded from Mexico. At least for the time being, *Lychnuchoides* should be dropped from the Mexican list.

A third specimen of *frappenda* has surfaced, again a female. She was sent to me because, in her unmounted state and with her pale band dividing her

Table 1. Length (mm) of right primary in *Atrytonopsis lunus* from southeastern Arizona.

Sex	N	Range	Mean with Standard Error	Standard Deviation	Coefficient of Variation
♂	13	19.8–22.1	20.95 ± 0.22	0.78	3.72
♀	44	19.6–23.6	21.80 ± 0.13	0.87	3.99

brown primary, she suggested some sort of *Autochton*. When I took a hard look at her, she said, "I belong to *Atrytonopsis*," which provoked a review of that genus and the writing of this paper.

At the end of his original description of *A. zweifeli* Freeman (1969: 277) said, "The nearest related species to *A. zweifeli* is *A. lunus* (Edwards)." Actually, *lunus*, *frappenda*, and *zweifeli* all cluster tightly. It is sometimes difficult to characterize this group: although *lunus* is represented by adequate series of both sexes, *frappenda* is known only from three females and *zweifeli*, from two males.

In what follows, I consider one sort of character at a time, first with respect to its use in defining the *lunus* group within genus *Atrytonopsis* and then, when pertinent, with respect to its further use in defining species within the *lunus* group. Throughout I give special attention to problems involving variation in characters, not only within the species of the *lunus* group but also in the genus as a whole.

THE *LUNUS* GROUP

Size.—The largest species of *Atrytonopsis* are in this group. Certainly *lunus* itself and probably *frappenda* are markedly larger than most other species of *Atrytonopsis*; however, the largest individuals of *deva* (Edwards) and of *ovinia* (Hewitson) enter the size range of *lunus* and *frappenda*.

Using a vernier caliper calibrated to tenths of a millimeter, I measured the primary of each available specimen of the *lunus* group on two different days: 25% of my double readings agreed, and another 60% differed by only 0.1 or 0.2 mm. Differing measurements were averaged before calculation of the statistics in Table 1.

In *Atrytonopsis*, females average larger than males—a prevalent feature of sexual dimorphism in skippers, as in many other animals. Because females of *lunus* are collected more often than males (the reverse is more usual among skippers), females afford the better sample ($N = 44$). With a mean primary length of 21.80 mm which exceeds that of males by nearly 1 mm (Table 1), females of *lunus* are significantly larger than males ($t = 3.16$, $P < .005$).

The wing lengths of the female type and paratype of *frappenda* are both 21.8 mm, the same as the mean wing length of *lunus* females. The third

Table 2. Frequency of nudum variants in members of the *lunus* group.

		Number of Nudum Segments (on base of club/on apiculus)							
Species	*N*	4/7	3/8	4/8	5/8	4/9	5/9	4/10	5/10
A. lunus	46	1	2	9	10	12	7	2	3
A. frappenda	3	1			1		1		
A. zweifeli	2			2					

known female of *frappenda* is smaller (20.4 mm) but well within the female size range of *lunus* (Table 1). These scant data suggest that *frappenda* is about as large as *lunus*. The still more limited data for *zweifeli*—male type and paratype with wing lengths of 19.5 and 18.1 mm, respectively—fall below the male size range of *lunus* (see Table 1, but note that *N* is only 13) and suggest that *zweifeli* is substantially smaller than *lunus* and *frappenda*.

Nothing can be said about possible geographic variation in size in any of these forms except that *lunus* appears undifferentiated over its discontinuous distribution in the mountain islands of southeastern Arizona.

Antenna.—On average, the apiculus is longer in members of the *lunus* group than it is in any of the other species of *Atrytonopsis* that rarely or never show spots on the dorsal secondary. Among these species, the shortest apiculus relative to size occurs in *deva* and a somewhat longer apiculus, in *loammi, hianna* (Scudder) plus *turneri* Freeman, and *vierecki* (Skinner). Among those species that usually or always have spots on the dorsal secondary, the shortest apiculus (in fact, the shortest and stubbiest in genus *Atrytonopsis*) occurs in *python* (Edwards) and *margarita* (Skinner) and the longest, in *ovinia* and *edwardsi* Barnes and McDunnough. Intermediate lengths occur in *pittacus* (Edwards) and *cestus* (Edwards). Like other continuously varying characters, the apiculus varies appreciably within species and populations of *Atrytonopsis,* though not so much as to obliterate differences between species or species groups.

In characterizing genus *Atrytonopsis,* Evans (1955: 384) pegs the nudum of the antenna at "4/6," that is, at a total of 10 segments, of which 4 are on the base of the club and 6 are on the apiculus. However, in the *lunus* group, the number of segments in the nudum is usually 12, 13, or 14; and their arrangement is usually 4/8, 5/8, 4/9, or 5/9 (Table 2). The terminal segment is almost always long.

Scoring nudum segments is complicated by asymmetry in segmentation between left and right antennae, incomplete sutures on a single antenna, variation in the scaling that marks the start of the nudum on the club, and difficulties in pinpointing the junction between the apiculus and the rest of the club. Some of these problems have been discussed by MacNeill (1964: 51) and Burns (1964: 10). I scored each specimen at least twice.

Because I could detect neither sexual dimorphism nor geographic variation in the expression of the nudum within the sizable series of *A. lunus* from southeastern Arizona, I pooled all data. Although the variate is discontinuous, the resulting frequency distribution of nudum variants looks "normal," especially when the data appear by total number of segments, regardless of their arrangement on the club:

	Number of nudum segments				
	11	12	13	14	15
Frequency in *A. lunus*	3	9	22	9	3

Distribution of number of nudum segments is similar, with a range of 5 segments and a pronounced peak, in homogeneous samples of *Erynnis propertius* (Scudder and Burgess) and *E. meridianus* Bell (Burns, 1964: 97).

Stigma.—Males belonging to the *lunus* group lack a stigma. Both this assertion and the simultaneous assertion that the lack of a stigma helps define the *lunus* group contradict important literature.

The end of Evans' (1955: 384) characterization of genus *Atrytonopsis*, "♂ upf [upper forewing] with a narrow stigma from base vein 3 to mid vein 1, broken at vein 2 and mid space 1b," reappears, slightly altered, at the beginning of Freeman's (1969: 276) original description of *A. zweifeli*: "There is a very narrow indistinct stigma from base vein 3 to mid vein 1, broken at vein 2 and mid space 1b." It is not enough for Freeman to change "narrow stigma" to "very narrow indistinct stigma"; there is no stigma at all in *A. zweifeli*, at least not in the two males from which it was described.

Evans incorrectly attributes a stigma to males of all species of *Atrytonopsis* not only in his characterization of the genus, quoted above, but also in his key to genera of the *Lerodea* Group where, given the choice "♂ upf with a stigma or brands" versus "♂ upf no stigma or brands," one must choose the former to get to *Atrytonopsis* (Evans, 1955: 383). In defense of Evans, recall that *zweifeli* was then unknown and *frappenda*, though described, unseen by him and therefore left in *Lychnuchoides*; so the only species he included in *Atrytonopsis* whose males never have a stigma was *lunus*, and it was represented in the British Museum (Natural History) only by females (Evans, 1955: 384)!

However, the situation in *Atrytonopsis* is more complex than all-or-none: the degree of development of the stigma varies greatly both between and within species. Most extreme is *A. deva* which runs a gamut from no stigma, through many and various vestigial and reduced expressions, all the way to the complete three-part structure. Of the 160 males of *deva* that I have microscopically examined (mostly from Arizona, but also from New Mexico and Mexico), 40% are virtually or quite without a stigma. Of those 60% that have one, about half show at least some of each of the three parts; but half show only a bit (to all) of only one or two parts—upper or middle or lower or upper plus middle or middle plus lower or upper plus lower. In one other species outside the *lunus* group, *A. pittacus*, a lone male wholly lacks the stigma; and the stigma is inconspicuous in 30% of the 117 males I have examined from Arizona, west Texas, and Mexico (and very weak in 8, and exceedingly reduced in 2, of these). In males of all other species, the stigma, though somewhat variable, is easy to find with a stereomicroscope; nonetheless, occasional individuals show marked reduction: 3 males (from Manitoba) out of 157 males of *hianna* from eastern North America; 1 out of 84 males of *loammi* from Florida; 2 males (from Texas) out of 77 males of *vierecki* from New Mexico and west Texas; 1 male (from Arizona) out of 146 males of *edwardsi* from Arizona, west Texas, and Mexico; 1 male (from Oaxaca) out of 25 males of *ovinia* from Mexico and Nicaragua; and 8 males (from Arizona) out of 145 males of *python* from Arizona and New Mexico. The stigma is "always" well-developed in *margarita* (43 males from New Mexico), *turneri* (14 males from Kansas and Nebraska), and *cestus* (10 males from Arizona).

With one important exception, I support MacNeill's (1975: 443–446) observations on stigmas in *Atrytonopsis*. Regarding the more aberrant species, he writes, "there is no obvious male stigma" in *lunus* (here, "obvious" can be dropped) and "no well developed stigma" in *deva* (which is a fair average statement). And he correctly notes the routine occurrence of a stigma in males of *vierecki, pittacus, edwardsi, python,* and *cestus*. However, he errs in stating that "The male stigma is absent" in *hianna* (and, by implication, in the closely related populations *turneri* and *loammi*); males of all three of these forms always have a stigma.

So I reiterate that only the males of the *lunus* group never have a stigma. One may object that no such statement can be made because the male of *frappenda* is unknown and the sample of *zweifeli* is small. But judging from the divers characters (including geographic distribution) that closely bind the members of the *lunus* group, and knowing something of the ways of evolution, I stick out my neck with confidence.

Facies.—Members of the *lunus* group always have a bold spot (often dual) spanning the cell of the primary but rarely any spots on the dorsal secondary (Figs. 3–8). In dorsal view, the spot in space 1b of the primary, when present (it usually is), is more distal than it is in other species of *Atrytonopsis:* look for it under the spot in space 2, not more medial than the spot in space 2.

The fringe of the secondary is yellowish to whitish, at least around the apex and sometimes all the way to the tornus. At and below the apex, short scales of the fringe tend more to brown on the dorsal surface of the secondary but to white on the ventral surface, so that the fringe usually looks a little wider and a little whiter ventrally than dorsally. Fringes of both wings are uncheckered.

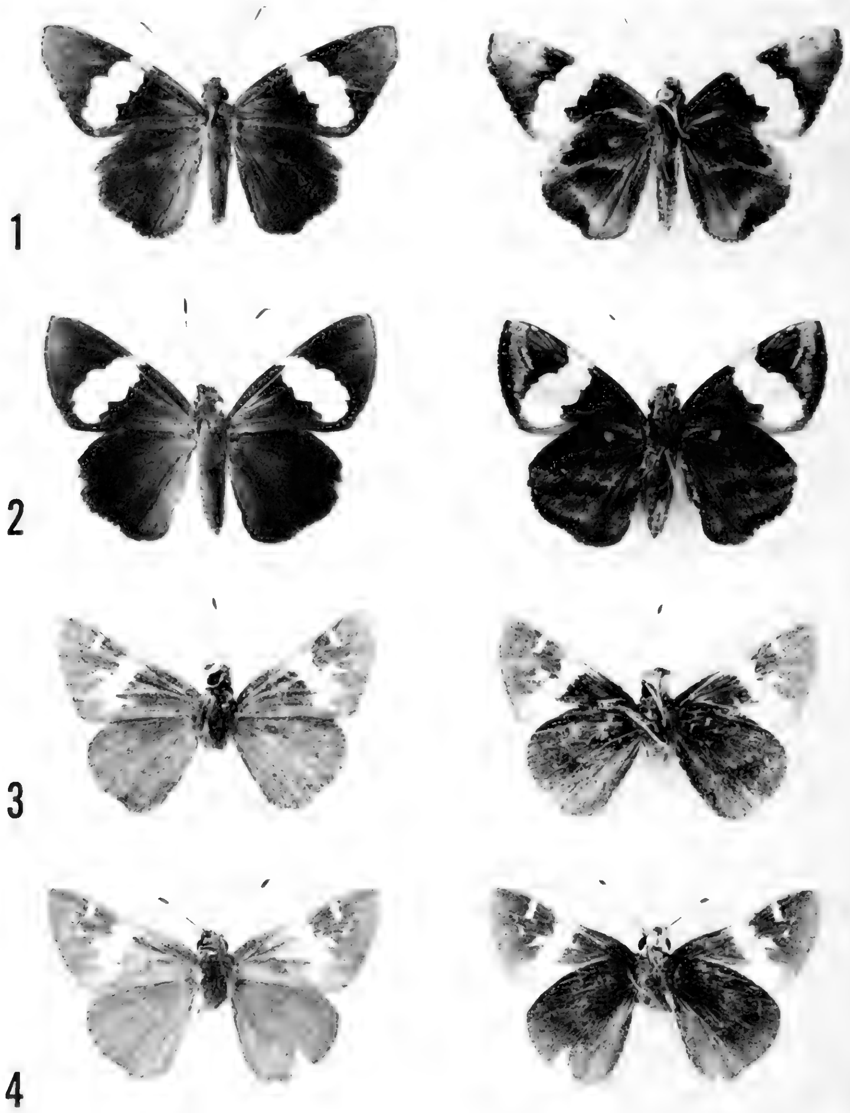
With data on quantitative and sexual characters still so limited and fragmentary, facies seems to provide the best means of distinguishing among members of the *lunus* group. To appreciate many of the following points, keep comparing Figs. 3–8.

The spots of the primary are white in *lunus* and *zweifeli* but creamy in *frappenda*. The three subapical spots (in spaces 6, 7, and 8 of the primary) are prominent in *lunus* and *frappenda* but small in *zweifeli*. (I have seen one male of *lunus* from the Santa Rita Mountains of southern Arizona with subapical spots reduced about halfway toward their very reduced level of expression in *zweifeli*.) All three females of *frappenda* have a spot in space 4 of the primary; this spot is tiny in two of them (Figs. 3 and 5) and small in the other (Fig. 4), which also has a small spot in space 5. By contrast, both males of *zweifeli* lack spots in spaces 4 and 5, and *lunus* never has spots in these spaces in either sex. Again, all three females of *frappenda*, but no specimens of *lunus* or *zweifeli*, have pale scales dorsally in spaces 9, 10, and 11 forming narrow opaque spots immediately anterior to the large semihyaline cell spot and, in effect, extending the pale primary band to the costa.

Of the remaining spots on the primary, not only the cell spot but also the spots in spaces 2 and 3 are always present, whereas the spot in space 1b is sometimes absent. These spots are smaller, well separated, and relatively out of line in *lunus* but much enlarged, in broad contact, and aligned to form a salient band across the middle of the wing in *frappenda*; *zweifeli* is peculiarly intermediate with only the spots in the cell and space 2 somewhat enlarged and imperfectly aligned to form a conspicuous patch.

Expression of the spot in space 1b varies greatly, and both sexual and specific differences contribute to the variation. The spot occurs in one of the two males of *zweifeli*, where it appears in the *upper* part of space 1b, adjacent to the spot in space 2 (Fig. 8). It occurs in 50% of the males of *lunus*, but appears only in the *lower* half of space 1b. It occurs in 91% of the females of *lunus*, appearing only in the *lower* half of space 1b in 67% (Fig. 6) but in *both* halves in 24% (Fig. 9). It occurs, greatly hypertrophied, in all three females of *frappenda*, where it appears in *both* halves of space 1b and looks like a fat chevron lying on its side and pointing toward the base of the wing (Figs. 3–5).

Ignoring individual variation invites error. The original description of *zweifeli* (Freeman, 1969: 276) specifies that, "In space 3 there is a very narrow elongated spot which curves outward at the lower end." This is true of the holotype (male) but not of the paratype (also male), in which this spot



Figs. 1–4. Females of *Lychnuchoides* and *Atrytonopsis* in dorsal and ventral view (all USNM, all ×1). 1, *L. saptine,* Volcan Santa Maria, Guatemala, October. 2, *L. ozias,* Castro, Parana, Brazil. 3, *A. frappenda,* holotype, Mexico City, Mexico, August 1917, R. Müller. 4, *A. frappenda,* paratype, near Mexico City, Mexico, July, R. Müller.

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Figs. 5–8. *Atrytonopsis* in dorsal and ventral view (all ×1). 5. *A. frappenda*, ♀, 7 km SE Morelos Canada, Puebla, Mexico, 4 to 5 July 1974, J. Chemsak and J. Powell (UCB). 6. *A. lunus*, ♀, Herb Martyr Camp and Dam, Cave Creek, Chiricahua Mountains, 1770 m, Cochise County, Arizona, 31 July 1974, J. M. and S. N. Burns (USNM). 7. *A. zweifeli*, ♂, holotype, 1.6 km S Cedritos, Coahuila, Mexico, 23 June 1957, R. Zweifel (AMNH). 8. *A. zweifeli*, ♂, paratype, Durango-Villa Union highway, route 40, 1980 m, Sinaloa, Mexico, 29 April 1966, P. Hubbell (AMNH).

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Fig. 9. Dorsal and ventral view of female of *Atrytonopsis lunus* whose facies varies in the direction of *A. frappenda.* Baboquivari Mountains, Arizona, 15 to 31 August (AMNH) (×1).

is quadrilateral and relatively large (cf. Figs. 7 and 8). Typologists might still defend an original description based solely on the holotype. But there is no excuse for the general assertion (Freeman, 1969: 277) that, "*lunus* has the spot in space 3 oval and better defined than in *zweifeli* where this spot is very linear and indistinct." Comparison of the lone paratype of *zweifeli* with males of *lunus* shows this spot to be as large and distinct in the former as in the latter (and equally angular in both).

Of the 60 specimens of *lunus* I have examined, one female (Fig. 9) from the Baboquivari Mountains of southern Arizona deviates remarkably from the "*lunus* look" in the direction of *frappenda.* This deviant underscores both the close genetic similarity of the two species and the potential one species may have for abruptly approximating the superficially different facies of the other. The deviant female is clearly *lunus*: her primary spots are white rather than cream; dorsally her primary "band" does not reach the costa, nor is it as wide or as even along its proximal edge as it is in *frappenda,* and ventrally it is much less striking than it is in *frappenda* (cf. Figs. 3–5 with 9).

More important, the deviant female is like *lunus* and unlike *frappenda* in a morphologic detail involving the spacing of veins 1, 2, and 3 where they are nearly parallel in the distal third of the primary: the vertical distance between veins 1 and 2 exceeds that between veins 2 and 3 by a lot in *lunus* but by relatively little in *frappenda.* This difference, surprising in what are likely sister species, is obvious (once you have seen it): compare Figs. 3–5 (females of *frappenda*) with Figs. 6 and 9 (females of *lunus*). Having seen it repeatedly, I quantified the difference by measuring the height of spaces lb and 2 with a filar micrometer—its scale through the proximal end of the spot in space 3, and line 60 directly over vein 2—on the left primary of every female of *lunus* and *frappenda* at hand and then calculating the ratio of the height of the shorter space to that of the taller. The frequency distribution of this ratio is quite distinct for the two species (Fig. 10).

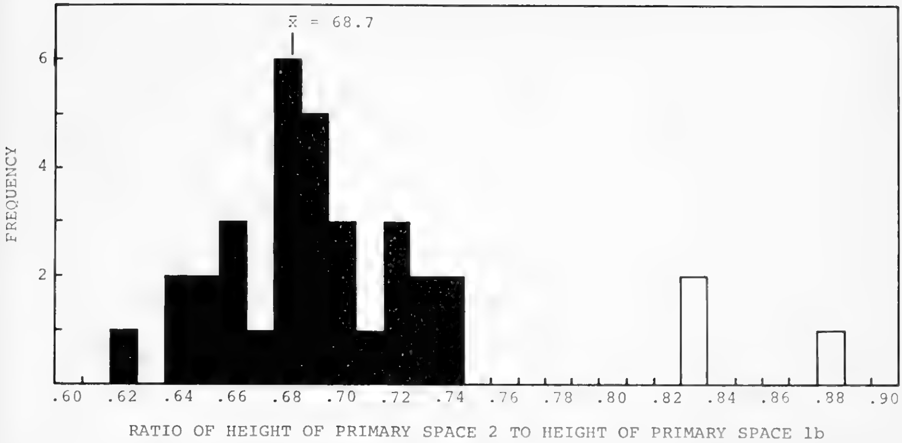


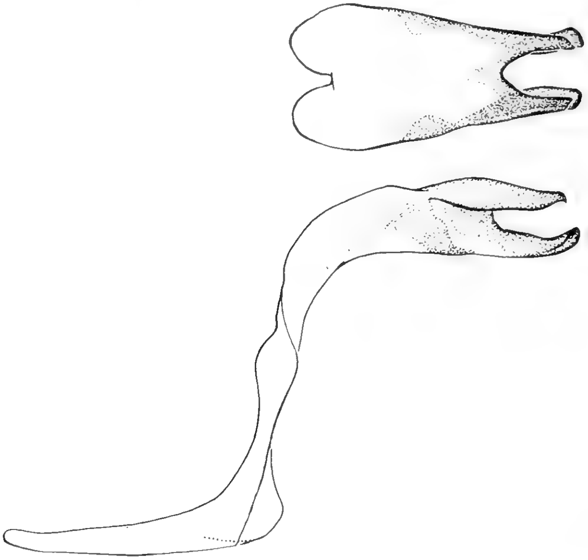
Fig. 10. Frequency distribution of the ratio of the height of space 2 to the height of space 1b on the left primary in females of *Atrytonopsis lunus* (solid) and *A. frappenda* (open). The mean ratio for *A. lunus* ($N = 31$) is indicated.

Genitalia.—Although male genitalia of *Atrytonopsis* have been examined and figured, more or less inadequately, for nearly a century (Scudder, 1889: pl. 37, fig. 36; Skinner and Williams, 1924: figs. 21–28; Williams and Bell, 1930: fig. 1; Lindsey et al., 1931: pl. 7, fig. 5; pl. 29, figs. 21–24; pl. 30, figs. 25–28; Evans, 1955: pl. 82, figs. N.1.1–N.1.8; Forbes, 1960: fig. 129), female genitalia have been wholly ignored.

Both sexes of *Atrytonopsis* have genitalia so conservative in essential form that they loudly proclaim their genus and so individually variable that they may scarcely whisper which species. Facies, though also individually variable, is generally easier to use in distinguishing differentiates. Because interspecific genitalic differences may be subtle, or quantitative rather than qualitative, series of dissections should be closely and repeatedly compared.

The taxonomically most useful genital element in males of *Atrytonopsis* is the uncus, especially its form, but also its position in relation to the gnathos. (Unexpectedly, the valvae are next to useless.) In females, the most useful element is the lamella postvaginalis, which amounts to little more than midventral sclerotization projecting caudad from the dorsal rim of the ostium bursae (sometimes expanding laterad, as well) and bearing many short fine setae. Variation in this simple device deserves all-out scrutiny.

The 200 *Atrytonopsis* genitalia dissected in connection with this study spent 6 to 9 minutes in boiling 10% KOH and, after thorough cleaning, went with their descaled abdominal skins into 1-dram vials of 80% ethanol plus 3 drops of glycerin. They never wound up on slides because slides severely



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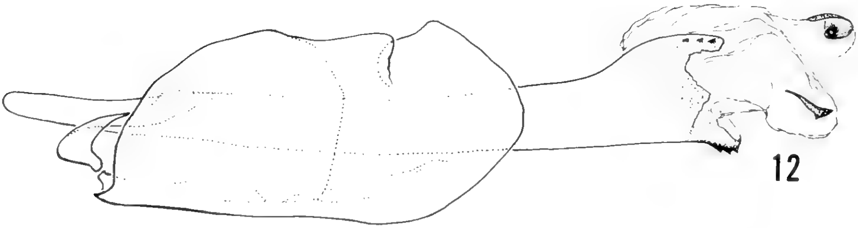

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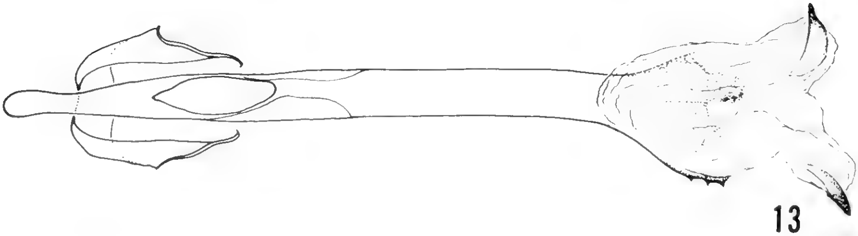

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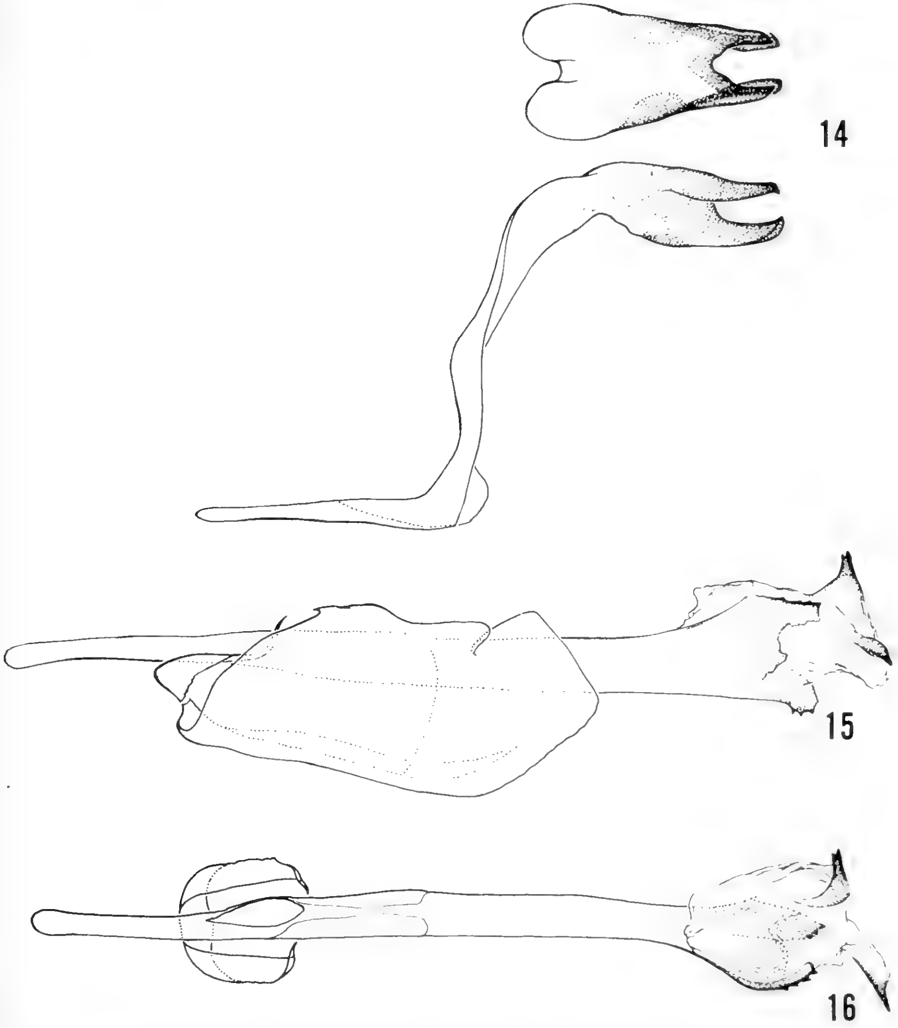
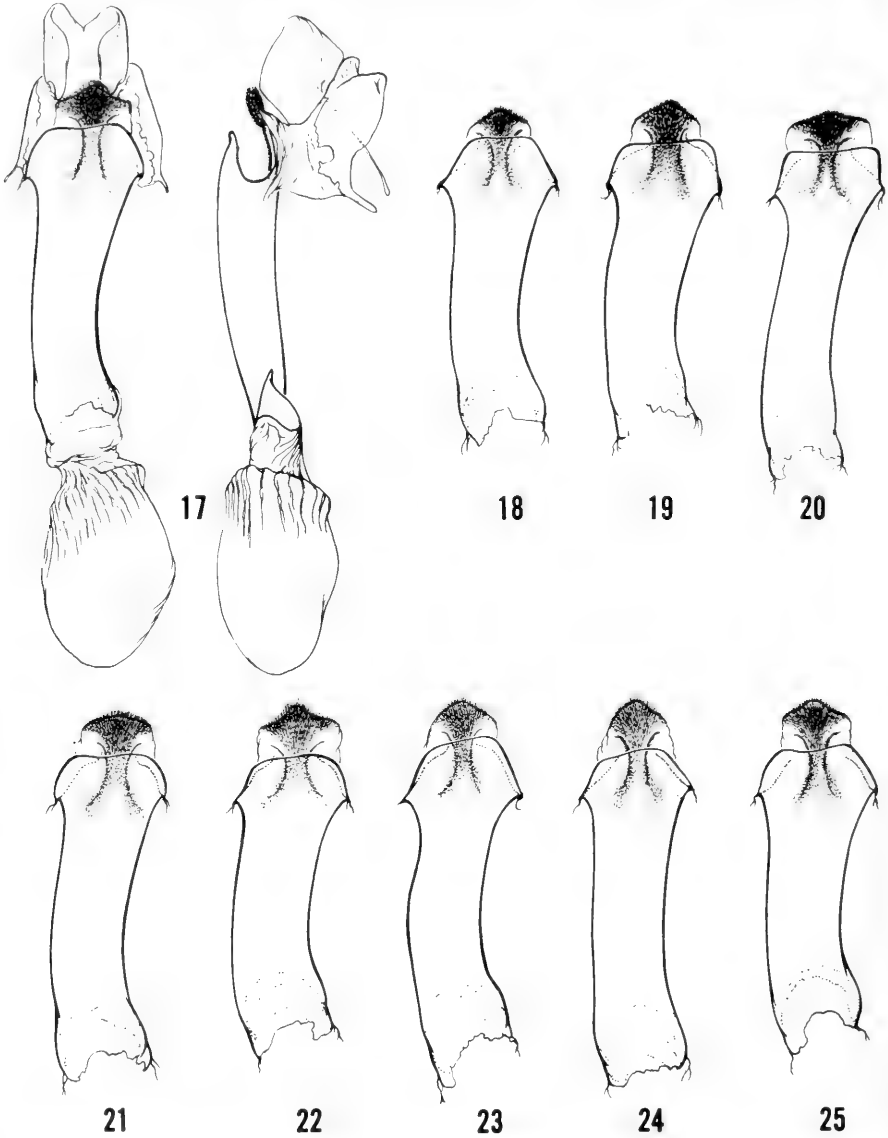
Figs. 11–13. Male genitalia of *Atrytonopsis lunus* from Apache Indian Reservation, White Mountains, 1830–2440 m, Arizona, 20 to 27 July 1925, O. C. Poling (X-1082) (USNM). 11, Uncus, gnathos, and tegumen in dorsal view and uncus, gnathos, tegumen, vinculum, and saccus in left lateral view. 12, Left valva, aedeagus, and juxta in left lateral view. 13, Aedeagus and juxta in dorsal view.



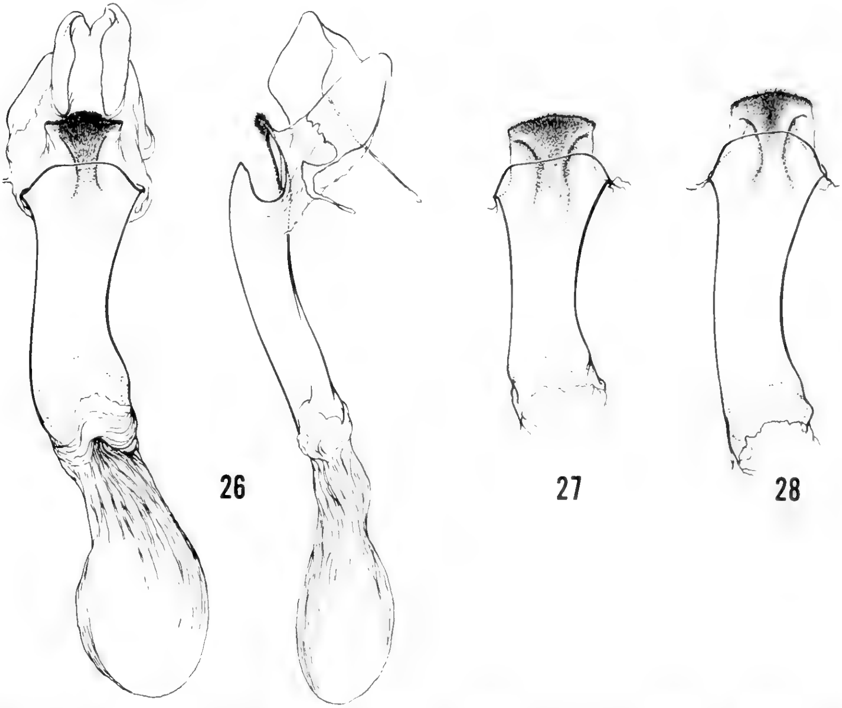
Figs. 14–16. Male genitalia of paratype of *Atrytonopsis zweifeli* from Durango-Villa Union highway, route 40, 1980 m, Sinaloa, Mexico, 29 April 1966, P. Hubbell (X-1062) (AMNH). 14, Uncus, gnathos, and tegumen in dorsal view and uncus, gnathos, tegumen, vinculum, and saccus in left lateral view. 15, Left valva, aedeagus, and juxta in left lateral view. 16, Aedeagus and juxta in dorsal view.

limit angles of observation, preclude direct side-by-side comparison of different individuals, and may distort genitalic form. Genitalia dissection numbers of drawn individuals appear in figure legends in parentheses.

Male genitalia: In the *lunus* group (Figs. 11–16) and those other species



Figs. 17–25. Female genitalia of *Atrytonopsis lunus* from southeastern Arizona (all USNM). 17, Bursa copulatrix and tip of abdomen in ventral and right lateral view. 18–25, Lamella postvaginalis, ostium bursae, and ductus bursae in ventral view. 17, Tonto Basin, Gila County (X-1079). 18–21, "Redington" (probably Santa Catalina Mountains), Pima County (X-1050, 1078, 1141, and 1142). 22, E Nogales, Santa Cruz County, 9 August 1963, A. R. Moldenke (X-1083). 23–24, Huachuca Mountains, Cochise County, 16 to 23 August (X-1077 and 1084). 25, Chiricahua Mountains, Cochise County, 24 to 31 July (X-1076).



Figs. 26–28. Female genitalia of *Atrytonopsis frappenda* from southcentral Mexico. 26, Bursa copulatrix and tip of abdomen in ventral and right lateral view. 27–28, Lamella postvaginalis, ostium bursae, and ductus bursae in ventral view. 26, Holotype from Mexico City, August 1917, R. Müller (X-1059) (USNM). 27, Paratype from near Mexico City, July, R. Müller (X-1058) (USNM). 28, 7 km SE Morelos Canada, Puebla, 4 to 5 July 1974, J. Chemsak and J. Powell (X-1153) (UCB).

of *Atrytonopsis* that usually or invariably lack spots on the dorsal secondary (i.e., *deva, vierecki, loammi,* and *hianna* including *turneri*), uncus and gnathos end in long paired prongs *that are widely separated from one another both horizontally and vertically* (Figs. 11 and 14). The uncus prongs *do not* (or barely) *converge* toward their tips. Though the horizontal gap between uncus prongs usually exceeds the vertical gap between uncus and gnathos prongs, the vertical gap is still large.

Uncus and gnathos prongs in the *lunus* group are a little shorter than they are in the rest of the species that usually or always lack spots on the dorsal secondary. Because the difference is not only small but also variable, it is elusive. In the *lunus* group, uncus prongs are shorter than gnathos prongs (see Figs. 11 and 14); though this difference is variable, too, it is often conspicuous. Uncus prongs are usually shorter than gnathos prongs in *deva,* as well; but the difference is a trifle less pronounced, on average (and, as noted above, both pairs of prongs are slightly longer than they are in the *lunus* group). By contrast, uncus prongs are usually as long as, or longer than, gnathos prongs in *vierecki* and in *loammi* and *hianna* (plus *turneri*).

I cannot separate *lunus* and *zweifeli* genitalically on the basis of available material. Differences between the drawn specimens of *lunus* and *zweifeli* are apparently individual rather than specific. For example, the sclerotized arm on the left side of the flared distal end of the aedeagus bears 3 teeth in *lunus* (Figs. 12 and 13), 4 in *zweifeli* (Figs. 15 and 16). But the other known specimen of *zweifeli* (the holotype) has 3 teeth on this arm; and in the series of *lunus* dissections I have examined, these teeth vary from 2 to 4, with a mode of 3. Again, the right cornutus ends in a single point in the drawn individual of *lunus,* in two points in that of *zweifeli.* But there is only one point on the right cornutus in the holotype of *zweifeli*; and though there is only one in the other dissections of *lunus,* two are likely to occur in occasional individuals in view of the fact that the number of points always varies by one or two in longer series of dissections of such related species as *deva, vierecki,* and *hianna.* Finally, valval shape often varies more within species of *Atrytonopsis* than it does between the drawn individuals of *lunus* and *zweifeli,* and aedeagal length varies intraspecifically as well as interspecifically.

Freeman's (1969: fig. 19) figure of the genitalia of the holotype of *zweifeli* is all wrong. It shows an uncus prong longer than its corresponding gnathos prong (the reverse is true) and misrepresents both the shape of the uncus and the nature of its union with the tegumen. The vinculum is oversimplified; the valva, inaccurate (most seriously along its dorsal and distal margins); and the aedeagus, far too short. In Freeman's genitalic dissection of the holotype, vinculum and saccus are badly torn, and at least the anterior half of the aedeagus is missing. This piece may still be in the type-specimen because Freeman removed only the distal part of its abdomen (see Fig. 7), even though the aedeagus has long been known to be notably long in *Atrytonopsis.* He must, then, have manufactured the anterior end of the aedeagus in his figure. In his text where he compares *zweifeli* with *lunus,* Freeman (1969: 277) says only that "there are differences in the genitalia." He neither provides comparative figures nor analyzes and describes the "genitalic differences" he claims to see, and he does not check series of genitalia for variation. Unfortunately, such broad statements as "the genitalia are different" often appear, without amplification, in Freeman's descriptions of new species.

Female genitalia: In the *lunus* group (Figs. 17–28), as in females of *Atrytonopsis* generally, the ductus bursae is large in diameter, slightly bowed to the left, and heavily sclerotized from end to end, whereas the corpus bursae

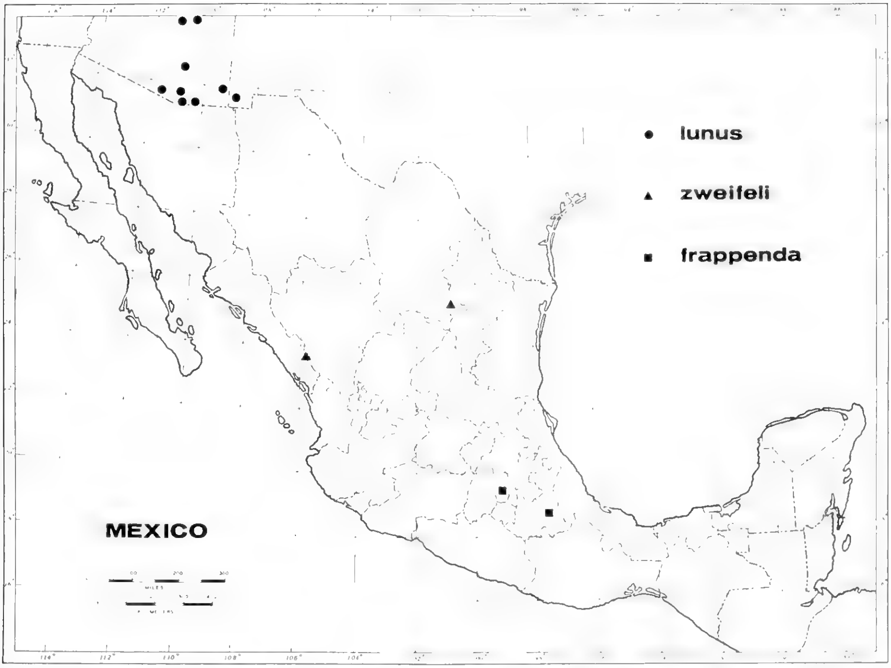


Fig. 29. Geographic distribution of the *lunus* group of *Atrytonopsis* (based on material examined).

is modest in size and fully membranous. In the *lunus* group and a number of other species, the ductus bursae is not exceedingly long but is wide and is conspicuously flared at its posterior end (i.e., at the ostium bursae), where the sclerotized walls of the ductus bursae extend much farther caudad both dorsally and ventrally than laterally (see particularly the lateral views in Figs. 17 and 26).

Slight bilateral swelling of the sort shown in Figs. 17–28 near or at the anterior end of the ductus bursae is peculiar to the *lunus* group.

In dorsal or, better, ventral view, the quietly distinctive lamella postvaginalis of *lunus* and *frappenda* suggests a toadstool in outline; its projecting cap lies just anterior to the ovipositor lobes (=papillae anales) and its stalk, embracing the midline like a pair of parentheses in reverse, merges with the ductus bursae dorsally (Figs. 17–28). The whole device, especially the cap, is densely felted with fine setae.

Usually the cap is flatter and broader in *frappenda* (Figs. 26–28), more sharply humped and less wide in *lunus* (Figs. 17–25).

Temporal distribution.—Among the nine or so species of *Atrytonopsis* in the United States, *lunus* is peculiar because it flies in summer rather than spring. The spring-flying species variously appear from March to June (especially in April, May, and June), and some reappear in latter summer and fall. Every dated specimen of *lunus* that I know of (N = 188, including 148 courtesy K. Roever) is from July or August (save one from June and one from September); and most are from a one-month span, 15 July to 15 August. Adult emergence is almost certainly geared to summer rains.

Presumed misdated and so discounted is one male of *lunus*, in AMNH, collected by O. C. Poling in the Baboquivari Mountains, Arizona, 15 to 30 March 1924. Williams and Bell (1930: 137) published these data without questioning the date.

The fact that the three known specimens of *frappenda* are also from July and August might suggest a distinctive flight period for the *lunus* group as a whole. But *zweifeli* breaks the mold: although one specimen is from latter June, the other is from late April. So few examples of *Atrytonopsis* have been collected in Mexico that it is hard to generalize about flight periods there except to say that they seem to depart from those evident in the United States, becoming more spread out in time and more continuous.

Spatial distribution.—The *lunus* group occurs at middle elevations—1190 to 2240 m (3900–8000 ft), usually 1555 to 2010 m (5100–6600 ft)—from the southwestern United States to southcentral Mexico (Fig. 29). The three species appear to be limited in distribution and allopatric, with wide intervening gaps: *lunus* is known from the Mogollon Rim country south through the mountain islands of southeastern Arizona and extreme southwestern New Mexico—see Fig. 30 for details (K. Roever, personal communication 1981); *zweifeli*, from both the Sierra Madre Oriental (southern Coahuila) and Occidental (southern Sinaloa); and *frappenda*, from the Distrito Federal and Puebla. Undoubtedly, each is more widespread in Mexico than available data show: *lunus* must occur at the very least in some montane parts of Sonora and Chihuahua; *zweifeli*, in some mountains on the Central Plateau as well as more extensively in the ranges that flank it; and *frappenda*, in more of the Volcanic Cordillera and mountains to the south, plus perhaps in mountains to the north. But whether any two of these species make contact or overlap is anybody's guess.

In broad ecologic terms, all three are skippers of woodland and scrub: *lunus* is most often in oak (-pine-juniper) woodlands; the type of *zweifeli* was in a dry pinyon-yucca association on rocky limestone (R. G. Zweifel, personal communication 1981); and the Puebla female of *frappenda* was near agave and thorn scrub on rocky limestone (J. A. Powell, personal communication 1981).

Bell (1942: 465) reported that the collection of R. Müller contained one male of *lunus* taken in Mexico, Distrito Federal, in August. Since R. Müller

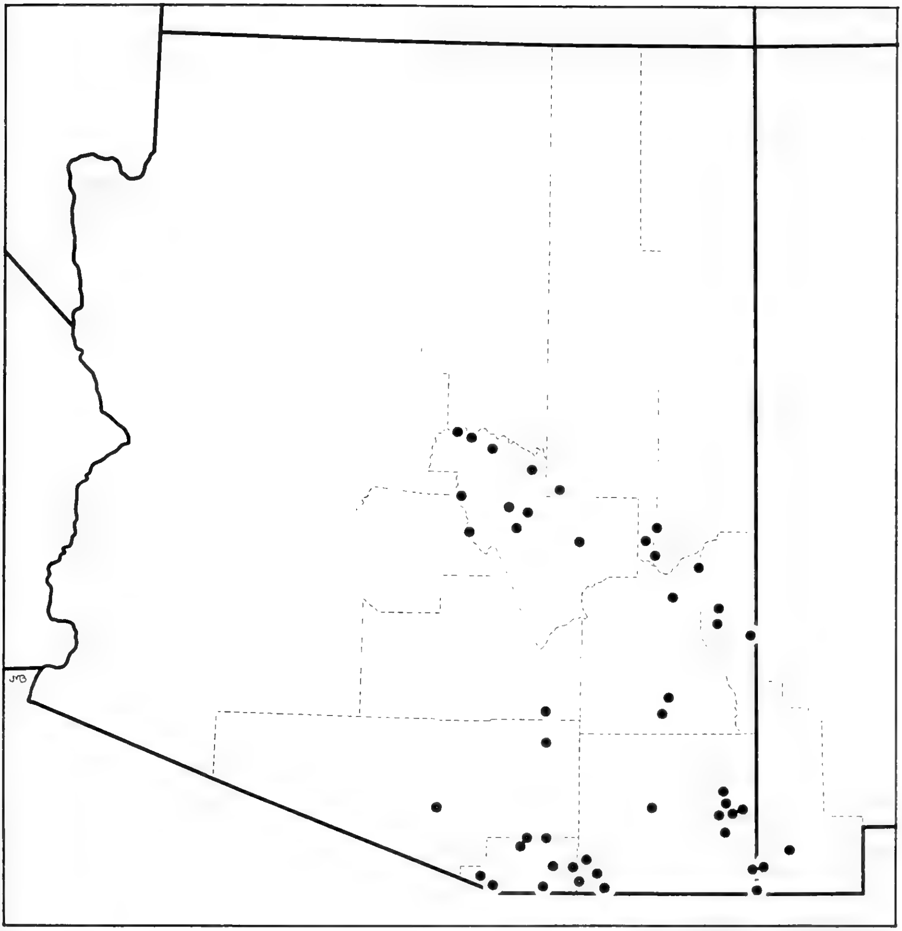


Fig. 30. Detailed geographic distribution of *Atrytonopsis lunus* (based on personal records of K. Roever). The map centers on Arizona and adjacent New Mexico; *lunus* occurs in ten counties, outlined with dashes, from northwest to southeast, as follows: Gila, southern Navajo, southern Apache, eastern Pinal, Graham, Greenlee, eastern Pima, Santa Cruz, Cochise, and Hidalgo.

took both the type and paratype of *frappenda* in this very area in July and August, since (as shown earlier in this paper) at least females of *lunus* and *frappenda* can run close, and since Bell knew neither *frappenda* nor *zweifeli,* there is some question about the true identity of this male.

A female of *lunus* in AMNH bears a pair of phony labels (roman type denotes machine-printed information; italic, information inked in by hand):

[1] Santa Cruz
IX·14·1923 Cal
[2] O. C. Poling

I have long since marshalled enough evidence for an airtight case against this recurring and treacherous pair of labels (Burns, 1964: 110). The data have been listed for *lunus* (Williams and Bell, 1930: 137), but publication does not make them valid.

Discussion

Two-thirds of the North American species of *Erynnis* neatly cluster in half a dozen essentially transcontinental superspecies each comprising 2 or 3 species (Burns, 1964, and unpublished). *Atrytonopsis,* too, shows signs of considerable recent speciation (though most patterns of splitting differ from those in *Erynnis*). At present, the *lunus* group—three closely related, allopatric species replacing one another from northwest to southeast—looks like a superspecies (Fig. 29). Especially with *zweifeli* intermediate as regards both development of the band on the primary and geography, it is tempting to assume that *lunus, zweifeli,* and *frappenda* are still distributed much as they were when they speciated. This assumption may be wrong because *lunus* and *frappenda,* which occur at opposite ends of the *lunus* group's "linear" distribution, share features suggesting that each is the other's nearest relative. Given such tiny samples for inferring relationship and total range (two males of *zweifeli,* three females of *frappenda*), I will not speculate further.

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Thank you: For specimens lent, Frederick H. Rindge and the American Museum of Natural History, New York (AMNH) and Jerry A. Powell and the Essig Museum of Entomology, University of California, Berkeley (UCB); for data from personal notes, Jerry A. Powell, Richard G. Zweifel, and especially Kilian Roever; for 200 exquisite dissections of male and female genitalia and for statistical calculations, Richard G. Robbins; for photographs, Victor E. Krantz; for drawings of genitalia plus a histogram, George L. Venable; for skill with a word processor, Noreen M. Connell; and for critical review of the manuscript, C. Don MacNeill and Robert K. Robbins.

Literature Cited

Bell, E. L. 1942. New records and new species of Hesperiidae from Mexico. An. Esc. Nac. Cienc. Biol. Mex. 2: 455–468.

Burns, J. M. 1964. Evolution in skipper butterflies of the genus *Erynnis*. Univ. Calif. Publ. Entomol. 37, 216 pp.

Dyar, H. G. 1920. New Lepidoptera, chiefly from Mexico, with synonymic notes. Insecutor Inscitiae Menstruus 8: 187–198.

Evans, W. H. 1955. A catalogue of the American Hesperiidae indicating the classification and nomenclature adopted in the British Museum (Natural History). Part IV. Hesperiinae and Megathyminae. British Museum, London. 499 pp., pls. 54–88.

Forbes, W. T. M. 1960. Lepidoptera of New York and neighboring states. Part IV. Cornell Univ. Agric. Exp. Stn. Mem. 371, 188 pp.

Freeman, H. A. [1969] "1968." New species and records of Hesperiidae from Mexico (Lepidoptera). J. N.Y. Entomol. Soc. 76: 267–277.

Godman, F. D. 1900, 1901. *In* Godman, F. D. and O. Salvin, 1879–1901. Biologia Centrali-Americana. Insecta. Lepidoptera-Rhopalocera. Vol. I, xlvi + 487 pp.; vol. II, 782 pp.; vol. III, 113 pls.

Hoffmann, C. C. 1941. Catalogo sistematico y zoogeografico de los Lepidopteros Mexicanos. Segunda Parte. Hesperioidea. An. Inst. Biol. Mex. 12: 237–294.

Lindsey, A. W., E. L. Bell, and R. C. Williams, Jr. 1931. The Hesperioidea of North America. Denison Univ. Bull., J. Sci. Lab. 26, 142 pp.

MacNeill, C. D. 1964. The skippers of the genus *Hesperia* in western North America with special reference to California (Lepidoptera: Hesperiidae). Univ. Calif. Publ. Entomol. 35, 230 pp.

———. 1975. Family Hesperiidae, pp. 423–578. *In* Howe, W. H., ed., The Butterflies of North America. Doubleday and Co., Inc., Garden City, N.Y. 633 pp., 97 pls.

Okano, K. 1981. Studies on the Mexican butterflies (1). Additions and revisions to . . . Hoffmann's "Catalogo sistematico y zoogeografico de los Lepidopteros Mexicanos." Part 1. Hesperiidae (Lepidoptera: Rhopalocera). Tokurana (Acta Rhopalocera) No. 1: 23–139.

Scudder, S. H. 1889. The butterflies of the eastern United States and Canada with special reference to New England. Publ. by the author, Cambridge. Vol. I, pp. i–xxiv, 1–766; vol. II, pp. i–x, 767–1774; vol. III, pp. i–vi, 1775–1958, pls. 1–89, 3 maps.

Skinner, H. and R. C. Williams, Jr. 1924. On the male genitalia of the Hesperiidae of North America. Paper IV. Trans. Am. Entomol. Soc. 50: 57–74.

Williams, R. C., Jr. and E. L. Bell. 1930. Short studies in American Hesperiidae (Lepidoptera: Rhopalocera). Trans. Am. Entomol. Soc. 56: 133–138.

PROC. ENTOMOL. SOC. WASH.
84(3), 1982, pp. 568–585

THE CACAO-POLLINATING MIDGES OF THE *FORCIPOMYIA ARGENTEOLA* GROUP (DIPTERA: CERATOPOGONIDAE)

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Abstract.—Diagnoses and keys are given for the *Forcipomyia argenteola* Group of species of the subgenus *Forcipomyia* s. str. Included in this group are *F. argenteola* Macfie from southern Brazil; *quatei* Wirth, ranging from the southern United States to southern Brazil; ***calatheae***, n. sp., from Brazil, Colombia, and Dominica; and ***youngi***, n. sp., from Costa Rica, Ecuador, and Panama. Because of its close similarity to species of the *argenteola* Group, diagnostic notes are also given for the widespread Neotropical species, *squamitibia* Lutz. Larvae of species of the *argenteola* Group are commonly found in rotting banana stems, cacao pods, bracts of *Calathea* and *Heliconia*, and similar decaying vegetable matter; and the species are often abundant in cacao plantations where the adults may serve as pollinators.

Beginning with the classic work of Saunders (1956, 1959), intensive studies have been made on the immature stages and classification of the *Forcipomyia* midges associated with cacao culture. Although the smaller adults of the subgenera *Euprojoannisia* Brèthes, *Thyridomyia* Saunders, and *Warmkea* Saunders are most important in cacao pollination, the very abundance and ubiquity of the species of the subgenus *Forcipomyia* s. str. also place these midges high on the list of important cacao pollinators. Previous publications have reported on the taxonomy of all stages of *Euprojoannisia* (Saunders, 1956; Soria and Bystrak, 1975; Bystrak and Wirth, 1978); *Thyridomyia* (Saunders, 1956); and *Warmkea* (Wirth and Soria, 1980). Wirth and Soria (1975) described all stages of *Forcipomyia* (*Forcipomyia*) *genualis* (Loew) and a closely related species, *F. harpegonata* Wirth and Soria. Wirth (1976) described all stages of *F.* (*F.*) *pictoni* Macfie and two new closely related species from Florida, *F. seminole* Wirth and *F. beckae* Wirth.

The larval habitats of these *Forcipomyia* midges are somewhat correlated with their taxonomic group; the habitats of *Euprojoannisia* species are usually semiaquatic situations such as algae-covered rocks or mud, wet moss, or leaves, mats of decaying aquatic vegetation, and leaf axils of water-holding plants. Species of *Thyridomyia* usually are found in association with moss or algae in rather damp habitats. Immature stages of *Warmkea* species are frequently found in leaf axils of *Pandanus,* aroids and epiphytic and terrestrial bromeliads, and less often in rotting cacao leaves on the ground, in banana stems, and in bracts of *Heliconia.* Species of the subgenus *Forcipomyia* are less aquatic and are more commonly associated with rotting plant material, which in cacao plantations and their environs often involves heaps of cacao pods, old banana stems, cacao leaves, coconut debris, bracts of *Heliconia* and *Calathea,* and rotting fruits of coconut, calabash, palm nuts, etc.

Over the past few years I have received numerous samples of *Forcipomyia* midges closely resembling *F. argenteola* Macfie. Dr. Allen M. Young, working in Costa Rica, found them especially abundant in decaying sections of banana stems he set out in cacao plantations to attract ovipositing female midges and thus to sample the relative abundance of various ceratopogonid species. Although the adults of these species were almost indistinguishable from each other, larval and pupal characters were found to separate two distinct species in Costa Rica, neither of which proved to be *argenteola.* On closer study, adult characters were also discovered. A review of the material in the National Museum of Natural History, Smithsonian Institution, disclosed that there are at least four species in this group, closely related to *argenteola.* One species, *quatei* Wirth (1952), ranges from Florida and California to southern Brazil; *argenteola* apparently is restricted to southern Brazil; a third species, *calatheae* n. sp., is recorded from Brazil, Colombia and Dominica; and the fourth, *youngi* n. sp., is found in Costa Rica, Ecuador, and Panama. In this paper I am presenting descriptions or diagnoses, figures, and a key for the separation of these species. Although it is not a member of the *argenteola* Group, *Forcipomyia squamitibia* Lutz adults are so similar to members of that group that a diagnosis is also presented for *squamitibia.*

A discussion of the taxonomic characters used in this paper can be found in the publications by Saunders (1924, 1956), Wirth (1952), Chan and LeRoux (1965), and Bystrak and Wirth (1978). Holotypes of the new species are deposited in the National Museum of Natural History, Smithsonian Institution, Washington, D.C.; paratypes will be deposited in the Museu de Zoologia, Universidade de São Paulo, Brazil, the British Museum (Natural History), London; the Muséum National d'Histoire Naturelle, Paris; the California Academy of Sciences, San Francisco; and the Milwaukee Public Museum, Milwaukee, Wisconsin.

I am greatly indebted to the following individuals and institutions for the submission of material and for their interest and efforts in collecting and rearing all stages of the most common *Forcipomyia* midges in American cacao plantations: The late Leslie G. Saunders, working in Costa Rica, Mexico, Puerto Rico, and Trinidad, with financial assistance from the American Cocoa Research Institute; Saulo de J. Soria, Centro de Pesquisas do Cacau, Itabuna, Bahia, Brazil; Eduarto J. Ureta S., Sanidad Agropecuaria, Dept. Antioquia, Medellín, Colombia; and Allen M. Young, Milwaukee Public Museum, Milwaukee, Wisconsin, working in Costa Rica under grants from the American Cocoa Research Institute.

Forcipomyia (*Forcipomyia*) *argenteola* Group

Diagnosis.—Legs yellowish, at most tarsi and apex of hindfemur infuscated; hindtarsal ratio 0.50–0.76; female wing brownish with one small yellowish spot at end of costa, base of costa sometimes yellowish; male wing usually extensively pale; male abdomen banded and genitalia yellowish with pattern of brownish infuscation; 3rd palpal segment swollen at base and bearing a deep round sensory organ; female tibiae without hastate spines; spermathecae ovoid, rather elongate, tapering to slender opening without elongate neck; male aedeagus poorly sclerotized, in form of an elongated shield, more than 1.5× as long as basal breadth, with a submedian pair of faint longitudinal ridges; parameres with bases broadly fused, caudal processes moderately stout, each tapering to a sharp tip.

Larva hypognathous, typical of subgenus *Forcipomyia*; body yellowish white, without cuticular armature, head capsule brownish to blackish. Prothoracic pseudopods short and cleft a short distance, with 6–8 pairs of blackish hooks; posterior pseudopod with a double row of 16–20 brownish hooks. Head with *p* and *q* hairs long and curved or bent, slender or with tips slightly expanded. Body hairs *b* and *c* arising from a large conical common prominence; *a* hairs moderately long and distinctly hastate, their bases often connected across midline by a narrow blackish pigmented line; *b, c,* and *d* hairs elongate, usually microscopically fringed; *e* and *f* hairs moderately short to long, simple, *a, b,* and *e* hairs pale; *c, d,* and *f* hairs pigmented.

Pupa moderately stout; integument without conspicuous armature except for the usual 6 pairs of dorsal thoracic tubercles; abdomen sometimes with 1 or 2 pairs of elongate lateral processes and some inconspicuous spinose tubercles in transverse dorsal row on each segment. Prothoracic respiratory horn small to moderate in size, with short basal petiole, distal portion variably swollen in a rounded or globular knob bearing a row of 12–35 spiracular openings along apex and down dorsal side. Last abdominal segment drawn out in a pair of long tapering processes, at least twice as long as basal breadth of segment. Last instar larval exuviae remain attached to posterior end of pupal abdomen.

KEY TO SPECIES OF THE *FORCIPOMYIA ARGENTEOLA* GROUP

1. Female tibiae with row of hastate spines on extensor surface; pale wing spot at end of costa larger, including most of 2nd radial cell; hindtarsal ratio 1.05; male parameres with slender common base .... *squamitibia* Lutz
– Female tibiae without hastate spines; pale wing spot smaller, not covering end of 2nd radial cell; hindtarsal ratio 0.50–0.76; male parameres with bases joined in a broad plate (*argenteola* Group) 2
2. Abdomen without broad dark brown scales; femora and tibiae without broad scales, entirely yellowish; halter slightly infuscated; hindtarsal ratio 0.72; female mandibular teeth vestigial; male parameres fused on proximal ½; larval head entirely dark brown .... *calatheae*, new species
– Abdomen with broad dark brown scales; femora and tibiae with some broad scales; hindtarsal ratio 0.42–0.56; apex of hindfemur pale or dark; mandible, male parameres, and larval head various (see below) 3
3. Hindfemur brownish on approximately distal ¼, this portion bearing broad brownish scales; mandibular teeth vestigial; 3rd palpal segment rather slender, swollen on proximal ½; halter infuscated .... *argenteola* Macfie
– Femora and tibiae entirely yellowish (hindfemur brown at tip in some *quatei*, in which case broad scales are pale); mandible with well developed teeth; halter pale or dark 4
4. Halter brownish; female mandible with about 20 small teeth; larval head unicolorous pale brown .... *quatei* Wirth
– Halter pale; female mandible with 12–15 strong teeth; larval head very dark brown toward mouth .... *youngi*, new species

KEY TO KNOWN LARVAE

1. Head hairs *p* and *q* swollen distally, not much longer than antenna; head pale brownish, dark only along oral margin; bases of dorsal body hairs not strongly pigmented .... *quatei* Wirth
– Head hairs *p* and *q* slender distally, more than twice as long as antenna; head dark brown, especially toward oral margin; bases of dorsal body hairs strongly pigmented 2
2. Head strongly pigmented, blackish on anterior ½ toward mouth; *e* and *f* hairs shorter than *c* and *d* hairs; *a* hair of last segment slender, not hastate distally .... *youngi*, new species

– Head unicolorous dark brown; *e* and *f* hairs much longer than *c* and *d* hairs; *a* hair of last segment hastate .... *calatheae,* new species

KEY TO KNOWN PUPAE

1. Dorsal tubercles of thorax short and inconspicuous, not longer than basal breadth; respiratory horn with petiole stouter, bearing 30–35 spiracular openings in a much convoluted row; each abdominal segment with 2 pairs of lateral processes .... *calatheae,* new species

– Dorsal tubercles of thorax in form of elongate process at least twice as long as basal breadth; respiratory horn with slender petiole, bearing 12–25 spiracular openings; each body segment with 1 pair of lateral processes or with none 2

2. Respiratory horn slender, the slightly swollen apex with 12–15 spiracular openings; abdominal segments without conspicuous lateral processes; thoracic processes torchlike, the pair just behind level of respiratory horn with seta less than ¼ as long as process .... *quatei* Wirth

– Respiratory horn globular, with 20–25 spiracular openings; abdominal segments each with 1 pair of elongate lateral processes; dorsal thoracic processes between respiratory horns with apical seta about ½ as long as process .... *youngi,* new species

Forcipomyia argenteola **Macfie**

Forcipomyia argenteola Macfie, 1939: 146 (♀; Brazil; fig. palpus, antenna, hindleg, radial cells, spermatheca); Lane, 1947: 163 (♂, larva, pupa; Brazil; fig. ♂ genitalia).

Female diagnosis.—Wing length 1.1–1.8 mm. Wing with a small yellow spot at end of costa; costal ratio 0.45. Halter pale brownish. Thorax brown, scutellum yellowish brown. Legs yellowish, hindfemur infuscated at apex, sometimes infuscation continued across knee to base of tibia; fore- and midfemora sometimes slightly darker at tip, but this apparently due to more numerous, broad, striated, brownish scales there than elsewhere on legs; tarsi pale brownish; hindtarsal ratio 0.50–0.55. Palpus more slender than in related species; 3rd segment swollen on proximal ½; palpal ratio 3.0. Proboscis longer than in related species; mandible with vestigial teeth. Abdomen with numerous dark brown, appressed, broad scales; penultimate segment yellowish; spermathecae ovoid, tapering to slender opening, without distinct necks.

Male diagnosis.—Wing length 1.5 mm. Coloration similar to that of female, dark area on hindfemur broader; wing pale brownish, veins slightly darker, dark brown on radial field, yellow spot at end of costa prominent; costal ratio 0.40. Hindtarsal ratio 0.42. Abdomen yellowish with prominent dark brown segmental bands; genitalia similar to those of *F. youngi*, brownish except at base of 9th segment and on bases of basistyles, which are yellow.

Distribution.—Brazil.

Types.—Brazil, Santa Catarina, Nova Teutonia, 15.iii.1937, and 1.viii.1938, F. Plaumann, 2 ♀ syntypes (British Museum (Nat. Hist.)).

Specimens examined.—BRAZIL: Santa Catarina, Nova Teutonia, various dates, 1965–1971, F. Plaumann, 4 ♂, 7 ♀ (USNM).

Immature Stages.—I have not seen the immature stages of this species. Lane's (1947) descriptions of the larvae and pupae are brief and typical of the group. The pupal description as translated below is most diagnostic:

"*Pupa*. Respiratory tube constricted at the base, expanded and rounded toward the apex where it terminates in approximately 10 spiracles.

"Cephalothorax with the setae (anterior, dorsal, and marginal) small, smooth, and inserted on small mammillae; dorso-lateral tubercle conical, smooth and with a small smooth seta on the apex; dorsal tubercles conical, spiculose, and with blunt apices.

"Abdomen: Segments I to VII glabrous, VIII and IX spiculose, the spicules in the form of minute scales. Segments I to IV with the postero-marginal tubercles elongated, spiculose and from whose apex go off small smooth setae inserted on the middle of the lateral margin; in addition to these processes there are on the median portion other much smaller ones, likewise with smooth setae inserted on mammillae. Segment V like the preceding except for the postero-marginal tubercle which is defective. Segments VI and VII with the postero-marginal setae inserted on mammillae which are distinct, elongated, and uniform at the base, the apex transformed into a pennant, the internal much smaller than the external. Besides these setae there are discrete spicules. Segments VIII with only 2 setae like pennants. Last segment with apex blunt and the terminal filaments longer than the body of the segment."

Forcipomyia calatheae Wirth, New Species

Fig. 1

A brownish species with pale yellow legs; wing dark brown with a small yellow spot at end of costa, male wing yellowish with dark brown macrotrichia over radial veins and infuscation over vein Cu_1; halter brown.

Female Holotype.—Wing length 1.18 mm; breadth 0.51 mm.

Head: Brown, with abundant long bristly brownish setae. Antenna (Fig. 1a) short, proximal segments moniliform; flagellar segments with lengths in proportion of 16-13-13-13-13-13-13-13-20-20-20-20-25, antennal ratio 1.00. Palpus (Fig. 1b) with lengths of segments in proportion of 9-11-30-13-12; 3rd segment moderately swollen on proximal ½, bearing a deep sensory pit

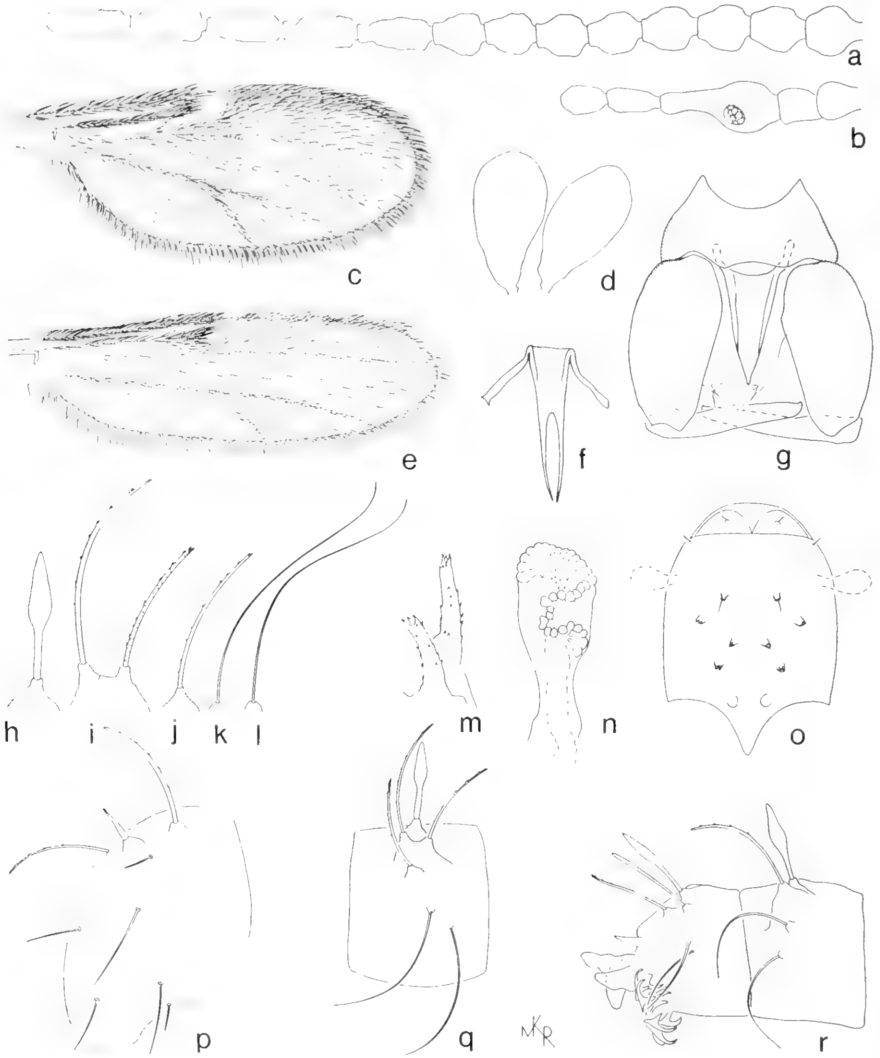

Fig. 1. *Forcipomyia calatheae*. a–d, Female. e–g, Male. h–l, p–r, Larva. m–o, Pupa. a, Antenna. b, Palpus. c,e, Wing. d, Spermathecae. f, Parameres. g, Genitalia, parameres removed. h–l, *a*, *b*, *d*, *c*, *e*, *f* hairs respectively, of 2nd abdominal segment. m, Lateral processes of abdomen. n, Respiratory horn. o, Thoracic tubercles. p, Head, lateral view. q, Second abdominal segment, lateral view. r, Two posterior abdominal segments, lateral view.

opening by a slightly smaller pore; palpal ratio 2.1. Mandibular teeth vestigial.

Thorax: Brown; mesonotum and scutellum with long bristly hairs and shorter finer setae. Legs unicolorus yellowish with brownish tinge due to numerous flattened, narrow appressed scales; tarsi concolorous with tibiae; femora and tibiae stout, tibiae with longest bristly hairs on extensor surface about 3× diameter of tibia; hindtibial spur short and inconspicuous, pointed, about ½ as long as diameter of tibia. Tarsi with ventral palisade setae prominent on tarsomeres 1 and 2 of fore- and midlegs, poorly developed on hindleg; some stronger dark ventral spines scattered on tarsomeres 1 and 2 of hindlegs, apical only on remaining tarsomeres 1–4. Tarsal ratios 1.00 on foreleg, 0.70 on midleg, and 0.76 on hindleg. Wing (Fig. 1c) brown, darker anteriorly, with dense, long, brown macrotrichia, a small yellow spot at end of costa; costal ratio 0.44. Halter brown.

Abdomen: Brown, last 2 segments and cerci paler; vestiture of rather short brown hairs, those on pleura less conspicuous; terga with some narrow brown scales. Spermathecae (Fig. 1d) 2, dark brown, elongate ovoid, tapering gradually to slender opening to duct; subequal, each measuring 0.087 by 0.043 mm.

Male allotype.—Wing length 1.37 mm; breadth 0.40 mm. Similar to female with usual sexual differences. General color as in female, but wing (Fig. 1e) pale yellowish brown, slightly darker anteriorly and a line along vein Cu_1, costal and radial veins dark brown due to prominent long slender, scalelike macrotrichia. Abdomen with broad brown segmental bands bearing long yellowish to brown, bristly setae. Costal ratio 0.42; tarsal ratios 0.82 on foreleg, 0.65 on midleg, and 0.72 on hindleg.

Genitalia (Fig. 1g): Basistyle and distal part of 9th segment brown, dististyle and midportion of 9th sternum pale. Aedeagus elongate, nearly triangular, about 2× as long as basal breadth, poorly sclerotized, apex narrowly pointed. Parameres (Fig. 1f) poorly sclerotized, yellowish bases fused for ½ the total length of parameres, the caudomedian emargination forming an acute angle; caudal processes slender with sharp-pointed apices.

Pupa.—Length 2.5–3.0 mm. Color brownish, abdomen paler. Respiratory horn (Fig. 1n) on distinct stalk, the distal portion 1.5–2× as broad as stalk depending on angle viewed, and about as long as stalked portion; bearing about 30–35 spiracular openings in a single, much convoluted row around apex and partway down dorsal side of swollen portion. Thoracic tubercles (Fig. 1o) low and conical, bearing a fine seta or fine spicules as figured. Each abdominal segment (Fig. 1m) with 2 pairs of spiculate lateral processes, their apices with several short spines.

Larva.—Length 4–5 mm when mature. Color yellowish white; head capsule (Fig. 1p) uniformly brownish; dorsal body hairs borne on prominent dark brown conical prominences as figured (Fig. 1q). Hairs *p* and *q* of head long and slender, of uniform width to tip, pale yellowish. Body hairs *a, b,* and *e* pale, *c, d* and *f* brownish (Figs. 1h–l); *b* and *d* hairs arising from a common tubercle. Last 2 segments as in Fig. 1r. In mature larvae and larval exuviae, the *a* hairs connected across midline by a slender black sclerotized line; *a* hair on last segment not so broadened subapically, with margins microscopically and sparsely serrate. Cuticular armature absent. Prothoracic pseudopod cleft apically, each lobe with 6–7 brown hooks; posterior pseudopod with a row of 16–20 brown hooks; anal blood gills bilobed.

Distribution.—Brazil, Colombia, Dominica.

Types.—Holotype ♀, allotype ♂, Dominica, Calabishie, swamp at mouth of Hodges River, 27.ii.1965, W.W. Wirth, reared from bracts of *Calathea lutea* (Type no. 76582, USNM). Paratypes, 22 ♂, 24 ♀, as follows: DOMINICA: Same data as types, 8 ♂, 6 ♀, with associated larval and pupal exuviae, 3 larvae. BRAZIL: Santa Catarina, Nova Teutonia, various dates 1961–1970, F. Plaumann, 14 ♂, 18 ♀.

Other material examined.—BRAZIL: Bahia, Ilheus, Itabuna, 24.x.1977, S. J. Soria, reared from sugar cane leaf axils, 1 ♂ with pupal exuviae, 4 larvae. COLOMBIA: Antioquia, San Jeronimo, 17.i.1974, E. Urueta, reared from decaying papaya stem, 2 ♂, 3 ♀, 1 pupa, 2 larvae.

Discussion.—The species takes its name from the plant from which the type-series was reared in Dominica. *Forcipomyia calatheae* is distinguished from the other species in this group by rather negative characters: The vestigial mandibular teeth; lack of hastate spines on the female tibiae; narrow rather than broad scales on the abdominal terga and legs; the uniformly dark brown larval head; the large pupal respiratory horns with long, more or less convoluted, line of spiracular openings; and the short dorsal tubercles on the pupal cephalothorax.

Forcipomyia quatei **Wirth**

Fig. 2

Forcipomyia quatei Wirth, 1952: 142 (♂, ♀; Calif.; fig. ♂ genitalia).

A pale brown species with yellowish legs; wing dark brown with a small yellow spot at end of costa; abdomen with conspicuous clumps of broad striated blackish scales on pleural segments; halter brown.

Female.—Wing length 1.15 mm; breadth 0.48 mm.

Head: Brown including antenna and palpus. Antenna (Fig. 2a) with lengths of flagellar segments in proportion of 15-11-11-12-12-11-11-11-24-25-27-28-33; antennal ratio 1.45. Palpus (Fig. 2b) with lengths of segments in proportion of 7-13-29-10-10; 3rd segment broad and evenly swollen on proximal ½, abruptly tapering to slender tip past the sensory pit, palpal ratio 2.0; sensory pit 2× as deep as diameter of pore opening, which is slightly

Fig. 2. *Forcipomyia quatei.* a–e, Female. f–g, Male. h, k–q, Larva. i–j, Pupa. a, Antenna. b, Palpus. c, Wing. d, Mandible. e, Spermathecae. f, Parameres. g, Genitalia, parameres removed. h, Second abdominal segment, lateral view. i, Thoracic tubercles. j, Respiratory horn. k, Head, lateral view. l–p, *a, b, d, c, e, f* hairs respectively, of 2nd abdominal segment. q, Two posterior abdominal segments, dorsal view.

less than diameter of pit. Mandible (Fig. 2d) with 21 small teeth, their size slightly increasing proximad in series.

Thorax: Brown; mesonotum and scutellum dark brown, with abundant mixture of long bristly hairs and shorter, fine, somewhat flattened hairs. Legs bright yellow, tarsi and narrow apex of hindfemur brownish; knees, foretibia, and all of tarsi appearing shaggy due to abundant vestiture of broad, striated brown scales; tibiae with long extensor bristles, as long as 4× diameter of tibia on hindleg. Hindtibial spur yellowish, inconspicuous, length less than apical breadth of tibia; tarsomeres 1 and 2 with ventral row of palisade setae, prominent only on foreleg; some long, rather slender ventral spines apically and subapically on tarsomeres 1–4 on mid- and hindlegs, poorly developed on foreleg. Tarsal ratios 0.54 on foreleg, 0.49 on midleg, and 0.56 on hindleg. Claws slender and curved, empodium well developed. Wing (Fig. 2c) brownish, with abundant brownish long decumbent macrotrichia, more prominent along veins, a small yellowish spot formed by yellowish scales at end of costa; veins in radial field appearing much darker due to abundant flattened broad striated scales; costal ratio 0.44. Halter brownish.

Abdomen: Brown; covered with broad flattened brown scales, pleura appearing blackish due to prominent clumps of such scales; cerci yellowish. Spermathecae (Fig. 2e) 2, dark brown, ovoid, tapering gradually to slender opening to duct; subequal, each measuring 0.081 by 0.032 mm.

Male.—Wing length 1.39 mm; breadth 0.45 mm. Similar to female with usual sexual differences. General color as in female, but wing appearing slightly paler brown between veins due to sparser vestiture of longer narrower macrotrichia; abdomen yellow with segmental banding of brown integumental color plus abundant broad, flattened, dark brown, appressed scales. Antennal segments 12–15 with lengths in proportion of 42-45-50-50; 3rd palpal segment not as broadly swollen on proximal ½, palpal ratio 2.5; costal ratio 0.44; tarsal ratios 0.45 on foreleg, 0.53 on midleg, and 0.55 on hindleg.

Genitalia (Fig. 2g): Short and broad; dark brown, yellowish on proximal halves of basistyles, proximal halves of dististyles, and proximal portion of 9th segment; with abundant vestiture of long bristly yellowish hairs and broad, flattened, moderately long, striated, dark brown scales. Aedeagus shield-shaped as usual in the subgenus, slightly longer than basal breadth, without basal arch, tip with a slender, pointed process, and with a pair of faint, linear, submedian internal ribs. Parameres (Fig. 2f) with bases joined in a broad basal portion extending to ¼ of total length, the caudal processes rather stout and swordlike with pointed apices.

Pupa.—Length 2.7–2.8 mm. Color of exuviae pale yellowish. Respiratory horn (Fig. 2j) slender, with distinct petiole on proximal ½; apex rounded with 12–15 spiracular openings in a row at apex and down posterior side, the anterior margin of distal portion carinate and meeting proximal end of 1st spiracle as figured. Thoracic tubercles (Fig. 2i) elongated, stalklike, the anterior 2 pairs each bearing a short slender seta, the other 3 pairs bearing numerous spinules on distal halves. Abdomen without conspicuous lateral processes.

Larva.—Length 4–5 mm when mature. Color yellowish white; head capsule pale brownish, somewhat darker around oral margin; prominences at bases of body hairs not strongly pigmented. Hairs *p* and *q* of head (Fig. 2k) slightly bent forward, thickened and microscopically spiculose on distal halves. Body hairs *a–f* as in Figs. 2h and 2l–p. Last 2 body segments as in Fig. 2q, the *a* hair of last segment hastate and only slightly longer than those on preceding segments; anal blood gills short, bilobed. Cuticular armature absent. Prothoracic pseudopod cleft apically, each lobe with 7–8 slender black hooks; posterior pseudopod with a row of 16–20 brown hooks.

Distribution.—USA (California, Louisiana, Florida), Dominica, Belize, Costa Rica, Panama, Ecuador, Brazil.

Types.—Holotype ♂, Bakersfield, Kern Co., California, vii.1946, B. Brookmam (Type no. 60929, USNM). Allotype and 2 paratypes, Kern Co., California.

Specimens examined.—All from light traps unless otherwise noted. BELIZE: Hummingbird Hershey, viii.1981, A. M. Young, from cacao pods, 10 ♂, 9 ♀. BRAZIL: Bahia, Itabuna, iv.1971, J. Winder 1 ♂; same, 1973, reared from cacao pods, 1 ♂; from emergence traps, 6 ♂, 6 ♀. COSTA RICA: Heredia Prov., La Virgen, Finca La Tigra, 19.ix.1979, A. Young, ex banana stem, 4 larvae, 10 pupae. Limon Prov., Finca La Lola near Siquirres, ex banana stems, Young, ii.1981, 2 ♂, 4 ♀, 9 larvae, 8 pupae; viii.1981, 3 ♂, 3 ♀, 2 larvae, 4 pupae. DOMINICA: Clarke Hall, 28.i.1965, W. W. Wirth, reared from banana stem, 7 ♂, 1 ♀, 4 larvae, 4 pupal exuviae (specimens figured). ECUADOR: Pichilingue (INIAP), iv.1978, reared from rotting log, J. Mendoza no. 13, 8 ♂, 1 ♀. PANAMA: Canal Zone near Arraijan, monsoon forest, *Spondias* tree canopy, 23.vii.1979, E. Broadhead, 1 ♂. USA: *Florida:* Alachua Co., Gainesville, iv.1967, F. S. Blanton, 1 ♂; 18.xi.1969, F. W. Mead, 1 ♀. Collier Co., Collier Seminole St. Park, 17.v.1973, Wirth, 1 ♂, 4 ♀. Escambia Co., Molina, 12.viii.1969, Blanton, 2 ♂; Walnut Hill, vi.1969, Blanton, 1 ♂. Jackson Co., Florida Caverns St. Park, 26.v.1973, Wirth, 5 ♂. Jefferson Co., Monticello ix.1969, W. H. Whitcomb, 5 ♂, 4 ♀. Lee Co., Sanibel Island, 11.v.1973, Wirth, 1 ♂, 3 ♀. Leon Co., 3 mi. N. Tallahassee, v.1970, Blanton, 2 ♀. Liberty Co., Torreya St. Park, 15.v.1971, G. B. Fairchild, 1 ♂. Monroe Co., Big Pine Key, 10.iv.1970, Wirth, 13 ♂, 15 ♀. Orange Co., Lake Magnolia Park, 6.viii.1970, E. Irons, 1 ♀. Putnam Co., Lon's Lake, v.1971, Blanton, 3 ♂, 18 ♀. Sarasota Co., Myakka River St. Park, 21.v.1973, Wirth, 1 ♀. *Louisiana:* E. Baton Rouge Parish, Baton Rouge, University Campus, v.1947, Wirth, 1 ♀.

Forcipomyia (*Forcipomyia*) *youngi* Wirth, New Species

A brown species with banded abdomen and pale yellow legs; wing in both sexes dark brown with a small yellow spot at end of costa and a clump of yellow scales at base of costa; abdomen with segmental bands of broad striated blackish scales and pleura with additional mixture of golden scales; tibia with broad brown scales; halter pale.

Holotype female.—Wing length 1.48 mm; breadth 0.60 mm.

Head (Fig. 3i): Brown, with abundant blackish, long, bristly setae on vertex, clypeus, and first 2 antennal segments. Antenna (Fig. 3a) with segments 3–10 yellow, 11–15 pale brown; lengths of flagellar segments in proportion of 16-12-13-13-13-13-13-13-33-33-33-32-44; antennal ratio 1.50. Palpus (Fig. 3b) dark brown; lengths of segments in proportion of 10-14-30-14-13; 3rd segment swollen on proximal ⅔, bearing a deep sensory pit opening by a slightly smaller pore; palpal ratio 1.9. Mandible with 11 coarse teeth, the proximal teeth larger.

Thorax: Mesonotum, scutellum and postscutellum dark brown, pleuron yellowish with some pale brown areas; mesonotum with long bristly hairs and shorter finer setae; scutellum with numerous long bristly setae. Legs bright yellow, tarsi pale brownish; tibiae with vestiture of short, broad, appressed, striated brown scales; tarsi with similar scales more numerous but more slender, scales at narrow apices of tarsomeres golden; tibiae with numerous long yellowish extensor bristles, the longest on hindtibia as long as 5× diameter of tibia; hindtibial spur yellowish, slender, pointed, about as long as apical breadth of tibia. Tarsi with ventral palisade setae in one row, prominent and spinelike on tarsomeres 1 and 2 of foreleg, poorly developed on mid- and hindlegs; some stronger dark ventral spines scattered on tarsomeres 1 and 2 of mid- and hindlegs, apical only on tarsomeres 1 and 2 of foreleg and on tarsomeres 3 and 4 of all legs. Tarsal ratios 0.58 on foreleg, 0.52 on midleg, and 0.54 on hindleg. Wing (Fig. 3c) brown, darker anteriorly and along veins due to denser vestiture of long black macrotrichia; a small yellow spot at end of costa and a clump of yellow scales on costa at wing base; long, narrow, dark scales on costa and over radial field shaped as in Fig. 3g; costal ratio 0.48. Halter pale.

Abdomen: Dark brown, last 2 segments and cerci yellowish; densely covered dorsally and ventrally with moderately long and broad, flattened, striated, dark brown scales; pleura with similar scales but golden yellow in color; last tergum with long bristly yellow hairs. Spermathecae (Fig. 3h) 2, dark brown, elongate ovoid, tapering gradually to slender opening to duct; subequal, each measuring 0.104 by 0.054 mm.

Male allotype.—Wing length 1.44 mm; breadth 0.50 mm. Similar to female with usual sexual differences. General color as in female, but wing with costa yellowish and bearing yellow scales on proximal ½; abdomen yellow below and brown above, each tergum with a line of brown infuscation following the bases of the long bristly hairs across midlength of tergum. Antennal segments 12–15 with lengths in proportion of 63-48-40-47; 3rd palpal

Fig. 3. *Forcipomyia youngi*. a–d, g–i, Female. e–f, Male. j–n, r–t, Larva. o–q, Pupa. a, Antenna. b, Palpus. c, Wing. d, Mandible. e, Genitalia, parameres removed. f, Parameres. g, Scalelike macrotrichia from wing. h, Spermathecae. i, Head, anterior view. j–n, *a, b, d, c, e, f* hairs, respectively, of 2nd abdominal segment. o, Lateral processes of abdomen. p, Respiratory horn. q, Thoracic tubercles. r, Head, lateral view. s, Second abdominal segment, lateral view. t, Two posterior abdominal segments, dorsal view.

segment not as swollen as in female, palpal ratio 2.3. Costal ratio 0.45; tarsal ratios 0.57 on foreleg, 0.47 on midleg, and 0.56 on hindleg.

Genitalia (Fig. 3e): Slightly longer than broad; moderately brown infuscated except at bases of 9th segment, basistyles, and dististyles. Aedeagus almost hyaline, with rather narrow base, about 1.5× as long as basal breadth, tip with slender process. Parameres (Fig. 3f) poorly sclerotized, yellowish, basal portion fused for about ¼ of total length, the caudomedian emargination narrow and pointed, distal processes rather stout and sword-like with pointed apices.

Pupa.—Length 2.8–3.0 mm. Color pale brownish. Respiratory horn (Fig. 3p) short and globular, with short slender petiole; swollen distal portion with a row of 20–25 spiracular openings around apex and a slightly undulating row down posterior side of swollen portion. Thoracic tubercles (Fig. 3q) greatly elongated and slender, the anterior 2 pairs each bearing a long slender seta about as long as tubercle itself, the posterior 3 pairs with apices finely and densely spinulose. Each abdominal segment (Fig. 3o) with a pair of elongate lateral processes, each process with spiculose tip and a subapical seta.

Larva.—Length 5–6 mm when mature. Color yellowish white; head capsule (Fig. 3r) brown, becoming conspicuously blackish toward oral margin; conical prominences at bases of dorsal body hairs moderately brownish pigmented; *a* hairs connected across dorsum of each body segment by a conspicuous narrow line of blackish pigment. Hairs *p* and *q* of head (Fig. 3r) long and slender, pale, of uniform width to tip, and sparsely fringed with microscopic spinules. Body hairs *a, b,* and *e* hyaline, *c, d,* and *f* dark brown; hairs *b, c,* and *d* with fringe of short, coarse spinules as figured. Last 2 body segments as in Fig. 3t, the 4 *a* and *b* hairs on last segment arising from a common sclerotized plate, the *a* hairs long and slender, only slightly flattened and expanded, and bearing fringing spinules; anal blood gills comparatively slender, apparently undivided. Cuticular armature absent. Prothoracic pseudopod short and only slightly cleft, each lobe with 6–8 blackish hooks; posterior pseudopod with a row of 18–20 blackish hooks.

Distribution.—Costa Rica, Ecuador, Panama.

Types.—Holotype ♀, allotype ♂, Panama, Canal Zone, Gamboa, Pipeline Road, vii.1967, W. and M. Wirth, reared from rotting bracts of *Heliconia mariae* (Type no. 76583, USNM). Paratypes, 29 ♂, 28 ♀, 20 larvae, 24 pupae, as follows: COSTA RICA: Limon Prov., Finca La Lola, ii.1981, 7 ♂, 10 ♀, 6 larvae, 10 pupae; same, but viii.81, 3 ♂, 6 ♀, 3 larvae, 3 pupae; same, but 9–11.xi.1980, ex rotten cacao pods, 1 ♂. Siquirres, 29.v.1956, L. G. Saunders, reared from cacao pods and tree bark, 1 ♂, 2 ♀, 3 larvae; same but 6.vi.1956, reared from cacao pods, 5 ♂, 5 ♀, 3 larvae. Cartago Prov., Turrialba, CATIE, 24.vi.1980, A. Young, 1 ♂ and pupal exuviae.

Heredia Prov., La Virgen, Finca El Uno, 19.ix.1979, A. Young, ex banana stem, 1 larva, 6 pupae. ECUADOR: Quevado, Pichilingue, INIAP, iv.1978, J. Mendoza, reared from rotting vegetation, 8 ♂, 1 ♀. PANAMA: Same data as types, 3 ♂, 4 ♀, 4 larvae, 5 pupae.

Discussion.—This species is named for Dr. Allen Young, Milwaukee Public Museum, in appreciation of his interest and his studies on the biology of Costa Rican ceratopogonid cacao pollinators.

Forcipomyia youngi is easily recognized by its enlarged female mandibular teeth, and by the very broad, short, flattened, blackish scales on the tibiae. The larva has the head pale posteriorly and dark brown towards the mouth, and the pupa is distinguished by the elongate thoracic tubercles with long apical setae.

Because of its close external similarity with species of the *argenteola* Group, the following diagnosis and discussion are presented for *Forcipomyia squamitibia* Lutz.

Forcipomyia squamitibia Lutz

Forcipomyia squamitibia Lutz, 1914: 88 (♀; Brazil; fig. wing, leg); Macfie, 1939: 145 (♀ redescribed; Brazil; fig. antenna, palpus, tibial spine; radial cells, spermatheca); Macfie, 1949: 111 (♂ described; Mexico; fig. parameres).

Female (measurements from a female from Nova Teutonia, Brazil):—Wing length 1.30 mm; breadth 0.80 mm. A brown species with yellowish legs; antenna pale brown; last 2 abdominal segments and cerci yellowish. Wing dark brown, darker along anterior margin and along veins; a rather large yellow spot covering most of 2nd radial cell and slightly distad on anterior wing margin; costal ratio 0.44. Halter slightly infuscated. Antennal segments short and vasiform, antennal ratio 0.80. Palpus with 3rd segment moderately swollen on proximal ½, with a small deep sensory pit; palpal ratio 2.2. Mandibular teeth vestigial. Body, legs, and abdomen without broad flattened scales, long narrow scales on abdominal terga. Tibiae with slender, pointed hastate spines in extensor series. Tarsal ratios 1.05 on foreleg, 1.06 on midleg, and 1.08 on hindleg. Spermathecae 2, oval to ovoid, slightly tapering to short slender neck; slightly unequal, measuring 0.101 by 0.058 mm and 0.087 by 0.057 mm.

Male.—Similar to female with usual sexual differences. Tibiae without hastate spines. Wing yellowish, anterior margin with large yellow spot over tip of 2nd radial cell, preceded by a strip of dark brown scalelike macrotrichia over costal and radial veins and followed by a prominent quadrate patch of dark brown scales; a dark brown line along vein Cu_1. Abdomen with prominent brown segmental bands giving rise to long golden to brownish, bristly hairs; no broad flattened scales. Genitalia with 9th segment brown, basistyles and dististyles yellowish; aedeagus shield-shaped, slightly longer than basal breadth, caudal apex pointed; parameres a pair of long processes, rodlike at bases and tapering to filamentous tips, their bases fused only a short distance in a rather narrow common base (as figured by Macfie, 1949).

Distribution.—Brazil to Mexico.

Types.—An unspecified number of syntypes, Manguinhos, Brazil, Lutz collection, common at lights with other marine species (Inst. Oswaldo Cruz, Rio de Janeiro).

Specimens examined.—BRAZIL: Santa Catarina, Nova Teutonia, various dates 1961–1970, F. Plaumann, 40 ♂, 45 ♀ (USNM). COSTA RICA: Limon Prov., Finca La Lola near Siquirres, ii.1981, A. M. Young, reared ex banana stems, 2 ♂, 2 ♀, 2 larvae, 2 pupae; same but viii.1981, 1 pupa.

Discussion.—This species is set apart and readily distinguished from the other species discussed in this paper by the following characters: The yellow wing spot is much larger, covering the distal portion of the second radial cell; the female tibiae bear an extensor series of prominent pale brownish, slender, pointed, hastate spines; the hindtarsal ratio is 1.0 or slightly more; and the male parameres are much more slender, filiform distally, and have their common base much narrower and fused only a short distance.

The immature stages of the series from Costa Rica will be described later in a paper dealing with other groups of *Forcipomyia (Forcipomyia).*

LITERATURE CITED

Bystrak, P. G. and W. W. Wirth. 1978. The North American species of *Forcipomyia*, subgenus *Euprojoannisia* (Diptera: Ceratopogonidae). U.S. Dep. Agric. Tech. Bull. 1591, 51 pp.

Chan, K. L. and E. J. LeRoux. 1965. Description of *Forcipomyia (Neoforcipomyia)* sp. n. and redescription of *Forcipomyia (Neoforcipomyia) eques* (Johannsen) (Diptera: Ceratopogonidae), with an account of the digestive and reproductive systems. Phytoprotection 46: 74–104.

Lane, J. 1947. A biologia e taxonomia de algunas espécies dos grupos *Forcipomyia e Culicoides* (Diptera, Ceratopogonidae) (Heleidae). Arq. Fac. Hig. Saude Publica Univ. São Paulo 1: 159–170.

Lutz, A. 1914. Contribuição para o conhecimento das Ceratopogoninas do Brazil. Terceira memoria. Aditamento terceiro e descrição de espécies que não sugam sangue. Mem. Inst. Oswaldo Cruz, Rio de J. 6: 81–99, 2 plates.

Macfie, J. W. S. 1939. A report on a collection of Brazilian Ceratopogonidae (Dipt.). Rev. Entomol. 10: 137–219.

———. 1949. Notes on Ceratopogonidae. Proc. R. Entomol. Soc. Lond. (B) 18: 109–115.

Saunders, L. G. 1924. On the life history and the anatomy of the early stages of *Forcipomyia* (Diptera, Nemat., Ceratopogoninae). Parasitology 16: 164–213, 3 pls.

———. 1956. Revision of the genus *Forcipomyia* based on characters of all stages (Diptera, Ceratopogonidae). Can. J. Zool. 34: 657–705.

———. 1959. Methods for studying *Forcipomyia* midges, with special reference to cacao-pollinating species (Diptera, Ceratopogonidae). Can. J. Zool. 37: 33–51.

Soria, S. J. de and P. G. Bystrak. 1975. A new species of *Forcipomyia* (Diptera, Ceratopogonidae) described in all stages, with an account of its role as a cacao pollinator. Rev. Theobroma 5(2): 3–11.

Wirth, W. W. 1952. The Heleidae of California. Univ. Calif. Publ. Entomol. 9: 95–266.

———. 1976. *Forcipomyia pictoni* Macfie and descriptions of two new related species from Florida (Diptera: Ceratopogonidae). Fla. Entomol. 59: 77–84.

Wirth, W. W. and S. J. de Soria. 1975. A new Neotropical *Forcipomyia* midge closely related to *F. (F.) genualis* (Loew) (Diptera: Ceratopogonidae). Rev. Theobroma 5(2): 19–27.

———. 1980(1979). Studies on the genus *Forcipomyia* VI. The Neotropical species of the subgenus *Warmkea* (Diptera: Ceratopogonidae). Rev. Theobroma 9: 137–161.

PROC. ENTOMOL. SOC. WASH.
84(3), 1982, pp. 586–593

ANTENNAL SENSILLA AND SETAE OF *ANOPLIUS TENEBROSUS* (CRESSON) (HYMENOPTERA: POMPILIDAE)

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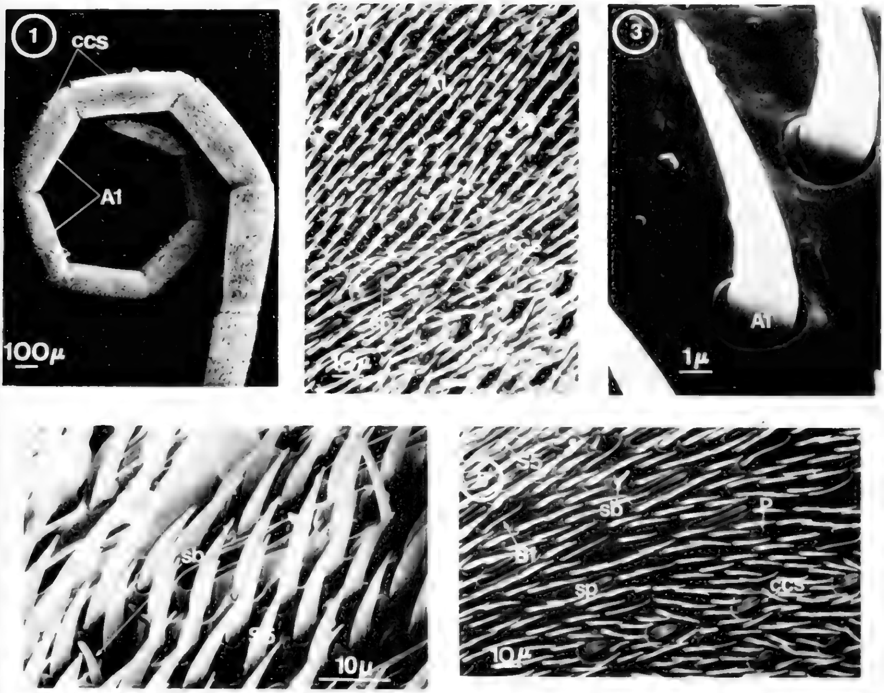
Abstract.—The antennal sensilla and setae of both sexes of *Anoplius tenebrosus* (Cresson) (Pompilidae) were examined with a scanning electron microscope. Sensilla placodea, corrugated conical sensilla, pit organs, sensilla campaniformia, sensilla trichodea A1, B1, C1, sensilla basiconica, and several types of setae were found, and are described and illustrated. The sensilla are rather similar in both sexes, except that females have numerous corrugated conical sensilla which males lack. Sensilla trichodea C1 are found only in the males. While most of the setae are similar in the two sexes, the shape and sculpturing of some distinguish males from females.

Scanning electron microscopy studies of Hymenoptera to date have primarily involved parasitoids, ants, social wasps, and bees. No such studies have been reported for the Pompilidae, or spider wasps. In the following examination of *Anoplius tenebrosus* antennae, the external morphology of various sensilla are illustrated and described. Morphological similarities of *A. tenebrosus* sensilla to those of other Hymenoptera are noted, and the possibilities of functional analogies are discussed.

MATERIALS AND METHODS

Air dried antennae of male and female *A. tenebrosus* were mounted on specimen studs with silver conducting paint. Specimens were coated *in vacuo* with a gold/palladium mixture. The microscope used was an ETEC autoscan, model R1, at accelerating voltages of 10–20 KV.

The nomenclature follows that of Ågren (1977), who combined the classifications of Lacher (1964) and Esslen and Kaissling (1976), except for the corrugated conical sensillum and sensilla trichodea designated A1, B1, C1 for Pompilidae. Flagellar segments are designated fl.1, 2, etc. from proximal to distal.



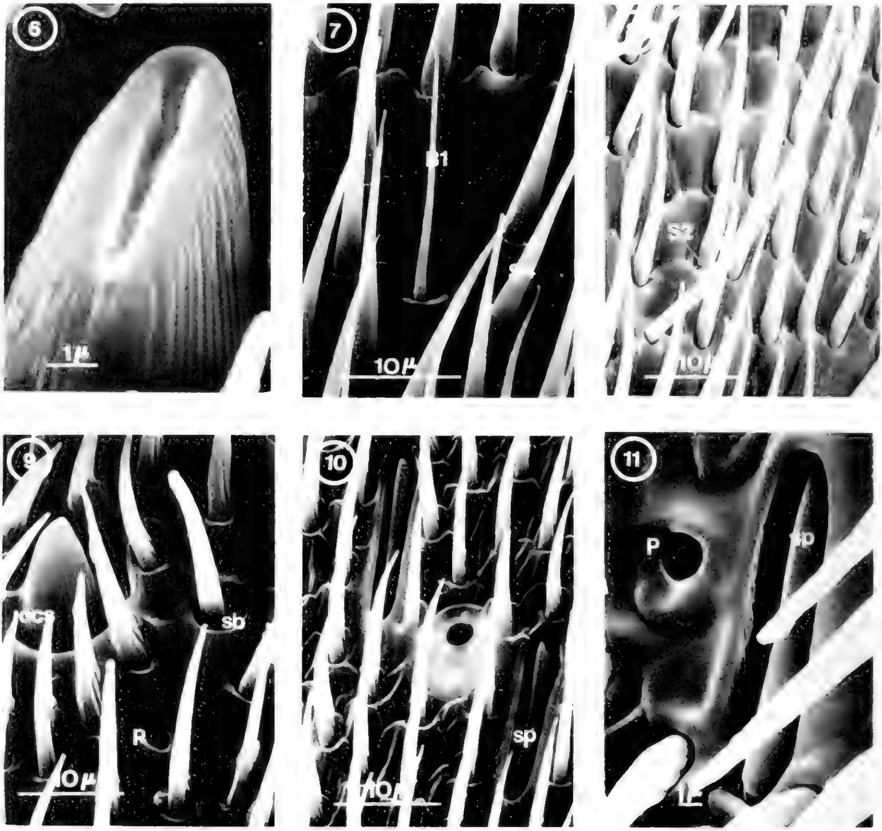
Figs. 1–5. *Anoplius tenebrosus*, female antenna. 1, Underside of antenna showing patches of sensilla trichodea; numerous openings on outer edge of antenna are corrugated conical sensilla. 2, Enlargement of flagellar segment 5. 3, Sensilla trichodea, flagellar segment 10. 4, Enlargement of flagellar segment 4. 5, Enlargement of flagellar segment 7. A1 = sensilla trichodea; B1 = slender sensilla trichodea; ccs = corrugated conical sensilla; P = pit organ; sb = sensilla basiconica; sp = sensilla placodea; S5 = sabre-shaped seta.

RESULTS

Specimens of Pompilidae have filiform antennae. Females of *A. tenebrosus* have 12 segments, males 13 including the scape and pedicel. The sensilla and setae are as follows:

Sensilla placodea (Figs. 2, 5, 10, 11, 16, 17, 20).—These elongate sensilla are found on fl.2–11 in males and are distributed around the entire flagellum. In females they are found on fl.1–10 and are dispersed in an area encompassing slightly more than half of each flagellum. Females possess a region of corrugated conical sensilla in which s. placodea are not found. Sensilla placodea consist of pits averaging 3.5 × 18.4 μ (females), 3.7 × 18.3 μ (males) which contain elongate sensilla.

Corrugated conical sensilla (Figs. 1, 2, 5, 6, 9).—These sensilla are found only in females on fl.1–10. They are one of the more numerous types of

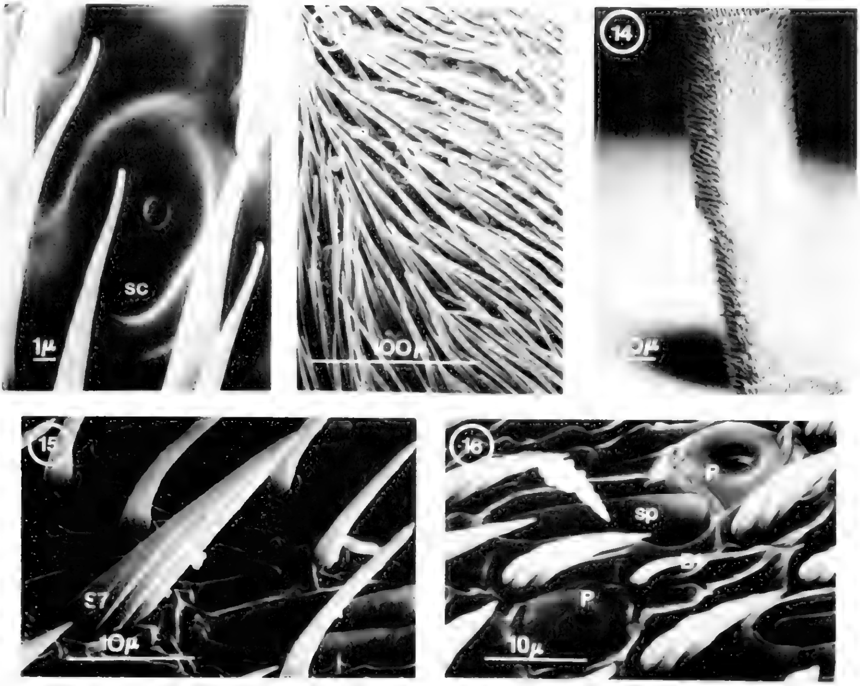


Figs. 6–11. *Anoplius tenebrosus*, female antenna. 6, Corrugated conical sensilla, flagellar segment 2. 7, Enlargement of flagellar segment 1. 8, Long setae on scape. 9, Enlargement of flagellar segment 2. 10, Enlargement of flagellar segment 6. 11, Enlargement of flagellar segment 2. B1 = sensilla trichodea; ccs = corrugated conical sensilla; P = pit organ (Fig. 9, probably s. ampullacea; Fig. 10, probably s. coeloconica); sb = sensilla basiconica; sp = sensilla placodea; S2 = long seta; S4 = seta.

sensilla *A. tenebrosus* females possess (see Fig. 1). The oval pit surrounding the sensillum is approximately 7.6 × 9.6 μ and contains a conical shaped peg which is corrugated and has the apex recessed.

Pit organs (Figs. 5, 9–11, 16, 18, 21).—Pit organ openings of *A. tenebrosus* range from 1.1 to 5.7 μ. Some pit organs contain pegs that are not exposed above the rim around the opening.

Sensilla campaniformia (Figs. 12, 20).—Sensilla campaniformia are found on fl.1, 3–6, and 9 in males and 1–10 in females. They consist of a slightly



Figs. 12–16. *Anoplius tenebrosus*, antenna. 12–13, Female. 14–16, Male. 12, Enlargement of flagellar segment 1. 13, Enlargement of scape, 14, Flagellar segments 5–8 showing differential setae on underside of antenna (arrow); region composed of stout setae, sensilla trichodea, and sensilla placodea. 15, Enlargement of flagellar segment 7. 16, Enlargement of flagellar segment 2. A1 = sensilla trichodea; B1 = sensilla trichodea; P = pit organs; sc = sensilla campaniformia; sp = sensilla placodea; S1 = smooth setae; S7 = stout setae.

depressed oval region ca. 6.3 × 9.6 μ (females) and 5.5 × 6.9 μ (males) with a centrally located node.

Sensilla trichodea A1 (Figs. 1–3, 15, 17).—These receptors are found on the undersides of fl. 1–10 in females and 1–11 in males. They occur in patches in females; in males they are more numerous but are not found in patches. This sensillum is smooth, sabre-shaped and appears to have a terminal papilla.

Sensilla trichodea B1 (Figs. 5, 7, 16).—Sensilla trichodea B1 are found on all flagellar segments and pedicels of both males and females. They are slender structures that lay close and nearly parallel to the cuticle.

Sensilla trichodea C1 (Figs. 17, 19).—These sensilla are found mainly on the undersides of fl. 1–11 in males. They are deeply ridged and are nearly perpendicular to the flagellar segment.

Sensilla basiconica (Figs. 4, 5, 9, 18).—These receptors are found in both sexes on all flagella. They have blunt tips, are found in pits and are relatively common (see Fig. 5). They are ridged but not nearly as much as s. trichodea C1. There are two sizes of this sensillum (see Fig. 4).

Setae S1–S7 (Figs. 4, 5, 7, 8, 13, 15, 17, 18, 21, 22).—These appear to be modifications of one basic type and the sculpturing and thickness vary considerably from smooth on the scape (S1) to stout with deep sculpturing (S7, males only) on the flagellum.

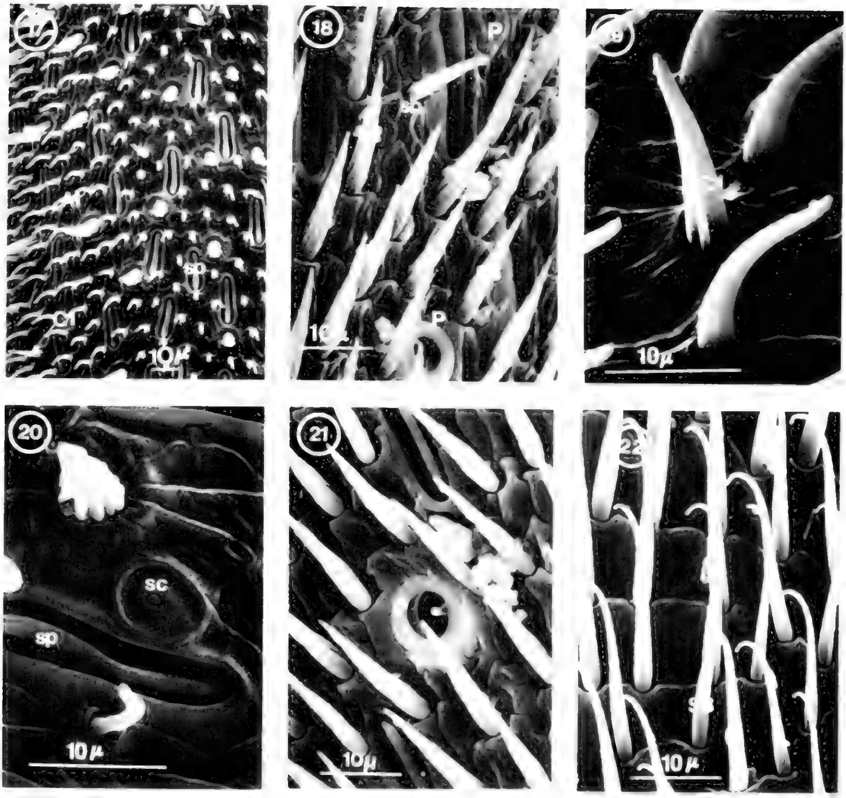
Discussion

Although the functions of the various sensilla in Pompilidae and other morphologically related Hymenoptera are mostly unknown, structural similarities imply physiological similarities. Sensilla placodea of *A. tenebrosus* are similar to those found in the Vespidae (Spradbery, 1973; Callahan, 1975), Braconidae (Norton and Vinson, 1974a, 1974b; Borden et al., 1978b), and Ichneumonidae (Borden et al., 1973, 1978a; Norton and Vinson, 1974b). Oval s. placodea of *Apis mellifera* L. have been shown to be odor receptors (Lacher and Schneider, 1963 [cited by Ågren, 1977]). Slifer (1970) suggested that the s. placodea of *Nasonia vitripennis* (Walker) (Pteromalidae) have an olfactory function. Richerson et al. (1972) and Richerson and Borden (1972) postulated that the s. placodea of *Coeloides brunneri* Viereck (Braconidae) function in host finding by detection of metabolic heat produced by a host beetle larva beneath bark.

Corrugated conical sensilla are found only in females of *A. tenebrosus*. The apex of this sensillum was found to be recessed in air dried specimens. Spradbery (1973) called similar structures on Vespidae, s. campaniformia; however, it seems unlikely that so many s. campaniformia would be found on the antenna. Callahan (1975) named a similar sensillum of *Polistes metricus* Say (Vespidae) a corrugated pyramidal sensillum, and his nomenclature has been modified for the conical shaped peg of *A. tenebrosus*. Kaissling (personal communication) stated that this receptor is reminiscent of a taste bristle, s. chaeticum. Ulla Klein, working in Kaissling's laboratory, found similar structures to be taste bristles in crickets.

Pit organs are thought to function as CO_2, temperature, and/or humidity receptors in *A. mellifera* (Lacher, 1964 [cited by Ågren, 1977]). In *A. tenebrosus* they may function similarly. These organs can be separated into s. ampullacea or s. coeloconica by the structure of the sensory peg within the pit (Dietz and Humphreys, 1971). Scanning electron microscopy of *A. tenebrosus* antennae does not reveal enough of the peg to differentiate between these organs.

Sensilla campaniformia are probably mechanoreceptors in *A. mellifera* (Esslen and Kaissling, 1976 [cited by Ågren, 1977]). Dietz and Humphreys



Figs. 17–22. *Anoplius tenebrosus*, male antenna. 17, Enlargement of flagellar segment 2. 18, Enlargement of flagellar segment 8. 19, Enlargement of flagellar segment 3. 20, Enlargement of flagellar segment 9. 21, Enlargement of flagellar segment 9. 22, Enlargement of pedicel. A1 = sensilla trichodea; C1 = sensilla trichodea; P = pit organ (probably sensilla coeloconica in Fig. 21); sb = sensilla basiconica; sc = sensilla campaniformia; sp = sensilla placodea; S3 = seta; S6 = seta; S7 = stout seta.

(1971) suggested that mechanical depression of the node of s. campaniformia in *A. mellifera* may result in a neural response but added that the numerous hairs on the antennae would probably prevent that mode of stimulation from taking place. S. campaniformia have been found in several species of bees, but not in all wasps.

Sensilla trichodea A1 of *A. tenebrosus* bear resemblance to the small trichoid of *Cheiloneurus noxius* Compere (Encyrtidae) (Weseloh, 1972), curved non-fluted sensilla of *Cardiochiles nigriceps* Viereck (Braconidae) (Norton and Vinson, 1974a), s. chaetica$_1$ in *A. mellifera* (which also has a terminal papilla) (Whitehead and Larsen, 1976), and the s. trichodea A of

Colletidae (Ågren, 1977) and Andrenidae (Ågren, 1978). The morphology of a similar sensillum studied by Slifer and Sekhon (1961) in *A. mellifera* indicated an olfactory function.

Sensilla trichodea B1 of *A. tenebrosus* resemble the s. trichodea B2 of *A. mellifera* (Esslen and Kaissling, 1976 [cited by Ågren, 1977]) and the s. trichodea B of Colletidae (Ågren, 1977) and Andrenidae (Ågren, 1978). Lacher (1964 [cited by Ågren, 1977]) indicated they are responsive to mechanical stimuli in *A. mellifera*.

Sensilla trichodea C1 of *A. tenebrosus* look like the fluted basiconic sensilla of *Cardiochiles nigriceps* (Norton and Vinson, 1974a). However, the tip is more pointed and the sculpturing more pronounced. Norton and Vinson (1974b) suggested that the fluted basiconic sensilla of three parasitoid species are contact receptors.

Sensilla basiconica are known to be olfactory receptors in many insects (Schneider and Steinbrecht, 1968), although attempts to determine a function for these sensilla in *A. mellifera* have been unsuccessful.

The nomenclature applied to various hymenopteran sensilla is unstable at the present time. Borden et al. (1973) described a "new" sensillum (truncate cuticular peg) on *Itoplectis conquisitor* (Say) (Ichneumonidae) which resembles the small basiconicum b of *Cheiloneurus noxius* (Weseloh, 1972). The small, subterminal basiconicum of *C. noxius* may be homologous to the basiconic capitate peg of *Nasonia vitripennis* (Miller, 1972). Other similarities among sensilla of various groups have been discussed. Only from knowledge of the neuro- and electrophysiology of each sensillum will this instability be resolved.

ACKNOWLEDGMENTS

We thank G. N. Lanier and R. A. Norton, SUNY College of Environmental Science and Forestry, for reviewing the manuscript; and H. E. Evans, Colorado State University, for identifying *Anoplius tenebrosus*. W. A. Coté and A. C. Day instructed in the use of the scanning electron microscope. Karl-Ernst Kaissling, Max Planck Institut für Verhaltenphysiologie, J. H. Borden, Simon Fraser University, and P. S. Callahan, USDA, Gainesville, Florida, aided in identifying sensilla.

LITERATURE CITED

Ågren, L. 1977. Flagellar sensilla of some Colletidae (Hymenoptera: Apoidea). Int. J. Insect Morphol. Embryol. 6: 137–146.

———. 1978. Flagellar sensilla of two species of *Andrena* (Hymenoptera: Andrenidae). Int. J. Insect Morphol. Embryol. 7: 73–79.

Borden, J. H., G. E. Miller, and J. V. Richerson. 1973. A possible new sensillum on the antennae of *Itoplectis conquisitor* (Hymenoptera: Ichneumonidae). Can. Entomol. 105: 1363–1367.

Borden, J. H., L. Chong, and A. Rose. 1978a. Morphology of the elongate placoid sensillum on the antennae of *Itoplectis conquisitor*. Ann. Entomol. Soc. Am. 71: 223–227.

Borden, J. H., A. Rose, and R. J. Chorney. 1978b. Morphology of the elongate sensillum placodeum on the antennae of *Aphidius smithi* (Hymenoptera: Aphidiidae). Can. J. Zool. 56: 519–525.

Callahan, P. S. 1975. Insect antennae with special reference to the mechanism of scent detection and the evolution of sensilla. Int. J. Insect Morph. Embryol. 4: 381–430.

Dietz, A. and W. J. Humphreys. 1971. Scanning electron microscopic studies of antennal receptors of the worker honey bee, including sensilla campaniformia. Ann. Entomol. Soc. Am. 64: 919–925.

Esslen, J. and K.–E. Kaissling. 1976. Zahl und verteilung antennaler sensillen bei der honigbiene (*Apis mellifera* L.). Zoomorphologie (n.s.) 83: 227–251.

Lacher, V. 1964. Elektrophysiologische unterschungen an einzelnen rezeptoren für geruch, kohlendioxyd, luftfeuchtigkeit und temperatur auf den antennen der arbeitsbiene und der drohne (*Apis mellifica* L.). Z. VGl. Physiol. (n.s.) 48: 587–623.

Lacher, V. and D. Schneider. 1963. Elektrophysiologischer nachweis der riechfunktion von porenplatten (sensilla placodea) auf den antennen der drohne und der arbeitsbiene (*Apis mellifica* L.). Z. VGl. Physiol. (n.s.) 47: 274–278.

Miller, M. C. 1972. Scanning electron microscopic studies of the flagellar sense receptors of *Peridesmia discus* and *Nasonia vitripennis* (Hymenoptera: Pteromalidae). Ann. Entomol. Soc. Am. 65: 1119–1124.

Norton, W. N. and S. B. Vinson. 1974a. A comparative ultrastructural and behavioral study of the antennal sensory sensilla of the parasitoid *Cardiochiles nigriceps* (Hymenoptera: Braconidae). J. Morphol. 142: 329–350.

———. 1974b. Antennal sensilla of three parasitic Hymenoptera. Int. J. Insect Morphol. Embryol. 3: 305–316.

Richerson, J. V. and J. H. Borden. 1972. Host finding by heat perception in *Coeloides brunneri* (Hymenoptera: Braconidae). Can. Entomol. 104: 1877–1881.

Richerson, J. V., J. H. Borden, and J. Hollingdale. 1972. Morphology of a unique sensillum placodeum on the antennae of *Coeloides brunneri* (Hymenoptera: Braconidae). Can. J. Zool. 50: 909–913.

Schneider, D. and R. A. Steinbrecht. 1968. Checklist of insect olfactory sensilla. Symp. Zool. Soc. Lond. No. 23, pp. 279–297.

Slifer, E. H. 1970. The structure of arthropod chemoreceptors. Annu. Rev. Entomol. 15: 121–142.

Slifer, E. H. and S. S. Sekhon. 1961. Fine structure of the sense organs on the antennal flagellum of the honeybee, *Apis mellifera* L. J. Morphol. 109: 351–381.

Spradbery, J. P. 1973. Wasps—an account of the biology and natural history of solitary and social wasps. Sidgwick and Jackson, London. 408 pp.

Weseloh, R. M. 1972. Sense organs of the hyperparasite *Cheiloneurus noxius* (Hymenoptera: Encyrtidae) important in host selection processes. Ann. Entomol. Soc. Am. 65: 41–46.

Whitehead, A. T. and J. L. Larsen. 1976. Ultrastructure of the contact chemoreceptors of *Apis mellifera* L. (Hymenoptera: Apidae). Int. J. Insect Morphol. Embryol. 5: 301–315.

PROC. ENTOMOL. SOC. WASH.
84(3), 1982, pp. 594–602

NOTES ON *GRETCHENA*: A NEW SPECIES AND THE SYNONYMY OF *GWENDOLINA* (LEPIDOPTERA: TORTRICIDAE)

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Abstract.—Morphological characteristics of *Gretchena* are discussed and compared with those of the related *Pseudexentera*. *Gretchena* **obsoletana,** a new species occurring in California, is described and compared with *Epinotia biangulana* (Walsingham), with which it has previously been confused. *Gwendolina* is synonymized with *Gretchena*.

Gretchena was described by Heinrich (1923) to include eight species of Nearctic Eucosmini that were characterized chiefly by distinctive male genitalia. References to *Gretchena* have been scant since 1923 but include the description of an additional species by McDunnough (1925) and the occasional mention of the pecan bud moth, *G. bolliana* (Slingerland) (Payne et al., 1979). The larvae of *G. bolliana* and *G. dulciana* Heinrich have been described by MacKay (1959). Tedders and Osburn (1970) have described the morphology of the female reproductive system of *G. bolliana*.

Adults of *Gretchena* have a gray to grayish-brown ground color. In most species, the basal patch is distinct and is usually more distinct on the inner margin than on the costa of the forewing. Median and apical streaks are present on the forewing of most species and are often confluent with each other. *Gretchena* and the related *Pseudexentera* Heinrich are superficially similar; some species are often mixed in collections. Heinrich distinguished *Gretchena* from the latter by the presence of raised scales on the forewing and by characters of the genitalia. As the raised scales are often difficult to detect, characters of the genitalia should be used to separate the two genera.

In males of *Gretchena*, the uncus is absent; the elongately triangular socii are separate and are joined with the tegumen dorsally; the aedeagus is long and is supported by a long caulis of the juxta; and the cucullus of the valva has a projecting anal area with developed anal and ventral marginal spines. In *Pseudexentera*, the males have socii that are fused basally and anal and ventral marginal spines of the valvae are absent. The valvae are more setose

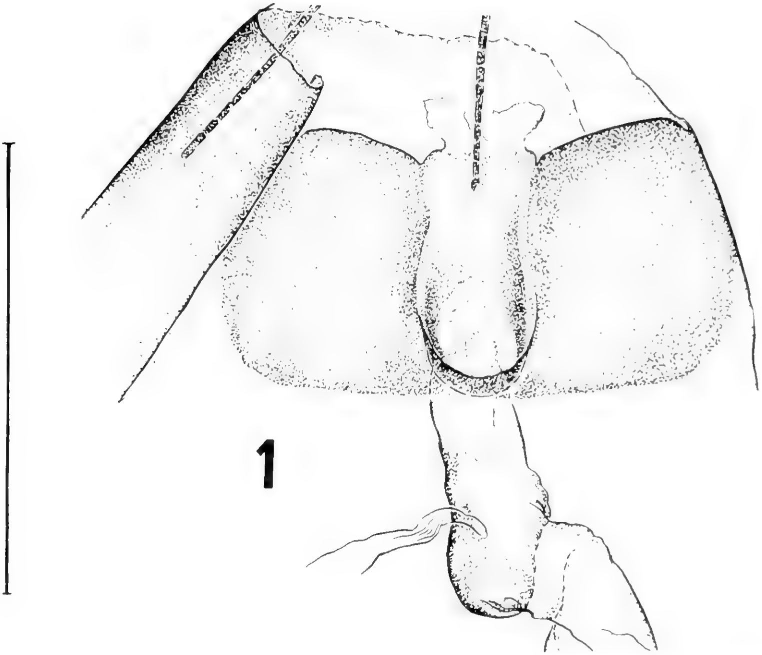

Fig. 1. *Pseudexentera spoliana*, ♀, 7th sternum and lamella postvaginalis; Ithaca, N.Y.; R. L. Brown genitalia slide 252. Scale line = 1 mm.

in *Pseudexentera* than in *Gretchena*. Male genitalia of the two genera have been figured by Heinrich (1923).

The females of *Gretchena* have a seventh sternum that is not emarginate around the ostium bursa; the posterior margin of the sternum is inflected greatly; the lamella postvaginalis is reduced; the ductus bursa has a long, sclerotized band; and the globular corpus bursa has two signa. The females of *Pseudexentera* are distinct from *Gretchena* in having a seventh sternum that is deeply emarginate around the ostium and a well-developed lamella postvaginalis (Fig. 1). Females of these two genera can be separated easily, without dissections, by the scale patterns on the seventh sternum that indicate the presence or absence of an emargination.

Of the eight species included by Heinrich in *Gretchena*, seven occur in eastern United States and one occurs in California. The California species was misidentified by Heinrich as *Steganoptycha biangulana* Walsingham. Examinations of type-specimens of Eucosmini in the British Museum (Natural History) have revealed that Walsingham's species, described from Oregon, is a polymorphic species belonging to *Epinotia* Hübner. Although

Fig. 2. *Gretchena obsoletana*, paratype ♂; Mt. Washington District, Los Angeles, Calif.; approximately 4× natural size.

Heinrich figured the California *Gretchena* species and differentiated it from related species, the following description is given to make a name available.

Gretchena obsoletana **Brown, New Species**

Figs. 2–4

Description.—*Head:* Frons and labial palpus dark grayish brown, vertex dark grayish brown, tips of scales white.

Thorax: Mesonotum dark grayish brown to brown, tegula dark grayish brown basally, grayish brown to brown apically.

Forewing (Fig. 2): 8.5–9.0 mm long; ♂ costal fold absent; termen weakly convex; ground color grayish brown, most scales with white tips; basal patch dark grayish brown, basal inner margin suffused with light grayish brown in some specimens; median fascia weakly defined in some specimens, dark grayish brown; outer marginal scales unicolorous with or slightly darker than ground color.

Hindwing and abdomen: Light grayish brown, without contrasting colors dorsally or ventrally.

Male genitalia (Fig. 3): Tegumen narrow, expanded below socii; socius with dorsal margin irregularly serrate, apex directed dorsally, setose from near base to apex; gnathos arising from ventral bases of socii, lightly sclerotized; caulis without lateral flanges; anellus not closely surrounding aedeagus ventrally; aedeagus with 20–22 cornuti; cucullus with 1–5 ventral marginal spines. Six preparations examined.

Female genitalia (Fig. 4): Sternum VII with posterior margin inflected inward, posterior lateral areas sclerotized, not in same plane as posterior median area. Tergum VIII without lateral extensions, without scales or se-

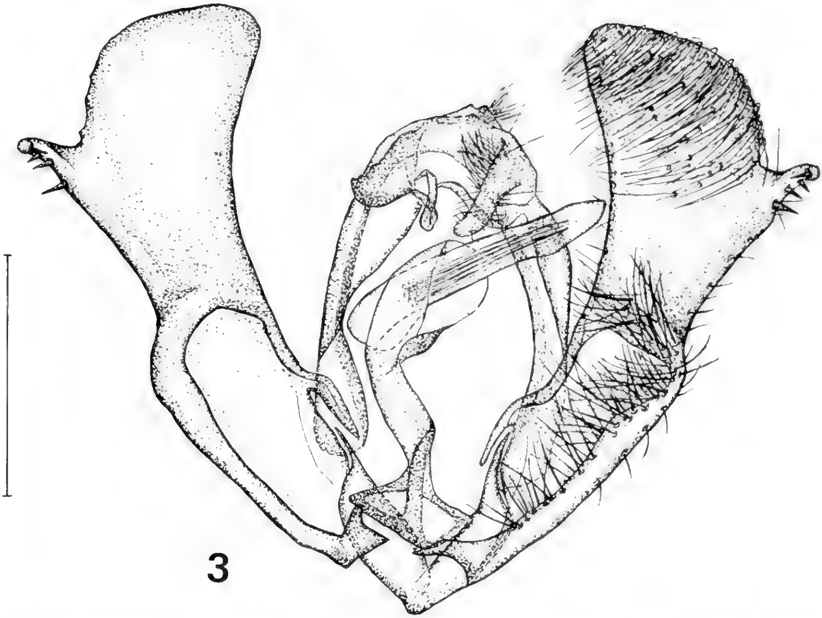

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Fig. 3. *Gretchena obsoletana*, paratype, ♂ genitalia; Los Angeles, Calif.; USNM genitalia slide 17785. Scale line = 0.5 mm.

tae. Papillae anales with shallow, posterior cleft, setae moderately sparse, numbering less than 7 across middle of one ventral face; sterigma forming ringlike antrum cephalad to posterior margin of sternum VII; poststerigmal membrane covered with small papillae between ostium and papillae anales; inception of ductus seminalis cephalad to sclerotized band of ductus bursae; signa subequal in size, equidistant from neck. Three preparations examined.

Holotype.—♀, Los Angeles, California, L. A. Co., elev. 840 ft., Mt. Washington Dist., III-30-1976; at light, J. Powell, Collector; genitalia slide 970, R. L. Brown; in California Academy of Sciences, San Francisco, on indefinite loan from University of California, Berkeley.

Paratypes.—California: Same data as holotype, 6 ♂, JAP genitalia 4083, in University of California, Berkeley; same data as holotype, 1 ♂, R. L. Brown genitalia slide 969, R. L. Brown photo 157, in R. L. Brown Collection; Ventura Co., N end of Casitas Res., III-16-67, Collectors P. A. Opler, J. Powell, 1 ♂, JAP genitalia 2225, in University of California, Berkeley; 1 ♀, in R. L. Brown Collection; Saticoy, 3-6-17, S. E. Flanders, Collector, 1 ♂, AB genitalia slide Mar. 20, 1927, in the National Museum of Natural History, Smithsonian Institution. The following 7 specimens are labeled as collected by Coquillett in California and probably represent one lot; all have

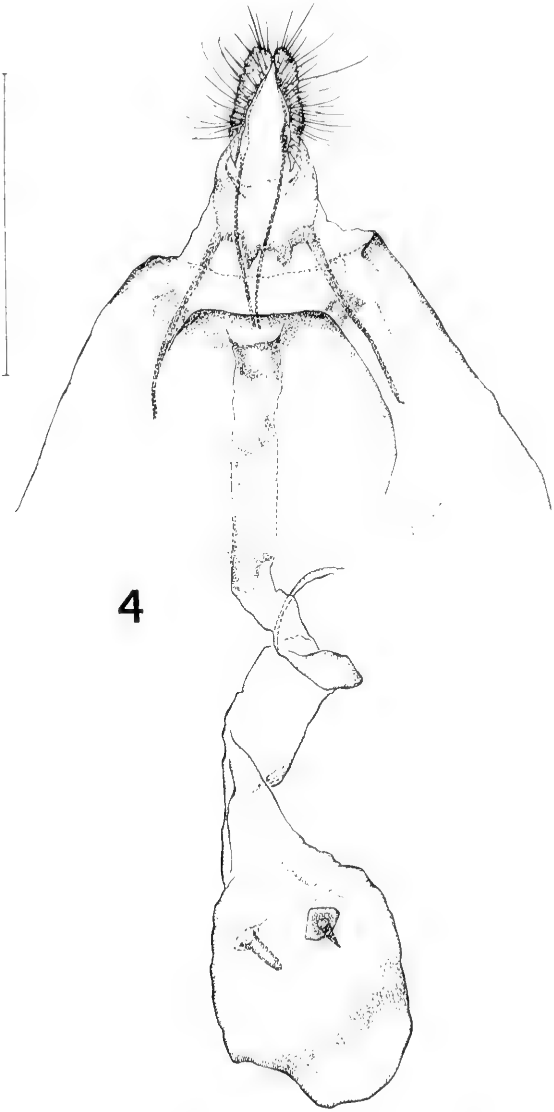

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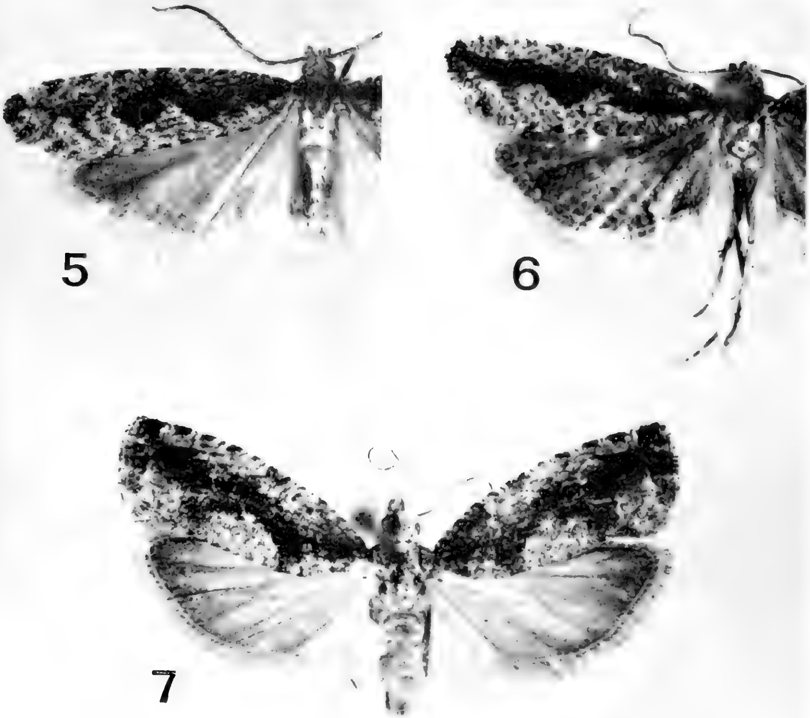
Fig. 4. *Gretchena obsoletana*, paratype, ♀ genitalia, unmated; Los Angeles, Calif.; USNM genitalia slide 17783. Scale line = 1 mm.



Figs. 5–7. Imagos, approximately 4× natural size. 5, *Epinotia biangulana*, ♂; Siskiyou Co., Calif. 6, *E. biangulana*, ♂; Marin Co., Calif. 7, *Gretchena concitatricana*, ♀; Cave Creek Canyon, Chiricahua Mountains, Ariz.

"62" on the first label, with 2 specimens also bearing "164" on a second label. Three specimens are labeled "Los Angeles"; 3 other specimens labeled "through C. V. Riley 1888": 3 ♂ (one without abdomen), USNM genitalia slide 17785, CH genitalia slide 19 Nov. 1917; 3 ♀, USNM genitalia slides 17783, 17784, CH genitalia slide 21 Feb. 1940, #7, in the National Museum of Natural History, Smithsonian Institution; 1 ♂, in University of California, Berkeley. [Two pupal exuviae are included with this series, labeled—"62, Cal., Coquillett, Collector, through C. V. Riley 1888".]

Remarks.—*Gretchena obsoletana* can be separated from other species in the genus by the uniform, grayish-brown color of the apical half of the forewing, lacking median and apical streaks. This species can be superficially distinguished from *Epinotia biangulana*, also occurring in California,

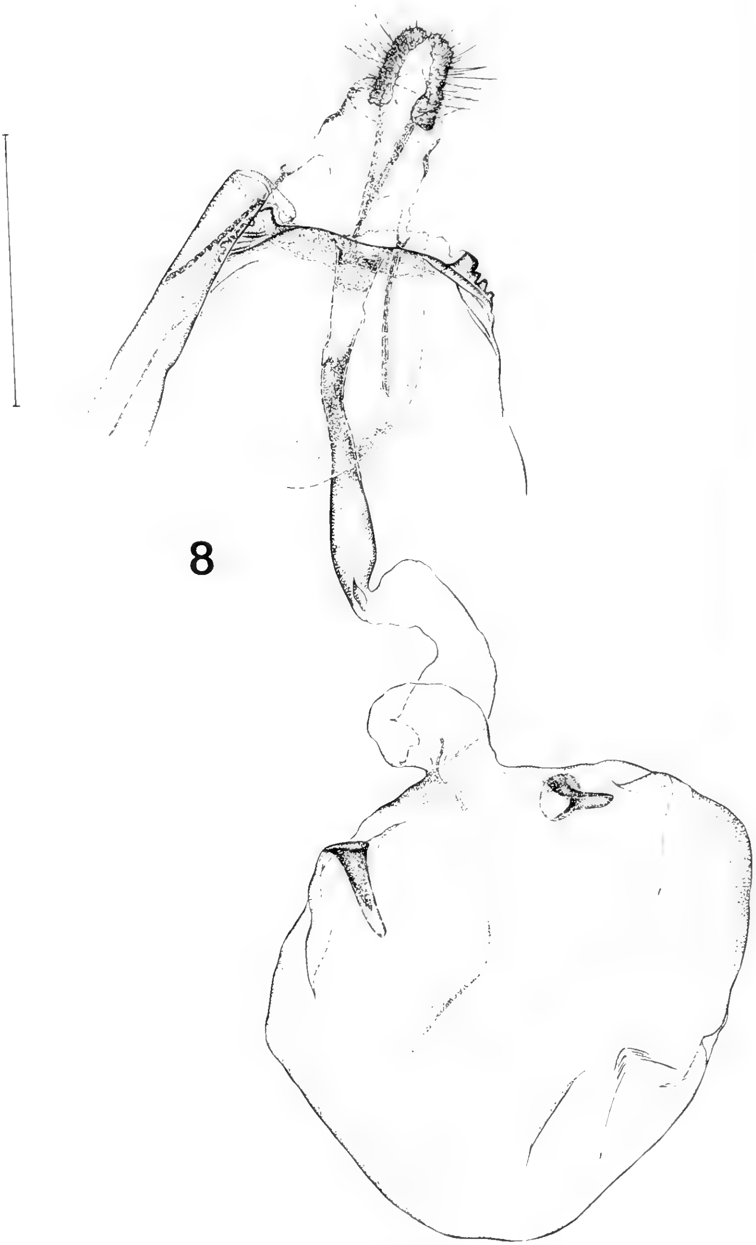


Fig. 8. *Gretchena concitatricana*, ♀ genitalia, mated; Madera Canyon, Santa Rita Mountains, Ariz.; USNM genitalia slide 17785. Scale line = 1 mm.

by the shape of the forewing termen, slightly convex in *G. obseletana* and emarginate in *E. biangulana*. The latter species also has hindwings that are mottled rather than being uniform in coloration (Figs. 5, 6).

Gretchena Heinrich

Gwendolina Heinrich, 1923. **New Synonymy.**

Gwendolina was described by Heinrich (1923) to include a single species, *concitatricana* Heinrich (Fig. 7). Heinrich distinguished this species from *Gretchena* by wing venation, male genitalia, and secondary sexual characters. According to his description, the hindwing has veins M_3 and Cu_1 connate or very short stalked; the male genitalia (figured by Heinrich) are similar to *Gretchena* except that the socii are not strongly chitinized nor elongately triangular but are as broad as long and almost circular; the male has a forewing costal fold and heavy black sex scaling on the upper surface of the abdomen, on the upper surface of the inner margin of the hindwing, and along the upper and lower margins of the cells on the undersides of both wings.

The acquisition of additional material, and the reassessment of characters used for defining genera provide the basis for synonymizing *Gwendolina* and *Gretchena*. In a series of *concitatricana* collected by Ronald W. Hodges in Arizona at Madera Canyon, Santa Rita Mountains, veins M_3 and Cu_1 vary from nearly connate to stalked over one-third the length. The differences in the male genitalia between *Gwendolina* and *Gretchena* are only of species level significance. The female genitalia of *concitatricana* are similar to other *Gretchena* species, differing in having short projections on the posterior lateral angles of the seventh sternum (Fig. 8). The absence of secondary sexual characters are not of generic significance. These characters, such as the costal fold and sex scales, are reduced or lost independently in many groups, e.g. *Epinotia* and *Rhopobota* Lederer.

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LITERATURE CITED

Heinrich, C. 1923. Revision of the North American moths of the subfamily Eucosminae of the family Olethreutidae. U.S. Natl. Mus. Bull. 123, IV+ 298 pp.

MacKay, M. R. 1959. Larvae of the North American Olethreutidae (Lepidoptera). Can. Entomol. Suppl. 10, 338 pp.

McDunnough, J. H. 1925. New Canadian Eucosminae (Lepidoptera). Can. Entomol. 57: 115–116.

Payne, J. A., H. L. Malstrom, and G. E. KenKnight. 1979. Insect pests and diseases of the pecan. U.S. Dep. Agric. Agric. Rev. and Man. S-5, 43 pp.

Tedders, W. L. and M. Osburn. 1970. Morphology of the reproductive system of *Gretchena bolliana*, the pecan bud moth. Ann. Entomol. Soc. Am. 63: 786–789.

NOTE

Change of Name of a North American *Ypsolopha* (Lepidoptera: Plutellidae)

Cataloging of the world microlepidoptera fauna has uncovered an overlooked homonym caused by the inclusion of two species of the same name in the plutellid genus *Ypsolopha*. The species homonymy was previously not existent due to the prevalent usage of the genus name *Cerostoma* Latreille. *Ypsolopha* Latreille, 1796, and *Cerostoma* Latreille, 1802, are now considered congeneric. The following correction is therefore recorded:

Ypsolopha buscki Heppner, **New Name**

Cerostoma manella Busck, 1903, J. N.Y. Entomol. Soc. 11: 51 (type-locality: Williams, Arizona), preocc. in *Ypsolopha* by *Ypsolophus* [sic] *manella* Möschler, 1890, Abh. Senckenberg Nat. Ges. 15: 344 (type-locality: Puerto Rico).

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LARVAL HABITATS AND MATE-SEEKING SITES OF FLOWER FLIES (DIPTERA: SYRPHIDAE, ERISTALINAE)

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Abstract.—Larval habitats of 26 species and mate-seeking locations of 30 species of Syrphidae (subfamily Eristalinae) are described. Males search for mates near flowering plants and/or larval habitats. These observations confirm and extend previous findings, which indicate that males seek mates near resources utilized by females.

Male syrphids search for mates near resources that attract females. Species of Eristalinae (=Milesiinae) studied by Maier and Waldbauer (1979a) use flowering plants, larval habitats, or both as sites for finding mates. Females visit blossoms to feed upon pollen and sometimes nectar, the former being necessary for rapid ovarian development (Maier, 1978; Schneider, 1948). Maier and Waldbauer (1979a, b), Morse (1981), and many others have investigated sexual and foraging behavior at flowers. Maier (1978) and Maier and Waldbauer (1979a) have examined reproductive behavior of native species near larval habitats. Individual males defend territories centered around larval habitats and thus gain access to females arriving to lay eggs (Maier and Waldbauer, 1979a).

Metcalf (1913, 1916) used his own studies and those of Verrall (1901), Williston (1886), and others to categorize syrphid larval habitats, mate-seeking sites for male Eristalinae (Maier and Waldbauer, 1979a). Valuable compilations by Coe (1953), Dixon (1960), Hartley (1961), Heiss (1938), Johannsen (1935), and others supplemented this early work. Nevertheless, larval habitats of most of the species of Eristalinae are unknown or poorly described. In this paper, I describe the larval habitats of 26 species, eight for the first time, and extend Maier and Waldbauer's (1979a) and Maier's (1980) observations on male mate-seeking behavior.

Materials and Methods

Third-instar larvae were collected from rotting areas of cacti and trees and from sewage settling and woodland ponds between November and May

1974–1981 and were then released in uncovered Petri dishes containing their apparent food. Petri dishes were enclosed in plastic vegetable crispers that were partially filled with sand, a suitable material for pupariation. Rearing was done in growth chambers adjusted to 24 ± 2°C and to a 16 h light: 8 h dark photoperiod. Less than one month after collection, larvae pupariated in the sand. Adults eclosed 2 weeks or less after pupariation.

Male mate-seeking behavior was studied in Arizona, Connecticut, Illinois, and North Carolina between April and July 1972–1981. Individual males were observed for 30 min or until their departure from a mate-seeking location. Each observation (Table 1) represented a male that pursued conspecific flies, mated, or engaged in both activities at a mate-seeking site. Representatives of all species mentioned here are deposited in my syrphid collection.

RESULTS AND DISCUSSION

LARVAL HABITATS

The following list gives the larval habitats of Syrphidae in the subfamily Eristalinae. The species is followed by the locality, number reared (in parentheses), and description of larval habitat.

Brachyopini

Brachyopa vacua Osten Sacken.—Mason Co., Illinois. (6). Sap-soaked decaying wood and associated plant growth in live *Fagus grandifolia* Ehrh. and *Quercus* spp.

Myolepta nigra Loew.—Mason Co., Illinois. (4). Moist detritus in treehole of live *Quercus marilandica* Muenchh. and *Q. velutina* Lam.

Myolepta varipes Loew.—Gibson Co., Indiana. (2). Moist detritus in treehole of live *Acer saccharum* Marsh.

Cerioidini

Ceriana abbreviata (Loew).—Champaign Co., Illinois. (3). Sap-soaked detritus in treehole of live *Liquidambar styraciflua* L. (treehole with *Camponotus* sp. colony).

Eristalini

Eristalinus aeneus (Scopoli).—Champaign Co., Illinois. (200). Sewage settling pond with standing water.

Helophilus fasciatus Walker.—Champaign Co., Illinois. (5). Small, leaf-filled pools in mesic forest dominated by *Acer, Fagus,* and *Quercus* spp.

Mallota bautias (Walker).—New Haven Co., Connecticut. (2). Wet detritus in decayed center of live *Pyrus malus* L. (opening to outside less than 2 cm in diameter).

Mallota posticata (Fabricius).—New Haven Co., Connecticut. (4). Mason Co., Illinois. (200). Gibson Co., Indiana. (1). Montgomery Co., Virginia. (3). Wet detritus in large treeholes or in water-filled crotches of many species of live deciduous trees (treeholes usually with entrances of 10–20 cm diameter).

Milesiini

Blera umbratilis (Williston).—Mason Co., Illinois. (1). Moist detritus in treehole of live *Quercus velutina* Lam.

Chalcosyrphus chalybeus (Wiedemann).—New Haven Co., Connecticut. (3). Champaign Co., Illinois. (2). Moist to wet detritus in rot pockets of fallen *Acer saccharum* Marsh. logs.

Chalcosyrphus metallicus (Wiedemann).—Union Co., Illinois. (6). Pulpy wood of partially submerged *Acer* sp. log in small stream.

Chalcosyrphus nemorum (Fabricius).—Litchfield Co., Connecticut. (47). Champaign Co., Illinois. (12). Piatt Co., Illinois. (5). Union Co., Illinois. (4). Spaces (partly filled with detritus and insect frass) in firm, moist decaying wood near surface of fallen logs of *Acer* and *Ulmus* spp. in marshes and along streams. Actual site of larval development may be elsewhere in logs as these larvae were collected after feeding was completed.

Lejota aurea (Loew).—Mason Co., Illinois. (10). Friable, slightly moist decaying wood at top of *Quercus* sp. stump.

Milesia virginiensis (Drury).—Mason Co., Illinois. (2). Gibson Co., Indiana. (1). Wet detritus in water-filled center of decaying stumps.

Somula decora Macquart.—New Haven Co., Connecticut. (3). Mason Co., Illinois. (50). Moist detritus in treeholes of live *Quercus* spp. (treeholes with elongate vertical openings).

Spilomyia alcimus (Walker).—Washtenaw Co., Michigan. (5). Wet detritus in treehole of live *Quercus alba* L.

Spilomyia longicornis Loew.—Mason Co., Illinois. (3). Wet detritus along wall of treeholes in live *Quercus velutina* Lam.

Temnostoma alternans Loew.—Middlesex Co., Connecticut. (2). Firm, moist decaying wood in fallen *Betula alleghaniensis* Brit. log in marshy area (wood-boring larvae).

Temnostoma barberi Shannon.—Middlesex Co., Connecticut. (10). Same as previous species.

Temnostoma vespiforme (Linnaeus).—Middlesex Co., Connecticut. (1). Same as previous two species.

Volucellini

Copestylum apiciferum (Townsend).—Pima Co., Arizona. (20). Soupy, decaying material in rot pockets in trunk of live and dead *Ferocactus wislizenii* (Engelm.) Brit. & Rose.

Copestylum florida (Hull).—Marion Co., Florida. (35). Monroe Co., Florida. (23). Rotting areas in joints of live *Opuntia* spp.

Copestylum isabellinum (Williston).—Pima Co., Arizona. (35). Soupy, decaying material in rot pockets in upright and fallen trunks of live and dead *Carnegiea gigantea* Brit. & Rose.

Copestylum marginatum (Say).—Pima Co., Arizona. (7). Rotting areas in thin, non-basal joints of live *Opuntia phaeacantha* Engelm.

Copestylum mexicanum (Macquart).—Pima Co., Arizona. (5). Rotting areas in large, basal joints of live *Opuntia phaeacantha* Engelm.

Copestylum vittatum Thompson.—Marion Co., Florida. (69). Mason Co., Illinois. (8). Rotting areas in joints of live *Opuntia* sp. (Florida) and *O. compressa* (Salisb.) Macbr. (Illinois).

Larvae of the 26 reared species inhabited many different types of decaying material. Except for *Eristalinus aeneus* larvae collected from sewage settling ponds, all lived in natural habitats, mostly decaying parts of living and dead cacti or deciduous trees. My descriptions of larval habitats of *Ceriana abbreviata, Chalcosyrphus chalybeus, C. metallicus, Helophilus fasciatus, Spilomyia alcimus, S. longicornis, Temnostoma alternans,* and *T. barberi* are the first.

Habitats listed here are similar to those described by earlier workers (e.g. Dixon, 1960; Hartley, 1961; Heiss, 1938) for the same or congeneric species. My descriptions augment previous ones by giving data on plant identities, moisture conditions, and/or other features around the larval habitats. This new information contributes to a better understanding of the range of larval habitats used by genera and tribes of Eristalinae.

Two or three species sometimes coexisted in the same log (*Temnostoma alternans, T. barberi, T. vespiforme*), treehole (*Mallota posticata, Somula decora, Spilomyia longicornis*), or cactus (*Copestylum marginatum, C. mexicanum*). A decaying area in a particular log, rot pocket, or cactus was usually inhabited by a single species. For example, *Copestylum marginatum* and *C. mexicanum* larvae were spatially separated by about 1 m in the same cactus. *Copestylum marginatum* larvae ($n = 7$) lived in thin, non-basal joints of *Opuntia phaeacantha* Engelm.; and *C. mexicanum* larvae ($n = 5$), which are larger, inhabited thicker, basal joints.

MATE-SEEKING SITES

Males searched for females near flowering plants, potential larval habitats (=oviposition sites), or both (Table 1). Although male mate-seeking was

Table 1. Mate-seeking locations of male Syrphidae in the subfamily Eristalinae. Evidence: 1 = initiation of copulation observed near flowers; 2 = initiation of copulation observed near larval habitat; 3 = mating pair(s) observed near flowers; 4 = mating pair(s) observed near larval habitat; and 5 = males chased conspecific flies and other flying insects of similar size and grappled with conspecifics (territorial defense).

Tribe and Species	Number Observed	Evidence
A. Flowering plants		
Brachyopini		
Neoascia distincta Williston	4	5
N. globosa (Walker)	>40	1, 3, 5
Sphegina flavimana Malloch	3	5
S. keeniana Williston	13	1, 5
S. lobata Loew	5	5
S. rufiventris Loew	21	5
Eristalini		
Lejops albiceps (Macquart)	12	5
L. anausis (Walker)	3	5
L. bilinearis (Williston)	32	1, 5
L. chrysostomus (Wiedemann)	15	1, 5
L. stipatus (Walker)	9	1, 5
Parhelophilus anniae (Brimley)	6	5
Milesiini		
Blera analis (Macquart)	4	5
Chalcosyrphus chalybeus (Wiedemann)	2	1, 5
Criorhina verbosa (Walker)	11	1. 5
Tropidia albistylum Macquart	2	1, 5
Xylota angustiventris Loew	3	5
Rhingiini		
Rhingia nasica Say	>30	5
Volucellini		
Copestylum mexicanum (Macquart)	15	5
Volucella bombylans (Linnaeus)	2	5
B. Larval habitat		
Milesiini		
Chalcosyrphus metalliferus (Bigot)	4	2, 5
C. nemorum (Fabricius)	>40	2, 5
C. plesia Curran	2	5
C. Both A and B		
Brachyopini		
Sphegina campanulata Robertson	>100	1, 2, 3, 5
Merodontini		
Eumerus tuberculatus (Fabricius)	23	4, 5
Merodon equestris Rondani	4	5

Table 1. Continued.

Tribe and Species	Number Observed	Evidence
Milesiini		
Brachypalpus oarus (Walker)	9	1, 2, 5
Temnostoma alternans Loew	16	1, 2, 3, 4, 5
T. balyras Walker	>80	2, 3, 5
Xylota bicolor Loew	7	5

concentrated near these resources, its behavioral characteristics varied among species. As described by Maier and Waldbauer (1979a), males of most species alternately rested on flowering plants and patrolled blossoms to locate potential mates at flowers. Hovering near blossoms sometimes accompanied patrolling or occurred by itself. For example, on July afternoons between 1200 and 1500 EST, groups of 2–20 *Rhingia nasica* Say males hovered directly above patches of flowering *Impatiens biflora* Walt. These males were equally spaced except when they pursued flying insects or conspecific males that entered or passed by their aerial territories. After pursuits males returned to their original hovering spot, suggesting they have visual spatial memory (Collett and Land, 1975).

Within 1 m of larval habitats, males defended territories. They spent 80–90% of their time resting in places that afforded an unobstructed view of females arriving to oviposit. Representative examples of mate-seeking behavior at flowering plants and larval habitats are more fully described by Gruhl (1924) and Maier and Waldbauer (1979a).

Fifteen species of Eristalinae, eight listed by Maier and Waldbauer (1979a, Table 4) and seven recorded here (Table 1), employ dual mate-seeking strategies. As larval habitats of more species become known, this number will surely grow. The present evidence, however, strongly suggests that dual mate-seeking strategies are common among species of Eristalinae. Comprehensive studies are necessary to determine the entire range of mate-seeking strategies utilized in the other two subfamilies, the Microdontinae and the Syrphinae.

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LITERATURE CITED

Coe, R. L. 1953. Handbooks for the identification of British insects. Vol. X(1). Diptera: Syrphidae. R. Entomol. Soc. Lond. 98 pp.

Collett, T. S. and M. F. Land. 1975. Visual spatial memory in a hoverfly. J. Comp. Physiol. 100(A): 59–84.

Dixon, T. J. 1960. Key to and descriptions of the third instar larvae of some species of Syrphidae (Diptera) occurring in Britain. Trans. R. Entomol. Soc. Lond. 112: 345–379.

Gruhl, K. 1924. Paarungsgewohnheiten der Dipteren. Z. Wiss. Zool. 122: 205–280.

Hartley, J. C. 1961. A taxonomic account of the larvae of some British Syrphidae. Proc. Zool. Soc. Lond. 136: 505–573.

Heiss, E. M. 1938. A classification of the larvae and puparia of the Syrphidae of Illinois exclusive of aquatic forms. Ill. Biol. Mongr. 16, 142 pp.

Johannsen, O. A. 1935. Aquatic Diptera. Part II. Orthorrhapha-Brachycera and Cyclorrhapha. Mem. Cornell Univ. Agric. Exp. Stn. 177, 62 pp.

Maier, C. T. 1978. The immature stages and biology of *Mallota posticata* (Fabricius) (Diptera: Syrphidae). Proc. Entomol. Soc. Wash. 80: 424–440.

———. 1980. Mate-seeking strategies in male flower flies (Diptera: Syrphidae). J. N.Y. Entomol. Soc. 87: 59–60.

Maier, C. T. and G. P. Waldbauer. 1979a. Dual mate-seeking strategies in male syrphid flies (Diptera: Syrphidae). Ann. Entomol. Soc. Am. 72: 54–61.

———. 1979b. Diurnal activity patterns of flower flies (Diptera: Syrphidae) in an Illinois sand area. Ann. Entomol. Soc. Am. 72: 237–245.

Metcalf, C. L. 1913. Syrphidae of Ohio. Ohio Biol. Surv. Bull. 1: 7–123.

———. 1916. Syrphidae of Maine. Maine Agric. Exp. Stn. Bull. 253: 193–264.

Morse, D. H. 1981. Interactions among syrphid flies and bumblebees on flowers. Ecology 62: 81–88.

Schneider, F. 1948. Beitrag zur Kenntnis der Generationsverhältnisse und Diapause räuberischer Schwebfliegen (Syrphidae, Dipt.). Mitt. Schweiz. Entomol. Ges. 21: 249–285.

Verrall, G. H. 1901. British flies. Vol. VIII. Platypezidae, Pipunculidae, and Syrphidae of Great Britain. Gurney and Jackson, London. 691 pp.

Williston, S. W. 1886. Synopsis of North American Syrphidae. Bull. U.S. Natl. Mus. 31: 1–335.

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SOME NEW NEOTROPICAL LEAFHOPPERS OF THE SUBFAMILIES IASSINAE AND DELTOCEPHALINAE (HOMOPTERA: CICADELLIDAE)

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Abstract.—Six new species of Neotropical leafhoppers, *Krisna* ***aesta*** (Puerto Rico), *Scaroidana* ***blockeri*** (Bolivia), *Tenucephalus* ***hamatus*** (Bolivia, Argentina), *Mendozellus* ***serratus*** (Bolivia), *M.* ***tarandus*** (Bolivia), and *M.* ***incisus*** (Bolivia) are described. *Bolarga nigriloba* Linnavuori is placed in the genus *Daltonia*.

The genus *Krisna* was described by Baker (1919). Osborn (1938) described *Scaroidana*, and Kramer (1963) treated the known species of the genus. The genus *Tenucephalus* was described by DeLong (1944). Linnavuori (1959) described *Mendozellus* as a subgenus of *Amplicephalus*.

A new species of each *Krisna*, *Scaroidana*, and *Tenucephalus*, and three new species of *Mendozellus* are described in this paper. *Bolarga nigriloba* Linnavuori is placed in the genus *Daltonia*. All holotypes are in the DeLong collection, Ohio State University, Columbus.

Krisna aesta DeLong, NEW SPECIES

Figs. 1–5

Description.—Length of male 10 mm, female unknown. Crown thin, foliaceous, twice as wide at base, between eyes, as long at middle. Crown, pronotum and scutellum dull yellow. Forewing yellow with slight tint of green, without contrasting color markings.

Male genital plates slender, elongate, 9× as long as wide at middle, apices narrow, rounded. Style bearing a ventral spine at more than $^4/_5$ its length, apical $^1/_5$ curved dorsally, apex pointed. Aedeagus short and broad in lateral view, with apical portion divided and curved dorsobasally, extending twice width of shaft. Pygofer with rounded, blunt projection apically.

Holotype.—♂, Manayes, Puerto Rico, May 25, 1924, G. N. Wolcott coll.

Remarks.—*Krisna aesta* is related to *K. insularis* Oman and can be separated from it by the absence of small spots on the forewing, by the shorter, broader aedeagus, and by the wider, more foot-shaped apical portion of the style.

This may prove to be the male of *K. montana* Caldwell (in Caldwell and Martorell 1952: 19) which was described from female specimens. There are no color markings on either male or female to assist in the identification. For illustrations of the structural features of the other Puerto Rican members of the genus see Caldwell and Martorell (1952: 21).

Scaroidana blockeri **DeLong, New Species**

Figs. 6–10

Description.—Length of male 11 mm, female 11.5 mm. Crown broadly rounded, short and broad, more than 4× as broad between eyes at base as long at middle. Crown, pronotum, and scutellum dull, sordid yellowish green with a brownish tint; reddish color of abdomen often showing through wings. Apical portion of wing including all apical cells, dark brown, smoky.

Female 7th sternum with posterior margin broadly, slightly, concavely rounded.

Male plates more than 3× as long as wide at middle, apices rounded. Style elongate, slender, apical ½ gradually tapered to a narrow, pointed, dorsally bent apex. Ventral margin of apical position serrate. Aedeagus narrow dorsoventrally, rather broad with apical portion of shaft curved dorsally and bluntly pointed in dorsal view. Shaft broadened at middle with a thin spinelike portion extending dorsally. Pygofer rounded apically and bearing prominent ventral spine which curves dorsally on inner margin of pygofer at apex, and bears enlarged portion at ⅔ length of spine.

Types.—Holotype ♂, Bolivia, Santa Cruz, Saavedra, 250 m, 2-IV-1980, D. R. Foster coll. Paratypes: 1 ♂ same as holotype; 1 ♂, 13 ♀ same except 12-IV-1979; 1 ♀, Santa Cruz, 2-III-79, Foster coll.

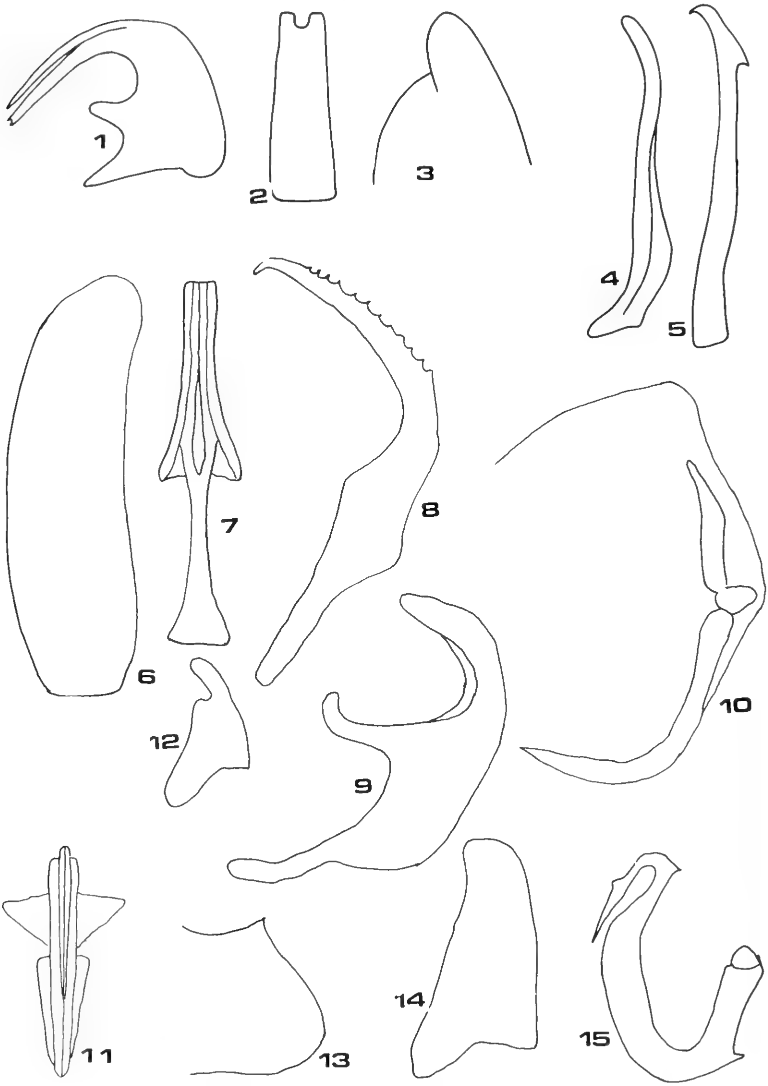
Remarks.—*Scaroidana blockeri* is related to *S. fulvula* Osborn (see Kramer 1963: 42) and can be separated from it by the narrower basal portion of the aedeagus, the enlarged process on the median portion of the pygofer spine, and the dorsally curved pointed apex of the style.

I take pleasure in naming this species for Dr. H. Derrick Blocker, Kansas State University, who assisted me with the generic placement of this species.

Tenucephalus hamatus **DeLong, New Species**

Figs. 11–15

Description.—Length of male 8 mm, female unknown. Crown broadly rounded, more than twice as wide at base between eyes as long at middle. Crown dull smoky greenish, with black marginal band between eyes. Pronotum and scutellum same color as crown. Forewing dull white, opaque,



Figs. 1–5. *Krisna aesta*. 1, Aedeagus laterally. 2, Aedeagus ventrally. 3, Pygofer laterally, apical portion. 4, Plate ventrally. 5, Style laterally. Figs. 6–10. *Scaroidana blockeri*. 6, Plate ventrally. 7, Aedeagus ventrally. 8, Style laterally. 9, Aedeagus laterally. 10, Pygofer with spine. Figs. 11–15. *Tenucephalus hamatus*. 11, Aedeagus ventrally. 12, Style laterally. 13, Pygofer laterally, apical portion. 14, Plate ventrally. 15, Aedeagus laterally.

veins brown. Fuscous blotch on costal area at more than ⅓ its length. Apical portion smoky. Veins of apical ⅓ broadly margined with brown.

Male genital plates more than twice as long as wide at middle, apices broadly rounded. Style rather short and broad, apophysis curved outwardly with apex rounded. Aedeagal shaft narrowed near apex and terminating in a slender dorsobasally curved portion, widened at middle, slender, sharply pointed apically, extending ⅓ length of shaft. Shaft bearing a short ventral tooth at point of curvature and with a broad platelike process on ventral margin subapically. Pygofer bearing sharply pointed tooth on ventro-caudal margin.

Types.—Holotype ♂, Bolivia, Santa Cruz, 36 miles S, 26-IV-1978, 500 m, C. E. Ward coll. at light, Paratypes: 5 ♀, 1 ♂, Tucumán, Argentina, Jan. 1947, Fernandez coll.; 1 ♂, 1 ♀ Urundel, Salta, Argentina, 1-31-1950, R. Gelbach coll.

Remarks.—*Tenucephalus hamata* is related to *T. sagittarius* Linnavuori and DeLong (1976: 29) and can be separated from it by the slender dorsobasally curved apical portion of the aedeagal shaft.

Mendozellus Linnavuori

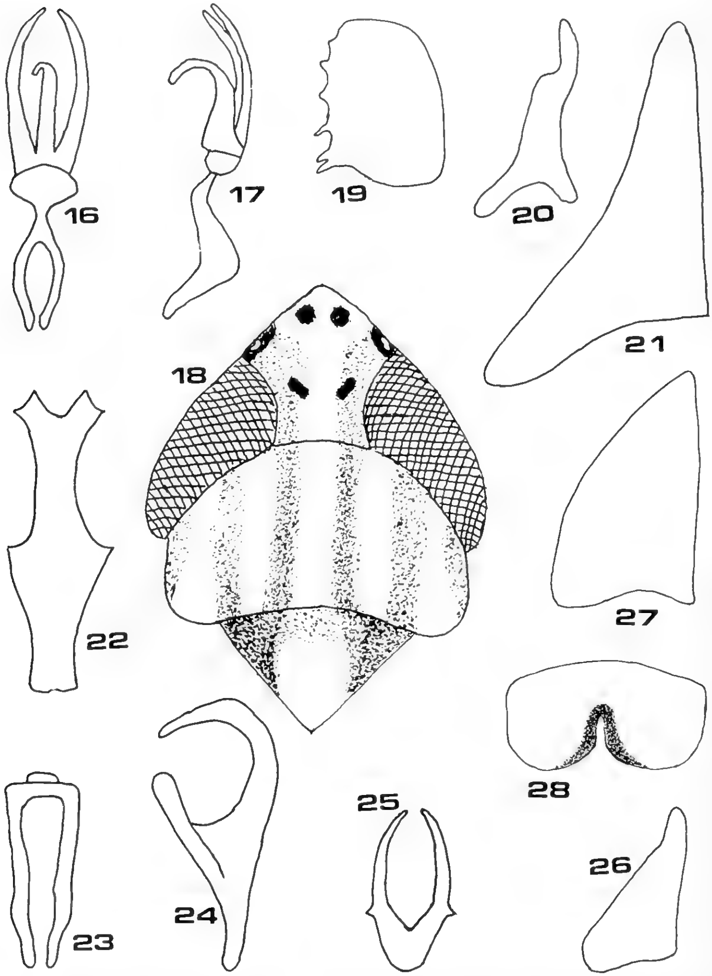
The genus *Mendozellus* contains a group of closely related species found in Bolivia, Argentina, and Peru. Color patterns of a few of these species are quite similar and the color pattern of each is variable. In general, the species can usually be separated by the male or female genital structures. *Mendozellus lineiceps* (Osborn) was described from female specimens and cannot be separated by genital structures. *Mendozellus incisus*, n. sp., which is being described from a female specimen in the following pages, has an incised seventh sternum and can easily be separated from its congeners on this basis.

Mendozellus serratus DeLong, New Species

Figs. 16–21

Description.—Length of male 3.5 mm, female 3.7 mm. Crown produced and broadly angled, longer at middle than wide at base between eyes. Crown whitish with round black spot on each side of apex, elongate black spot just above margin between round black spot and eye, and angled black spot on each side between eyes at ⅔ length of crown. Longitudinal orange stripe extends just behind round black apical spot, on each side, along eyes and continues across pronotum. Pronotum white with 2 longitudinal orange stripes behind each eye. Scutellum orange, basal angles black, central portion and apical angle white. Forewing smoky, veins white, margined with brown.

Female 7th sternum with posterior margin broadly, shallowly, concavely rounded.



Figs. 16–21. *Mendozellus serratus*. 16, Aedeagus and connective ventrally. 17, Aedeagus and connective laterally. 18, Head, pronotum and scutellum. 19, Pygofer laterally. 20, Style laterally. 21, Plate ventrally. Figs. 22–27. *M. tarandus*. 22, Aedeagus ventrally. 23, Connective ventrally. 24, Aedeagus laterally. 25, Aedeagus apically. 26, Style laterally. 27, Plate ventrally. Fig. 28, *M. incisus*, 7th sternum.

Male genital plates 2½× as long as wide at middle, apices bluntly pointed. Style elongate, apophysis with apex rounded. Aedeagal shaft short, narrowed and curved dorsally on apical ⅓. A pair of slender, apically pointed processes arise near base of shaft on ventral margin and extend caudally along and beyond shaft to length of caudally directed portion. Pygofer with ventral margin bearing row of irregular, sharply pointed "teeth."

Types.—Holotype ♂, El Gaite, Bolivia, 18-III-1980, on Maiz, Don Foster coll. Paratypes: 5 ♀ same data as holotype; 2 ♂ Santa Cruz, Bol., 19-VIII-'80; 1 ♂, Buena Vista, Bol., 14-V-'80, DeLong coll.; 2 ♂ Portachuela, Bol., 14-V-'80, DeLong coll.

Remarks.—*Mendozellus serratus* is related to *M. devius* Linnavuori and DeLong (1977: 251) but differs in color pattern as described, by the long ventral processes of the aedeagus, and the serrate ventral margin of the pygofer.

Mendozellus tarandus DeLong, New Species

Figs. 22–27

Description.—Length of male 3 mm, female unknown. Crown angularly produced, apex blunt, rounded, slightly longer at middle than width at base between eyes. Crown orange brown with longitudinal white stripe extending from apex to apex of scutellum, and commissure of forewing white. Elongate dark brown spot on each side of white stripe at apex of crown, and similar pair at ⅓ and ⅔ length of crown. Brown line parallel to margin back of each ocellus extending to eyes. Pronotum brown with darker brown longitudinal stripe on each side of median white stripe, and 6 narrow white longitudinal stripes. Scutellum brown with dark brown longitudinal stripe bordering white stripe, on each side. Forewing brownish subhyaline, veins white.

Male genital plates almost twice as long as wide at middle, apices bluntly pointed. Style with straight, finger-like apophysis. Aedeagus divided at ⅔ its length, forming 2 curved processes which extend dorsally and curve laterally, with apices proximal. Connective elongate with proximal apices. Pygofer bluntly pointed apically.

Types.—Holotype ♂, Bolivia, Santa Cruz, 21-VII-'80, D. R. Foster coll. Paratypes: 3 ♂ same as holotype; 1 ♂ same except 17-IX-'80; 1 ♂ same except 27-V-'80; 1 ♂ same except 3-VIII-'80.

Remarks.—*Mendozellus tarandus* is closely related to *M. isis* Linnavuori (1959: 117) and can be separated from it by the slender, dorsally curved apical processes of the aedeagus and their slender pointed tips.

Mendozellus incisus DeLong, New Species

Fig. 28

Description.—Length of female 4 mm, male unknown. Crown angularly produced, as long at middle as wide between eyes at base. Crown roundly angled at apex. Color dull yellowish, pair of rounded, slightly elongated, brown spots at apex. Two pairs of similar brownish spots, more elongate, between eyes, ½ and ⅔ length of crown. Pronotum mostly white with 2 brownish longitudinal stripes on each side of median white stripe, and faint brownish longitudinal stripe behind each eye. Scutellum white with brown basal angles. Forewing pale brownish subhyaline, veins white.

Female 7th sternum with posterior margin broadly convexly rounded each side of a narrow incision half way to base of segment which is broadly embrowned.

Holotype.—♀, Bolivia, Santa Cruz, 20-IV-'80, Don Foster coll.

Remarks.—*Mendozellus incisus* can be separated from all other described species of *Mendozellus* by the deeply incised seventh female segment.

Daltonia nigriloba (Linnavuori), New Combination

Linnavuori described *D. nigriloba* and placed it in *Bolarga*. A series of specimens from Bolivia and Argentina, one of which was identified by Linnavuori as *Bolarga nigriloba*, are very similar in form, coloration, and appearance to specimens of *Daltonia estacada* (Ball), which is a common species in the southern United States and in the lower gulf coastal area of Mexico. The forewings of *D. nigriloba* are a little more elongate and the apical cells are longer than those of *D. estacada*. The aedeagus of *D. nigriloba* is similar to that of *D. estacada*, but it is not notched apically, and the apophysis of the style is more elevated and pointed. *Bolarga nigriloba* is considered a good species and is placed in *Daltonia*.

Literature Cited

Baker, C. F. 1919. The genus *Krisna* (Jassidae). Philipp. J. Sci. 15: 209–226.

Caldwell, J. S. and L. F. Martorell. 1952. Review of the Auchenorhynchous Homoptera of Puerto Rico, Part I, Cicadellidae. J. Agric. Univ. P. R. 34: 1–132.

DeLong, D. M. 1944. A New Genus (*Tenucephalus*) and species of Mexican leafhopper related to *Parabolocratus*. Ohio J. Sci. 44: 236-237.

Kramer, J. P. 1963. A key to the new world species of Jassinae with reviews of *Scaroidana* and *Pachyopsis* (Homoptera: Cicadellidae) Bull. Brooklyn Entomol. Soc. 58: 37–50.

Linnavuori, R. 1959. Revision of the Neotropical Deltocephalinae and some related subfamilies (Homoptera). Ann. Zool. Soc. 'Vanamo' 20(1): 1–370.

Linnavuori, R. and D. M. DeLong. 1976. New Neotropical leafhoppers from Peru and Bolivia (Homoptera: Cicadellidae). Rev. Peru. Entomol. 19(1): 29–36.

———. 1977. The leafhoppers (Homoptera: Cicadellidae) known from Chile. Brenesia 12/13: 163-267.

Osborn, H. 1938. Neotropical leafhoppers of the Carnegie Museum, Part 7, report on the species of the subfamily Gyponinae. Ann. Carnegie Mus. 27: 11–62.

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ETHOLOGY OF *NEOITAMUS VITTIPES* (DIPTERA: ASILIDAE) IN SOUTH AUSTRALIA[1,2]

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Abstract.—A field study of the predatory and mating behavior of *Neoitamus vittipes* (Macquart) is reported. Prey taken by *N. vittipes* represented five orders, the majority being in the order Diptera. Mating, without prior courtship, took place in a tail-to-tail position, mostly in the afternoon. Incidental data is included concerning distribution and predatory behavior of *Neoitamus armatus* (Macquart) and *N. margites* (Walker).

With the exception of the recent paper by Daniels (1976) on the predatory and courtship behavior of *Promachus interponens* Walker, nothing has been written of the behavior of Australian robber flies. Thus far, the majority of behavioral studies have been done on species in North America, Russia, and Europe.

Neoitamus vittipes (Macquart)

Published records of the occurrence of *Neoitamus vittipes* (Macquart) are few. The original type-series was collected in Tasmania, but the synonymy established by Hardy (1920) extended its distribution to continental Australia, with records from Victoria and New South Wales (January to March). While on sabbatical at the Waite Agricultural Research Institute (November 1978–May 1979), I collected *N. vittipes* at the following locations in South Australia: 2.6 km N of Port Wakefield (23.xi.78), 6 km SW of Virginia (23.xi.78), 4.5 km E of Keyneton (30.xi.78), 16 km N of Kingston (18–19.xii.78), ca. 12 km SE of Milang (20.xii.78, 1.iii.79), 3 km E of Milang (8.i.79, 2–3.iii.79), 8 km E of Milang (19.xii.78, 12.ii.79, 1.iii.79), 10 km S

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of Milang (20.xii.78), 11.6 km NW of Morgan (22–27.iii.79), 2.7 km S of Kapunda, bank of Light River (22.iii.79). Additionally, specimens in student collections provided records for Adelaide (early February 1979) and Port Gawler (16.ii.77, "flying around Melaleuca").

Typical habitats from which *N. vittipes* was collected included rocky hillside pastures dominated by *Avena barbata* Pott ex Link, dryland lucerne (alfalfa) fields, borders of irrigated lucerne fields, weedy borders of cropland, a weedy horse paddock and open rangeland dominated by *Maireana sedifolia* (F. Muell.) Wilson (bluebush) and *Danthonia* sp. (wallaby grass).

Most behavioral observations were made on a population inhabiting a field of irrigated lucerne 3 km east of Milang, S.A. This population was largely concentrated within the first 5 m of lucerne along the borders of the field, except where incursions of grass created clearings. The asilids would then be found foraging from individual plants bordering the clearings. The species was studied during the period March 5 to 13, 1979 at this site; a few additional observations were made December 18–19 in a dryland lucerne field opposite Coorong National Park, 16 km N of Kingston.

METHODS

Approximately 100 localities in South Australia were surveyed during spring and summer of 1978–79 to ascertain the distribution and abundance of species of robber flies. An hour or two of walking through a particular habitat was usually sufficient to establish what species were present and their density. In disturbed habitats in South Australia, it was not uncommon to find only one species present, whereas many undisturbed areas, e.g., conservation parks, supported several species concurrently.

Once a suitably dense population of an asilid species was encountered, one or two observers visited the area on several successive days. In general two approaches were employed, (1) single flies were continuously observed for one to two hours each, and (2) the observer slowly traversed the area noting the activities of many different flies.

Constant and extended surveillance of individual flies yielded a mass of information concerned primarily with foraging and feeding, whereas surveying the area provided greater opportunity for observation of mating pairs and for locating ovipositing females.

Observations were recorded in notebooks on the study site. These included detailed records of foraging, feeding, mating, and oviposition, whenever observed. Times and when possible, durations of these activities were noted. Temperatures were taken from the soil surface or the height on the vegetation where the behavior was occurring. Permanent photographic records of each behavior were obtained using a Nikon 35 mm, single lens reflex camera with a Micro-Nikkor-P.C. Auto 1:3.5, 55 mm lens.

Recorded behavior patterns involving flight were defined as follows: (1) Foraging flights were those in which the individual flew towards a potential prey, regardless of whether it was successful; (2) investigatory flights where the asilid would fly towards a potential prey, but turn back without attempting capture (presumably, size or structural characteristics functioned to make the insect unsuitable); (3) manipulation flights (rotation flights of Scarbrough and Norden, 1977) in which an individual would fly briefly from a feeding site, manipulate prey, and return to the same or nearby perch; (4) orientation flights in which the asilid would move to a new location as a result of being shaded, disturbed, or not making visual contact with potential prey over a period of time (these flights were made slowly and usually covered only a short distance); (5) agonistic flights which involved aggressive encounters between males; and (6) searching flights which consisted of long, rapid, sometimes undulating flights taken by males in search of receptive females.

Prey was collected whenever possible. Either the robber flies observed feeding on prey were netted, the prey was collected, and the asilid was released unharmed, or the predator was observed until completion of feeding and the prey was recovered where it was dropped. The latter method, while supplying information on feeding times and manipulation behavior, sometimes resulted in the loss of prey, since asilids often dart after new prey, releasing the exhausted meal in flight. Occasionally, an insect net was placed carefully over the feeding asilid and held in place until completion of feeding. However, this method lacks desirability since a puff of wind striking the net may disturb the asilid, causing it to drop prey, which if tiny, may disappear among the surface debris.

Collected prey were placed in a 2 dram vial and subsequently measured for total body length to the nearest 0.5 mm, after which it was either mounted by pinning or placed in 70% ETOH. Similar measurements were made of the predator, i.e., 14 specimens of each sex. In this way, the predator to prey size ratio was obtained. An additional procedure, although not used in this study, is that of Scarbrough (1978), who oven-dried prey of selected lengths to obtain predator to prey weight ratios.

Prey were identified to order-family and then submitted to specialists for further identification (see Acknowledgments). The prey collection is housed at Waite Agricultural Research Institute in Adelaide, S.A.

FORAGING AND FEEDING BEHAVIOR

Perch sites, from which *N. vittipes* launched attacks on potential prey, varied with the character of the habitat. In the population which inhabited the lucerne field, the majority of flies foraged from vegetation (lucerne, 62%; weeds, 16%; irrigation pipe, 6%; soil, 10% and grass stalks, 6%) throughout

Fig. 1. *Neoitamus vittipes* male feeding on the syrphid, *Simosyrphus grandicornis*, while holding onto lucerne leaves.

the day. However, in rocky pastures and dryland alfalfa fields, the majority of asilids launched attacks from the soil surface or from small rocks.

Exclusive of soil the heights on plants, where foraging individuals were observed, varied from 5 to 38 cm (mean 19.3 cm). When on soil, individuals were either resting broadside to the sun or facing directly into it, a behavior which is directly related to soil surface temperature in other asilid species (Lavigne and Holland, 1969; Dennis and Lavigne, 1975, 1979). These other asilids studied maintain temperature control through positional changes, utilizing soil in early morning, thereby increasing heat absorption, and vegetation around midday when soil temperatures are excessive. Presumably the Kingston population functioned in a similar manner.

While resting on foraging sites, the flies were largely quiescent, except when potential prey flew within their field of vision. The asilid would then turn its whole body to face the organism. One can assume that such postural changes increase range of vision and place the asilid in a suitable position to make a direct forage flight (Dennis and Lavigne, 1975).

All forage flights were directed at insects that were air borne. Distances covered in forage flights ranged from 7.6 to 71 cm (mean 25.6 cm). Flights which resulted in prey capture ranged in length from 7.6 to 45.7 cm (mean

Table 1. Relation between length of *Neoitamus vittipes* and that of its prey.

Sex	Predator Length (mm)[1]			Prey Length (mm)			No. Prey Measured	Mean Ratio of Predator: Prey
	Min.	Max.	Mean	Min.	Max.	Mean		
Male	10.0	13.0	11.6	1.0	9.0	3.7	12	3.1
Female	11.5	14.5	12.6	0.5	10.0	4.4	24	2.9
Combined	10.0	14.5	12.1	0.5	10.0	4.2	36	2.9

[1] 14 predators of each sex were measured from the Milang population.

21.4 cm), suggesting that as distance increases between predator and potential prey, the asilids decrease in capture efficiency.

Most flights initiated in pursuit of prey were unsuccessful. Based on a limited number of observations, prey capture efficiency for *N. vittipes* is poor, i.e., 16%. On two occasions (one male, one female) flights were directed towards cruising honeybees. In both instances, the asilid turned away and returned to the foraging site, after covering ⅓ to ½ of the distance. These investigatory flights undoubtedly maximize net energy gain, i.e., lower pursuit costs since the asilid does not chase prey that is likely to escape.

Once prey were captured, the asilid hovered briefly, manipulated the prey using all six tarsi and impaled it prior to landing.

During the feeding sequence, most prey were manipulated one or more times. The prey were manipulated with all six tarsi, during a short flight 1–2 cm away from the feeding site. Manipulation, while hovering is typical of the behavior of Asilinae in North America (Dennis and Lavigne, 1975, 1979; Lavigne, 1979; Lavigne et al., 1976; Lavigne and Dennis, 1980).

Once feeding is completed, the chitinous exoskeleton of the prey is pushed off the proboscis by the asilid's foretarsi on the feeding site.

Only twice were complete feedings monitored. In one instance a female fed upon a bushfly, *Musca vetustissima* Walker, for 25 minutes. A second case involved a male, which fed upon the syrphid, *Simosyrphus grandicornis* (Macquart), for a period of 2 hours and 10 minutes (Fig. 1).

One case of cannibalism was observed in the population 16 km N of Kingston. In this instance a male attacked and killed a second smaller male (Fig. 2). During the initial struggle, the larger male lay on its side on the ground manipulating the other male with all six tarsi, a technique apparently forced on it by the large size of the prey.

Based on 36 measured prey of *N. vittipes*, the "preferred" prey length was 4.3 mm, although the size of prey taken varied from 0.5 to 10.0 mm (Table 1). Females were slightly larger than males (12.6 vs. 11.6 mm) and tended to capture slightly larger prey (4.4 vs. 3.7 mm). Males concentrated

Table 2. Comparison of prey items taken by three species of *Neoitamus* in various parts of the world.

	N. vittipes (Australia)		*N. angusticornis* (Japan)[1]		*N. cyanurus* (England)[2]	
Order	No.	%	No.	%	No.	%
Araneae			3	2.8		
Coleoptera			15	14.2	9	14.0
Diptera	28	73.8	58	54.8	38	59.3
Ephemeroptera			3	2.8		
Heteroptera	2	5.2			3	4.7
Homoptera	4	10.6	4	3.8		
Hymenoptera	2	5.2	12	11.3	1	1.6
Isoptera			1	0.9		
Lepidoptera	2	5.2	9	8.5	11	17.2
Neuroptera			1	0.9	1	1.6
Odonata					1	1.6
Totals	38	100	106	100	64	100

[1] Records of prey collected by Iwata and Nagatomi (1962).

[2] Compilation of prey records collected by Hobby (1931, 1933, 1934), and Poulton (1907).

on Diptera (90%) and only incidentally took Hemiptera (10%). Females, while concentrating on Diptera (65%), fed on representatives of four other orders, Hemiptera (3.9%), Homoptera (15.5%), Hymenoptera (7.8%) and Lepidoptera (7.8%). The mean predator to prey length ratio for this species was 2.9 (Table 1).

Various authors (Bromley, 1945; Crowhurst, 1969; Fattig, 1945; Melin, 1923; Myers, 1928; Valentine, 1967) have recorded occasional instances of predation by members of the genus *Neoitamus*. However, for only two species, *N. angusticornis* Loew and *N. cyanurus* Loew, are there sufficient data for a prey selection comparison. As can be seen in Table 2, the tendency of *N. vittipes* to selectively choose Diptera over other available insects in the habitat is shared by these two other species in widely separated parts of the world.

In addition to the records for *N. cyanurus* presented in Table 2, Melin (1923) noted Diptera and Lepidoptera as prey in Sweden. Diptera also were recorded as the most common prey in Romania (Ionescu and Weinberg, 1960) and in England by Parmenter (1952). Attwood (1937), although not collecting prey, noted that *N. cyanurus* took large numbers of *Tortrix viridana* L. (Lepidoptera: Tortricidae.)

Herein is a list of prey taken by *N. vittipes*. Specific identifications were made, where possible, but because of the state of knowledge in some groups, only genus and/or family are included for some specimens. The

Fig. 2. A case of cannibalism in which one *Neoitamus vittipes* male has captured and is feeding on another male of the same species.

number of records and sex of the predator are indicated in parenthesis following the prey record.

DIPTERA, Anthomyiidae: *Hylemyia deceptiva* Malloch, 7.iii.79 (♀); Asilidae: *Neoitamus vittipes* (Macquart), 18.xii.78 (♂); Chironomidae: *Pentaneura levidensis* (Skuse), 6.iii.79 (♂); *Procladius paludicola* Skuse, 6.iii.79 (♂), 7.iii.79 (♂); Choloropidae: indet. A, 6.iii.79 (♀); *Lioscinella* sp., 6.iii.79 (♀); Ephydridae: indet., 8.iii.79 (♀); Lauxaniidae: *Poecilohetaerus schineri* Hendel, 9.iii.79 (2 ♀); Muscidae: *Atherigona* sp. A, 7.iii.79 (2 ♀); *Coenosia acuticornis* Stein, 7.iii.79 (♀), 9.iii.79 (♂); *Musca vetustissima* Walker, 19.xii.78 (♂, 2 ♀), 6.iii.79 (♀); Phoridae: *Megaselia* sp., 6.iii.79 (♀); Sepsidae: *Lasionemapoda hirsuta* (de Meij.), 9.iii.79 (♀), Syrphidae: *Melangyna collata* (Walker), 5.iii.79 (♀), 7.iii.79 (♀), 9.iii.79 (♀); *Simosyrphus grandicornis* (Macquart), 6.iii.79 (♂). HEMIPTERA-HETEROPTERA, Lygaeidae: *Nysius vinitor* Bergr., 5.iii.79 (♂), Miridae: *Campylomma lividum* Reuter, 8.iii.79. HEMIPTERA-HOMOPTERA, Aphididae: indet. winged reproductive, 7.iii.79 (♀); Cicadellidae: indet., 7.iii.79 (♂). HYMENOPTERA, Braconidae: Aphidiinae, indet., 8.iii.79 (♂); Ichneumonidae: *Diplaxon* sp., 7.iii.79 (♀). LEPIDOPTERA, Lycaenidae: *Zizina labradus labradus* (Godart), 7.iii.79 (2 ♀). An additional two Diptera and three Homoptera remain unidentified.

MATING

As with other species of Asilinae studied, there is no courtship by males. It is probable that encounters between males and females resulted from searching flights of males, although such data were not collected. This strategy is used by many species of Asilini.

Upon observing a female, the male launches itself towards her, catching her in flight. Copulation takes place prior to landing, in the male atop female position. Approximately five seconds after landing, the pair take a tail-to-tail position which is maintained throughout the copulation period (Fig. 3). The male rotates his abdomen 70–90° at intermittent intervals which causes the female's abdomen to be extended, curved and pulled towards the male. Rotations occur at a rate of ca. 1/s in a short series, followed by periods of rest. As the mating progresses, the rate of rotation increases to ca. 2/s. The male's wings remain folded over his dorsum throughout mating, being flicked open occasionally, while the female's wings remain slightly open. Separation occurs when the male releases his claspers. Both either fly off immediately or rest for short periods of time, and then fly.

Mated pairs were observed on vegetation (grass stalks and lucerne) at heights ranging from 2.5 to 35 cm (mean 22 cm). Temperatures at these heights ranged from 22 to 34°C (mean 26.9°C). Additionally, three mated pairs were encountered resting on soil (surface temperature 26–28°C) at the site north of Kingston. Pairs were observed in copula as early as 9:37 AM and as late as 3:58 PM, with all but one occurring after 12 noon. Total time in copula for two observed complete matings (i.e., initial contact to separation) was 21 and 33 minutes.

OVIPOSITION

According to Melin (1923), female *Neoitamus cyanurus* deposits its eggs in "closed top buds," in "small round strobiles," and in the apices of boughs of alder from which the species also forages. The elongate, laterally compressed ovipositor is highly suitable for this task.

The ovipositor of *N. vittipes* is similarly laterally compressed suggesting that this species also oviposits in suitable locations on vegetation. On one occasion, the author observed a female probing with its ovipositor, in the manner described for *Machimus callidus* (Williston) (Dennis and Lavigne, 1975). The ovipositor was moved from side to side at the tips of lucerne leaves and inserted within folded unopened leaves at heights of 20 to 36 cm. No eggs were found, however, when these sites were examined. Whether or not such sites are utilized is probably immaterial since the lucerne was cut two days later. It is much more probable, since the species has survived in this field as well as along the margins of several other lucerne fields in

Fig. 3. Mating pair of *Neoitamus vittipes* resting on vegetation in a field of lucerne.

the vicinity, that oviposition sites are grasses or weeds. Certainly, such sites suffice for some other Asilini (Dennis and Lavigne, 1979).

Neoitamus armatus (Macquart)

Occasional specimens of this species were collected at two locations in South Australia in areas containing native vegetation, Aldinga Beach and The Ferries-McDonald Conservation Park, south of Monarto. The species was collected during the period December 11th to January 31st. Hardy (1920) recorded this species in New South Wales and Tasmania, from October to January and April.

Specimens were observed foraging from branches of malee at heights up to 1.7 m. It was also observed resting on fallen branches while feeding on prey. Prey of one male in the Aldinga Beach scrub community was an unidentified tiphiid wasp (Hymenoptera), while a female captured a specimen of *Anthrenocerus australis* Hope (Coleoptera: Dermestidae). A male at Ferries-McDonald Conservation Park was photographed while feeding on *Nysius vinitor* Bergr. (Hemiptera: Lygaeidae).

Neoitamus margites (Walker)

South Australian collection records for this species are as follows: Mortlock Experiment Station, Auburn (17.i.79, 24.i.79), Ferries-McDonald Conservation Park, S of Monarto (11.xii.78), 3.3 km S of Echunga (1.iii.79), and

8 km ENE of Callington (21.xi.78). *Neoitamus margites* had previously been recorded from Tasmania and New South Wales by Hardy (1920). Habitats, in which this species was found were dominated by *Eucalpytus* sp. with an understory of *Avena barbata* or native vegetation, e.g., horse paddocks and conservation areas.

Foraging flights were initiated from the soil surface, from fallen *Eucalyptus* branches and from the trunks of gum trees. Flights were at heights of 25–50 mm over distances of 0.15 to 0.3 m. The only prey observed being taken were four specimens of unidentified winged reproductive ants at Mortlock Experiment Station.

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Literature Cited

Attwood, R. W. 1937. "Robber flies" attacking *Tortrix viridana*. Entomol. Rec. J. Var. 49: 104–105.

Bromley, S. W. 1945. Insect enemies of the house fly, *Musca domestica* L. J. N. Y. Entomol. Soc. 53: 145–152.

Crowhurst, P. S. 1969. Notes on *Neoitamus bulbus* (Walker) (Diptera: Asilidae). N. Z. Entomol. 4(3): 121–124.

Daniels, G. 1976. Notes on the behavior of the robber fly *Promachus interponens* Walker (Diptera: Asilidae). Aust. Entomol. Mag. 2(6): 124–125.

Dennis, D. S. and R. J. Lavigne. 1975. Comparative behavior of Wyoming robber flies II (Diptera: Asilidae). Univ. Wyo. Agric. Exp. Stn. Sci. Monogr. No. 30, 68 pp.

———. 1979. Ethology of *Machimus callidus* with incidental observations on *M. occidentalis* in Wyoming (Diptera: Asilidae). Pan-Pac. Entomol. 55: 208–221.

Fattig, P. W. 1945. The Asilidae or robber flies of Georgia. Emery Univ. Mus. Bull. No. 3, 33 pp.

Hardy, G. H. 1920. Descriptions of Australian flies of the family Asilidae, (Diptera) with synonyms and notes. Proc. Linn. Soc. N.S.W. 45(Pt. 2): 185–202.

Hobby, B. M. 1931. The British species of Asilidae (Diptera) and their prey. Trans. Entomol. Soc. South England 6: 1–42.

———. 1933. Supplementary list of the prey of Asilidae (Dipt.). J. Entomol. Soc. South England 1: 69–74.

———. 1934. Predacious Diptera and their prey. J. Soc. Brit. Entomol. 1(2): 35–39.

Ionescu, M. A. and M. Weinberg. 1960. Specii de Asilide (Diptera, Asilidae) din R. P. R. Colectia Petru Suster. Acad. Repub. Pop. Rom. Stud. Cercet. Biol., Ser. Biol. Anim. 11: 301–313.

Iwata, K. and A. Nagatomi. 1962. Prey of some Japanese asilids (Diptera). Kontyû 30: 87–100.

Lavigne, R. J. 1979. Notes on the ethology of *Efferia argyrogaster* (Diptera: Asilidae) in Mexico. Proc. Entomol. Soc. Wash. 81: 544–551.

Lavigne, R. J. and D. S. Dennis. 1980. Ethology of *Proctacanthella leucopogon* in Mexico (Diptera: Asilidae). Proc. Entomol. Soc. Wash. 82: 260–268.

Lavigne, R. J. and F. R. Holland. 1969. Comparative behavior of eleven species of Wyoming robber flies (Diptera: Asilidae). Univ. Wyo. Agric. Exp. Stn. Sci. Monogr. No. 18, 61 pp.

Lavigne, R. J., L. Rogers, and F. Lavigne. 1976. Ethology of *Efferia benedicti* (Diptera: Asilidae) in Wyoming. Proc. Entomol. Soc. Wash. 78: 145–153.

Melin, D. 1923. Contributions to the knowledge of the biology, metamorphosis and distribution of the Swedish Asilids. Zoolog. Bidr. Upps. 8: 1–317.

Myers, J. G. 1928. The habits and prey of three Asilidae in New Zealand. Proc. R. Entomol. Soc. Lond. 2(3): 54–56.

Parmenter, L. 1952. Diptera. Notes on the Asilidae (robber flies). Entomol. Rec. J. Var. 64: 295–299.

Poulton, E. B. 1907. Predacious insects and their prey. Trans. Entomol. Soc. Lond. 1906, pt. III, pp. 323–409.

Scarbrough, A. G. 1978. Ethology of *Cerotainia albipilosa* Curran (Diptera: Asilidae) in Maryland: predatory behavior. Proc. Entomol. Soc. Wash. 80: 113–127.

Scarbrough, A. G. and A. Norden. 1977. Ethology of *Cerotainia albiplosa* Curran (Asilidae: Diptera) in Maryland: diurnal activity rhythm and seasonal distribution. Proc. Entomol. Soc. Wash. 79: 538–554.

Valentine, E. W. 1967. A list of the hosts of entomophagous insects of New Zealand. N.Z. J. Sci. 10: 1100–1209.

PROC. ENTOMOL. SOC. WASH.
84(3), 1982, pp. 628–631

A NEW SPECIES OF *SYMMETRISCHEMA* POVOLNÝ (LEPIDOPTERA: GELECHIIDAE) FROM TEXAS

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Abstract.—Symmetrischema ***kendallorum,*** n. sp., is described. Imagines, male and female genitalia, and wing venation are figured. The host is *Physalis virginiana* Mill. var. *spathulaefolia* (Torr.) (Solanaceae).

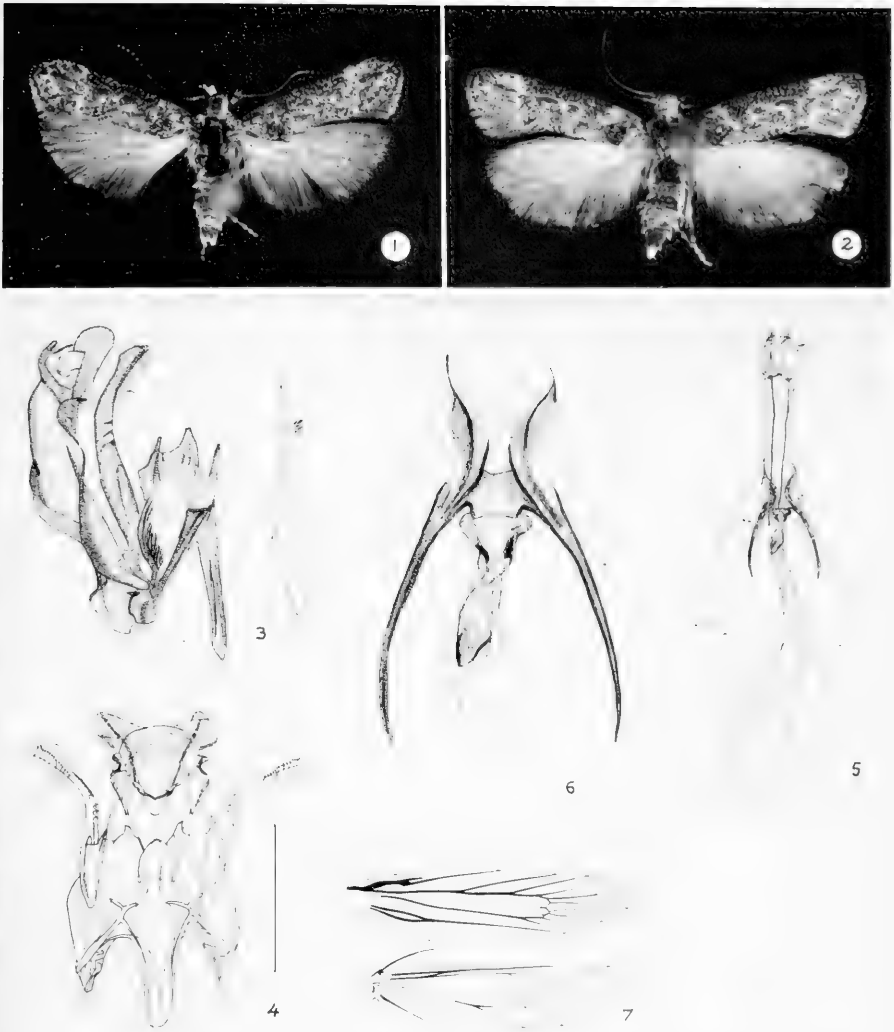
The following new species was discovered in Neuces and Kleberg counties, Texas. Adults were reared from larvae and pupae found in galls on the upper stems of *Physalis virginiana* var. *spathulaefolia* of the family Solanaceae.

Symmetrischema kendallorum Blanchard and Knudson, New Species
Figs. 1–7

Description.—*Head:* Front and vertex light ochreous variably irrorated with fulvous. *Labial palpi:* Exceeding front by 3 eye diameters, basal segments covered by ventro-anteriorly directed divided brush of ochreous scales, terminal segment light ochreous with 2 black bands, 1 submedial, 1 supramedial, scales closely appressed. *Ocelli:* Present. *Antenna:* Simple, flagellum with 2 scale rows per segment. Proximal scale row black with narrow whitish base. Distal 19 scale rows are as follows: 1 white 3 black, 1 white 3 black, 1 white 3 black, 1 white 3 black, 1 white 3 black, 1 white 2 black.

Thorax: Light ochreous, speckled with fulvous.

Forewing: Ground color light ochreous, largely obscured by extensive fulvous overscaling and grayish-black patches. Grayish-black patches appear, under magnification, to consist of black scales having a grayish-white base and a narrow yellowish-white tip. An extensive grayish black patch occupies middle ½ of forewing from costal margin to fold and is interrupted, in the cell, by 2 fulvous spots, narrowly edged with ground color. A single row of grayish-black scales extends along dorsal margin, broadening to form a grayish-black patch near base. Extensive fulvous present along termen and above dorsal margin along fold. Fringe consisting of 3 rows of scales,



Figs. 1–7. *Symmetrischema kendallorum.* 1, Male holotype, North Padre Island, Nueces Co., Texas, 17-IX-81. 2, Female paratype, same locality, 18-IX-81. 3, Male genitalia, side view and separate aedeagus, slide ECK 239, paratype from same locality, 18-IX-81. 4, Male genitalia, ventral view, slide ECK 232, paratype from same locality, 22-IX-81. 5, Female genitalia, slide ECK 240, paratype from same locality, 18-IX-81. 6, Female genitalia, same slide, greater magnification, to show ostium bursae, 8th segment and its apophyses. 7, Wing venation of male paratype, same locality, 25-IX-81, slide A.B. 5050. Segments in Figs. 3, 4, 6, represent 0.5 mm; in Fig. 5, 1.0 mm.

inner 2 rows whitish with broad black apices, outer row ochreous with deeply dissected tips.

Hindwing: Light fuscous. Fringe concolorous, longer than width of wing.

Abdomen: Light fuscous, usually with some ochreous scaling at caudal end.

Length of forewing: Male: ($N = 20$) 4.9–6.0 mm, average 5.5 mm. Female: ($N = 20$) 5.0–6.6 mm, average 5.9 mm.

Venation: As in Fig. 7. which represents a male paratype.

Male genitalia (Figs. 3, 4): Sacculus with 2 sets of paired processes; small, thornlike, outer pair more sclerotized. Median unpaired saccular process prominent, lightly sclerotized, not reaching tips of paired processes, but at base covers ½ of inner pair of paired processes. Valvae exhibiting typical chaetotaxy of genus (row of hairs passing obliquely from tip towards base), but in addition, have 6 to 8 rows of thornlike projections on middle ⅓. Circumanal membrane prominent, densely scobinate, extending beyond uncus laterally and supported by thin rodlike processes. Subscaphial membrane prominent, subtriangular. Along lateral margins of tegumen, near base of uncus, are complicated curved processes which seem to support the cephalad margin of uncus. Aedeagus with short lateral process tipped with numerous fine spines.

Female genitalia (Figs. 5, 6): Bursa lacking signum. Fig. 6 shows simplified 8th segment sternum and ostium bursae.

Holotype (Fig. 1).—♂, Nueces Co., Texas, North Padre Island, ex-larva *Physalis virginiana* Mill. var. *spathulaefolia* (Torr.) (Solanaceae), emerged 17-IX-81, collected by Roy O. and C. A. Kendall and deposited in the National Museum of Natural History, Smithsonian Institution, Washington, D.C.

Paratypes.—Nueces Co., Texas, North Padre Island, 24-VIII-79, 1 ♂, 1 ♀; same location, 25-VIII-79, 3 ♂ (all collected by A. and M. E. Blanchard in blacklight traps). Nueces Co., Texas, North Padre Island, ex-larva or pupa *Physalis virginiana* var. *spathulaefolia*, dates of emergence as follows: 25-IX-79, 1 ♂; 2-IX-81, 1 ♂; 3-IX-81, 2 ♂; 4-IX-81, 1 ♂; 13-IX-81, 2 ♂, 1 ♀; 14-IX-81, 2 ♂, 1 ♀; 16-IX-81, 4 ♀; 17-IX-81, 4 ♂, 4 ♀; 18-IX-81, 11 ♂, 10 ♀ (Fig. 2); 19-IX-81, 4 ♂, 5 ♀; 20-IX-81, 3 ♂, 4 ♀; 21-IX-81, 4 ♂, 3 ♀; 22-IX-81, 4 ♂, 2 ♀; 23-IX-81, 1 ♀. Kleberg Co., Texas, Padre Island National Seashore, 5-IX-81, 1 ♀ (all collected and reared by Roy O. and C. A. Kendall).

Distribution.—So far known only from Nueces and Kleberg counties, Texas.

Life history.—Larvae and pupae found in galls on upper stems of *Physalis virginiana* Mill. var. *spathulaefolia* (Torr.) (Solanaceae). Examples were collected on sand dunes at various locations in Padre Island National Seashore, in Nueces and Kleberg counties.

Remarks.—The genus *Symmetrischema* was erected by Povolný (1967) in his notes on Nearctic and Neotropical *Gnorimoschemini. Symmetrischema* is separated from its nearest relative, *Gnorimoschema* Busck (1903), mainly by characteristics of the male genitalia which include tendency toward the formation of a median unpaired process of the sacculus, enlargement of the terminal portion of the valvae to form irregularly trapezoidal planes with typical chaetotaxy, strongly developed circumanal membrane, and a lateral process of the aedeagus. Additionally, the female genitalia show a tendency towards reduction of the signum. *Symmetrischema kendallorum* clearly exhibits all of the above characteristics, but it is obviously distinct from all other known species. The authors take pleasure in naming this new species for Roy O. and C. A. Kendall, who discovered the larval food plant and reared nearly all of the type-series.

ACKNOWLEDGMENTS

The authors are extremely grateful to J. F. Gates Clarke, research associate of the National Museum of Natural History, for examining the type-series and critically reviewing the manuscript. Appreciation is also due the U.S. National Park Service for their cooperation in allowing collecting of this new species within the Padre Island National Seashore.

LITERATURE CITED

Busck, A. 1903. A revision of the American moths of the family Gelechiidae, with descriptions of new species. Proc. U.S. Natl. Mus. 25(1304): 767–938.

Povolný, D. 1967. Genitalia of some nearctic and neotropical members of the tribe Gnorimoschemini (Lepidoptera, Gelechiidae). Acta Entomol. Mus. Natl. Prague 37: 51–127.

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THREE NEW LEAFHOPPERS (HOMOPTERA: CICADELLIDAE) FROM COCOS ISLAND[1]

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Abstract.—Two new species, *Scaphytopius* (*Cloanthanus*) ***biflavus*** and *Chlorotettix* ***canolaterus,*** belonging to the subfamily Deltocephalinae, and one new species, *Idona* ***murrayae,*** belonging to the subfamily Typhlocybinae, are described. All are from Cocos Island, Costa Rica.

Through the kindness of Charles Hogue, Natural History Museum of Los Angeles County, we were able to examine leafhoppers collected on Cocos Island. This isolated tropical island lies 500 km southwest of Costa Rica and 445 km northeast of the Galapagos Islands.

Although most of the examined leafhopper fauna of Cocos Island is shared with the mainland, the three new species may be endemic. All types are deposited in the Natural History Museum of Los Angeles County, California.

Scaphytopius (*Cloanthanus*) *biflavus* Cwikla and Freytag, NEW SPECIES

Figs. 1–4

Description.—*Length:* Male 3.2 mm, female unknown.

Structural characteristics: Body relatively slender. Head as wide as pronotum. Crown produced anteriorly, median coronal length greater than least interocular width.

Coloration: Anterior margin of crown with dark brown band. Anterior ½ of crown yellow, posterior ½ whitish yellow. Face yellowish. Pronotum whitish yellow with lateral margins brown and irrorate with yellow. Forewing transparent with brownish markings on area of discal cell and around apical and subapical cells.

Male genitalia: Pygofer broadly rounded in apical ½. Genital plates short,

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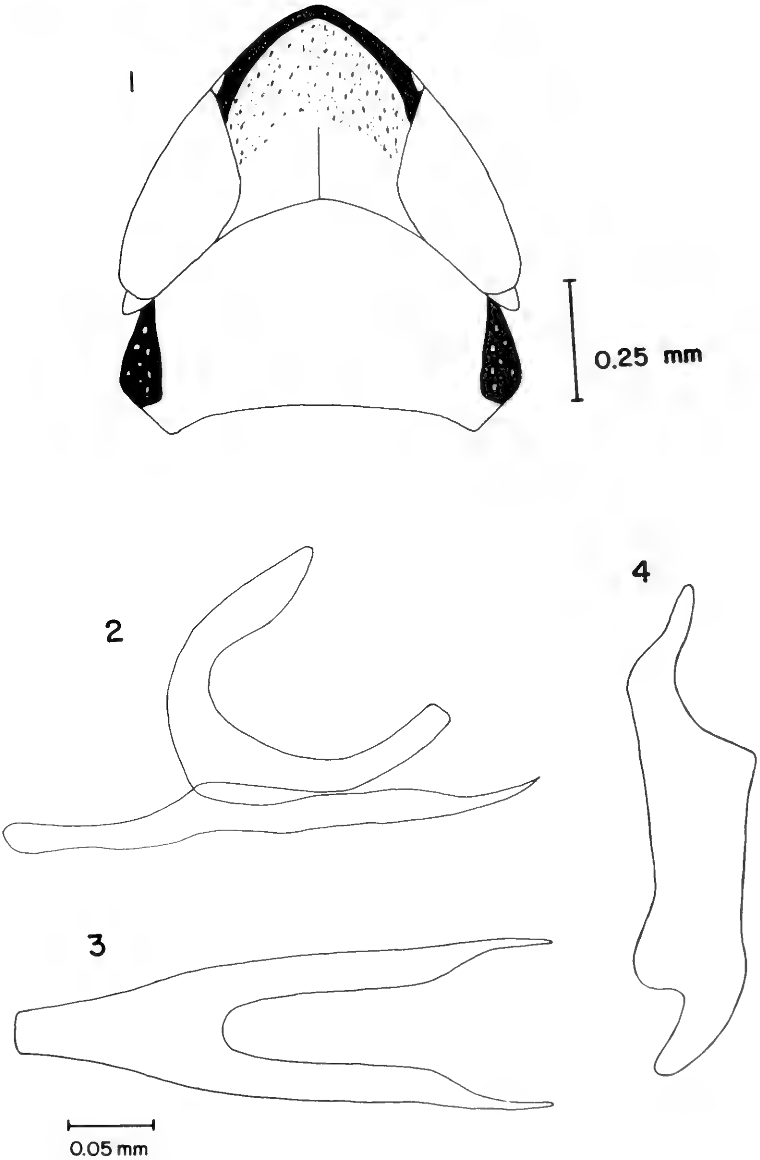
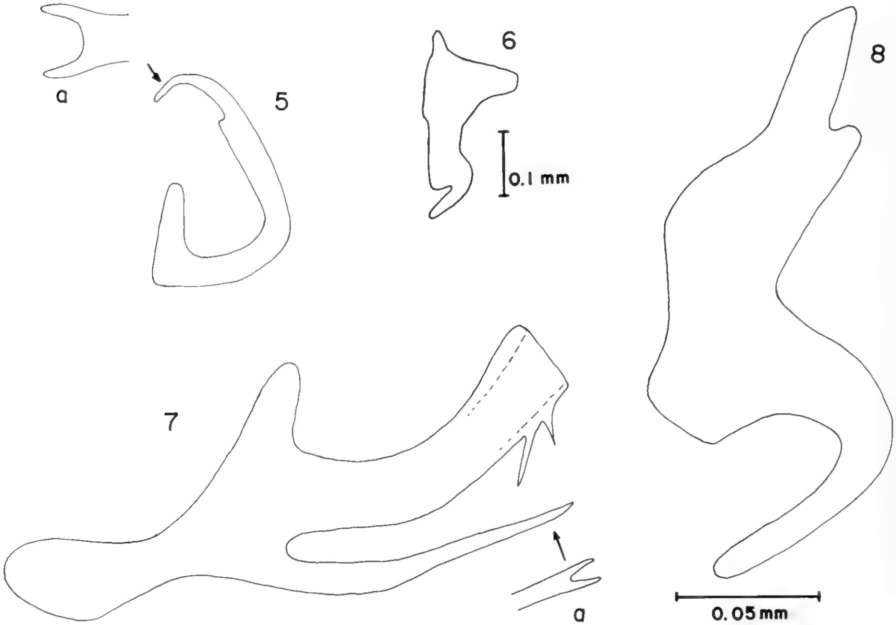
[1] The investigation reported in this paper (81-7103) is in connection with a project of the Kentucky Agricultural Experiment Station and is published with approval of the Director.



Figs. 1–4. *Scaphytopius* (*Cloanthanus*) *biflavus*. 1, Head and pronotum, dorsal view. 2, Aedeagus and pseudostyle, lateral view. 3, Pseudostyle, ventral view. 4, Style, ventral view.



Figs. 5–8. 5, 6, *Chlorotettix canolaterus*. 5, Aedeagus, lateral view. 5a, Aedeagal apex, dorsal view. 6, Style, ventral view. 7, 8, *Idona murrayae*. 7, Aedeagus, lateral view. 7a, Ventral aedeagal process apex, ventral view. 8, Style, ventral view.

triangular, with row of setae on lateral margins. Style with apex blunt. Aedeagal shaft slender, truncate at apex. Pseudostyle (=paraphysis) fused at base, long, apex tapering to a point in ventral view.

Type.—Holotype ♂, Cocos Island (Costa Rica), Wafer Bay, 17–22 April 1975, C. L. Hogue.

Discussion.—This species will key to couplet 2 in Linnavuori's (1959: 73) key to the Neotropical *Scaphytopius* (*Cloanthanus*) Ball; however, a definite association with any of the keyed species cannot be made. It can be separated from other *Scaphytopius* (*Cloanthanus*) by the two shades of yellow on the crown and by the slender aedeagus that is apically truncate.

Chlorotettix canolaterus Cwikla and Freytag, New Species
Figs. 5–6

Description.—*Length:* Male 2.9 mm, female unknown.

Structural characteristics: Body slender. Crown short, slightly produced anteriorly, granulose microsculpturing only on anterior margin.

Coloration: Crown, pronotum, and scutellum whitish yellow. Face yellow. Forewing whitish yellow with yellow patch on costal area and brown patch on 3rd apical cell. Legs and thorax brown.

Male genitalia: Style with apex hooked, blunted pointed. Aedeagus similar to *C. berryi* DeLong (DeLong, 1945: Plate 3) but with aedeagal shaft curved anteriorly, with pair of short dorsally curved processes.

Type.—Holotype ♂, Cocos Island (Costa Rica), Wafer Bay, 24 March 1978, Malaise trap, Station 3, C. Hogue and S. Miller, Steele Exped. 1978.

Discussion.—The generic placement of this species is based on genitalic similarities. This species is similar to *C. berryi* DeLong, but can be separated from it by the small size and the apical processes which are curved dorsally but not laterally.

Idona murrayae, Cwikla and Freytag, New Species

Figs. 7–8

Description.—*Length:* Male 2.5 mm, female 2.6 mm.

Coloration: Body pale yellow. Forewing light yellow with white patch on costal area.

Male genitalia: Style with apex broadly hooked, bluntly pointed. Aedeagus similar to *I. aptera* (Beamer) (Beamer, 1943: Fig. 6D), but 2 spines on ventral margin of shaft near apex and ventral aedeagal process only bifurcate at apex.

Female genitalia: Posterior margin of 7th sternum truncate with median slightly produced.

Types.—Holotype ♂, Cocos Island (Costa Rica), Wafer Bay, 26 March 1978, Malaise trap, Station 3, C. Hogue and S. Miller, Steele Exped. 1978. Paratype ♀, Cocos Is. (500 km SW of Costa Rica), Chatham Bay, Malaise trap over stream, 9–11 April 1979, R. Silberglied.

Discussion.—The generic characters are like those described by Young (1952: 62) for *Idona* DeLong. This species is similar to *I. aptera* (Beamer) but can be separated from it by the two spines on the venter of the aedeagal shaft and by the apically bifurcate aedeagal process. This species is named in honor of Evelyn Murray.

LITERATURE CITED

Beamer, R. H. 1943. Notes and descriptions of some new species of *Dikraneura* (Homoptera: Cicadellidae) J. Kans. Entomol. Soc. 16: 54–63.

DeLong, D. M. 1945. The genus *Chlorotettix* (Homoptera: Cicadellidae) in Mexico. Lloydia (Cinci.) 8: 1–30.

Linnavuori, R. 1959. Revision of the Neotropical Deltocephalinae and some related subfamilies (Homoptera). Ann. Zool. Soc. 'Vanamo' 20: 1–370.

Young, D. A. 1952. A reclassification of Western Hemisphere Typhlocybinae (Homoptera: Cicadellidae). Univ. Kans. Sci. Bull. 35: 3–217.

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FIVE NEW SPECIES OF *DIACHLORUS* (DIPTERA: TABANIDAE) FROM SOUTH AMERICA WITH A REVISED KEY TO SPECIES AND NEW LOCALITY RECORDS[1,2]

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Abstract.—Five new species of the genus *Diachlorus* are described and figured and a revised key to the species is presented. New species are: ***D. leticia, D. trevori, D. leucotibialis, D. habecki,*** and ***D. heppneri.*** Males of two species, *D. xynus* Fairchild and *D. pechumani* Fairchild, are described for the first time. *D. aitkeni* Fairchild is reduced to a subspecies of *D. pechumani.* New distribution records are given for *D. anduzei* Stone, *D. bicinctus* Fabricius, *D. curvipes* Fabricius, *D. fuscistigma* Lutz, *D. jobbinsi* Fairchild and *D. podagricus* Fabricius.

The genus *Diachlorus* was reviewed and a species key was provided by Fairchild (1972). The recent discovery of five undescribed species and change in status of 1 species prompts us to report these taxa, describe males of two species, revise the key, and add new records which extend the geographic ranges of several species. Species of *Diachlorus* are primarily characterized by a patch of silvery gray ("pearly") pollinosity on their pleura and a bare, shiny frontoclypeus. Most are small to medium sized yellow and black species, but a few are primarily black and at least one has a banded abdomen suggesting that it is a wasp mimic. In addition, many have apical wing patches and all have multicolored black and yellow and/or white legs. Eye patterns are quite varied and many resemble *Chrysops* spp. The genus ranges from eastern and southern United States (New Jersey to Texas) and the Bahamas to Argentina but is absent in Chile and the Antilles.

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[2] This paper was prepared during the tenure of National Science Foundation grant DEB-8020081.

KEY TO SPECIES OF *DIACHLORUS* BASED ON FEMALES

1. Subcallus bare and shiny. Largely shiny black species. Apical dark wing patch a vertical band which leaves apex hyaline 2

– Subcallus wholly pollinose. Apical dark wing patch present, faint, or absent; if outwardly dilute, then abdomen not largely black 4

2. Subcallus with a median silvery pollinose streak. Foretibia wholly black and black haired. Subapical dark wing band concave outwardly. Abdomen wholly shiny black, occasionally with faint sparsely pale-haired median triangles on terga 2 to 5 (northern S. America; Trinidad) .... *scutellatus* Macquart

– Subcallus entirely bare and shiny. Foretibia basally white and white-haired. Subapical dark wing band straight or convex outwardly 3

3. Frons about 2.5× as high as basal width. Abdomen with a mid-dorsal yellow integumental stripe, or vestige thereof. Terga 2 and often 3 yellowish or brown laterally. Frontal callus, subcallus and palp yellowish brown. All femora yellowish to brown, the hind pair often with subapical brown band (Brazil, (Bahia to Mato Grosso)) .... *neivai* Lutz

– Frons about 3.5× as high as basal width, abdomen wholly shiny black. Frontal callus black, subcallus black or brown, palp yellow to black, largely pale-haired. All femora black (Brazil (Pará) to E. Peru) .... *xynus* Fairchild

4(1). Antennal scape longer than basal plate. Abdomen black, the first 2 terga with conspicuous white transverse bands. Mesonotum black, shiny, with small pale triangles connected to the yellow-haired notopleural lobes. Scutellum yellow pollinose and yellow haired. Wing with broad dark costal band to apex, a narrow dark band covering crossveins at ends of basal cells and small clouds on fork of 3rd vein (N.E. South America) ..... *bicinctus* Fabricius

– Antennal scape shorter than basal plate. Abdomen rarely black; if so, then otherwise marked. If wing with costal band, then lacking band at ends of basal cells 5

5. Frons about 3.6× as high as basal width, distinctly narrower at vertex, the callus drop-shaped. Antennae unusually long and slender, markedly longer than frons, the style as long or longer than basal plate, the 3rd segment about 3× length of scape. Abdomen dull yellowish with a pair of sublateral blackish stripes covering terga 2 to 6, the median yellowish stripe wider than the black. Fore- and hindlegs mainly brown to black, midleg wholly

pale. Apical wing spot dilute, brownish, often fading out in cell r_4 (S. Brazil) .... *bivittatus* Wiedemann

– Without the above combination of characters 6

6\. Frons narrow, over 3.5× as high as basal width, generally parallel sided or widened in the middle (rarely narrowed above) .. 7

– Frons broad, less than 2.5× as high as basal width, nearly always narrowed above 19

7\. Mesonotum and scutellum both pollinose, the former unstriped. Stigma yellow, brown or black 8

– Either mesonotum or scutellum or both with bare shiny areas 9

8\. Median yellow-haired abdominal stripe broad, at least ⅓ width of abdomen, often appearing as a series of broadly overlapping triangles. Distal ends of basal cells distinctly brown bordered and often with brown streaks in 1st basal and base of 1st posterior cells (USA (New Jersey) to Costa Rica) .... *ferrugatus* Fabricius

– Median yellow-haired abdominal stripe narrow, often indistinct, not over ¼ width of abdomen on terga 2 to 4, occasionally wider on posterior terga. Wings without dark clouds except apical patch (Northern S. America) .... *fuscistigma* Lutz

9(7). Mesonotum without pollinose stripes on bare shiny areas. Stigma intensely black and wing patch strongly black 10

– Mesonotum with at least a median yellow pollinose stripe on bare shiny areas, rarely absent. Stigma yellow to brown, rarely black. Wing patch variable 13

10\. Abdomen translucent yellow on first 2 segments, 3 with diffuse dark patches on posterolateral corners, 4 largely brown, 5 to 7 shiny black, all black pilose dorsally except yellow hairs laterally on terga 1 to 3. All tibiae largely black (E. Colombia) .... *leticia,* new species

– Abdomen yellow in the middle of first 4 terga and with broad blackish dorsolateral stripes. Terga 5 to 7 shiny black. Pilosity yellow in middle and at extreme sides of first 4 terga, black elsewhere 11

11\. Frontal callus square, narrower than frons. Scutellum shiny black. Forecoxa, distal ½ of forefemur, all of mid- and hindfemora and fore- and hindtibiae black, only midtibia and mid- and hindtarsi white. Pale pollinosity and pilosity whitish (E. Ecuador; Brazil (Amazonas)) .... *leucotibialis,* new species

– Frontal callus higher than wide, filling width of frons. Scutellum yellow, as is pale pollinosity and pilosity. Forecoxa and mid- and hindfemora largely pale 12

12. All femora and midtibia pale, at most fore- and midfemora distally dusky. Fore- and hindtibiae black (E. Ecuador) .... *habecki,* new species

– Distal ½ to ⅓ of fore- and hindfemora black. All tibiae black (E. Ecuador) .... *trevori,* new species

13(9). Mesonotum without a pair of anterolateral dark shiny oval spots above pronotal lobes. Median pale pollinose stripe on mesonotum widened at level of wing insertions. Frons about 4.5× as high as basal width. Scutellum yellow margined (Panama to Amazon basin) .... *curvipes* Fabricius

– Mesonotum with a pair of anterolateral dark shiny oval spots or streaks above pronotal lobes 14

14. Abdomen with a pair of prominent black integumental dorsolateral stripes from 1st through 3rd terga; terga 4 to 7 black with broad middorsal yellow-haired triangles. Apical wing patch rather dilute, not obvious much posterior to vein M_1. Frons about 5× as high as basal width. Scutellum black at base (E. Peru) .... *pechumani pechumani* Fairchild

– Abdomen without prominent black integumental dorsolateral stripes, at most with faint black spots on terga 2 to 4, and stronger spots on terga 5 to 7 15

15. Abdomen with faint blackish spots dorsolaterally on terga 2 to 4, and small shiny black spots on terga 5 to 7. A pair of diffuse broad black-haired stripes extends from terga 2 to 4, becoming narrower posteriorly. Apical wing patch as in *pechumani,* but frons slightly narrower and scutellum wholly yellow (Brazil (Pará)) .... *pechumani aitkeni* Fairchild

– Abdomen otherwise. Scutellum at least dark at base 16

16. Median yellow stripe of mesonotum conspicuous, slender. Scutellum wholly black (Brazil (Rio de Janeiro)) .... *varipes* Rondani

– Median yellow stripe of mesonotum faint or, more usually, absent. Scutellum rarely wholly dark 17

17. Dark wing patch rarely evident beyond 1st posterior cell, and then only in dilute form (Costa Rica to Ecuador, and Brazil (Amazonas)) .... *jobbinsi* Fairchild

– Dark wing patch extended along hindborder of wing in full intensity to anal cell 18

18. Hindtibia black and densely black pilose. Last 2 abdominal segments all black and black pilose. Frontal callus higher than wide, frontal index 5.0 to 5.4 (E. Peru) .... *heppneri,* new species

– Hindtibia yellow to brown, yellow to brown pilose. Last 2 abdominal segments at most with shiny black dorsolateral patches.

largely yellow pilose. Frontal callus as wide as high. Frontal index 4.0 or less (Venezuela to Brazil (Mato Grosso)) .... *nuneztovari* Fairchild and Ortiz

19(6). Abdomen with a large prominent black median integumental spot on 2nd tergum, often extending onto 3rd segment. Inner margin of dark apical wing patch proximal to fork of 3rd vein 20

– Abdomen otherwise. Apical wing patch distal to fork of 3rd vein, often faint 21

20. Apical wing patch complete, extensive and intense, its proximal border curved inward, nearly reaching end of discal cell (Northern S. America) .... *podagricus* Fabricius

– Apical spot a broad vertical band, leaving apex of wing hyaline, its proximal border straight (S. Central Brazil) ... *fascipennis* Lutz

21. Mesonotum dark with at most a slender median pale line and margins and scutellum pale haired. Abdomen with pale-haired hind marginal bands widened into low median triangles 22

– Mesonotum with a pattern of dark shiny areas separated by 3 pale pollinose stripes. Abdomen with a median pale-haired stripe or series of connected triangles 23

22. Mesonotum with a slender pale-haired median stripe; sides, posterior margin, and scutellum also pale haired. Abdomen largely black, the hindmargins of all terga pale, yellow haired, and with small median yellow-haired triangles. Sides of 1st 2 terga with yellowish patches (Brazil (Minas Gerais)) .... *altivagus* Lutz

– Mesonotum without median stripe. Abdomen shining light yellow-brown, with anterior parts of terga darkened dorsolaterally. Hindmargins of all terga pale margined, with median triangles and pale hairs (Brazil) .... *glaber* Wiedemann

23. Shiny black areas of undenuded mesonotum consisting of a pair of inverted comma-shaped marks nearly meeting in median line just anterior to scutellum. Abdomen light yellow on first 3 terga; succeeding terga each with a dorsolateral pair of black patches on anterior border. Each tergum with a yellow-haired median triangle reaching anterior border and broad yellow-haired hindmargins. Wings with but a faint trace of apical spot in marginal and submarginal cells (S. Central Brazil) .... *immaculatus* Wiedemann

– Black pattern of mesonotum more extensive. Abdomen otherwise 24

24. Abdomen light yellow brown, tergum 2 with golden yellow midstripe, terga 3 to 5 with a gradually darkening and more distinct dark midstripe, and 3 to 6 with lateral brown streaks. Black

mesonotal pattern consisting of 4 dorsal stripes, the outer pair curved dorsad and joining before scutellum. Femora yellow, except tips of fore- and hindfemora. Wing as in *distinctus* (Brazil (Bahia)) .... *afflictus* Wiedemann

– Abdomen without median dark stripe 25

25. Abdomen with a broad diffuse middorsal yellow-haired stripe, widening on posterior terga. Apical wing spot dilute but well defined, its proximal border sharp, straight, to fork of 3rd vein. Mesonotum on disk shiny black with 3 grayish pollinose stripes, the margins and scutellum yellow haired. Palp dark brown to blackish, shiny (S. E. Brazil) .... *distinctus* Lutz

– Abdomen with a narrow, even yellow-haired middorsal stripe. Apical wing spot dilute and diffuse, seldom reaching fork of 3rd vein. Median pale stripe of mesonotum broader than laterals, usually yellow haired 26

26. All femora brown or blackish, at least darker than tibiae of midpair. Abdomen largely brown to blackish (S. Brazil, Paraguay, Argentina) .... *flavitaenia* Lutz

– All femora yellow. Abdomen generally extensively yellow 27

27. Abdomen yellow to yellowish brown, with a pair of diffuse dark integumental spots on tergum 2, and terga 4 to 6 generally darkened (S. Brazil, Bolivia, E. Ecuador) .... *bimaculatus* Wiedemann

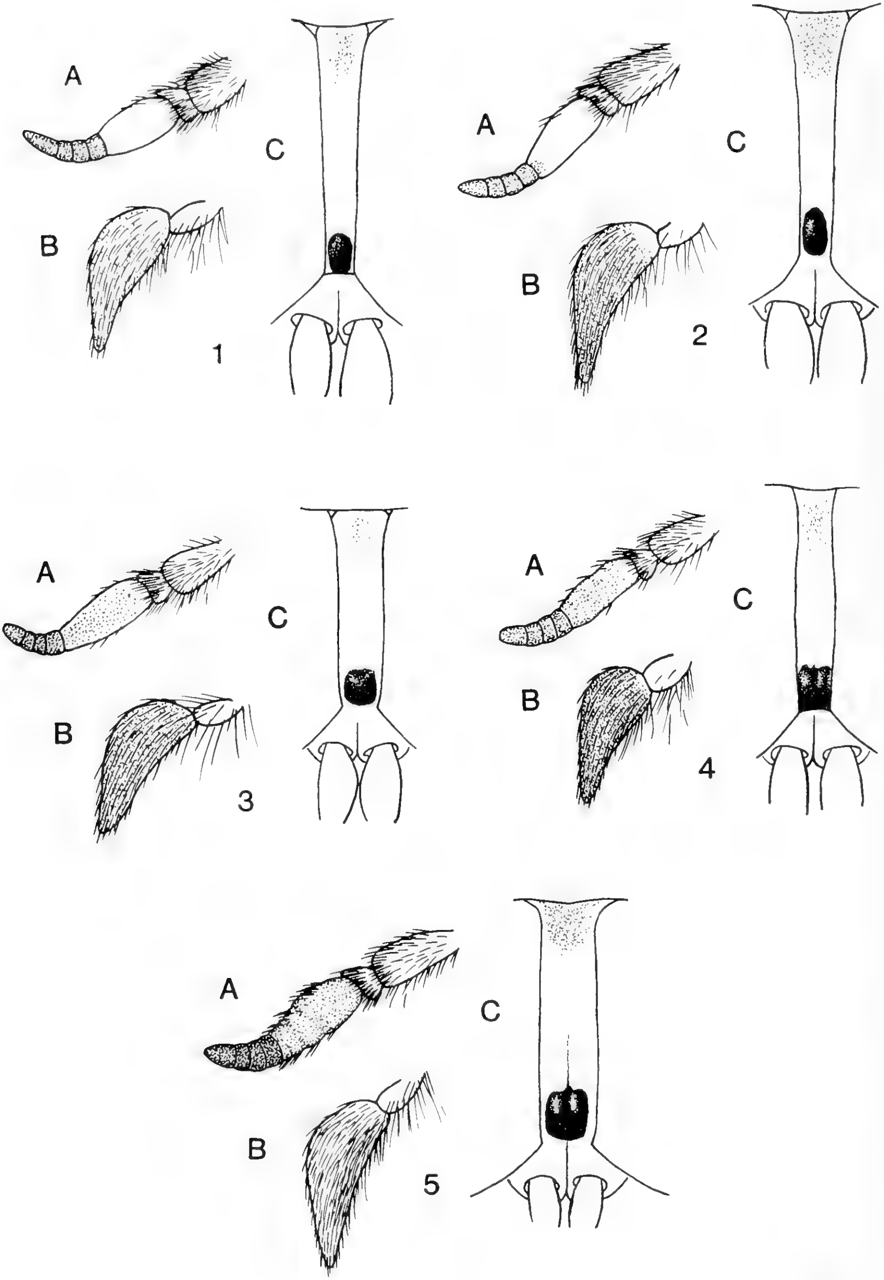
– Abdomen yellow, with more or less distinct dark patches or triangles on extreme sides of terga 4 to 6 (Venezuela, Ecuador, Colombia) .... *anduzei* Stone

Diachlorus leticia Wilkerson and Fairchild, NEW SPECIES

Figs. 1A–C

A slender species resembling *fuscistigma* Lutz, the mesonotum blackish, unstriped, scutellum yellowish, all femora and coxae largely pale, all tibiae blackish. Frons very narrow, abdomen without conspicuous pattern, and wing with black stigma and strong apical spot.

Female.—Length 9 mm; of wing 8 mm. Head structures as figured. Frontal index 8.2, index of divergence 1.2. Frons pale silvery gray pollinose with shiny brown callus and diffuse black patch at vertex. Vestiture of short, sparse, pale yellow hairs, becoming darker around dark patch at vertex. Integument of subcallus and face dark brown; the subcallus shiny silvery pollinose, gena pale yellow pollinose. Frontoclypeus mostly bare, shiny dark brown, lateral area below tentorial pit thinly pale pollinose. Beard sprase, of pale yellow hairs except for small patch of black hairs and dark pollinosity above base of palp next to eye. Eye in life green with dark blue border and horizontal blue mark as figured by Lutz (1913) for *D. fuscistig-*



Figs. 1–5. 1, *Diachlorus leticia*. 2, *D. trevori*. 3, *D. leucotibialis*. 4, *D. habecki*. 5, *D. heppneri*. All holotypes. A, Antenna. B, Palp. C, Frons.

ma. Antennal scape, pedicel, and base of flagellum yellow to orange, remainder of basal plate pale brown becoming dark brown on annuli. Antennal hairs pale yellow above and below, dark brown laterally. First palpal segment yellow pollinose, pale yellow haired; 2nd segment with brown integument showing through sparse shiny yellow pollinosity, hairs pale yellow. Proboscis blackish, stylets about as long as palp, labella large and wholly fleshy.

Mesonotum black in ground color. Central area in a broad diffuse transverse band between transverse sutures, and prescutellar area shiny blackish. Area anterior to transverse suture thinly pale pollinose. Notopleural lobes, postalar lobes, prescutellum and scutellum thickly yellowish pollinose and yellow pilose. Pilosity on dark areas sparse, black. Pronotal lobes, propleural lobes and forecoxa yellow and pale pollinose and pilose. Mesopleuron including midcoxa infuscated, mesoanepisternum and mesokatepisternum shiny black in ground color, sparsely covered with pearly pollinosity; remainder of pleura including portions of the mesoanepisternum and mesokatepisternum near the wing base sparsely yellow pollinose. Hindcoxa pale yellow and pale yellow pollinose. Basal ½ of forefemur, all of midfemur, and all but apex of hindfemur pale yellow. Apical ½ of forefemur and apex of hindfemur heavily infuscated. Tibiae black; midtibia whitish apically. Foretarsus black; 1st tarsomere of mid- and hindlegs contrastingly white, remainder brown. Leg hairs yellow, black or whitish, corresponding to underlying color. Wings hyaline with smoky brown apical patch reaching from end of vein R_1, through fork of 3rd vein and continuing posteriorly more faintly through distal area of posterior cells. Costal cell brown. Stigma dark brown, vein R_1 from the stigma to its termination yellow. Wing veins brown margined, more intensely so at apices of basal cells. Halter with yellow stem and dark brown knob. Integument of abdominal terga 1, 2, and most of 3 translucent yellow. Tergum 3 with dorsolateral faint, diffuse black patches, remaining terga shiny black. Dorsal pilosity of numerous short black hairs except for pale yellow hairs laterally and mesially on tergum 1 and a quite small inconspicuous median patch on tergum 2. Abdominal sterna 1–4 yellow pollinose and yellow haired; remaining sterna black and black haired.

Types.—Holotype, ♀, Colombia, Comisaría of Amazonas, 17 km N. Leticia, 25 July 1973, elev. 100 m, Malaise trap, Wilkerson and Young coll. To be deposited in Florida State Collection of Arthropods (F.S.C.A.).

Paratypes, 2 ♀, same locality but 26 July 1973. To be retained in collections of the authors.

Paratypes have wing lengths of 8.5 and 9.0 mm and frontal indices of 8.2 and 9.3. They agree in detail with the holotype, one differs slightly in that there is faint indication of a pale middorsal abdominal stripe.

Discussion.—*Diachlorus fuscistigma* is similar to *D. leticia* but the two are readily distinguished by leg coloration and abdominal vestiture. The midtibia of *D. leticia* is black and the middle and back first tarsomeres white. The midtibia of *D. fuscistigma* is pale yellowish brown and the midtarsus pale yellowish brown, the hindtarsus pale basally darkening to brown apically. *Diachlorus fuscistigma* has a broad middorsal yellow-haired abdominal stripe not evident in *D. leticia*. These two species share the same eye pattern which, to our knowledge, is unique in the genus.

It is unlikely that *D. leticia* is but a color form or subspecies of *D. fuscistigma* since it occurs in the middle of the range of *fuscistigma*: Surinam; Brazil (Amazonas, Pará, Bahia); Bolivia; Colombia; Ecuador; Peru. Both have been taken in the vicinity of Leticia, Colombia, and we have seen no intermediates.

Diachlorus trevori Wilkerson and Fairchild, NEW SPECIES

Figs. 2A–C

A slender species with narrow frons, unstriped mesonotum, largely yellow coxae and femora, black tibiae and white mid- and hindtarsi. Abdomen yellow with broad sublateral dark stripes and apex. Wings with dark stigma and a conspicuous black apical patch.

Female.—Length 10 mm; of wing 9 mm. Head structures as figured. Frontal index 8.4; index of divergence 1.3. Head structures, pilosity and pollinosity as in *D. leticia*. Eye pattern not noted.

Thorax, wings and legs as in *D. leticia*, except that the scutellum is mostly yellow in ground color, darkened slightly at base and lateral bare shiny areas are anterior to transverse sutures.

First abdominal tergum yellow; 2–4 yellow with broad dorsolateral black stripes formed of large contiguous spots; remaining terga black. Dorsal hairs largely black but yellow laterally and in central portion of mid-dorsal yellow stripe. Abdominal sterna 1–4 yellow and yellow haired; remaining sterna black and black haired.

Male.—Length 9.5 mm; of wing 9.0 mm. Like female with following differences. Eyes bare, holoptic, a central area of poorly demarcated larger facets occupies about ⅓ eye area. Vertex with small black tubercle which does not reach eye level and bears no visible vestiges of ocelli. Palp greatly swollen, drop-shaped, shiny black and sparsely yellow haired. Sublateral abdominal spots less extensive than in female, not contiguous.

Types.—Holotype, ♀, Ecuador, Napo Province, Limoncocha, Playaco River, Malaise trap, 23–28-VIII-1980, Knopf and Dunkle coll. Allotype, ♂, same information as holotype but netted. Paratypes 12 ♀, 7 ♂, same data as holotype. Holotype and Allotype to be deposited in F.S.C.A.

Female paratypes, length 8.5–11.0 mm; wings 8.5–9.5 mm. Frontal indices 7.0–9.3; indices of divergence 1.2–1.6. Male paratypes, length 9–11 mm; wings 8–9 mm, paratypes to be retained in collections of the authors.

Discussion.—The sublateral abdominal stripes of the males vary from very faint, with some lacking the spot on the fourth segment, to nearly as prominent as in the female.

Diachlorus trevori is similar to two species described here, *D. habecki* and *D. leucotibialis*. *Diachlorus leucotibialis* has black mid- and hindfemora and a white midtibia; *habecki* has wholly yellow midlegs; *D. trevori* has largely yellow mid- and hindfemora and a black midtibia. *Diachlorus leucotibialis* has a black scutellum and grayish yellow thoracic pollinosity instead of the yellow scutellum and yellow thoracic pollinosity of *trevori* and *habecki*.

Named for Trevor Alan Wilkerson, son of the senior author.

Diachlorus leucotibialis **Wilkerson and Fairchild, NEW SPECIES**

Figs. 3A–C

A slender species with a narrow frons, extensively black legs but midtibia and basitarsus and hindbasitarsus contrasting ivory white. Scutellum black and shiny. Abdomen yellow with broad dorsolateral black stripes and a black tip, the wing with a black stigma and dilute black apical patch not extending along hind border beyond 3rd posterior cell.

Female.—Length 8 mm; of wing 7.5 mm. Head structures as figured. Frontal index 4.6, frons slightly widened below. Color of vestiture of head and appendages as described for *D. leticia*. Mesonotum as in *D. leticia* but yellow integumental and pollinose borders paler, whitish yellow instead of yellow. Scutellum shiny black in ground color with sparse yellow hairs and pollinosity. Propleuron pale yellow pollinose and sparsely yellow haired. Remainder of pleural integument and midcoxa black, showing through sparse silvery gray pollinosity typical of genus. Foreleg with coxa black in ground color, sparsely yellow pollinose and yellow haired; femur bicolored, basally yellow, apically black; tibia and tarsus entirely black. Midleg with trochanter yellow, femur black, tibia and basitarsus white, remainder of tarsus brown. Hindleg with coxa, trochanter, and extreme base of femur yellow; rest of femur and all but extreme base of tibia black; basitarsus white, remainder of tarsus brown. Wing and halter as in *D. leticia*. Abdominal tergum 1, sides of 2 and a middorsal broad stripe through 5, yellow and yellow haired; the remainder black and black haired. Sterna 1, 2, and large median areas of 3–5 yellow and yellow haired; lateral areas of 3–5 and remaining segments black and black haired.

Types.—Holotype, ♀, Ecuador, Napo Province, Primavera, netted, 26-VIII-1980, Dunkle and Knopf coll. To be deposited in F.S.C.A.

Paratypes: 1 ♀ same data as holotype; 8.5 mm long, wing 8.0 mm, frontal index 4.9. 2 ♀, Brazil, Amazonas, Manaus, Reserva Ducke, VI-1976, L. Albuquerque; length 6.5 and 7.0 mm, of wing 7.0 and 7.5 mm, frontal indices 4.3 and 4.9. All paratypes agree well with the holotype though the 2 from Brazil are paler yellow than the Ecuadorian specimens.

Discussion.—*Diachlorus leucotibialis* is quite similar to *D. trevori* and *D. habecki*. The differences between these three are discussed under *D. trevori*.

Diachlorus habecki Wilkerson and Fairchild, New Species

Figs. 4A–C

A slender species with a narrow frons, unstriped mesonotum, and legs mostly yellow, but with the fore- and hindtibiae black, the foretarsus black and the mid- and hindtarsi white. Abdomen with large sublateral black spots on terga 2 to 3 or 4, the last 3 segments of the abdomen black.

Female.—Length 8 mm; of wing 8 mm. Head structures as figured. Frontal index 6.8. Frons slightly widened in middle. Color of integument and vestiture of head structures as in *D. leticia* except that palp is darker, 1st segment concolorous with 2nd black, not orange brown as in *leticia*. As noted from figures, basal plate of antenna of *habecki* not markedly widened. Mesonotum, scutellum, pleura, wing, and halter all as in *D. leticia*. Coxae, femora, and midtibia yellow and yellow haired. Foretibia and tarsus and hindtibia black and black haired. Mid- and hindbasitarsi white and white haired, remainder of tarsus brown.

Abdominal terga 1–4 yellow and yellow haired with broad dorsolateral black and black pilose stripes, broadest on tergum 2, narrower on 3, and obsolete or absent on 4. Abdominal segments 5–7 shiny black and black haired. Sterna 1–4 yellow and yellow haired.

Types.—Holotype, ♀, Ecuador, Napo Province, Limoncocha, Playaco River, 23–28-VIII-1980, Malaise trap, Knopf and Dunkle coll. To be deposited in F.S.C.A. Paratypes, 3 ♀, same data as holotype. The paratypes are 7.5–9 mm long; wings 7–8.5 mm with frontal indices of 6.5–6.7. One has a parallel-sided frons, another is slightly widened in the middle, another slightly wider below than above. To be retained in the collections of the authors.

Discussion.—*Diachlorus habecki* is very similar to *D. leucotibialis* and *D. trevori*. The differences between these three are discussed under *D. trevori*.

Named in honor of Professor Dale Habeck of the Department of Entomology and Nematology, University of Florida, in grateful acknowledgment of numerous kindnesses to both of us.

Diachlorus heppneri Wilkerson and Fairchild, New Species

Figs. 5A–C

A slender species similar to *D. nuneztovari*, with yellow palpi, striped mesonotum, mostly yellow scutellum and legs mostly yellow except for black fore- and hindtibiae and foretarsus. Wings with a distinct dark apical patch extending in full intensity along hind border to anal cell. Abdomen orange with a sharply black and shiny tip.

Female.—Length 9.5 mm; of wing 10.0 mm. Head structures as figured. Frontal index 5.4. Frons nearly parallel sided, widened slightly in middle and above. Frons grayish yellow pollinose with shiny dark brown callus and diffuse black patch at vertex. Vestiture of short sparse pale yellow hairs becoming black and numerous at dark patch at vertex. Subcallus, gena, and lateral area of frontoclypeus silvery gray pollinose. Remainder of frontoclypeus shiny, dark brown. Scape and pedicel yellow, outer aspect brown haired, remainder yellow haired. Flagellum brown, annuli slightly darker than basal plate. Palp yellow and yellow haired. Stylets about as long as palp, proboscis brown and brown pollinose, labella large and wholly fleshy. Beard of sparse pale yellow hairs.

Mesonotum yellow and yellow pollinose with broad median shiny black stripe reaching to prescutellar area and projecting laterally to transverse suture and back to wing base. Anterior to transverse sutures are a pair of subshiny dorsolateral spots formed of dark integument showing through sparse pollinosity which are separated from median dark stripe by dense pale pollinosity. Scutellum shiny dark orange, sparsely yellow haired and with dark spot at base. Propleuron yellow pollinose and yellow haired. Remainder of pleura with black integument showing through silvery gray pollinosity. Area below wing base sparsely yellowish pollinose. Foreleg with coxa and femur yellow; tibia and tarsus black. Midleg with coxa black; femur and tibia yellow; basitarsus white, remainder of tarsus pale brown. Hindleg with coxa and femur yellow; tibia black; basitarsus white, remainder black. Leg hairs concolorous with integument. Halter yellow. Wing with distinct smoky brown apical patch beginning at end of vein R_1, continuing through fork of 3rd vein and posteriorly in broad band through 5th posterior cell. Costal cell tinted yellow, 1st basal cell with broad anterior brown streak, and stigma pale brown.

Abdominal terga 1–5 dark yellow, 6 and 7 black. Tergum 1 and 4 and 5 yellow haired; 2 and 3 black haired with broad median yellow haired stripe; 6 and 7 black haired. Sterna 1–4 yellow and yellow haired; 5 dusky and yellow haired; 6 and 7 black and black haired. Five yellow anterior segments thinly yellow pollinose, 2 terminal black segments shiny.

Types.—Holotype, ♀, Peru, Madre de Dios, Rio Tampopata Reserve, 30 air km SW Pto. Maldonado, 290 m, 6–10-XI-1979, Subtropical Moist Forest, J. B. Heppner coll. To be returned to National Museum of Natural History, Washington, D.C. (USNM). Paratypes 2 ♀, same locality as holotype, one, 21–25-XI-1979, the other 16–20-XI-1979. To be returned to USNM.

Paratypes are 9.5 and 9.0 mm long and have wing lengths of 9.5 mm. Frontal indices are 5.0 and 4.8.

Discussion.—*Diachlorus heppneri* is quite similar to a sympatric species, *D. nuneztovari*. *Diachlorus nuneztovari* has a slightly broader frons, pale hindtibia, and a distinct broad abdominal yellow-haired stripe reaching through terga 6 or 7. *Diachlorus jobbinsi* is also similar but has a pale hindtibia and less extensive wing coloring, the apical patch not extended posteriorly, and the first basal cell not infuscated brown.

Named in honor of Dr. John B. Heppner, lepidopterist of the National Museum of Natural History and the collector of this and many other interesting tabanids.

Diachlorus pechumani Fairchild

This species was based on 4 females from Quince Mil, Prov. Cuzco, Peru. An additional female collected by Wilkerson and Young is from Colombia, Amazonas, 17 km W. of Leticia, 22-VII-73. It is paler than the available paratype, the dark abdominal stripes being only a little darker than the darkest available paratype of *D. aitkeni,* while the dark pilose areas on the hindlegs are less dark and less extensive than on the paratypes of *D. pechumani.* Three additional females from Surinam, though not in perfect condition, are nearly as dark as the Colombian example cited above, although geographically closer to the type-locality of *aitkeni.* Further specimens from the type-locality of *aitkeni* are a male and a female taken by D. G. Young in July–Aug. 1974, and 4 females taken in the forest canopy by I. S. Gorayeb, and J. A. Rafael, 1–6-VII-1981. Surprisingly, the species proves to be sexually dimorphic, the male being even darker than *pechumani,* the female with almost entirely yellow legs and abdomen. A description of the male follows.

Male.—Length 9 mm, of wing 8 mm. Eyes bare, holoptic, bearing a poorly demarcated area of greatly enlarged facets in middle, covering about ⅓ or less of whole eye area. Vertex with a black subshiny tubercle beset with long black hairs and reaching to eye level. Subcallus and frontal triangle brown in ground color, the former silvery pollinose, the latter bare and shiny. Frontoclypeus inflated, black, shiny, with sunken orange pollinose lower median subtriangular area. Cheeks thinly gray pollinose, sparsely pale haired. Antenna as in female but basal plate and style more slender. Palp inflated, banana-like, black and shiny, the 1st segment orange, contrasting with the 2nd, both sparsely haired. Proboscis blackish, theca sclerotized, labella soft, exceeding length of palp.

Thorax marked as in female, though dark areas more extensive and less pollinose, so that thorax appears more dark and shiny. Scutellum blackish, shiny. Wings as in female, apical spot dilute, barely visible beyond apical cell. Stigma yellow. Forecoxa yellow, mid- and hindcoxae lightly infuscated on outer surface. Forefemur apically black, basally pale, bicolored. Midfemur largely brown, yellow at base and apex. Hindfemur black except for pale basal ⅕ and extreme apex. Foretibia and tarsus black to dark brown. Midtibia white and white pilose, as is tarsus except for dusky tip. Hindtibia about ⅓ pale basally, otherwise black, tarsus white except for a dusky tip. Vestiture follows integumental color. Halter with yellow stem and brown knob.

Abdomen translucent yellowish, 1st segment brownish on posterior margins, 2nd to 6th terga with broad blackish patches which form dorsolateral stripes on terga 2 and 3 but reach lateral margins on terga 4 to 6. Terga 2 and 3 also have extreme sides somewhat infuscated. Median yellow strip widened to form complete or nearly complete pale hindmargin on segments 4 to 6. Beneath abdomen is translucent on first few segments, except for chalky white patch at sides of 1st segment. Posterior segments yellow, increasingly brown infuscated to nearly black terminally. Vestiture sparse, of long hairs, and integument largely shiny both above and below.

Discussion.—Plesiotype ♂, Brazil, Pará, Belem, APEG forest, 29-VII to 6-VIII-1974, D. G. Young coll., flight trap.

The additional material here reported and the appearance of the male make it necessary to reduce *D. aitkeni* to a subspecies of *D. pechumani* since the latter has page precedence and was the species illustrated.

Diachlorus xynus Fairchild

Two additional females from Colombia, Meta, El Porvenir and Carimagua, II and III 1979, Wilkerson coll., agree closely with paratypes from Surinam and eastern Colombia in having the wings more lightly marked and in being smaller than Peruvian examples. Two male examples from Brazil, Mato Grosso, Rio Aripuana, Humboldt, 59°27′W., 10°10′S., 12–16-VIII-74, D. G. Young coll., flight trap, are unfortunately not accompanied by females. We believe, however, that they belong with *xynus* rather than *scutellatus,* as they lack the median pollinose stripe on the subcallus and have very dark costal cells, irregular proximal margin of apical spot, and strong clouds around apices of basal cells and discal cell. Both specimens are almost entirely shiny black and sparsely black-haired, showing pale vestiture or integument only on the four posterior basitarsi, extreme bases of four posterior tibiae, and small tufts of dark golden hairs on notopleural lobes and disk of scutellum. The halteres have blackish stems and orange heads. The eyes are bare with large facets confined to a small area in the front of the eye, the facets not much enlarged nor demarcated from the small facets. Although holoptic, the eyes are in contact for only a short distance, and there is a prominent brownish subshiny frontal triangle and a large black and hirsute tubercle at vertex rising well above eye level. The antennae are like those of the female, though more slender, the palpi greatly inflated, both segments shiny black and the 2nd with long outstanding hairs. Wings are like those of females from eastern Peru, heavily marked, and with the basal cells strongly brownish tinged.

New Distribution Records

Diachlorus anduzei Stone. 1 ♀, Ecuador, Napo Prov., Limoncocha, 18–25-V-76, T. E. Rogers coll., flight trap.

Diachlorus bicinctus Fabricius. 1 ♀, Bolivia, Dept. Beni, Rio Itenez at mouth of Rio Baures, 30-IX-1964, J. K. Bouseman coll. 2 ♀ Brazil, Mato Grosso, Rio Aripuana, Humboldt, 12–16-VIII-1974, D. G. Young coll., flight trap. These specimens are darker than those from Surinam, with more extensive and darker wing spots at ends of basal and discal cells and at fork, while the costal dark band is extended in a faint apical patch along the hind border to the 3rd posterior cell.

Diachlorus curvipes Fabricius. 3 ♀, Bolivia, Dept. Beni, Rio Mamore and Rio Itenez, Aug., Sept. 1964, Bouseman coll.

Diachlorus fuscistigma Lutz. 1 ♀, Bolivia, Rio Itenez, Pampa de Meio, 11–13-IX-1964, J. K. Bouseman coll.

Diachlorus podagricus Fabricius. 2 ♀, Brazil, Pará, Mocambo, (APEG forest), I–VII and 4–6-VII-1981, flight trap in forest canopy 1 ♀, 29-VII to 6-VIII-1974, flight trap, D. G. Young coll.; 4 ♀, Brazil, Amazonas, Reserva Ducke near Manaus, 24, 25, 29-VII-1981 and 14-VIII-1981, arboreal flight trap; 2 ♀, Brazil, Amazonas, Manaus, Parque Laranjeiras, 29-VII-1981, arboreal flight trap and 1 ♀, Brazil, Pará, Belem-Brasilia highway, km 94, 10-I-1962, in tree. The species seems almost wholly arboreal. The recent specimens were taken in an arboreal flight trap designed by J. A. Rafael and I. S. Gorayeb.

Diachlorus jobbinsi Fairchild. 2 ♀, Brazil, Amazonas, Lago Amana, 10-IX-1979, at light, Robin Best coll. In coll. INPA, Manaus.

Acknowledgments

We express our appreciation to D. G. Young and D. H. Habeck for their kind help in reviewing this manuscript.

Literature Cited

Fairchild, G. B. 1972. Notes on neotropical Tabanidae (Diptera) XIII. The genus *Diachlorus* O. S. Fla. Ent. 55(4): 219–229.

Lutz, A. 1913. Tabanidas do Brazil e alguns Estados vizinhos. Mem. Inst. Oswaldo Cruz (Rio de J.) 5(2): 142–191.

PROC. ENTOMOL. SOC. WASH.
84(3), 1982, pp. 651–652

Book Review

The World of the Tent-Makers. A Natural History of the Eastern Tent Caterpillar, by Vincent G. Dethier. The University of Massachusetts Press, Amherst. 1980. 148 pp.

This delightful book is a popular account of the biology of the Eastern Tent Caterpillar. The book is very much in the tradition of the author's previous *To Know a Fly* and Howard Evans' *Wasp Farm* and *Life on a Little Known Planet.* The story line follows the fate of a clutch of tent caterpillar eggs from the dormant eggs in midwinter to the emergence of the adults and the laying of the next generation of eggs the following summer.

The book begins with a discussion of how the overwintering first-instar larvae in the egg shells survive the sub-freezing temperatures and how they measure the gradually lengthening days of spring and hatch after the proper period of light and warmth. The newly hatched young are followed through the first stages of their colonial life, and in the process, the topics of pheromone trails, social behavior, silk production, movement, and orientation are presented. One of the more interesting aspects of their loose social life, I think, is the heterogeneity of the larvae in terms of their activity. Dethier discusses admirably the paradox of a social animal that depends on active and slightly asocial individuals to keep the colony well fed and healthy. As early summer progresses, Dethier follows the caterpillars through their molts, briefly touching on the hormonal control of metamorphosis. The selection of foodplants and the relationship between chemicals produced by the plant and the food-seeking behavior of the larvae are reviewed. The nemesis of death is also portrayed: the predators, parasitoids, and pathogens. As last-instar larvae, they leave the nest and wander. As random as it looks to those of us who have watched it, their search for a pupation site is not haphazard, and the discussion of the search gives Dethier a chance to elaborate on how the larvae orient. Once the larva has located a pupation site, the author talks about the construction of the cocoon, the molt into the pupal stage, and hints, too briefly I thought, at the reorganization of the body tissues of the larva into the adult stage. The book concludes with the emergence of the adult and the laying of the next generation of eggs.

The book is filled with interesting details and tidbits of information, all of it presented in a light and easy manner. The writing style, at times, tends to become a bit romantic, but never enough to irritate. The author's background as a physiologist is apparent as physiology and neurobiology tend to dominate the ecology and evolution. Perhaps a bit more information on the coevolutionary relationship between the host plants and the caterpillars might have been welcome. Dethier's list of references has one important omission: John G. Franclemont's treatment of the genus *Malacosoma* and the beautiful color plates in *The Moths of North America North of Mexico,* fascicle 20.1, 1973.

These ritual carpings do not detract, however, from the enjoyability and quality of the book. It's the sort of book I would buy to give to a relative who wondered what I'm doing and why I'm doing it.

Robert W. Poole, *Systematic Entomology Laboratory, IIBIII, Agricultural Research Service, USDA, % National Museum of Natural History, Washington, D.C. 20560.*

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BOOK REVIEW

Taxonomic Studies of the Encyrtidae with the Description of New Species and a New Genus, by Gordon Gordh and V. A. Trjapitzin. University of California Publications in Entomology. 1981. Vol. 93, 55 pp., 6 pls. of 23 figs. Cost: $7.00 (paperback).

This paper discusses 13 North American genera of Encyrtidae. One genus and five species are described as new, three lectotypes are selected, one tribe and three genera are placed in synonymy, a key to four genera of one subtribe is given, and keys to the species of five genera are provided.

Basically the paper is divided into a brief introduction, a taxonomic section, a summary, a bibliography, and six plates of figures. Of these sections, possibly the introduction and summary are the most important to the majority of readers, and it is herein that the reader might be confused. The authors state that "there are no keys available to the genera" of North American Encyrtidae (first paragraph), but then they cite two recent generic keys for this region (third paragraph). The summary states that the paper treats "the chalcidoid family Encyrtidae as it is represented in North America," but actually it treats only 13 of 131 genera. These statements, I feel, are possibly just misworded, but the abstractor or reader who relies solely on these sections for information will be misinformed or misled as to what is accomplished or presented in the main body of the text. Additionally, the summary incorrectly lists the taxa *Tetralophiellus brevicollis* Ashmead and *Cerapterocerus floridanus* Ashmead as "Generic Redescriptions," when the authors really meant new combinations in the genus *Tetracnemus* (*brevicollis* is not cited as such in the text or the summary).

This paper will have limited appeal to most readers, as it mainly consists of descriptive and taxonomic notes on a few selected genera. Keys to species of five genera may prove useful to some readers. There are 23 figures, unfortunately without a figure legend, so that the identity of each must be found in the text. (On page 46, the reference to Fig. 24 should read Fig. 23.)

On a personal note, I do not care much for the format adopted for this volume by the University of California Press. It has apparently used a camera-ready, typed manuscript (unjustified right margin) with wide-spaced lines. By my estimate, the older style issues contain at least twice the numbers of words per page as the new, and thus require half the number of pages as the presently used format. At the same time, I believe the text of the older issue is more easily readable, with the various sections and subsections being quite distinct. I hope the press will consider returning to its previous format. Additionally, it has been my impression that the U. C. Publications in Entomology have been used for comprehensive taxonomic and biological treatments of subjects rather than fragmentary works such as the one discussed here. I believe this series should be reserved for comprehensive works, and that other papers should be referred to the appropriate journals.

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TAXONOMIC STUDIES IN THE GENUS *RHIPIBRUCHUS* BRIDWELL (COLEOPTERA: BRUCHIDAE), WITH DESCRIPTIONS OF FOUR NEW SPECIES

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Abstract.—The South American genus *Rhipibruchus* is apparently restricted to seeds of *Prosopis* spp. (Leguminosae), common name "mesquite." Six species are now assigned to it including *Rhipibruchus picturatus* (Fahraeus), *R. prosopis* Kingsolver, and four new species, ***R. rugicollis, R. oedipygus, R. atratus,*** and ***R. psephenopygus.*** Host records, geographical distribution, a key to species, and illustrations of salient characters are provided.

Since my summary of *Rhipibruchus* was published in 1967, four additional new species and numerous host associations have been discovered. In this paper the generic description is revised, new species are described, host records are tabulated, and a key to species is given. Life histories of some of these species are being investigated by Arturo Terán and Susana M. de L'Argentier in Argentina. Collections have also been made by Hugo Cordo and associates in Argentina for possible biological control of mesquite in that country and in the United States.

Genus *Rhipibruchus* Bridwell

Rhipibruchus Bridwell, 1932: 105. New name for *Megalorhipis* Philippi, 1859: 668 (not Lacordaire, 1857). Type-species: *Megalorhipis leiboldi* Philippi, 1859: 668 = *Rhipibruchus picturatus* Fahraeus, 1839: 2. Automatic type designation.

Genus in subfamily Bruchinae, tribe Acanthoscelidini. Body ovate, rather broad. Head short, broad; width across eyes approximately equal to height of head, strongly constricted behind eyes; eyes prominent, more narrowly separated in ♂ than in ♀ (Fig. 23); frons with prominent median carina expanded dorsally into triangular boss; ♂ antenna strongly pectinate from 4th segment (Fig. 16), ♀ antenna strongly serrate from 4th segment (Fig.

17). Pronotum campaniform, disk convex with narrow median sulcus separating paired basal and apical tumescences, or pronotum uniformly convex without prominent tumescences; median basal lobe rounded, lateral margins slightly convex or sinuate; lateral carina obsolete or faintly indicated by threadlike line. Scutellum small, narrow. Elytra subquadrate, each elytron evenly rounded at apex; disk flat, or subdepressed medially; striae usually well defined, 3rd and 4th striae commonly arising at base from prominent, rounded, bidentate gibbosity. Pro- and mesolegs slender, procoxae contiguous apically, mesocoxae narrowly separated; metafemur moderately incrassate, finely serrate in basal ⅔ on ventroposterior margin, pecten with 3 or 4 denticles (Fig. 24). Male pygidium arcuate in lateral profile, apex fitting into emargination of 5th sternum; sterna 2–5 telescoped; ♀ pygidium nearly flat in lateral profile, vertical or oblique. Male genitalia with median lobe long and slender (Fig. 2); lateral lobes elongated, slightly expanded apically (Fig. 3).

The male genitalia in the six known species of *Rhipibruchus* (and one species of *Pectinibruchus* Kingsolver, a closely related genus) are basically similar with only subtle specific differences; however, the basic structure is so unlike that of any other species or group of species that for future reference in relating *Rhipibruchus* and *Pectinibruchus* to other groups, the following description is given (Fig. 10): The median lobe is elongated, parallel-sided in apical two-thirds but cucullate in basal one-third; the ventral valve is ovate-acuminate and varies but little throughout the genus. Details of the armature of the internal sac are:

1. A pair of acute, obliquely positioned transparent plates with their apices extending into apical orifice: the surfaces of the plates appear to be minutely pitted perhaps with glandular openings but the shape of the plate does not vary to supply specific differences except in *R. picturatus*.
2. A transparent plate bearing 3–6 spines on its dorsal face: the shape of this plate and the number of spines is diagnostic.
3. A cluster of setae resembling a brush: length and shape of the brush is diagnostic.
4. A cluster of thornlike spines or denticles: the shape, number, and relative number of spines is diagnostic.
5. A saclike structure near apex of internal sac carrying two rodlike sclerites; not diagnostic.

The lateral lobes are not strikingly different among the species, the principal diagnostic features being the length of the lobes, shape of the apex of each lobe, and the depth of the cleft between them.

Color and pattern of the pronotum and pygidium are fairly consistent for each species but the pattern on the elytra is somewhat variable and must be used with caution in concert with other characters.

Table 1. *Rhipibruchus* species and their *Prosopis* host plants.

Rhipibruchus Species	*Prosopis* Species
R. atratus	*P. abbreviata* Benth.; *P. alba* Griseb.; *P. caldenia* Burkart; *P. flexuosa* DC.; *P. nigra* (Griseb.) Hieron.; *P. ruscifolia* Griseb.; *P. torquata* (Lag.) DC.
R. oedipygus	*P. kuntzei* Harms.
R. picturatus	*P. alba*; *P. affinis* Spreng.; *P. caldenia*; *P. chilensis* (Mol.) Stuntz; *P. elata* (Burk.) Burk.; *P. ferox* Griseb.; *P. flexuosa*; *P. humilis* Hook. & Arn.; *P. nigra*; *P. strombulifera* (Lam.) Benth.; *P. torquata*.
R. prosopis	*P. affinis* Spreng.; *P. alpataco* Phil., *P. calingastana* Burk.; *P. chilensis*; *P. juliflora* (Sw.) DC.; *P. kuntzei*; *P. nigra*; *P. sericantha* Hook. & Arn.; *P. strombulifera*.
R. psephenopygus	*P. alba*; *P. alpataco*; *P. caldenia*; *P. chilensis*; *P. flexuosa*; *P. juliflora*; *P. nigra*; *P. torquata*.
R. rugicollis	*P. kuntzei*; *P. sericantha*.

Species in this genus are so far known to breed only in seeds of various species of *Prosopis* L. (Leguminosae) (mesquite, algarrobo, algarobillo). *Rhipibruchus* is restricted to South America principally in north and central Argentina and Chile but records from Uruguay and a questionable record from Colombia are known. Host species and their associated bruchids are listed in Tables 1 and 2.

Rhipibruchus is closely related to *Pectinibruchus* Kingsolver but the affinities of these genera remain obscure. The South American genus *Pseudopachymerina* superficially resembles *Rhipibruchus* but I believe that they are only remotely related. The male genitalia of *Pseudopachymerina* are quite different from those of *Rhipibruchus* in basic structure; the metafemur is broader than in *Rhipibruchus;* the antenna is not sexually dimorphic as it is in *Rhipibruchus;* and the basal denticles of the third and fourth elytral striae are not elevated on a tumescence.

Rhipibruchus is tentatively separated into three groups primarily on the basis of body form and color pattern, (1) the *rugicollis* group including only *rugicollis;* (2) the *oedipygus* group including only *oedipygus;* and (3) the *picturatus* group including *picturatus, prosopis, atratus,* and *psephenopygus*.

KEY TO SPECIES OF *RHIPIBRUCHUS*

1. Body large, 3.6–5.4 mm in length; with no distinct pattern on pronotum, elytra, or pygidium; vestiture mostly gray with pronotum and elytra with mixed gray and bronze; pronotum (Fig. 7) without prom-

Table 2. *Prosopis* species and their *Rhipibruchus* predators.

Prosopis Species	*Rhipibruchus* Species
P. abbreviata	*R. atratus*
P. affinis	*R. picturatus*
P. alba	*R. atratus*; *R. picturatus*; *R. psephenopygus*
P. algarobilla	*R. picturatus* (literature record, Bosq, 1942) = *P. affinis*
P. alpataco	*R. prosopis*; *R. psephenopygus*
P. caldenia	*R. atratus*; *R. picturatus*; *R. psephenopygus*
P. calingastana	*R. prosopis*
P. chilensis	*R. picturatus*; *R. prosopis*; *R. psephenopygus*
P. elata	*R. picturatus*
P. ferox	*R. picturatus*
P. flexuosa	*R. atratus*; *R. picturatus*; *R. prosopis*; *R. psephenopygus*
P. humilis	*R. picturatus* (literature record, Bosq, 1942)
P. juliflora	*R. prosopis*; *R. psephenopygus*
P. kuntzei	*R. oedipygus*; *R. prosopis*; *R. rugicollis*
P. nigra	*R.atratus*; *R. picturatus*; *R. prosopis*; *R. psephenopygus*
P. ruscifolia	*R. atratus*
P. sericantha	*R. prosopis*; *R. rugicollis*
P. silaquastrum	*R. picturatus* (literature record, Zacher, 1952) = *P. chilensis*
P. strombulifera	*R. picturatus*; *R. prosopis*
P. torquata	*R. atratus*; *R. picturatus*; *R. psephenopygus*

inent median tumescences but with subbasal tumescences .... *oedipygus*, new species

– Body large or small; usually with pattern on dorsal surfaces, color mixed; pronotum with longitudinal tumescences adjacent to midline; sub-basal tumescences prominent 2

2\. Pronotum in lateral aspect with dorsal profile strongly sinuate (Fig. 6); elytra without strongly contrasting pattern (Fig. 1); pygidium with short, narrow, white basal triangle and small tuft of white either side at basal ⅓ (Figs. 4, 5) .... *rugicollis*, new species

– Pronotum in lateral aspect with dorsal profile only slightly sinuate (Fig. 18); elytra and pygidium usually with contrasting pattern 3

3\. Antenna strongly pectinate (Fig. 16); eyes narrowly separated by frons (Fig. 23, ♂); pygidium with faint sublateral depressions (Fig. 28); male 4

– Antenna serrate (Fig. 17); eyes more widely separated by frons (Fig. 23, ♀); pygidium with prominent sublateral depressions often contrastingly marked in integument and vestiture (Fig. 29); female 7

4\. Pygidium with integument uniformly dark brown to black with at most a narrow reddish-yellow stripe from middle of disk to apex, vestiture sparse, evenly distributed (Fig. 33) .... *psephenopygus*, new species

– Pygidial integument with extensive yellowish to yellowish-red areas, vestiture usually in dense patches (Fig. 28) 5

5. Pronotum mostly piceous with contrasting narrow, white basal patch of setae and narrow median line, rarely with cruciate mark in middle of disk (Fig. 25); elytra with lateral and apical margins broadly black, median area of disk with 2–4 isolated dark spots but without large median, common discal spot, or broad, transverse band (Fig. 25) . ... *atratus,* new species

– Pronotal disk piceous with flanks and cruciate median mark gray; elytra with margins usually mottled or streaked with longitudinal spots, median area usually with large discal spot or continuous or broken band (Figs. 12, 19, 30) 6

6. Vestiture and integument of basal ⅓ of elytra yellowish, middle of elytra usually with large, common discal spot (Fig. 19), occasionally with transverse band; male genitalia with transparent plates at apical orifice elongated (Fig. 21) .... *prosopis* Kingsolver

– Vestiture of basal ⅓ of elytra gray; middle of elytra occasionally with discontinuous transverse dark band but never with discal spot (Fig. 12); male genitalia with transparent plates short and broad (Fig. 14) .... *picturatus* (Fahraeus)

7. Apical 1/5 of elytra largely black, occasionally with paler elongate spot on 7th interval (Fig. 25); pygidium with strongly contrasting black or piceous sublateral depressions, these separated by median, white stripe (Fig. 29) .... *atratus,* new species

– Apices of elytra variegated black and yellowish brown (Figs. 12, 19, 30); pygidium with contrasting spots or these obscure (Figs. 13, 20, 34) 8

8. Pygidial integument uniformly piceous with at most a reddish stripe from middle of pygidium to apex (Fig. 34); sublateral spots obscure .... *psephenopygus,* new species

– Pygidial integument with contrasting dark sublateral spots (Figs. 13, 20) 9

9. Pygidium with basal triangle and short median stripe white, remaining vestiture yellowish, lateral spots piceous or black (Fig. 20) ... . *prosopis* Kingsolver

– Pygidial vestiture silvery gray, basal triangle and "eyebrow" spots above sublateral black or piceous spots appearing more intensely white than intervening areas (Fig. 13) .... *picturatus* (Fahraeus)

RUGICOLLIS GROUP

Pronotum with prominent medial and subbasal tumescences; elytra and pygidium with mottled pattern; pygidium not sexually dimorphic and without darkened depressions in female.

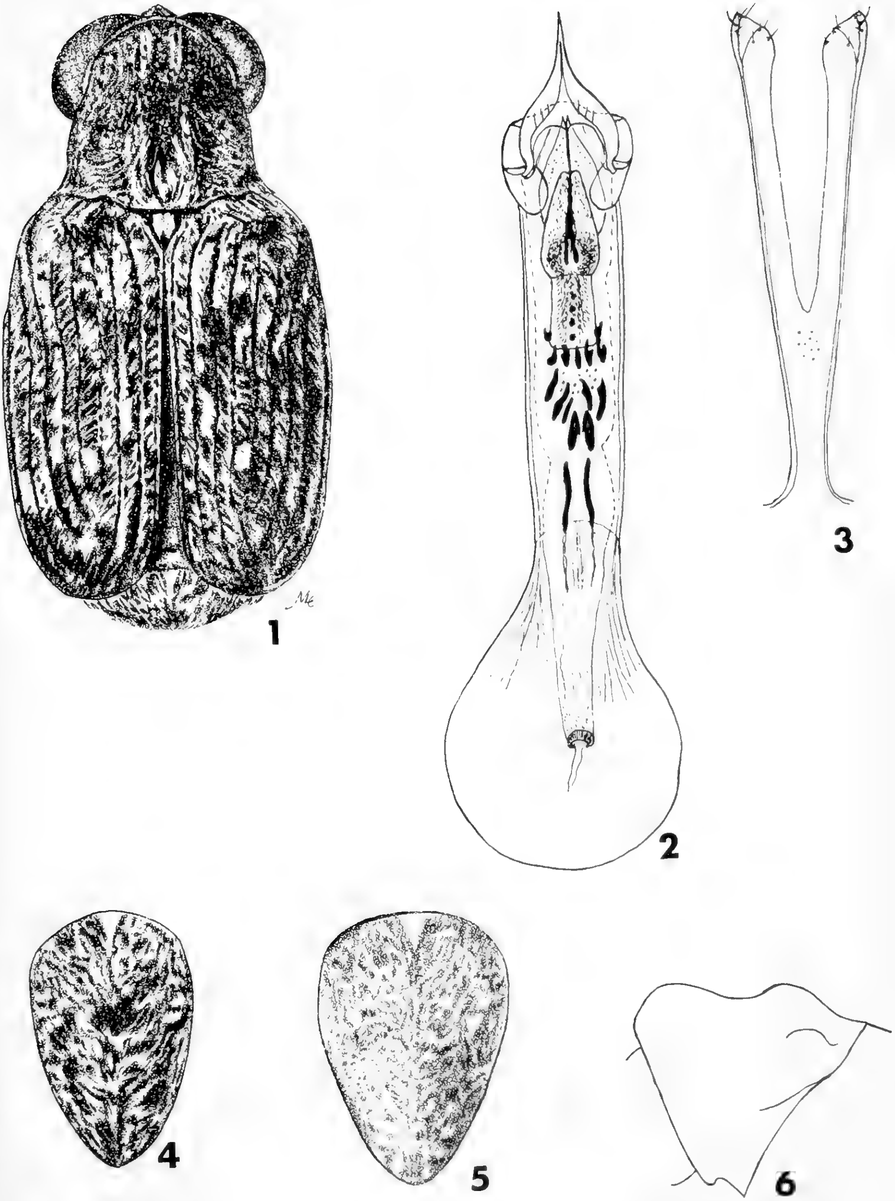
Rhipibruchus rugicollis **Kingsolver, New Species**

Figs. 1–6, 38

Body length.—3.9–4.4 mm; width, 2.1–2.3 mm. Pronotal length, 1.3–1.5 mm; width, 1.4–1.6 mm.

Color.—Integument dark red to piceous, without distinct pattern; head piceous except eyes black, spot above each eye reddish; antenna uniformly piceous; pronotum, elytra, pygidium, and venter of body uniformly piceous except metacoxa reddish, metafemur darker in ventral ½. Vestiture of gray and yellowish hairs in mottled pattern on both dorsal and ventral surfaces (Fig. 1); pygidium mottled with hairs obliquely positioned toward midline, with short basal triangle and 2 small lateral clumps of white hairs (Figs. 4, 5).

Structure.—Body elongated; pronotum campaniform; elytra rectangular, together slightly longer than wide. Head obovate, eyes strongly protuberant laterally, vertex finely, densely punctate, frons strongly carinate in both sexes, narrower in ♂ than in ♀, slopes of carina punctulate, clypeus microrugose, postocular fringe narrow. Pronotum (Figs. 1, 6) with lateral margins sinuate; longitudinal, median, undulate elevation broadly sulcate, sublateral gibbosities prominent; surface of pronotum densely foveolate, each foveola setiferous; lateral carina traceable from posterolateral corner to a point immediately above procoxal cavity; cervical sulcus fine, short; cervical boss prominent, bisetiferous; prosternum short, intercoxal piece extending ½ length of coxae; mesosternum narrow, triangular; postmesocoxal sulci meeting on midline, fine, parallel to coxal cavity. Scutellum elongate, 2× as long as wide, bidentate apically, densely pilose. Elytra elongate (Fig. 1), gently convex but subdepressed along suture and basally between 3rd intervals; striae fairly regular in course except 3rd and 4th bent laterally at base, shallowly sulcate, punctures elongate, setiferous; 1st stria arising near scutellar apex, 2nd arising behind vertical basal ridge, 3rd and 4th arising from fine denticles on summit of prominent subbasal gibbosity, 5th arising on lateral limits of gibbosity; all striae free apically, 4th and 5th abbreviated; intervals flat, strigulate, densely setose. Abdomen of ♂ strongly telescoped, length of segments 2–5 less than that of 1st segment, 5th segment with posterior border emarginate for reception of apex of pygidium; pygidium elongate and narrowly triangular, basal margin arcuate, surface convex, densely, evenly microfoveolate; abdomen of ♀ with segments 2–5 together slightly longer than 1st segment, 5th segment with posterior margin evenly rounded; pygidium (Figs. 4, 5) elongate-obovate, oblique, surface convex, shallowly impressed sublaterally toward apex, surface densely microfoveolate. Pro- and mesolegs not modified; metacoxa densely, finely punctate except for elongate, polished proximal area; metafemur moderately incrassate, dorsal margin evenly arcuate, ventral margin arcuate in basal 4/5,



Figs. 1–6. *Rhipibruchus rugicollis*. 1, Habitus, dorsal. 2, ♂ genitalia, median lobe. 3, ♂ genitalia, lateral lobes. 4, Pygidium ♂. 5, Pygidium ♀. 6, Prothorax, lateral profile.

sinuate apically, pecten with 1 long and 3 shorter denticles on its distal slope; metatibia slender, more narrowed proximally and gradually widened distally, mucro short, acute, lateral denticle short, coronal denticles 3 or 4; lateral, ventral and dorsomedial carinae distinct and complete to apex, lateroventral carina obsolete in apical 4/5. Male genitalia (Figs. 2, 3) with internal sac of median lobe with brush of setae inconspicuous, poorly defined; spinous plate elongate, with 4–5 spines; median cluster of 12–15 thornlike or sickle shaped denticles. Lateral lobes with apices oblique, cleft to about ⅔ their length.

Holotype ♂.—ARGENTINA: Salta Prov., Tartagal, December 1950, Daguerre (USNMNH type #76390).

Allotype ♀ and 6 ♂, 3 ♀ paratypes.—ARGENTINA; Santiago del Estero Prov., Termes de Rio Hondo, 20 April 1972, ex *Prosopis sericantha.*

Other paratypes.—ARGENTINA: Tucumán Prov., Tucumán, 1941, J. Hayward, 4 ♂, 2 ♀. Formosa Prov., Rt. 81, 14 mi SE Cdte. Fontana, 12 March 1977, ex *Prosopis kuntzei,* 1 ♂, 1 ♀; Rt. 81, 58 mi SE Ing. Juarez, 11 March 1977, ex *Prosopis kuntzei,* 1 ♀. Chaco Prov., in "itin" (*Prosopis kuntzei*), 1 ♂, 1 ♀; Chaco, ex *Prosopis kuntzei,* 1 ♂, 1 ♀. Paratypes deposited in the National Museum of Natural History, Washington, D.C. (USNMNH), the Fundación Miguel Lillo, Tucumán, and Bernadino Rivadavia Museum of Natural Sciences, Buenos Aires, Argentina.

Discussion.—This species is easily recognized by the prominent medial tumescences, the mottled pattern on the elytra and pygidium, the lack of darkened depressions on the female pygidium, and the larger size.

Remarks.—The name *rugicollis* is derived from the Latin *ruga* (wrinkled) and *collum* (neck) and refers to the rugose pronotum. In Kingsolver et al. (1977: 115), *R. rugicollis* was listed as *R.* sp. *D.*

OEDIPYGUS GROUP

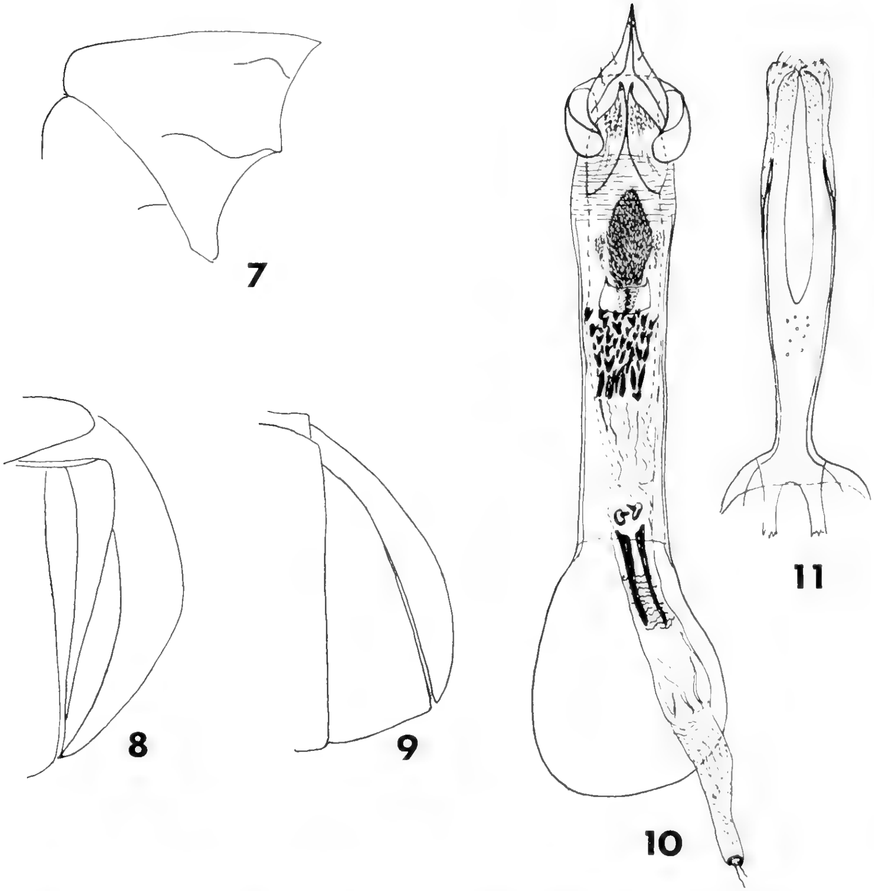
Pronotum convex, without medial but with subbasal tumescences; elytra and pygidium with vestiture evenly distributed, not sexually dimorphic, without darkened depressions in female.

Rhipibruchus oedipygus Kingsolver, NEW SPECIES

Figs. 7–11, 38

Body length.—3.6–5.4 mm; width, 2.0–2.6 mm. Pronotal length, 1.8–2.0 mm; width, 2.0–2.5 mm.

Color.—Integument mostly piceous with following areas reddish: triangular spot above eye, lateral margin of pronotum, posterior ⅓ of metasternum, abdominal sterna, pro- and mesofemora, dorsal ½ of metafemur, metatibia; with following areas yellowish red: antenna with rami darker in ♂, pro- and mesotibiae. Vestiture of intermixed gray and bronze slender hairs



Figs. 7–11. *Rhipibruchus oedipygus.* 7, Prothorax, lateral profile. 8, Pygidium ♂, lateral profile. 9, Pygidium ♀, lateral profile. 10, ♂ genitalia, median lobe. 11, ♂ genitalia, lateral lobes.

evenly distributed over body, elytra with predominantly bronze vestiture, remainder of body predominantly gray with bronze setae set in foveolae.

Structure.—Body elongate, head subtriangular, eyes strongly protuberant, nearly divided by ocular sinus with about 7 rows of facets between sinus and posterior margin of eye, supraocular sulcus with setiferous, umbilicate punctures; vertex densely foveolate posteriorly, with subtriangular, minutely granulose boss anteriorly leading to frontal carina, frons foveolate on lateral slopes, narrower in ♂ (width across eyes: narrowest frontal width 7:1) than in ♀ (4:1); clypeus broadly concave, shallowly foveolate, densely setose; labrum finely granulose; ♂ antenna with scape cucumiform, pedicel short, 1st flagellar segment angular, 2nd with short ramus, remaining segments each with long, setose ramus; ♀ antenna serrate from 4th segment. Pronotum campaniform, apex evenly arcuate, lateral margins moderately sinuate, posterolateral angles slightly flared, basal margin sinuate, basal lobe prominent, prominent condyle near basal margin either side of basal lobe; in lateral aspect, dorsal profile nearly flat in basal $^4/_5$, strongly convex at apex; surface densely, evenly foveolate, each foveola bearing short, bronze seta; lateral carina short (Fig. 7); cervical sulcus short, obscure, cervical boss with 3–5 setae; prosternum short, triangular, not separating procoxae apically; mesosternum narrow, rounded and slightly sulcate at apex; postmesocoxal sulcus absent. Scutellum 1½× as long as wide, apex shallowly emarginate, bidentate. Elytra slightly longer than wide, evenly convex; striae uniform, evenly spaced, shallowly sulcate, foveolate, well marked in medial ½, partly to completely obliterated laterally, especially in basal ½, sutural stria deep, narrow, 2nd stria arising basally from deep pit beneath marginal bead, 3rd and 4th arising from prominent bidentate basal gibbosity, 5th on lateral margin of gibbosity, bases of remaining discal striae obliterated in imbricate caudal extension of humeral umbo, striae free apically with 4th and 5th abbreviated and approximate; intervals finely imbricate and foveolate, especially toward base. Abdomen with basal sternum 2× as long as 5th sternum in ♂, subequal in length in ♀, caudal margin of 5th deeply emarginate for reception of apex of pygidium in ♂, evenly rounded in ♀; pygidium obovate in caudal aspect in both sexes, strongly convex in ♂ (Fig. 8), only slightly convex in ♀ (Fig. 9) in lateral aspect, apex of pygidium fitting into emarginate 5th sternum, ♀ pygidium nearly vertical, disk in both sexes densely, evenly, shallowly foveolate, foveolae nearly concealed by dense vestiture. Pro- and mesolegs not modified; metacoxa finely, densely punctate except for anterior polished area; metafemur moderately incrassate, pecten with 1 large and 2 small denticles; metatibia slender, mucro short, acute; lateral, ventral, and dorsomedial carinae distinct and complete, lateroventral carina obsolete in apical ⅓.

Male genitalia (Figs. 10, 11).—Internal sac of median lobe with brush of setae short; spinous plate small with 5 spines; median cluster of about 40 small denticles; lateral lobes rounded apically, cleft to about ½ their length.

Holotype ♂.—ARGENTINA: Chaco, ex seed of *Prosopis kuntzei,* Harms, #1365. In collection of Fundación Miguel Lillo, Tucumán, Argentina.

Allotype ♀.—ARGENTINA: Tucumán, 1941, J. Hayward; on temporary loan to the National Museum of Natural History, Washington, D.C.

Other paratypes.—ARGENTINA: Formosa Prov., Rio Bermejo (Pto. Lavalle), 23 August 1972, ex seeds *Prosopis kuntzei,* 2 ♂, 3 ♀; Ibarreta, 8 April 1976, ex seeds "itin" (*Prosopis kuntzei*) 2 ♂. Santiago del Estero Prov., north of the city, July 1965, ex seeds *Prosopis kuntzei,* 2 ♂.

Diagnosis.—This distinctive species differs from *R. prosopis, R. picturatus, R. atratus,* and *R. psephenopygus* by the absence of a distinct color pattern, its larger size, strongly convex ♂ pygidium, and details of the ♂ genitalia. It differs from *R. rugicollis* by its color, lack of median pronotal tumescences, color patterns of the ♂ and ♀ pygidia, and details of the ♂ genitalia.

Remarks.—The name *oedipygus* is derived from the Greek *oidema* (swelling) and *pyge* (rump) and refers to the bulbous pygidium of the male. In Kingsolver et al. (1977: 115) *R. oedipygus* was listed as *R.* sp. *E.*

PICTURATUS GROUP

Pronotum with slight medial tumescences and prominent subbasal tumescences; elytra and pygidium with prominent pattern; pygidium sexually dimorphic with darkened depressions in female.

Discussion.—The four known species in this group are quite closely related. Color patterns on the pronotum and elytra are comparatively uniform for each sex of the four species. Sexual dimorphism in pygidial patterns is quite striking and offers excellent distinguishing features. Characters given in the key should be sufficient for identification but they are reiterated here for convenience.

Rhipibruchus psephenopygus is easily separated by the dark median, transverse band extending nearly or completely across the middle of the elytra (Fig. 30), and by the uniformly distributed pygidial vestiture in both sexes (cf. *picturatus* below) (Figs. 33, 34) except for the dark, slightly depressed sublateral patches in the female.

Rhipibruchus atratus is distinctive in its contrasting black-and-white pronotal and elytral patterns (Fig. 25). The male pygidial pattern (Fig. 28) is quite similar to those of *picturatus* and *prosopis* but elytral color and pattern will serve to separate these three species. The pygidial pattern (Fig. 29) of females of *atratus* with strikingly contrasted large, black subapical patches margined medially by reddish brown hairs, and with dorsal patches of the same reddish brown is diagnostic.

Rhipibruchus prosopis is easily separated from others in the genus by the yellow vestiture of the elytra in both sexes. The pygidium in the female (Fig. 20) is distinctively marked with a basal triangular and narrow median line white, subapical marginal, depressed patches black, and the remainder of the vestiture yellow. The middle of the elytra is usually marked with a large, dark common spot (Fig. 19).

Rhipibruchus picturatus is most easily confused with *psephenopygus* but the pale areas on the elytra are more extensive with the dark spots disconnected and not forming a transverse band. The white basal triangle and white median line in both sexes of *picturatus* as well as the more prominent white subbasal patches in the male (as in Fig. 28) and the more densely white "eyebrow" patches above the dark subapical depressed patches in ♀ *picturatus* (Fig. 13) are diagnostic.

Rhipibruchus picturatus (Fahraeus)
Figs. 12–18, 35

Bruchus picturatus Fahraeus, 1839: 2.
Megalorhipis leiboldi Philippi, 1859: 669.
Megalorhipis leyboldi: Pic, 1913: 12 (error).
Rhipibruchus picturatus: Bridwell, 1932: 105; Blackwelder, 1946: 758; Kingsolver, 1967: 320; Kingsolver et al., 1977: 115.

The redescription (Kingsolver, 1967) and the group diagnosis given above are sufficient to distinguish this species from others in the group.

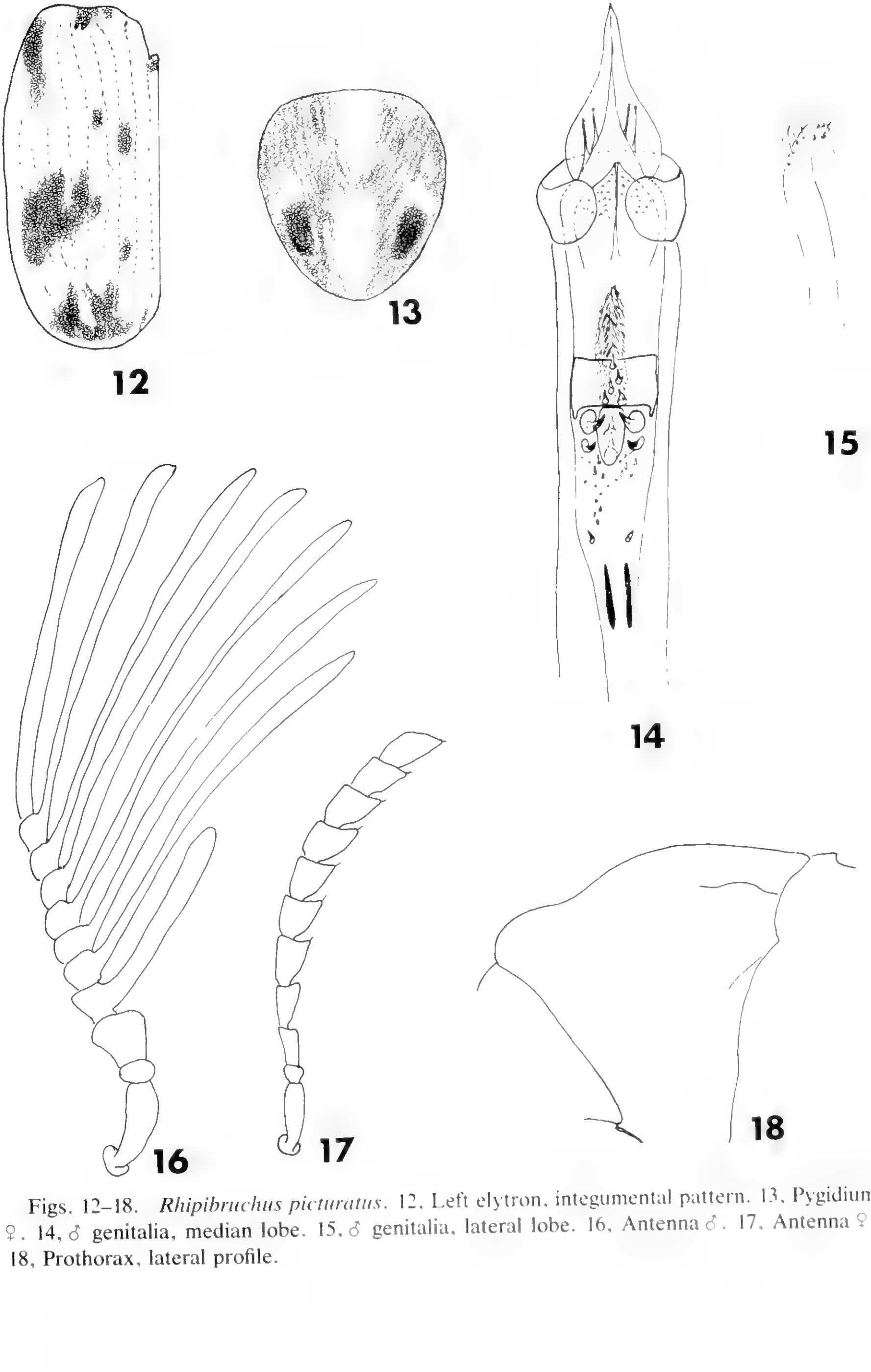
Male genitalia (Figs. 14, 15).—Internal sac of median lobe with brush of setae short; spinous plate short, broad, with 4–5 spines; median cluster of 5 large, thornlike, curved spines and 3–4 smaller denticles; lateral lobes blunt apically, somewhat oblique on median margin, cleft to about ½ their length.

New host records.—ARGENTINA: Catamarca Prov., Rt. 307 6 km N Sta. Maria, 11 January 1980, in *Prosopis flexuosa;* 30 mi N Catamarca, ex seeds *Prosopis nigra;* Arauco, near Aimogasta, ex seeds *Prosopis chilensis.* Santiago del Estero Prov., Rt. 34, 31 mi SE La Banda, 12 June 1976, in *Prosopis alba.* La Rioja Prov., Aimogasta, 25 February 1978, in *Prosopis chilensis;* Rt. 9, 46 km N from Rt. 38, in *Prosopis chilensis.* Cordoba Prov., Rt. 38, Capilla del Monte, 22 February 1978, in *Prosopis alba;* Rt. 38, Camino a los Mogotes, 25 February 1977, in *Prosopis chilensis;* Rt. 7, 1 mi E. Cordoba-San Luis border, 19 November 1976, in *Prosopis caldenia.* Entre Rios Prov., Rt. 126, 9 mi NE La Paz, 15 March 1977, in *Prosopis nigra.* San Juan Prov., 3 mi E Caucete, 19 February 1978, in *Prosopis torquata;* Calingasta, 17 May 1977, in *Prosopis strombulifera.* Mendoza Prov., Rt. 40, Mojon km 19, 24 November 1976, in *Prosopis strombulifera.* San Luis Prov., Alto Pencosa, 6 February 1951; Lavaisse, Don Roberto Estancia. January 1943, 17 October 1942, February–March 1943; La Pampa Prov., Rt. 35, 85 mi N Sta. Rosa, 15 February 1978. CHILE: Santiago Prov., Antumapu, 11 June 1974.

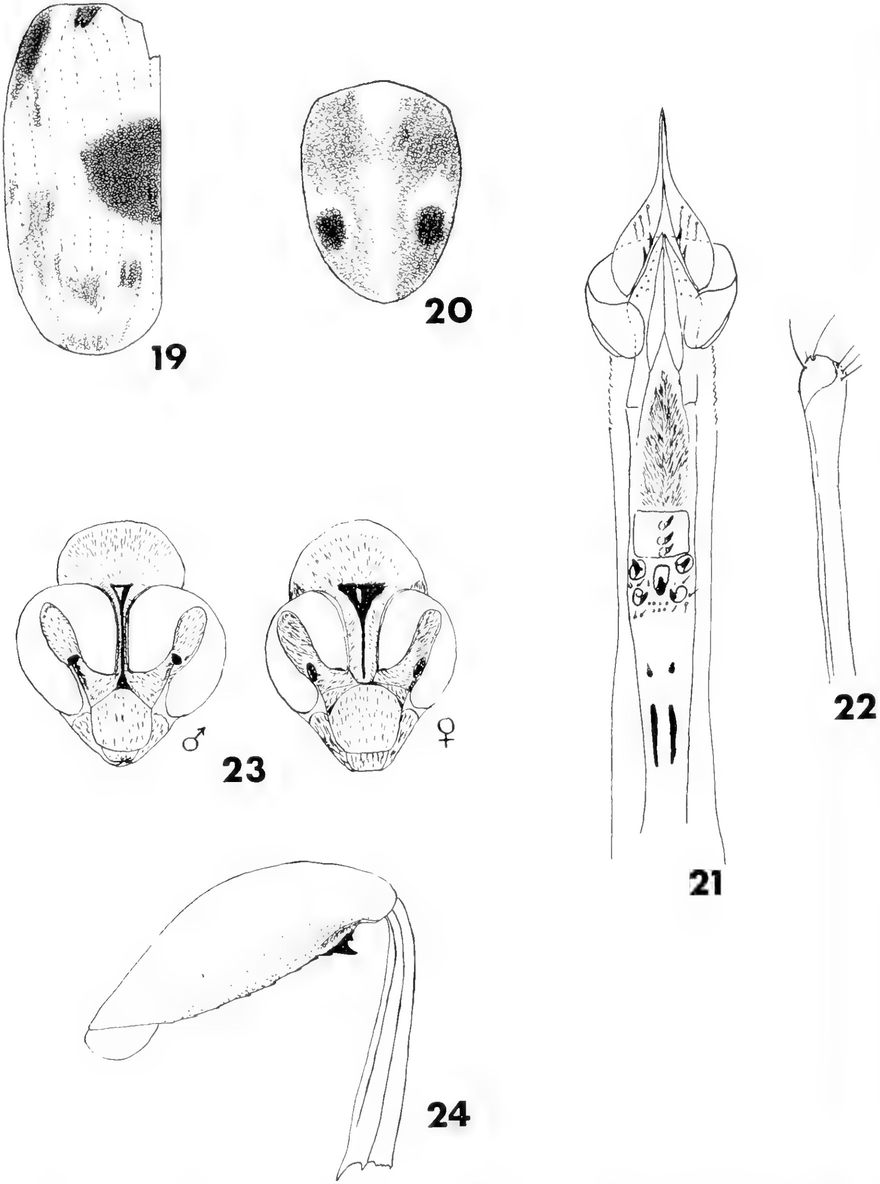
Rhipibruchus prosopis Kingsolver
Figs. 19–24, 36

Rhipibruchus prosopis Kingsolver, 1967: 322; Kingsolver et al., 1977: 115.

The original description (Kingsolver, 1967) and the group diagnosis given above are sufficient to distinguish this species.



Figs. 12–18. *Rhipibruchus picturatus*. 12, Left elytron, integumental pattern. 13, Pygidium ♀. 14, ♂ genitalia, median lobe. 15, ♂ genitalia, lateral lobe. 16, Antenna ♂. 17, Antenna ♀. 18, Prothorax, lateral profile.



Figs. 19–24. *Rhipibruchus prosopis*. 19, Left elytron, integumental pattern. 20, Pygidium ♂. 21, ♂ genitalia, median lobe. 22, ♂ genitalia, lateral lobe. 23, Heads, ♂, ♀. 24, Metafemur and metatibia.

Male genitalia (Figs. 21, 22).—Internal sac with brush of setae moderately long; spinous plate short, broad, with 2–3 spines; median cluster of 5 large, curved, thornlike spines and 2–3 denticles; lateral lobes rounded apically, cleft to about $^3/_5$ their length.

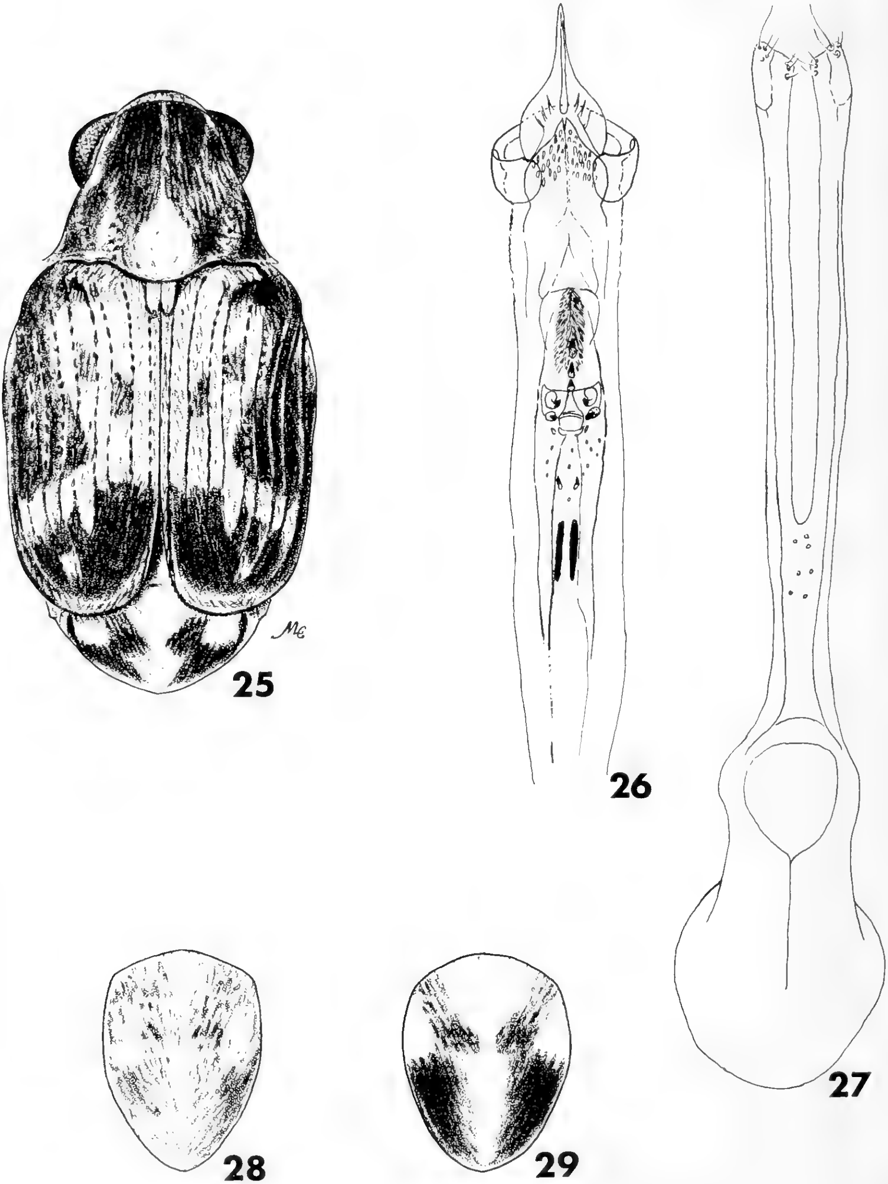
New host records.—ARGENTINA; Formosa Prov., Rt. 81, 15 mi NW Formosa, 10 December 1976, in *Prosopis nigra;* Rt. 81, 14 mi SE Cdte. Fontana, 12 March 1977, in *Prosopis kuntzei.* Catamarca Prov., Catamarca, 31 January 1970. La Rioja Prov., Aimogasta, 25 February 1978, *Prosopis chilensis.* San Juan Prov., Rt. 20, 1 mi SE Caucete, 19 February 1978, in *Prosopis alpataco* and *strombulifera;* Rt. 40, 18 mi NE Mendoza-San Juan border, 22 February 1977, in *Prosopis flexuosa;* Rt. 141, 12 mi S Calingasta, 16 May 1977, in *Prosopis calingastana;* Airport, Rt. 20, 10 km from San Juan, 26 November 1976, in *Prosopis strombulifera.* Cordoba Prov., Rt. 38, 8 mi NW Cruz del Eje, 24 February 1977, in *Prosopis chilensis.* Entre Rios Prov., Rt. 126, 9 mi NE La Paz, 15 March 1977, in *Prosopis nigra.* Mendoza Prov., Rt. 40, 8 mi NE Mendoza, 22 February 1977, in *Prosopis strombulifera* and *alpataco;* Rt. 40, Mojon, km 19, 24 November 1976, in *Prosopis strombulifera;* Rt. 40, 4 mi N. Mendoza, 19 February 1978, in *Prosopis strombulifera.*

***Rhipibruchus atratus* Kingsolver, New Species**

Figs. 25–29, 39

Body length.—2.9–3.1 mm; width, 1.5–1.7 mm. Pronotal length, 0.8–0.9 mm; width, 1.1–1.3 mm.

Color.—Integument reddish brown to black, head black except apex of clypeus and postocular spots reddish; antenna piceous; pronotum black except basal triangle and lateral and apical margins reddish; elytra (Fig. 25) with reddish-brown median vitta extending laterally to 5th or 6th interval and with subapical band extending to lateral margin, 3rd interval with subapical black spot grading to apical ¼ of elytra black, lateral margins black; venter of body piceous to black, abdomen often reddish; pro- and mesolegs reddish brown, darker proximally, metafemur piceous with dorsal reddish brown area; metatibia reddish brown, darker proximally; pygidium of ♂ reddish brown, with subapical lateral margins dusky; pygidium of ♀ dark red. Vestiture of black, dark brown, yellowish-brown, yellow, and white slender setae, those on head yellowish brown, on pronotum yellowish with narrow, median white stripe expanded basally, white often intermixed with yellow, darker areas of disk with dark brown hairs, flanks with yellowish and white; elytra with white or yellowish setae on reddish integument, and black with scattered intermixed white on black integumental areas; venter of body and legs evenly covered with white hairs; pygidium of ♂ (Fig. 28) densely covered with white hairs condensed into basal triangle and vague



Figs. 25–29. *Rhipibruchus atratus*. 25, Habitus, dorsal. 26, ♂ genitalia, median lobe. 27, ♂ genitalia, lateral lobes. 28, Pygidium ♂. 29, Pygidium ♀.

lateral patches, of ♀ (Fig. 29) with condensed basal triangle, median stripe, and basolateral patches of white hairs intermixed with yellow; apicolateral depressed, ovate spots with dark brown hairs.

Structure.—Body ovate, elytra quadrilateral, pronotum campaniform. Head subtriangular, eyes strongly protruding laterally, sexually dimorphic, relatively larger and more narrowly separated medially in ♂, ocular sinus narrow, extending about $^4/_5$ length of eye, vertex finely reticulate, frons narrow, strongly carinate, finely punctate, clypeus scabriculous, labrum semicircular, sparsely punctate, supraantennal ridges prominent, frons between ridges concave; ♂ antenna strongly pectinate, reaching metacoxa, in ♀ serrate from 4th segment, reaching humerus. Pronotum (Fig. 25) with basal margin strongly lobed, apical margin semicircular, lateral margins sinuate; disk strongly convex, shallowly sulcate either side of broad median gibbosity, this with shallow sulcus in basal ½; obsolete subbasal gibbosity near each posterolateral angle, surface of disk densely microfoveolate, each foveola with a hair arising from its center or from its anterior rim; lateral carina present as an obsolete ridge extending to procoxal cavity; cervical sulcus short, fine; cervical boss small but distinct, bisetiferous; prosternum short, triangular, acute posteriorly, procoxae contiguous in apical ⅓. Scutellum short, narrow, 2× as long as wide, deeply bifid apically. Elytra (Fig. 25) slightly longer than wide, widest at basal ⅓, disk moderately convex, subdepressed at basal, median ⅓; striae slightly sinuate, 1 and 2 each arising from basal fovea, 3 and 4 arising from a prominent, minutely dentate, subbasal gibbosity, 5 arising laterad of gibbosity, striae 4 and 5 and 6 and 7 conjoined apically, remaining striae ending free; intervals flat, finely strigose, 3 and 5 wider than 2, 4, and 6. Mesosternum acute apically; postmesocoxal sulci conjoined on midline, ending laterad of coxal cavity. Abdomen of ♂ telescoped, 1st sternum longer than remaining 4 together, 5th sternum with posterior margin shallowly emarginate and narrowly reflexed ventrad to receive apex of pygidium, of ♀, 1st sternum subequal in length to remaining 4 together, 5th sternum slightly tumescent in profile, perceptibly emarginate on posterior border; ♂ pygidium strongly reflexed, disk moderately convex transversely, surface finely, sparsely punctate, of ♀ not reflexed, disk convex with lateral darker areas subdepressed and finely, densely punctulate, white setae nearly concealing punctuation. Pro- and mesolegs not unusually modified; metacoxa densely, evenly punctate except for elongate, polished area near trochanteral insertion; metafemur moderately incrassate, more strongly arcuate on dorsal margin than on ventral, pecten with 1 long and 2 shorter distal denticles, metatibia slender, wider distally, mucro short, acute, lateral denticle prominent, 4 coronal denticles fine, lateral, ventral, and dorsomedial carinae distinct and complete, lateroventral carina obsolete in apical ¼.

Male genitalia (Figs. 26, 27).—Internal sac of median lobe with brush of setae short; spinous plate elongate, parallel-sided, with 4 spines; median cluster of 5 large, thornlike and 2–3 smaller spines; lateral lobes elongate, apices bluntly oblique, cleft to about ⅔ their length.

Holotype ♂.—ARGENTINA: Formosa Prov., Rt. 11, 12 mi N. Chaco-Formosa border, 8 December 1976, in pods *Prosopis nigra*.

Allotype ♀.—Same data as holotype.

Other paratypes.—ARGENTINA: Catamarca Prov., Rt. 60, 47 mi SE Tinogasta, 25 February 1978, in seed pods, *Prosopis torquata,* 2♀; Rt. 307, 6 km N Santa Maria, 11 January 1980, in seed pods *Prosopis flexuosa,* 1♀; Rt. 62, 26 mi S Andalgala, 1 March 1977, in pods, *Prosopis abbreviata,* 1♀; 50 km W Andalgala, 31 October 1972, on *Cassia,* 1♂, 1♀; same data except in pods, *Prosopis flexuosa,* 1♀. Formosa Prov., Rt. 81, 15 mi NW Formosa, 10 December 1976, in pods on ground, *Prosopis nigra,* 2♂, 1♀. La Pampa Prov., Rt. 188, 38 mi W Realico, 15 February 1978, in pods, *Prosopis caldenia,* 1♀. La Rioja Prov., Rt. 20, 23 mi E Chepas, 20 February 1978, in pods on ground, *Prosopis torquata,* 1♀; La Rioja, January 1970, Peña, in *Prosopis abbreviata* 5♀. San Juan Prov., Rt. 20, 3 mi E Caucete, 19 February 1978, in pods on ground, *Prosopis torquata* 4♀; Matagusanos, 29 February 1970, 4♂, 6♀. Santiago del Estero Prov., Rt. 34, 31 mi SE La Banda, 6 December 1976, in seed pods, *Prosopis alba,* 1♀. San Luis Prov., Lavaisse, Don Roberto Estancia, 12 and 18 October 1942, 2♂. PARAGUAY: Pres. Hayes Prov., Hwy. Trans Chaco 365 km NW Asunción, 18 January 1976, DeLoach #72179, in pods, *Prosopis ruscifolia,* 1♂, 2♀.

Type and paratypes deposited in the Fundación Miguel Lillo, Tucumán; paratypes deposited in the National Museum of Natural History, Washington, D.C., Rivadavia Museum of Natural Sciences, Buenos Aires, Utah State University, Logan, British Museum (Natural History), London, and the Museo Nacional de Historia Natural, Santiago, Chile.

Diagnosis.—This species is easily recognized by the intensely black border of the elytra, the predominantly dark pronotum, and the strikingly marked pygidium. It is probably most closely related to *R. picturatus.* See the *picturatus* group diagnosis above.

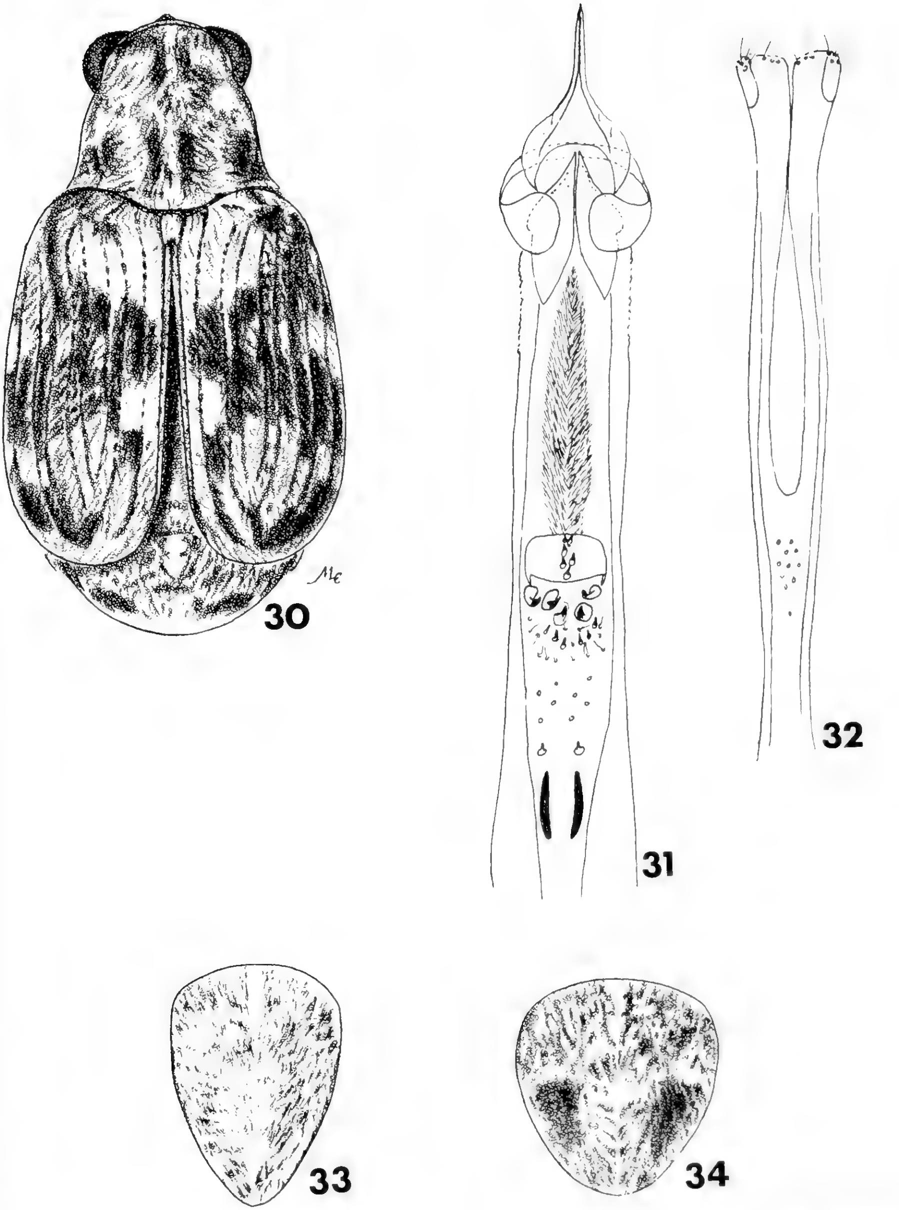
Remarks.—The name *atratus* is derived from the Latin *atratus* (dressed in black) and refers to the prominent black border of the elytra.

Rhipibruchus psephenopygus Kingsolver, New Species

Figs. 30–34, 37

Body length.—2.2–4.3 mm; width, 1.4–1.9 mm. Pronotal length, 0.7–0.9 mm; width, 0.9–1.3 mm.

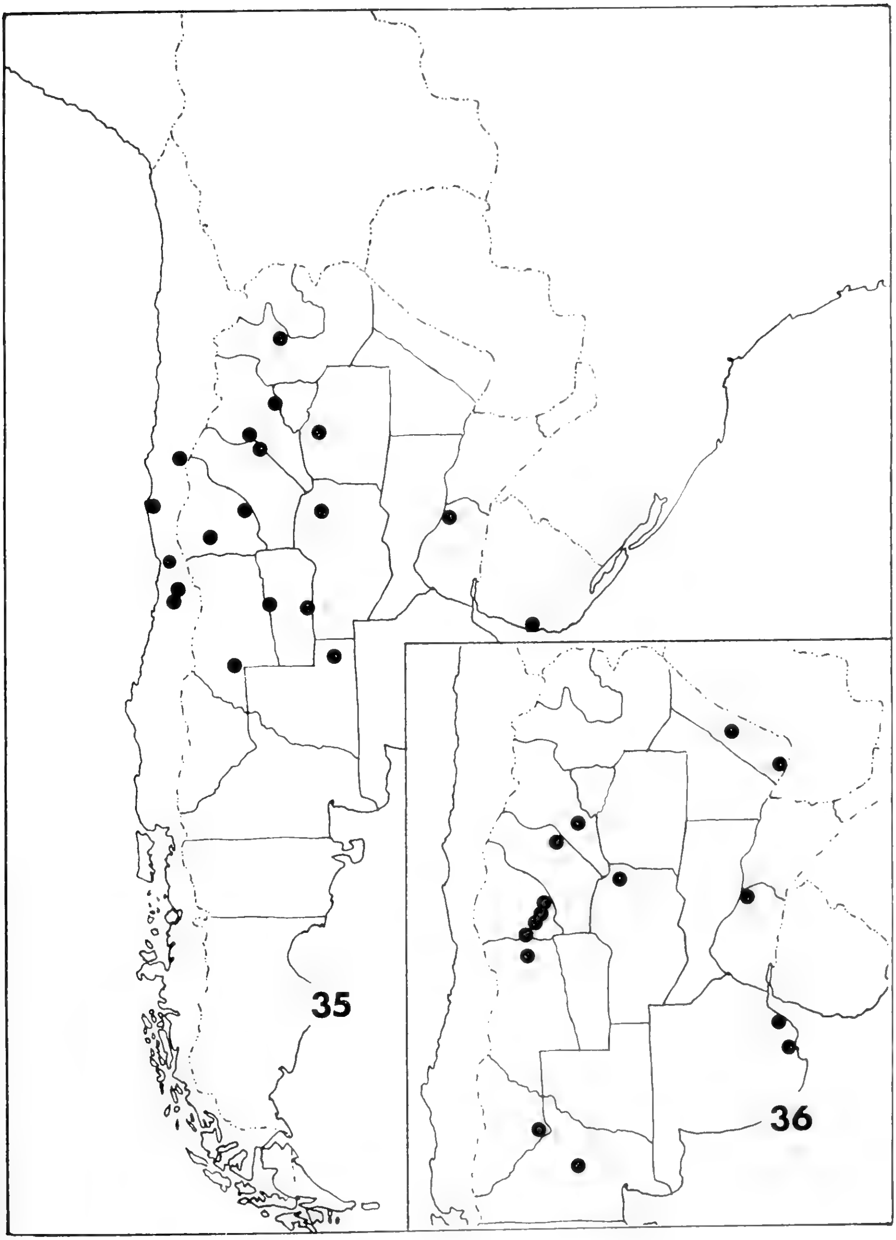
Color.—Integument yellowish brown to reddish brown or piceous; head piceous, clypeus and labrum usually reddish, head behind eye reddish, an-



Figs. 30–34. *Rhipibruchus psephenopygus*. 30, Habitus, dorsal. 31, ♂ genitalia, median lobe. 32, ♂ genitalia, lateral lobes. 33, Pygidium ♂. 34, Pygidium ♀.

tenna dark reddish brown with segments 1 and 2 paler beneath, pronotum mostly piceous fading to reddish brown along anterior border and occasionally along posterior border; elytra with contrasting piceous and reddish-yellow to reddish-brown variable pattern with humeri and basal umbones darker, circumscutellar area reddish yellow to brown sometimes extended to surround umbones, median transverse band piceous divided laterally by paler blotch, this sometimes small or absent, apical ½ of elytra usually with oblique pale band extending to lateral margins, apical ⅓ variable from nearly all piceous to all mottled; venter of body piceous with some reddish areas especially on abdomen; legs pale reddish yellow except ventral ½ of metafemur and base of metatibia dusky; pygidium uniformly piceous to black with depressed lateral spots of ♀ slightly darker. Vestiture of black, gray, and brownish hairs, paler areas of integument generally with gray hairs, piceous or reddish areas with brown or black hairs; head with brownish hairs, antenna with gray, pronotum with a broad, black median stripe divided by gray stripe and transversely bisected by grey band, sublateral stripe and flanks intermixed gray and brown, subbasal gibbosities piceous; scutellum gray; elytra with pale area gray, darker areas black with gray and brown intermixed; venter with evenly distributed gray hairs; ♂ pygidium (Fig. 33) with gray hairs nearly evenly distributed, some specimens with faint median gray line of hairs; ♀ pygidium (Fig. 34) with basal white triangle leading to intermittent median line of hairs, lateral depressed areas sometimes with black hairs intermixed with gray; legs evenly covered with gray hairs.

Structure.—Body ovate, base of pronotum narrower than elytral base (Fig. 30). Head subtriangular; ♂ eyes larger than ♀ eyes, ♂ frons narrow; ocular sinus narrow, about ¾ length of eye, carina above base of antenna prominent; vertex densely, finely punctate, frons strongly carinate arising dorsally as impunctate, triangular boss, clypeus broader in ♂ than in ♀, postocular fringe narrow; ♂ antenna strongly pectinate from 4th segment, ♀ antenna serrate from 4th segment. Pronotum (Fig. 30) campaniform, lateral margins slightly sinuate, disk strongly convex, with narrow median sulcus, and shallow longitudinal sulcus extending anteriorly from sinuation of basal margin, subbasal gibbosities prominent; surface of disk microfoveolate, each foveola bearing a hair at its anterior rim, interspaces micropunctate; lateral carina fine in basal ½, obsolete apically; cervical sulcus fine, short; cervical boss prominent, bisetiferous; prosternum short, acutely triangular medially, separating procoxae for only ½ their length. Scutellum 2× as long as wide, bidentate apically. Elytra quadrilateral, slightly longer than wide, gently convex except subdepressed along suture, and more strongly depressed around scutellum; striae slightly sinuate, 1st stria arising near scutellum, 2nd arising in basal pit beneath oblique marginal ridge, 3rd and 4th arising from prominent, dentate subbasal gibbosity, 5th arising along



Figs. 35–36. Distribution of *Rhipibruchus* spp. 35, *R. picturatus*. 36, *R. prosopis*.

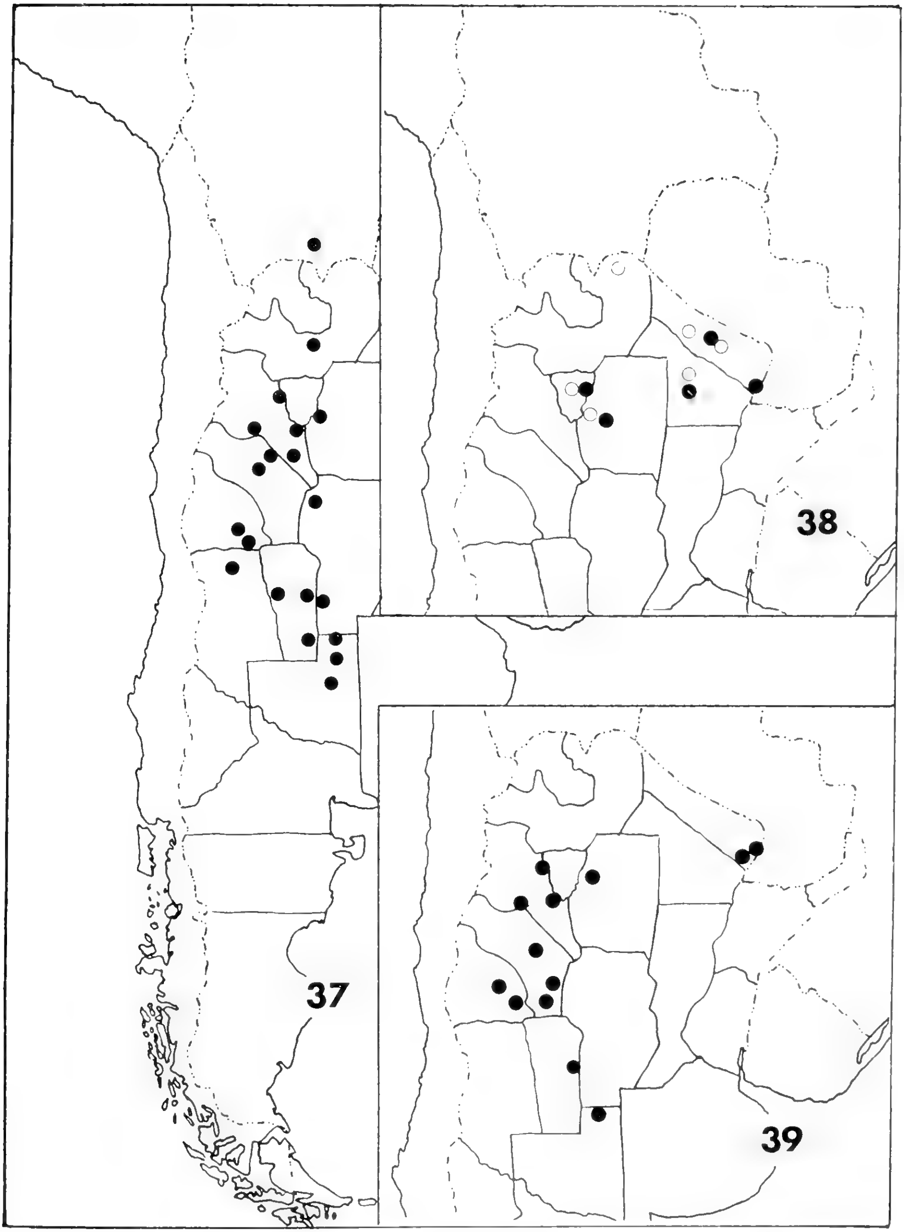
lateral border of gibbosity; strial punctures fine, elongated, closely spaced; 3rd, 5th, 7th, and 9th intervals slightly wider than 2nd, 4th, 6th, and 8th; intervals flat, finely strigose; mesosternum strongly narrowed apically, postmesocoxal sulci fine, meeting on midline, inconspicuous behind coxae. Abdomen and pygidium as in *R. atratus*. Pro- and mesolegs not modified, metacoxa finely punctate except for narrow, polished sulcus; metafemur incrassate but narrow, dorsal margin more strongly arched in distal ½ than proximal ½, ventral margin nearly straight, pecten consisting of 2 or 3 short denticles, proximal denticle longer than distal denticles; metatibia slender, more narrowed at base, gradually broadening distally, mucro short, acute, lateral denticle small, coronal denticles fine, inconspicuous; lateral, ventral, and dorsomedial carinae fine but complete to apex, lateroventral carina obsolete in apical $^{1}/_{5}$.

Male genitalia (Figs. 31, 32).—Ventral valve of median lobe with elongated apex; internal sac with brush of setae nearly ½ as long as sac; spinous plate short, broad, with 5–6 spines; median cluster with 5 large, thornlike spines and 3 smaller denticles; lateral lobes blunt apically, cleft to about $^{3}/_{5}$ their length.

Holotype ♂.—ARGENTINA: La Pampa Prov., Rt. 35, 1 mi N Santa Rosa, 18 November 1976, from pods *Prosopis caldenia.*

Allotype ♀, 3 ♂, 1 ♀ paratypes.—Same data as holotype.

Other paratypes.—ARGENTINA: San Juan Prov., Rt. 20, 32 mi SE Caucete, 19 February 1978, in *Prosopis alpataco* and *chilensis,* 2 ♂; Rt. 20, 3 mi E Caucete, 19 February 1978, in *Prosopis torquata,* 1 ♀; Rt. 20, 1 mi SE Caucete, 19 February 1978, in *Prosopis alpataco,* 1 ♂. Catamarca Prov., Rt. 62, 26 mi S Andalgala, 1 March 1977, in *Prosopis flexuosa,* 2 ♂; Rt. 307, 6 km N Santa Maria, 11 January 1980, in *Prosopis flexuosa,* 1 ♂; Rt. 40, 14 mi NE Tinogasta, February 1978, sweeping *Larrea cuneifolia,* 1 ♀; Andalgala, 23 October 1973, from *Prosopis nigra,* 1 ♂; Andalgala, 25 October 1972, 1 ♂; Colpes, 19 October 1973, from *Prosopis nigra,* 1 ♂. Santiago del Estero Prov., Rt. 34, 31 mi SE La Banda, 6 December 1976, in *Prosopis alba,* 1 ♀. Las Termas, 11 October 1972, *Prosopis alba,* 1 ♂; La Rioja Prov., Rt. 74, 1 mi SE Chilecito, 30 November 1976, on *Acacia aroma,* 1 ♂; Aimogasta, 11 February 1978, *Prosopis chilensis,* 4 ♂, 5 ♀, 25 February 1978, in *Prosopis chilensis,* 3 ♂. Cordoba Prov., Rt. 7, 1 mi E Cordoba-San Luis border, 19 November 1976, in *Prosopis caldenia,* 4 ♂; Rt. 38, 9 mi SW Cruz del Eje, 24 February 1977, in *Prosopis chilensis,* 1 ♂. Mendoza Prov., Rt. 40, 8 mi NE Mendoza, 22 February 1977, in *Prosopis alpataco,* 1 ♀. San Luis Prov., Rt. 188, 20 mi W La Pampa-S. Luis border, 15 February 1978, in *Prosopis caldenia,* 1 ♀; Rt. 188, 20 mi W La Pampa-S. Luis border, 17 February 1977, in *Prosopis flexuosa,* 1 ♂, 1 ♀; Alto Pencosa, 6 February 1951, 1 ♀. Lavaisse, Don Roberto Estancia, 17 Oc-



Figs. 37–39. Distribution of *Rhipibruchus* spp. 37, *R. psephenopygus*. 38, *R. oedipygus* (solid circles); *R. rugicollis* (open circles). 39, *R. atratus*.

tober 1942, 1 ♂; La Pampa Prov., Rt. 188, 38 mi W Realico, 15 February 1978, in *Prosopis caldenia*, 3 ♂, 4 ♀; Rt. 35, 85 mi N Santa Rosa, 15 February 1978, in *Prosopis caldenia*, 1 ♂, 1 ♀. Salta Prov., Oran Salta, 14–17 August 1917, *Prosopis juliflora*, 2 ♂. BOLIVIA: Tarija Prov., Tarija, 7 July 1980, in seed *Prosopis* sp., 1 ♀.

Holotype and paratypes deposited in Fundación Miguel Lillo, Tucumán. Allotype and paratypes deposited in National Museum of Natural History, Washington, D.C.; paratypes in Bernardino Rivadavia Museum of Natural Sciences, Buenos Aires, British Museum (Natural History), London, and Utah State University, Logan.

Diagnosis.—This species is recognized by the evenly distributed pygidial vestiture in both sexes and by the broad, transverse dark band across the middle of the elytra. It is probably most closely related to *R. picturatus*.

Remarks.—The name *psephenopygus* is derived from the Greek *psephenos* (dark, obscure) and *pyge* (rump) and refers to the dark pygidium.

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LITERATURE CITED

Blackwelder, R. E. 1946. Checklist of the coleopterous insects of Mexico, Central America, the West Indies, and South America. U.S. Natl. Mus. Bull. 185(4): 551–763.

Bosq, J. M. 1942. Segundo lista de Coleopteros de la Republica Argentina, daninos a la agricultura. Ing. Agron. 4(18–22): 1–80.

Bridwell, J. C. 1932. The subfamilies of the Bruchidae (Coleoptera). Proc. Entomol. Soc. Wash. 34(6): 100–106.

von Fahraeus, O. I. 1839. (New species). *In* Schoenherr, Genera et species Curculionidum, cum synonymia hujus familiae 5(1): 1–456.

Kingsolver, J. M. 1967. On the genus *Rhipibruchus* Bridwell, with descriptions of a new species and a closely related new genus (Coleoptera: Bruchidae: Bruchinae). Proc. Entomol. Soc. Wash. 69(4): 318–327.

Kingsolver, J. M., C. D. Johnson, S. R. Swier, and A. Terán. 1977. *Prosopis* fruits as a resource for invertebrates. *In* Simpson, B. B., Mesquite. Its biology in two desert scrub ecosystems. Dowden, Hutchinson, and Ross, Stroudsburg, Pa. 250 pp.

Philippi, F. H. E. 1859. Algunas especias nuevas de Coleopteros de la Provincia de Valdivia. Anal. Univ. Chile 16: 656–678.

Pic, M. 1913. Coleopterorum catalogus, pars 55, Bruchidae (Vol. 26): 1–74.

Zacher, F. 1952. Die Nährpflanzen der Samenkäfer. Z. Angew. Entomol. 33(3): 461–480.

PROC. ENTOMOL. SOC. WASH.
84(4), 1982, pp. 685–689

A NEW SPECIES OF *TETANOCERA* DUMÉRIL FROM COLORADO (DIPTERA: SCIOMYZIDAE)

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Abstract.—A new species, *Tetanocera* ***arnaudi,*** is described from Teller County, Colorado. It is one of the smaller *Tetanocera* species found in North America, and shows some similarities with *T. spreta* van der Wulp (externally) and *T. brevihirta* Steyskal (male terminalia). Illustrations of the new species are included.

The genus *Tetanocera* is widespread in both the Nearctic and Palaearctic regions. In North America there are 31 species (including the species described herein), 11 of which are Holarctic. The genus is well represented in collections as these flies are relatively large and easily identified. The body coloration varies from yellowish to reddish-brown. Many species within the genus exhibit little diversity in external differences and in many cases dissection of the adult terminalia is the only effective means of separation.

The most complete work on North American *Tetanocera* was by Steyskal (1959), in which he listed 27 species, of which 8 were described as new. Illustrations and keys were provided for all species and a phylogenetic grouping was suggested where relationships could be shown. Since that work two new species occurring in North America have been described, *Tetanocera andromastos* Steyskal (1963), a very small species from Churchill, Manitoba, and *Tetanocera freyi* Stackelberg (1963), a Holarctic species from the NW European part of the USSR and North America (Alaska). Stackelberg (1963) also provided extensive illustrations for other members of the genus in the European part of USSR.

Tetanocera arnaudi **Orth and Fisher,** New Species

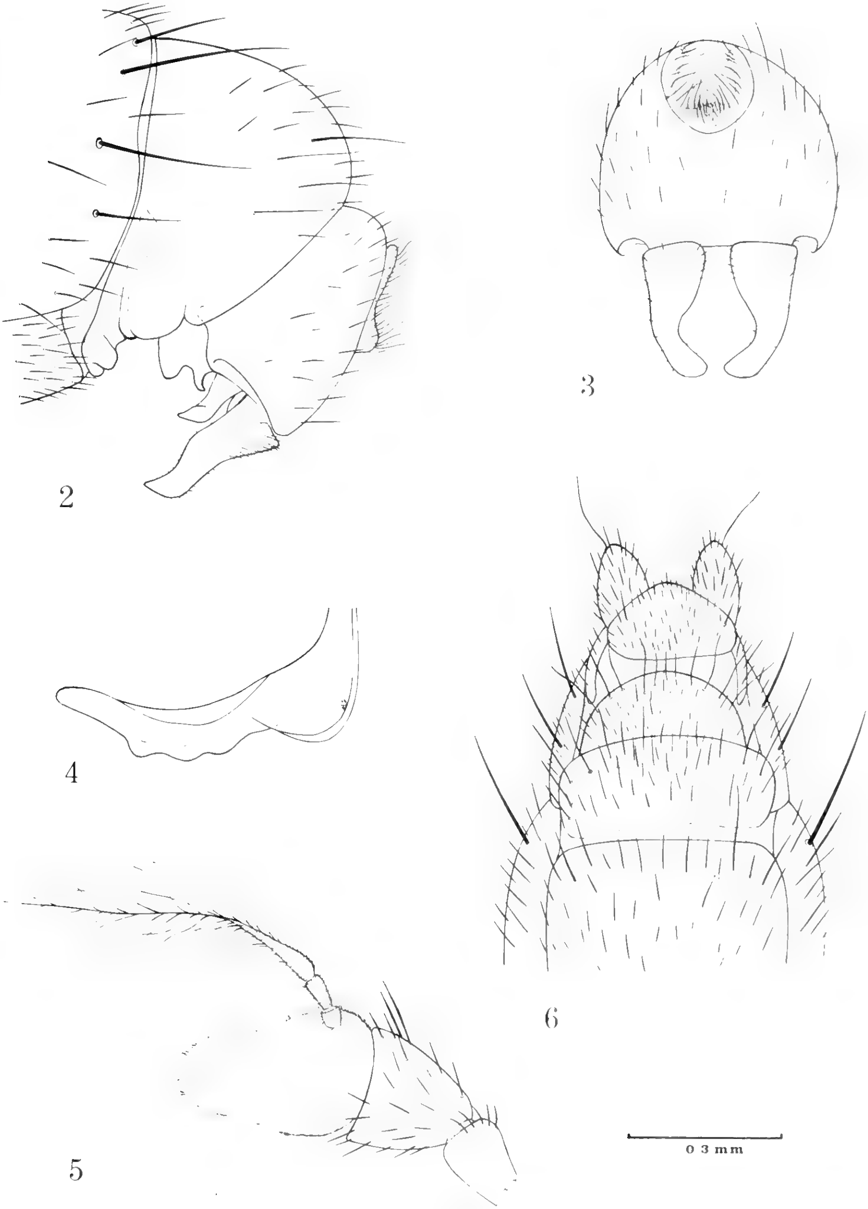
Figs. 1–6

Holotype male.—Height of head 7/10 width. Medifacies, parafacies, and cheeks whitish pruinose with a tinge of yellow. Parafacies with hairs extending less than halfway from lower margin of eyes to antennal sockets. Frons yellow, slightly narrowed anteriorly. Midfrontal stripe orangish brown, extending more or less parallel sided to anterior margin of frons. Ocellar

Fig. 1. *Tetanocera arnaudi,* holotype male. Before terminal segments were excised. Photo by M. E. Badgley, University of California, Riverside.

triangle and orbital plates with brownish pruinosity. Orbital plates tapered anteriorly, extending well beyond ocellar triangle. Orbitoantennal spot lacking, narrow strip of white pruinosity along upper orbital margin. Two pairs of fronto-orbital bristles of approximately equal length; ocellars, postocellars, and inner and outer verticals well developed. Occiput whitish pruinose. Lateral occipital margins with strong setae and bristles. Antenna testaceous, segment 2 approximately ⅔ length of 3; segment 3 elongate, dorsal margin slightly concave. Arista black, plumosity of moderate length and density. Palpi yellowish, labium and labella brownish.

Thorax tannish yellow pruinose; dorsum with brownish longitudinal stripes. Pleura bare except sternopleuron with fine short hairs over most of the surface and well-developed bristles ventrally; propleuron with 1 or more fine hairs above base of forecoxa. Prosternum bare.



Figs. 2–6. *Tetanocera arnaudi*, Florissant, Petrified Forest Area, Teller County, Colorado, 2530 m, 11 August 1973, P. H. Arnaud, Jr. 2–5, Paratype, male. 2, Postabdomen, sinistral view. 3, Hypopygium, rear view. 4, Protandrium, ventral view. 5, Antenna. 6, Allotype, female, ventral view of terminalia.

Coxae whitish pruinose with some testaceous areas. Legs mostly yellowish, forefemur more testaceous. Foretarsus and apical ⅓ of foretibia black; mid- and hindtarsal segments 4 and 5 black, preceding segments with some brown. Posterior surface of midfemur with a single strong bristle near tip.

Wing length 4.4 mm. Membrane greyish yellow hyaline with costal browning; costal margin and veins yellow, slightly testaceous; crossveins arcuate, infuscated. Halter and squama pale yellow.

Abdominal segments tannish yellow pruinose; postabdomen as in Figs. 2–5.

Allotype female.—Similar to holotype except in abdominal morphology. Fig. 6. Wing length 5.2 mm.

Holotype.—♂, USA, Colorado, Teller County, Florissant, Petrified Forest Area, 2530 m, 11 August 1973, Paul H. Arnaud, Jr., CAS. California Academy of Sciences Type no. 13967.

Allotype.—♀, same data as holotype. Deposited with holotype.

Paratypes.—Same data as holotype (7♂, 2♀); Colorado, Teller County, 21 August 1959, N. Marston (2♂, 2♀); Colorado, Saguache County, 1 August 1937, 9000 feet [2743 m], R. H. Painter (1♂). At the California Academy of Sciences, University of California at Riverside, and the National Museum of Natural History, Washington, D.C.

Variation.—The specimens at hand show very little variation in color and size. Wing length of 10♂, 4.4 to 4.8 mm. Wing length of 4♀, 4.8 to 5.4 mm.

Diagnosis.—In Steyskal's (1959) "Key to the American Species of *Tetanocera*," *T. arnaudi* would be placed close to *T. spreta* van der Wulp, a species from the highlands of Mexico. However, examination of the terminalia reveals them to be entirely different. The male terminalia of *T. arnaudi* show some similarity to *T. brevihirta* Steyskal, a species known only from Fairbanks, Alaska, but the external characters are quite different. At rubric 10 in Steyskal's key, *T. spreta* and *T. arnaudi* would be separated as follows:

10(11). Part of foretibia and all of foretarsus black.

a. Apical $^1/_7$ of foretibia black, abdomen with middorsal brown stripe, terminalia as illustrated (by Steyskal, Fig. 9) .... *T. spreta* van der Wulp

b. Apical ⅓ of foretibia black, abdomen dorsally unicolorous, terminalia as illustrated (in our Figs. 2–6) .. *T. arnaudi*, new species

Discussion.—*Tetanocera arnaudi* is one of the smallest of the North American *Tetanocera;* perhaps only *T. andromastos* is smaller. The type-locality, Florissant, Teller County, is in the center of the state of Colorado at approximately 39°N latitude. This species is named after Dr. Paul H. Arnaud, Jr., California Academy of Sciences, Golden Gate Park, San Francisco, California, who for many years has provided material to further our studies on the Sciomyzidae.

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LITERATURE CITED

Stackelberg, A. A. 1963. Species of the genus *Tetanocera* Dum. (Diptera: Sciomyzidae) in the European part of the USSR. Entomol. Rev. 42(4): 492–497.

Steyskal, G. C. 1959. The American species of the genus *Tetanocera* Duméril (Diptera). Pap. Mich. Acad. Sci. Arts Lett. (1958)44: 55–91.

———. 1963. Taxonomic notes on Sciomyzidae (Diptera: Acalyptratae). Pap. Mich. Acad. Sci. Arts Lett. (1962)48: 113–125.

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84(4), 1982, pp. 690–703

PSALLUS VARIABILIS (FALLÉN) AND *P. ALBIPENNIS* (FALLÉN), TWO EUROPEAN PLANT BUGS ESTABLISHED IN NORTH AMERICA, WITH NOTES ON TAXONOMIC CHANGES (HEMIPTERA: HETEROPTERA: MIRIDAE)

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Abstract.—The Palearctic phyline mirids *Psallus variabilis* (Fallén) and *P. albipennis* (Fallén) were collected and found established on Long Island, New York, in 1981–1982. These are the first substantiated records for *variabilis* in North America and the first published record of a breeding population of *albipennis* in North America. On Long Island, adults and nymphs of *P. variabilis* were collected from staminate inflorescences of scrub oak, *Quercus ilicifolia* Wang.; adults also were taken from *Q. coccinea* Muenchh. and several other plants. Adults and nymphs of *P. albipennis* were collected from leaves and stems of common sagewort, *Artemisia campestris* L.

The adult and fifth-instar nymph of both species are described and illustrated; the male genitalia of each species also are illustrated. A review of the European literature discussing host plants and seasonal history is presented for both species. In addition, an unpublished record of *P. albipennis* from Minnesota is given. *Psallus waldeni* Knight is proposed as a junior synonym of *P. albipennis,* new synonymy; and *albipennis* is formally transferred from *Plagiognathus* to *Psallus,* new combination.

As part of the USDA-APHIS "High Hazard Pest Survey" program, Hoebeke (1980) identified the mirid *Psallus variabilis* (Fallén), based on a specimen collected at Oyster Bay, Long Island, N.Y. Although Van Duzee (1889) had reported this European plant bug from Ontario and later (1894) from New York, Knight (1927), after examining Van Duzee's specimens, considered them to represent a native species, *Lepidopsallus rubidus* var. *atricolor* Knight. The Long Island collection thus is the first New World record for *P. variabilis*.

We visited the Oyster Bay area in May 1981 and 1982 to confirm the establishment of *P. variabilis* and to determine its host range. On the Long

Island trips we also collected the Palearctic *Psallus albipennis* (Fallén), a mirid recorded in the New World only from Bradore Bay, Quebec (Moore, 1950). We now confirm that this *Artemisia* feeder is established in North America.

In this paper we provide descriptions and illustrations for the adult and fifth-instar nymph of both species; the male genitalia of each species also are illustrated. We also propose *Psallus waldeni* Knight, described from Connecticut in 1923, as a junior synonym of the Palearctic *Psallus albipennis,* and transfer *albipennis* from *Plagiognathus* to *Psallus.*

***Psallus variabilis* (Fallén)**

Butler (1923) considered *P. variabilis* one of the most common British heteropterans. Although in England it apparently is confined to species of *Populus* and *Salix* (Southwood and Leston, 1959), on the continent it feeds mainly on oak (*Quercus* spp.). Kullenberg (1944) recorded this mirid from *Quercus macranthera* Fisch. and Mey., *Q. petraea* L. ex Liebl. (cited as *Q. sessiliflora* Salisb.), and *Q. robur* L. Scudder (1956) also said it is common on *Q. petraea,* and Ehanno (1965) recorded populations on *Q. robur* (cited as *Q. pedunculata* Ehrh.) and on *Q. ilex* L. On oak, Kullenberg observed that feeding takes place on young shoots and leaf veins, as well as on catkin stalks and pollen sacs. He noted that when staminate inflorescences of oak begin to dry the late instars and adults move to the pistillate flowers. We believe that the large number of "hosts" listed in the European literature (e.g., Stichel, 1956) reflect a movement to other plant species, especially their inflorescences, when reproductive structures of oak have shriveled. Kullenberg (1944) and Strawinski (1964) stated that *P. variabilis* often supplements its diet with soft-bodied prey occurring on its host plants.

Psallus variabilis is a univoltine species that overwinters in the egg stage; adults are present from mid-June to early August (Kullenberg, 1944) or may appear as early as mid-May (Aukema, 1981). The October record of Butler (1923) must be based on a misidentification. Indeed, the subgenus to which *variabilis* belongs, *Hylopsallus* Wagner, includes several closely related oak feeders (e.g., *perrisi* Mulsant) that can be separated reliably only by characters of the male genitalia (Aukema, 1981). Woodroffe (1957) believes that many of the British records of *variabilis* should be referred to *perrisi.*

The first North American record of *P. variabilis* resulted from the collection of an adult female in the Planting Fields Arboretum, Oyster Bay, Long Island, on June 6, 1979; the specimen was taken in a vegetable garden by K. Uchida as part of the USDA-APHIS "High Hazard" survey. Following the identification of this specimen (by ERH) in June 1980, we made plans to make additional collections in 1981.

On May 29, 1981, we found a small population of *P. variabilis* at the Planting Fields Arboretum; five adults were collected on scarlet oak, *Quer-*

cus coccinea Muenchh., growing in a hedgerow. Single specimens were taken on a nearby red maple, *Acer rubrum* L., and a quaking aspen, *Populus tremuloides* Michx. The next day we collected two adults from the inflorescences of *Viburnum recognitum* Fernald growing in the same hedgerow, and two adults at Port Jefferson on a fir, *Abies* sp., whose needles were coated with honeydew from an aphid infestation.

We found a larger population of *P. variabilis* on May 30 at Center Moriches on southeastern Long Island; about 40 adults and six fifth-instar nymphs were beaten from staminate inflorescences of scrub oak, *Q. ilicifolia* Wang. The trees, part of a dense thicket dominated by bayberry, *Myrica pennsylvanica* Loisel., were growing along a railroad.

In May 1982 we found large numbers of adults on flowers of black cherry (*Prunus serotina* Ehrh.), hawthorn (*Crataegus* sp.), and downy serviceberry (*Amelanchier arborea* (Michx.) Fern.) after catkins had largely dropped from nearby oaks. We collected *P. variabilis* at these additional localities in Suffolk Co., Long Island, during May 28–30, 1982: Bayard Cutting Arboretum, Oakdale; Blue Point; and near Tiana Bay.

Our limited observations suggest that *P. variabilis* is a univoltine, early-season mirid associated mainly with staminate inflorescences of oaks. Based on the European literature and our collections, adults on Long Island probably appear by mid-May and are present only until mid- to late June. In the Planting Fields Arboretum the staminate flowers had withered and fallen from most of the scarlet oaks, and the mirid population already may have begun to decline. Our collection of adults on inflorescences of various plant species probably reflected a dispersal to an alternate food source. On southeastern Long Island at Center Moriches, the scrub oaks still retained their male catkins although some had withered; the development of mirid populations on scrub oak in 1981 lagged slightly behind that on scarlet oak at Oyster Bay.

Psallus variabilis appears well established on Long Island, and the large numbers found on native scrub oak suggest that it has been present for several years, if not longer. This mirid is widely distributed on Long Island; we have seen a specimen collected by Roy Latham from the northern peninsula. His unlabeled specimen was among material donated to Cornell University and known to have been collected in the Orient area between 1968 and 1978 when this well-known naturalist was in his 80's, or nearly 90 (L. L. Pechuman, personal communication).

Psallus variabilis most likely was introduced with nursery stock imported from Europe. Long Island, site of the first nursery in the New World (Bailey, 1935; Hedrick, 1950), was an early center of plant importation. Imported plants were purchased by nurseries, as well as by private estates. In fact, the Planting Fields Arboretum, originally a private estate, is known to have been landscaped partly with plants that originated in Europe (G. Clarke, personal communication).

The following adult description of *P. variabilis* is taken from Aukema (1981), who discussed color variation found among populations in the Netherlands and Great Britain. Similar color variation is found among Long Island populations we examined. Females tend to be reddish brown, males dark brown or fuscous and more slender.

Adult.—Small (3.3–4.4 mm), oval, dorsal habitus as in Fig. 1, yellow brown, red brown, bright orange red, sometimes dark brown. Pubescence consisting of both shiny golden scales and semi-erect black setae.

Head dirty yellow brown to dark brown, sometimes with a reddish tinge. Antenna yellow brown, with extreme base of segment I more or less dark or black.

Pronotum light yellow brown to dark brown, tinged with black and sometimes anteriorly and/or posteriorly with dark markings; sometimes (especially in female) tinged with red or orange red. Mesoscutum and scutellum colored as pronotum; lateral margins of mesoscutum and scutellum and apex of scutellum usually somewhat lighter.

Hemelytra light yellow brown to dark brown, especially near apex more or less tinged with red or orange red. Cuneus yellow brown, red brown to deep red, basally more or less white along fracture. Wing membrane dark gray to black, with a clear spot just behind the outer cell. Veins colorless to grayish, usually tinged with red.

Femora dark brown, broadly red to orange red apically, sometimes with a few indistinct dark spots beneath. Tibiae light yellow with black spines arising from distinct dark spots, especially on hindtibia. Tarsi yellow, segment 3 dark apically.

Ventral surface light red brown to dark brown.

Structural differences of the aedeagus and parameres offer the most dependable characters for separating species of *Psallus*. The male genitalia of *P. variabilis* are briefly described here to facilitate recognition. The right paramere is large and oblong (Fig. 3a), while the left paramere is also large with the sensorial process broadly rounded apically (Fig. 3b, c). The aedeagus is oblong and robust, with two lateral processes (Fig. 3d); the basal process is short and hooked at apex.

Kelton (1980) listed approximately 40 species of *Psallus* occurring in North America; Knight (1941) treated 13 of these species in a key to the mirid fauna of Illinois and eastern North America. *Psallus variabilis* will key near *P. amorphae* Knight in Knight's key, but differs from *amorphae* mainly by its lighter dorsal coloration, by its pubescence consisting of shiny golden scales and semi-erect black setae, and by its distinctive male genitalia (Fig. 3a–d).

Figs. 1, 2. Dorsal habitus of adults. 1, *Psallus variabilis*. 2, *P. albipennis*.

Fifth-instar nymph.—(In alcohol), Fig. 4. Length 3.0–3.1 mm; background color pale brown to reddish brown; head, pro-, meso- and metanotum and wing pads moderately, densely clothed with erect silvery setae; abdomen moderately clothed with erect pale to dark setae. Head: Length 0.40 mm, width across eyes 0.67 mm. Rostrum: Length 1.30–1.34 mm, reaching metacoxae. Antenna: Pale yellowish, extreme base of segment I dark or black, clothed with fine recumbent setae; segment I, length 0.25–0.26 mm; II, 0.67–0.70 mm; III, 0.50 mm; IV, 0.30 mm. Pronotum: Length 0.40–0.50 mm, median width 0.80 mm, anterior and posterior angles broadly rounded, somewhat uniformly dark brown to fuscous, especially borders; median line and other adjacent median areas pale, rather moderately and uniformly punctured. Meso- and metanotum: Length 0.60–0.67 mm, median width across wing pads 1.40–1.47 mm, moderately and uniformly punctured; wing pads relatively long, reaching slightly beyond apex of abdominal segment III, moderately coarsely punctured. Abdomen tapered to apex, mostly reddish; basal segments on mid-dorsal line marked with dark brown; small, irregular brownish spot on each side of midline on segments V–VIII. Apical 2 abdominal segments brownish dorsally. Dorsal abdominal gland opening conspicuous along suture between terga 3 and 4; opening (=Type 3 of Akingbohungbe, 1974) with a sinuate sclerotized bar.

Forefemur dark reddish brown, apex pale; foretibia pale yellow, slightly darkened apically, clothed with fine, recumbent setae; foretarsus pale brownish. Mid- and hindfemora reddish brown; mid- and hindtibiae pale

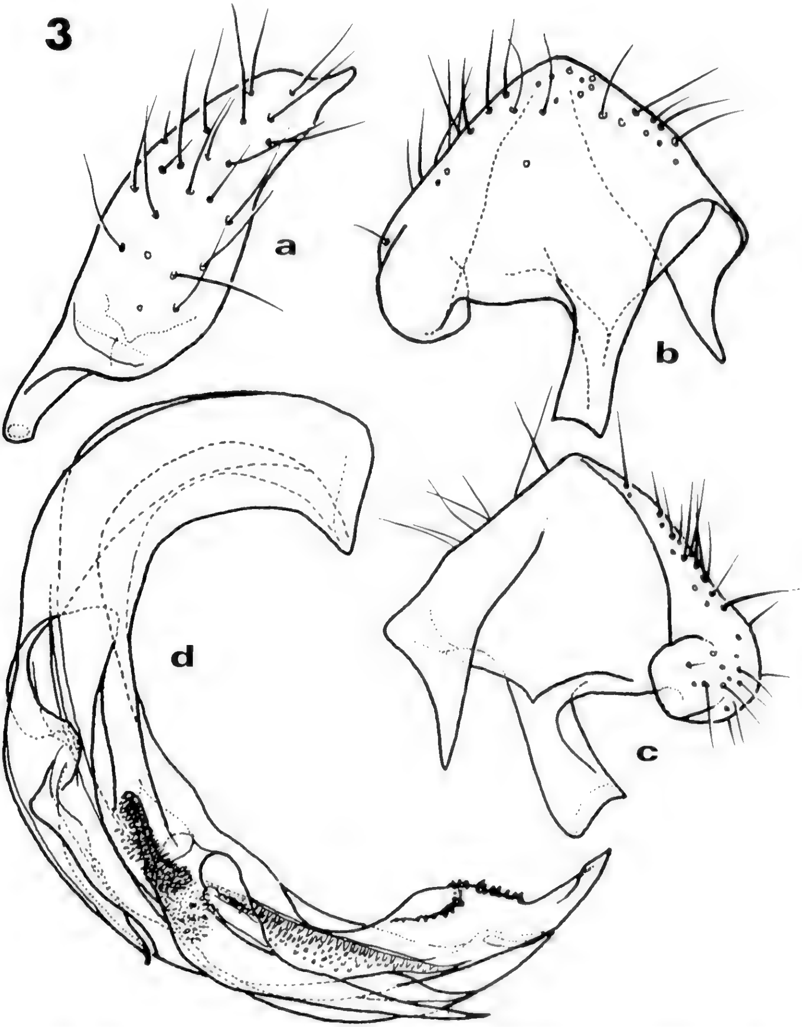

Fig. 3. Male genitalia of *Psallus variabilis*. a, Right paramere. b, c, Opposing views of left paramere. d, Aedeagus. (All structures reproduced from Aukema, 1981.)

yellow, with black, erect setae arising from black spots. Mid- and hindtarsi pale brownish. Venter pale reddish to fuscous, extreme lateral areas of abdominal segments brownish.

Material examined.—2 fifth-instar nymphs, collected from male catkins of *Quercus ilicifolia*, near Center Moriches (Suffolk Co.), Long Island, on May 30, 1981. Determined by association with adults.

Fig. 4. Dorsal habitus of *Psallus variabilis* nymph, fifth instar.

Psallus albipennis (Fallén), New Combination

This common and widely distributed European species has been termed a "Holopalearctic" mirid (Wagner, 1952). Kullenberg (1944) noted that *P. albipennis* is restricted to feeding on plants of the genus *Artemisia,* with *A. absinthium* L. as the principal host, although Kullenberg also observed feeding on *A. vulgaris* L. and on an ornamental species. He found that the bugs prefer unopened flower buds but also will feed on leaves and stems. Adults of this bivoltine mirid are present from mid-July to early September (Kullenberg, 1944), or late June to October (Southwood and Leston, 1959). Kullenberg determined that the egg represents the overwintering stage of this species.

Psallus albipennis so varies in coloration that at least seven varieties have been described (Reuter, 1878). Wagner (1941) described two new *Artemisia*-feeding species of *Plagiognathus* that had been confused with *albipennis;* since then, several other species, all restricted to *Artemisia,* have been described in the subgenus *Poliopterus* Wagner of *Plagiognathus* (see Wagner, 1975). In disagreeing with Wagner's (1941) interpretation, Southwood and Leston (1959) regarded the extreme morphological forms occurring on different species of *Artemisia* as a single, quite variable species. The different forms show "no constant differences between them," and second generation adults of *albipennis* are somewhat larger than those of the first generation.

The only published North American record of *P. albipennis* is from Bradore Bay, Quebec, on the easternmost point adjoining Labrador; no dates or number of specimens were given (Moore, 1950). Carvalho (1958) did not list a New World record for *albipennis* in his catalogue of world Miridae. We found that Moore's record was based on specimens taken during August 2–8, 1930, by the coleopterist W. J. Brown, who spent the summer of that year collecting at Thunder Bay and at Bradore Bay "on the western extremity of the Straits of Belle Isle" (Brown, 1932). Most of his material is housed in the Canadian National Collection in Ottawa, with the remainder of the series in the H. H. Knight collection at the National Museum of Natural History, Washington, D.C. Knight's collection also contains 32 specimens of *P. albipennis* from Cook Co. in northeastern Minnesota; this record, actually predating that from Bradore Bay, was never published. The data for this early collection of *P. albipennis* are: Grand Marais, Minnesota, Aug. 13, 1922, H. H. Knight.

On May 30, 1981, we found a large population of *P. albipennis;* adults and a few fourth- and fifth-instar nymphs were feeding on *Artemisia campestris* L. growing in dry, sandy soil along a railroad south of Yaphank. One of us (AGW) and T. J. Henry returned to the same site on August 29 and found adults and instars II–V. In 1982 we found two adults on *A. campestris* in Suffolk Co., near the Suffolk County Air Force Base, NW of Quogue.

It appears that this species breeds throughout the summer and that instead of the two annual generations reported for Europe there are at least three on Long Island. We consider *P. albipennis* to have been introduced from Europe with man's commerce. This species can easily be overlooked and may be more widespread in eastern North America. Crossley (1980), in explaining the lack of records for Yorkshire, England, pointed out that because these bugs develop on "plants of waste places they often escape the attention of entomologists!"

As we were collecting mirids from *Artemisia campestris,* we suspected we might be dealing with a European species. We were not aware of any phylines associated with *Artemisia* spp. in the eastern U.S. (they are common on these plants in the western states), and Long Island is especially liable to accidental introductions with commerce. We described the Long Island mirid to T. J. Henry, who suggested that it might represent *Psallus waldeni* Knight, a species whose identity has long remained in doubt. Knight (1923) described *waldeni* from two females taken at New Haven, Connecticut, on May 30, 1911. The Connecticut record is cited by Blatchley (1926) and listed by Carvalho (1958), but no further records are available. If this species has been collected since 1911, it apparently has not been correctly identified. After comparing our specimens with Knight's holotype, Henry concluded that even though only females of *waldeni* were available, the Long Island material was conspecific. We then borrowed European specimens of *P. albipennis*. After examining and comparing the male genitalia of the Yaphank specimens with those of the borrowed European specimens, we concluded that our material was conspecific with the Old World species. Therefore, we propose a NEW SYNONYMY; *Psallus waldeni* Knight (1923) is a junior synonym of *P. albipennis* (Fallén).

As Henry (1981) pointed out, the generic limits of *Plagiognathus* and *Psallus* are poorly defined; the North American species of both genera are badly in need of revision. At the time Knight (1923) described *waldeni,* he separated the two genera on the basis of simple setae (*Plagiognathus*) vs. tomentose or scalelike setae, plus simple setae (*Psallus*). Because *waldeni* has sericeous setae, especially on the head and pronotum, he placed the new species in *Psallus*. Because of this setal type, *albipennis* will key to *Psallus* in Knight (1923, 1941) and in some of the European literature. Wagner (1975) uses scalelike setae to separate *Plagiognathus* from *Psallus* but places *albipennis* in the former genus. The mirid specialists L. A. Kelton and T. J. Henry feel that *albipennis* properly belongs in *Psallus,* and they have allowed us to formalize this generic transfer. We therefore recognize the new combination, *Psallus albipennis* (Fallén).

Adults of *P. albipennis* are characterized by the following brief description, drawn from the European literature and from specimens at hand.

Adult.—Small (2.8–3.3 mm), elongate-oval, dorsal habitus as in Fig. 2, color highly variable, usually grayish white but varying from pale to brownish black. Pubescence consisting of dense, long, silvery white setae.

Head dark in front. Antenna with segment I dark or black; segment II dark or black at base, paler at apex; segments III and IV pale.

Pronotum transverse, blackish; lateral margins slightly rounded, brown or grayish white. Scutellum blackish.

Hemelytra usually dark. Cuneus pale at base. Wing membrane dusky, veins and spot below cuneus white or pale.

Hindfemur, and usually also fore- and midfemora, black or blackish brown, yellow brown at apex. Fore-, mid-, and hindtibiae yellowish, with row of black spots, each bearing a black seta. All tarsi brownish.

The male genitalia of *P. albipennis* are characterized as follows: The right

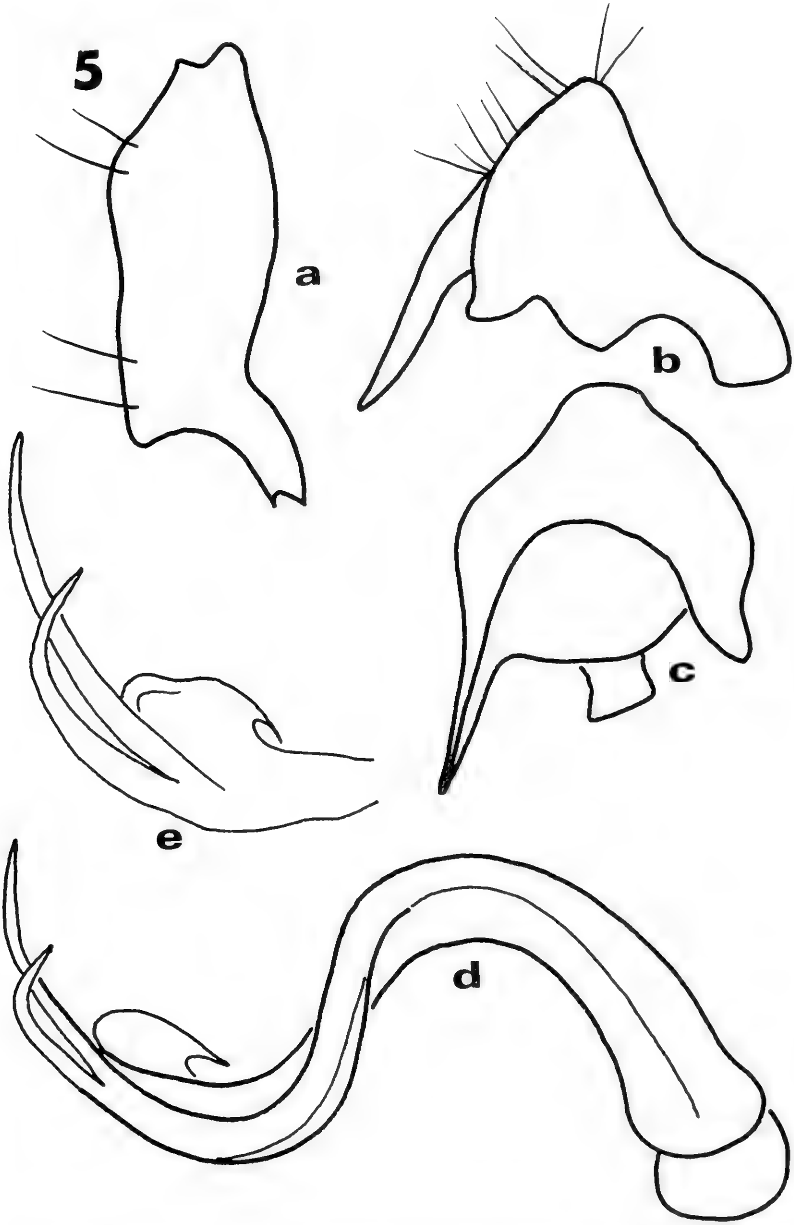

Fig. 5. Male genitalia of *Psallus albipennis*. a, Right paramere. b, c, Opposing views of left paramere. d, Aedeagus. e, Close-up of apex of aedeagus. (All structures redrawn from Wagner, 1941.)

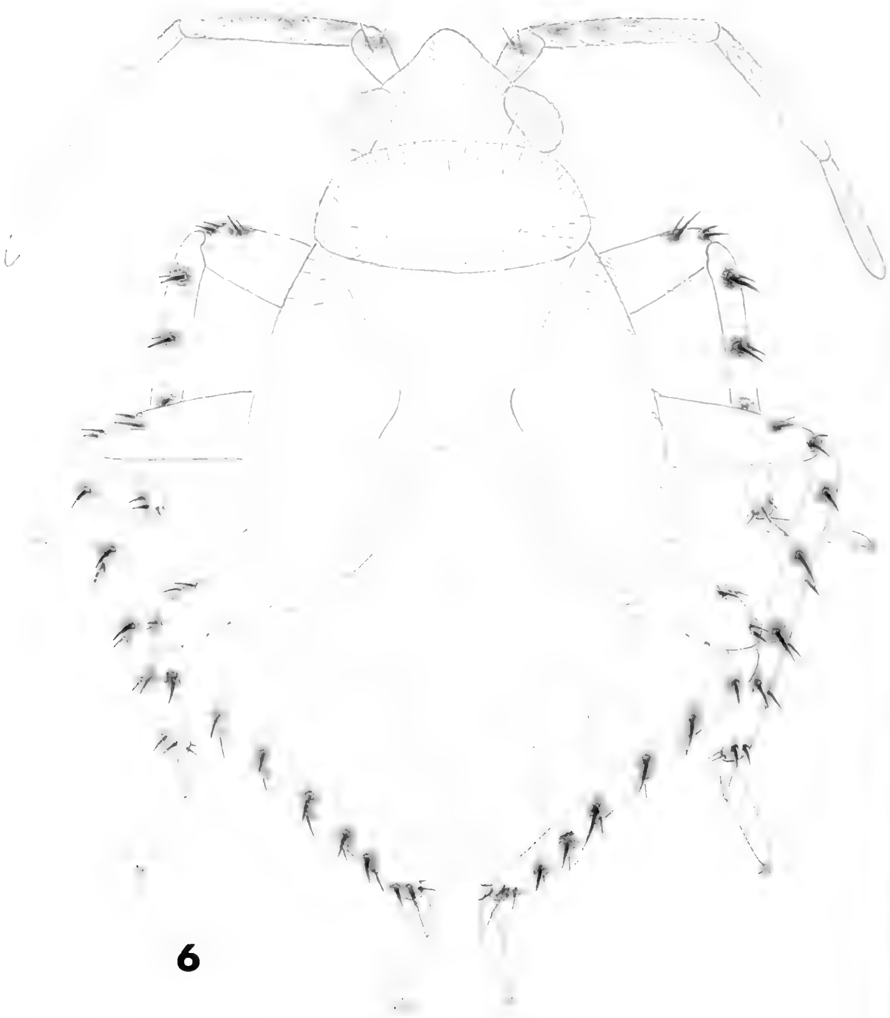

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Fig. 6. Dorsal habitus of *Psallus albipennis* nymph, fifth instar.

paramere is moderately large with a small, but prominent subapical protuberance (Fig. 5a), while the left paramere is shaped as in Fig. 5b,c. The aedeagus is quite long and broadly curved (Fig. 5d); the apical appendage is short, evenly curved and directed laterally, and the apex of the membranous appendage is pointed and caudally directed (Fig. 5e). *Psallus albipennis* does not key readily to any species in Knight (1941), but will key to *waldeni* n. sp. in Knight (1923); *waldeni* Knight is a junior synonym of *P. albipennis*.

Fifth-instar nymph.—(In alcohol), Fig. 6. Length 2.1 mm; background color pale cream white; head, pro-, meso-, and metanotum, wing pads, and basal abdominal segments moderately, densely clothed with long, semi-erect pale setae; apical abdominal segments clothed dorsally with long, semi-erect, pale, brownish setae. Head: Length 0.30 mm, width across eyes 0.60 mm. Rostrum: Length 1.0 mm, extending to metacoxae; pale white, apex infuscated. Antenna: slightly brownish, inner margin of segment I at apex with large dark spot bearing 2 erect dark setae; basal ⅓ of segment II mottled with small brownish spots; all segments clothed with fine recumbent setae; segment I, length 0.20 mm; II, 0.48 mm; III, 0.40–0.45 mm; IV, 0.30 mm. Pronotum: Length 0.27–0.30 mm, median width 0.60–0.70 mm, anterior and posterior margins broadly rounded, each with a very small dark spot bearing a single seta; surface uniformly cream white. Meso- and metanotum: Length along median line 0.40–0.60 mm, median width across wing pads 1.0 mm, uniformly pale cream white, apices slightly infuscated, extending nearly to apex of abdominal segment IV. Abdomen broadly tapered to rounded apex, uniformly pale cream white. Dorsal abdominal gland opening small and inconspicuous along suture between terga 3 and 4; opening (Type 3) with sinuate sclerotized bar.

Fore-, mid-, and hindfemora pale, each with a large, dorsal, subapical dark spot bearing a single dark seta, and a smaller, apical, dark spot bearing 2 setae. Fore-, mid-, and hindtibiae pale white, slightly infuscated apically, with 2 rows of large dark spots along dorsal face bearing dark setae. Fore-, mid-, and hindtarsi brownish. Venter pale cream white throughout.

Material examined.—8 fifth-instar nymphs, collected from foliage of *Artemisia campestris*, growing along Rt. 21 south of Yaphank (Suffolk Co.), Long Island, on May 30, 1981. Determined by association with adults.

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LITERATURE CITED

Akingbohungbe, A. E. 1974. Nymphal characters and higher classification analysis in the Miridae (Hemiptera: Heteroptera) with a subfamily key based on the nymphs. Can. Entomol. 106: 687–694.

Aukema, B. 1981. A survey of the Dutch species of the subgenus *Hylopsallus* of *Psallus* (Hemiptera-Heteroptera, Miridae). Tijdschr. Entomol. 124: 1–25.

Bailey, L. H. 1935. The standard cyclopedia of horticulture. Vol. II, Macmillan Co., New York. Pp. 1201–2421.

Blatchley, W. S. 1926. Heteroptera or true bugs of eastern North America with especial reference to the faunas of Indiana and Florida. Nature Publ. Co., Indianapolis, Ind. 1116 pp.

Brown, W. J. 1932. Additional notes on the Coleoptera of the north shore of the Gulf of St. Lawrence. Can. Entomol. 64: 198–209.

Butler, E. A. 1923. A biology of the British Hemiptera-Heteroptera. H. F. & G. Witherby, London. 682 pp.

Carvalho, J. C. M. 1958. Catalogue of the Miridae of the world. Pt. II. Subfamily Phylinae. Arch. Mus. Nac., Rio de J. 45: 1–216.

Crossley, R. 1980. Some interesting insects at Tag Lock, Elland. Naturalist (Leeds) 105(955): 159–160.

Ehanno, B. 1965. Notes ecologiques sur les Miridae (Insecta-Heteroptera) observes en Bretagne sur le chene. Vie Milieu 16: 517–533.

Hedrick, U. P. 1950. A history of horticulture in America to 1860. Oxford University Press, New York. 551 pp.

Henry, T. J. 1981. A new eastern United States *Psallus* Fieber (Heteroptera: Miridae) from *Physocarpus* (Rosaceae). Proc. Entomol. Soc. Wash. 83: 399–402.

Hoebeke, E. R. 1980. A mirid bug (*Psallus variabilis* (Fallen)). Coop. Plant Pest Rpt. 5(33): 628.

Kelton, L. A. 1980. The insects and arachnids of Canada. Part 8. The plant bugs of the prairie provinces of Canada (Heteroptera: Miridae). Biosystematics Research Institute, Ottawa, Publ. 1703, 408 pp.

Knight, H. H. 1923. Family Miridae (Capsidae), pp. 422–658. *In* Britton, W. E., ed., The Hemiptera or sucking insects of Connecticut. Conn. State Geol. Nat. Hist. Surv. Bull. 34.

———. 1927. On the Miridae in Blatchley's "Heteroptera of Eastern North America." Bull. Brooklyn Entomol. Soc. 22: 98–105.

———. 1941. The plant bugs, or Miridae, of Illinois. Ill. Nat. Hist. Surv. Bull. 22: 1–234.

Kullenberg, B. 1944. Studien über die Biologie der Capsiden. Zool. Bidr. Upps. 23: 1–522.

Moore, G. A. 1950. Check-list of Hemiptera of the Province of Quebec. Contrib. Inst. Biol. Univ. Montreal 26: 1–49. [Reprinted Nat. Can. (Que.) 77: 233–271.]

Reuter, O. M. 1878. Hemiptera Gymnocerata Europae. Hemipteres Gymnocerates d'Europe, du bassin de la Mediterranee et de l'Asie russe. I. Acta Soc. Sci. Fenn. 13: 1–188.

Scudder, G. G. E. 1956. A contribution to a survey of the distribution of the Hemiptera-Heteroptera of Wales. Entomol. Mon. Mag. 92: 54–64.

Southwood, T. R. E. and D. Leston. 1959. Land and water bugs of the British Isles. Frederick Warne, London & New York. 436 pp.

Stichel, W. 1956. Illustrierte Bestimmungstabellen der Wanzen. II. Europa. 10. Heft, pp. 289–320.

Strawinski, K. 1964. Zoophagism of terrestrial Hemiptera-Heteroptera occurring in Poland. Ekol. Pol. (A)12: 429–452.

Van Duzee, E. P. 1889. Hemiptera from Muskoka Lake District. Can. Entomol. 21: 1–11.

———. 1894. A list of the Hemiptera of Buffalo and vicinity. Bull. Buffalo Soc. Nat. Sci. 5: 167–204.

Wagner, E. 1941. Zwei neue deutsche *Plagiognathusarten* (Hem. Miridae). Stett. Entomol. Ztg. 102: 248–257.

———. 1952. Die Tierwelt Deutschlands, 41. Teil: Blindwanzen oder Miriden. Verlag von Gustav Fischer, Jena. 218 pp.

———. 1975. Die Miridae Hahn, 1831, des Mittelmeerraumes und der Makaronesischen Inseln (Hemiptera, Heteroptera). Entomol. Abh. Mus. Tierk. Dresden 40(suppl.): 1–483.

Woodroffe, G. E. 1957. A preliminary revision of the British *Psallus* Fieber (Hem., Miridae), with a description of a new species. Entomol. Mon. Mag. 93: 258–271.

PROC. ENTOMOL. SOC. WASH.
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SYNOPSIS OF THE HILAROGRAPHINI (LEPIDOPTERA: TORTRICIDAE) OF THE WORLD

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Abstract.—A summary of the world Hilarographini (Lepidoptera: Tortricidae: Chlidanotinae) is provided, with distribution notes, host records, and a world checklist.

The Hilarographini were formerly a group of genera in Glyphipterigidae sensu Meyrick (1914) but have been shown in recent years to belong to the Tortricidae (Heppner, 1977, 1978). The tribe was described by Diakonoff (1977a) and placed in the Chlidanotinae. The genital characters of Hilarographini, as well as other characters, show relationships to other Chlidanotinae, in fact, bridging previous gaps between Schoenotenini and Polyorthini. The latter tribe may even require redefinition inasmuch as one of the main distinctions of the Polyorthini (split valvae with valval coremata, in the male genitalia) is also found among many Hilarographini species. Tortricoid abdominal apodemes, among other characters, distinguish the Hilarographini from Glyphipterigidae, and the naked haustellum clearly distinguishes the tribe from Choreutidae, a family also recently segregated from Glyphipterigidae and one with many species superficially resembling Hilarographini species.

The tribe currently includes 78 species in 9 genera. Although 9 genera are now in the tribe, it is possible that *Mictopsichia* Hübner (possibly also *Embolostoma* Diakonoff and *Mictocommosis* Diakonoff) should be placed in the tribe Archipini of the subfamily Tortricinae (by genital characters), but this requires further study. The distribution of the 78 included species can be seen by referring to the map (Fig. 1). Each dot represents the type-locality of a described species of Hilarographini except for a few localities that have a number of species described from approximately the same area and where all the dots cannot be included. Multiple type-localities are found in the following areas: Assam, India (8 spp.); Java, Indonesia (8 spp.); Sri Lanka (4 spp.); Surinam (5 spp.); Amazonas, Brazil (4 spp.). Table 1 gives a summary of the species of Hilarographini in each faunal region of the world. Most species are currently known only from the type-locality, but many species should have a wider distribution in adjacent tropical forests or other suitable habitats (encircled on map).

Host records for Hilarographini include only those for 5 species: *Thaumatographa caminodes* (Meyrick), from rhyzomes of *Cardamon* sp. (Zingiberaceae); *Thaumatographa cubensis* Heppner, from *Pinus cubensis* Grisebach (Pinaceae); *Thaumatographa eremnotorna* (Diakonoff and Arita), from the cambium of *Pinus densiflora* Siebold and Zuccerini (Pinaceae); *Thaumatographa oenobapta* Diakonoff, from the inflorescence of *Ixora* sp. (Rubiaceae); and *Thaumatographa regalis* (Walsingham), from the cambium of *Pinus sabiniana* Douglas and *Pinus ponderosa* Douglas (Pinaceae). Other species like *Thaumatographa youngiella* (Busck) and *Thaumatographa jonesi* (Brower) have been collected in or near pine forests. The Neotropical species are diurnally active, and it may be that most members of the tribe are diurnally active.

The checklist format includes the original generic combination at the end of each citation, with the type-locality noted to the far right. Localities in brackets are presumed type-localities where the original author did not specifically indicate the locality.

GENERIC SYNOPSIS OF HILAROGRAPHINI

Embolostoma Diakonoff, 1977	1
Mictopsichia Hübner, [1825]	11
Mictopsychia [sic] Riley, 1889, missp.	
Mictropsichia [sic] Heppner, 1978, missp.	
Mictocommosis Diakonoff, 1977	4
Irianassa Meyrick, 1905	4
Idiothauma Walsingham, 1897	4
Nexosa Diakonoff, 1977	4
Charitographa Diakonoff, 1979	1
Thaumatographa Walsingham, 1897	32
Tharmatographa [sic] Diakonoff, 1977, missp.	
Hilarographa Zeller, 1877	17

TORTRICIDAE: CHLIDANOTINAE

HILAROGRAPHINI

Embolostoma Diakonoff, 1977b: 51 (Type-species: *E. plutostola* Diakonoff, 1977).

plutostola Diakonoff, 1977b: 52. Indonesia (Java)

Mictopsichia Hübner, [1825]: 374 (Type-species: *M. hubnerana* [sic] Hübner, [1825], missp. [=*Phalaena (Tortrix) hubneriana* Stoll, 1787]).

Mictopsychia [sic] Riley, 1889: 158, missp.

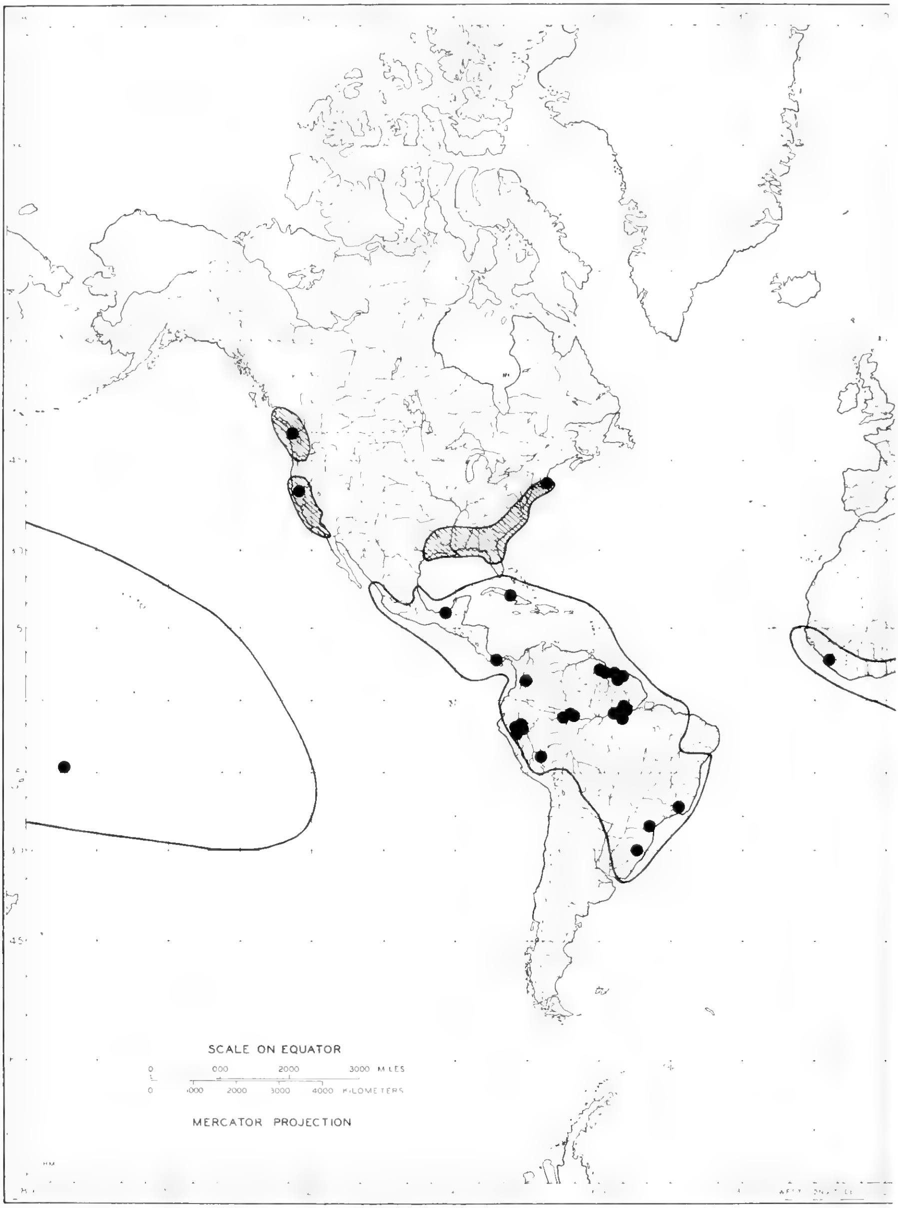
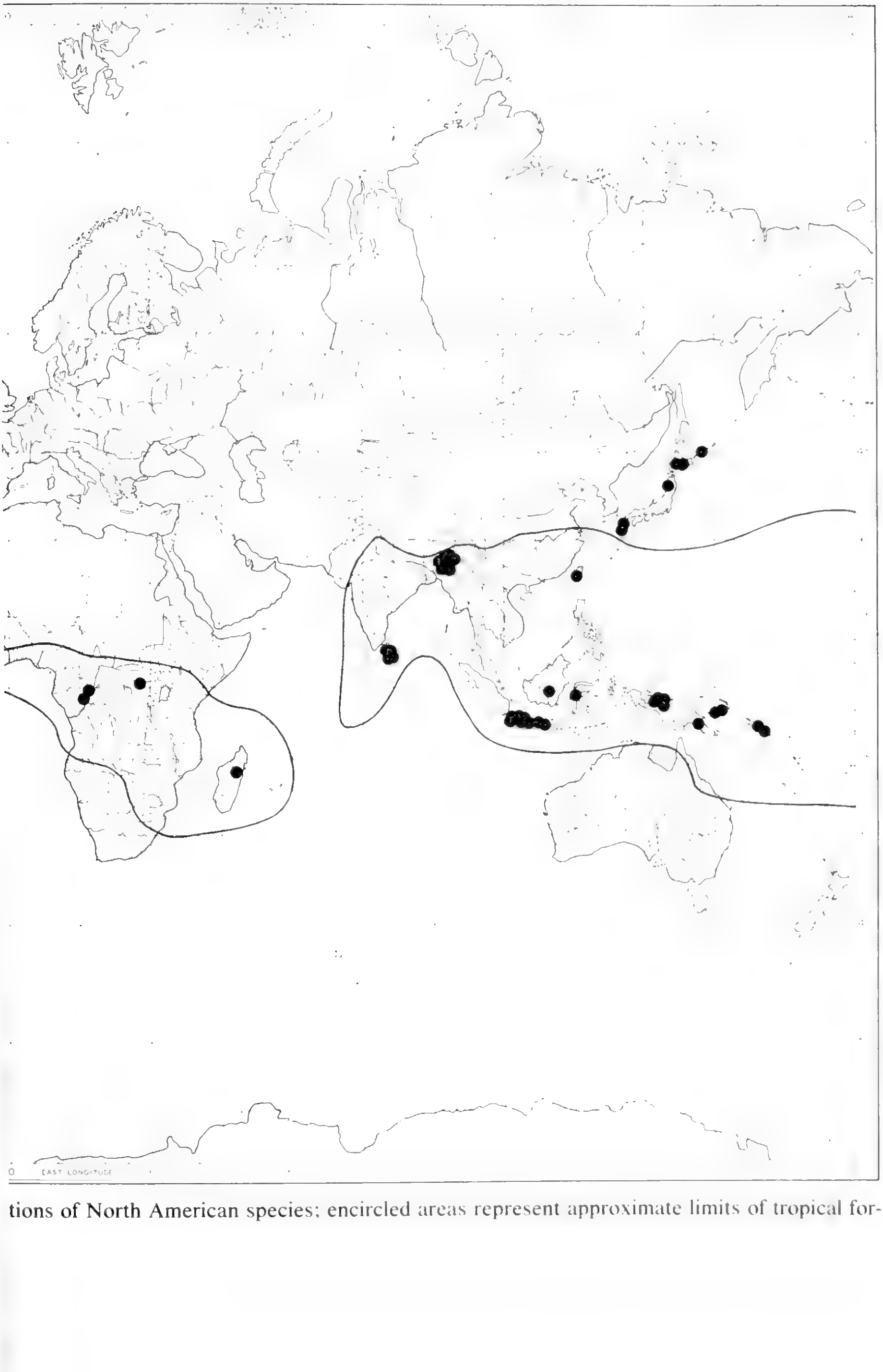


Fig. 1. Distribution of Hilarographini by type-localities (shaded areas are known distribuests on land areas).



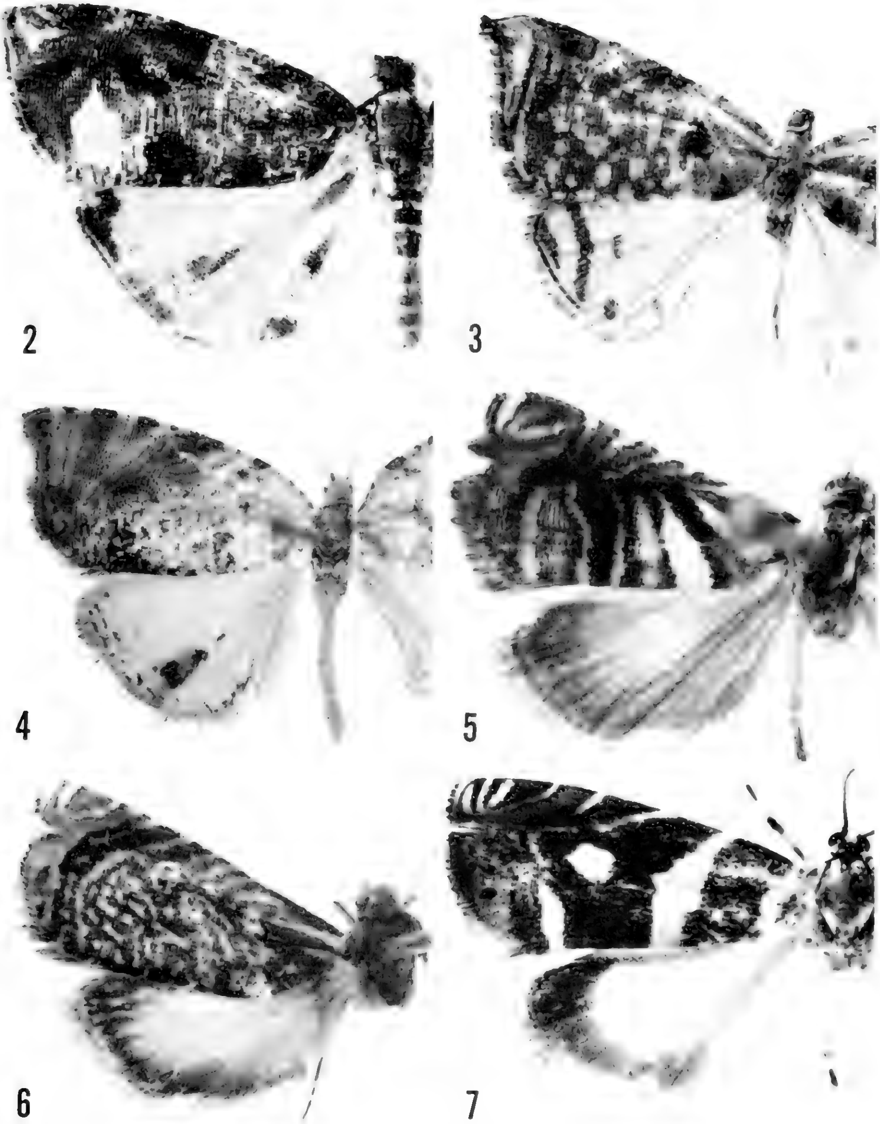
tions of North American species; encircled areas represent approximate limits of tropical for-

Table 1. Faunal region distribution of Hilarographini. N = Nearctic; NL = Neotropical; P = Palearctic; E = Ethiopian; O = Oriental; A = Australian; OC = Oceania.

Genus	N	NL	P	E	O	A	OC	Total
Embolostoma					1			1
Mictopsichia		11						11
Mictocommosis			1	2	1			4
Irianassa					3		1	4
Idiothauma				3	1			4
Nexosa					3	1		4
Charitographa			1					1
Thaumatographa	3	1	5		16	5	2	32
Hilarographa		17						17
Faunal totals	3	29	7	5	25	6	3	78

Mictropsichia [sic] Heppner, 1978: 53, missp.
callicharis Meyrick, 1921b: 477. Brazil (Amazonas)
durranti Walsingham, 1914: 304. Brazil (Pará)
fuesliniana (Cramer, 1781: 163) ([*Phalaena (Tortrix)*]). [*Surinam*]
fueslynialis (Cramer, 1782: 249 [index])(*Phalaena (Pyralis)*), emend.
fueslyniana [sic] (Verloren, 1837: 138)(*Pyralis*), missp.
fuesslyana Walsingham, 1914: 304, emend.
gemmisparsana (Walker, 1863: 415) (*Gauris*). Brazil (Amazonas)
godmani Walsingham, 1914: 305. Mexico (Tabasco)
hubneriana (Stoll, 1787: 41) (*Phalaena (Tortrix)*). [Surinam]
hubnerana [sic] Hübner, [1825]: 374, missp.
superba Felder and Rogenhofer, 1875: 13.
miocentra Meyrick, 1920: 330. Brazil (Pará)
ornatissima (Dognin, 1909: 94) (*Gauris*) Peru
pentargyra Meyrick, 1921b: 478. Peru
periopta Meyrick, 1913a: 99. Guyana
renaudalis (Stoll, 1787: 42) (*Phalaena (Pyralis)*). [Surinam]

Mictocommosis Diakonoff, 1977b: 8 (Type-species: *Simaethis nigromaculata* Issiki, 1930).
argus (Walsingham, 1897: 54) (*Mictopsichia*), **New Combination.** Rep. Congo
microctenota (Meyrick, 1933: 370) (*Mictopsichia*), **New Combination.** Sierra Leone
nigromaculata (Issiki, 1930: 423) (*Simaethis*). Japan
takaonis (Matsumura, 1931: 1081) (*Simaethis*).
stemmatias (Meyrick, 1921a: 178) (*Mictopsichia*), **New Combination.** Indonesia (Celebes)



Figs. 2–7. Examples of typical Hilarographini. 2, *Mictopsichia hubneriana*, ♂ (7.5 mm), Panama [USNM]. 3, *M. fuesliniana*, ♂ (8 mm), Brazil [USNM]. 4, *M. ornatissima*, ♂ (9.5 mm), Bolivia [ZMHB]. 5, *Idiothauma africanum*, ♂ (6 mm), Spanish Guinea [ZMHB]. 6, *Thaumatographa zapyra*, ♀ (7 mm), New Guinea [USNM]. 7, *Hilarographa swederiana*, ♂ (9 mm), Costa Rica [USNM]. Lengths are forewing base to apex dimensions.

Irianassa Meyrick, 1905: 609 (Type-species: *I. sapphiropa* Meyrick, 1905).
poecilaspis Meyrick, 1923: 616. India (Assam)
sapphiropa Meyrick, 1905: 609. Sri Lanka
speciosana (Pagenstecher, 1900: 225) (*Grapholitha* [sic]). Papua New Guinea (Bismarck Is.)
alcyonopa Meyrick, 1926: 301.
uranopa Meyrick, 1927: 101. Samoa

Idiothauma Walsingham, 1897: 49 (Type-species: *I. africanum* Walsingham, 1897).
africanum Walsingham, 1897: 50. Rep. Congo
druidicum (Meyrick, 1909: 428) (*Hilarographa*), **New Combination.** India (Assam)
malgassicellum Viette, 1958: 112. Madagascar
rigatiellum (Ghesquière, 1940: 30) (*Hilarographa*), **New Combination.** Zaire

Nexosa Diakonoff, 1977b: 12 (Type-species: *Mictopsichia marmarastra* Meyrick, 1932).
aureola Diakonoff, 1977b: 15. Papua New Guinea
hexaphala (Meyrick, 1912a: 36) (*Mictopsichia*). Sri Lanka
marmarastra (Meyrick, 1932: 273) (*Mictopsichia*). Indonesia (Java)
picturata (Meyrick, 1912a: 35) (*Mictopsichia*). India (Assam)

Charitographa Diakonoff, 1979: 291 (Type-species: *Hilarographa mikadonis* Stringer, 1930).
mikadonis (Stringer, 1930: 418) (*Hilarographa*). Japan
micadonis [sic] (Diakonoff and Arita, 1976: 193) (*Hilarographa*), missp.

Thaumatographa Walsingham, 1897: 52 (Type-species: *Hilarographa zapyra* Meyrick, 1886).
Tharmatographa [sic] Diakonoff, 1977b: 51, missp.
aurosa (Diakonoff and Arita, 1976: 181) (*Hilarographa*). Japan
calathisca (Meyrick, 1909: 427) (*Hilarographa*), **New Combination.** India (Assam)
caminodes (Meyrick, 1905: 610) (*Hilarographa*), **New Combination.** Sri Lanka
ceramopa (Meyrick, 1920: 329) (*Hilarographa*), **New Combination.** India (Assam)
cirrhocosma (Meyrick, 1930: 1) (*Hilarographa*). Solomon Is.
citharistis (Meyrick, 1909: 428) (*Hilarographa*), **New Combination.** India (Assam)
cladara Diakonoff, 1977b: 33. Indonesia (Borneo)
cubensis Heppner, *in press*. Cuba
decoris (Diakonoff and Arita, 1976: 191) (*Hilarographa*). USSR (Kuril Is.)

dolichosticha Diakonoff, 1977b: 32.	Indonesia (Java)
eremnotorna (Diakonoff and Arita, 1976: 185) (*Hilarographa*).	Japan
excellens Pagenstecher, 1900: 230.	Papua New Guinea (Bismarck Is.)
pyranthis (Meyrick, 1907: 91) (*Hilarographa*).	
ferox (Meyrick, 1921a: 179) (*Hilarographa*).	Indonesia (Java)
hermatodes (Meyrick, 1909: 426) (*Hilarographa*), **New Combination.**	Sri Lanka
jonesi (Brower, 1953: 96 (*Hilarographa*).	USA (Massachusetts)
leucopyrga (Meyrick, 1912a: 36) (*Hilarographa*).	Japan
ludens (Diakonoff, 1948: 200) (*Hilarographa*).	Indonesia (Buru)
macaria Diakonoff, 1977b: 46.	Indonesia (Java)
machaerophora (Diakonoff and Arita, 1976: 180) (*Hilarographa*).	Japan
mechanica (Meyrick, 1909: 427) (*Hilarographa*), **New Combination.**	India (Assam)
merinthias (Meyrick, 1909: 426) (*Hilarographa*), **New Combination.**	India (Assam)
mesostigmatias Diakonoff, 1977b: 42.	Taiwan
oenobapta Diakonoff, 1977b: 28.	Indonesia (Java)
opistocapna Diakonoff, 1977b: 38.	Indonesia (New Guinea)
phlox Diakonoff, 1977b: 40.	Indonesia (Java)
regalis (Walsingham, 1881: 320) (*Glyphipteryx* [sic]).	USA (California)
spermatodesma (Diakonoff, 1955: 17) (*Hilarographa*).	Indonesia (New Guinea)
tetralina (Meyrick, 1930: 1) (*Hilarographa*).	Solomon Is.
tornoxena Diakonoff, 1977b: 50.	Indonesia (Java)
undosa Diakonoff, 1977b: 45.	Indonesia (New Guinea)
youngiella (Busck, 1922: 278) (*Hilarographa*).	Canada (British Columbia)
olympica (Braun, 1923: 118) (*Hilarographa*).	
zapyra (Meyrick, 1886: 286) (*Hilarographa*).	Papua New Guinea

Hilarographa Zeller, 1877: 187 (Type-species: *Phalaena (Tortrix) swederiana* Stoll, 1790: 75).

aenigmatica (Meyrick, 1912b: 682) (*Cnephasia*).	Colombia
bellica Meyrick, 1912a: 37.	Surinam
bryonota Meyrick, 1921b: 479.	Peru
dulcisana (Walker, 1863: 415) (*Gauris*).	Brazil (Amazonas)
dulciana Meyrick, 1913b: 24, emend.	
eriglypta Meyrick, 1921b: 478.	Peru
euphronica Meyrick, 1920: 328.	Brazil (Pará)
hexapeda Meyrick, 1913a: 99.	Guyana
methystis Meyrick, 1921b: 479.	Peru
orthochrysa Meyrick, 1932: 274.	Brazil (Santa Catarina)
plectanodes Meyrick, 1921b: 480.	Peru

plurimana (Walker, 1863: 416) (*Gauris*). Brazil (Pará)
quinquestrigana (Walker, 1866: 1796) (*Carpocapsa*). Brazil (São Paulo)
firmana (Felder and Rogenhofer, 1875: 5) (*Carpocapsa*).
refluxana (Walker, 1863: 416) (*Gauris*). Brazil (Rio de Janeiro)
ribbei (Zeller, 1877: 189) (*Setiostoma*). Panama
swederiana (Stoll, 1790: 75) (*Phalaena (Tortrix)*). [Surinam]
trabeana (Felder and Rogenhofer, 1875: 11) (*Grapholitha* [sic]).
thaliarcha Meyrick, 1920: 328. Brazil (Pará)
xanthotoxa Meyrick, 1920: 329. Brazil (Amazonas)

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LITERATURE CITED

Braun, A. F. 1923. Microlepidoptera: notes and new species. Trans. Am. Entomol. Soc. 49: 115–127.

Brower, A. E. 1953. Three new species of microlepidoptera (Olethreutidae, Glyphipterygidae and Yponomeutidae). Ann. Entomol. Soc. Am. 46: 95–98.

Busck, A. 1922. Microlepidoptera from British Columbia. Can. Entomol. 53: 276–280.

Cramer, P. 1780–1782. De Uitlandsche Kapellen voorkomende in de drie waereld-deelen Asia, Africa en America. Vol. 4. Baalde, Amsterdam. 252 pp., pls. 289–400.

Diakonoff, A. 1948. Fauna Buruana. Microlepidoptera II. Treubia 19: 197–219.

———. 1955. Microlepidoptera of New Guinea. Results of the third Archbold Expedition (American-Netherlands Indian Expedition 1938–1939). Pt. 5. Verh. Koninkl. Nederl. Akad. Wetenschappen, Afd. Natuurk (Tweede Reeks) 50(3): 1–212.

———. 1977a. Description of Hilarographini, a new tribus in the Tortricidae (Lepidoptera). Entomol. Ber. (Amsterdam) 37: 76–77.

———. 1977b. Rearrangement of certain Glyphipterygidae sensu Meyrick, 1913, with descriptions of new taxa (Lepidoptera). Zool. Verh. (Leiden) 158: 1–55.

———. 1979. Descriptions of new taxa of the so-called Glyphipterigidae auctorum (Lepidoptera). Zool. Meded. (Leiden) 54: 291–312.

Diakonoff, A. and Y. Arita. 1976. New and old species of Glyphipterigidae and a new species of Acrolepiidae from Japan and the Far East (Lepidoptera). Zool. Meded. (Leiden) 50: 179–219.

Dognin, P. 1909. Hétérocères nouveaux de l'Ámerique du Sud. Ann. Soc. Entomol. Belg. 53: 74–94.

Felder, R. and A. F. Rogenhofer. 1875. *In*, Felder C., R. Felder, and A. F. Rogenhofer, Reise der österreichischen Fregatte Novara um die Erde in den Jahren 1857, 1858, 1859 unter den Behilfen des Commodore B. von Wüllerstorf-Urbair. Zoologischer Theil. Zweiter Band. Zweite Abtheilung: Lepidoptera. Vienna. 20 pp., pls. 108–140.

Ghesquière, J. 1940–42. Catalogue raisonnés de la faune entomologique du Congo Belge. Lépidoptères, microlépidoptères. Tervuren, Belgium. 240 pp., 6 pls.

Heppner, J. B. 1977. The status of the Glyphipterigidae and a reassessment of relationships in yponomeutoid families and ditrysian superfamilies. J. Lepid. Soc. 31: 124–134.

———. 1978. Transfers of some Nearctic genera and species of Glyphipterigidae (auctorum) to Oecophoridae, Copromorphidae, Plutellidae, and Tortricidae (Lepidoptera). Pan-Pac. Entomol. 54: 48–55.

———. *In press*. Revision of North American Hilarographini (Lepidoptera: Tortricidae), with a new species from Cuba. Pan-Pac. Entomol.

Hübner, J. 1816–[1825]. Verzeichniss bekannter Schmettlinge [sic]. Augsburg. 431 pp.

Issiki, S. T. 1930. New Japanese and Formosan microlepidoptera. Ann. Mag. Nat. Hist. (10) 6: 422–431.

Matsumura, S. 1931. 6000 illustrated insects of Japan-Empire. Japan. 1496 pp.; 191 pp., index.

Meyrick, E. 1886. Descriptions of Lepidoptera from the South Pacific. Trans. Entomol. Soc. Lond. 1886: 189 -296.

———. 1905. Descriptions of Indian micro-lepidoptera. I. J. Bombay Nat. Hist. Soc. 16: 580–619.

———. 1907. Descriptions of Australasian micro-lepidoptera. XIX. Plutellidae. Proc. Linn. Soc. N. S. W. 32: 47–150.

———. 1909. Descriptions of Indian micro-lepidoptera. IX. J. Bombay Nat. Hist. Soc. 19: 410–437.

———. 1912a. Glyphipterygidae. Exotic Microlepid. 1: 35–63.

———. 1912b. Descriptions of South American micro-lepidoptera. Trans. Entomol. Soc. Lond. 1911: 673–718.

———. 1913a. Glyphipterygidae. Exotic Microlepid. 1: 98–104.

———. 1913b. Carposinidae, Heliodinidae, Glyphipterygidae. *In* Wagner, H., ed., Lepidopterorum catalogus. Part 13. W. Junk, Berlin. 53 pp.

———. 1914. Lepidoptera Heterocera. Fam. Glyphipterygidae. *In* Wytsman, M. P., ed., Genera insectorum. Fasc. 164. Brussels. 39 pp., 2 pls.

———. 1920. Glyphipterygidae. Exotic Microlepid. 2: 325–338.

———. 1921a. New microlepidoptera. Zool. Meded. (Leiden) 6: 145–202.

———. 1921b. Glyphipterygidae. Exotic Microlepid. 2: 477–480.

———. 1923. Glyphipterygidae. Exotic Microlepid. 2: 616–619.

———. 1926. Glyphipterygidae. Exotic Microlepid. 3: 301–308.

———. 1927. Micro-lepidoptera. *In* Insects of Samoa and other Samoan terrestrial Arthropoda. Lepidoptera. Fasc. 2, Part 3, pp. 65–116.

———. 1930. Glyphipterygidae. Exotic Microlepid. 4: 1–7.

———. 1932. Glyphipterygidae. Exotic Microlepid. 4: 273–276.

———. 1933. Glyphipterygidae. Exotic Microlepid. 4: 370–372.

Pagenstecher, A. 1900. Die Lepidopterenfauna des Bismarck-Archipels. Mit Berücksichtigung der thiergeographischen und biologischen Verhältnisse systematisch dargestellt. Zweiter Theil: Die Nachtfalter. Zoologica (Stuttgart) 12(29): 1–268, 2 pls.

Riley, C. V. 1889. Two brilliant and interesting microlepidoptera new to our fauna. Proc. Entomol. Soc. Wash. 1: 155–159.

Stoll, C. 1787–1791. Aanhangsel van het Werk, de Uitlandsche Kapellen, voorkomende in de drie Waereld-deelen Asia, Africa en America, door den Heere Pieter Cramer, vervattende naauwkeurige afbeeldingen van Surinaamsche Rupsen en Poppen; als mede van veele zeldzaame en nieuwe ontdekte Uitlandsche Dag-en Nagt-Kapellen. [vol. 5]. Gravius, Amsterdam. 184 pp., 42 pls.

Stringer, H. 1930. New species of microlepidoptera in the collection of the British Museum. Ann. Mag. Nat. Hist. (10)6: 415–422.

Verloren, H. 1837. Catalogus systematicus lepidopterorum, quae in opere Crameri descripta sunt, secundum methodum Latreillii. J. Altheer, Utrecht. 280 pp.

Viette, P. E. L. 1958. Microlepidoptera nouveaux de Madagascar. Rev. Fr. Entomol. 25: 111–124.

Walker, F. 1863. List of the specimens of lepidopterous insects in the collection of the British Museum. Part XXVIII. Tortricites & Tineites. British Museum, London. Pp. 288–561.

———. 1866. List of the specimens of lepidopterous insects in the collection of the British Museum. Part XXXV. Supplement.—Part 5. British Museum, London. Pp. 1535–2040.

Walsingham, T. de G. 1881. On some North American Tineidae. Proc. Zool. Soc. Lond. 1881: 301–325; pls. 35–36.

———. 1897. Western equatorial African micro-lepidoptera. Trans. Entomol. Soc. Lond. 1897: 33–67; pls. 2–3.

———. 1914. Hemerophilidae, pp. 300–319. *In* Tineina, Pterophorina, Orneodina and Pyralidina and Hepialina (part). *In* Godman, F. D., and O. Salvin, eds., Biologia Centrali-Americana. Insecta. Lepidoptera-Heterocera. Vol. 4. London. 482 pp., 9 pls.

Zeller, P. C. 1877. Exotische microlepidoptera. Hor. Soc. Entomol. Ross. 13: 3–493, 6 pls.

Alphabetical List of Species Names

aenigmatica (Meyrick), Hilarographa
africanum Walsingham, Idiothauma
alcyonopa Meyrick, Irianassa
argus (Walsingham), Mictocommosis
aureola Diakonoff, Nexosa
aurosa (Diakonoff and Arita), Thaumatographa
bellica Meyrick, Hilarographa
bryonota Meyrick, Hilarographa
calathisca (Meyrick), Thaumatographa
callicharis Meyrick, Mictopsichia
caminodes (Meyrick), Thaumatographa
ceramopa (Meyrick), Thaumatographa
cirrhocosma (Meyrick), Thaumatographa
citharistis (Meyrick), Thaumatographa
cladara Diakonoff, Thaumatographa
cubensis Heppner, Thaumatographa
decoris (Diakonoff and Arita), Thaumatographa
dolichosticha Diakonoff, Thaumatographa
druidicum (Meyrick), Idiothauma
dulciana Meyrick, Hilarographa
dulcisana (Walker), Hilarographa
durranti Walsingham, Mictopsichia
eremnotorna (Diakonoff and Arita), Thaumatographa
eriglypta Meyrick, Hilarographa
euphronica Meyrick, Hilarographa
excellens Pagenstecher, Thaumatographa
ferox (Meyrick), Thaumatographa
firmana (Felder and Rogenhofer), Hilarographa
fuesliniana (Cramer), Mictopsichia
fueslyniana [sic] (Verloren), Mictopsichia
fueslynialis (Cramer), Mictopsichia
fuesslyana Walsingham, Mictopsichia
gemmisparsana (Walker), Mictopsichia
godmani Walsingham, Mictopsichia
hermatodes (Meyrick), Thaumatographa
hexapeda Meyrick, Hilarographa
hexaphala (Meyrick), Nexosa
hubnerana [sic] Hübner, Mictopsichia
hubneriana (Stoll), Mictopsichia
jonesi (Brower), Thaumatographa
leucopyrga (Meyrick), Thaumatographa
ludens (Diakonoff), Thaumatographa
macaria Diakonoff, Thaumatographa
machaerophora (Diakonoff and Arita), Thaumatographa
malgassicellum Viette, Idiothauma
marmarastra (Meyrick), Nexosa
mechanica (Meyrick), Thaumatographa
merinthias (Meyrick), Thaumatographa
mesostigmatias Diakonoff, Thaumatographa
methystis Meyrick, Hilarographa
micadonis [sic] (Diakonoff and Arita), Charitographa
microctenota (Meyrick), Mictocommosis
mikadonis (Stringer), Charitographa
miocentra Meyrick, Mictopsichia

nigromaculata (Issiki), Mictocommosis
oenobapta Diakonoff, Thaumatographa
olympica (Braun), Thaumatographa
opistocapna Diakonoff, Thaumatographa
ornatissima (Dognin), Mictopsichia
orthochrysa Meyrick, Hilarographa
pentargyra Meyrick, Mictopsichia
periopta Meyrick, Mictopsichia
phlox Diakonoff, Thaumatographa
picturata (Meyrick), Nexosa
plectanodes Meyrick, Hilarographa
plurimana (Walker), Hilarographa
plutostola Diakonoff, Embolostoma
poecilaspis Meyrick, Irianassa
pyranthis (Meyrick), Thaumatographa
quinquestrigana (Walker), Hilarographa
refluxana (Walker), Hilarographa
regalis (Walsingham), Thaumatographa
renaudalis (Stoll), Mictopsichia
ribbei (Zeller), Hilarographa
rigatiellum (Ghesquière), Idiothauma
sapphiropa Meyrick, Irianassa
speciosana (Pagenstecher), Irianassa
spermatodesma (Diakonoff), Thaumatographa
stemmatias (Meyrick), Mictocommosis
superba Felder and Rogenhofer, Mictopsichia
swederiana (Stoll), Hilarographa
takaonis (Matsumura), Mictocommosis
tetralina (Meyrick), Thaumatographa
thaliarcha Meyrick, Hilarographa
tornoxena Diakonoff, Thaumatographa
trabeana (Felder and Rogenhofer), Hilarographa
undosa Diakonoff, Thaumatographa
uranopa Meyrick, Irianassa
xanthotoxa Meyrick, Hilarographa
youngiella (Busck), Thaumatographa
zapyra (Meyrick), Thaumatographa

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84(4), 1982, pp. 716–725

TAXONOMY AND ETHOLOGY OF A NEW CENTRAL AMERICAN SPECIES OF ROBBER FLY IN THE GENUS *GLAPHYROPYGA* (DIPTERA: ASILIDAE)

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Abstract.—*Glaphyropyga* **dryas,** from Panama and Costa Rica, is described and illustrated. The genus *Glaphyropyga* Schiner is characterized by species with a very narrow face, a slender third antennal segment with a short to long arista, lack of postscutellar pile, and possession of a gray microvillous shadow in the anteroapical portion of the wing. Known species of *Glaphyropyga* share the habitat preference of *G. dryas* and range from eastern Mexico to southern Brazil. Adults of *G. dryas* are active during the rainy season and inhabit the shaded forest understory, perching on twig tips 0.5 to 2.0 m above ground. Prey records include nine orders of insects, with Diptera, Coleoptera, Hymenoptera, and Homoptera accounting for 94% of recorded captures. The order Zoraptera is reported for the first time as prey of an asilid. Size of prey ranges from 1.1 to 6.5 mm and averages 3.07 mm for 101 measured items. Courtship consists of the male's hovering and bobbing, with hindlegs extended below, to the side of the perched female. Copulating pairs assume a tail-to-tail position on a branch tip.

The tropical forests of Central America possess a very rich and diverse robber fly fauna. Field studies by the authors on Barro Colorado Island, Panama, indicate that more than 70 species of Asilidae occur at this small (15.6 km^2), tropical moist forest site (Hespenheide and Fisher, unpublished data). About half of these species are undescribed—a legacy of both the species richness of Neotropical forests and the very limited taxonomic attention so far given to Central American robber flies. An undescribed species of *Glaphyropyga* Schiner is one of the most abundant asilids on Barro Colorado Island. The purpose of this paper is to describe this species and to present observations on the taxonomy and biology of it and of the genus *Glaphyropyga*. The taxonomic portion of this paper was prepared by EMF, the ethological portion primarily by HAH.

Glaphyropyga dryas Fisher, New Species

Figs. 1–6

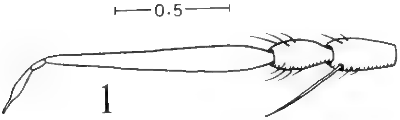
Diagnosis.—A small species, most closely related to *G. himantocera* (Wiedemann), differing from that species as follows: Male with conspicuous, dorsal-median, setigerous protuberance on epandrium; female with a group of 6 apically convergent, black bristles at apex of tergum 7.

Holotype male.—Length 12.1 mm. Head yellowish brown anteriorly, black dorsally and posteriorly. Face $^1/_{10}$ width of head at middle, very densely silvery tomentose above, thinly yellowish gray tomentose below at base of proboscis; front with tomentum yellowish brown laterally, black medially; vertex dark brown tomentose, more yellowish posteriorly, a polished black spot anterior to ocellar tubercle; occiput with tomentum mostly gray, dark brown next to vertex; mystax silvery white, with 10 long, prominent bristles on gibbosity, arranged in a triangular fashion—2 vertical rows of 3 slender bristles above, which diverge ventrad, and 2 pairs of strong bristles below on oral margin, the middle pair stoutest—plus 6 short, slender bristles on oral margin; a few short, yellow hairs laterally on frons, a brown pair on ocellar tubercle; slender, subproclinate occipital bristles yellowish dorsally, white laterally and ventrally; beard white. Proboscis black, palpi yellow, the sparse hair white.

Antenna (Fig. 1) 1.8 mm long, 3rd segment about 3½ × as long as arista plus microsegment; segments 1, 2, and extreme base of 3 brownish yellow, remainder blackish brown (including sub-apical ring on 2); strong ventroapical bristle on 1 and setae on 1 and 2 yellowish white; segment 3 dark brown tomentose dorsally, yellowish brown ventrally; arista glabrous.

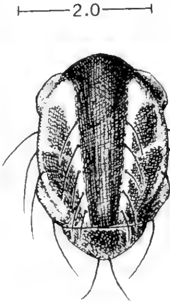
Thorax black, yellowish brown posteroventrally on pleurae. Mesonotum (Fig. 3) with tomentum dark brown on broad central stripe (slightly paler along midline) and intermediate spots, golden brown on dorsocentral and lateral vittae, grayish brown on humeri, postalar calli and posterior declivity (latter with median, dark brown spot above scutellum), gray along extreme lateral margins; long, stout bristles black, distributed as follows: 5 pair of dorsocentrals, 2 pair of notopleurals, 1 pair of supraalars, 1 pair of postalars; 5 pair of slender dorsocentrals, 6 pair of anterior acrostichals and very sparse bristles on anterior and posterior declivities all black and short (subequal in length to antennal segment 2); sparse, scattered pile on humeri and lateral margins white. Scutellum gray tomentose, more brownish centrally on disk; very sparse, short diskal pile white, 1 pair stout, long marginal bristles black. Pleurae and postscutellar slopes whitish gray tomentose, with pronotum dorsally and anepisternum posterodorsally brown tomentose; pile short, sparse, white; laterotergal fan of 6 to 8 stout bristles white.

Legs very pale brownish yellow, translucent, the foreleg almost white, except these areas dark brown: Anterodorsal stripe and apical ¼ hindfemur,



1

2



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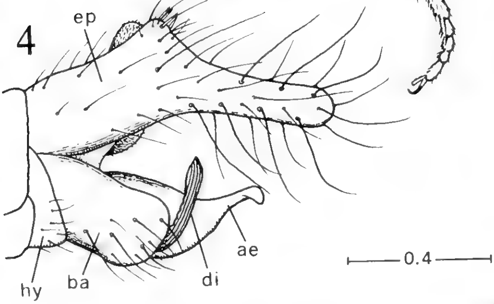
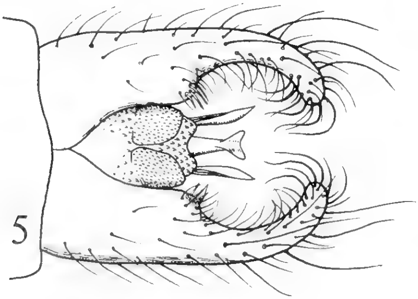


4



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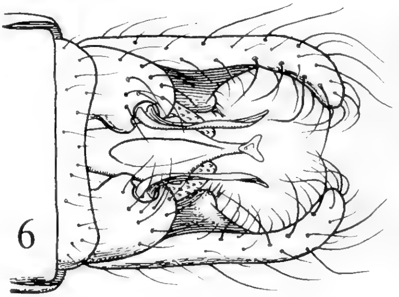

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dorsum of basal ⅓ and entire apical ¼ hindtibia, and apical ½ of 5th segment hindtarsus; very narrow anterodorsal stripe and apical $^{1}/_{5}$ midfemur, and segments 4 and 5 of midtarsus; segments 3 to 5 of foretarsus. Bristles and pile nearly all whitish yellow on pale areas of legs and brown to black on dark areas, but dorsal surfaces of all femora with short, sparse, recumbent black hair and tibiae and tarsi with scattered, minute black setulae; posteroventral surfaces of fore- and midfemora and foretibia with sparse, erect pile about as long as width of midfemur; remainder of vestiture typical for genus. Claws black, with extreme bases red. Coxae yellowish brown, with whitish-gray tomentum and white pile.

Wings (see Fig. 2) 8.9 mm long; membrane very faintly infuscate, slightly darker along posterior margin; gray shadow of microvilli extending across anterior $^{4}/_{5}$ of apex of 1st submarginal cell (R_{2+3}). Halter brownish yellow, edges of knob darker.

Abdomen black, narrow lateral and posterior margins of terga 1–5 yellowish brown; terga 1–7 with black areas dark brown tomentose, paler areas of terga 1–5 yellowish brown tomentose; sterna 1–6 grayish brown tomentose, sternum 7 thinly so; narrow lateral margin of tergum 7 and all of tergum and sternum 8 and genitalia polished black; short, recumbent dorsal pile black, longer bristles yellow, ventral pile and bristles yellow. Genitalia as in Figs. 4–6: epandrium near middle with prominent dorsomedian protuberance, which bears at apex a clump of about 6 short, stout bristles; apical ½ of epandrium, beyond protuberance, angled slightly ventrad; gonopods with basistyli rounded apically; hypandrium with apical margin slightly concave; aedeagus reddish brown, visible basal portion with oval-shaped ventral depression; bristles and pile whitish yellow, some recumbent pile at epandrium base black.

Allotype female.—Body length 11.1 mm; wing length 9.3 mm. Similar to male, differing as follows: Face with plane portion pale yellowish and gibbosity grayish white tomentose; 3 pair of dorsal bristles in mystax brown. Antenna with basal 2 segments brown tomentose, with brown bristles and black hair. Mesonotum with anterior acrostichal bristles shorter, subequal to ½ length of antennal segment 2. Legs much darker, chiefly blackish brown, with these areas yellowish: Ventral margins of basal ⅔ of all femora (extending onto dorsum at bases of mid- and hindfemora), dorsum of midtibia from before middle to apical $^{3}/_{4}$, and foretibia except apical $^{1}/_{5}$ and narrow posterior stripe; vestiture nearly all black, except large bristles at

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Figs. 1–6. *Glaphyropyga dryas*. 1, Antenna of female. 2, Lateral view of female. 3, Mesonotum and scutellum. 4–6, male genitalia. 4, Lateral view (ep = epandrium; hy = hypandrium; ba = basistylus; di = distylus; ae = aedeagus). 5, Dorsal view. 6, Ventral view. Scales in mm.

base of hindfemur and "cleaning pads" on fore- and hindlegs yellowish. Coxae with some anterior bristles brown. Abdomen with segments 7 and 8 and narrow lateral margin of tergum 6 polished black; apex of tergum 7 with file of 6 black bristles which converge and cross apically. Ovipositor with short, yellow pile.

Distribution.—Known from the Isthmus of Panama and Cartago and Heredia Provinces, Costa Rica.

Type specimens.—Holotype ♂ (USNM): Barro Colorado Island, Canal Zone, Panama, 11/13 June 1976 (E. M. Fisher). Allotype ♀ (USNM), same data as for holotype. Paratypes (55 ♂, 113 ♀). PANAMA: *Canal Zone*: Barro Colorado Island, 43 ♂, 63 ♀, 9 July to 11 Sept. 1974, 2/3 Aug. 1975, 8/20 June 1976, 10 May, 29 July 1977, 9 July to 12 Aug. 1978 (H. A. Hespenheide and/or E. M. Fisher); 9 km NW Gamboa, 3 ♀, 4/12 Aug. 1975 (E. M. and J. L. Fisher); Madden Forest, mi 3.5, 2 ♂, 4 July 1977 (H. A. Hespenheide); Chiva Chiva Rd., 8 air km N Fort Clayton, 2 ♀, 23 July 1978 (E. M. Fisher, N. E. Woodley, A. Worthington); 1 km E Farfan, 4 ♂, 20 ♀, 31 July, 11 Aug. 1975 (E. M. Fisher); 9 km NW Gatun, 2 ♀, 9 Aug. 1975 (E. M. Fisher); Devil's Beach, 5 km W Fort Sherman, 1 ♂, 2 ♀, 9/10 Aug. 1975 (E. M. Fisher). *Panama Prov.*: Bayano R. Bridge on Hwy 2, nr Chepo, 1 ♀, 12 Sept. 1974 (H. A. Hespenheide); Pacora, Sta. C, 1 ♂, 1 ♀, 9 July 1951 (F. Miller); Cerro Azul, N of Tocumen, 1 ♀, 7 June 1958 (W. J. Hanson); Cerro Campana, 800–860 m, 4 ♂, 18 ♀, 26 June, 13 July 1977 (H. A. Hespenheide), 17 July, 27 July, 19 Aug. 1978 (E. M. Fisher, N. E. Woodley).

Paratypes to be deposited in the National Museum of Natural History, Washington, D.C. (USNM); California Academy of Sciences, San Francisco; Natural History Museum of Los Angeles County, California; American Museum of Natural History, New York; University of California, Riverside; British Museum (Natural History), London; Naturhistorisches Museum, Vienna; the collections of the authors and Joseph Wilcox, and at other appropriate institutions and collections.

Other specimens examined.— COSTA RICA: *Cartago*: 5 km E Turriabla, C.A.T.I.E., 6 ♂, 36 ♀, 21/22 July 1975 (E. M. and J. L. Fisher); Turriabla, 1 ♀, 9 July 1965 (G. R. Noonan). *Heredia*: Finca La Selva, 3 km S Puerto Viejo, 2 ♀, 23/25 July 1976 (E. M. Fisher, H. A. Hespenheide).

The Costa Rican specimens agree with the Panamanian material in all respects but are not being made paratypes.

Discussion.—The specific name is derived from the Greek *Dryas* (f.—a wood nymph) and refers to the habitat of this species.

Variation among available specimens of *G. dryas* is very slight. Most notable are differences in body length, males ranging from 10.3 to 13.0 mm long, females from 10.2 to 13.2 mm. Many males have the lateral margins of tergum 6 narrowly polished, instead of entirely tomentose. About a quarter of the female specimens have a faint trace of the oval white spot near the apex of the first submarginal cell, a characteristic found in *G. himantocera* and several other *Glaphyropyga* species; however it is never as distinct and opaque in *G. dryas*.

The shape of the male epandrium and the file of bristles on tergum 7 of females are characteristics unique to *G. dryas*. The combination of the following characters are also useful for distinguishing this species from the other known (described and undescribed) species of *Glaphyropyga*: Small size (10.2 to 13.2 mm body length); form of the mystax (four stout bristles in-line along oral margin, six slender bristles above, in two dorsally converging rows of three each, leaving a triangular area in the center of the gibbosity bare of long bristles); arista and microsegment together being less than ⅓ the length of antennal segment 3; wing with shadow extending exactly to posterior $^1/_5$ of first submarginal cell and, in females, lacking a conspicuous, oval, opaque white spot. *Glaphyropyga dryas* is most similar to the Brazilian *G. himantocera,* which is a larger species (14.5–17.0 mm long; Carrera, 1945) and has non-protuberant, non-angulate epandria (parallel sided in lateral view). Carrera (1950) described *G. aristata* from Barro Colorado Island; it is similar in size and form to *G. himantocera* but has the arista nearly as long as the third antennal segment.

GENERAL REMARKS ON THE GENUS *GLAPHYROPYGA*

Taxonomy.—The genus *Glaphyropyga* was placed in the Asilinae by Hull (1962) and the Apocleinae by Papavero (1973). It may be recognized by the slender form of its species, their sparse pilosity and dark brown dorsal tomentum, the very narrow face with ventrally placed gibbosity and mystax, the narrow and elongate third antennal segment, and the lack of postscutellar pile. In addition, all known species of the genus have a gray microvillous shadow in the apical half of the subcostal cell of the wing (and usually the marginal and first submarginal cells also).

Hull (1962) emphasized the very short arista of the type-species, *G. himantocera,* as a means of recognizing the genus. Earlier Hull (1958) described the genus *Opopotes* to include a new species, *O. attenuatus* Hull, with an elongate arista (in describing *Opopotes,* Hull evidently overlooked Carrera's previous description of *G. aristata,* as this species obviously would fit his concept of the new genus). Papavero (1973) listed *Opopotes* as a synonym of *Glaphyropyga*; we agree with this synonymy. *Tapinostylus* Enderlein is also synonymous with *Glaphyropyga* (Hull, 1962; Martin and Papavero, 1970). Species of *Glaphyropyga* have also been incorrectly placed in *Senoprosopis* Macquart, a quite unrelated genus, but one whose members have a similarly slender habitus. Curran's figures 53 and 137 (Curran, 1934: 170, 180), identified as *Senoprosopis* sp., are actually of *G. dryas*.

As now understood, *Glaphyropyga* contains species with an arista length (including the short, basally attached microsegment) of about $^1/_7$ to subequal the length of the third antennal segment. Although the species of *Glaphyropyga* vary as to length of arista, they are otherwise a taxonomically and biologically cohesive and well characterized group. An arbitrary division of those species with a longer arista into another genus is unwarranted.

Six species of *Glaphyropyga* are currently known in the literature, and the genus is reported to range from Brazil to Costa Rica (Martin and Papavero, 1970). In addition to *G. dryas,* at least eight undescribed Middle American species are on hand. One of these occurs in the cloud forests of Hidalgo, Mexico, some 2000 km northwest of Costa Rica. We anticipate the discovery of many additional species in the genus, especially in South America.

Biology.—Probably all species of *Glaphyropyga* (11 species have been observed by us in the field) occur in well forested habitats at low to moderate elevations. The genus is apparently restricted to older second growth and ''primary'' tropical forest, and is absent from badly disturbed forest and early-successional second growth areas. *Glaphyropyga* species invariably perch on slender, bare tips of branches, at heights of one to several meters. They are seldom found in open, fully sunlit areas and instead prefer the partial to complete shade of the forest understory. Edges of trails and openings in the understory with abundant, but always indirect, light seem to be optimal habitat. On very cloudy or rainy days they may be seen on perches in clearings, and some species are quite active during rains.

ETHOLOGY OF *GLAPHYROPYGA DRYAS*

Microhabitat and foraging behavior.—*Glaphyropyga dryas* has been observed over most of Barro Colorado Island, and is the most common robber fly of the forest interior (Hespenheide and Fisher, unpublished data), accounting for about 25% of all flies observed in trailside censuses. Collection and observation records range from 10 May to 11 September and indicate that this species is active only during the rainy season, which on Barro Colorado Island is typically from early May through mid-December (Croat, 1978). For the small number of flies for which perch characteristics were recorded, most were observed in closed-canopy situations, but a significant proportion were also observed in the vicinity of sunflecks or at the shaded margins of larger openings created by fallen trees. Of 40 flies for which perch type was recorded, 36 were on the tips of bare twigs of understory shrubs or fallen branches, 2 were on tips of leaves, and 2 on vine tips or tendrils. Of 27 recorded perch heights, 3 were at or below about 0.5 m above ground, 12 between 0.5 and 1.5 m, 10 between 1.5 and 2.0 m, and 2 above 2.0 m. These heights undoubtably reflect the bias of our observational method toward flies at or near eye level, but they do differ significantly from those of some of the other typical forest understory robber fly species. Because a portion of our recorded perch sites and heights were of unusual

Table 1. Sizes of prey taken by *Glaphyropyga dryas*.

Taxon	Number of prey		Mean (mm)	±SD	Range
	Taken	Measured			
Coleoptera	32	31	2.63	1.053	1.1–5.9
Diptera	36	28	2.86	1.048	1.4–5.3
Hemiptera	2	2	4.15	2.899	2.1–6.2
Homoptera	15	13	4.18	1.769	1.3–6.5
Hymenoptera	21	20	3.28	1.192	1.7–5.4
Isoptera	1	1	2.70	—	—
Lepidoptera	4	4	3.65	1.493	1.7–5.2
Psocoptera	1	1	1.90	—	—
Zoraptera	1	1	1.20	—	—
Total	113	101	3.07	1.308	1.1–6.5

or extreme situations, the overall qualitative microhabitat of the species can be characterized as shaded forest understory, with preferred perches being twig tips between 1.5 and 2.0 m above ground.

In addition to foraging sites, we also collected 113 prey items from or together with flies. These represented nine orders of insects, of which Diptera (36 prey, 32%), Coleoptera (32, 29%), Hymenoptera (21, 18%), and Homoptera (15, 14%) predominated. The following taxa were included among these: COLEOPTERA: Cerambycidae (1), Chrysomelidae (3), Curculionidae (1, Cossinae), Phalacridae (1), Rhynchitidae (1), Scarabaeidae (1), Scolytidae (8), Staphylinidae (5), undetermined (11). DIPTERA: Ceratopogonidae (1), Culicidae (1), Drosophilidae (2), Empididae (2), Mycetophilidae (5), Phoridae (5), Psychodidae (1), Sciaridae (15), Sphaeroceridae (1), Stratiomyidae (1), Tipulidae (1), undetermined (1). HEMIPTERA: Cydnidae (1), Lygaeidae (1). HOMOPTERA: Achilidae (2), Cercopidae (1), Cicadellidae (5), Delphacidae (2), Kinnaridae (?, 2), Meenoplidae (?, 1), Fulgoroidea (1), undetermined (1). HYMENOPTERA: Formicidae (19, all reproductives, including the following taxa: *Azteca* sp. ♂ (1), *Myrmelachista* sp. ♂ (2), *Pachycondyla* sp. ♂ (3), *Paratrechina* sp. ♀ (1); Ponerinae genus A ♂ (1), genus B ♂ (1), genus C ♂ (2); *Solenopsis* sp. A ♂ (1), sp. B ♀ (1), sp. C ♀ (1), sp. D ♀ (1)), Tiphiidae (1), undetermined (1). ISOPTERA: undetermined (1). LEPIDOPTERA: undetermined moths (4). PSOCOPTERA: undetermined (1). ZORAPTERA: Zorotypidae (1). Of these, the zorotypid is especially noteworthy, apparently being the first record of this infrequently-collected group of insects as prey of an asilid. Sizes of these prey are presented in Table 1.

Courtship and mating behavior.—Courtship behavior was observed by both of us in detail on separate occasions, by EMF on 12 June 1976 between 10:20 and 10:40 h on a sunny day, and by HAH on 23 June 1977 somewhat before noon, in both instances along William Morton Wheeler trail between the 1400 and 1600 m posts. Courtship was also informally observed and photographed by HAH on other occasions in early July 1977.

Display sites were at typical forging sites, in the understory of closed-canopy forest and (on 23 June 1977) at a shaded broken-canopy site at a partially-overgrown treefall. In all cases females were observed perched on twig tips at heights of 1.5 to 2.0 m above ground. Males hover to the right or left side of the female at the same height, on an axis perpendicular to her, and at a distance of 1–3 cm. Although generally constant in position, the male moves slowly toward and away from the female over a range of 1–3 cm and oscillates vertically over a range of a few mm with an intensity that varies from slow (usually) to very rapid or agitated. While hovering the male holds the fore- and midlegs folded in toward the thorax, fully extends the hindlegs ventrally and occasionally rubs the hindtarsi together. The position of the hindlegs is significant with respect to their coloration, especially as seen by the female; only the whitish-yellow color would be visible to the female as the dark areas would be oriented away from her. Because the forelegs would also show only yellow and all the coxae are very pale, the male would be perceived as a bobbing, pale object against the relatively dim and therefore dark understory background.

Copulation is attempted by the male 1 to 3 times per minute by striking the female from the side and attempting to couple. No successful copulation was seen by us. Females would either leave the perch, and thus end the courting sequence, or fly out 2–3 cm toward the male in a manner similar to a sally for a prey item, although over a much shorter distance than typical. After a few to several minutes of unsuccessful courtship, the male flies off to a nearby perch by means of an erratic, bobbing flight, although with no audible sounds. After an interval of a few minutes, the male may again court the same female.

On 12 June 1976, a pair of *G. dryas* was seen *in copula* shortly afterwards and close by the pair observed courting, but evidently not the same individuals. The two flies were in a tail-to-tail orientation with the female at the tip of the branch facing outwards and the male behind her and facing away.

ACKNOWLEDGMENTS

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LITERATURE CITED

Carrera, M. 1945. Estudio sobre os generos *Glaphyropyga* e *Senoprosopis* con descricao de novo genero e novas especies. Pap. Avulsos Zool. (São Paulo) 5: 175–192.

———. 1950. Uma nova especies de *Glaphyropyga* da zona do canal no Panama (Diptera, Asilidae). Dusenia 1: 27–32.

Croat, T. B. 1978. Flora of Barro Colorado Island. Stanford Univ. Press, Stanford, Calif. 943 pp.

Curran, C. H. 1934. The families and genera of North American Diptera. New York. 512 pp.

Hull, F. M. 1958. More flies of the family Asilidae (Diptera). Ann. Mag. Nat. Hist. (12) 10: 884–895.

———. 1962. Robber flies of the world. The genera of the family Asilidae. U.S. Natl. Mus. Bull. 224 (Pt. 2): 433–907.

Martin, C. H. and N. Papavero. 1970. Family Asilidae. *In* A catalogue of the Diptera of the Americas south of the United States. Mus. Zool. Univ. São Paulo (35b): 1–139.

Papavero, N. 1973. Studies of Asilidae (Diptera) systematics and evolution. I. A preliminary classification in subfamilies. Arq. Zool. (São Paulo) 23: 217–274.

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A NEW SPECIES OF *TRIOXYS* (HYMENOPTERA: APHIDIIDAE) PARASITIC ON A PECAN APHID

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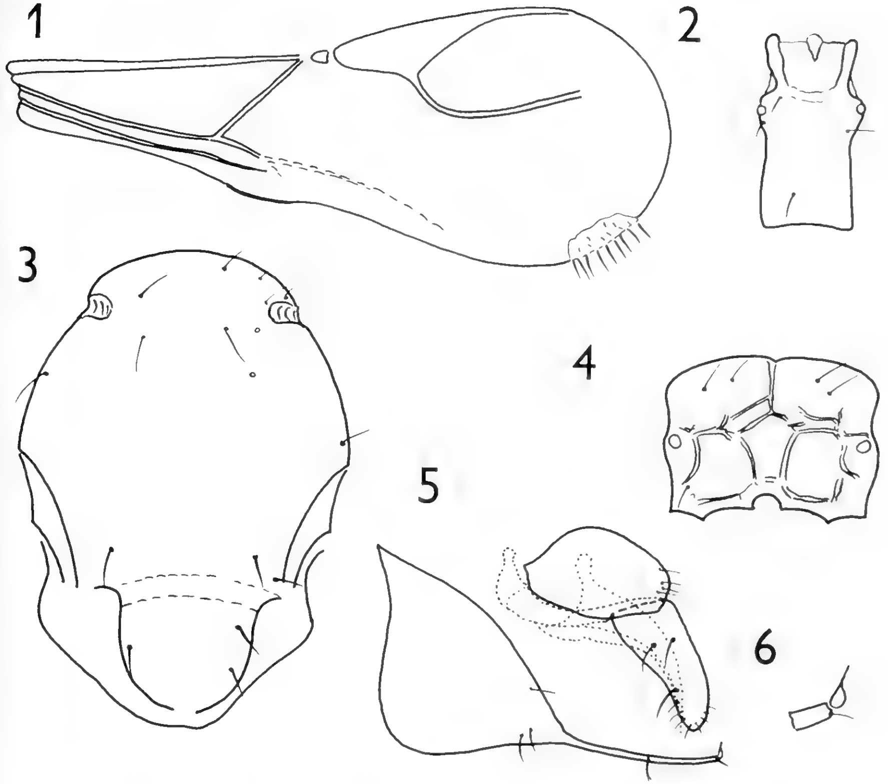
Abstract.—Trioxys **monelliopsis,** n. sp., a parasitoid of *Monelliopsis nigropunctata* (Gran.) on pecan, is described from Georgia. This is the first record of parasitism of this aphid in the field.

Parasitoids of aphid pests on pecan were first studied in connection with biological control of *Chrompahis juglandicola* (Kaltenbach) on walnut. The imported parasitoid *Trioxys pallidus* (Haliday) was found to parasitize *Monellia costalis* (Fitch) in the laboratory but not in the field (Schlinger et al., 1960; van den Bosch et al., 1962).

The parasitoid complex associated with the foliar-feeding aphids *Monellia costalis, Monelliopsis nigropunctata* (Granovsky), and *Tinocallis caryaefoliae* (Davis) on pecan was studied by Tedders (1977, 1978). Tedders successfully reared in the laboratory two introduced species, *Trioxys pallidus* and *T. complanatus* Quilis, but neither parasitoid species became established in the field. However, an unknown *Trioxys* species was found to parasitize *M. nigropunctata* in the field. Subsequent examination has shown that it represents a new, apparently indigenous species, which is described below. Thus, *M. nigropunctata* has been found to be parasitized by three *Trioxys* species in the United States: *T. pallidus* and *T. complanatus* in the laboratory (establishment not yet documented), and *T. monelliopsis,* n. sp., in the field.

Trioxys (Trioxys) monelliopsis Starý and Marsh, New Species

This species is easily distinguishable from other Nearctic species of *Trioxys* by characters on the prongs of the last abdominal sternum in the female. These prongs are hairless dorsally and bear a single claw-shaped apical bristle (Figs. 5, 6). Recently, a closely related species of *Trioxys,* a parasitoid of a *Myzocallis* species, has been described from Mexico (Starý and



Figs. 1–6. *Trioxys (T.) monelliopsis,* ♀ paratype. 1, Forewing. 2, Tergum 1. 3, Mesonotum. 4, Propodeum. 5, Genitalia. 6, Apex of the prong, detail.

Remaudiere, *in press*). This species is distinguishable from *T. monelliopsis* by the shape of the apical bristle on the prongs. The bristle is ovoid-shaped to droplike in the Mexican species and claw-shaped in *T. monelliopsis*. In Starý's (1978) key to European species, *T. monelliopsis* will run to couplet 14 but is distinguished from *T. curvicaudus* Mackauer and *T. phyllaphidis* Mackauer by the hairless dorsal surface on the abdominal prongs.

Female.—Eyes large. Gena equal to $^1/_7$ of eye length. Tentorial index (i.e., tentorio-ocular line over inter-tentorial line, relative length) 0.3. Antenna 11-segmented, slightly thickened to apex, reaching to about middle of abdomen. Mesonotum (Fig. 3) with sparse hairs. Propodeum (Fig. 4) distinctly areolated, central areola somewhat irregular in shape. Forewing (Fig. 1) with pterostigma almost 3× as long as wide, metacarpus equal to about ½ pterostigma length, and radial vein reaching about ⅔ of its possible length.

Tergum 1 (Fig. 2) twice as long as wide across spiracles. Spiracular tubercles distinct, situated before middle. Distance between spiracles and apex of tergum 1 distinctly longer than width across spiracles. Genitalia (Fig. 5) with prongs slightly arcuate, hairless dorsally, and with 1 claw-shaped apical bristle (Fig. 6).

Head brown, clypeus and mouthparts yellow brown. Scape brown, yellowish at apex. Pedicel and flagellomere 1 yellow, 2 mostly yellowish, rest brownish and darkened to apex. Thorax brown. Wings hyaline, venation brownish. Legs brown, trochanters, base of tibiae and tarsi (except dark specimens) yellowish. Abdomen brown, tergum 1 and triangular spot at base of tergum 2 yellowish, ovipositor sheaths light brownish, prongs yellowish.

Body length about 1.4 mm.

Male.—Unknown.

Holotype female.— Byron, Georgia, 12-VIII-1975, W. L. Tedders, ex *Monelliopsis nigropunctata* (Gran.) on pecan. Deposited in the National Museum of Natural History, Washington, D.C. (USNM).

Paratypes.—2 ♀, same data as holotype, deposited in USNM and in collection of P. Starý, Czechoslovakia.

Remarks.—The studies of Tedders (1977, 1978) show that this species is apparently specific to *M. nigropunctata* as it was not reared from other aphid species on pecan despite intensive rearing activities. Furthermore, it seems to be a rare species on the target host in the observed area. The mummy is yellowish white. Of the three mummies available, two were alate adults and one was a fourth-instar immature aphid.

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LITERATURE CITED

van den Bosch, R., E. I. Schlinger, and K. S. Hagen. 1962. Initial field observations in California on *Trioxys pallidus* (Haliday), a recently introduced parasite of the walnut aphid. J. Econ. Entomol. 55: 857–862.

Schlinger, E. I., K. S. Hagen, and R. van den Bosch. 1960. Imported French parasite of walnut aphid established in California. Calif. Agric. 14: 3–4.

Starý, P. 1978. Parasitoid spectrum of the arboricolous callaphidid aphids in Europe (Hymenoptera, Aphidiidae; Homoptera, Aphidoidea, Callaphididae). Acta Entomol. Bohemoslov. 75: 164–177.

Starý, P. and G. Remaudiere. *In press*. New genera, species, and host records of aphid parasitoids (Hym., Aphidiidae) from Mexico. Ann. Soc. Entomol. Fr. (N.S.).

Tedders, W. L. 1977. *Trioxys pallidus* and *Trioxys complanatus* as parasites of *Moenllia costalis, Monelliopsis nigropunctata* and *Tinocallis caryaefoliae*. Ann. Entomol. Soc. Am. 70: 687–690.

———. 1978. Important biological and morphological characteristics of the foliar-feeding aphids on pecan. U.S. Dep. Agric. Tech. Bull. 1579, 29 pp.

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THE MAYFLIES OF NORTHEASTERN MINNESOTA (EPHEMEROPTERA)[1]

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Abstract.—Analysis of the Ephemeroptora of northeastern Minnesota is based primarily on extensive sampling of larvae from St. Louis and Lake counties. Of 54 identifiable and nominal species, 33 represent new state records. Several notable range extensions are documented. The fauna has a strong affinity with that of eastern Canada; other faunistic relationships are also present. In Minnesota, *Baetis macani bundyae* Lehmkuhl larvae inhabit streams and complete their life cycle one and a half months earlier than larvae in the northern extreme of their range where they inhabit tundra ponds; larvae and adults are similar in size throughout their range.

The Ephemeroptera of Minnesota, especially in the northeastern region, are largely unknown. Although Daggy surveyed the mayfly fauna throughout the state (Daggy, 1938, 1941), he published only a small part of the data (Daggy, 1945). Thomas Say, who accompanied an expedition on the Minnesota and Rainy rivers in the 1820's, was probably the first to report on the state's mayflies (Say, 1823). Burks (1953) documented Minnesota distributions for species found in Illinois. Additional records occur in systematic works (Banks, 1910; Needham et al., 1935; Lewis, 1974; McCafferty, 1975; Edmunds et al., 1976; Berner, 1978; Bednarik and McCafferty, 1979; Morihara and McCafferty, 1979b; Pescador and Berner, *in press*) and in ecological studies of certain species (Waters, 1966; Fremling, 1973; Waters and Crawford, 1973; Hall et al., 1975).

In this paper we document the mayflies of northeastern Minnesota, predict those species likely to occur in the northern region of the state, show faunal relationships to other areas of North America, and discuss the efficacy of factors which may influence the faunal distributions. Larvae were

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[1] Part of the Minnesota Regional Copper-Nickel Study, Environmental Quality Board, St. Paul, Minnesota.

extensively sampled in St. Louis and Lake counties located in northeastern Minnesota (Fig. 1) during 1976 and 1977 by the following persons: M. D. Johnson, T. M. Lager, J. L. McCulloch, M. W. Mischuk, and S. N. Williams. Dr. L. Berner identified adult mayflies collected by the late W. V. Balduf, University of Illinois, at Eagles Nest Lake from 1953 to 1959 and made the data available to us. All collections from Eagles Nest Lake are credited to Dr. Balduf.

Description of Study Area

The Precambrian Shield, composed of metamorphic rocks and covered by glacial till and drift, extends into this region (Wright, 1972). The glacial history is evident in the generally flat but locally rugged topography. Many lakes formed in the glacial ice scoured troughs, and numerous streams drain surrounding ridges and lowlands. The Laurentian Divide partitions the area into northern and southern sections (Fig. 1). Streams in the northern section flow north to Hudson Bay via the Nelson System and those in the southern half are a part of the St. Lawrence System (Danks, 1979).

Within the study area, streams up to fourth order occur. The South Kawishiwi River, an atypical fifth order stream, is largely a chain of lakes or lake-like reaches connected by rapids. Most waters in this region are poorly buffered, particularly those in bog drainages. The alkalinity of the South Kawishiwi River, which receives water from most lakes and streams north of the divide ranged from 9 mg/l to 11 mg/l (as $CaCO_3$) (U.S. Geological Survey, 1978). South of the divide the alkalinity of the St. Louis River downstream from the confluence with the Partridge River ranged from 42 mg/l to 59 mg/l.

The forest is a part of the Great Lakes–St. Lawrence forest region, which is a transitional zone between the coniferous and deciduous forests (Scudder, 1979). The region extends from New Brunswick, Canada, to Lake of the Woods on the United States and Canada border about 210 km west of the study area. Portions of northern Wisconsin and Michigan are also included. The dominant vegetation of northeastern Minnesota is characterized by quaking aspen (*Populus tremuloides*) alder (*Alnus rugosa* and *A. crispa*), white pine (*Pinus strobus*), red pine (*P. resinosa*), and white cedar (*Thuja occidentalis*) (Swain, 1980).

The mayfly faunal list is presented systematically by family and alphabetically by genus and species within each family. New state records are indicated with an asterisk (*); new state records that were previously recorded by Daggy (1938; 1941) but unpublished are indicated with two asterisks (**). Collection sites are indicated by numbers corresponding to those listed below and plotted in Fig. 1. Predictions of mayfly species are listed below the lists of collected species. Voucher specimens are deposited at the University of Minnesota, St. Paul, Minnesota.

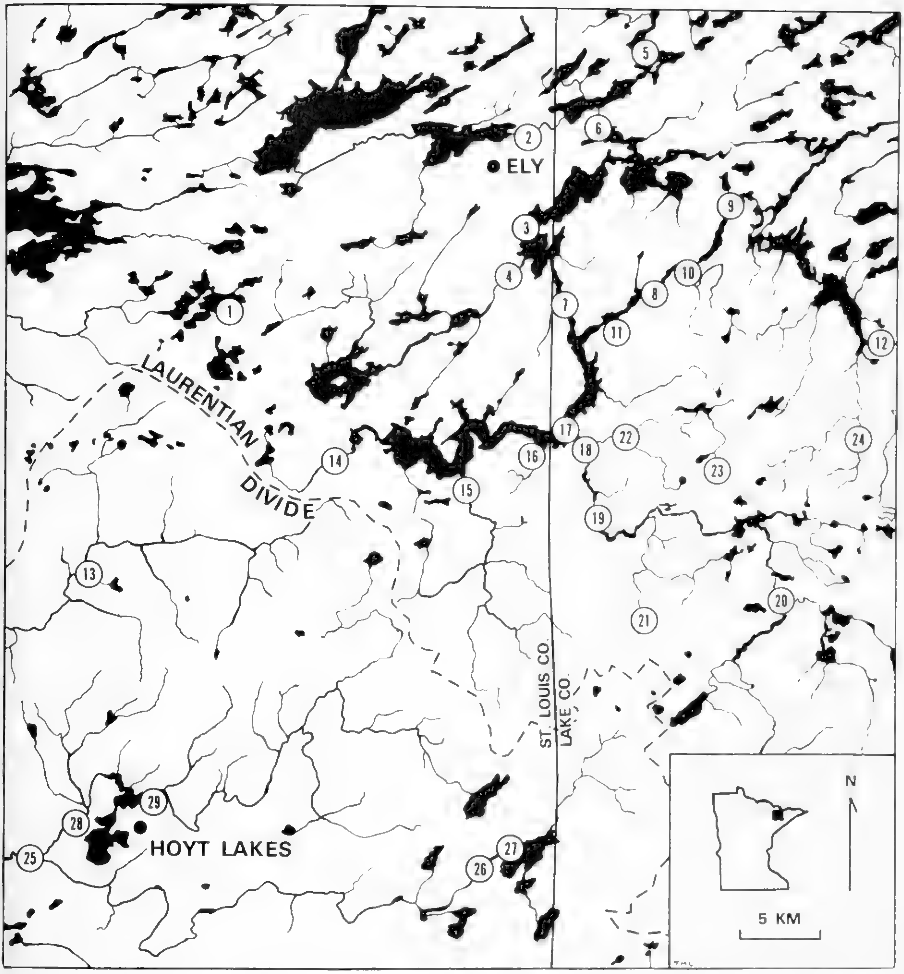

Fig. 1. Study area in St. Louis and Lake counties of northeastern Minnesota with site numbers plotted.

Collection Sites

1. Eagles Nest L., St. Louis Co.: T.62N., R.12W., S.26–28 and 33–35.
2. Shagawa R., St. Louis Co.: T.63N., R.12W., S.26.
3. L. White Iron, St. Louis Co.: T.62N., R.12W., S.11 and 14.
4. Bear Island R., St. Louis Co.: T.62N., R.12W., S.23.

5–9. South Kawishiwi R., Lake Co., 5: T.63N., R.11W., S.3; 6: T.63N., R.11W., S.20; 7: T.62N., R.11W., S.31; 8: T.62N., R.11W., S.23; 9: T.62N., R.10W., S.6.

10. Filson Cr., Lake Co.: T.62N., R.11W., S.24.
11. Two unnamed str., Lake Co.: T.62N., R.11W., S.33.
12. Isabella R., Lake Co.: T.61N., R.9W., S.6.
13. Embarrass R., St. Louis Co.: T.60N., R.15., S.25.
14. Birch R., St. Louis Co.: T.61N., R.13W., S.27.
15. Dunka R., St. Louis Co.: T.60N., R.12W., S.9.
16. An unnamed str., St. Louis Co.: T.61N., R.12W., S.36.
17. Birch L., Lake Co.: T.61N., R.11W., S.30.
18–20. Stony R., Lake Co. 18: T.61N., R.11W., S.30; 19: T.60N., R.11W., S.8; 20: T.60N., R.10W., S.28.
21. Nip Cr., Lake Co.: T.60N., R.11W., S.34.
22. Denley Cr., Lake Co.: T.61N., R.11W., S.28.
23. Nira Cr., Lake Co.: T.61N., R.10W., S.31.
24. Snake Cr., Lake Co.: T.61N., R.9W., S.30.
25–26. St. Louis R., St. Louis Co. 25: T.58N., R.15W., S.22; 26: T.58N., R.12W., S.22.
27. L. Seven Beaver, St. Louis Co.: T.58N., R.12W., S.14.
28. Partridge R., St. Louis Co.: T.58N., R.15W., S.13.
29. L. Colby, St. Louis Co.: T.58N., R. 14W., S.8.

List of Species

Family Siphlonuridae

Genus *Ameletus* Eaton

Ameletus was not taken, however, *A. browni* McDunnough, *A. lineatus* Traver, *A. ludens* Needham, and *A. walleyi* Harper are expected.

Genus *Parameletus* Bengtsson

This genus was not found; expected species are *P. croesus* McDunnough and *P. midas* McDunnough.

Genus *Siphlonurus* Eaton

Siphlonurus alternatus (Say): 5.

Larvae tentatively identified as *S. marshalli* Traver were found; expected species are *S. quebecensis* (Provancher), *S. rapidus* (McDunnough), and *S. typicus* Eaton.

Family Metretopodidae

Genus *Siphloplecton* Clemens

Siphloplecton interlineatum (Walsh): 17, 27.

Expected: *S. basale* (Walker).

Family Baetidae

Genus *Baetis* Leach

Baetis brunneicolor McDunnough: 13, 16, 21.
**Baetis flavistriga* McDunnough: 2, 5, 13, 18, 20, 25, 28.
**Baetis intercalaris* McDunnough: 25, 28.
**Baetis macani bundyae* Lehmkuhl: 11.
**Baetis pygmaeus* (Hagen): 2, 13, 15.
Baetis tricaudatus Dodds: 20, 24.
Expected: *B. frondalis* McDunnough and *B. hageni* Eaton.

Genus *Callibaetis* Eaton

**Callibaetis ferrugineus* (Walsh): 1.
Expected: *C. brevicostatus* Daggy, *C. fluctuans* (Walsh), and *C. skokianus* Needham.

Genus *Centroptilum* Eaton

Larvae were not identifiable to species. Expected species are *C. album* McDunnough, *C. bellum* McDunnough, *C. convexum* Ide, and *C. rufostrigatum* McDunnough.

Genus *Cloeon* Leach

***Cloeon simplex* McDunnough: 1.
Expected: *C. insignificans* McDunnough, *C. mendax* (Walsh), *C. minus* McDunnough, and *C. rubropictum* McDunnough.

Genus *Heterocloeon* McDunnough

***Heterocloeon curiosum* (McDunnough): 8.

Genus *Paracloeodes* Day

Although *P. minutus* (Daggy) inhabits the Mississippi River in southern Minnesota, the lack of large rivers in the study area may prevent its presence.

Genus *Pseudocloeon* Klapalek

Pseudocloeon anoka Daggy: 25.
***Pseudocloeon carolina* Banks: 15.
***Pseudocloeon cingulatum* McDunnough: 15.
***Pseudocloeon dubium* (Walsh): 13, 25.
***Pseudocloeon parvulum* McDunnough: 8, 4.
Expected: *P. punctiventris* McDunnough.

Family Oligoneuriidae

Genus *Isonychia* Eaton

Larvae were not identifiable to species. Expected species are *I. rufa* McDunnough, *I. sadleri* Traver, and *I. sicca* (Walsh).

Family Heptageniidae

Genus *Arthroplea* Bengtsson

**Arthroplea bipunctata* McDunnough: 27, 29.

Genus *Epeorus* Eaton

Larvae were not identifiable to species, however, *E. pleuralis* (Banks) and *E. vitreus* (Walker) are expected.

Genus *Heptagenia* Walsh

This genus was not collected, however, *H. flavescens* (Walsh) and *H. pulla* (Clemens) are expected.

Genus *Leucrocuta* Flowers

Leucrocuta hebe (McDunnough): 9, 15.
Expected: *L. umbratica* (McDunnough).

Genus *Nixe* Flowers

Nixe was not found; *N. lucidipennis* (Clemens) and *N. rusticalis* (McDunnough) are expected.

Genus *Pseudiron* McDunnough

Although *Pseudiron* was not found, *P. centralis* McDunnough may occur here.

Genus *Rhithrogena* Eaton

No larvae were identifiable to species; *R. impersonata* (McDunnough), *R. jejuna* Eaton, and *R. pellucida* Daggy are expected.

Genus *Stenacron* Jensen

***Stenacron candidum* (Traver): 15.
Stenacron interpunctatum (Say): 5, 28.
Stenacron minnetonka (Daggy): 13, 28.

Genus *Stenonema* Traver

Stenonema exiguum Traver: 13, 14, 15, 18, 20.
Stenonema femoratum (Say): 6, 9, 12, 29.

Stenonema integrum (McDunnough): 25.
Stenonema modestum (Banks): 10, 13, 14, 20, 22, 25, 28.
Stenonema pulchellum (Walsh): 9, 13, 28, 20.
Stenonema terminatum (Walsh): 12, 13.
Stenonema vicarium (Walker): 7, 12, 13, 15, 18, 24, 26.
Expected: *S. mediopunctatum* (McDunnough).

Family Leptophlebiidae

Genus *Choroterpes* Eaton

***Choroterpes basalis* (Banks): 20.

Genus *Habrophlebiodes* Ulmer

Although this genus was not collected, *H. americanus* (Banks) is expected.

Genus *Leptophlebia* Westwood

***Leptophlebia cupida* (Say): 1.
Expected: *L. nebulosa* (Walker).

Genus *Paraleptophlebia* Lestage

***Paraleptophlebia guttata* (McDunnough): 15.
***Paraleptophlebia mollis* (Eaton): 15, 20, 25.
***Paraleptophlebia praepedita* (Eaton): 11, 15, 20.
***Paraleptophlebia volitans* (McDunnough): 20.
Expected: *P. adoptiva* (McDunnough), *P. debilis* (Walker), *P. moerens* (McDunnough), *P. ontario* (McDunnough), and *P. strigula* (McDunnough).

Family Potamanthidae

Genus *Potamanthus* Pictet

This genus was not found but *P. myops* (Walsh), *P. rufous* Argo, and *P. verticis* (Say) are expected.

Family Palingeniidae

Genus *Pentagenia* Walsh

Although *P. vittigera* (Walsh) is known from Minnesota, the lack of large rivers with clay banks in the study area evidently precludes its presence.

Family Ephemeridae

Genus *Ephemera* Linnaeus

Ephemera simulans Walker: 15, 20.

Genus *Hexagenia* Walsh

Hexagenia bilineata (Say): 13.
Hexagenia limbata Serville: 1, 3.
Expected: *H. atrocaudata* McDunnough, *H. munda* Eaton, and *H. rigida* McDunnough.

Genus *Litobrancha* McCafferty

Litobrancha recurvata (Morgan): 24.

Family Polymitarcyidae

Genus *Ephoron* Williamson

Ephoron leukon Williamson: 19.
Expected: *Ephoron album* (Say).

Genus *Tortopus* Needham and Murphy

Tortopus was not collected, although the range of *T. primus* (McDunnough) may encompass northeastern Minnesota, the absence of large rivers having clay banks may preclude its presence.

Family Ephemerellidae

Genus *Attenella* Edmunds

***Attenella attenuata* (McDunnough): 15, 20.

Genus *Dannella* Edmunds

***Dannella simplex* (McDunnough): 15.

Genus *Drunella* Needham

Drunella was not found, however, *D. cornuta* (Morgan), *D. cornutella* (McDunnough), *D. lata* (Morgan), and *D. walkeri* (Eaton) are expected.

Genus *Ephemerella* Walsh

* *Ephemerella invaria* (Walker): 18.
***Ephemerella needhami* McDunnough: 15.
**Ephemerella rotunda* Morgan: 12, 13, 18.
Ephemerella subvaria McDunnough: 5, 7.

Genus *Eurylophella* Tiensuu

***Eurylophella bicolor* (Clemens): 15, 18, 25.
**Eurylophella minimella* (McDunnough): 15.
***Eurylophella temporalis* (McDunnough): 5, 9, 24.
**Eurylophella versimilis* (McDunnough): 29.
Expected: *E. bartoni* (Allen) and *E. lutulenta* (Clemens). *Eurylophella*

funeralis (McDunnough) and *E. prudentalis* (McDunnough) were found in the study area by Daggy (1941).

Genus *Serratella* Edmunds

***Serratella deficiens* (Morgan): 18, 20, 25.
**Serratella serrata* (Morgan): 15.
***Serratella sordida* (McDunnough): 15, 20.

Family Tricorythidae

Genus *Tricorythodes* Ulmer

No larvae were identifiable to species, however, *T. atratus* McDunnough is expected.

Family Caenidae

Genus *Brachycercus* Curtis

Brachycercus larvae were not identifiable to species but *B. lacustris* (Needham) is expected.

Genus *Caenis* Stephens

Caenis simulans McDunnough: 1.

Expected: *C. forcipata* McDunnough, *C. jocosa* McDunnough, *C. latipennis* Banks, and *C. tardata* McDunnough.

Family Baetiscidae

Genus *Baetisca* Walsh

Baetisca laurentina McDunnough: 9, 13, 15, 18, 19, 25.

Expected: *B. lacustris* McDunnough and *B. obesa* (Say).

FAUNISTICS SUMMARY

Fifty-four nominal Ephemeroptera species were confirmed from the study area; 33 are new state records, 20 of which were recorded by Daggy (1938, 1941) but are unpublished. As a result of earlier studies, including Daggy's surveys, 97 species are presently known from Minnesota. The total number for the northern region should eventually number at least 140; southern areas will yield additional numbers.

Of the 54 species, 46 have strong geographic affinities with eastern Canada, and most of these also occur in north central and/or northeastern United States. A total of 41 of these species range into southeastern United States; within the southeast 20 appear restricted to Appalachian areas and 21 extend on to the coastal plain. Only six species, *Baetis macani bundyae*, *Cloeon simplex*, *Pseudocloeon anoka*, *Siphloplecton interlinatum*, *Stenacron can-*

didum, and *Stenacron minnetonka*, show no affinities with far eastern Canada. *Baetis m. bundyae* and *C. simplex* are Canadian species from north central and western regions, respectively; the other four species are primarily midwestern species.

Only four species from the study area remain unknown from Canada: *Callibaetis ferrugineus, Hexagenia bilineata, Stenacron minnetonka,* and *Stenonema integrum.* Another group of four species, *Baetis tricadatus, Caenis simulans, Ephemera simulans, Hexagenia limbata,* are widely distributed North American species that range even into southwestern United States.

New central states distributions are reported for *B. m. bundyae, Paraleptophlebia volitans,* and *Serratella serrata. Baetis m. bundyae* was previously known only from eastern Northwest Territories, Canada (Lehmkuhl, 1973; Cobb and Flannagan, 1980) and *S. serrata* was thought restricted to the Appalachians (Allen and Edmunds, 1963). Ranges are extended westward for *Eurylophella minimella, Eurylophella versimilis,* and *S. serrata* and northwestward for *Ephemerella needhami.*

Use of the dominant vegetative-growth forms as a predictor of species presence appears to function for some species (Scudder, 1979; Ross, 1963). The study area which is located in an ecotome between the coniferous and deciduous forests was expected to have faunal elements common to these forest types. Approximately 57% of the mayfly fauna were distributed within these forested areas. A large portion of the fauna (43%) is distributed beyond the boundaries of the dominant vegetative-growth form on to the southeastern coastal plain and southwestern regions of the United States, and even into the tundra of northern Canada.

Borders of drainage systems in northeastern Minnesota do not delinate distributional boundaries for mayflies and did not function effectively as a biogeographic barrier to dispersal. Only one species, *B. m. bundyae,* was restricted to the Hudson Bay drainage system and only five other species are known to be restricted to regions south of the Laurentian Divide at this time. These five species, *Eurylophella versimilis, Hexagenia bilineata, Pseudocloeon anoka, Stenacron minnetonka,* and *Stenonema integrum,* may occur to the north in Canada where few studies have been conducted.

The efficacy of the Laurentian Divide as a barrier to dispersal may have been circumvented while glaciers receded and waters that now flow north were continuous with southern river systems. This hypothesis has been suggested to explain some present day disjunct distributions of mayflies (Ide, 1955; Lehmkuhl, 1972, 1976) and other aquatic insects (Laufersweiler and Flannagan, 1981). The relatively short distance across the divide (Fig. 1) and the similarity of habitats on both sides undoubtedly increases the probability of successful aerial dispersal between drainage systems. Nevertheless, drainage system boundaries may be effective barriers to those species restricted to large river environments since these species do not inhabit lower order streams near the boundaries.

Minnesota provides a good setting for the study of factors that may affect the distribution of aquatic insects since a number of distributional barriers and indicators converge within the state. The Mississippi River System, which drains much of central and all of southern regions of the state, borders the two northern drainage systems previously identified. Two major forest types (coniferous and deciduous) converge in the northeast. The prairie, which covers much of the south central and western sections, meet the deciduous forest along a diagonal line from the northwest to the southeast corners of the state. In addition some areas of the southeast are unglaciated. Perhaps future studies will develop a more complete understanding of the effects of climate, drainage system dynamics and glacial events of the present distribution of aquatic insects.

Since *B. m. bundyae* was found at a latitude much farther south than expected and in a distinctly different habitat, some biological notes are presented here on this species. In northern Canada this species inhabits edges of shallow tundra ponds (Lehmkuhl, 1973). In Minnesota larvae were found on wood, rock, sand, and detritus substrata in two first order streams. One stream flows among alder and tamarack [*Larix laricina* (Du Roi) K. Koch] and the other occurs in a cleared area; both are less than 1 m wide and about 0.1–0.3 m deep.

Specimens in the following stages of development were collected in 1977: two larvae with partially developed wing pads, 20 June (3.9–4.4 mm); four larvae with well developed but not darkened wing pads, 20 June (4.3–6.3 mm); two exuviae from mature larvae, 23 June (5.9–6.1 mm); one reared male, 23 June (6.2 mm); and one reared male, 29 June (6.4 mm). On 18 June 1981 five female larvae with well developed and darkened wing pads (6.5–7.0 mm) were collected. Mature larvae and adults in Canada are similar in size (5–7 mm and 5–6 mm, respectively) (Lehmkuhl, 1973; Morihara and McCafferty, 1979a). The temporal pattern of life cycles differ between northern and southern range extremes. In Canada larvae hatch in early July and adults emerge in early August (Lehmkuhl, 1973) while in Minnesota adults emerge in late June and larvae are presumed to hatch in May. *Baetis m. bundyae* is likely to have one generation per year and pass the winter in the egg state in Minnesota as in Canada since the streams it inhabits are reduced to pools in late summer and must surely completely freeze in winter.

ACKNOWLEDGMENTS

We thank A. F. Bednarik, L. Berner, and D. K. Morihara for verifications of *Stenonema*, *Baetisca*, and *Baetis*, respectively. We appreciate the use of the late W. V. Balduf's data provided by L. Berner and thank E. F. Cook for archiving the study specimens. R. Hrdlick and P. Cleveland, The Institute of Paper Chemistry, assisted with the preparation of the figure and typing, respectively.

LITERATURE CITED

Allen, R. K. and G. F. Edmunds, Jr. 1963. A revision of the genus *Ephemerella* (Ephemeroptera: Ephemerellidae). VI. The subgenus *Serratella* in North America. Ann. Entomol. Soc. Am. 56: 583–600.

Banks, N. 1910. Notes on our eastern species of the mayfly genus *Heptagenia*. Can. Entomol. 42: 197–202.

Bednarik, A. F. and W. P. McCafferty. 1979. Biosystematic revision of the genus *Stenonema* (Ephemeroptera: Heptageniidae). Can. Bull. Fish. Aquat. Sci. 201, (vi) + 73 pp.

Berner, L. 1978. A review of the mayfly family Metretopodidae. Trans. Am. Entomol. Soc. 104: 91–137.

Burks, B. D. 1953. The mayflies or Ephemeroptera of Illinois. Bull. Ill. Nat. Hist. Surv. 26, (iii) + 216 pp.

Cobb, D. G. and J. F. Flannagan. 1980. The distribution of Ephemeroptera in northern Canada, pp. 155–166. *In* Flannagan, J. F. and K. E. Marshall, eds., Advances in Ephemeroptera Biology. Plenum Publ. Co., New York. 556 pp.

Daggy, R. H. 1938. Studies on the biology of some Minnesota mayflies (Ephemeroptera) with special reference to immature stages. Univ. Minn., Master's Thesis (unpublished). 81 pp..

———. 1941. Taxonomic and biological investigation of Minnesota mayflies (Ephemeroptera). Univ. Minn. Ph.D. Thesis (unpublished). (viii) + 331 pp.

———. 1945. New species and previously undescribed naiads of some Minnesota mayflies (Ephemeroptera). Ann. Entomol. Soc. Am. 38: 373–396.

Danks, H. V. 1979. Physical basis for Canadian regional diversity, pp. 7–30. *In* Danks, H. V., ed., Canada and its insect fauna. Mem. Entomol. Soc. Can. No. 108, 573 pp.

Edmunds, G. F., Jr., S. L. Jensen, and L. Berner. 1976. The mayflies of North and Central America. Univ. Minnesota Press, Minneapolis. (x) + 330 pp.

Fremling, C. R. 1973. Environmental synchronization of mass *Hexagenia bilineata* (Ephemeroptera) emergences from the Mississippi River. Verh. Internat. Verein. Limnol. 18: 1521–1526.

Hall, R. J., L. Berner, and E. F. Cook. 1975. Observations on the biology of *Tricorythodes atratus* McDunnough (Ephemeroptera: Tricorythidae). Proc. Entomol. Soc. Wash. 77: 34–49.

Ide, F. P. 1955. Two species of mayflies representing southern groups occurring at Winnipeg, Manitoba (Ephemeroptera). Ann. Entomol. Soc. Am. 48: 15–16.

Laufersweiler, P. M. and J. F. Flannagan. 1981. Present recorded distributions and origins of the Ephemeroptera, Plecoptera, and Trichoptera of Manitoba. Program and Abstracts of N. Am. Benthol. Soc. 23rd Ann. Mtg. 63 pp.

Lehmkuhl, D. M. 1972. *Baetisca* (Ephemeroptera: Baetiscidae) from the western interior of Canada with notes on the life cycle. Can. J. Zool. 50: 1015–1017.

———. 1973. A new species of *Baetis* (Ephemeroptera) from ponds in the Canadian arctic, with biologial notes. Can. Entomol. 105: 343–346.

———. 1976. Additions to the taxonomy, zoogeography, and biology of *Analetris eximia* (Acanthametropodinae: Siphlonuridae: Ephemeroptera). Can. Entomol. 108: 199–207.

Lewis, P. A. 1974. Taxonomy and ecology of *Stenonema* mayflies (Heptageniidae: Ephemeroptera). U.S. Environ. Prot. Agency, Environ. Monitor. Ser., EPA-670/4-74-006, (vii) + 81 pp.

McCafferty, W. P. 1975. The burrowing mayflies (Ephemeroptera: Ephemeroidae) of the United States. Trans. Am. Entomol. Soc. 101: 447–504.

Morihara, D. K. and W. P. McCafferty. 1979a. Subspecies of the transatlantic species *Baetis macani* (Ephemeroptera: Baetidae). Proc. Entomol. Soc. Wash. 81: 34–37.

———. 1979b. The *Baetis* larvae of North America (Ephemeroptera: Baetidae). Trans. Am. Entomol. Soc. 105: 139–221.

Needham, J. G., J. R. Traver, and Y. C. Hsu. 1935. The biology of mayflies with a systematic account of North American species. Comstock Publ. Co., Ithaca, (xvi) + 759 pp.

Pescador, M. L. and L. Berner. *In press.* The mayfly family Baetiscidae (Ephemeroptera). Part II. Biosystematics of the genus *Baetisca.* Trans. Am. Entomol. Soc.

Ross, H. H. 1963. Stream communities and terrestrial biomes. Arch. Hydrobiol. 59: 235–242.

Say, T. 1823. Descriptions of insects belonging to the order Neuroptera Linn. Latr., collected by the expedition authorized by J. C. Calhoun under the command of Major S. E. Long. Godman's Western Quarterly Reporter 2(2): 160–165.

Scudder, G. G. E. 1979. Present patterns in the fauna and flora of Canada, pp. 87–179. *In* Danks, H. V., ed., Canada and its insect fauna. Mem. Entomol. Soc. Can. No. 108, 573 pp.

Swain, A. M. 1980. Landscape patterns and forest history in the Boundary Waters Canoe Area, Minnesota: A pollen study from Hug Lake. Ecology 61: 747–754.

U.S. Geological Survey. 1978. Water resources data for Minnesota Vol. 1, Great Lakes and Souris-Red-Rainy River basins. Report No. USGS/WRD/HD-79-028, (viii) + 300 pp.

Waters, T. F. 1966. Production rate, population density, and drift of a stream invertebrate. Ecology 47: 595–604.

Waters, T. F. and G. W. Crawford. 1973. Annual production of a stream mayfly population: A comparison of methods. Limnol. Oceanogr. 19: 286–296.

Wright, H. E., Jr. 1972. Physiography of Minnesota, pp. 561–578. *In* Sims, P. K. and G. B. Morey, eds., Geology of Minnesota: A centennial volume. Univ. Minn., Minn. Geol. Surv. St. Paul, 623 pp.

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NOTES ON THE ETHOLOGY OF *NEOSCLEROPOGON ELONGATUS* (DIPTERA: ASILIDAE) IN SOUTH AUSTRALIA[1,2]

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Abstract.—Notes are presented on the predatory and mating behavior of *Neoscleropogon elongatus* (Macquart) in South Australia. Prey taken by *N. elongatus* represented three orders, Diptera, Hymenoptera, and Heteroptera-Hemiptera, with Diptera and Hymenoptera accounting for 88% of the prey. Mating, without prior courtship, occurred in the tail-to-tail position, typical of Dasypogoninae.

The taxonomy of *Neoscleropogon elongatus* (Macquart) is somewhat confused. It was first described by Macquart in 1847 in the genus *Dasypogon.* White (1917) regarded it as belonging to the genus *Stenopogon* and recorded it from Tasmania in January and February. Hardy (1926) illustrated the genitalia of *S. elongatus* from New South Wales specimens, but later (1930) indicated that this drawing referred to *S. fraternus* Bigot. However, in 1934, he established *S. elongatus* as a synonym of *S. fraternum* (misspelled). As a result of his visit to Australia, Hull (1962) again separated the two species and placed both in the genus *Neoscleropogon.* Therefore, if White and Hardy were correct in their identifications, *N. elongatus* has been recorded, thus far, only from Tasmania and *N. fraternus* from New South Wales.

Data included herein on the behavior of *N. elongatus* is admittedly incomplete. However, since the behavior of Australian asilids is virtually undocumented, these notes may be of some interest.

Behavioral observations were made on this species, at Sandy Creek, near Gawler, South Australia, intermittently between November 28 and Decem-

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ber 12, 1978, in a harvested oat field and the weedy area adjoining it. Salvation jane (*Echium plantagineum* L.) was common in the field of oats, while the weedy area was dominated by a wallaby grass (*Danthonia geniculata* J. M. Black), a spear grass (*Stipa semibarbata* R. Br.), *Lipidosperma viscidum* R. Br., *Neurachne alopecuroidea* R. Br., and *Baeckea behrii* (Schldl.) F. Muell. The weather was typical for a South Australian spring, with several days of rain during the period and temperatures ranging from 16° to 28°C.

Other locations in South Australia where *N. elongatus* was collected are Aldinga Beach, 22.i.79, and Ferries-McDonald Conservation Park, south of Monarto, 12.xii.78. The habitat in both locations was composed of native vegetation, e.g., Mallee scrub, and beach scrub community, respectively.

Methods used to observe *N. elongatus* were the same as those used in describing the behavior of *Neoitamus vittipes* (Macquart) (Lavigne, 1982).

Foraging and Feeding Behavior

Asilids were active whenever it was not raining and temperatures exceeded 21°C. Orientation flights were long (3 to 7 m) undulating excursions with the asilid often zigzagging through the vegetation 15 to 46 cm above the ground. *Neoscleropogon elongatus* foraged from oat stubble and dried plant stalks at heights ranging from 12 cm to 0.75 m. Successful flights after prey were initiated from distances of 30 to 36 cm, although rapid flights of 2 m after prey were commonly observed. Potential prey were sometimes chased over long distances. In some instances the robber fly would veer away when close. Insufficient data are available for establishing any pattern. Foraging by *N. elongatus* occurred as early in the day as 0945 h and as late as 1920 h.

Prey were collected in the air, and, on the single occasion when the author was close enough to observe, the prey was impaled during manipulation following the landing. The same type of manipulation, that of holding the vegetation with one foretarsus and using the other five to revolve the prey, was seen during the feeding sequence on a honey bee. This behavior is similar to that exhibited by *Diogmites angustipennis* Loew in western North America (Lavigne and Holland, 1969). On the single occasion when prey release, following feeding, was observed, the asilid pushed a tachinid off its proboscis with both foretarsi.

Based on 25 measured prey of *N. elongatus*, the "preferred" prey length was 8.3 mm; the prey size varied from 2.8 to 15.0 mm. Measurements of four female and five male asilids suggest that females are slightly smaller than males (17.9 vs. 20.0 mm; range, male: 18.5–21.0 mm, female: 16.3–20.0 mm), an unusual situation. However, males chose smaller prey (18.5–21.0 mm, $\bar{x}$ 7.6 mm) than did females (16.3–20.0 mm, $\bar{x}$ 9.3 mm). Since it is unusual for female asilids to be smaller than males, it is probable that had a longer series of asilids been collected, the reverse situation would have been found, thus explaining the smaller prey size for males. The number of prey collected from males (9) was slightly more than one-half that collected from females (14). Males showed a slight "preference" for Hymenoptera, whereas females concentrated on both Hymenoptera and Diptera. The species appears to be stenophagic, as defined by Lavigne and Holland (1969), taking as prey representatives of only three insect orders, Diptera (40%), Hymenoptera (48%), and Hemiptera-Heteroptera (12%). Even though there were ca. 15 beehives in the adjoining paddock, honey bees were not being taken excessively in terms of their abundance; only 11% of the prey were honey bees. Despite the fact that bush flies were very conspicuous, these insects were largely ignored by the asilids, presumably because of their small size. The mean predator to prey ratio was 2.3.

Herein is a list of prey taken by *N. elongatus*. Specific identifications were made, where possible, but because of the state of knowledge in some groups, only genus and/or family names are included for some specimens. The number of records and sex of the predator are indicated in parenthesis following the prey record. All prey records are from Sandy Creek, unless otherwise noted.

DIPTERA, Asilidae: *Bathypogon* sp., 12.xii.78 (♀) (Ferries-McDonald Consv. Pk.); Muscidae: *Musca vetustissima* Walker, 7.xii.78 (♂), 8.xii.78 (?); Syrphidae: *Eristalis tenax* L., 1.xii.78 (♀); Tachinidae: *Chaetophthalmus* sp., 7.xii.78 (♀), 8.xii.78 (♂, 3 ♀). HEMIPTERA-HETEROPTERA, Alydidae: *Riptortus* sp., 28.xi.78 (♂); Lygaeidae: *Nysius vinitor* Bergroth, 1.xii.78 (♀); Miridae: *Creonotiades dilutus* Stål, 28.xi.78 (♂). HYMENOPTERA, Apidae: *Apis mellifera* L., 28.xi.78 (2 ♀), 8.xii.78 (♂); Halictidae: *Lasioglossum* sp., 1.xii.78 (♂), 7.xii.78 (♂, ♀); Tiphiidae: Thynninae, 28.xi.78 (♂, ♀), 7.xii.78 (♀), 8.xii.78 (♂, ♀). An additional unidentified Diptera and an unidentified Hymenoptera also served as prey at Ferries-McDonald Conservation Park.

MATING

Only one complete mating was observed (28.xi.78). In this instance there was no courtship. A female flying a zigzag pattern through the vegetation at 1240 h was accosted by a male rising out of the understory. Coupling took place at a height of ca. 45 cm and the pair landed on an oat stalk at approximately the same height (temperature 28°C). Upon landing the pair took a tail-to-tail position. The female was feeding on a tiphiid wasp when encountered by the male. She subsequently dropped the prey during a flight to a new resting place. Separation occurred at 1253 h after the female pushed at the genitalic junction with her hindtarsi.

Three other mated pairs were encountered 1101 h (24°C), 7.xii.78; 1223 h (26°C), 7.xii.78 and 1200 h (26.5°C), 8.xii.78. Remaining times in copula were

6 min., 17 min., and 10 min., respectively. Near the end of each mating, the female would alternately raise and lower her hindlegs several times. This action was accompanied by the female pushing against the genitalic connection with her hindtarsi, ca. two minutes prior to separation. At separation the male released his claspers and flew off, leaving the female on site.

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LITERATURE CITED

Hardy, G. H. 1926. A new classification of Australian robber flies belonging to the subfamily Dasypogoninae (Diptera: Asilidae). Proc. Linn. Soc. N.S.W. 51(Pt. 3): 305–312.

———. 1930. Fifth contribution towards a new classification of Australian Asilidae (Diptera). Proc. Linn. Soc. N.S.W. 55(Pt. 3): 249–260.

———. 1934. The Asilidae of Australia. Part II. Ann. Mag. Nat. Hist. (10)14: 1–35.

Hull, F. M. 1962. Robber flies of the world. The genera of the family Asilidae. Pt. 1. U.S. Natl. Mus. Bull. 224: 1–430.

Lavigne, R. J. 1982. Ethology of *Neoitamus vittipes* (Diptera: Asilidae) in South Australia. Proc. Entomol. Soc. Wash. 84: 617–627.

Lavigne, R. J. and F. R. Holland. 1969. Comparative behavior of eleven species of Wyoming robber flies (Diptera: Asilidae). Univ. Wyo. Agric. Exp. Stn. Sci. Monogr. No. 18, 61 pp.

White, A. 1917. The Diptera—Brachycera of Tasmania. Part 3. Families Asilidae, Bombyliidae, Empididae, Dolichopodidae and Phoridae. Pap. R. Soc. Tasmania 1916: 148–266.

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OCONOPERLA, A NEW GENUS OF NORTH AMERICAN PERLODINAE (PLECOPTERA: PERLODIDAE)[1]

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Abstract.—***Oconoperla weaveri***, a new genus and species of Perlodinae, is described from one adult male and five pre-emergent nymphs collected in mountainous North and South Carolina. *Oconoperla* appears to be most closely related to *Malirekus* Ricker. Descriptions are supported by SEM photomicrographs and original drawings.

The most recent study of Nearctic Perlodinae (Ricker, 1952) recognized 13 subgenera of *Isogenus*. All of these have subsequently been given generic rank by Illies (1966) and Zwick (1973). This study reports the discovery of an adult male and five nymphs of a previously undescribed genus in this group. Nymphs were associated by dissecting adult genitalia from specimens which died during emergence. Methodology follows Stark and Stewart (1981).

Oconoperla **Stark and Stewart NEW GENUS**

Type-species.—*Oconoperla weaveri,* n. sp.

Description.—*Size:* Medium sized, 12–14 mm in length.

Mesosternum: Y-ridge arms attached to posterior corners of furcal pits; transverse ridge present. Stem of Y-ridge short (Fig. 4).

Male 10th tergum: Cleft extends to near anterior margin; hemitergal lobes rounded and covered apically with dense patch of long thin setae (Fig. 1).

Epiproct: Bulbous apically and covered dorsolaterally with small scale-like setae. Dorsal sclerite slender, almost needle-like; not reaching tip (Figs. 1, 2). Ventral sclerite well developed, sharply upturned over apex; 2 ventrally directed teeth at midlength (Fig. 1).

Lateral stylets: Not exceeding apex of epiproct in length; most heavily

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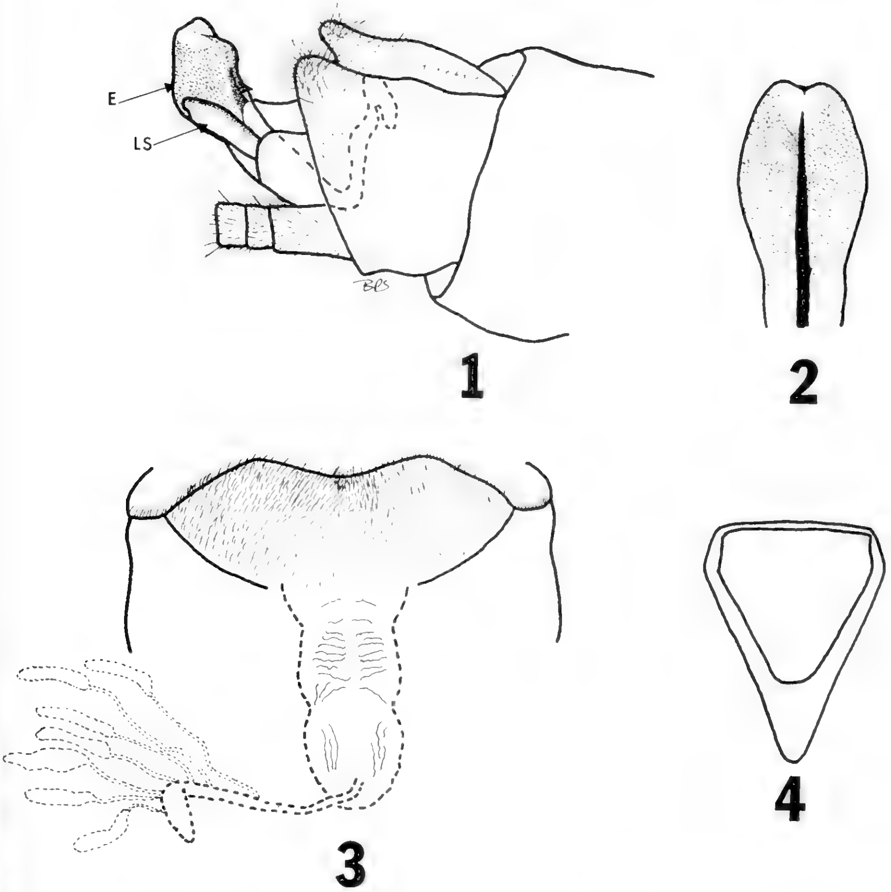


Figs. 1–4. *Oconoperla weaveri* adult structures. 1, Male terminalia, lateral (E = epiproct; LS = lateral stylet). 2, Epiproct, dorsal. 3, Female subgenital plate with vagina (dorsal aspect) inset. 4, Mesosternal grooves.

sclerotized along dorsal margin; ventral margin abruptly narrowed near apex to form truncate tip (Fig. 1).

Ventral lobes: Absent.

Female subgenital plate: Slightly produced and densely hairy; posterior margin truncate and emarginate mesally (Fig. 3).

Nymphal lacinia: Bicuspid; shorter subapical tooth strongly divergent from apical tooth. Apical tooth with groove along basal half of inner surface; slender, delicate sensillum located at base of tooth. Three or 4 prominent setae along inner margin of lacinia followed by row of smaller setae; base with patch of small setae near margin (Fig. 9).

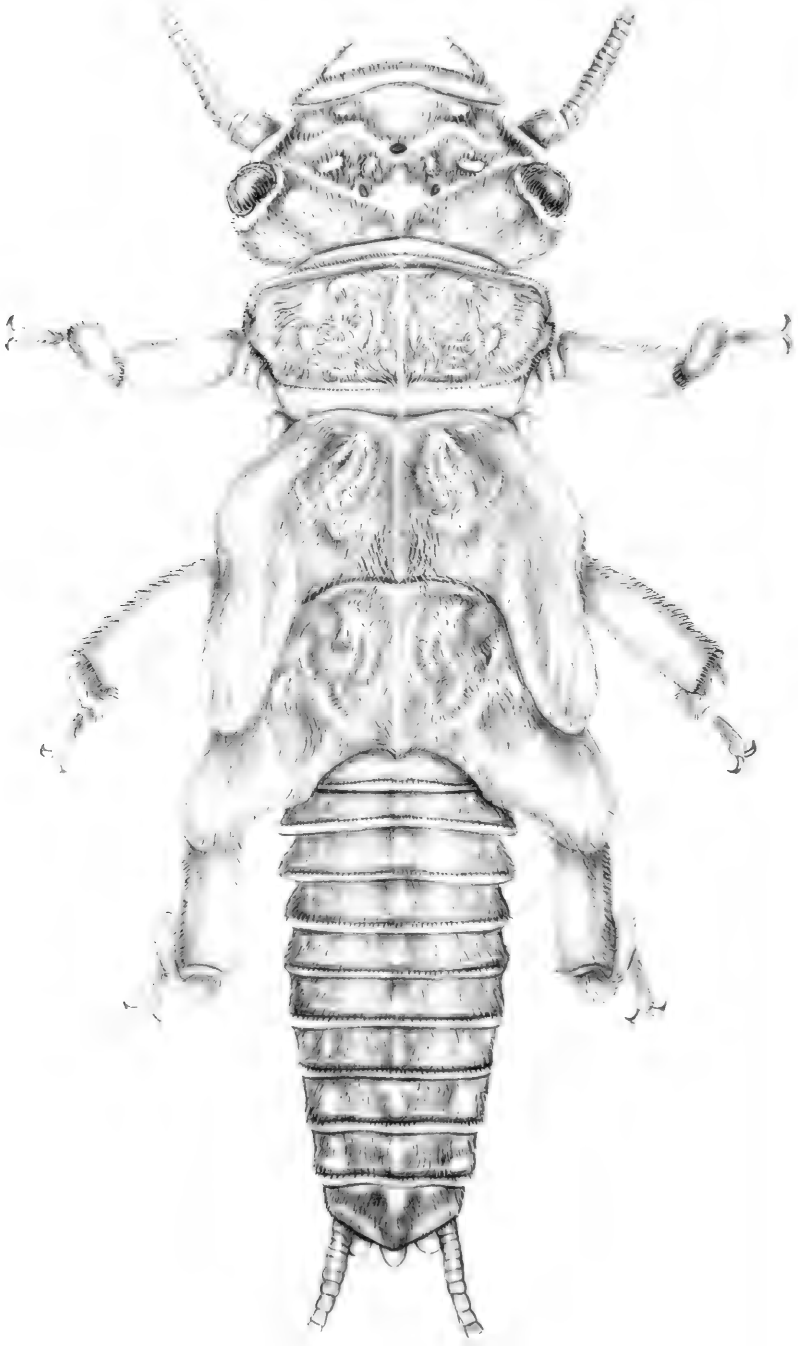
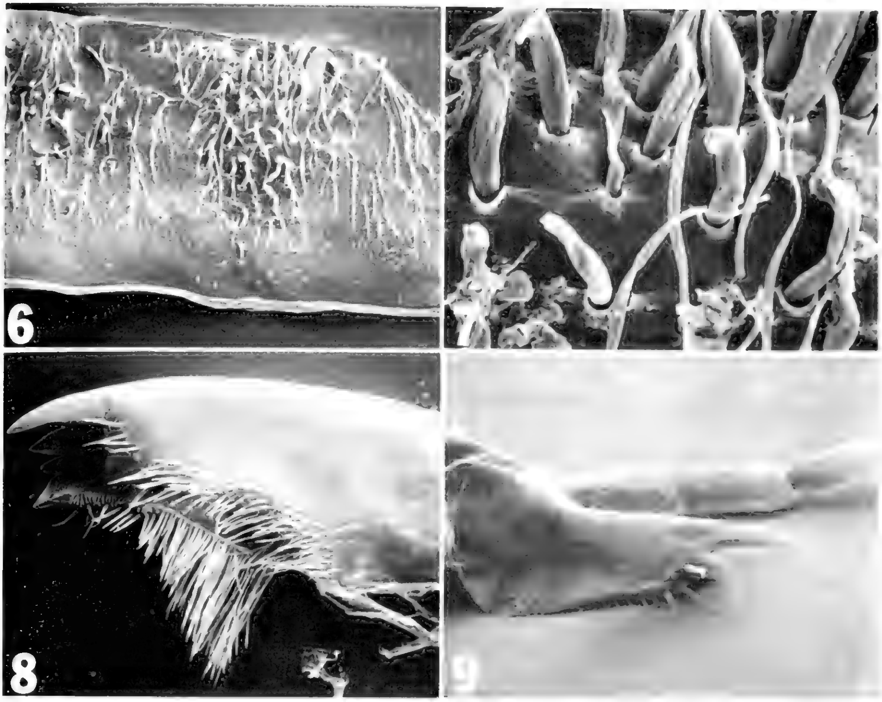


Fig. 5. *Oconoperla weaveri*, nymphal habitus.



Figs. 6–9. *Oconoperla weaveri*, SEM photomicrographs of nymphal structures. 6, Abdominal tergum 8, 200×. 7, Detail of tergal setae, 1000×. 8, Right mandible, 150×. 9, Lacinia, 170×.

Nymphal mandibles: Four major teeth; innermost tooth tridentate. Serrations absent. Marginal setal fringe covering ca. ½ of inner margin; ventral median setae forming an irregular linear patch; 4 prominent setae near base of apical tooth. Linear patch of stout spines near base of inner tooth on left mandible.

Submental gills: Not extending beyond lateral margins of submentum.

Nymphal pronotum: Posterolateral margins notched (Fig. 5).

Distribution.—Southern Appalachian Mountains.

Etymology.—The prefix, Ocono, is derived from Oconee, the South Carolina county in which the holotype was collected.

Diagnosis.—*Oconoperla* nymphs are distinguished from those of sympatric perlodinae genera (*Cultus, Diploperla, Helopicus, Hydroperla, Isogenoides, Malirekus, Remensus*, and *Yugus*) by the notched lateral pronotal margin and the densely hairy habitus (Fig. 5). *Yugus* and *Malirekus* nymphs bear the closest general resemblance to those of *Oconoperla*, but in both these genera the lacinia bears a short second tooth which arises unusually close to the apex of the major tooth, and a tuft of 4–5 large setae on a small knob near the base of the second tooth. The lacinia of *Oconoperla* bears a longer, more divergent and proximally located second tooth and lacks a tufted knob on the inner margin (Fig. 9).

Five of the sympatric genera listed above have lateral stylets but only two of these (*Isogenoides* and *Hydroperla*) also share the presence of spines on the ventral epiproct sclerite with *Oconoperla*. Males of these two genera are additionally distinguished from those of *Oconoperla* by the presence of long submental gills.

The affinities of this unique genus will be clearer once eggs and adult females are available for study. Male genitalic structure is suggestive of a close relationship with the *Malirekus-Yugus* group of genera, but the apparent absence of synapomorphies in nymphal mouthparts (e.g., tufted lacinial knob, grooved inner margin of major lacinial tooth, isolated setal row near base of apical mandibular tooth) between *Oconoperla* and *Malirekus-Yugus* group suggests the relationship is a remote one.

Oconoperla weaveri Stark and Stewart, NEW SPECIES

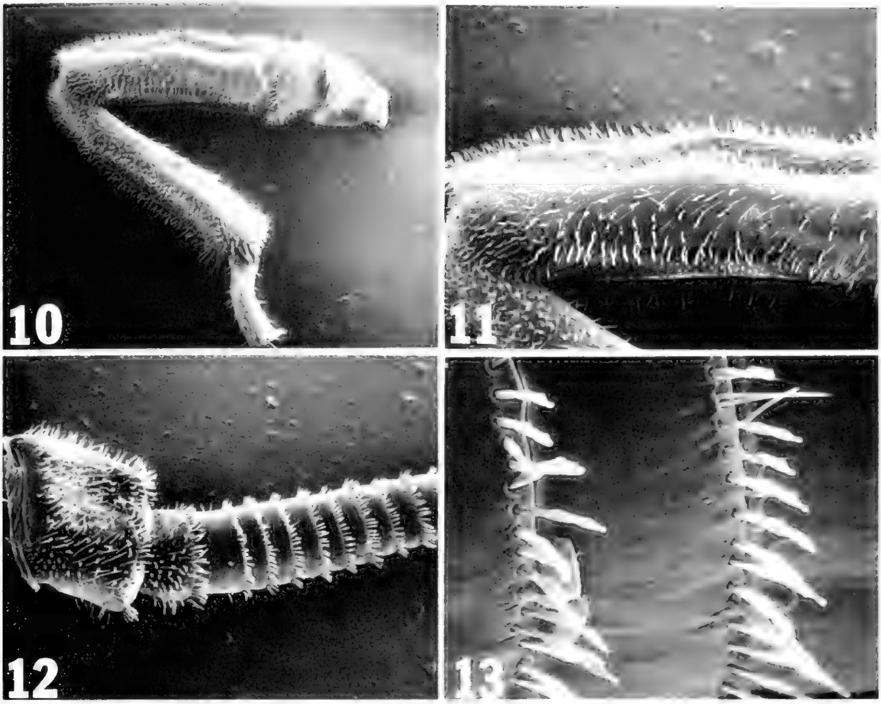
Figs. 1–13

Male.—Forewing length 14 mm; body length 11 mm. General color dark brown. Dorsum of head brown except for small pale spot posterior to ocelli. Pronotum brown with narrow yellow median stripe. Genitalia described above.

Female.—External genitalia from pre-emergent nymph described above. Vagina membranous; lateral margins sinuate. Spermatheca slender, membranous, bearing ca. 7 accessory glands in apical ½ (Fig. 3).

Nymph (Fig. 5).—General color brown patterned with yellow; membranous areas with purple-red pigment in living specimens. Head brown except for pale M-line and 2 pair small circular spots; smaller pair forward of M-line, larger pair lateral to ocelli and forward of ecdysial suture. Thoracic terga brown with scattered circular pale areas. Abdominal terga brown with double row pale spots on Ab 3–7 and mesal single row pale spots on Ab 6–9; additional expanded pale areas on Ab 6–10. Body densely hairy; occipital spinule row absent. Legs without fine silky setal fringe; femora without large socketed spinelike setae (Figs. 10, 11). Abdominal terga with dense mesal patch of short, thick curled setae (Figs. 6, 7).

Types.—Holotype ♂ (USNM #100106) from Oconee Co., S.C., 0.5 mi E Hwy 107, Tamassee Rd., small spring at headwaters of Wash Branch, 22-V-1981, B. Stark and J. S. Weaver, deposited in the National Museum of Natural History, Washington, D.C. Paratypes: NORTH CAROLINA: Macon Co., Dirty John Crk, Wayah Bald, 18-IV-81, J. S. Weaver and R. Holzenthal, 2 nymphs (NTSU, BPS); Rattlesnake Spring, Wayah Bald, 18-IV-1981, J. S. Weaver and R. Holzenthal, 1 nymph (BPS); Rattlesnake Spring,



Figs. 10–13. *Oconoperla weaveri*, SEM photomicrographs of nymphal structures. 10, Foreleg, anterior aspect, 58×. 11, Femur, anterior aspect, 125×. 12, Antenna, basal segments, 100×. 13, Detail of antennal setation, 1000×.

Wayah Bald, 26-V-1981, B. Stark and J. S. Weaver, 2 nymphs (USNM, BPS).

Etymology.—This species is named in honor of John S. Weaver, III.

Ecological note.—Nymphs of *O. weaveri* were found under rocks in splash zones of small spring seeps. Additional rarely collected species taken at Wayah Bald with *Oconoperla* include *Viehoperla ada* (Needham and Smith), *Isoperla distincta* Nelson, and *Beloneuria georgiana* (Banks).

ACKNOWLEDGMENTS

We are grateful to John S. Weaver, III, for his assistance in fieldwork and for his gift of additional specimens used in this study. Sarah Faison of the University of Mississippi Dental School assisted in preparation of SEM photomicrographs and Ellen Hart Navoor prepared the full nymphal illustration under our direction.

LITERATURE CITED

Illies, J. 1966. Katalog der rezenten Plecoptera. Das Tierreich, 82. Walter de Gruyter and Co., Berlin. 632 pp.

Ricker, W. E. 1952. Systematic Studies in Plecoptera. Indiana Univ. Publ. Sci. Ser. 18: 1–200.

Stark, B. P. and K. W. Stewart. 1981. The Nearctic genera of Peltoperlidae (Plecoptera). J. Kans. Entomol. Soc. 54: 285–311.

Zwick, P. 1973. Insecta: Plecoptera. Phylogenetisches system und Katalog. Das Tierreich, 94. Walter de Gruyter and Co., Berlin. 465 pp.

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LARVAL DEVELOPMENT IN BLISTER BEETLES OF THE GENUS *LINSLEYA* (COLEOPTERA: MELOIDAE)

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Abstract.—Twenty T_1 larvae of *Linsleya convexa* (LeConte) failed to feed on pollen taken from the comb of the honeybee. Two of nine T_1 larvae given eggs of the acridid grasshopper *Melanoplus differentialis* (Thomas) completed the developmental pattern T_1-FG_{2-5}-C_6 in 23 and 27 days. After being chilled at 5°C for two months to break diapause, one of the larvae reached instars SG_7, P_8, and A_9 in 19, 24, and 34 days, respectively. The other larva molted to instar C_7 after chilling but failed to complete ecdysis.

A previous contention that *L. sphaericollis* (Say) regularly follows the abbreviated ontogenetic pattern T_1-FG_{2-5}-P_6-A_7, with diapause in instar FG_5, is regarded as unfounded.

Some anatomical features of the larva and pupa of *L. convexa* are described. It is concluded that, while *Linsleya* does not belong in the Lyttina, the evidence for placing it in the Epicautina is, as a whole, equivocal.

Following MacSwain's (1951) proposal, based on external anatomy of the first-instar (triungulin) larva, that the genus *Linsleya* MacSwain be assigned to the subtribe Epicautina, rather than the Lyttina, several workers have addressed the question of whether species of this genus are, like most species of the genus *Epicauta* Dejean, predators of the eggs of acridid grasshoppers (Selander, 1964; Selander and Pinto, 1967; Church and Gerber, 1977). The question is certainly an important one systematically, since an affirmative answer would provide strong support for MacSwain's hypothesis.

Selander (1964) called attention to a report of Criddle (1931), in which *Linslelya sphaericollis* (Say) was cited as one of several "enemies" of grasshoppers in Canada, and of Romanov (1954), in which the larva of this species was stated to be predaceous on grasshopper eggs in Manitoba. Unfortunately, neither report gives any indication whatsoever regarding the evidence for the reputed predation of grasshopper eggs by larvae of *L. sphaericollis*. On the other hand, Church and Gerber (1977) reported that "none of several hundred meloids'' taken from egg pods of *Melanoplus sanguinea* (Fabricius), *M. bivittatus* (Say), and *Camnula pellucida* Scudder in the Canadian prairies ''in recent years'' proved to represent *Linsleya sphaericollis,* even in instances where adults of this species were abundant in the area in which grasshopper eggs were collected. Moreover, Selander and Pinto (1967) reported failure of 24 larvae of *Linsleya convexa* (LeConte) to feed on eggs of *Melanoplus differentialis* (Thomas) in an attempted laboratory rearing.

At this point one might suspect that the reports of Criddle and Romanov were perhaps suppositional and that grasshopper eggs are not, in fact, the prey-type of larvae of *Linslelya.* Yet Church and Gerber (1977) and Peterson (cited by them) were able to induce a small percentage of larvae of *Linsleya sphaericollis* to feed on the eggs of *Melanoplus* in the laboratory and in one instance actually obtained a complete rearing to the adult stage.

In this article I report an experimental rearing of *Linsleya convexa* in which first-instar larvae were given, as prospective food, either pollen provisioned by the honeybee (*Apis mellifera* Linnaeus) or eggs of the grasshopper *Melanoplus differentialis.* In addition, I describe some of the anatomical features of the larva and pupa of *L. convexa.*

An Experimental Rearing *Linsleya convexa*

Materials and methods.—I follow Selander and Mathieu (1964) in referring to the four phases of the larval stage of Meloidae as triungulin, first grub, coarctate, and second grub, commonly denoted by the symbols T, FG, C, and SG, respectively, with numerical subscripts to indicate instar, as necessary.

The experiment utilized 29 T larvae of *Linsleya convexa* eclosing from an egg mass laid by a female that was part of a group of adults collected at Fort Davis, Jeff Davis County, Texas, 3/10 August 1968, on *Chilopsis linearis* and *Tetraclea coulteri.* The eggs, laid 13 August at the collection site, were placed in a 3-dram vial and held at ambient temperature, 100% RH, in darkness until 15 August, when temperature was stabilized at 27°C. The egg mass contained 30 eggs, all of which hatched on 5 September (24 days). Larvae remained under the conditions of incubation before use in the experiment.

Twenty larvae were given pollen at the age of seven days (12 September); nine were given grasshopper eggs at the age of 10 days (15 September). One larva from the lot died at the age of 8 or 9 days, before entering the experiment.

Pollen was removed from a comb of the honeybee shortly before use, mixed with distilled water, and worked into small balls, as described by Selander and Mathieu (1964). The amount of water was varied to produce five balls each of four consistencies (from "rather dry" to "soupy"). Each ball was placed on the inner surface of a cotton-plugged glass tube (4 mm inner diameter), and a *Linsleya* larva was deposited on one of the cotton plugs near the pollen ball.

Melanoplus differentialis eggs were nine months old. They had been incubated initially at 27°C, 100% RH for 1–2 months in order to allow them to develop to the diapause state and then held at 5°C until use. Larvae of *Linsleya* were given about 40 *Melanoplus* eggs each in individual cotton-plugged glass tubes 8 mm inner diameter. Allotments were random selections of eggs from 50 egg pods.

Larvae receiving pollen were placed at 27°C, 100% RH, in darkness. Those receiving *Melanoplus* eggs were placed initially under the same conditions, but on day 8, surviving, unfed larvae were transferred to 35°C. Larvae that completed feeding in instar FG_5 were transferred to a sand/soil mixture (moistened with 10% water by volume). Subsequent treatment of larvae is described in the section on results.

Results.—All 20 larvae of *Linsleya convexa* given pollen died in the T phase, evidently without feeding. Seventeen became mired in the pollen and apparently drowned on day 1; two did so on day 2. On day 3 the lone survivor was transferred to a larger tube (8 mm inner diameter) with a fresh pollen ball of medium consistency in which a small amount of honey had been incorporated. This larva survived 31 days in rearing. The length of the survival period might be interpreted as evidence that the larva was obtaining some nourishment from the pollen ball. However, some of the T larvae of *L. convexa* studied by Selander and Pinto (1967) lived as long as 23 days at 27°C without feeding, and some of those of *L. sphaericollis* studied by Church and Gerber (1977) survived without food for 4–7 weeks on moist soil at 20°C.

Seven of the nine larvae of *L. convexa* given *Melanoplus* eggs died in the T phase, without feeding, in a mean of 13.1 (1.78) days (range 8–22). One larvae (#1, a female), after transfer to 35°C, began feeding on an egg on day 10; reached instars FG_2, FG_3, FG_4, and FG_5 on days 11, 13, 15, and 17, respectively; was transferred to sand/soil on day 22; and ecdysed to C_6 on day 27. A day later it was returned to 27°C. Another larva (#2, a male), which remained at 27°C, began feeding on day 2; reached instars FG_2, FG_3, FG_4, and FG_5 on days 5, 7, 9, and 12, respectively; was transferred to sand/soil on day 17; and ecdysed to instar C_6 on day 23.

In the FG phase both larvae produced a feces of paste-like consistency which was spread over the grasshopper eggs and on the sides of the glass tubes as droplets. In FG_5 both larvae excavated a cell in the sand/soil in which they became motionless two days before ecdysis occurred.

On day 176 of the experiment the two C larvae, which were evidently in diapause, were transferred to 8 mm inner diameter tubes and placed at 15°C, 100% RH, in darkness. After 60 days they were returned to 27°C, again at 100% RH in darkness.

Larva #1 broke diapause and entered instar SG_7 19 days after chilling ended (day 255), pupated five days later (day 260), and reached the adult stage 10 days after that (day 271). The adult was perfectly formed and of exceptionally large size (length, to end of elytra, 15 mm; cf. Selander, 1955). Larva #2 was killed 871 days after chilling ended (day 1107), at which time I found that it had molted, at some time during the post-chilling period, to instar C_7 inside the C_6 skin. The occurrence of two consecutive instars in the coarctate larval phase was recorded previously in *Pyrota palpalis* Champion by Selander and Mathieu (1964).

Discussion.—The results of the experiment are consistent with the rearing attempts of Church and Gerber (1977) in two major respects. First, it is now established that the larva of *Linsleya convexa,* like that of *L. sphaericollis,* is capable of developing to the adult stage on a diet of the eggs of *Melanoplus* grasshoppers. Second, as in the case of *Linsleya sphaericollis,* only a small proportion of *L. convexa* larvae provided with *Melanoplus* eggs in the laboratory respond positively to them.

In Church and Gerber's (1977) rearing of *Linsleya sphaericollis* on the eggs of *Melanoplus sanguinipes* and *M. bivittatus,* 16(4.3%) of 370 T larvae fed, 12 (3.2%) reached FG_2, and 8 (2.2%) reached FG_5. Five of the FG_5 larvae "lived 4 to 10 weeks at 20°C after they stopped feeding, but remained unchanged"; the fate of the remaining three was not mentioned. Peterson, in an unpublished study cited by Church and Gerber, obtained 31 FG larvae from 240 T larvae given food (12.9%); the percentage of success might have been higher had he reared each of the larvae individually, rather than placing 1–5 in a vial. Two of the FG larvae lived until at least day 76 of his rearing. In addition, a dead adult was found on day 76 among material kept at 29°C, having "evidently pupated directly from the fifth instar [FG_5]" (Church and Gerber, 1977).

A possible explanation for the poor feeding response obtained in the laboratory for both species of *Linsleya* is suggested by the exceptionally long survival period of T larvae under starvation, mentioned above. Comparable longevity is charactersitic of T larvae of *Epicauta pennsylvanica* (DeGeer) from Illinois and Mississippi (Selander, unpublished data). Moreover, larvae of this species, like those of *Linsleya,* are very unlikely to feed in the first few weeks following eclosion. In this case it can be shown that the newly eclosed T larvae are in a behavioral diapause state. A procedure that I have found effective in rearings of *E. pennsylvanica* is to chill newly eclosed T larvae for two months at 5°C. It might be interesting to see the effect of this or a similar treatment on the feeding response of T larvae of *Linsleya.*

Church and Gerber (1977) concluded that their and Peterson's FG_5 larvae of *Linsleya sphaericollis* that survived for several weeks were in diapause when they died and that "hypnothecal" (C) and "non-vorant" (SG) phases of the larval stage "probably seldom or never occur in this species." Further, they speculated that in nature larvae overwinter in instar FG_5, pupate directly from that instar in spring, and emerge as adults a few weeks later. Not only that, since the FG_5 larvae are "much less resistant to desiccation than [coarctate larvae] and likely could not survive more than one winter, a 1-year life cycle is indicated"!

This is highly imaginative ecology and, for all I know, may be true. But on the basis of the actual evidence, it is hardly to be taken seriously. The failure of the larvae of *L. sphaericollis* to develop beyond the FG phase may have been simply the result of lack of access to soil of proper moisture content (whether any soil was available to them in Church and Gerber's rearing is not stated). Although some Lyttini can complete the FG phase without access to moist soil, in my experience it is an absolute necessity for species of *Epicauta*. Nor can the possibility of disease or nutritional inadequacy of the food be ruled out. But in any event, arrested development is, by itself, hardly proof of diapause, especially when it terminates in death.

If, as Church and Gerber report, Peterson's adult did not pass through the C phase of larval development, this in itself may be taken as good evidence for regarding *Linsleya* as an epicautine genus, since the abbreviated pattern T-FG-P-A has been recorded previously only in members of the genus *Epicauta* (Selander and Weddle, 1969). However, no species of the subfamily Meloinae is known to diapause in the FG larval phase and no species of Meloidae is known to follow only the abbreviated ontogenetic pattern, and it was at best ingenuous, considering the fragmentary nature of their information, for Church and Gerber to suggest that *Linsleya sphaericollis* does so.

ANATOMY

The triungulin (T_1) larva of *Linsleya convexa* was described and illustrated by MacSwain (1956). Some anatomical features of the FG_2, FG_5, C_6, and SG_7 larva and of the pupa are noted below. The descriptions are limited to characters which, in my experience, vary significantly among genera and other higher taxa of Meloidae. Except in the case of the C_6 larva, they are based on exuvia.

FG_2 larva.—Cuticle sparsely but conspicuously clothed throughout with relatively long, slender setae. Spiracles lateral. Labrum rectangular, with anterior margin straight and with 8 setae in median transverse row. Mandible (Fig. 1a) with a series of 9–10 vestigial, blunt teeth on mesodorsal margin, terminating basad in a large, prominent, triangular tooth; mandibular setae

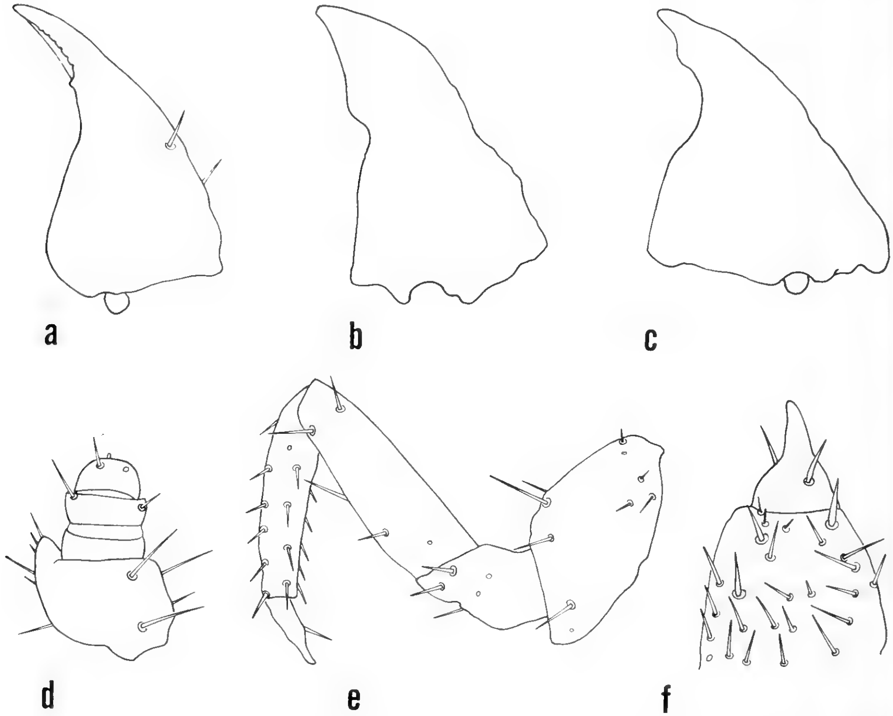

Fig. 1. *Linsleya convexa.* a, Right mandible of FG$_2$ larva, dorsal view. b, Right mandible of FG$_5$ larva, dorsal view. c, Right mandible of SG$_7$ larva, dorsal view. d, Left maxilla of FG$_2$ larva, ventral view. e, Right leg II of FG$_2$ larva, anterior view. f, Tibia and tarsungulus III of FG$_5$ larva, anterior view.

equal in length. Antennal segment III about $^3/_{10}$ as long as II, with terminal seta $2^1/_3\times$ as long as III; II bent, with sensory appendix rounded, button-like, lateral. Maxilla (Fig. 1d) with mala prominent, glabrous ventrally, with several setae dorsally; palpus retaining orbicular form much as in T$_1$. Labial palpus with segment II tapered, as long as I. End of abdomen with a row of 4 long setae of equal length. Leg (Fig. 1e) elongate, rather heavy, with a definite pattern of setation; coxa prominent; tibia about $1^1/_5\times$ as long as femur; tarsungulus ¼ as long as tibia, bearing a single seta.

FG$_5$ larva.—Cuticle relatively densely, very conspicuously clothed with setae, most of which are heavy and rather short. Mandible (Fig. 1b) much more massive than in FG$_2$, lacking teeth. Antennal segment III less than ¼ as long as II, less than ⅓ as wide, with terminal seta about as long as III; II $^3/_5$ as wide as long, with sensory appendix terminal, slightly wider than III. Maxilla with mala massive, sparsely setate ventrally, densely so dorsally;

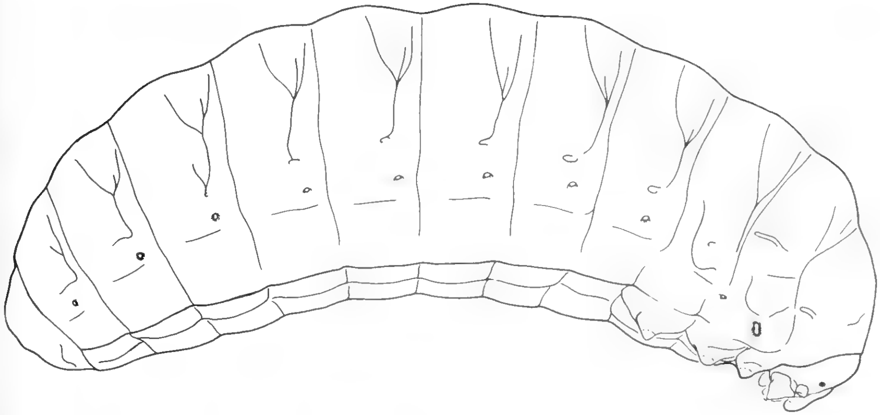

Fig. 2. C_6 larva of *Linsleya convexa*.

palpus not so orbicular as in FG_2. Labial palpus less elongate than in FG_2. Leg (Fig. 1f) heavy, relatively short, densely setate; tarsungulus well developed, bearing 2 setae.

C_6 larva (Fig. 2).—Subnavicular, slightly curved, lacking lateral ridge on abdomen. Cuticle uniform light brown in color, uniformly pebbled, completely lacking striae. Mandible stubs acute. Spiracular cones small, not at all bulbous or sagged posteriad; spiracular openings very small. Dorsal line of dehiscence well developed and complete on thoracic segments and abdominal segments I–VI.

SG_7.—Similar to FG_5. Mandible (Fig. 1c) much wider, with a chisel-like flange on mesal margin. Antenna, maxillary palpus, and labial palpus somewhat shorter; antennal segment III flattened, at least in exuvia hardly distinguishable as a separate segment. Leg lacking tarsungulus.

Pupa (P_8).—Propping spines conspicuous, each with a spinelike seta at apex; 4 small spines on head; 10 (6 very large) on pronotum; none on meso- and metathorax; 4 (2 large) on abdominal segment I, 6 on II–VII, 4 (small) on VIII.

Remarks.—With respect to the conspicuous setation of the body and the leg structure in FG_2 and the distribution of propping spines in the pupa (absent on mesothorax, few in number and strictly dorsal on abdomen), *Linsleya convexa* is more epicautine than lyttine. However, it differs strikingly from *Epicauta*, and at the same time agrees with the Lyttina and Pyrotina, in most of the characters of the coarctate larva mentioned above.

In view of the paucity of published work on the comparative anatomy of immature meloids other than the triungulin larva, it is difficult to interpret the curious mixture of lyttine and non-lyttine characteristics found in *Lin-*

sleya. It is, however, apparent that there is little about the genus that is specifically epicautine. Since grasshoppers eggs are the typical prey-type of larval Mylabrina (MacSwain, 1956), as well as of *Epicauta*, even positive proof that *Linsleya* utilizes this prey-type in nature would not constitute definitive evidence that the genus is epicautine. Pinto (1974) claimed to find special similarity in patterns of courtship of *Linsleya* and *Epicauta*, but his treatment was based on a decidedly restricted survey of the range of behavioral variation in the tribe Lyttini, and I fail to find his argument convincing. Indeed, it would appear that the only unequivocal basis for including *Linsleya* in the Epicautina is the characteristic originally cited by MacSwain (1951): the presence of lanceolate setae on the legs of the T larva. An alternative interpretation, and one apparently not considered heretofore, would be to place *Linsleya* in a separate subtribe, allied to the Epicautina and Mylabrina, at least phenetically, on bionomic grounds.

Acknowledgments

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Literature Cited

Church, N. S. and G. H. Gerber. 1977. The development and habits of *Linsleya sphaericollis* (Coleoptera: Meloidae). Can. Entomol. 109: 375–380.

Criddle, N. 1931. Grasshopper control in Canada east of the Rocky Mountains. Can. Dep. Agric. Bull. 143(n.s.), 18 pp.

MacSwain, J. W. 1951. A new genus of Meloidae from North America. Pan-Pac. Entomol. 27: 58.

———. 1956. A classification of the first instar larvae of the Meloidae (Coleoptera). Univ. Calif. Publ. Entomol. 12, 182 pp.

Pinto, J. D. 1974. Courtship behavior in *Linsleya compressicornis* and its taxonomic significance (Coleoptera: Meloidae). Pan-Pac. Entomol. 50: 1–8.

Romanov, W. 1954. Predators of grasshoppers. Proc. Entomol. Soc. Manit. 9: 14–18.

Selander, R. B. 1955. The blister beetles genus *Linsleya* (Coleoptera, Meloidae). Am. Mus. Novit. 1730, 30 pp.

———. 1964. The systematic position of the genus *Linsleya* (Coleoptera: Meloidae). Proc. Entomol. Soc. Wash. 66: 216.

Selander, R. B. and J. M. Mathieu. 1964. The ontogeny of blister beetles (Coleoptera, Meloidae). I. A study of three species of the genus *Pyrota*. Ann. Entomol. Soc. Am. 57: 711–732.

Selander, R. B. and J. D. Pinto. 1967. Sexual behavior in blister beetles (Coleoptera: Meloidae) II. *Linsleya convexa*. J. Kans. Entomol. Soc. 40: 396–412.

Selander, R. B. and R. C. Weddle. 1969. The ontogeny of blister beetles (Coleoptera, Meloidae). II. The effects of age of trungulin larvae at feeding and temperature on development in *Epicauta segmenta*. Ann. Entomol. Soc. Am. 62: 27–39.

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THE PERLODINAE OF VIRGINIA, USA (PLECOPTERA: PERLODIDAE)

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Abstract.—The taxonomy and distribution of the adult Perlodinae of Virginia, USA, are reviewed. The ten species occurring in the state are illustrated, and keys separating adult males and females are provided. Biological notes are also given for each species.

Ten species of Perlodinae were recorded by Kondratieff and Voshell (1979a) from Virginia. Ricker (1952) revised the species of Perlodinae of North America and subgenera of the world. He placed the species that we discuss in this paper in several subgenera of the genus *Isogenus*. Illies (1966) elevated all Ricker's subgenera to full generic rank. Since Ricker's work two new species that occur in the eastern United States have been described (Stark and Gaufin, 1974; Kondratieff and Voshell, 1979b). The purpose of this paper is to provide comprehensive and up-to-date taxonomic descriptions and keys to the species of Perlodinae that occur in Virginia and surrounding states. In addition, we have included biological information on the species.

Virginia (Fig. 1) is divided into five physiographic provinces (Hoffman 1969). These provinces range in elevation from sea level to 1743 m. This allows for a considerable faunal diversity to exist. Generally the members of the Perlodinae are restricted to clear, cool, fast flowing montane streams. Of the ten species of Perlodinae that occur in Virginia, seven are apparently restricted to the montane Ridge and Valley, and Blue Ridge provinces. Only *Diploperla duplicata* (Banks), *Helopicus subvarians* (Banks), and *Remenus bilobatus* (Needham and Claassen) have a wider distribution that includes the Piedmont Plateau Province.

Adults are not commonly collected in the field, but may be collected occasionally by sweeping riparian vegetation. In this study we obtained most adult specimens by rearing field collected nymphs.

The following key, primarily using genitalic characters, will separate males

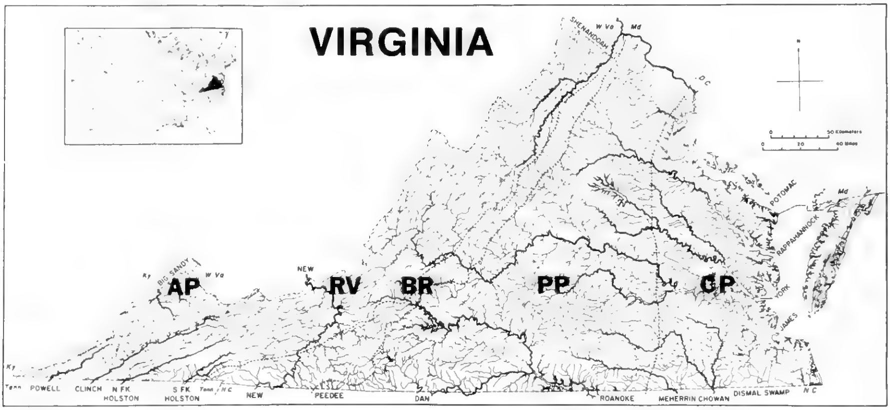
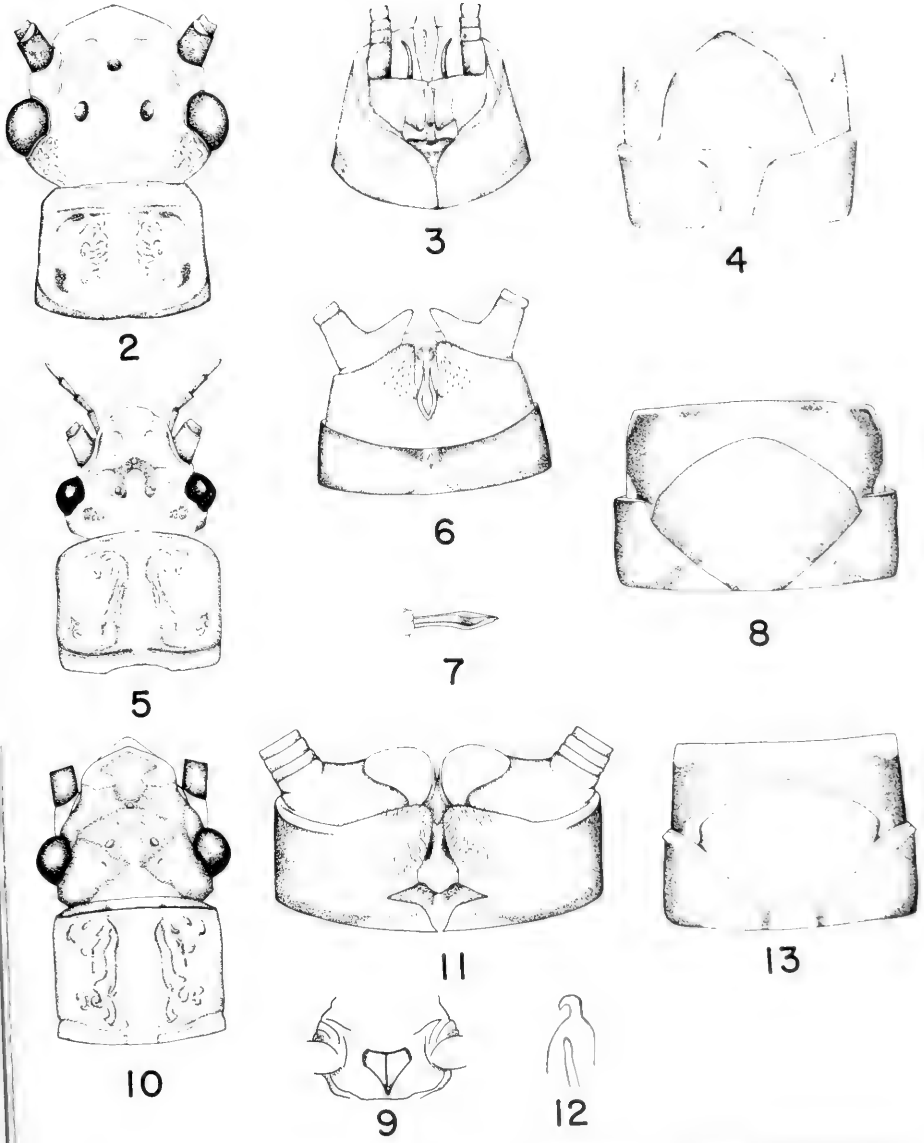


Fig. 1. Physiographic provinces of Virginia (according to Hoffman, 1969). CP = Coastal Plain; PP = Piedmont Plateau; BR = Blue Ridge; RV = Ridge and Valley; AP = Appalachian Plateau.

of the Virginia Perlodinae. Females are separable using head pattern combined with the form of the subgenital plate.

Key to the Species of Virginia Perlodinae

1. Tenth tergum completely cleft, subgenital plate absent from 8th sternum, male 2
– Tenth tergum entire; subgenital plate present on 8th sternum, female 11
2. A median mesosternal ridge present (Fig. 9); submental gills long; epiproct hooked at apex (Fig. 12) .... *Isogenoides hansoni* (Ricker)
– Median mesosternal ridge absent; submental gills short or apparently absent; epiproct not hooked at apex 3
3. Lateral stylets present (Figs. 3, 30) 4
– Lateral stylets absent (Figs. 6, 19) 8
4. Lateral stylets exceeding apex of epiproct by more than ⅔ of their length 5
– Lateral stylets exceeding apex of epiproct by no more than ½ of their length 7
5. Apex of lateral stylets distinctly 2-pronged (Fig. 34) .... *Diploperla morgani* Kondratieff and Voshell
– Apex of lateral stylets acute or somewhat truncate (foot-shaped) 6
6. Apex of lateral stylets somewhat truncate or foot-shaped (Fig. 31) .... *Diploperla duplicata* (Banks)



Figs. 2–13. 2–4, *Cultus decisus*. 5–8. *Helopicus subvarians*. 9–13, *Isogenoides hansoni*. 2, 5, 10, Adult head and pronotum. 3, 6, 11, Male terminalia, dorsal. 4, 8, 13, Female subgenital plate, ventral. 7, 12, Epiproct, lateral. 9, Mesosternum.

– Apex of lateral stylets acute (Fig. 37) .... *Diploperla robusta* Stark and Gaufin

7(4). Lateral stylets broad, tips distinctly hooked; epiproct covered with golden-brown setae (Figs. 15, 16) .... *Malirekus hastatus* (Banks)

– Lateral stylets slender, tips straight; epiproct not covered with setae (Fig. 3) .... *Cultus decisus* (Walker)

8(3). Epiproct terminating in a reversible threadlike "lash"; total body length 8–9 mm (Fig. 26) .... *Remenus bilobatus* (Needham and Claassen)

– Epiproct not terminating in a threadlike structure but apex bulbous or acute; body length 15–17 mm 9

9. Apex of epiproct bulbous, subcylindrical (Fig. 23) .... *Yugus bulbosus* (Frison)

– Apex of epiproct acute 10

10. Pronotum without lateral yellow spots (Fig. 5) .... *Helopicus subvarians* (Banks)

– Pronotum with lateral yellow spots (Fig. 18) .... *Yugus arinus* (Frison)

11. Mesosternal ridge on mesothorax present (Fig. 9); submental gills long .... *Isogenoides hansoni* (Ricker)

– Mesosternal ridge on mesothorax absent; submental gills short of apparently absent 12

12(11). Subgenital plate with a deep medial emargination or rounded notch (Figs. 17, 24) 13

– Subgenital plate entire or slightly emarginate (Figs. 28, 35) 14

13(12). Dorsal head pattern distinct, ocellar triangle with a spear shaped pale area (Fig. 14); subgenital plate with wide shallow rounded median notch (Fig. 17) .... *Malirekus hastatus* (Banks)

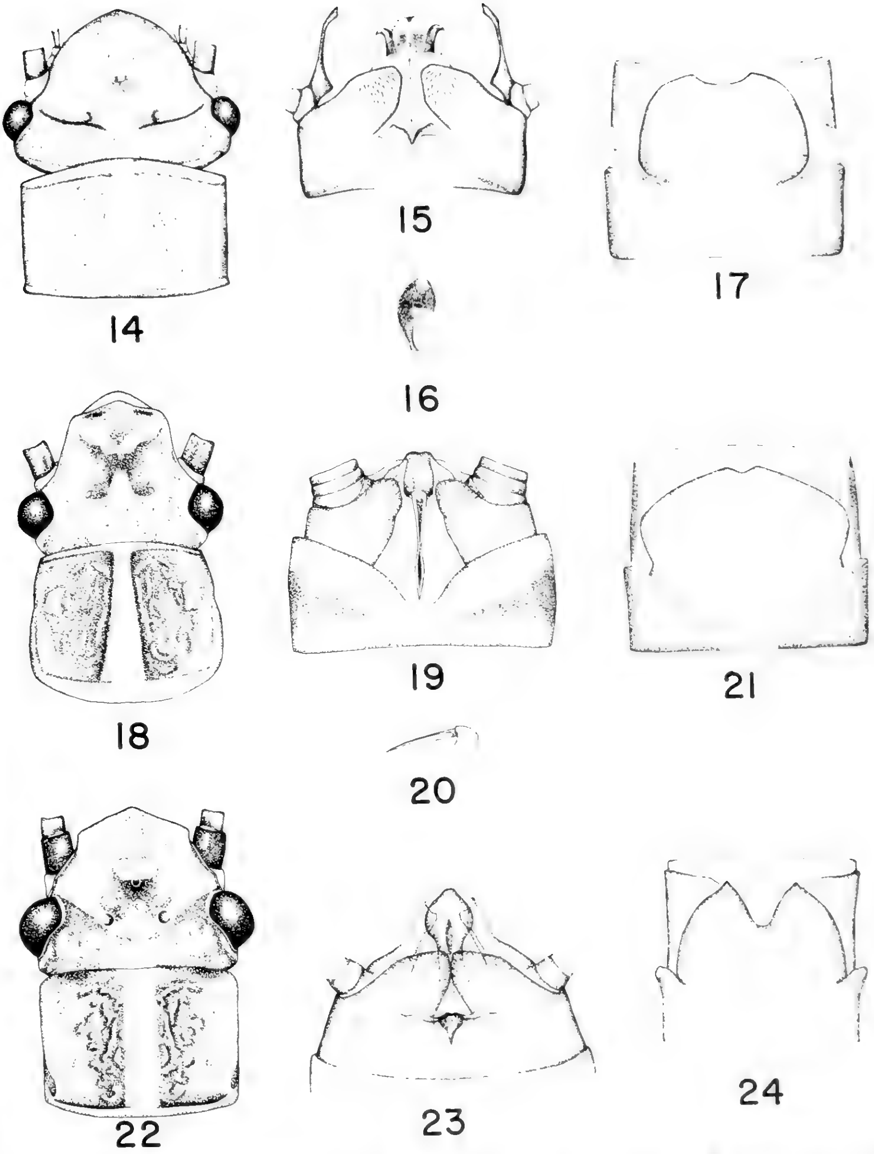
– Dorsal head pattern indistinct, with diffuse pale area (Fig. 22); subgenital plate with deep median notch, broadest distally (Fig. 24) .... *Yugus bulbosus* (Frison)

14(12). Subgenital plate slightly emarginate 15

– Subgenital plate entire 16

15. Dorsal head pattern with dark transverse band across ocelli (Fig. 33); pronotum without lateral yellow spots; subgenital plate somewhat truncate and usually slightly emarginate (Fig. 35). . ... *Diploperla morgani* Kondratieff and Voshell

– Dorsal head pattern with two dark patches posterior to ocelli (Fig. 18); pronotum with lateral yellow spots; subgenital plate rounded and usually expanded laterally and narrowly emarginate (Fig. 21) .... *Yugus arinus* (Frison)



Figs. 14–24. 14–17, *Malirekus hastatus*. 18–21, *Yugus arinus*. 22–24. *Y. bulbosus*. 14, 18, 22, Adult head and pronotum. 15, 19, 23, Male terminalia, dorsal, 16, 20, Epiproct, lateral. 17, 21, 24, Female subgenital plate, ventral.

16. Total body length 8–9 mm; dorsal head pattern with ocellar triangle uniformly pigmented and with areas of pigment gently curving anteriorly (Fig. 25) .... *Remenus bilobatus* (Needham and Claassen)
– Total body length 15–17 mm; dorsal head pattern with ocellar triangle either partially unpigmented (Figs. 2, 5), uniformly pigmented with diffuse pigment forming pointed areas anteriorly (Fig. 29) or with a pale spot in front of anterior ocellus (Fig. 36). 17
17. Apical margin of subgenital plate narrowly rounded; dorsal head pattern with a dark M-shaped band connecting ocelli .... *Cultus decisus* (Walker)
– Apical margin of subgenital plate broadly rounded; dorsal head pattern without a dark M-shaped band connecting ocelli 18
18. Dorsal head pattern with a cone-shaped pale area in the ocellar triangle (Fig. 5); subgenital plate broadly rounded to slightly truncate (Fig. 8) .... *Helopicus subvarians* (Banks)
– Dorsal head pattern with ocellar triangle either uniformly pigmented with diffuse pigment forming pointed areas anteriorly (Fig. 29) or with a pale spot in front of anterior ocellus (Fig. 36) 19
19. Dorsal head pattern with ocellar triangle uniformly pigmented with diffuse pigment forming pointed areas anteriorly (Fig. 29); subgenital plate with sides usually subparallel (Fig. 32); general body color light brown to yellow ... *Diploperla duplicata* (Banks)
– Dorsal head pattern with a pale spot in front of anterior ocellus (Fig. 36); subgenital plate with sides usually broadly rounded (Fig. 38); general body color dark brown .... *Diploperla robusta* Stark and Gaufin

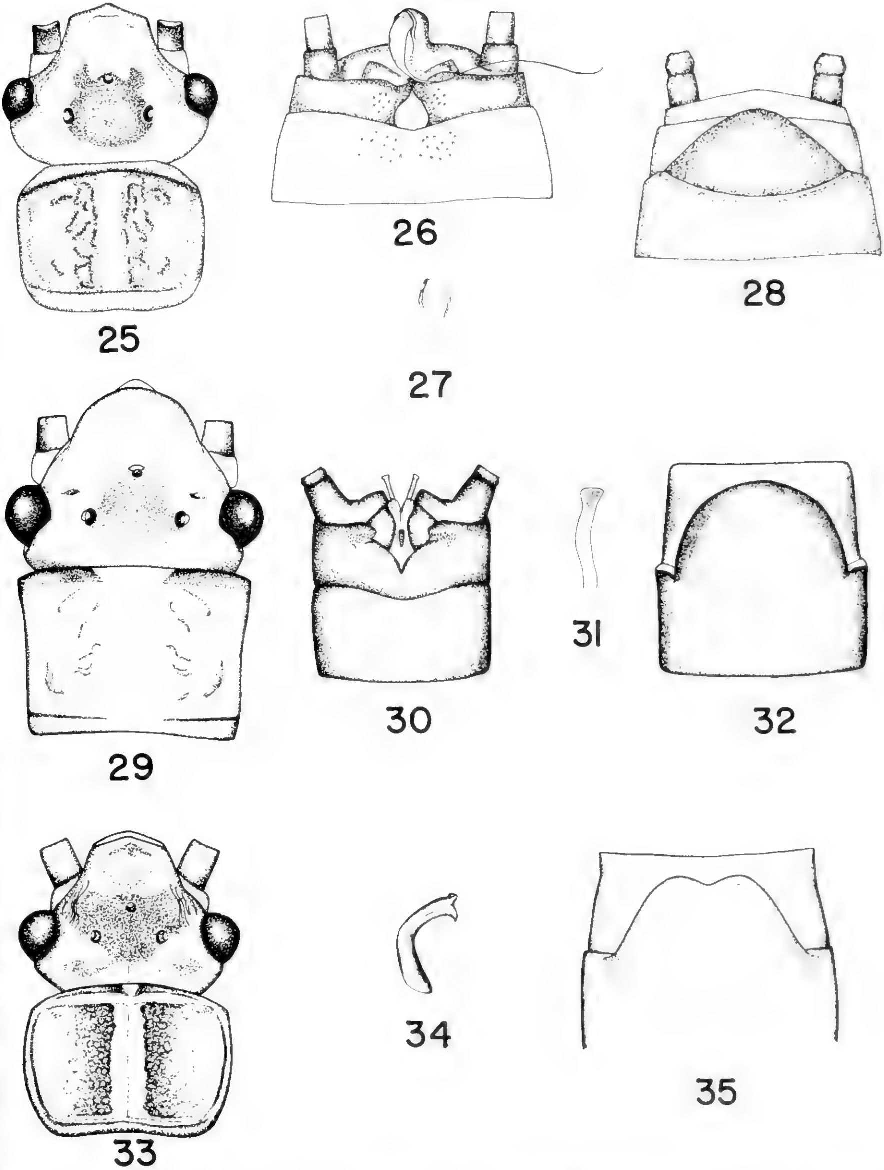
Cultus decisus (Walker)

Figs. 2–4

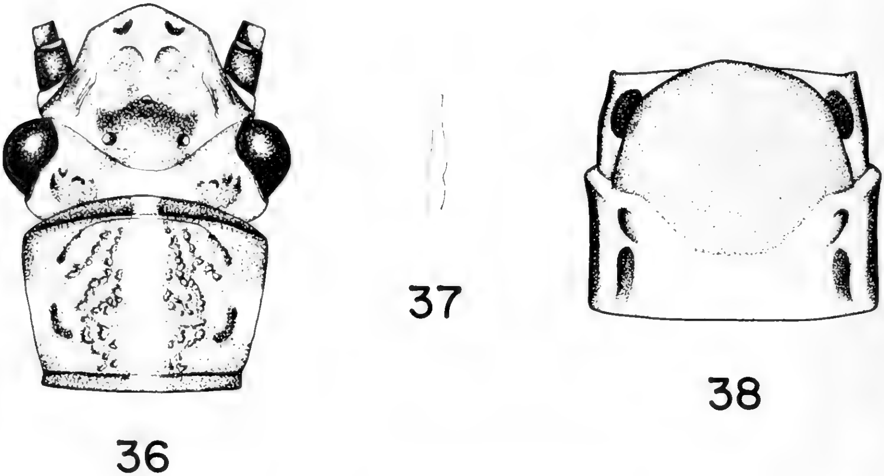
Perla decisa Walker, 1852: 170. Type-locality, St. Martin's Falls, Albany River, Ontario, Canada.
Isogenus (*Cultus*) *decisus,* Ricker 1952: 97.
Cultus decisus (Walker), Illies, 1966: 356.

Male.—Length of forewing 12–13 mm; length of body 12–13 mm. General body color in alcohol brown. Head and prothorax marked with pale yellow (Fig. 2). Wings hyaline; veins dark brown. Lateral stylets slender and acute; epiproct prominent and swollen near tip (Fig. 3).

Female.—Length of forewing 13–14 mm; length of body 13–14 mm. Color



Figs. 25–35. 25–28, *Remenus bilobatus*. 29–32, *Diploperla duplicata*. 33–35, *D. morgani*. 25, 29, 33, Adult head and pronotum. 26, 30, Male terminalia, dorsal. 27, Epiproct, lateral. 28, 32, 35, Female subgenital plate, ventral. 31, 34, Lateral stylet, lateral.



Figs. 36–38. *Diploperla robusta*. 36, Adult head and pronotum. 37, Lateral stylet, lateral. 38, Female subgenital plate, ventral.

pattern and external morphology similar to male. Subgenital plate produced to 10th sternum (Fig. 3); apical margin narrowly rounded.

Nymph.—Described by Claassen (1931) as *Perla verticalis* Banks.

Number of adults examined.—32♂, 8♀.

Geographic Range.—Eastern North America.

Distribution in Virginia.—Counties: Carroll, Craig, Floyd, Giles, Montgomery, Smyth, Washington.

In Virginia, adults were collected during May, usually from medium size 2nd and 3rd order montane streams. Adults are attracted to light.

Helopicus subvarians (Banks)

Figs. 5–8

Perla subvarians Banks, 1920: 317. Type-locality, Great Falls, Va.
Hydroperla subvarians, Frison, 1942: 292.
Isogenus (*Helopicus*) *subvarians*, Ricker, 1952: 103.
Helopicus subvarians, Illies, 1966: 361.

Male.—Length of forewing 15–16 mm; length of body 16–17 mm. General body color brown. Head and prothorax marked with pale yellow (Fig. 5). Wings hyaline with some tinting of membrane; veins black. Lateral stylets absent (Fig. 6). Epiproct tapering to an acute apex (Fig. 7).

Female.—Length of forewing 19–20 mm; length of body 19–20 mm. Color pattern and external morphology similar to male. Subgenital plate rounded to slightly truncate produced over ½ of sternum 9 (Fig. 8).

Nymph.—Described by Ricker (1952).

Number of adults examined.—19♂, 34♀.

Geographic range.—Eastern North America.

Distribution in Virginia.—Counties: Alleghany, Appomattox, Caroline, Carroll, Fairfax, Floyd, Giles, Grayson, Hanover, Henry, Louisa, Montgomery, Nottoway, Pulaski, Roanoke, Rockbridge, Smyth, Washington, Wythe.

This common species apparently prefers large streams with cobble and coarse pebble substrate, having been collected from 4th to 6th order rivers from the Ridge and Valley Province into the Piedmont Province. Adults may be collected from March to May. A large ovipositional flight of several hundred females was observed 2 May 1980 at the Appomattox River from 5:45 PM to 6:30 PM. Females were coming from nearby trees and descending 8 to 10 m in a "fluttering glide" each dipping its abdomen in riffle areas and releasing an egg pack of 75 to 100 eggs.

Isogenoides hansoni (Ricker)

Figs. 9–13

Isogenus (*Isogenoides*) *hansoni* Ricker, 1952: 111. Type-locality, Broadhead Creek, Analomink, Pa.

Isogenoides hansoni, Illies, 1966: 365.

Male.—Length of forewing 15–16 mm; length of body 16–17 mm. General body color in alcohol black. Head and prothorax marked with yellow (Fig. 10). Submental gills long. Wings hyaline to slightly smoky; veins black. Median mesosternal ridge present. Lobes of 10th tergum yellow. Lateral stylets slender, slightly flattened with acute tip not exceeding epiproct (Fig. 11). Epiproct with tip recurved with apical hook (Fig. 12).

Female.—Length of forewing 20–21 mm; length of body 21–22 mm. Color pattern and external morphology similar to male. Subgenital plate produced ⅓ to ½ length of 9th sternum (Fig. 13); apical margin broadly rounded to arcuate.

Nymph.—Described by Ricker (1952).

Number of adults examined.—12♂, 25♀.

Geographic range.—Eastern North America.

Distribution in Virginia.—Counties: Giles, Madison, Nelson, Smyth, Washington.

This is one of the rarest Perlodinae in the state. A large population occurs in Little Stony Creek, St. Rt. 460 in Giles County. Other nymphs and adults were collected from clear, cool, and fast flowing Ridge and Valley 2nd to 3rd order "trout" streams. Adults were active from April to June.

Malirekus hastatus (Banks)

Figs. 14–17

Isogenus hastatus Banks, 1920: 314. Type-locality, Andrews, N.C.

Isogenus (*Malirekus*) *hastatus*, Ricker, 1952: 117.
Malirekus hastatus, Illies, 1966: 369.

Male.—Length of forewing 18–19 mm; length of body 18–20 mm. General body color in alcohol dark brown. Head and prothorax marked with pale yellow (Fig. 14). Wings slightly smoky, veins dark brown. Lateral stylets hooked at tip; epiproct densely covered with golden-brown setae (Figs. 15, 16).

Female.—Length of forewing 19–20 mm; length of body 19–20 mm. Color pattern and external morphology similar to male. Subgenital plate produced ⅔ length of 9th sternum and deeply emarginate medially (Fig. 17).

Nymph.—Described by Claassen (1931).

Number of adults examined.—21♂, 24♀.

Geographic range.—Eastern North America.

Distribution in Virginia.—Counties: Albemarle, Alleghany, Augusta, Giles, Grayson, Floyd, Highland, Madison, Montgomery, Nelson, Patrick, Roanoke, Rockingham, Smyth, Tazewell, Washington, Wythe.

This species is very abundant in 1st to 3rd order streams in the Ridge and Valley and the Blue Ridge Provinces of Virginia. Adults are active from April to early June.

Yugus arinus (Frison)

Figs. 18–21

Diploperla arina Frison, 1942: 309. Type-locality, Balsam, N.C.
Isogenus (*Yugus*) *arinus*, Ricker, 1952: 124.
Yugus arinus, Illies, 1966: 380.

Male.—Length of forewing 16–17 mm; length of body 17–18 mm. General body color in alcohol brown. Head and prothorax marked with pale yellow (Fig. 18). Wings hyaline; veins dark brown. Lateral stylets absent (Fig. 19). Epiproct with tip slender and acute, transversely flattened (Fig. 20).

Female.—Length of forewing 19–20 mm; length of body 18–19 mm. Color pattern and external morphology similar to male. Subgenital plate produced ⅔ length of 9th sternum (Fig. 21); with a shallow apical emargination.

Nymph.—Described by Frison (1942).

Number of adults examined.—10♂, 21♀.

Geographic range.—N.C., Tenn., Va.

Distribution in Virginia.—10♂, 20♀, Giles Co., Little Stony Creek, U.S. 460, Pembroke, 11 April 1979, July, B. C. Kondratieff; 1♀, Rappahannock Co., Shenandoah National Park, Big Devils Stairs, 2 May 1976, O. S. Flint, Jr.

This very rare stonefly has been collected in April and May from small, clear, cool fast-flowing streams. Other Perlodidae collected in association with *Y. arinus* were *Cultus decisus*, *Isogenoides hansoni*, and *Isoperla namata* Frison. Female subgenital plate form varies from Frison's (1942) figure to Fig. 21, with the latter apparently more common.

Yugus bulbosus (Frison)

Figs. 22–24

Diploperla bulbosa Frison, 1942: 307. Type-locality, Greenbrier Cove, Tenn.
Isogenus (*Yugus*) *bulbosus*, Ricker, 152: 124.
Yugus bulbosus, Illies, 1966: 380.

Male.—Length of forewing 16–17 mm; length of body 16–17 mm. General body color in alcohol brown. Head marked with some yellow (Fig. 22). Wings hyaline; veins brown. Lateral stylets absent. Epiproct with tip swollen, subcylindrical (Fig. 23).

Female.—Length of forewing 16–17 mm; length of body 17–18 mm. Color pattern and external morphology simlar to male. Subgenital plate produced ⅔ length of 9th sternum (Fig. 24) with a deep medial emargination.

Nymph.—Described by Frison (1942).

Number of adults examined.—6 ♂, 4 ♀.

Geographic range.—N.C., Pa., Tenn., Va., W. Va.

Distribution in Virginia.—Counties: Grayson, Patrick, Smyth, Tazewell.

Nymphs have been collected and reared from spring-fed intermittent streams in Tazewell County (Burkes Garden) to several large, permanent, clear, cool and fast-flowing streams in Grayson, Patrick, and Smyth counties. Adults are active during April and May. Adults and nymphs of *Y. arinus* and *Y. bulbosus* are very distinct and readily separable.

Remenus bilobatus (Needham and Claassen)

Figs. 25–28

Perla bilobata Needham and Claassen, 1925: 95. Type-locality, Old Forge, N.Y.
Isogenus (*Remenus*) *bilobatus*, Ricker, 1952: 123.
Remenus bilobatus, Illies, 1966: 376.

Male.—Length of forewing 8–9 mm; length of body 8–9 mm. General body color in alcohol light brown. Head and prothorax marked darker brown (Fig. 25). Wings hyaline; veins light brown. Lateral stylets absent. Epiproct terminating in a long threadlike lash (Figs. 26, 27).

Female.—Length of forewing 10–11 mm; length of body 9–10 mm. General color pattern and external morphology similar to male. Subgenital plate produced ½ length of 9th sternum (Fig. 28); apical margin broadly rounded.

Nymph.—Described by Claassen (1931) and Frison (1942).

Number of adults examined.—7 ♂, 4 ♀.

Geographic range.—Eastern North America.

Distribution in Virginia.—Counties: Bland, Culpeper, Floyd, Grayson, Montgomery, Roanoke, Rockbridge, Smyth, Wythe.

This uncommon small species has been collected in late June and early July from small spring-fed head-water streams to medium-size 5th and 6th order rivers.

Diploperla duplicata (Banks)

Figs. 29–32

Perla duplicata Banks, 1920: 316. Type-locality, Newington, Fairfax Co., Va.

Isogenus (*Diploperla*) *duplicatus,* Ricker, 1952: 100. In part.

Diploperla duplicata, Illies, 1966: 359. In Part.

Diploperla duplicata, Stark and Gaufin, 1974: 435.

Male.—Length of forewing 10–11 mm; length of body 9–10 mm. General body color in alcohol yellow; head and prothorax darker yellow-brown (Fig. 29). Wings hyaline; veins yellow-brown. Tips of lateral stylets foot-shaped (Figs. 30, 31).

Female.—Length of forewing 12–13 mm; length of body 11–12 mm. Color pattern and external morphology similar to male. Subgenital plate ⅔ length of 9th sternum (Fig. 32); sides somewhat subparallel, apical margin rounded.

Nymph.—Described by Kondratieff et al. (1981).

Number of adults examined.—5♂, 6♀.

Geographic range.—Ga, S.C., Tenn., Va., W. Va.

Distribution in Virginia.—Counties: Bedford, Fairfax, Henry, Patrick, Pittsylvania, Smyth.

This species has been collected in April and May from small creeks to 5th order rivers from Ridge and Valley to the Piedmont Plateau Province. Two of the males were collected in a blacklight trap.

Diploperla morgani Kondratieff and Voshell

Figs. 33–35

Diploperla morgani Kondertieff and Voshell, 1979b: 451. Type-locality, Sinking Creek, Giles Co., Va.

Male.—Length of forewing 12–13 mm; length of body 12–13 mm. General body color in alcohol dark yellow; head and prothorax darker brown (Fig. 33). Wings hyaline; veins yellow brown. Tips of lateral stylets 2-pronged (Fig. 34). Epiproct reduced.

Female.—Length of forewing 16–17 mm; length of body 16–17 mm. Color pattern and external morphology similar to male. Subgenital plate ⅔ length of 9th sternum (Fig. 35); apical margin somewhat truncate and slightly emarginate medially and occasionally entire.

Nymph.—Described by Kondratieff et al. (1981).

Number of adults examined.—Besides type-series, 5♂, 8♀.

Geographic range.—Va., W. Va.

Distribution in Virginia.—Specimens in addition to types: 3♂, 5♀ (reared), numerous nymphs, Montgomery Co., Mill Creek, Co. Rt. 785, 15–25 April 1980. B. C. Kondratieff; 1♂, 2♀ (reared) Smyth Co., North Fork Holston River, Co. Rt. 620 near junction Co. Rt. 716, 28 April 1981, B. C. Kondratieff; 1♂, Smyth Co., North Fork Holston River, St. Rt. 42, 9 May 1981, B. C. Kondratieff; 1♀ (reared), 1 nymph, Wythe Co., Reed Creek, St. Rt. 11, 14 May 1977, R. F. Kirchner.

This rare species is known from several 3rd to 4th order clear, cool streams, located in the Ridge and Valley Province. Mill Creek supports good trout populations and has unusually high benthic diversity. Additional nymphs and adults have been examined from several West Virginia localities.

Diploperla robusta Stark and Gaufin

Figs. 36–38

Diploperla robusta Stark and Gaufin, 1974: 434. Type-locality, Union Township, Tuscarawas Co., Ohio.

Isoperla duplicata, Frison, 1935: 499.

Isogenus (*Diploperla*) *duplicatus,* Ricker, 1952: 100. In part.

Diploperla duplicata, Illies, 1966: 359. In part.

Male.—Length of forewing 12–13 mm; length of body 12–13 mm. General body color in alcohol dark yellow to brown. Head and prothorax darker brown (Fig. 36). Wings hyaline; veins brown. Tips of lateral stylets rounded to acute (Fig. 37). Epiproct reduced.

Female.—Length of forewing 14–15 mm; length of body 14–15 mm. Color pattern and external morphology similar to male. Subgenital plate $^2/_3$ length of 9th sternum (Fig. 38); sides broadly rounded, apical margin rounded.

Nymph.—Described by Frison (1935) as *Isoperla duplicata* (Banks) and by Kondratieff et al. (1981).

Number of adults examined.—6♂, 9♀.

Geographic range.—Ind., Ky., Ohio, Pa., Va. W. Va.

Distribution in Virginia.—Counties: Bedford, Craig, Giles, Montgomery, Wythe.

This species has been collected from late April to mid-June from 1st to 4th order streams in the Ridge and Valley and Blue Ridge Provinces.

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LITERATURE CITED

Banks, N. 1920. New neuropteroid insects. Bull. Mus. Comp. Zool. 64: 299–362.

Claassen, P. W. 1931. Plecoptera nymphs of America (north of Mexico). Thomas Say Found. 3: 1–199.

Frison, T. H. 1935. The stoneflies, or Plecoptera, of Illinois. Ill. Nat. Hist. Surv. Bull. 20: 281–471.

———. 1942. Studies of North American Plecoptera, with special reference to the fauna of Illinois. Ill. Nat. Hist. Surv. Bull. 22: 235–355.

Hoffman, R. L. 1969. The insects of Virginia. No. 1. Pt. II. The biotic regions of Virginia. Va. Polytech. Inst. Res. Div. Bull. 48: 23–62.

Illies, J. 1966. Katalog der rezenten Plecoptera. Das Tierreich. 82. Walter de Gruyter and Co., Berlin. 632 pp.

Kondratieff, B. C. and J. R. Voshell, Jr. 1979a. A checklist of the stoneflies (Plecoptera) of Virginia. Entomol. News 90: 241–246.

———. 1979b. A new species of *Diploperla* (Plecoptera: Perlodidae) from Virginia. Ann. Entomol. Soc. Am. 72: 451–453.

Kondratieff, B. C., R. F. Kirchner, and J. R. Voshell, Jr. 1981. The Nymphs of *Diploperla* (Plectopera: Perlodidae). Ann. Entomol. Soc. Am. 74: 428–430.

Needham, J. G. and P. W. Claassen. 1925. A monograph of the Plecoptera or stoneflies of America North of Mexico. Thomas Say Found. 2: 1–397.

Ricker, W. E. 1952. Systematic studies in Plecoptera. Ind. Univ. Publ. Sci. Ser. 18: 1–200.

Stark, B. P. and A. R. Gaufin. 1974. The genus *Diploperla* (Plecoptera: Perlodidae). J. Kans. Entomol. Soc. 47: 433–436.

Walker, F. 1852. Phryganides–Perlides, pp. 136–192. *In* Catalogue of the specimens of neuropterous insects in the collection of the British Museum, I.

PROC. ENTOMOL. SOC. WASH.
84(4), 1982, pp. 775–780

EVIDENCE FOR REPRODUCTIVE ISOLATION BETWEEN *XESTIA ADELA* FRANCLEMONT AND *XESTIA DOLOSA* FRANCLEMONT (LEPIDOPTERA: NOCTUIDAE)

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Abstract.—Males of the sibling species *Xestia adela* Franclemont and *X. dolosa* Franclemont respond preferentially to conspecific virgin females in numbers that indicate the presence of specific differences in sex pheromones. No fertile eggs were obtained from laboratory crosses between the species, although some mating occurred.

The results of pheromone studies within the species complex that includes the Eurasian *Xestia c-nigrum* (L.) and the North American *Xestia adela* Franclemont and *Xestia dolosa* Franclemont require some further investigation when considered with relationships proposed on the basis of morphological and genetic characters (Franclemont, 1980; Hudson and Lefkovitch, 1982).

Bestman et al. (1979) have shown that *X. c-nigrum* (as *Amathes c-nigrum*) in the vicinity of Frankfurt, West Germany are attracted to cis-7-tetradecenyl acetate. Similarly in Hokkaido, Japan, Fujimara (1976) and Hirai (1976) found that cis-7-TDA attracted males of *X. c-nigrum* (also as *A. c-nigrum*), whereas the trans isomer did not. Subsequently, Hirai (1976) extracted material from 2000 virgin females and found that the active factor eliciting responses from antennal receptors was indeed cis-7-TDA. North American representatives of the species, formerly known as large and small forms of *A. c-nigrum*, were found by Roelofs and Comeau (1971) to be differentially attracted to the two isomers, the large form (now *X. dolosa*) to cis-7-TDA and the small form (now *X. adela*) to trans-7-TDA. Further trials did not confirm these results, and it is possible that at this time some contaminants were present in the synthetic attractants. European *X. c-nigrum* and North American *X. adela* have been shown to have more characters in common than *X. adela* and *X. dolosa* (Franclemont, 1980; Hudson, 1981; Hudson and Lefkovitch, 1982); specimens of *A. c-nigrum* obtained from Osaka, Japan also appear to be morphologically and genetically closer to *X. adela* (Hudson, unpublished data), so that such interchange of behaviour towards the isomers of 7-TDA would be unexpected.

The purpose of the present study was to determine if the sex attractants for *X. adela* and *X. dolosa* are different by observing the attraction of males from wild populations to traps baited with virgin females, and to examine the possibility of interbreeding between laboratory colonies of the two species.

MATERIAL AND METHODS

The moths used in field and laboratory experiments were second and third generation insects reared from founder females obtained from North Gower (NG) and Harrow (HA), Ontario. Several lines of each species were crossed in the second generation. The moths were maintained in an incubator at 75°F and approximately 70% RH, with a photoperiod of 16 hours. Larvae were reared on an artificial diet as described by Hinks and Byers (1976).

In pheromone experiments Pherocon 1C (Zoecon) sticky traps were set up near Mallorytown, Ontario in an area close to the St. Lawrence Seaway where both *X. adela* and *X. dolosa* are known to occur. Twenty traps (8 baited with *X. adela* females; 8 with *X. dolosa* females; and 4 blanks) were maintained during the period August 28 to September 24, 1980, when the second brood of the wild populations were flying. Sixteen traps, including the 4 blanks, were attached at a height of approximately 1 m along a fence separating fields of oats and buckwheat from a wooded area; the remainder were hung from branches of small trees in the wooded area. The positions of the traps were randomized. Baited traps contained two 3-day old virgin females, each individually housed in a plastic mesh cage. The females were replaced every third or fourth day and the trapped males were identified by electrophoresis (Hudson and Lefkovitch, 1980) and by dissection (Hudson, 1981); sample collections have been retained in the Canadian National Collection of insects in Ottawa.

Mating experiments were carried out in wooden frame, plastic-mesh cages 30 × 30 × 17 cm in a rearing room maintained at 70°F and 70% RH with a 16 hour photoperiod. Five males and five females were used in all combinations, they were put into the cages immediately following eclosion until a substantial number of eggs had been laid in the control cage, then females were examined for spermatophores and in most cases for the presence of sperm in the spermatheca.

An attractancy index (A) was calculated substituting A for I (isolation index) in the formulae of Wasserman and Koepfer (1977):

$$A = \frac{\underset{(CS)}{\text{No. conspecific ♂♂ attracted}} - \underset{(OS)}{\text{No. other species ♂♂ attracted}}}{\text{Total no. ♂♂ (both species) attracted (CS + OS)}}.$$

Table 1. Observed numbers of males caught in female-baited traps at Mallorytown, August–September, 1980. Expected numbers in parentheses.

	♀ Bait				
♂ Caught	*X. adela*	*X. dolosa*	Blank	Total	
X. adela	741 (660.9)	103 (183.1)	0	844	
X. dolosa	6 (86.1)	104 (23.9)	0	110	
Total	747	207	0	954	$\chi^2_1 = 388.4$
Attractancy index (A)	0.76 ± 0.022	0.89 ± 0.044			

The standard error was calculated as

$$\mathrm{SE} = \left[\frac{1 - \mathrm{A}^2}{\mathrm{CS} + \mathrm{OS}}\right]^{\frac{1}{2}}.$$

A value of $\mathrm{A} > 2 \times$ standard error is considered to indicate significant conspecific attraction. A positive index indicates a preference by males for conspecific females, a negative index that no preference is shown.

RESULTS

Attraction of field population males to virgin females.—The number of males caught in traps baited with virgin females of each species (Table 1) indicates significant conspecific attraction (chi-square = 388.4). Expressed as an attractancy index (A) and standard error (SE), from the formulae described in the previous section, for *X. adela* $\mathrm{A} = 0.76 \pm 0.022$ and for *X. dolosa* $\mathrm{A} = 0.89 \pm 0.044$; these are significant ($2 \times \mathrm{SE} < \mathrm{A}$).

The number of *X. adela* males collected remained fairly constant over the total time period, for example 18.0% (153) were collected on August 28 and 18.7% (158) on September 16. The total number of *X. dolosa* males collected was lower, but the numbers increased towards the end of the period, 10.5% (11) were collected on August 28 and 42% (44) on September 16. Traps hung along the fence bordering the oat field collected 80% (678) of all *X. adela* males and 72% (80) of all *X. dolosa* males, the remainder were collected in the tree traps.

Interspecific breeding experiments.—*Xestia adela* adapts very easily to laboratory rearing and 83% of the females in control cages were found to contain from 1–4 spermatophores. Mating success was unaffected by crossing NG and HA populations. *Xestia dolosa* intraspecific crosses were less successful and only 38% of the females contained spermatophores at the time of dissection. Interpopulation crosses beween *X. dolosa* males and females produced infertile eggs only, but only two trials were made because of a scarcity of *X. dolosa* NG at that time.

Table 2. Crossing experiments between *X. adela* and *X. dolosa*.

Species combination 5♂ × 5♀	No. Trials	Fertile Eggs	Infertile Eggs	Max. No. Spermatophores per Female	% No. Females that had Spermatophores
adela × *adela*	10	++[1]	+	4	85
dolosa × *dolosa*	14	+	++	2	38
adela × *dolosa*	12	−	+	3	15
dolosa × *adela*	11	−	++	1	5

[1] ++ = over 200 eggs/♀; + = less than 200 eggs/♀; − = no eggs.

When *X. adela* males were caged with *X. dolosa* females, spermatophores were deposited and sperm were found in the spermatheca of one female, but no fertile eggs were laid (Table 2). Multiple mating was demonstrated by one female that had three spermatophores. In this combination 15% of the total number of females were found to have spermatophores either completely or partially deposited (with part extruding from the ductus bursae). Several pairs were observed in copula and three of these were unable to separate.

In crosses between *X. dolosa* males and *X. adela* females only 5% (2) of the total number of females (55) had one spermatophore each. There was no evidence of sperm in the spermathecae of these females and no fertile eggs were obtained, although many infertile eggs were laid.

Discussion

The results of attractancy tests using virgin females strongly indicate that the sex pheromones of *X. adela* and *X. dolosa* are different, but that some cross attractancy does occur. The highest proportion of cross attractancy was between *X. adela* males and *X. dolosa* females, but some also occurred in the reciprocal combination, particularly towards the end of the collecting period when there were more *X. dolosa* males flying.

No fertile eggs were obtained from interspecific no-choice crosses set up in the laboratory. The evidence that mating occurred between both combinations of males and females and yet only infertile eggs were produced indicates that circumvention of the long-distance (anemotactic) responses (Roelofs and Cardé, 1977) did not induce hybridization, and it probably means that both premating and post-mating isolation mechanisms are acting together to maintain the taxonomic discreteness of the species.

A measure of genetic differentiation between *X. adela* and *X. dolosa* and an European population of *X. c-nigrum* was obtained from an electrophoretic study of allozyme frequencies (Hudson and Lefkovitch, 1982). Distances between the species were calculated from the formulae of Nei (1972) as genetic distance (D) and suggested a closer relationship between *X. c-*

nigrum and *X. adela* (D = 0.104) and between *X. c-nigrum* and *X. dolosa* (D = 0.260) than between *X. adela* and *X. dolosa* (D = 0.319). These relationships could be interpreted as the result of two separate introductions of *X. c-nigrum,* one of which, as *X. dolosa,* remained restricted to the eastern and central regions of N. America, and the other, as *X. adela,* became distributed transcontinentally. Where the two species are sympatric reproductive isolation has been achieved in part by pheromone differentiation, possibly brought about by the presence of different proportions of attractant components; this could explain the cross-attractancy observed in our experiment.

The larger number of *X. adela* males attracted to *X. dolosa* females could be interpreted as a one-sided mating preference, but is more likely to be due to the larger number of *X. adela* males in the field population during the observation period.

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I thank J. R. Byers and J. D. Lafontaine for helpful discussions and J. W. van der Meer and W. H. Forrest for excellent technical assistance.

LITERATURE CITED

Bestmann, H. J., O. Vostrowsky, H. Platz, T. Brosche, K. H. Koschatzky, and W. Knauf. 1979. Pheromone XXIII. (Z)-7-Tetradecenylacetat, ein sexual-lockstoff für männchen von *Amathes c-nigrum* (Noctuidae; Lepidoptera). Tetrahedron Lett. (6) 497–500.

Franclemont, J. G. 1980. "*Noctua c-nigrum*" in eastern North America, the description of two new species of *Xestia* Hübner (Lepidoptera: Noctuidae: Noctuinae). Proc. Entomol. Soc. Wash. 82: 576–586.

Fujimura, T. 1976. Mating behavior and sex attractant of the spotted cutworm moth, *Amathes c-nigrum* L. (Lepidoptera: Noctuidae). Jpn. J. Appl. Entomol. Zool. 20: 133–138.

Hinks, C. F. and J. R. Byers. 1976. Biosystematics of the genus *Euxoa* (Lepidoptera: Noctuidae) V. Rearing procedures and life cycles of 36 species. Can. Entomol. 108: 1345–1357.

Hirai, Y. 1976. Cis-7-tetradecen-1-ol acetate: a sex pheromone component of the spotted curworm moth, *Amathes c-nigrum,* p. 165. *In* Kond, T. and S. Ishii, eds., Proc. of a Symposium on Insect pheromones and their applications. Japan Plant Protection Association.

Hudson, A. 1981. Distinguishing characters of the reproductive system and genitalia of *Xestia dolosa* and *Xestia adela* (Lepidoptera: Noctuidae). Proc. Entomol. Soc. Wash. 83: 413–420.

Hudson, A. and L. P. Lefkovitch. 1980. Two species of the *Amathes c-nigrum* complex (Lepidoptera: Noctuidae) distinguished by isozymes of adenylate kinase and by selected morphological characters. Proc. Entomol. Soc. Wash. 82: 587–598.

———. 1982. Allozyme variation in four Ontario populations of *Xestia adela* and *Xestia dolosa* and in a British population of *Xestia c-nigrum* (Lepidoptera: Noctuidae). Ann. Entomol. Soc. Am. 75: 250–256.

Nei, M. 1972. Genetic distances between populations. Am. Nat. 106: 283–292.

Roelofs, W. L. and R. T. Cardé. 1977. Responses of Lepidoptera to synthetic sex pheromone chemicals and their analogues. Annu. Rev. Entomol. 22: 377–405.

Roelofs, W. L. and A. Comeau. 1971. Sex attractants in Lepidoptera. Proc. Int. Congr. Pesticide Chem., IUPAC, Tel Aviv, Israel 2: 91–112.

Wasserman, M. and H. R. Koepfer. 1977. Character displacement for sexual isolation between *Drosophila mojavensis* and *Drosophila arizonensis*. Evolution. 31: 812–823.

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A NEW *LIRIOMYZA* MINING LEAFLETS OF BLACK LOCUST (DIPTERA: AGROMYZIDAE)

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Abstract.—*Liriomyza* **robiniae,** new species, an early season leaflet miner on black locust, *Robinia pseudoacacia* L., is described from Harrisburg, Pennsylvania. Records of larval collections are given for New York, Pennsylvania, Virginia, and West Virginia, and some biological information is presented.

The larva of *Liriomyza robiniae,* new species, forms a blotch mine (Fig. 1) on the leaflet of black locust, *Robinia pseudoacacia* L. (Fabaceae(=Leguminosae)). Adults were collected in late April in south central Pennsylvania, and larvae were found in May in New York, Pennsylvania, Virginia, and West Virginia. Only one generation is produced annually, the pupae overwintering.

Apparently the only record of any agromyzid feeding on black locust is that of Weaver and Dorsey (1965), who reared three species of Eulophidae (Hymenoptera) from larvae of an unidentifed agromyzid leafminer on *R. pseudoacacia* in West Virginia. A conversation with J. E. Weaver, West Virginia University, leaves little doubt that the parasitized larvae he collected were those of *L. robiniae.*

Liriomyza robiniae Valley, NEW SPECIES

Figs. 1, 2

Male.—*Head:* Front yellow, sometimes light orange anteriorly, darkened at base of each fronto-orbital bristle, except foremost 1 or 2; ocellar area black; 3 lower fronto-orbital bristles turned mesad; 2 upper fronto-orbitals reclinate, anterior one somewhat the larger; front narrowly raised above eye, slightly more than twice width of one eye at level of anterior ocellus; both vertical bristles in black area, inner one at margin of dark color; parafrontal setulae lacking; gena (jowl) yellow, approximately 0.6 eye height; face yellow; palpi light orange; antenna with 2 basal segments yellow, 3rd segment round, orange, sometimes with light infuscation on outer basal ½;

Fig. 1. Mine of *L. robiniae* in leaflet of black locust.

arista brown, pubescent, slightly longer than antenna, evenly tapering from rather thick base.

Thorax: Scutum black, densely gray tomentose with humerus and notopleuron largely yellow, black spot on anterior face of humerus; pleura yellow and black as follows: propleuron yellow; mesopleuron with black largely confined to lower ½; pteropleuron largely yellow; hypopleuron largely black; sternopleuron yellow along dorsal border, broadly around sternopleural bristle, narowly anterior thereof; scutellum black, gray tomentose, yellow mesally, especially between apical bristles, sometimes only faintly yellowish basally; scutum with 4 irregular rows of acrostichal setulae anteriorly, grading into more regular rows behind transverse sulcus; wing 1.6–1.8 mm long, hyaline, costa extending to M (4th vein), anterior crossvein approximately opposite costal break; last section of Cu (5th vein) 1.4–1.5× as long as discal cell; halter yellow; squamal cord and fringe dark brown; legs yellow, coxae and femora partly blackish.

Abdomen: Dorsum black, with narrow yellow posterior margin of segments 1–6 and yellow anterior corners of segment 1; postabdomen as in Fig. 2, epandrium yellowish, with yellowish bristles; ventral lobe (surstylus) rounded with a few minute pale triangular scaly bristles; cerci not evident; aedeagus slightly infuscated basally, otherwise colorless, details of distiphallus difficult to distinguish, but pair of narrow approximated processes at apex (Fig. 2B); sperm pump (Fig. 2A) unusually small, on short duct.

Female.—External characters similar to male but with 3rd antennal segment sometimes more heavily infuscated and legs darker. Wing length 1.8–2.0 mm.

Type-Material.—All specimens have the following locality and host in-

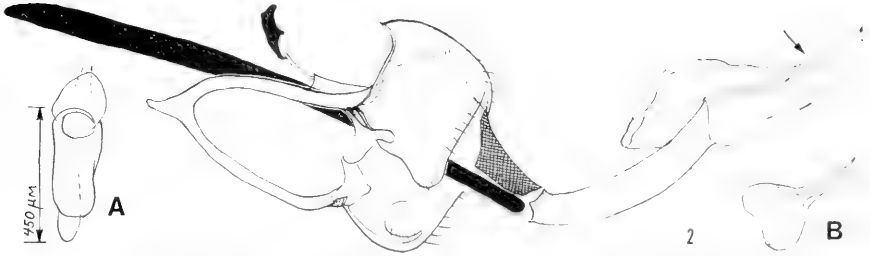

Fig. 2. Postabdomen of *L. robiniae* male, ventrolateral view. Drawn from macerated preparation in water. A, Sperm pump, from microslide preparation. B, Outline of tip of aedeagus as seen in direction of arrow above in dry specimen; not to scale.

formation: PENNSYLVANIA: Dauphin Co., Harrisburg, 2301 N. Cameron St., taken on *Robinia pseudoacacia*. Holotype ♂: 22 April 1981, A. G. Wheeler, Jr. (USNM). Allotype ♀: 30 April 1979, AGW (USNM). Paratypes: 1♂, 1♀, 25 April 1979, AGW (CU): 2♀, 24 April 1980, T. J. Henry, 1♀, 23 April 1980, KRV, and 1♂ 25 April 1979, AGW (PDA); 1♂, 24 April 1979, KRV, and 1♀, 25 April 1979, KRV (USNM).

Specimens deposited in the Cornell University Insect Collection, Ithaca, New York (CU); Pennsylvania Department of Agriculture, Harrisburg (PDA); and the National Museum of Natural History, Washington, D.C. (USNM).

Relationships.—*Liriomyza robiniae* is anomalous in the genus *Liriomyza* because of its largely black scutellum, densely tomentose scutum, and postabdominal structure, especially the reduced cerci, colorless distiphallus that is difficult to examine, and the very small, peculiarly shaped sperm pump. However, a microscope preparation confirms its assignment to *Liriomyza* by the presence of fine, abundant stridulatory spicules on the lateral abdominal membrane of the male. Its only close relative, at least in North America, seems to be a species from an unknown host in California, now in press in K. A. Spencer's comprehensive work on the Agromyzidae of California. That species has a wholly black scutellum and has been given a name referring thereto; it lacks parafrontal setulae and the postabdomen is apparently fairly similar to that of *L. robiniae*. It also differs from *L. robiniae* in having but one upper fronto-orbital bristle, a subshining scutum, and black pleura except for the narrow yellow upper margin of mesopleuron.

Comments.—*Liriomyza robiniae* runs to couplet 38 in Spencer's (1969) key, although specimens do not agree with either choice, *L. kenti* Spencer or *L. nordica* Spencer. In Frick's (1959) key, specimens of *L. robiniae* trace to *L. eupatorii* (Kaltenbach), a leafminer on *Aster* and *Eupatorium* in North America.

Larvae of *L. robiniae* were collected in black locust leaflets at the following localities: NEW YORK: Delaware Co., Rt. 97, 2.6 mi. S. jct. with old Rt. 17 in Hancock, 16 May 1979 and 27 May 1981, KRV; Cadosia, 16 May 1980, KRV; Sullivan Co., Long Eddy, along Rt 97, 16 May 1980 and 27 May 1981, KRV; Tompkins Co., Ithaca, Cornell University, 17 May 1980, A. G. Wheeler, Jr.; Suffolk Co., Long Island, Yaphank, 30 May 1981, AGW. PENNSYLVANIA: Centre Co., Rt. 45 nr. jct. with Rt. 26, betw. Pine Grove Mills & Shingletown, 19 May 1980, AGW & KRV; Dauphin Co., Linglestown, 9 May 1979 and 1 May 1980, AGW & KRV; Clark's Valley, Rt. 325, 18 May 1979, KRV; Wayne Co., Damascus Twp., on road to Callicoon, N.Y., nr. Curtis Nursery, 17 May 1979, KRV. VIRGINIA: Augusta Co., I-81 S., 5.4 mi. N. Rt. 606, Raphine-Steeles Tavern Exit, 10 May 1979, AGW; Montgomery Co., I-81, 2 mi. S. Roanoke Co. line, 26 April 1981, AGW; Lancaster Co., Windmill Pt., 8 May 1981, AGW & KRV; James Co., Williamsburg, Wm. & Mary Campus, 9 May 1981, AGW & KRV. WEST VIRGINIA: Berkeley Co., I-81 Rest Area W. of Potomac River, 10 May 1979, AGW.

Detection of *L. robiniae* has been hindered by the early and ephemeral appearance of the adults and the short larval feeding period. The type-material was collected shortly after leaf flush of black locust in the Harrisburg area, when leaves were less than 4 cm long. In 1979, abandoned mines were found as early as 9 May, and by 21 May no larvae were found in any of the leaflets sampled. Small, heavily mined leaflets dropped from the trees; larger leaflets with mines remained on the trees, but by 29 May the mined areas had begun to dry and drop from the leaflets, thus preventing easy detection of the larval feeding activities. By mid-June little evidence remained to document the mining activities of the larvae.

The collecting records show this species is widespread, and I suspect that additional early-season efforts will yield new distribution records from throughout the native range of black locust. The tree is not native to states and provinces north of Pennsylvania, where it has been naturalized north to Nova Scotia, Quebec, and Ontario (Fernald, 1950). Thus *L. robiniae* probably has been introduced into at least New York State through man's commerce or has followed the tree's movement along highway banks, waste land, and other areas disturbed by man.

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I thank George C. Steyskal, Systematic Entomology Laboratory, USDA, Washington, D.C., for reviewing the manuscript and especially for his assistance with the description, comments on relationships, and for Fig. 2. I also thank my Harrisburg colleague, A. G. Wheeler, Jr., for reviewing the paper and making suggestions for its improvement, and who, along with

Thomas J. Henry, Systematic Entomology Laboratory, USDA, collected specimens of *L. robiniae*. J. E. Weaver, West Virginia University, Morgantown, shared with me his observations on *L. robiniae*.

LITERATURE CITED

Fernald, M. L. 1950. Gray's manual of botany. American Book Co., New York. 1632 pp.

Frick, K. E. 1959. Synopsis of the species of agromyzid leaf miners described from North America (Diptera). Proc. U.S. Natl. Mus. 108: 347–465.

Spencer, K. A. 1969. The Agromyzidae of Canada and Alaska. Mem. Entomol. Soc. Can. 64, 311 pp.

Weaver, J. E. and C. K. Dorsey. 1965. Parasites and predators associated with five species of leaf-mining insects in black locust. Ann. Entomol. Soc. Am. 58: 933–934.

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A NEW *ALLOCAPNIA* FROM WEST VIRGINIA (PLECOPTERA: CAPNIIDAE)

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Abstract.—*Allocapnia* ***frumi,*** n. sp., is described from specimens collected in West Virginia. It is included in the *forbesi* Group and is closely related to A. *curiosa* Frison. A holotype male, allotype, and 37 paratypes are designated.

During an investigation of the winter stoneflies from Fayette, Greenbrier, and Pocahontas counties, West Virginia, an undescribed species of *Allocapnia* was discovered. The following description and morphological terms generally follow those of Ross and Ricker (1971).

Allocapnia frumi **Kirchner, New Species**

Male (Figs. 1–4).—Dark brown, almost black. Wings variable in length, reaching from 2nd to 5th segment of abdomen. Length of body 5–7 mm. Anterior ½ of 7th tergum produced into a conical process. Dorsal process of 8th tergum with apex angled slightly forward with well separated lobes forming a deep trough, anterior portion with a distinct white oval membraneous area. Apical segment of upper limb of epiproct about ⅓ length of entire process and diamond shaped in dorsal aspect. Lower limb of epiproct with apical segment moderately deep, its tip narrowed into a thin tongue.

Female (Figs. 5–7).—Dark brown, almost black. Wings variable in length, reaching from 3rd to 9th segment of abdomen. Length of body 6–8 mm. Eighth tergum entirely sclerotized to nearly so, or a mesal membranous area extending its whole length. Seventh and 8th sterna heavily sclerotized. Seventh with posterior margin projecting well over anterior margin of 8th sternum. Eighth sternum with conspicuous lateral lobes, mesal area wide and flat, its apex produced into a truncate lobe.

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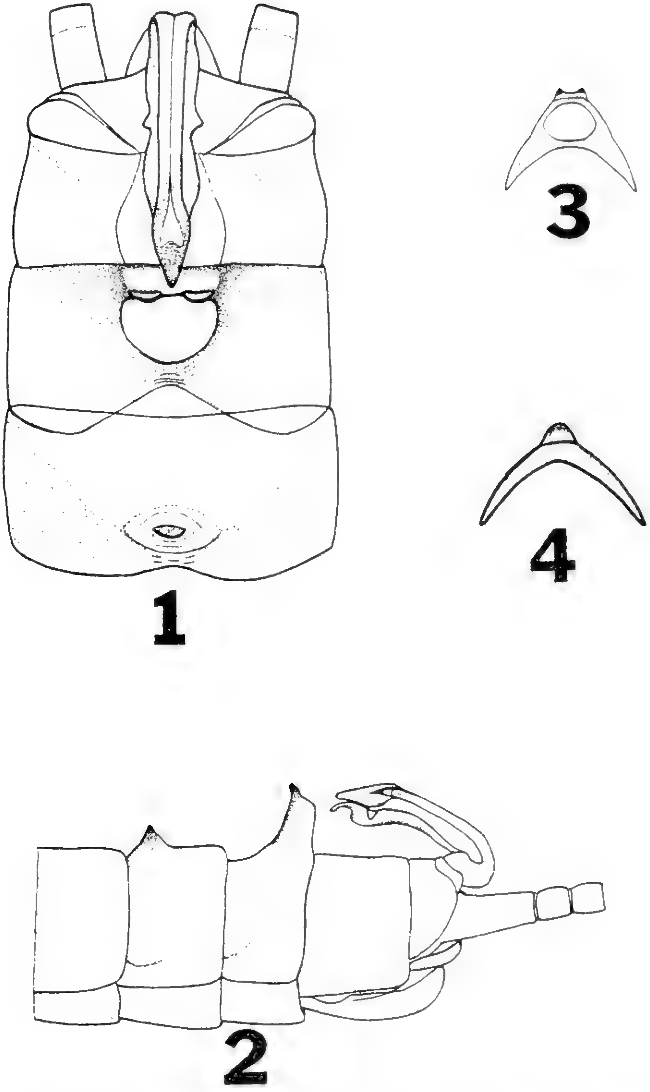
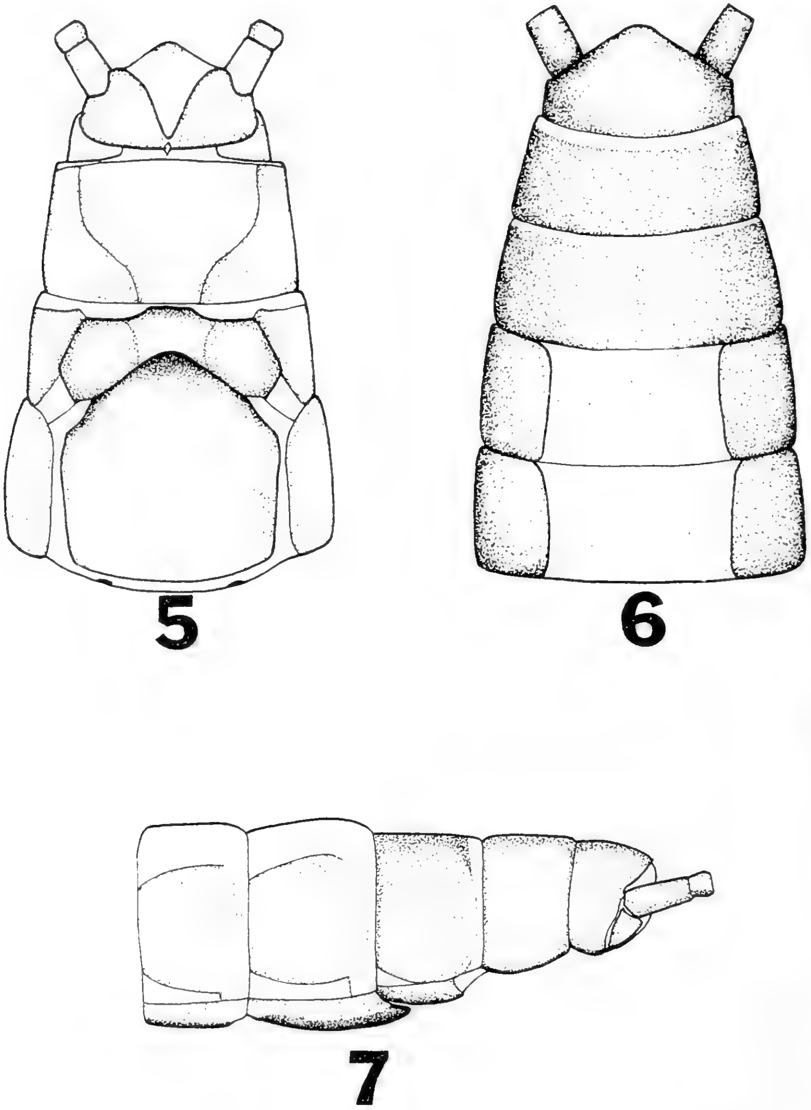
[1] The views of the author do not purport to reflect the position of the Department of the Army or the Department of Defense.



Figs. 1–4. *Allocapnia frumi* (male), terminalia. 1, Dorsal. 2, Lateral. 3, Dorsal process of 8th tergum, posterior aspect. 4, Dorsal process of 7th tergum, posterior aspect.

Type material.—Holotype ♂ and Allotype, West Virginia, Greenbrier Co., Monongahela National Forest, Coats Run of North Fork Cherry River, 8.0 km east of Richwood, Rt. 39, 14 March 1981, R. F. Kirchner. Paratypes: WEST VIRGINIA: Greenbrier Co., Coats Run, 3♂, 17 March 1979, R. F.



Figs. 5–7. *Allocapnia frumi* (female), terminalia. 5, Ventral. 6, Dorsal. 7, Lateral.

Kirchner and R. M. Meyer; 2 ♂, 1 ♀, 23 February 1980, R. F. Kirchner; 2 ♂, 3 ♀, 16 March 1980, R. F. Kirchner, R. M. Meyer, and V. J. Marchese; 1 ♂, 28 March 1981, R. F. Kirchner and V. J. Marchese. Pocahontas Co., Monongahela National Forest, Hills Creek, 24.1 km east of Richwood, Rt.

39, 1♂, 16 March 1980, R. F. Kirchner, R. M. Meyer and V. J. Marchese. Pocahontas Co., Monongahela National Forest, Sugar Creek of Williams River, Forest Service Rt. 76, 5♀, 8 May 1980, R. F. Kirchner; 3♂, 9♀, 3 May 1981, R. F. Kirchner and V. J. Marchese. Fayette Co., Big Hollow of Paint Creek, 3.2 km northwest of Kingston, W. Va. turnpike, 3♂, 24 January 1980, R. F. Kirchner and L. K. Evans; 1♂, 3♀, 27 February 1981, R. F. Kirchner.

The holotype, allotype, and two paratypes will be deposited in the National Museum of Natural History, Washington, D.C. (type No. 100222). Other paratypes will be deposited in the collections of the Illinois Natural History Survey, Champaign; Virginia Polytechnic Institute and State University, Blacksburg; C. H. Nelson, University of Tennessee at Chattanooga; P. P. Harper, University of Montreal; and my personal collection.

Diagnosis.—*Allocapnia frumi* is a member of the *forbesi* group of Ross and Ricker (1971), which includes *A. curiosa* Frison, *A. forbesi* Frison, *A. maria* Hanson, *A. minima* (Newport), *A. ozarkana* Ross, and *A. pechumani* Ross and Ricker. Within this group, *A. frumi* is most closely related to *A. curiosa* in having the male terga highly ornamented and the female 7th sternum well produced over the 8th sternum. The male of this new species can be separated from others in the group by the prominent oval membranous area of the 8th tergum (Fig. 1) (one male had an oval membranous area on both the 7th and 8th terga), which is lacking in males of the other species. The female of *A. frumi* may be distinguished by a wide truncate mesal lobe of the 8th sternum (Fig. 5). In *A. curiosa*, the mesal area is rounded posteriorly and without a mesal lobe (Ross and Ricker, 1971, Fig. 69).

Etymology.—This species is named in honor of Prof. W. Gene Frum, Department of Biological Sciences, Marshall University.

Remarks.—*Allocapnia frumi* was collected from first order mountain streams ranging in altitude from 427 m in Fayette County to 1220 m in Pocahontas County. The dominant riparian vegetation varied from cove hardwoods to nearly pure stands of red spurce. Other Capniidae associated with this species included *A. curiosa* Frison, *A. frisoni* Ross and Ricker, *A. harperi* Kirchner, *A. nivicola* (Fitch), and *Paracapnia angulata* Hanson. *Allocapnia harperi* was previously known only from the type-locality in Virginia (Kirchner, 1980). It was collected from Greenbrier and Pocahontas counties during this study.

ACKNOWLEDGMENTS

I am indebted to B. C. Kondratieff and J. R. Voshell, Jr., Virginia Polytechnic Institute and State University, Blacksburg, for reviewing the manuscript and to Penelope F. Kondratieff for preparing the illustrations. I also thank P. P. Harper, University of Montreal, Quebec, for loan of specimens of *Allocapnia pechumani*.

LITERATURE CITED

Kirchner, R. F. 1980. A new *Allocapnia* from Virginia (Plecoptera: Capniidae). Entomol. News. 91: 19–21.

Ross, H. H. and W. E. Ricker. 1971. The classification, evolution, and dispersal of the winter stonefly genus *Allocapnia*. Ill. Biol. Monogr. 45: 1–166.

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CHROMOSOME AND ISOZYME STUDIES IN *TRICHOGRAMMA* (HYMENOPTERA: TRICHOGRAMMATIDAE)[1]

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Abstract.—Karyotype and isozyme analyses were carried out in *Trichogramma chilonis* Ishii, *T. evanescens* Westwood, *T. nubilale* Ertle and Davis, and *T. pretiosum* Riley. No significant differences were detected among karyotypes of these four species as they all have $n = 2SM + 2T + 1A$. However, these species can be readily distinguished on zymograms of superoxide dismutase and esterase.

Trichogramma have been widely used in biological control projects in various parts of the world. However, because of the inadequacy of classical, morphological studies of *Trichogramma*, the precise identities of the species and strains used are in most cases unknown. This problem has been somewhat alleviated by the use of male genitalia as a diagnostic morphological character and crossbreeding experiments as a genetic approach in biosystematics of this group of parasitic insects (see review article by Nagarkatti and Nagaraja, 1977). As pointed out by Harland and Atteck (1933), the basic solution to the problems of systematics in *Trichogramma* is the study of biological characters, crossing relationships, cytology, and genetics of various races and species.

Due to the minute size of *Trichogramma*, cytological and isozyme studies in these insects are rather difficult and have not been adequately carried out. The only cytological study of *Trichogramma* was that of Fukada and Takemura (1943). However, no detailed karyotype analysis was given in their report. Voegele and Berge (1976) published the first paper on electrophoresis of *Trichogramma*. Further isozyme studies have been carried out by Voegele and his associates (Jardak et al., 1979; Pintureau et al., 1980;

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[1] Approved as TA 21 by the Director of the Guam Agricultural Experiment Station.

Pintureau and Babault, 1981). Their results look promising for use in species differentiation of these difficult parasitic Hymenoptera.

In 1979–80, karyotype and isozyme analyses were carried out at the University of Guam in order to determine the value of these two techniques in the biosystematics of *Trichogramma*. The results of these studies are presented here.

MATERIALS AND METHODS

The following four species of *Trichogramma* were used in these studies: *T. chilonis* Ishii (reared from sphinx moth eggs collected from wild taro leaves on Guam), *T. evanescens* Westwood (from a laboratory culture of W. J. Lewis, USDA, Tifton, Georgia; positive identification of this sample has yet to be determined), *T. nubilale* Ertle and Davis (from a laboratory culture of P. P. Burbutis, University of Delaware, Newark), and *T. pretiosum* Riley (from a laboratory culture of R. K. Morrison, USDA, College Station, Texas). With the exception of *T. evanescens*, species identifications were confirmed by the author. Voucher specimens of these four species are deposited at the Beneficial Insect Introduction Laboratory, IIBIII, USDA, Beltsville, Maryland.

Field collected eggs of a sphinx moth from wild taro were used as host eggs. Freshly laid host eggs were collected in the morning, removed from taro leaves with a camel hair brush, and stored at −10°C in a sealed vial for three weeks in order to kill any egg parasites that might have already parasitized the eggs. After three weeks, the host eggs were removed from the freezer and thawed at room temperature. They were glued in a cluster of ten with Elmer's glue® to a strip of filter paper and used for rearing the *Trichogramma* species according to the method of Morrison (1970).

Chromosome preparation.—Due to the minute size of *Trichogramma*, the technique of Hung et al. (1972) was modified. Four to five days after the host eggs were stung, *Trichogramma* pupae with light pink eyes or prepupae were removed from the host eggs and placed on a drop of colchicine-hypotonic solution on a microslide. Testes and ovaries of pupae or brains of prepupae were dissected out and pushed aside to a corner. The remainder of the tissue was then wiped off the slide. The organs to be used were kept on the slide with another drop of colchicine-hypotonic solution for ten minutes. To prevent the organs from drying out, the droplet was covered with a depression slide. After ten minutes, the solution was carefully removed with a piece of filter paper. Special care was used to avoid contact of the filter paper with the organs and at the same time not to dry out the organs. Before the organs dried out, a wax pencil mark was made on the other side of the slide to indicate the position of the organs. A drop of aceto-orcein was then placed on the organs and covered with a cover glass. The materials were squashed between filter paper with the thumb. One drop of immersion oil was placed on the slide at the position opposite to the wax pencil mark. The pencil mark was then wiped off, and the slide was finally placed under the microscope for examination. Chromosome photographs were taken with Wild M20-EB Phase Microscope® using Fuji Minicopy film®.

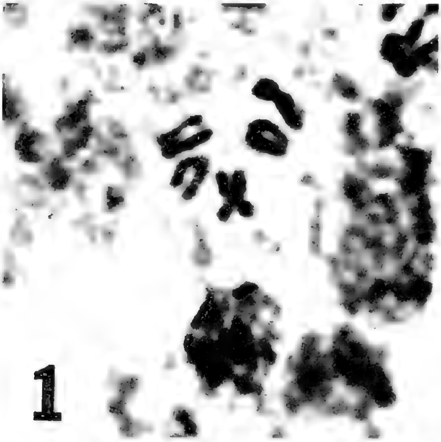
Electrophoresis.—The vertical dual slab cell (Bio-Rad Model 220®) with 0.75 × 140 mm spacer and Buchler 3-1500® constant power supply were used. The Laemmli system (Laemmli 1970) of reagents and acrylamid gels for SDS electrophoresis was followed in gel preparation, except that in all cases SDS was omitted and sample buffer was replaced with 10% sucrose.

At least five individuals of each species were used for each sample well. The wasps were homogenized in 0.01 ml of 10% sucrose on a 12-cavity white porcelain plate with a glass rod. The homogenate in each cavity was obsorbed onto a very narrow strip of Whatman #1 filter paper (ca. 5 × 0.1 mm). These strips were inserted into the wells already filled with electrode buffer (tris base 6.0 g, glycine 28.8 g q.s. to 1 liter with deionized water). The gel was initially run with constant current of 15 mA until the tracking dye reached the separating gel which took about 3 hours. It was then run for another 2 hours at constant power of 10 watts at which time the gel front would have reached the bottom of the separating gel. During the run, the gel was cooled with circulating ice water. After electrophoresis, the gel was stained for either esterase or superoxide dismutase. The esterase stain consists of 100 ml sodium phosphate buffer, 0.12 M (pH 6.0); 1 ml 1% beta-napthyl acetate (w/v) in 50% acetone-water (v/v); and 40 mg Fast Garnet GBC salt. The stain for superoxide dismutase was composed of 15 mg NADP, 15 mg NBT, 5 mg PMS, 50 mg MgCl, and 75 ml 0.2 M Tris-HCl buffer (pH 8.0). All four species were used in esterase assay; however, the culture of *T. evanescens* died later and was thus not included in superoxide dismutase studies.

RESULTS AND DISCUSSION

As shown in Figs. 1–6, these four species of *Trichogramma* each have $n = 5$ which is the same as that reported by Fukada and Takemura (1943) for seven "strains" of *Trichogramma* sp. and is the predominant haploid number in chalcidoids (Crozier, 1977). Further analyses revealed that they not only have the same haploid number, but the morphology of these five chromosomes in each species are the same, i.e. $n = 2SM + 2T + 1A$ as indicated in the idiogram in Fig. 7. This striking homogeneity in the karyotypes of these four species representing two different species groups (Nagarkatti and Nagaraja, 1977) is significant in the application of karyotype analysis in the biosystematics of *Trichogramma*. It indicates that more advanced cytological techniques such as chromosome banding may have to be developed for these minute insects.

Although no significant differences have been detected among karyotypes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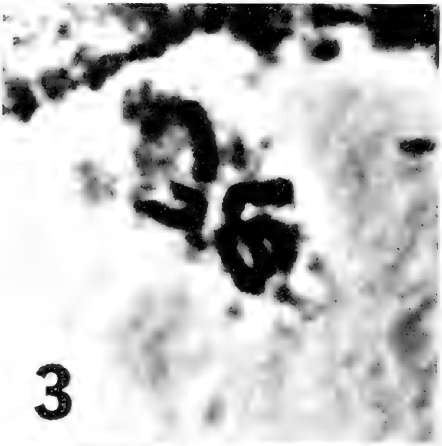
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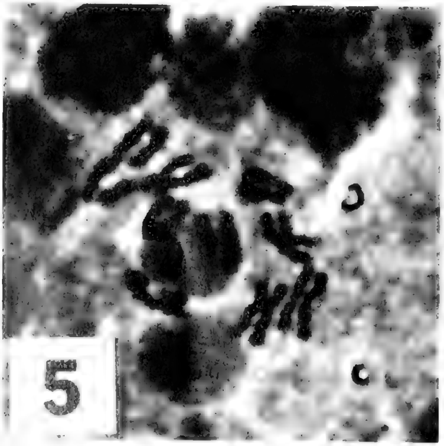
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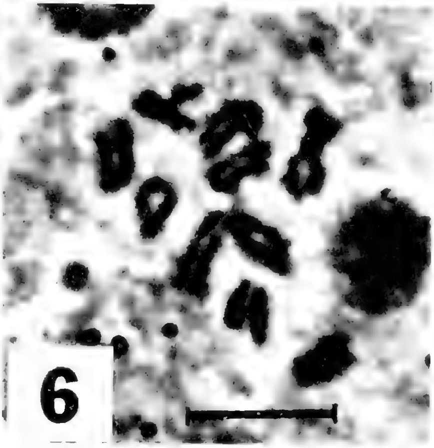
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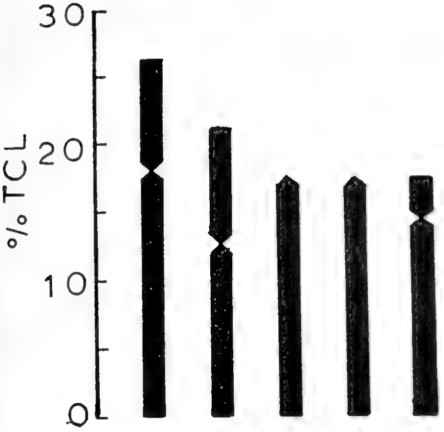

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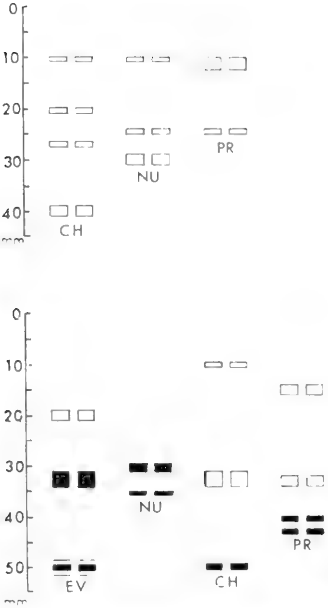

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Figs. 7, 8. 7, Idiogram based on Figs. 1–6; TCL = total chromosome length. 8, Diagrammatic illustrations of superoxide dismutase (top) and esterase (bottom) banding patterns in *Trichogramma*. CH = *chilonis*; EV = *evanescens*; NU = *nubilale*; PR = *pretiosum*.

of these four *Trichogramma* species, they can be readily distinguished on zymograms of superoxide dismutase and esterase (Fig. 8). Formal progeny analyses to establish the number of loci have not been carried out because at least five wasps have to be used in each well in order to obtain detectable enzyme activity due to the level of sensitivity of slab gel. Nevertheless, the banding patterns of the two enzymes are unique in each of these four species. The esterase zymogram of *T. evanescens* reported here is different from that of Pintureau and Babault (1981). Perhaps my sample is not *evanescens* as I have questioned. Furthermore, whether the three-band phenotype of esterase found in *T. evanescens* represents a heterozygote at this locus has yet to be determined.

A pooled sample of male progeny of a single virgin female has been used to circumvent the difficulty of assaying a single wasp (Pintureau et al., 1980;

←

Figs. 1–6. Haploid and diploid karyotypes. 1, 2, *Trichogramma chilonis*, male and female. 3, 4, *T. evanescens*, male and female. 5, *T. nubilale*, female. 6, *T. pretiosum*, female. Scale = 10 μ.

Pintureau and Babault, 1981). However, a technique that uses only one wasp per sample well is still highly desirable. This technique would not only facilitate the direct analysis of allele frequency of each population, but also would enable us to use isozyme analysis in hybridization experiments (Hung and Vinson, 1977). Nevertheless, unless chromosome banding pattern turns out to be species specific, isozyme analysis will still be the most useful tool in *Trichogramma* biosystematics.

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LITERATURE CITED

Crozier, R. H. 1977. Evolutionary genetics of the Hymenoptera. Annu. Rev. Entomol. 22: 263–288.

Fukada, H. and M. Takemura. 1943. Genetical studies of *Trichogramma*. (In Japanese). Jpn. J. Genet. 19: 275–281.

Harland, S. C. and O. M. Atteck. 1933. Breeding experiments with biological races of *Trichogramma minutum*. Z. Indukt. Abstammungs. Vererbungsl. 64: 54–76.

Hung, A. C. F., H. T. Imai, and M. Kubota. 1972. The chromosomes of nine ant species (Hymenoptera:Formicidae) from Taiwan, Republic of China. Ann. Entomol. Soc. Am. 65: 1023–1025.

Hung, A. C. F. and S. B. Vinson. 1977. Interspecific hybridization and caste specificity of protein in fire ant. Science (Wash., D.C.) 196: 1458–1460.

Jardak, T., B. Pintureau, and J. Voegele. 1979. Mise en evidence d'une nouvelle espece de *Trichogramma* (Hym., Trichogrammatidae). Phenomene d'intersexualite; etude enzymatique. Ann. Soc. Entomol. Fr. (N.S.) 15: 635–642.

Laemmli, U. K. 1970. Cleaveage of structural proteins during the assembly of the head of bacteriophage T4. Nature 227: 680–685.

Morrison, R. K. 1970. A simple cage for maintaining parasites. Ann. Entomol. Soc. Am. 63: 625–626.

Nagarkatti, S. and H. Nagaraja. 1977. Biosystematics of *Trichogramma* and *Trichogrammatoidea* species. Annu. Rev. Entomol. 22: 157–176.

Pintureau, B. and M. Babault. 1981. Caractérisation enzymatique de *Trichogramma evanescens* et de *T. maidis* (Hym.:Trichogrammatidae): Étude des hybrides. Entomophaga 26: 11–22.

Pintureau, B., R. Goujet, D. Martouret, and J. Voegele. 1980. Étude des esterases chez *Trichogramma embryophagum* Hartig (Hym.:Trichogrammatidae). Choix d'une souche pour lutter contre *Laspeyresia pomonella* L. (Lep.: Tortricidae) dans la région parisienne. Bull. Soc. Entomol. Mulhouse, pp. 17–24.

Voegele, J. and J. B. Berge. 1976. Les Trichogrammes (Insectes Hymenop. Chalcidiens, Trichogrammatidae), caractéristiques isoesterasiques de deux espèces:*Trichogramma evanescens* Westw. et *T. achaeae* Nagaraja et Nagarakatti. C. R. Acad. Sci. Paris 283: 1501–1503.

PROC. ENTOMOL. SOC. WASH.
84(4), 1982, pp. 797–821

SEXUAL BEHAVIOR, BIONOMICS, AND FIRST-INSTAR LARVAE OF THE LAUTA AND DIVERSICORNIS GROUPS OF *EPICAUTA* (COLEOPTERA: MELOIDAE)

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Abstract.—*Epicauta lauta* (Horn) is removed from the Diversicornis Group and placed in a group by itself. Male courtship behavior in *E. lauta* and *E. polingi* Werner is described in detail. In both species the orientation phase is short and the mounted phase long. The mounted phase involves distinct riding and displaying subphases. On the basis of limited observation, *Epicauta arizonica* Werner is not distinguishable behaviorally from *E. polingi*.

Data on adult activity, adult feeding behavior, and oviposition are summarized for the Lauta and Diversicornis groups. Adults of *Epicauta lauta* feed on *Larrea*; those of the Diversicornis Group favor Leguminosae (especially *Prosopis*). Hatching time of eggs and number of eggs per mass are recorded for *E. lauta, E. polingi,* and *E. arizonica.* A rearing of *E. polingi* on the eggs of the acridid *Melanoplus differentialis* (Thomas) is described.

The Lauta, Diversicornis, and Fabricii groups are characterized and compared on the basis of anatomical characters of the first-instar larva. The larva of *E. lauta* possesses several characteristics not found in other species of the subgenus *Macrobasis* and one characteristic (only three minor setae on each side of the head dorsally) that is unique in *Epicauta*. Larvae of *E. polingi* and *E. arizonica* share many characteristics with *E. fabricii* (LeConte) and *E. murina* (LeConte), of the Fabricii Group.

This paper treats the sexual behavior, bionomics, and larval anatomy of species of blister beetles currently assigned to the Diversicornis Group of the subgenus *Macrobasis* LeConte of the genus *Epicauta* Dejean. This group was established by Werner (1949) on the basis of anatomical characters of the adult male. Twelve species were included, all strictly North American in distribution except *Epicauta flagellaria* (Erichson), which occurs in Panama and northern South America. *Epicauta luteola* Dillon (1952), described subsequently from Texas, apparently should be included also. Species treated in detail herein are *Epicauta lauta* (Horn), *E. polingi* Werner, and *E. arizonica* Werner. In the adult stage, as noted by Werner et al. (1966), *E.*

lauta differs from other species of the group in exhibiting relatively slight sexual dimorphism of the antenna. Associated with this trait is a distinctive, elaborate pattern of male courtship display, described below. Further, in anatomical characters of the first larval instar, *E. lauta* is much less similar to *E. arizonica* and *E. polingi* than these species are to *E. fabricii* (LeConte) and *E. murina* (LeConte), of the Fabricii Group of *Macrobasis*. Taken together, the evidence clearly indicates that *E. lauta* must be removed from the Diversicornis Group and assigned to a separate group, which I will hereafter refer to as the Lauta Group.

For comparative purposes, descriptions of the larvae of species of the Lauta and Diversicornis groups given in this paper are supplemented with details regarding anatomical characteristics of *Epicauta fabricii* and *E. murina* not included in MacSwain's (1956) larval descriptions of these species.

Materials and Methods

Studies of sexual behavior were carried out largely at field sites under relatively primitive conditions. Behavioral data were obtained by observation and photography of field-caught adults confined to cages in groups of 12–25. Some observations were made in sunlight, others under a bank of fluorescent lamps. Temperature during observation and filming periods ranged from 27° to 31°C. Data were taken in the form of tape recorded descriptions of activities, still photographs, and, in the case of *E. lauta* and *E. polingi*, 200 and 800 feet, respectively, of 16 mm motion picture film (24 fps). In describing the courtship behavior of *E. lauta* I occasionally record mean duration or rate of movement for an activity. These values, derived from data obtained by counting motion picture frames, are generally based on samples of no more than five bouts of behavior and, accordingly, have little or no value for comparative purposes. They are presented simply to give the reader a rough idea of the tempo of the behavior.

Epicauta lauta was studied behaviorally at two localities (inclusive dates of study in parentheses): Van Horn, Culberson County, Texas (5-VIII-59), and Balmorhea, Texas (30-VIII/1-VIII-63). All material was taken at light. At the time of the studies no food plant had been recorded for the species. Adults from Van Horn were confined without food; those from Balmorhea were given lettuce, which they ate.

Epicauta polingi was studied at Apodaca, Nuevo León, Mexico (3/21-VII-60); Quemado, Maverick County, Texas (27-VIII/2-IX-61); Balmorhea, Reeves County, Texas (26/29-VII-63); and Ft. Davis, Jeff Davis County, Texas (8-VII-63). The bulk of the adult material of this species was collected at lights. Captive adults were given flowers of *Prosopis juliflora* and *Solanum elaeagnifolium* as food.

The behavior of *Epicauta arizonica* was studied only superficially on the basis of a sample of adults from Culiacán, Sinaloa, Mexico (26/27-IX-72). Lettuce was provided as food.

In describing postembryonic ontogeny, I have adopted Selander and Mathieu's (1964) use of the symbols T, FG, C, SG, P, and A for the four phases of the larval stage (triungulin, first grub, coarctate, second grub), the pupal stage, and the adult stage, respectively, with numerical subscripts to indicate instars. The technique used in rearing *Epicauta polingi* is described in the account of the rearing.

First-instar larvae described in this work were progeny of adults used in the behavioral studies or additional field-caught material. The geographic source and number of larvae studied are specified in the section on larval anatomy.

Egg masses, which were generally laid on plant material or cage floors, were placed in individual cotton-stoppered 3-dram vials and incubated at 100% RH in darkness. Larvae were killed in 70% ethyl alcohol (in water) a few days after eclosion. Those selected for detailed study were dehydrated through an alcohol series, cleared in oil of wintergreen and toluene, and mounted on slides in Harleco Synthetic Resin.

The following conventions were adopted in describing larvae: Length of the head is the distance from the posterior margin of the head capsule to the clypeolabral suture. Coloration is that in preserved, unmounted specimens. Setae in a transverse row, whether on the labrum, frontal margin of the head, or abdominal terga and sterna, are numbered consecutively on each side of the body, beginning with the seta nearest the midline and proceeding laterad.

In the text, values accompanying means in parentheses are estimated standard errors.

SEXUAL BEHAVIOR

Following Selander and Mathieu (1969), I divide the courtship stage of sexual behavior in *Macrobasis* into (1) an *orientation phase*, in which the male may (depending on the species) touch or press the antennae and maxillary palpi on the female but does not contact her with the body or legs, and (2) a *mounted phase*, in which he holds her with at least the fore- and hindlegs. The mounted phase may be divided into (2a) an active stimulus or "*display*" *subphase*, in which the male performs stereotyped acts evidently intended to stimulate the female, (2b) a *genital presentation subphase*, in which he attempts to insert his genitalia in her genital opening, and (2c) a *riding subphase*, in which he neither displays nor presents the genitalia. The second subphase, which constitutes the entire mounted phase in the Albida Group, was termed "abortive mounting" by Selander and Mathieu (1969).

The mounted position of the male is basically the same in all species of *Macrobasis* (Selander and Mathieu, 1969; Selander, unpublished data). Depending on the size of the male, his head is at the level of the female's or somewhat behind. The forelegs are brought to the sides of the female's prothorax, where principal contact is made by the first tarsal segment. In the Albida and Fabricii groups the male's foretarsi are merely pressed against the sides of the prothorax (foreleg *clasp*); in the Lauta and Diversicornis groups the first segment of the foretarsus is inserted under the hind margin of the female's pronotum (foreleg *lock*). The hindlegs grasp the female on the lateral margins of the elytra or on the sides of the abdomen just below the elytral margin. Here contact is made by the posterior side of the apex of the hindtibia, which is provided with a *hindtibial comb* apparently instrumental in maintaining the grasp (Selander and Mathieu, 1969). In the Lauta and Diversicornis groups the midlegs are extended to the sides as soon as the fore- and hindlegs are positioned properly and are not used to grasp the female at all.

In all groups of *Macrobasis* studied behaviorally a fixed series of activities occurs immediately before copulation to which the name *precopulatory sequence* has been applied (Selander and Mathieu, 1969). The sequence is initiated by the female's *tipping* sharply forward, opening the last segment of the abdomen, and turning it slightly upward. In direct response, the male, if not already mounted, mounts the female immediately, extrudes the genitalia downward and forward and inserts them in her genital opening. The female remains still until the genitalia are coupled, at which point she lowers the body. As a prelude to dismounting, the male usually raises the midlegs or brings them to the substrate at the sides of the female. Finally, he releases the foreleg grasp and either walks off her or falls over backward and then rights himself. During copulation the sexes face in opposite directions, connected only by the genital coupling.

Epicauta lauta (Horn)

Courtship.—The orientation phase is characteristically brief, lasting a few seconds to a few minutes. The male appears to recognize a female only when within a distance of a few centimeters. He then turns to face her and approaches directly, with little indication of wariness and with no tendency to hesitate or posture before her. The antennae are directed forward and held immobile; the maxillary palpi are fully extended forward. There is no attempt to antennate or palpate the female.

As the male mounts the female he brushes the tips of the maxillary palpi lightly over her elytra. On reaching the dorsal position he immediately establishes the foreleg lock and hindleg grasp, raising his body well above the female's dorsum. The apex of the foretibia, as well as the first foretarsal

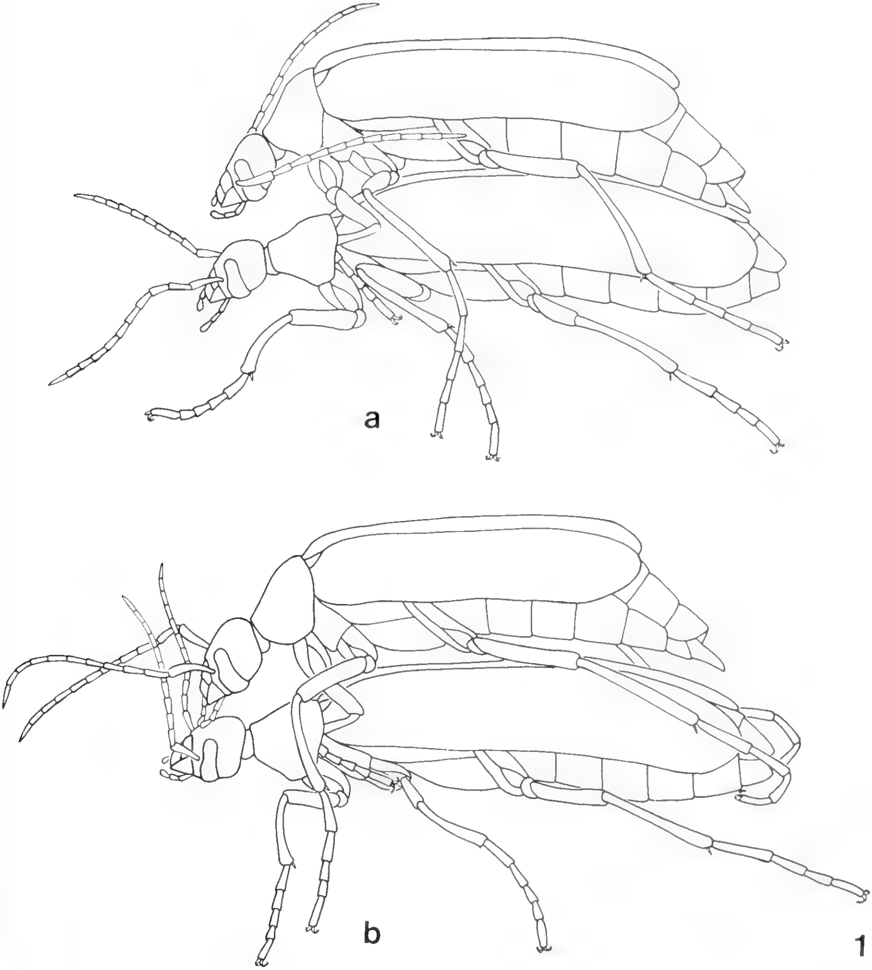

Fig. 1. Courtship in *Epicauta lauta*. a, Riding. b, Antennal embracing.

segment, may be inserted beneath the female's pronotum. The posterior surface of the foretibia rests lightly on the female, conforming by its curvature to the shape of the humeral area of the elytra. The positioning of the hindlegs is nearly as precise as that of the forelegs. The apex of the hindtibia rests just on the lateral margin of the female's elytron, near the level of the hind margin of the third visible abdominal sternum. The hindtarsi do not touch her.

The mounted phase of courtship is characteristically of long duration (sev-

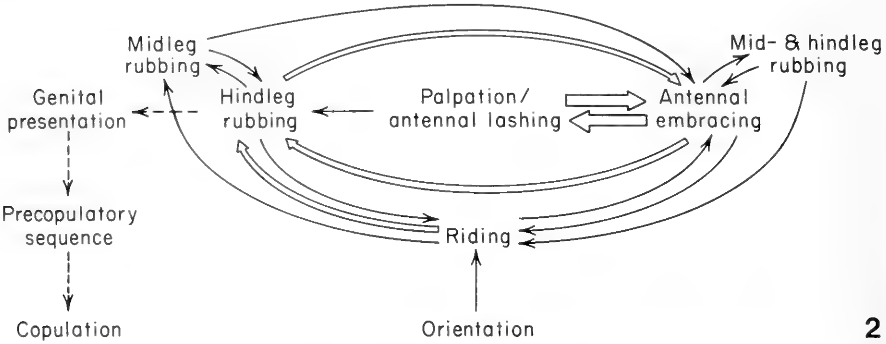

Fig. 2. Sequence of male sexual behavior in *Epicauta lauta*. Relative frequencies of the observed transitions are suggested by the thicknesses of the arrows. Transitions not actually observed are represented by dashed arrows.

eral minutes to an hour or more). It is characterized by extended bouts of display interspersed with brief bouts of riding.

In the riding subphase (Fig. 1a) the head is elevated, the maxillary palpi are folded, and the antennae assume the position shown in the figure or are directed even more strongly backward, parallel to the body. The femur of the midleg projects horizontally to the side, with the tibia and tarsus sloping diagonally downward; the tarsi sometimes rest on the substrate at each side of the female. In no case that I observed were the midlegs fully extended or the femur directed above the horizontal. During both the riding and display subphases the end of the male's abdomen is open and the genitalia partially extruded.

Riding seems to occur chiefly in response to sudden movement of the female or an especially vigorous attempt to dislodge the male by brushing over the back with the mid- or hindlegs.

The male courtship display of *Epicauta lauta* is unusually complex for a species of *Macrobasis*. It involves three principal activities: *leg rubbing, antennal embracing* (AE), and *palpation/antennal lashing* (PAL). These occur sequentially (Fig. 2), although the first two usually overlap at least briefly.

Leg rubbing is a compound activity consisting of *hindleg rubbing* (HLR) and *midleg rubbing* (MLR), which are performed separately as a rule but on occasion occur simultaneously. In any case, the head is elevated and the antennae are directed backward, as in riding. In HLR, which is typically the initial activity in a bout of display, the hindlegs are straightened, directed backward, and rubbed rapidly from side to side over the female's elytra. The two legs move synchronously and in phase. Frequently the tarsi curl over the end of the female's abdomen, as in Fig. 1b. A bout of HLR lasts about two s; at 30°C, complete leg strokes occurred at a mean rate of 6.3 per s.

MLR consists of curling the midtarsi and rapidly and rather delicately dabbing or brushing them on the legs and sides of the female's abdomen in a poorly controlled, rather indiscriminate manner. Frequently the behavior occurs in several brief bursts of activity following one another in rapid succession. Mean duration of bouts of MLR was about 1⅓ s; mean rate of movement (at 30°C) was 7.4 strokes per s.

In the typical pattern of courtship, HLR alternates with repeated cycles of AE and PAL. However, in what I interpret to be especially intense behavior, AE alternates with simultaneous rubbing by both the mid- and hindlegs. In this behavior the midlegs are straightened and directed backward in the same manner as the hindlegs and move synchronously with them, in opposite phase.

It is interesting that MLR may be performed as a substitute or HLR (or vice versa). For example, in two filmed sequences in which the female is tipped to the side and resting on one of the male's hindlegs, there is simultaneous movement of the free hindleg and the opposite midleg.

AE (Fig. 1b) is a precise manipulation of the female's antennae by the male's. To initiate it the male, while lowering the head, brings each antenna forward just to the outside of the corresponding antenna of the female and, by bending his antennae at the junction of segments I and II, crosses his flagella in front of the female's head, completely encircling her antennae in a very loose embrace. If the female does not resist, each of her antennae slides into the bend in the male's antenna. The male then presses his antennae inward and raises his head, bringing the female's antennae straight up and parallel in front of his head, where they are held momentarily before release. In film timings (at 30°C) males spent a mean of about 1 s bringing their antennae forward and a mean of ¼ s embracing the female's.

Frequently AE is followed immediately by HLR. However, when the female is passive, a pattern of extended, rhythmic cycling between AE and PAL develops. In each cycle there is a relatively extended period of PAL, followed by a single performance of AE, during which palpation is not interrupted but, rather, is directed to the top of the female's head.

The palpation element of PAL is an animated, vigorous rubbing of the maxillary palpi on the female's pronotum produced by the male's rapidly and repeatedly nodding the head. At 30°C, mean duration of bouts of rubbing was 1.2 s, mean rate of head movement 5.4 nods per s. Palpation is always accompanied by antennal lashing, in which the male directs his antennae forward and moves them rapidly from side to side over the female's. The movement is poorly controlled and is apparently not directed at any specific part of the female's antennae. Occasionally, the male's flagellum may be thrown into a complete loop; and in one filmed sequence a loop momentarily encloses one of the female's antennae. There is no indication in the films that the male attempts to grasp the female's antennae or manipulate them in a deliberate manner, but one cannot help but be impressed by the similarity of this behavior to the much more highly developed and stereotyped antennal whipping and curling of some species of the Albida Group.

Females did not attack males in the orientation phase of courtship and were, in general, rather tolerant of courting males in the mounted phase. The most common negative response of the female is to brush over the back with the middle or hind legs. This often interrupts the male's display cycle but is apparently ineffectual in dislodging him. A second negative response is to lower the head and antennae, making it difficult or impossible for the male to perform AE. In a third negative response the female elevates her head and antennae as far as possible, pressing the latter against the front of the male's head. In both observed cases of this behavior the male lowered the head onto the female's pronotum and appeared to push against it with the mandibles.

Genital presentation apparently occurs very infrequently during courtship. I did not record a single complete bout of this behavior. However, on one occasion, following HLR, a male strongly extruded the genitalia, directed them downward, and began lowering the end of the abdomen. It is on this basis that I indicate in Fig. 2 a possible transition of HLR to genital presentation.

Precopulatory sequence and copulation.—Not observed.

Epicauta polingi Werner

Courtship.—In this species, as in *E. lauta,* the orientation phase of courtship is brief, the mounted phase is generally lengthy, and there is a definite display subphase of the mounted phase.

The male of *E. polingi* seems rather wary when approaching a female; otherwise, his behavior is essentially like that of *E. lauta.* A figure of an orienting male of *E. polingi* is given by Selander and Mathieu (1969).

In nearly all observed bouts of courtship the male mounted from directly or diagonally behind the female. As he mounts he slides the maxillary palpi along the female's elytra. On reaching her dorsum he quickly inserts the foretarsi under the female's pronotum and brings the ends of the hindtibiae to the lateral margins of her elytra, exactly as in *E. lauta.*

The male in one filmed sequence, having just mounted, lashed the antennae over those of the female for several seconds, at times throwing a complete loop in one of the flagella and loosely encircling one of the female's flagella, in the fashion described for *E. lauta.* In another case, a male initiating a bout of courtship that led shortly to copulation performed essentially this same behavior while standing in front of the female, just before mounting. No comparable behavior was noted in any other bouts of courtship.

All but a small fraction of the male's time in the mounted phase is devoted to riding. In this behavior (Fig. 3a) the head is moderately elevated and the midlegs are fully extended and directed to the sides. In low-level riding the flagellum is directed nearly straight forward, the midfemur is nearly horizontal, and the rest of the midleg droops slightly. In high-intensity riding, performed when the female moves suddenly or brushes over her back, antennal segment I is directed upward and the midlegs are elevated well above the horizontal, with the tarsi curving upward, as the male clearly tries to keep these appendages as far as possible from the female. The male's genitalia are extruded throughout the mounted phase. The degree of extrusion is consistently greater than in *E. lauta*.

Periodically, especially when the female is still, the male slowly lowers the antennae and tries to perform *antennal rubbing* (AR) (Fig. 3b). In this act antennal segment I is directed diagonally forward and the flagella curve downward, closely paralleling each other distally. By moving antennal segment I, the male then rubs the flagella rapidly and vigorously forward and backward several times on the top and front of the female's head. The antennae move synchronously and in phase. Two or more brief bouts of AR may be performed in succession. In many females that I have examined the clothing setae on the midline of the head are abraided, presumably as a result of AR.

There is a second form of antennation, antennal touching (AT), observed less frequently than AR, in which the male inclines the head to one side and delicately touches the end of his opposite antenna on the front of the female's head. In one case AT was followed immediately by AR; in another, two bouts of AT occurred in succession. In three filmed bouts of the behavior males touched the female's head 6, 12, and 2 times, respectively.

The only other active component of display in the mounted phase is a delicate, casual dabbing of the maxillary palpi on the top of the female's head. In my observations it was performed sporadically and then only briefly.

Genital presentation subphase.—Males rarely attempted to insert the genitalia except in the course of the precopulatory sequence. In a few instances a male presented the genitalia as soon as he mounted, a form of behavior suggesting the "abortive mounting" of the Albida Group.

Precopulatory sequence.—As a rule, tipping by the female occurs while the male is mounted, usually as an immediate response to AR. When the female tips, the male usually dabs the maxillary palpi lightly on her head or pronotum. Males that were large enough to insert the genitalia without moving backward continued to perform AR during genital presentation. After

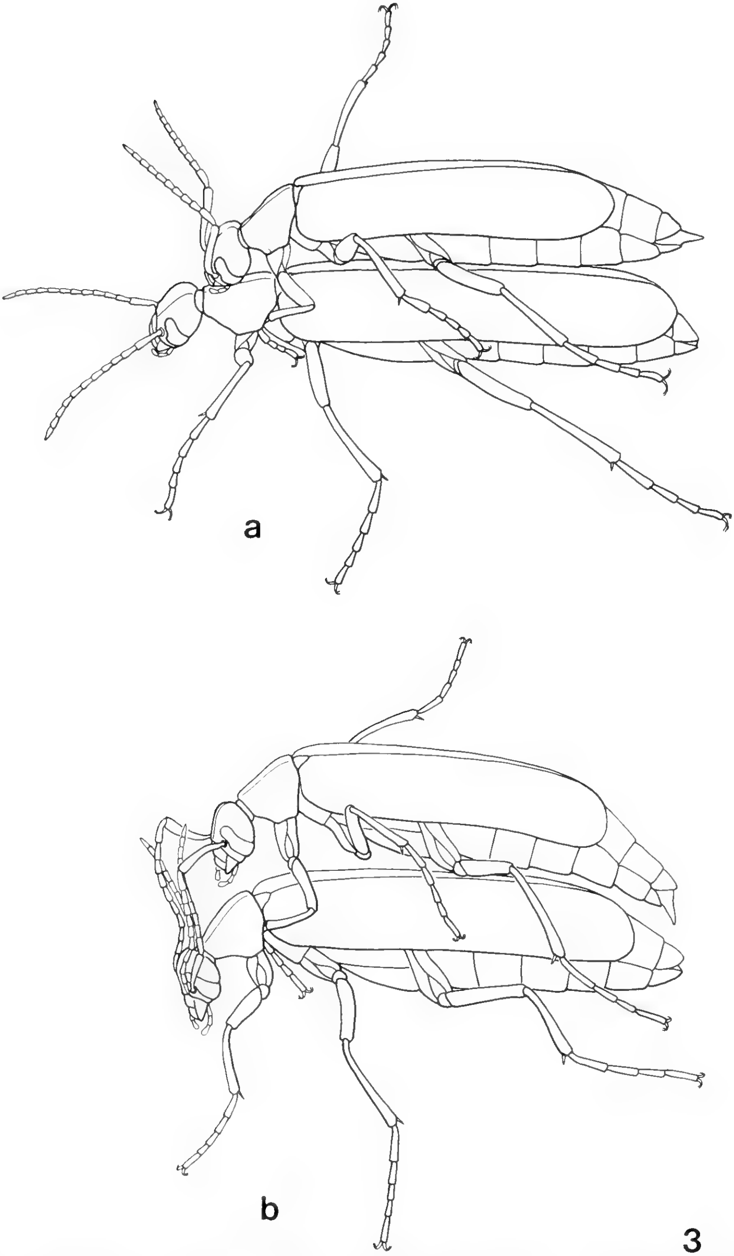

Fig. 3. Courtship in *Epicauta polingi*. a, Riding (after Selander and Mathieu, 1969; copyright, Board of Trustees, University of Illinois, used with permission). b, Antennal rubbing.

the genitalia are coupled the male lowers the midlegs to the substrate, if he has not already done so. In two separate timings, the precopulatory sequence, from presentation of the genitalia until "turnoff" of the male, lasted 100 and 130 s, respectively.

If a female is ready to copulate when approached by a male, she may solicit copulation by tipping during the orientation phase of courtship. This behavior was observed in two cases in which reared females about a month old were exposed to males for the first time.

Copulation.—I observed several bouts of copulation in *E. polingi* but did not record the duration of any.

***Epicauta arizonica* Werner**

In my very limited observation of this species I was unable to detect any significant difference in its courtship behavior and that of *E. polingi*. As in that species, the orientation phase is brief and the mounted phase involves long periods of riding interspersed with short bouts of display. The riding behavior appears to be identical. The display consists of male antennal manipulation of the female's head at least superficially like antennal rubbing in *E. polingi*.

DISCUSSION

The Lauta and Diversicornis groups both differ markedly from the Albida Group with respect to the general pattern of male courtship behavior. In the Albida Group, as described by Selander and Mathieu (1969), the orientation phase dominates courtship temporally and incorporates stereotyped visual and tactile stimulatory acts by the male, whereas the mounted phase entails only genital presentation, typically performed forceably and briefly. An intermediate pattern is found in the Fabricii Group, where the mounted phase incorporates a distinct riding subphase but, as in the Albida Group, lacks a display subphase (Selander and Mathieu, unpublished data).

There is, among species of *Macrobasis*, a strong correlation between the length of the mounted phase of male courtship and the strength of modification of the male's fore- and hindlegs. In the Lauta and Diversicornis groups, where, as we have seen, the male spends nearly all of the courtship period mounted on the female, the forelegs are strongly modified to facilitate the foreleg lock (Fig. 4) and the hindtibial comb is consistently present and well developed. In contrast, modification of the male forelegs in the Albida and Fabricii groups consists largely of loss of one of the tibial spurs, and the hindtibial comb is vestigial or absent in most species.

Antennal segment I is somewhat longer and thicker in the male of *Epicauta lauta* than in the female, but the sexual dimorphism is minor compared to that in the Diversicornis Group. The adaptive significance of the great

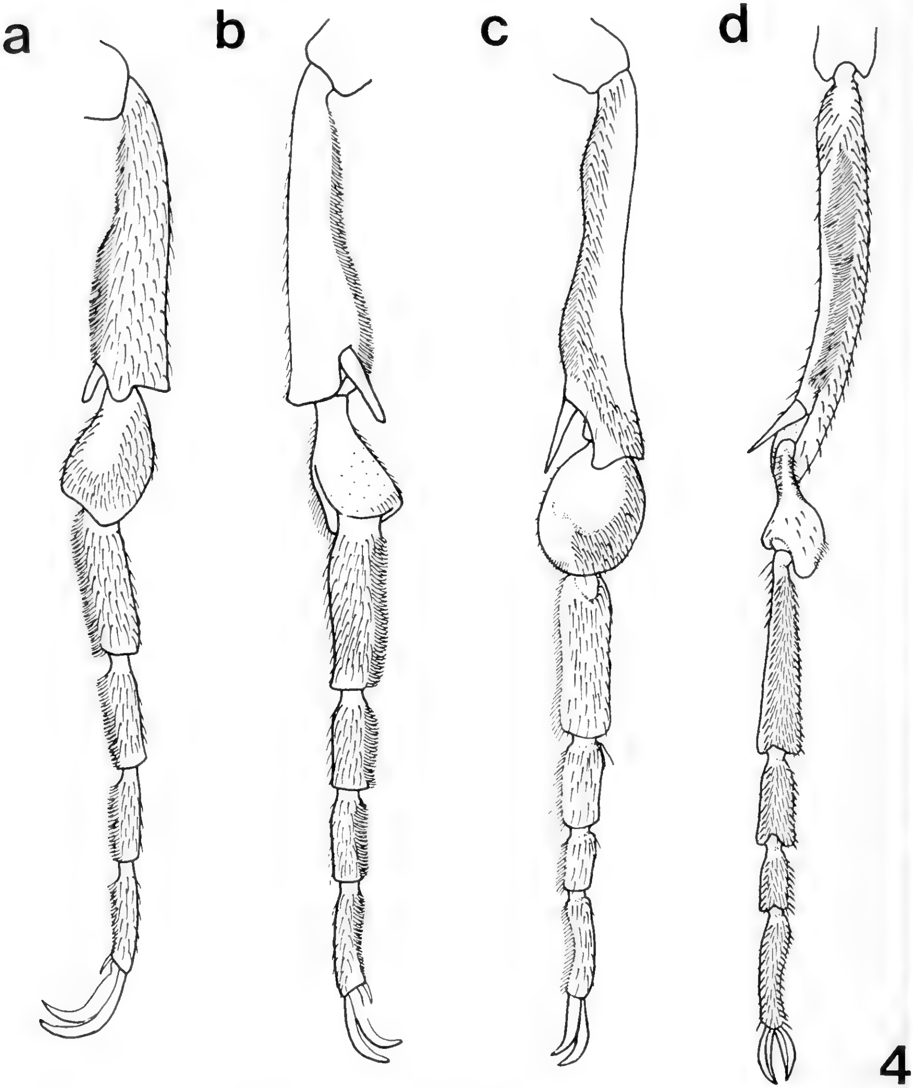

Fig. 4. Tibia and tarsus of male foreleg. a, *Epicauta lauta*, anterior view. b, Same, posterior view. c, *E. polingi*, anterior view. d, Same, ventral view.

enlargement of the first two antennal segments of the male in *E. polingi, E. arizonica*, and many other species of *Macrobasis* is difficult to interpret solely in mechanical terms. Despite the lengthening of these segments, the male's antennae are not much longer than the female's, so the dimorphism presumably reflects more than a means of increasing the effective distance at which they may be employed in tactile stimulus. That the modifications are important mechanically in the curling and other contortions of the flagellum seems unlikely since males of many other species of Meloidae lacking marked sexual dimorphism of the antennae perform equal elaborate flagellar movements in courtship. Almost certainly, the antennal dimorphism in *Macrobasis* involves visual stimulation of the female by the male. In the Albida Group, males possessing enlarged basal antennal segments characteristically posture in front of females, literally displaying the antennae, whereas in males without the enlargement this behavior is much less developed or absent (Selander and Mathieu, 1969). Moreover, in some species of *Macrobasis* the enlarged antennal segments contrast strongly with the remainder of the antenna and with the body in being yellow in color, as though designed to attract attention.

BIONOMICS

Adult activity.—Adults of *Epicauta lauta* and the species of the Diversicornis Group are attracted to lights at night, often in huge numbers. They are not strictly nocturnal, however, since large populations of some of the more common species have been found feeding in the daytime. Adults of at least one species of the Diversicornis Group migrate in large swarms. On the morning of 21 July 1955 at Lo de Lomeda, in the mountains of Nayarit, I found a migrating population of thousands of *E. beckeri* (Dugès) adults crossing the highway that connects Tepic and Mazatlán. The beetles moved in slow, steady flight two to 15 feet above the ground, coming up in waves a few minutes apart from a low area on one side of the highway and dropping down into a canyon on the other. Some individuals alighted and then took off again. None walked an appreciable distance and none was found feeding on the vegetation nearby. I observed the migration for 75 minutes; it was still in progress when I left the site.

In Arizona, the seasonal range of adults of *Epicauta lauta* is June to November (Werner et al., 1966). In Apodaca, Nuevo León, Hernández (1960) took adults of the species in a light trap from May to November; the percentage distribution by month of the catch ($N = 7663$) was: May, 2.8; June, 13.1; July, 6.5; August, 50.7; September, 25.8; October, 1.0; and November, 0.2. *Epicauta polingi* has been taken from April to September, *E. arizonica* from July to September, and *E. liebecki* Werner from May to July (Werner, 1945; Werner et al., 1966).

Feeding behavior.—Although *Epicauta lauta* is one of the more commonly collected species of meloids in the southwestern United States, no food plant was known before Hurd and Linsley (1975) reported finding adults on *Larrea tridentata* at several localities in southern Arizona.

The Diversicornis Group resembles the Fabricii Group in apparently fa-

Table 1. Hatching time of eggs and number of eggs per mass.

	Hatching Time (Days)					Eggs per Mass			
Species	Mean	SE	Range	*N* Masses	Temp. (°C)	Mean	SE	Range	*N* Masses
E. lauta	18.0	2.00	16–20	2	?	355	0.0	—	1
E. arizonica	16.0	0.00	—	3	27	229	14.2	201–248	3
E. polingi	15.1	0.61	12–21	18	?[a]	171	13.8	128–220	7

[a] Two masses (Balmorhea, Texas) hatched in 17 and 19 days, respectively, at 27°C. Temperature was not controlled for the other masses.

voring plants of the family Leguminosae. Werner et al. (1966) reported finding *Epicauta liebecki* on *Prosopis* several times ("once in great numbers") and *E. arizonica* on *Prosopis* foliage at night. I have found *E. polingi* feeding on *Prosopis juliflora* flowers at night in Texas and have taken an adult here and there on *Solanum elaeagnifolium* in the day. Hernández (1960) collected 28 adults from *S. elaeagnifolium* in Nuevo León. Captive adults used in my behavioral studies ate the flowers of *Solanum elaeagnifolium* but clearly preferred those of *Prosopis juliflora*. I occasionally saw them chewing on the leaves of *Prosopis*. Reared adults of *E. polingi* lived 40–87 days [mean 59.5 (7.77)] on a diet of *Medicago sativa* and *Solanum tuberosum* (four cases) or *Medicago* alone (one case). *Solanum dulcamara* was refused by these adults, and a local, spiny *Solanum* and a local *Amaranthus* were refused by adults of *E. arizonica* collected at light in Culiacán, Sinaloa.

I have taken *Epicauta diversicornis* in Nayarit and Michoacán on unidentified legumes and in Morelos on *Prosopis*. In addition, in Guerrero I once found the species feeding in great abundance on the leaves of a viny shrub (without flowers) that was identified by the botanist Faustino Miranda as a species of Malpighiaceae.

Epicauta isthmica Werner was taken in large numbers by W. H. Young at Cotaxtla, Veracruz, in July 1958 on *Crotalaria*.

Eggs.—Available data on hatching time of eggs and number of eggs per mass are summarized in Table 1. Hatching time is comparable to that recorded for *E. murina* (Gilbertson and Horsfall, 1940) and species of the Albida Group but much shorter than that of *E. fabricii* (Horsfall, 1943). *Epicauta polingi* is one of several species whose eggs I have tested for ability to produce blisters by taping eggs to my forearm. The test was positive.

Postembryonic development.—*Epicauta polingi* was reared on diapausing, year-old eggs of the acridid grasshopper *Melanoplus differentialis* (Thomas) in 1963 by J. M. Mathieu and myself. Twenty-five 7-day-old T larvae from an egg mass laid by a female from Balmorhea, Texas, were

Table 2. Cumulative time (days) for larvae of *Epicauta polingi* to reach developmental periods.

Period	Mean	SE	*N*
FG_2	4.5	.38	22[a]
FG_3	5.7	.43	19
FG_4	7.6	.68	14
FG_5	10.2	.66	14
FG_{5pf}[b]	17.4	.70	11
FG_6	14.0	—	1
FG_{6pf}[b]	21.0	—	1
C_6	21.0	—	1
C_7	26.0	—	1
P_6	26.9	1.22	9
A_7	36.6	.87	5

[a] Data for one larva, greatly delayed in reaching FG_2 (14 days), omitted entirely.
[b] Postfeeding period in FG (after transfer from food to sand).

confined individually with *Melanoplus* eggs in glass tubes and placed at 27°C, 100% RH, in darkness in a homemade incubator. Twenty-three larvae (92.0%) fed and reached FG_2. As the rearing progressed, 11 larvae and one pupa were killed as specimens; one larva died after several months in the C phase. FG_5 or FG_6 larvae were given food until they stopped eating and then transferred to 3-dram vials packed with moist sand.

Developmental timing, summarized in Table 2, is well within the norm for rearings of species of *Epicauta*. Eleven larvae had four instars in the FG phase; one had five. As reported previously (Selander and Weddle, 1969), nine (75.0%) of 12 larvae followed the pattern T-FG-P-A; the rest followed the pattern T-FG-C. One of the two C_6 larvae and the single C_7 larva were chilled at 5°C from day 86 to day 255 of the rearing and then returned to 27°C. The former died 32 days after chilling. The latter ecdysed in 61 days to form a SG_8 that was structurally abnormal in retaining some coarctate characteristics.

The incidence of the pattern T-FG-P-A is unusually high, especially at 27°C. Taken together with the lengthy seasonal range of adult activity, it almost certainly indicates that *E. polingi* has more than one generation a year.

THE FIRST-INSTAR LARVA

MacSwain (1956) distinguished the first-instar larvae of *Epicauta fabricii* and *E. murina* from those of other species of *Epicauta* as follows: (1) abdominal sternite VII well developed, complete; maxillary palpal segment III of a unique form (short, with sensory area subcircular, dorsal, extending less than ½ length of segment, set with numerous long papillae); and (3) labial palpal segment II with two dorsobasal setae, each extending beyond the apex of the segment. *Epicauta arizonica* and *E. polingi* agree with this diagnosis except that sternite VII is divided on the midline of the body. However, the significant point, it seems to me, is that the sternite is nearly as fully developed in these species as in those of the Fabricii Group, whereas no other species of the genus is comparable in this respect. Another noteworthy similarity between larvae of the Diversicornis and Fabricii groups is the presence of two dorsobasal setae on segment III of the maxillary palpus. All other species of *Macrobasis* have one. As recorded in the key and descriptions that follow, the two groups closely resemble each other in several other anatomical characters, including chaetotaxy of the frontal area of the head, labrum, and antennae and the form of the labrum, mandibles, gula, and cardo.

Epicauta lauta shares none of the special similarities linking the Diversicornis and Fabricii groups. Abdominal sternum VII is no more strongly or extensively sclerotized than usual for the genus. The maxillary cardo is better developed. Maxillary palpal segment III is slender and elongate; its sensory area is positioned dorsolaterally and is sparsely set with short, peglike papillae; and there is only a single dorsobasal seta. Labial palpal segment II has only a single dorsobasal seta also. As a matter of fact, the larva of *E. lauta* is one of the most distinctive types yet described in *Macrobasis*. It differs from all other larvae of the subgenus in having the labrum (and clypeus) much enlarged, the mandibles greatly elongated and bearing an unusually large number of teeth, the lanceolate setae of femur I more numerous, and the reticulations of the abdominal sclerites devoid of posterior projections. In addition, it is the only species of the genus *Epicauta* possessing three, rather than four, basal setae on each side of the dorsum of the head.

The form of the mandibles and maxillary palpi in *E. lauta* suggests the condition in *E. atrata* (Fabricius), a species of the nominate subgenus of *Epicauta* for which I recently obtained evidence indicating larval predation on the eggs of blister beetles rather than those of grasshoppers, the usual prey of larvae of *Epicauta* (Selander, 1981). The modifications of the mouthparts are not as extreme in *E. lauta*. Further, spiniform cuticular evaginations are relatively well developed, whereas in *E. atrata* and in other species that I believe share its larval prey-type, the evaginations are poorly developed or absent. Still, the mouthparts of *E. lauta* differ sufficiently from the norm of the genus as to suggest a special study of larval feeding behavior of the species at the earliest opportunity.

Formal diagnoses of the Lauta, Diversicornis, and Fabricii groups in the larval stage are given in the following key, which further serves to emphasize the distinctiveness of the Lauta Group with respect to the others.

DIAGNOSTIC KEY TO THE LAUTA, DIVERSICORNIS, AND FABRICII GROUPS BASED ON THE FIRST-INSTAR LARVA

1. Median pair of setae on anterior margin of frontal area of head set close to margin; gula flared anteriorly, well separated from labium; stemma 2× as large as mesothoracic spiracle; apical setae of antennal segments II and III short; labrum more than $^{2}/_{5}$ as wide as head; mandible slender, elongate, with 15–18 teeth, these small, truncate; maxilla with cardo large; maxillary palpal segment III 2× as long as wide, with a single dorsobasal seta and with sensory area dorsolateral, bearing short, peglike papillae; labial palpal segment II with a single dorsobasal seta; reticulations of abdominal sclerites lacking posterior projections; sternum VII weakly sclerotized, none of the posterior marginal setae sharing a common sclerite; caudal seta 1½× as long as segments VII–IX combined; femur I with 8–9 (rarely 7) lanceolate setae; tarsungulus distinctly curved .... Lauta Group

– Median pair of setae on anterior margin of frontal area of head set well back from margin; gula gradually wider anteriorly, touching labium; apical setae of antennal segments II and III long; labrum ⅓ as wide as head; mandible robust, with 13 or fewer teeth; cardo vestigial; maxillary palpal segment III at most $1^{2}/_{5}$× as long as wide, with two dorsobasal setae and with sensory area dorsal, bearing long, spiniform papillae; labial palpal segment II with 2 dorsobasal setae; reticulations of at least abdominal tergites and pleurites with distinct posterior spiniform projections; sternum VII strongly sclerotized, with a distinct sternite (divided or not); caudal seta at most $1^{2}/_{5}$× as long as segments VII–IX combined; femur I with 7 (rarely 6) lanceolate setae; tarsungulus weakly curved 2

2. Gular setae not attaining anterior margin of gula; stemma 1½× as large as mesothoracic spiracle; apical setae of antennal segment II reaching or surpassing apex of III; mandible with 5–12 teeth, these truncate or not; metanotum with line of dehiscence complete; reticulations of abdominal sternites with distinct posterior projections; seta 1 of posterior row of tergite V at most ¾ as long as tergite; seta 1 of median transverse row of tergite V $^{1}/_{6}$ as long as tergite; sternum VII with sternite divided on midline; caudal seta at least 1⅓× as long as segments VII–IX combined .... Diversicornis Group

– Gular setae surpassing anterior margin of gula; stemma no larger than mesothoracic spiracle; apical setae of antennal segment II not attaining apex of III; mandible with 11–13 teeth, these truncate; metanotum with line of dehiscence incomplete; reticulations of abdominal sternites lacking posterior projections; seta 1 of posterior marginal row of tergite V nearly as long as tergite; seta 1 of median transverse row of tergite V ⅛ length of tergite; sternum VII with a complete, undivided sternite; caudal seta $1^{1}/_{10}\times$ as long as segments VII–IX combined .... Fabricii Group

Description of the Species

Epicauta lauta (Horn)

Figs. 5, 7a, d

Color of head, pro- and mesonotum, and abdominal tergites I–V or I–VI light brown; metanotum and tergites VI–IX or VII–IX dark brown. Body surface weakly reticulate; reticulations without posterior projections.

Head ¾–$^{4}/_{5}$ as long as pro- and mesonotum combined, widest near middle, $1^{1}/_{10}\times$ as wide as long, strongly constricted behind middle, basal width $^{7}/_{10}$ maximum width; dorsal surface with 18 major and 3 minor setae on each side; stem of epicranial suture $^{2}/_{5}$ as long as head; distance from bifurcation of suture to level of first pair of setae on frontal area no more than $^{3}/_{5}$ length of stem. Gula flared, much widened anteriorly, more than 7× as wide at apex as at base, well separated from labium; length $^{4}/_{5}$ maximum width of head; distance from base to gular setae $^{4}/_{5}$–$^{9}/_{10}$ length of gula; setae not reaching anterior margin. Stemma large. Antenna elongate; segment II $2^{1}/_{2}$–$2^{7}/_{10}\times$ as long as III, anteroventral apical seta minute, much shorter than other two, which reach about middle of III, sensory organ at least as long as III; segment III with apical setae about ½ as long as segment, terminal seta $1^{1}/_{10}$–$1^{3}/_{10}\times$ as long as II. Labrum with 6 setae in median row, seta 3 of row well separated from lateral margin, seta 1 much shorter than rest; lateral margin with 3 short setae. Mandible $^{3}/_{4}$–$^{4}/_{5}$ as long as head, $^{1}/_{3}$ to nearly $^{2}/_{5}$ as wide as long, bearing 15–18 teeth (14–16 visible in outline); distal seta longer than basal one. Maxilla with cardo bearing a long, conspicuous seta; palpal segment III with sensory area extending $^{3}/_{5}$ length of segment, not extending onto ventral surface at apex, papillae sparse, length of 2-segmented sensory appendix $^{7}/_{10}$ width of segment II of labial palpus. Labium with premental plate bearing 4 setae; palpal segment II more than 2× as long as wide, dorsobasal seta extending beyond apex of segment, 2-segmented sensory appendix prominent, about $^{3}/_{5}$ as long as that of maxillary palpus. Thorax with line of dehiscence well developed on all segments. Abdomen with 10 setae in posterior marginal row on tergites I–VIII; setae not divided apically; spiniform evaginations at bases of posterior marginal setae moderately developed on tergites I–VI, vestigial on VII; tergite V $2^{7}/_{10}$–$3\times$ as wide as long, seta 1 of posterior marginal row $^{7}/_{10}$–$^{3}/_{4}$ as long as tergum, ratio of lengths of setae 1, 2, and 3 of posterior marginal row 1:1.2–1.3:0.7–0.8, seta 1 of median transverse row thin, ¼ as long as tergite, pleurites ventral, that of V $^{9}/_{10}$ as wide as long, spiracle near center of dorsal ⅓; spiracle I ⅔ or less as large as mesothoracic spiracle, at least 1¼× as large as II–VIII, which are subequal in size; sterna I–VII weakly sclerotized,

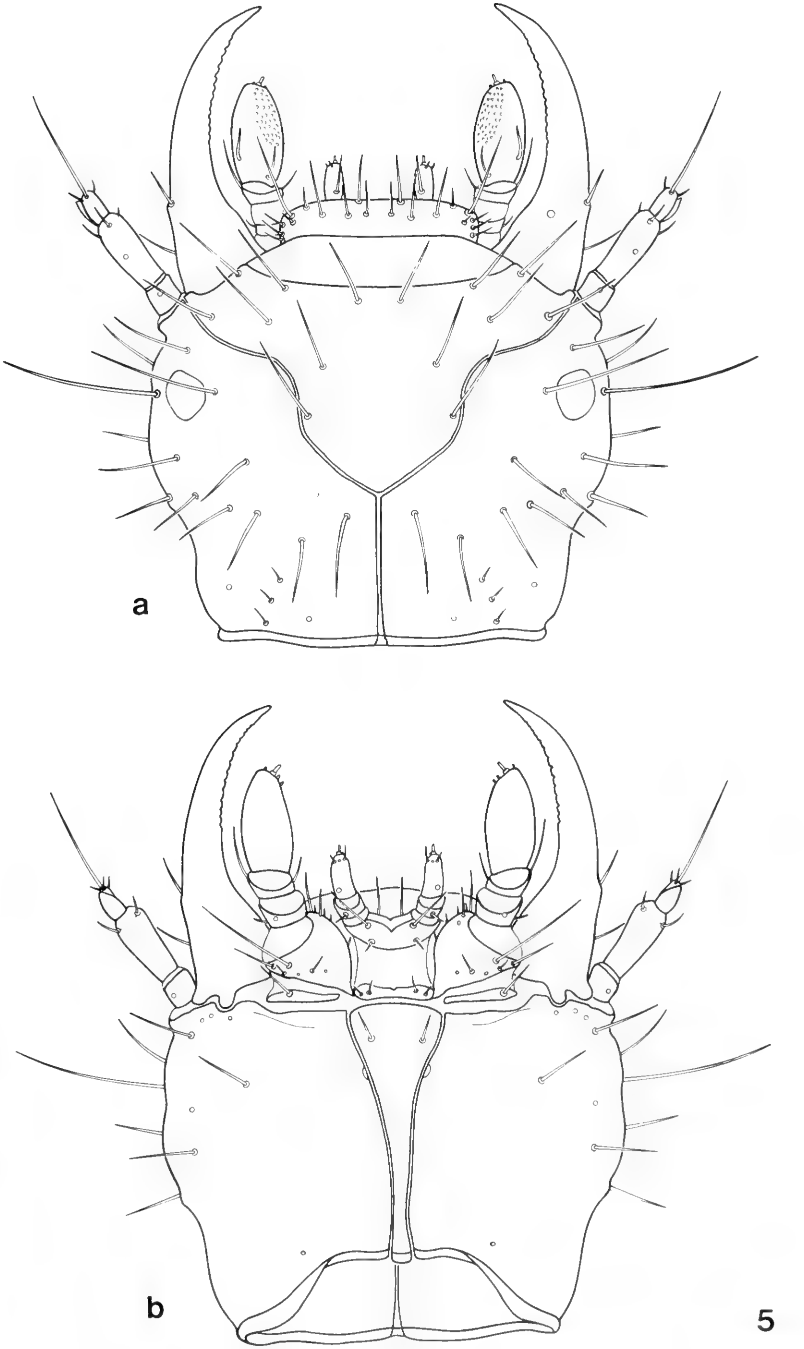

Fig. 5. Head of first-instar larva of *Epicauta lauta*. a, Dorsal view. b, Ventral view.

VIII–IX strongly so. Leg I with lanceolate setae on femur heavy; leg III with femur about 1½× as long as coxa, tibia 1½× as long as femur, tarsungulus $^3/_{10}$ as long as tibia, longer seta $^7/_{10}$ as long as tarsungulus and about $1^1/_5$× as long as shorter seta. Length of body 2.7 mm. Length of caudal seta 0.8 mm.

Material studied.—18 larvae, adults from Van Horn, Culberson County, Texas, 6-VIII-59, R. B. Selander and J. C. Schaffner; 27 larvae, adults from highway 40, 29 mi. SW Ciudad Lerdo, Durango, Mexico, 31-VII-60, R. B. Selander and J. M. Mathieu.

Remarks.—This species is distinguished at a glance from all other species of *Macrobasis* by the form of the mandible and maxillary palpus.

There are typically eight lanceolate setae on femur I. About a third of the specimens examined have eight on one femur and nine on the other; one specimen has seven and eight.

***Epicauta arizonica* Werner**

Figs. 6, 7b, e

Color of head and pronotum dark brown; meso- and metanotum and abdominal terga light brown. Body surface strongly reticulate; reticulations of abdominal sclerites, including sternites, with distinct spiniform posterior projections.

Head subequal in length to pro- and mesonotum combined, widest near middle, $1^1/_{10}$× as wide as long, strongly constricted behind middle, basal width $^7/_{10}$–$^3/_4$ maximum width; dorsal surface with 18 major and 4 minor setae on each side; stem of epicranial suture $^2/_5$ as long as head; distance from bifurcation of suture to level of first pair of setae on frontal area no more than $^2/_5$ length of stem. Gula 4× as wide at apex as at base, projecting anteriad; length $^4/_5$ maximum width of head; distance from base to gular setae $^4/_5$ length of gula. Stemma small. Antenna moderately long; segment II less than 2½× as long as III, anteroventral apical seta much shorter than others, longer than III and reaching its apex, other 2 setae surpassing apex of III, sensory organ longer than III; segment III with apical setae much longer than segment, terminal seta $1^2/_3$–$1^4/_5$× as long as II. Labrum with 6 setae in median row, seta 3 of row near lateral margin, seta 1 about as long as rest; lateral margin with 1–2 short setae. Mandible $^3/_5$ as long as head, ½ as wide as long, bearing 5–6 teeth (4 visible in outline); teeth large, rounded; distal and basal setae subequal in length. Maxilla with cardo small, very thin, bearing a short seta; palpal segment III short, barrel-shaped, at most $1^2/_5$× as long as wide, bearing 2 dorsobasal setae, sensory area extending $^2/_5$ length of segment, not extending onto ventral surface at apex, papillae dense, length of 2-segmented sensory appendix nearly equal to that of segment II of labial palpus. Labium with premental plate bearing only 2 setae; palpal segment II nearly 2× as long as wide, dorsobasal setae extending beyond apex of segment, 2-segmented sensory appendix prominent, nearly

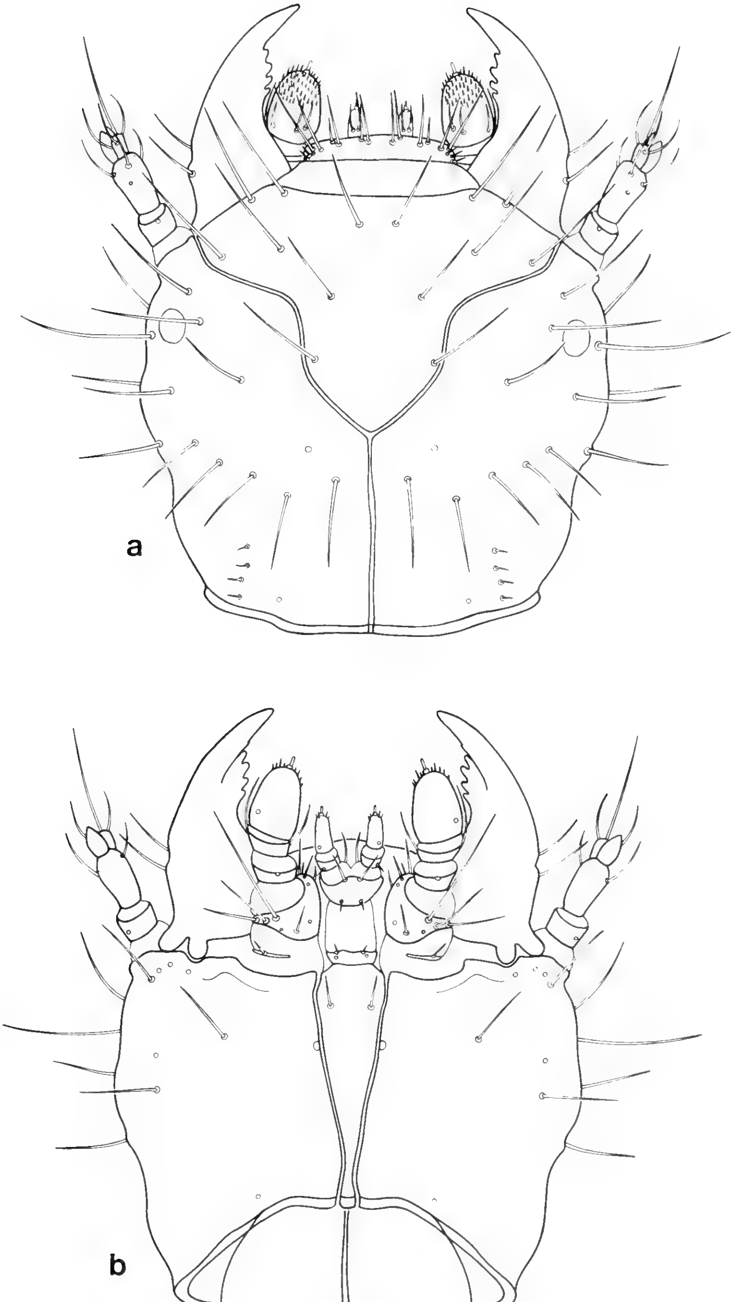

Fig. 6. Head of first-instar larva of *Epicauta arizonica*. a, Dorsal view. b, Ventral view.

$^4/_5$ as long as that of maxillary palpus. Thorax with line of dehiscence well developed on all segments. Abdomen with 10 setae in posterior marginal row on tergites I–VIII; setae not divided apically; spiniform evaginations at bases of posterior marginal setae moderately developed on tergites I–VI, vestigial on VII; tergite V $3^1/_5$–$3^3/_5$× as wide as long, seta 1 of posterior marginal row $^7/_{10}$–$^3/_4$ as long as tergite, ratio of lengths of setae 1, 2, and 3 of posterior marginal row 1:1.1:0.8–1.1, seta 1 of median transverse row thin; pleurites ventral, that of V $^9/_{10}$ as wide as long, spiracle near center of dorsal $^1/_3$; spiracle I $^7/_{10}$–$^4/_5$ as large as mesothoracic spiracle, at least $1^1/_5$× as large as II–VIII, which are subequal in size; sterna I–VI weakly sclerotized, VII moderately so, VIII–IX strongly so, VII with sternite divided on midline into 2 plates each of which contains posterior marginal setae 1 and 2; caudal seta $1^3/_{10}$–$1^2/_5$× as long as segments VII–IX combined. Leg I with lanceolate setae on femur heavy; leg III with femur about $1^3/_{10}$× as long as coxa, tibia $1^1/_4$–$1^3/_{10}$× as long as femur, tarsungulus weakly curved, about $^1/_3$ as long as tibia, longer seta about $^7/_{10}$ as long as tarsungulus and about $1^2/_5$ length of shorter seta. Length of body 2.0 mm. Length of caudal seta 0.9 mm.

Material studied.—23 larvae, adults from Culiacán, Sinaloa, Mexico, 26/27-IX-72, R. B. Selander and A. Berríos-Ortiz (Notes 601-72 RBS).

Remarks.—One specimen has seven lanceolate setae on femur I on one side of the body and six on the other.

Epicauta polingi Werner

Fig. 7c

Color of head, pro- and metanotum, and (usually) abdominal tergites VII–IX brown; mesonotum and tergites I–VI light brown.

Mandible bearing 10–12 teeth (7–11 visible in outline); teeth medium in size, truncate.

Material studied.—15 larvae, adults from Balmorhea, Reeves County, Texas, 26-VII-63, R. B. Selander and J. M. Mathieu (Notes 32–63 RBS); 15 larvae, adults from Ft. Davis, Jeff Davis County, Texas, 8-VIII-63, R. B. Selander and J. M. Mathieu (Notes 22–63 RBS); 8 larvae, adults from Quemado, Maverick County, Texas, 27-VIII-61, R. B. and J. M. Selander (Notes 32–63 RBS); 14 larvae, adults from Quemado, Texas, 29-VIII-61, R. B. and J. M. Selander (Notes 35–61 RBS); 33 larvae, adults from Apodaca, Nuevo León, Mexico, 3/28-VII-60, R. B. Selander and J. M. Mathieu; 10 larvae, adults from Ciudad Victoria, Tamaulipas, Mexico, 9-VIII-62, R. B. Selander and R. H. Storch (Notes 13–62 RBS).

Remarks.—The only differences between this species and *Epicauta arizonica* of use in identifying larval specimens are those of coloration and the form of the mandible, as described above.

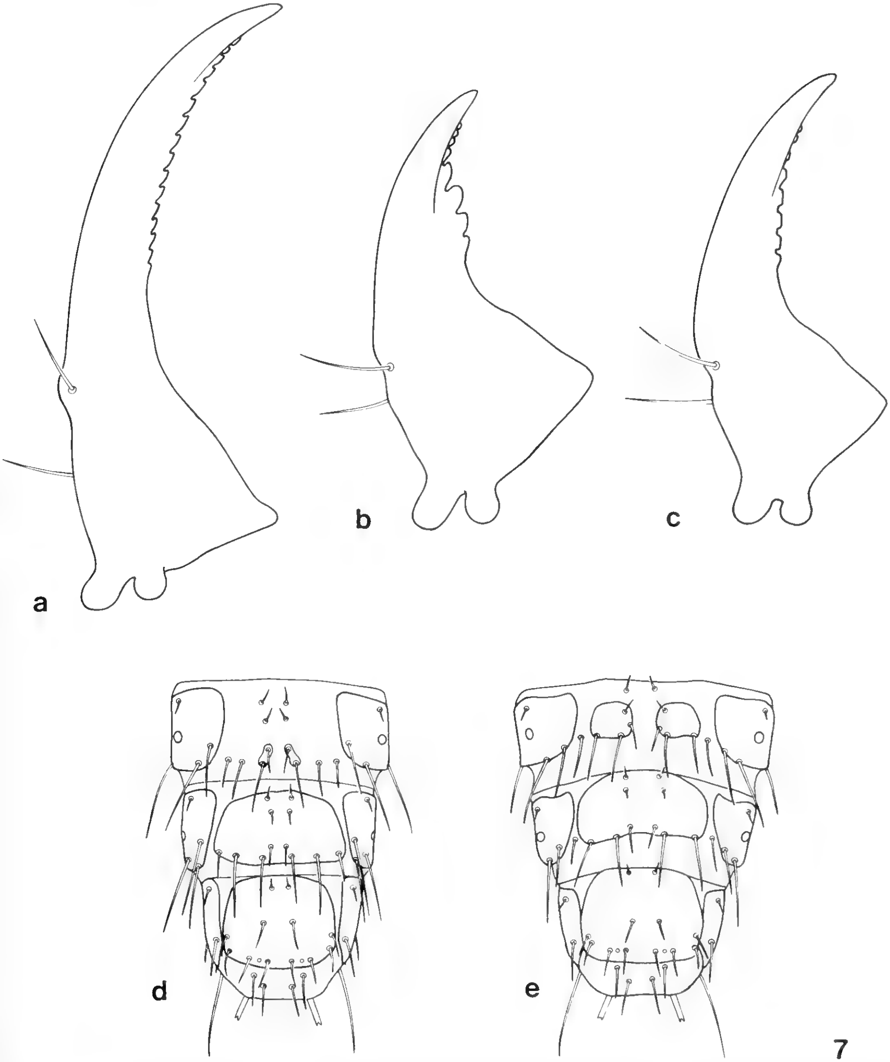

Fig. 7. a–c, Right mandible of first-intar larva, ventral view. a, *Epicauta lauta*. b, *E. arizonica*. c, *E. polingi*. d–e, Abdominal segments VII–IX of first-instar larva, ventral view. d, *Epicauta lauta*. e, *E. arizonica*.

Despite the extensive geographic range from which samples of larvae of *E. polingi* have been obtained, I have been unable to detect significant geographic variation in either color or structural characters. All specimens examined have seven lanceolate setae on femur I.

Epicauta fabricii (LeConte)

Reference.—MacSwain. 1956: 53, pls. 8–9.

Color light brown; pronotum sometimes suffused with brown. Reticulations of abdominal tergites and pleurites with distinct spiniform projections; these not quite so strongly developed as in *E. arizonica* or *E. polingi,* not evident on sternites.

Head with basal width $^4/_5$–$^9/_{10}$ maximum width. Length of gula at least $^1/_2$ maximum width of head. Antenna with anteroventral seta of segment II much shorter than others, no longer than III, not reaching its middle, other 2 apical setae surpassing middle of III, not attaining its apex. Labrum ⅓ as wide as head, with seta 1 of median row distinctly shorter than setae 2 and 3. Mandible bearing 11–13 teeth (9–10 visible in outline); teeth medium in size; distal seta longer than basal one. Metanotum with line of dehiscence incomplete, not attaining margins. Abdomen with spiniform evaginations at bases of posterior marginal setae moderately developed on tergites I–IV, smaller on V, vestigial on VI–VII; tergite V with posterior marginal setae 1, 2, and 3 subequal in length, $^4/_5$–$^9/_{10}$ length of tergite, seta 1 of median transverse row thin; sterna I–VI weakly sclerotized, VII–IX strongly so. Length of caudal seta 0.4 mm.

Material studied.—10 larvae, adults from West Jordan, Salt Lake County, Utah, 11-VII-49, R. B. Selander; 15 larvae, adults from Urbana, Champaign County, Illinois, 31-V-63, R. B. Selander and J. M. Mathieu (Notes 4–63 M); 19 larvae, adults from Urbana, Illinois, 4-VII-61, R. B. Selander and J. K. Bouseman (Notes 4–61 RBS); 51 larvae, adults from Arkansas, received from W. R. Horsfall.

Remarks.—The above description is limited to characters in which *E. fabricii* differs significantly from *E. arizonica* and *E. polingi.* A more comprehensive description is given by MacSwain (1956). I have found no appreciable differences among samples of *E. fabricii* from Utah, Arkansas, and Illinois.

Epicauta murina (LeConte)

Reference.—MacSwain, 1956: 54, pl. 9.

Remarks.—As far as I can determine, from MacSwain's (1956) description and a single larval specimen that I have examined, *E. murina* differs from *E. fabricii* only in having a somewhat less robust mandible.

ACKNOWLEDGMENTS

For their help in collecting adults and obtaining larvae I am indebted to A. Berríos-Ortiz, J. K. Bouseman, J. C. Schaffner, J. M. Selander, and, in particular, J. M. Mathieu. Dr. Mathieu also took an active part in the rearing of *Epicauta polingi*. A special note of appreciation is extended to W. R. Horsfall for a gift of larvae of *Epicauta fabricii* and other species of Meloidae studied by him in Arkansas. The drawings of adult behavior and male forelegs were done by Alice Prickett, who also inked the drawings of larval anatomy. Field work was supported in part by grants from the National Science Foundation.

LITERATURE CITED

Dillon, L. S. 1952. The Meloidae (Coleoptera) of Texas. Am. Midl. Nat. 48: 330–420.

Gilbertson, G. I. and W. R. Horsfall. 1940. Blister beetles and their control. S.D. State Coll. Agric. Exp. Stn. Bull. 340, 23 pp.

Hernández, J. D. 1960. Estudio taxonómico y datos biologicos de la familia Meloidae (Coleoptera) en los alrededores de Monterrey, N.L. Unpubl. thesis, Instituto Tecnológico y de Estudios Superiores de Monterrey, Escuela de Agricultura, 163 pp.

Horsfall, W. R. 1943. Biology and control of common blister beetles in Arkansas. Univ. Arkansas Agric. Exp. Stn. Bull. 436, 55 pp.

Hurd, P. D., Jr. and E. G. Linsley. 1975. Some insects other than bees associated with *Larrea tridentata* in the southwestern United States. Proc. Entomol. Soc. Wash. 77: 100–120.

MacSwain, J. W. 1956. A classification of the first instar larvae of the Meloidae (Coleoptera). Univ. Calif. Publ. Entomol. 12, 182 pp.

Selander, R. B. 1981. Evidence for a third type of larval prey in blister beetles (Coleoptera, Meloidae). J. Kans. Entomol. Soc. 54: 755–783.

Selander, R. B. and J. M. Mathieu. 1964. The ontogeny of blister beetles (Coleoptera, Meloidae). I. A study of three species of the genus *Pyrota*. Ann. Entomol. Soc. Am. 57: 711–732.

———. 1969. Ecology, behavior, and adult anatomy of the Albida Group of the genus *Epicauta* (Coleoptera, Meloidae). Ill. Biol. Monogr. 42, 168 pp.

Selander, R. B. and R. C. Weddle. 1969. The ontogeny of blister beetles (Coleoptera, Meloidae). II. The effects of age of triungulin larvae at feeding and temperature on development in *Epicauta segmenta*. Ann. Entomol. Soc. Am. 62: 27–39.

Werner, F. G. 1945. A revision of the genus *Epicauta* in America north of Mexico (Coleoptera, Meloidae). Bull. Mus. Comp. Zool. 95: 421–517, 7 pls.

———. 1949. *Epicauta diversicornis* and its allies in the Neotropical Region. Psyche (Camb., Mass.) 56: 74–80.

Werner, F. G., W. R. Enns, and F. H. Parker. 1966. The Meloidae of Arizona. Univ. Ariz. Agric. Exp. Stn. Tech. Bull. 175, 96 pp.

PROC. ENTOMOL. SOC. WASH.
84(4), 1982, pp. 822–827

NEW SPECIES AND NEW COLLECTION RECORDS OF CERATOPOGONIDAE (DIPTERA) FROM SRI LANKA

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Abstract.—Two new species of Ceratopogonidae from Sri Lanka are described and illustrated: *Parabezzia* ***orientalis,*** the first of the genus to be found in the Orient, and *Atrichopogon* ***schizonyx.*** New collection records from Sri Lanka are presented for seven species of *Alluaudomyia.*

This paper is one in a series reporting on the biting midges of the family Ceratopogonidae collected by members of the Smithsonian Ceylonese Insect Project. We thank Karl V. Krombein, director of the project, for the opportunity to study this material. We are grateful to Molly K. Ryan for making the illustrations.

For explanation of methods of measurement and of ratios see Giles et al. (1981). The first values presented are those of the holotype followed by the range of variation of the paratypes in parentheses.

Genus *Alluadomyia* Kieffer

The genus *Alluaudomyia* is a cosmopolitan group of approximately 114 species. A revision of the Oriental species with a key was published by Wirth and Delfinado (1964). Delfinado and Hardy (1973) listed three species from the island, *marginalis* Wirth and Delfinado, *spinosipes* Tokunaga, and *xanthocoma* (Kieffer). Four additional species are represented in the Ceylonese Project collections.

Alluaudomyia bifurcata Wirth and Delfinado

New Record.—SRI LANKA: Col. Dist., Beyagama, sea level, 20–21.viii.1973, G. Ekis, 1 ♀.

Alluaudomyia formosana Okada

New Records.—SRI LANKA: Keg. Dist., Kitulgala Resthouse, 3–5.ii.1979, UVL trap, K.V. Krombein, P.B. Karunaratne, T. Wijesinhe, S.

Siriwardane, and T. Gunawardane, 10♀; Rat. Dist., Ratnapura, 1–3.ii.1979, UVL trap, K.V. Krombein, P.B. Karunaratne, T. Wijesinhe, S. Siriwardane, and T. Gunawardane, 2♀.

Alluaudomyia fuscipes Wirth and Delfinado

New Record.—SRI LANKA: Uggalkaltota, 5.ii.1970, D. Davis and W. Rowe, light trap, 1♀.

Alluaudomyia maculosipennis Tokunaga

New Record.—SRI LANKA: Matale Dist., Bandarapola, 12.v.1974, UVL trap, Gans and Prasanna, 1♀.

Alluaudomyia marginalis Wirth and Delfinado

New Record.—SRI LANKA: Uggalkaltota, 5.ii.1970, D. Davis and W. Rowe, light trap, 1♀.

Alluaudomyia spinosipes Tokunaga

New Record.—SRI LANKA: Uggalkaltota, 5.ii.1970, D. Davis and W. Rowe, light trap, 2♀.

Alluaudomyia xanthocoma (Kieffer)

New Record.—SRI LANKA: Keg. Dist., Kitulgala Resthouse, 3–5.ii.1979, UVL trap, K. V. Krombein, P.B. Karunaratne, T. Wijesinhe, S. Siriwardane, and T. Gunawardane, 1♂.

Genus *Parabezzia* Malloch

The genus *Parabezzia* has been considered as mainly a New World genus with 18 known species from the Americas. There are four known Afrotropical species, *falcipennis* Clastrier (1960) from Zaire, *insolita* Vattier and Adam (1966) from the Congo Republic, and *obscura* de Meillon and Wirth (1981b) and *stagni* de Meillon and Wirth (1981a) from South Africa. The discovery of a new species from Sri Lanka in the Oriental Region indicates that the genus is still more widespread than formerly suspected.

Parabezzia orientalis Giles and Wirth, New Species

Fig. 1

Female holotype.—Wing length 0.90 (0.89–1.12, $n = 5$) mm; breadth 0.40 (0.39–0.48, $n = 5$) mm.

Head: Brown. Eyes well separated. Antennal pedicel light brown, flagellum darker; verticils well developed on all segments; length of flagellar segments (Fig. 1a) in proportion of 42-36-30-31-32-31-32-30-38-43-44-44-61, antennal ratio 0.87. Palpus (Fig. 1b) light brown, 4-segmented; lengths of segments in proportion of 10-20-34-21; 3rd segment with 2 (1–2, $n = 5$) cap-

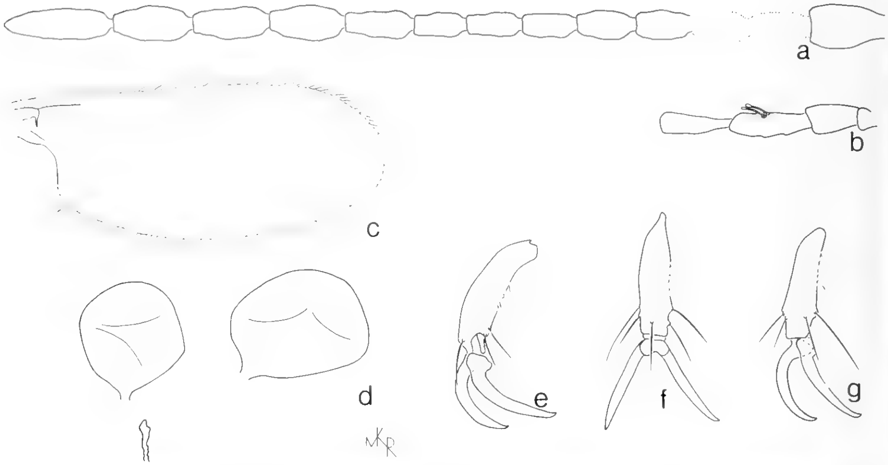

Fig. 1. *Parabezzia orientalis*, female. a, Antenna. b, Palpus. c, Wing. d, Spermathecae. e, Fifth tarsomere and claws of foreleg. f, Same of midleg. g, Same of hindleg.

itate sensilla; palpal ratio 3.29 (3.14–3.86, *n* = 5). Proboscis dark brown, short, P/H ratio 0.43 (0.43–0.53, *n* = 3); mandible with 12 (10–12, *n* = 5) large teeth, the distal ones slightly longer.

Thorax: Dark brown, prescutellar median area and large humeral areas paler brown. Legs dark brown from coxae to tibiae; hindtibial comb with 7 (7–8, *n* = 4) spines, the 3rd from the spur longest. Tarsi pale, hindbasitarsus and 5th tarsomeres light brown; claws (Fig. 1e–g) slightly unequal, long and slender, the longer claw on each leg with proportional lengths of 29, 29, 28.

Wing (Fig. 1c): Hyaline; costa, base of subcosta, radial veins, medial stem, basal arculus, and base of 1st A slightly infuscated, all other veins faint; costal sections I-II-III with lengths in proportion of 96-75-18, Rs 52, Rs extending 0.95 (0.89–0.97, *n* = 5) of wing length; costa with slight pale basal swelling covered with fine microtrichia, also bearing 2 (2–4, *n* = 5) large setae; fringe of costal setae longer than the width of costa, extending to the wing tip, the fringe consisting of a series arising from the anterior edge of the costa. Halter pale.

Abdomen: Brown with segments 8, 9, and cerci darker. Spermathecae (Fig. 1d) 2, ovoid with short necks; unequal, measuring 0.071 by 0.054 mm and 0.061 by 0.053 mm; a tubelike rudimentary spermatheca present.

Male.—Unknown.

Distribution.—Sri Lanka.

Types.—All on slides in phenol balsam. Holotype ♀, Sri Lanka, Monaragala District, Mau Ara, 10 mi. E Edawalawa, 100 m, UV light, 24–26 Sept. 1977, coll. K.V. Krombein, P.B. Karunaratne, T. Wijesinhe, and M.

Jayawiera (Type no. 76119, USNM). Paratypes, 4♀, same data as holotype. Holotype and 2 paratypes deposited in the National Museum of Natural History, Washington, D.C. (USNM); 1 paratype will be deposited in the Colombo National Museum, Colombo, Sri Lanka, and another in the National Museum at the University of Sri Lanka at Peradeniya.

Discussion.—*Parabezzia orientalis* is the first species of *Parabezzia* to be recorded from the Oriental Region.

Parabezzia falcipennis (male) and *insolita* (female) differ from *orientalis* by the possession of a conspicuous beadlike swelling at the base of the costa. In *P. stagni* the costa extends markedly past the end of vein R4 + 5, nearly attaining vein M1 and the wing tip, the antennal ratio is 1.0, and the spermathecae lack sclerotized necks. *Parabezzia obscura* is known only from the male; it is marked very similar to *P. stagni,* but has a 3-segmented palpus.

Genus *Atrichopogon* Kieffer

The genus *Atrichopogon* is difficult taxonomically and the Oriental species are poorly known, although they are abundantly represented in nearly all ceratopogonid collections. We have been unable to make specific determinations of the Smithsonian Sri Lanka material except for the following species which possesses remarkable tarsal claws.

Atrichopogon schizonyx Giles and Wirth, New Species

Fig. 2

Female Holotype.—Wing Length 0.87 mm; breadth 0.43 mm.

Head: Brown. Eyes finely pubescent above, bare below; contiguous for a distance equal to 3 facets. Antenna (Fig. 2a) light brown with well-developed verticils on all segments; segment 15 with terminal papilla; flagellar segments with lengths in proportion of 26-14-17-20-20-20-20-22-74-72-76-74-100, antennal ratio 2.49; segments 3–5 disciform and closely appressed. Palpus (Fig. 2c) light brown; segments in proportion of 21-25-38-26-22; 3rd segment swollen, spindle-shaped, with sensory pit moderately large and shallow; palpal ratio 2.1. Proboscis brown, moderately long, sections A-B-C (see Wirth, 1980) with lengths as 50-24-26; mandible (Fig. 2f) with 17 large teeth becoming smaller proximad.

Thorax: Brown, pleural regions lighter. Legs with coxae brown, trochanters light brown; femora and tibiae light brown with faint basal and apical light bands; hindtibial comb with 8 spines; tarsi light brown, hindtarsal ratio 3.15; paired claws (Fig. 2g–i) of each leg with lateral claw bifid with small tooth, mesal claw trifid, the middle tooth longest.

Wing (Fig. 2e): Light brown becoming paler caudad, veins darker. Macrotrichia few on anterior veins. Costal ratio 0.73; 2nd radial cell 4× length of 1st. Halter slightly infuscated.

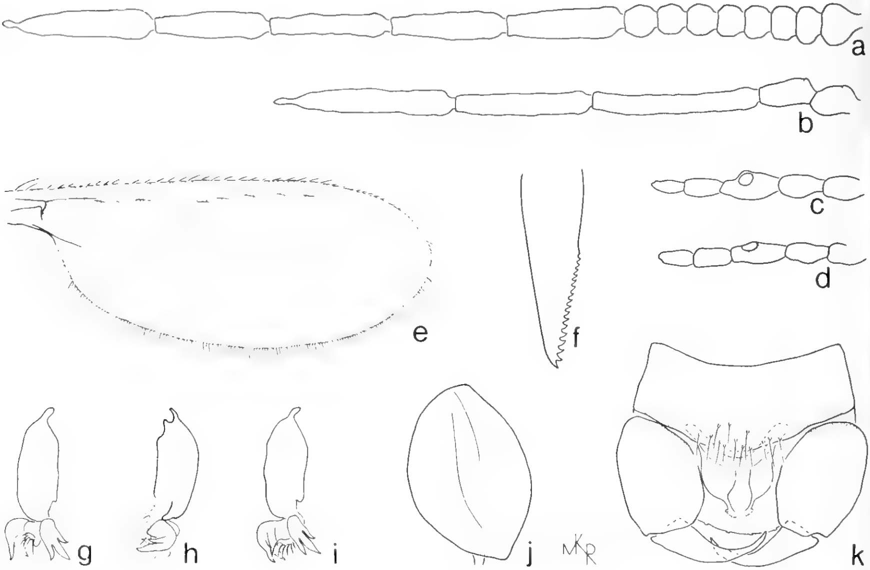

Fig. 2. *Atrichopogon schizonyx.* a, c, e–j, Female. b, d, k, Male. a, b, Antennae. c, d, Palpi. e, Wing. f, Mandible. g, Fifth tarsomere and claws of foreleg. h, Same of midleg. i, Same of hindleg. j, Spermatheca. k, Male genitalia.

Abdomen: Light brown darkening toward tip. Spermatheca (Fig. 2j) 1, partially collapsed, measuring 0.106 by 0.074 mm, ovoid with short slender neck.

Male Allotype.—Similar to female except for usual sexual differences. Genitalia (Fig. 2k) with 9th sternum short, caudal margin convex with approximately 17 setae; 9th tergum about 2× length of 9th sternum. Basistyle stout, about as wide as long, extending slightly past tip of 9th tergum; basal apodeme with slender base, swelling at midportion, then extending cephalad and tapering to a long point; dististyle stout basally, tapering quickly and smoothly from base in a moderate curve and ending in a sharp point. Aedeagus with basal arms stout, arch about 2× as broad as long; main body with rounded shoulders, slightly broader than long, with a short caudal process terminating in a cap.

Distribution.—Sri Lanka.

Types.—On slides in phenol balsam. Holotype ♀, Sri Lanka, Ratnapura District, Ratnapura, 1–3 Feb. 1979, UVL trap, coll. K. V. Krombein, P. B. Karunaratne, T. Wijesinhe, S. Siriwardane, and T. Gunarwardane. Allotype ♂, Sri Lanka, Uggalkaltota, 5 Feb. 1970, coll. D. Davis and W. Rowe, light trap. Both deposited in USNM (Type no. 76120).

Discussion.—The name *A. schizonyx* refers to the unusually cleft claws, by which it can readily be distinguished from related species. Although nothing is known of the life history of this species, the large mandibular teeth and cleft claws suggest that it is an insect parasite.

Atrichopogon schizonyx appears to be an ordinary member of the genus without any noteworthy features except for the unusual condition of the tarsal claws. The usual condition for the tarsal claws in *Atrichopogon* is for the female claw to be simple on the end, but a considerable number of species have the claws slightly bifid at the very tip or each bearing a slender spur partway down on the side. The male claws are usually both slightly cleft at the tip. Tokunaga, however, has described three *Atrichopogon* species departing from this pattern. In *A. gressitti* Tokunaga, (in Tokunaga and Murachi, 1959), known only from the male from the Caroline Islands, the claws are "stout, with tips bifid and each with a stout median tooth on the lateral side." In *A. unguis* Tokunaga (1962) from the Yaeyama Islands, the female claws are "cleft into 3 parts, lateral 1 small, other 2 equal," and male "claws bifid at ends." In *A. xanthopygus* Tokunaga (1962) from the Yaeyama Islands, the male claws are all "equally bifid and each with a small tooth on lateral side."

LITERATURE CITED

Clastrier, J. 1960. Notes sur les Cératopogonidés. X. Cératopogonidés de la République du Congo (2). Arch. Inst. Pasteur Alger. 38: 258–298.

Delfinado, M. D. and D. E. Hardy. 1973. A catalog of the Diptera of the Oriental Region. Vol. 1 Suborder Nematocera. The University Press of Hawaii, Honolulu. 618 pp.

Giles, F. E., W. W. Wirth, and D. H. Messersmith. 1981. Two new species of biting midges and a check list of the genus *Culicoides* (Diptera: Ceratopogonidae) from Sri Lanka. Proc. Entomol. Soc. Wash. 83: 537–543.

Meillon, B. de and W. W. Wirth. 1981a. Subsaharan Ceratopogonidae (Diptera) VI. New species and records of South African biting midges collected by A. L. Dyce. Ann. Natal Mus. 24: 525–561.

———. 1981b. Subsaharan Ceratopogonidae (Diptera). VII. The biting midges of the Kruger National Park, South Africa, exclusive of the genus *Culicoides*. Ann. Natal Mus. 24: 563–601.

Tokunaga, M. 1962. Biting midges of the Ryukyu Islands (Diptera: Ceratopogonidae). Pac. Insects 4: 153–217.

Tokunaga, M. and E. K. Murachi. 1959. Insects of Micronesia Diptera: Ceratopogonidae. Insects Micronesia 12(3): 100–434.

Vattier, G. and J. P. Adam. 1966. Les Ceratopogonidae (Diptera) des Grottes de la République du Congo (Brazzaville). Ann. Speleol. 21: 711–773.

Wirth, W. W. 1980. A new species and corrections in the *Atrichopogon* midges of the subgenus *Meloehelea* attacking blister beetles (Diptera: Ceratopogonidae). Proc. Entomol. Soc. Wash. 82: 124–139.

Wirth, W. W. and M. D. Delfinado. 1964. Revision of the Oriental species of *Alluaudomyia* Kieffer (Diptera, Ceratopogonidae). Pac. Insects 6: 599–648.

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BIOLOGY AND IMMATURE STAGES OF *SETACERA ATROVIRENS*, A GRAZER OF FLOATING ALGAL MATS (DIPTERA: EPHYDRIDAE)[1]

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Abstract.—Information is presented on the life history and larval feeding habits of *Setacera atrovirens* (Loew), a common and widely distributed shore fly species in lentic freshwater habitats. Adults and larvae are associated with floating algal mats where the larvae feed rather non-selectively on algal cells, including those of various blue-green genera. The egg, mature larva, and puparium of *S. atrovirens* are described and illustrated.

Miscellaneous observations on the habitat distribution, life cycle, and larval feeding habits are given also for *S. durani* (Cresson) and *S. pacifica* (Cresson).

The family Ephydridae, shore flies, consists of at least 1200 species in the world (Rohdendorf, 1974), with over 400 species in 68 genera being recorded from America north of Mexico (Deonier, 1979). This vast fauna is reflective of the large amount of adaptive radiation that has occurred within this family of wetland-inhabiting flies. Among the radiations into different habitats has been the invasion of floating algal mats by at least three Nearctic genera of the tribe Ephydrini of the subfamily Ephydrinae. Adults of species of *Cirrula, Ephydra,* and *Setacera* typically are found on the surface of the shallow water of lake margins, ponds, and marshes. Larvae of several of these species have been collected repeatedly from floating or partially submerged mats of filamentous algae, although they may be actually feeding microphagously on the interstitial unicellular algae growing within the filamentous matrix (Brock et al., 1969; Collins, 1975; Simpson, 1973).

The biology, life history, and larval feeding preferences of certain of the algal mat-inhabiting species have been elucidated previously. Aldrich (1912), Beyer (1939), Brock et al. (1969), Collins (1975, 1977, 1980a, 1980b), Hennig

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(1943), Johannsen (1935), Nemenz (1960a, 1960b), Ping (1921), Simpson (1973, 1976, 1979), Trägårdh (1903), Wirth (1971, 1975), and Zavatarri (1921) have presented information on species of *Ephydra*. Apparently the only references to the immature stages of *Cirrula* are those of Mathis and Simpson (1981) and Simpson (1973) dealing with the life history of *C. gigantea* Cresson, a species inhabiting algal mats in salt marshes along the northeastern coast of North America. The only author who has published biological information on Nearctic species of *Setacera* is Johannsen (1935), who illustrated the immature stages of *S. atrovirens* (Loew) and *S. needhami* Johannsen. Beyer (1939) discussed in considerable detail the ecology, life cycle, and larval morphology of an European species, *S. micans* (Haliday) (as *Ephydra*).

The genus *Setacera* currently contains eight species in the Nearctic Region (Mathis, 1982), one in the Neotropics (Wirth, 1968), one in the Afrotropical Region (Cogan, 1980), and five in the Palaearctic Region (Wirth, 1975). *Setacera atrovirens* is widely distributed in North America, occurring between 55° and 105° west longitude and 38° and 49° north latitude (Mathis, *in press*). In contrast, *S. durani* (Cresson) has been recorded primarily in the Southwest, and *S. pacifica* (Cresson) apparently is known only from the western states and provinces (Wirth, 1965).

This publication is the fourth in a series of papers devoted to ephydrid species whose larvae can utilize blue-green algae (Foote, 1977, 1981a, 1981b). The present paper gives life history data and discusses the larval feeding habits of *S. atrovirens,* a common and widely distributed species in freshwater lakes, ponds, and marshes. Additionally, the egg, mature larva, and puparium of that species are described and illustrated. Fragmentary biological observations are also given for *S. durani* and *S. pacifica*.

MATERIALS AND METHODS

Most of the field observations on *S. atrovirens* were obtained near Kent, Ohio, in Portage County. Supporting observations for this species and for *S. pacifica* were obtained along the south shore of Flathead Lake east of Polson, Montana, in Lake County. Most of the field work dealing with the latter species was conducted at a highly alkaline pond located 5.0 miles south of Ronan, Montana, on the Ninepipes Wildlife Refuge.

The laboratory rearings were carried out in an environmental chamber programmed to give a photoperiod of 15L:9D and a temperature of 22°C (±1°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 given 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 sp.
Cylindrospermum sp. (LB-942)
Gloeocapsa sp. (795)
Lyngbya sp.
Nostoc commune (584)
Oscillatoria chalybea (B-386)
Oscillatoria tenuis (B-428)
Phormidium sp. (1540)
Synechococcus leopoliensis (625)

Chlorophyceae

Chlamydomonas sp.
Chlorella vulgaris (29)

Bacillariophyceae

Navicula pelliculosa (668)

Chrysophyceae

Botrydiopsis alpina (295)

Life History of *Setacera atrovirens*

Adults of *Setacera atrovirens,* like those of most other species of the tribe Ephydrini, are typically found on the surface of shallow water of small ponds, marshes, and lakes. They have elongated tarsi and straight claws, adaptations which permit adults to move over the surface film in a manner resembling that of the water striders of the family Gerridae (Hemiptera). The mouthparts are rather broad and fleshy and apparently allow adults to lap up microorganisms from the water surface. Deonier (1965) recorded adults as common in the floating algal-mat habitat and rare on muddy shores in Iowa, while Scheiring and Foote (1973) collected specimens only in the mud-shore habitat in Ohio. In contrast, I have found adults primarily on floating algal mats and only rarely on muddy shorelines.

Deonier (1972) in a study of the gut contents of adult Ephydridae reported that diatoms and other algal cells were about equally represented in guts of *S. atrovirens.* I have observed adults of *S. atrovirens* applying their mouthparts to the surface of algal mats and subsequently found cells of numerous algal genera in their alimentary canals. Adults fed readily on a variety of algal monocultures in the laboratory but survived longest on a diet of *Na-*

vicula pelliculosa, although good survival was obtained also on cultures of *Anabaena variabilis* and *Chlamydomonas* sp. Adults died within 2 or 3 days in pure cultures of *Chlorella vulgaris.*

The premating period varied between 2 and 4 days ($n = 4$). No overt courtship behavior was observed, and males seemingly attempted to copulate with any suitably sized individual, including other males. Males were rebuffed by all adults of the wrong species, by males of *S. atrovirens,* and frequently even by females of that species. Mating behavior seemed to be of the assault type described by Spieth (1974). Copulation lasted anywhere from a few minutes to well over an hour. During mating the pair remained relatively inactive, although females frequently fed intermittently. During copulation the male assumed a position dorsal to the female and facing in the same direction. The preoviposition period in 4 laboratory-reared females ranged between 4 and 7 days and averaged 6 days.

An indication of the potential fecundity of *S. atrovirens* was obtained by determining the number of developing eggs per ovariole and the total number of ovarioles in each of 8 females that were collected in northeastern Ohio during August, 1979. The number of ovarioles per female varied between 28 and 36 and averaged 31.3. The number of detectable oocytes per ovariole averaged 7.8 and ranged between 6 and 11. Assuming that each ovariole is capable of producing 8 eggs during the life of a female and that each female possesses 31 ovarioles, the average fecundity is around 250 eggs. The range would be between 168 (28 × 6) and 396 (36 × 11). Actual egg counts obtained from field-collected and laboratory-reared females were considerably less than the values given above. Two females collected in nature deposited an average of only 40 eggs each in the breeding chambers.

In the laboratory rearings, females oviposited into monocultures of *Anabaena variabilis, A.* sp., *Cylindrospermum* sp., *Oscillatoria* spp., and *Navicula pelliculosa.* In contrast, no eggs were deposited in cultures of *Chlorella vulgaris.* Eggs were widely scattered over the algal substrate and no clumping was noted. They were generally oriented horizontally and occasionally were completely imbedded in the alga mat. The eggs were elongate-ovoid in shape, lacked terminal filaments, and possessed a distinct pinkish cast. The incubation period varied between 1 and 2 days and averaged 1.8 days ($n = 45$) in the laboratory rearings.

Eggs in nature were usually found in floating mats dominated by blue-green algae. In Ohio, they were found in a small mat of *Oscillatoria* sp. growing in a shallow, mud-bottomed rain pool having a surface area of less than 2 m^2. They were also taken abundantly in a mixed mat of *Anabaena* and *Spirogyra* that was floating on the surface of a small marsh. In Montana, eggs were discovered in a floating mat composed largely of species of *Nostoc* and *Cylindrospermum* located in shallow water along the south shore of Flathead Lake. A few filamentous green algae were present in the mat also, and unicellular interstitial algae, particularly diatoms, were abundant. Also included in the mats were floating fragments of macrophytes, particularly debris derived from *Typha* and *Potamogeton.* A series of 3 petri dish samples of the mat was taken along a transect extending from the sand shore to the far edge of the algal growth. Very few *Setacera* eggs were found within algae occurring on the moist shoreline sand, whereas they were equally abundant in samples taken at the water's edge and 2 m away from the shore. Eggs were particularly common in growths of *Nostoc* but relatively uncommon in colonies of *Cylindrospermum.*

Newly hatched larvae quickly began ingesting algae and seemingly preferred small unicells such as those of various species of diatoms. Older larvae apparently could utilize a broader range of algal species and frequently ingested trichomes of blue-green algae. A gut sample of a nearly mature larva collected in an *Oscillatoria* mat in Ohio contained numerous trichomes of that genus but also included considerable quantities of detritus. The gut of a third-instar larva taken from the *Nostoc-Cylindrospermum* mat at Flathead Lake, Mont. contained many trichomes of *Nostoc,* several fragments of *Cylindrospermum,* numerous cells of *Cosmarium,* and a few specimens of *Oocystis, Scenedesmus, Navicula,* and *Pediastrum.* Whether all these algal taxa were being digested and assimilated was not determined. To determine whether larvae preferred *Cylindrospermum* or *Nostoc,* 5 second instars were placed in the center of a petri dish which contained 2 samples of each of those 2 genera. The observations began at 3 PM and ended 6 hours later. By the end of the first hour 4 larvae were on *Nostoc* and only one was on *Cylindrospermum,* a situation that did not change during the subsequent 5 hours. A second test involved *Anabaena* sp., the larval food of *S. pacifica* at a highly alkaline (pH 9.4) pond located south of Ronan, Mont. Ten second- and third-instar larvae of *S. atrovirens* were placed in a dish containing *Anabaena,* and 10 others were placed in *Nostoc* collected at the Flathead Lake site. Larvae seemingly fed equally well in both algal genera, suggesting that larvae of these 2 *Setacera* species are not trophically segregated.

Examination of floating balls of *Nostoc* collected along the south shores of Flathead Lake revealed that the algal colonies were noticeably damaged due to larvae burrowing through the gelatinous matrix. The colonies became riddled with holes and soon assumed a shredded, frayed appearance. Shortly thereafter, they lost any semblance of cohesiveness and disappeared.

Larvae frequently fed while completely submerged but seemingly had to return to the water surface periodically to place the posterior spiracles in contact with air. This generally presented no problem, as algal mats in nature typically floated at or near the surface. Similar behavior was noted in *S. micans* in Europe by Beyer (1939).

Table 1 summarizes data obtained in laboratory feeding tests utilizing

Table 1. Results of larval feeding tests for *S. atrovirens* using different algal monocultures.

Alga	*n*	Percent Reaching Different Life Stages 2L	3L	P	A
Cyanophyceae					
Anabaena variabilis	30	100	100	97	97
Anabaena sp.	10	100	80	80	80
Cylindrospermum sp.	30	100	70	50	40
Gloeocapsa sp.	30	97	83	40	0
Lyngbya sp.	30	97	90	46	27
Nostoc commune	30	100	33	20	20
Oscillatoria chalybea	30	43	7	0	0
Oscillatoria tenuis	30	100	100	97	47
Phormidium sp.	30	100	97	40	7
Synechococcus leopoliensis	30	100	93	10	0
Chlorophyceae					
Chlamydomonas sp.	20	100	85	35	20
Chlorella vulgaris	30	0	0	0	0
Bacillariophyceae					
Navicula pelliculosa	30	100	100	77	50
Xanthophyceae					
Botrydiopsis alpina	10	100	10	10	0

unialgal cultures. Larvae completed development and eventually produced adults in monocultures of certain blue-green species as well as in cultures of *Chlamydomonas* sp. and *Navicula pelliculosa*. In contrast, no larval development occurred in cultures of *Chlorella vulgaris*. Interestingly, not all species of blue-greens permitted development, as no adults were obtained in cultures of *Synechococcus leopoliensis*, *Gloeocapsa* sp., and *O. chalybea*. The *Oscillatoria* tests were patricularly intriguing in that *O. tenuis* seemed quite satisfactory as a larval food, whereas *O. chalybea* gave very poor growth.

Table 2 presents data on the duration of the larval and pupal periods in those monocultures that permitted complete development. Developmental times were shortest in *A. variabilis* (14 days); somewhat longer in *Anabaena* sp., *Cylindrospermum* sp., *Chlamydomonas* sp., *Lyngbya* sp., *Phormidium* sp., and *N. pelliculosa* (17–21 days), and longest in *Nostoc commune* (24.9 days).

Shortly before forming puparia, larvae moved away from the algal colonies and sought out floating or slightly submerged stems or narrow leaves of such aquatic macrophytes as *Potamogeton* and *Myriophyllum*. Occasionally, larvae attached themselves to filaments of green algae. The last proleg was used to attach the mature larva to the support. Interestingly,

Table 2. Developmental times in days for *S. atrovirens* using different algal monocultures.

	Larval Period		Pupal Period		Combined Period	
Algal	$\bar{x}$	s	$\bar{x}$	s	$\bar{x}$	s
Anabaena variabilis ($n = 29$)	6.9	0.37	7.2	0.75	14.1	0.92
Anabaena sp. ($n = 8$)	12.8	0.46	7.5	0.93	20.3	1.39
Cylindrospermum sp. ($n = 12$)	13.2	1.60	6.7	1.21	19.9	0.90
Nostoc commune ($n = 7$)	17.4	0.98	7.5	0.79	24.9	0.90
Lyngbya sp. ($n = 1$)	10.0	—	7.0	—	17.0	—
Phormidium sp. ($n = 1$)	10.0	—	7.0	—	17.0	—
Chlamydomonas sp. ($n = 1$)	14.0	—	7.0	—	21.0	—
Navicula pelliculosa ($n = 10$)	9.6	0.84	7.4	0.84	17.0	1.15

many puparia were formed below the water surface and thus out of contact with atmospheric air. Submergence had no apparent effect on pupal development, as numerous adults were obtained from puparia that were as much as 10 cm below the surface. Under laboratory conditions, the pupal period lasted about 7 days (Table 3).

Several successful attacks on *Setacera* larvae by larvae of water scavenger beetles (Hydrophilidae) were noted in field-collected samples of algal mats. Hydrophilid larvae were quite abundant in nearly all of the mats examined and probably served as the primary predator of the larval stages of the fly, although nymphs of damselflies may also have affected larval populations. Several adults of a species of chalcidoid wasp were reared from a few puparia that had been collected in nature.

With a preoviposition period of 6 days, an incubation period of 2 days, a larval period of 10 days, and a pupal period of 7 days, the life cycle can be completed in approximately 25 days. This suggests that at least 4 generations are produced in the northern states during a warm season lasting from late May to late September. Overwintering probably occurs as adults in a state of reproductive diapause (Beyer, 1939). Examination of 8 females collected in nature on October 10, 1980, revealed undeveloped ovaries and numerous fat deposits within the abdominal cavity. The latest record for a female in northern Ohio was obtained on November 7, but no effort to discover overwintering adults in nature has been made. The first seasonal record for an adult was obtained on April 5.

OBSERVATIONS ON OTHER SPECIES OF *SETACERA*

Setacera durani (Cresson)

Adults of this species were swept from the surface of an algal mat that had developed in Sonoita Creek at Patagonia, Ariz. The stream was receiving effluent from a sewage lagoon with the result that blue-green algae and

Table 3. Life cycle data for *S. atrovirens* in northeastern Ohio. Rearings maintained at 22°C, with *Anabaena variabilis* serving as adult and larval food.

Flight Period	Early April–early November (?)
Premating Period	2–4 days
Preoviposition Period	4–7 days
Incubation Period	2 days
Larval Period	5–7 days
Pupal Period	7–8 days
Length of Life Cycle	18–24 days
Fecundity	168–396 eggs/female
Number of generations/year	4+

other algal taxa had developed extensive growths in and along the watercourse. Several larvae and puparia were collected from the mat.

Setacera pacifica (Cresson)

Large populations of this western species were found during the summer of 1973 and 1980 at highly alkaline ponds located at the Ninepipes Wildlife Refuge near Ronan, Mont. The pH of the study pond averaged above 9 during both summers, and the water contained large quantities of carbonate and bicarbonate ions. Algae were abundant, particularly species of the blue-green genera *Anabaena* and *Oscillatoria,* and formed extensive floating mats in the shallow nearshore water. Other algal genera found in the mats were *Navicula, Pandorina, Euglena, Cosmarium, Staurastrum, Scenedesmus,* and *Tetraedron.* The shores became increasingly exposed as the pond dried during the months of July and August, with the result that a wide band of highly alkaline mud developed around the open water. Aquatic plants were abundant, particularly hornwort (*Ceratophyllum demersum* L.), water-milfoil (*Myriophyllum spicatum* L.), and pondweed (*Potamogeton pectinatus* L., *P. zosteriformis* Fernald).

Other species of Ephydridae repeatedly collected at the alkaline ponds were *Paracoenia bisetosa* (Coquillett), *Lamproscatella muria* Mathis, *Scatella paludum* (Meigen), *Scatophila despecta* (Haliday), *Discocerina obscurella* (Fallén), and *Hydrellia* spp. Occasionally, *Psilopa olga* Cresson and *Philotelma alaskense* Cresson also appeared. The commonest species was *P. bisetosa,* which occurred by the thousands on the muddy shorelines. Except for a species of *Hydrellia,* whose larvae mined the leaves of pondweed, all of the associated species were far more abundant on shoreline muds than on the floating algal mats. To determine the microspatial distribution of adults of *P. bisetosa* and *S. pacifica,* 5 pan traps containing water and a detergent (Grigarick, 1959) were placed along a transect perpendicular to the shoreline. One pan was placed on the mud shore, one was at the shoreline, and 3 were on the floating algal mat 0.5, 1.0, and 2.0 m away from the shoreline, respectively. They were positioned at the pond after sunset and were collected 24 hours later. The results are given below:

Pan I (on shore mud): 29 *Setacera*, 67 *Paracoenia*
Pan II (at shoreline): 169 *Setacera*, 134 *Paracoenia*
Pan III (0.5 m from shoreline): 111 *Setacera*, 24 *Paracoenia*
Pan IV (1.0 m from shoreline): 48 *Setacera*, 12 *Paracoenia*
Pan V (2.0 m from shoreline): 102 *Setacera*, 45 *Paracoenia*

Although the 2 species showed considerable spatial overlap, *S. pacifica* was most abundant on the floating mat while *P. bisetosa* reached its greatest abundance on the organic-rich mud of the shoreline. Interestingly, very few larvae of *Paracoenia* were found in the offshore algal mats. Conversely, no *Setacera* larvae were present in samples of the shore mud, even though they were fairly common in pieces of the algal mat that had been stranded on the mud by dropping water levels.

Eggs and larvae of *S. pacifica* were abundant in the algal mats, particularly in areas where *Anabaena* formed conspicuous gelatinous growths. The eggs possessed a pinkish color and frequently were imbedded in the mat. As in *S. atrovirens*, no clumping of eggs was noted. The incubation period of 8 eggs lasted an average of 2.3 days in a laboratory rearing.

Larvae at the alkaline pool were not restricted to *Anabaena* colonies, as numerous individuals were found within a mat composed largely of a species of the filamentous green alga *Rhizoclonium*. Also present in this mat were abundant cells of the diatom genera *Navicula* and *Synedra* and the desmid genera *Closterium*, *Cosmarium*, and *Staurastrum*. Examination of the gut contents of 2 third-instar larvae revealed a nearly pure assemblage of *Cosmarium* cells. Only a few cells of the other genera of desmids were present, and there were no fragments of the alga genus *Rhizoclonium*. The gut of another third-instar larva collected elsewhere in the mat contained numerous cells of *Cosmarium*, plus representatives of *Cymbella* (diatom), *Scenedesmus* (green alga) and the blue-green genera *Chroococcus* and *Merismopedia*. Laboratory observations of a larva collected in the *Rhizoclonium* mat showed that it moved along the filaments of that alga while scraping off epiphytic algal cells with its mouthparts.

Larvae collected from mats dominated by *Anabaena* definitely were ingesting trichomes of that alga as determined by examination of the contents of 2 nearly mature larvae. However, other algal genera were also present in the guts, such as *Chroococcus*, *Cosmarium*, and *Staurastrum*. Laboratory-reared larvae also freely ingested trichomes of a species of *Nostoc* that was serving as the primary food of *S. atrovirens* along the shores of Flathead Lake.

As those of *S. atrovirens*, larvae occasionally fed below the water surface but returned periodically to the surface to renew their air supply. However, most larvae retained contact with atmospheric air via their posterior spiracles while feeding within the algal mats. The larval period of 6 laboratory-reared larvae that had fed on *Anabaena* averaged 10 days.

Puparia in nature were affixed by their last abdominal proleg to thread-like pieces of aquatic macrophytes or to filaments of algae. Two 0.3 m^2 samples of potential substrate for puparia were taken in the pond whose depth at the point of sampling was 0.2 meters. Sample I consisted largely of algal filaments, whereas sample II contained both algal filaments and several leaves and stems of *Ceratophyllum*, *Myriophyllum*, and *Potamogeton*. Sample I contained 11 larvae and 3 puparia, whereas sample II produced 39 larvae and 28 puparia. These results plus general field observations suggest that mature larvae rarely attach themselves to algal strands but rather become affixed to narrow-leaved macrophytes. In sample II, all 28 puparia were attached to either *Ceratophyllum* or *Myriophyllum*, even though *Potamogeton* was equally abundant. Similar results were obtained elsewhere in the study site.

Puparia frequently were formed below the water surface and thus out of contact with atmospheric air. The greatest depth for attachment was approximately 10 cm below the surface of water that was 30 cm deep. Adults successfully escaped from these puparia. In the laboratory rearings, the pupal period lasted 6–7 days for males and 7–8 days for females ($n = 10$).

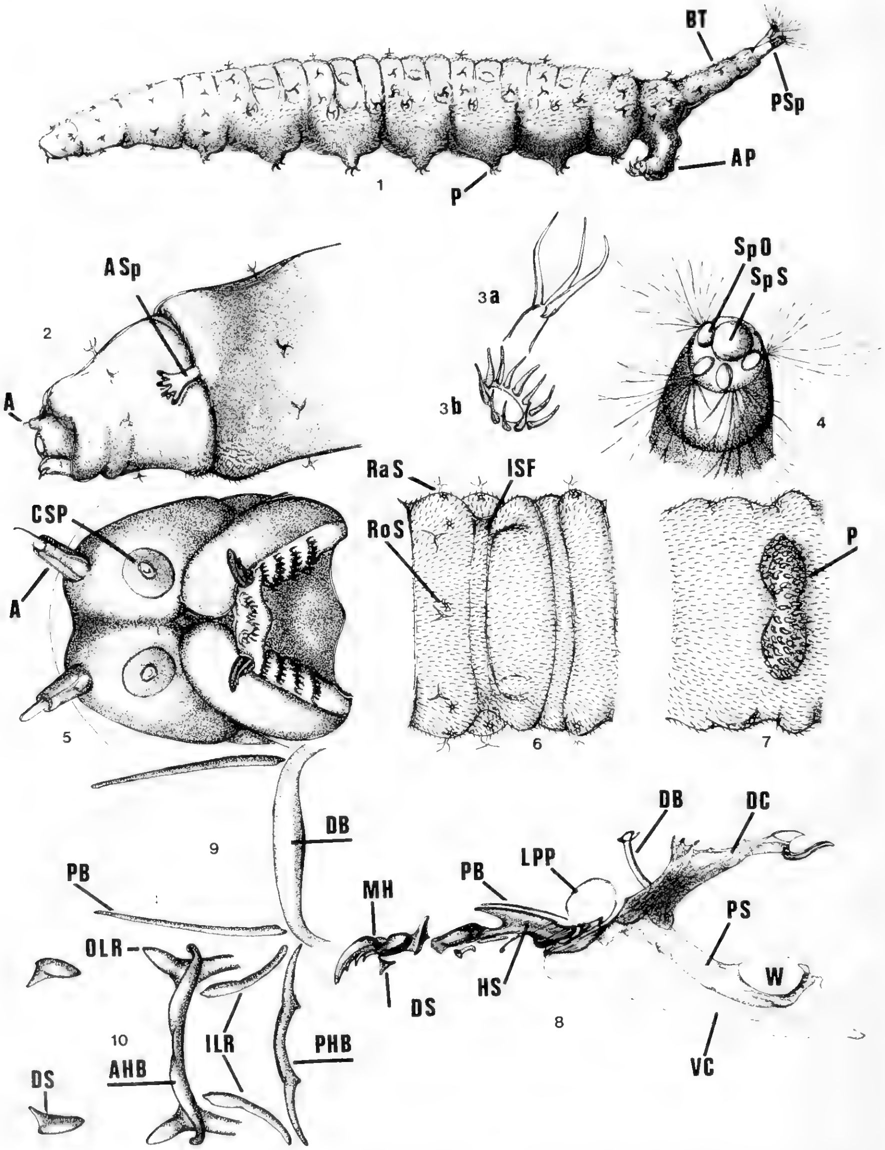
Enemies of *S. pacifica* included parasitic nematodes that were in the abdominal cavities of adults, hydrophilid larvae that preyed on the larval stages, and small chalcidoid wasps that emerged from the puparia.

As in *S. atrovirens*, there were several generations a year, with considerable overlapping of generations. The total life cycle could be completed in 25–30 days.

DESCRIPTIONS OF IMMATURE STAGES OF *SETACERA ATROVIRENS*

Egg (Fig. 13).—Length: 0.68–0.75 mm, $\bar{x} = 0.70$, width: 0.23–0.26 mm $\bar{x} = 0.25$ ($n = 10$). Elongate, ellipsoidal to cylindrical, both ends rounded; chorion appearing minutely papillose micropyle terminal on small papilla, micropylar end bluntly rounded, opposite end somewhat more tapering; living embryo with faint pinkish color.

Mature third-instar Larva (Fig. 1).—Length: 10.5–14.0 mm, $\bar{x} = 12.0$; width: 1.7–2.0 mm, $\bar{x} = 1.8$ ($n = 5$). Elongate, nearly cylindrical, both ends tapering, posterior end telescoping and forming apically branched breathing tube. Integument nearly concolorous and transparent. without distinct pattern; surface densely covered by somewhat darkened, elongate spinules, no spinules broadened (Fig. 6); integument of each segment bearing 2 kinds of sensilla, each rayed sensillum with elongate base and 3–4 apical branches



Figs. 1–10. *Setacera atrovirens*, mature larva. 1, Lateral habitus. 2, Lateral view of anterior end. 3a, Rayed sensillum. 3b, Rosette sensillum. 4, Posterior spiracle. 5, Facial mask. 6, Dorsum of segment 8. 7, Venter of segment 8. 8, Lateral view of cephalopharyngeal skeleton. 9, Dorsal view of parastomal bars and dorsal bridge. 10, Ventral view of hypostomal and associated sclerites. Abbreviations: A = antenna; AHB = anterior hypostomal bridge; AP = anal proleg; ASp = anterior spiracle; BT = breathing tube; CSP = circular sensory plate; DB = dorsal bridge; DC = dorsal cornu; DS = dentate sclerite; HS = hypostomal sclerite; ILR = in-

(Fig. 3a), each rosette sensillum very short and bearing several narrow branches apically (Fig. 3b). Prolegs present on venter of segments 5–12, anal proleg largest, all prolegs bearing heavy, recurved crochets apically (Fig. 7). Segment 1 (pseudocephalic) (Fig. 2, 5) frequently invaginated, bearing antennae apicodorsally, circular sensory plate apicoventrally, and facial mask ventrally; antennae elongate, appearing 2-segmented; circular sensory plates with rims unbroken, each plate bearing few peg-like structures; facial mask (Fig. 5) with several rows of comb-like structures. Segment 2 (prothoracic) spinulose, bearing anterior spiracles posterolaterally; each spiracle (Fig. 2) somewhat elongate and bearing 3–4 finger-like papillae apically. Segments 3 and 4 very similar, densely spinulose, and bearing prolegs ventrally; each segment with 4 rayed sensilla (Fig. 1), one rosette sensillum next to each dorsal, dorsolateral, and ventrolateral rayed sensillum. Segment 12 (caudal) bearing breathing tube posteriorly and anal proleg and perianal pad ventrally (Fig. 15); breathing tube branched apically, with branches capped by spiracular plates, each spiracular plate (Fig. 4) bearing 4 semioval spiracular openings, circular scar, and 4 highly branched spiracular processes; perianal pad at apex of anal proleg posterior to crochets, pad nearly circular (Fig. 16); anal proleg large and somewhat curved forward (Fig. 15).

Cephalopharyngeal skeleton (Fig. 8).—Length: 0.60–0.65 mm, $\bar{x} = 0.62$ ($n = 5$). Mouthooks paired, not connected dorsally; hook part slender in lateral view, broader in dorsal view and bordered by several accessory teeth; basal part narrow, with indication of elongate window. Dentate sclerite below basal part of each mouthhook narrowly triangular. Ligulate sclerite narrow and elongate. Hypostomal sclerite (Fig. 10) composed of 2 lateral rods seemingly connected by 2 narrow and strap-like hypostomal bridges, anterior bridge somewhat broader than posterior bridge. Epistomal sclerite broad, poorly pigmented, and fenestrate anteriorly. Parastomal bars (Fig. 9), arising near but not connected to anterior border of pharyngeal sclerite, running forward between and dorsal to hypostomal sclerite, bars not connected to each other or to epistomal sclerite anteriorly. Inner longitudinal rods of hypostomal sclerite converging anteriorly (Fig. 10). Pharyngeal sclerite (Fig. 8) rather deeply pigmented; dorsal cornua slender, connected anteriorly by dorsal bridge; bridge narrow, with few small windows (Fig. 9);

←

ner longitudinal rod; ISF = intrasegmental fold; LPP = lateral pharyngeal process; MH = mouthhook; OLR = outer longitudinal rod; P = proleg; PB = parastomal bar; PS = pharyngeal sclerite; PHB = posterior hypostomal bridge; PSp = posterior spiracle; RaS = rayed sensillum; RoS = rosette sensillum; SpO = spiracular opening; SpS = spiracular scar; VC = ventral cornu; W = window.

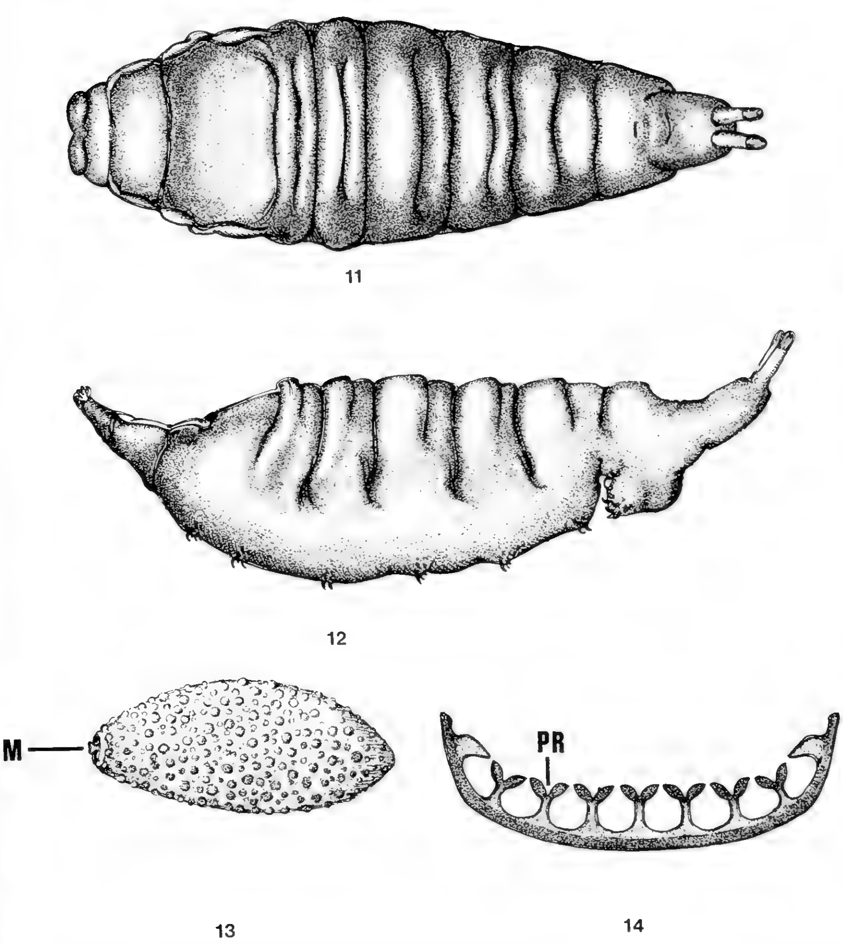
ventral cornua broader, each with large window posteroapically; subcircular lateral process arising from anterior margin of pharyngeal sclerite above parastomal bars; floor of pharyngeal sclerite with 9 ridges (Fig. 14), lateral 2 ridges incomplete, remaining 7 ridges each with well-developed lateral lamellae apically that form filtering surface.

Puparium (Fig. 11, 12).—Length: 7.5–8.0 mm, ($\bar{x}$ = 7.8; width: 1.4–1.8 mm, $\bar{x}$ = 1.6 (n = 5). Somewhat swollen at midlength, with both ends tapering and upturned; anterior end invaginated, bearing anterior spiracles laterally; posterior end elongated into breathing tube. Prolegs on segments 5–11 somewhat reduced compared to larva but bearing distinct crochets apically; anal proleg largest, curved forward and frequently attaching puparium to narrow-leaved macrophyte or algal filament. Integument nearly concolorous brown, without dorsal pattern, densely spinulose, no spinules broadened. Perianal pad somewhat invaginated, subcircular.

Discussion

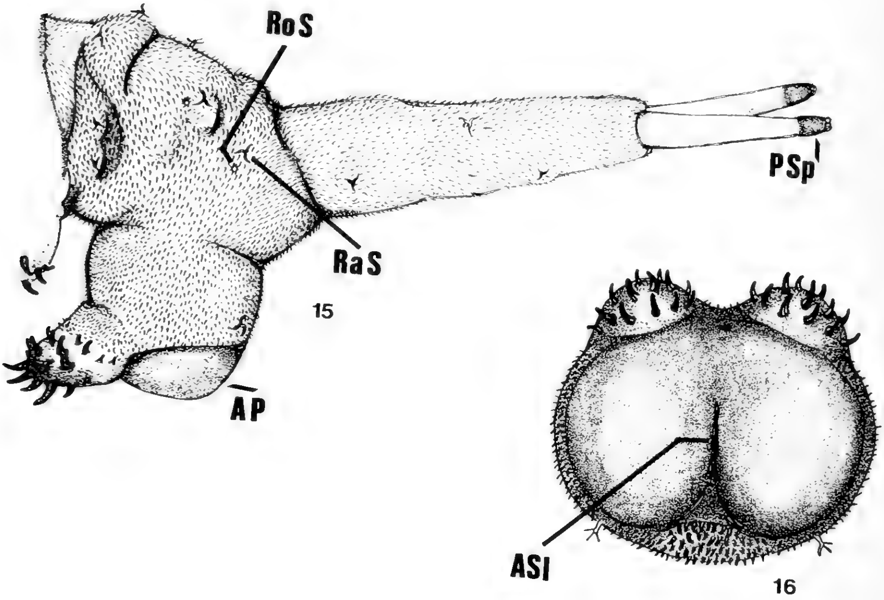
Species of *Setacera* apparently are ecologically unified by their preference for the floating algal-mat habitat. However, little information is available concerning ecological isolation among the eight species occurring in North America. There are indications that some species prefer lentic habitats that have particular water chemistries. For example, *S. atrovirens* has been found most frequently in freshwater habitats with low alkalinity, whereas *S. pacifica* apparently prefers waters of high alkalinity. Thus, these two species may be segregated by habitat. Certainly they do not seem to be segregated trophically, as the larvae of both species readily fed upon and completed development on a wide variety of algal foods. Furthermore, in laboratory tests, larvae of *S. atrovirens* consumed *Anabaena,* the blue-green algal genus heavily grazed in nature by *S. pacifica*. Similarly, *S. pacifica* developed readily on cultures of *Nostoc,* the preferred larval food of *S. atrovirens* at Flathead Lake. Equally obvious is that these two species are not separated temporally, as both occur throughout the warm season and are multivoltine.

Results of the larval food tests involving *S. atrovirens* and 14 species of algae belonging to four classes (Table 1) suggest that larvae of this species are rather generalized trophically. Nine species of 8 genera of 3 algal classes permitted complete larval growth. These data suggested that *S. atrovirens* may be slightly less generalized than *Scatella stagnalis* (Fallén), as that species was able to attain the adult stage on 13 algal species (Zack and Foote, 1978). Moreover, the latter species was able to utilize certain algal taxa that are seemingly unsuitable as larval foods for *S. atrovirens* (e.g., *Gloeocapsa, Chlorella, Botrydiopsis*). However, larvae of *S. stagnalis* developed very poorly on cultures of *Cylindrospermum* and *Nostoc,* genera of blue-green algae which gave excellent growth in *S. atrovirens*.



Figs. 11–14. *Setacera atrovirens*, immature stages. 11, Dorsal view of puparium. 12, Lateral view of puparium. 13, Egg. 14, Cross section of pharyngeal ridges. Abbreviations: M = micropylar end; PR = pharyngeal ridge.

An interesting question concerns the ecological relationship of species of *Setacera* to those of the two other genera of Nearctic Ephydrini associated with floating algal mats. Species of *Cirrula* do not present much of a problem as they are restricted to coastal salt marshes, habitats rarely (if ever) utilized by North American species of *Setacera*. However, there are numerous examples of geographic and perhaps habitat overlap among species of *Ephydra* and *Setacera*. Thus, *S. atrovirens* is sympatric with *E. riparia* Fallén in the



Figs. 15–16. *Setacera atrovirens,* mature larva. 15, Lateral view of caudal segment. 16, Perianal pad. Abbreviations: ASl = anal slit; other abbreviations as in Figs. 1–10.

northeastern states. There may be some habitat segregation in these two species as *E. riparia* is most abundant in saline waters having relatively high chloride ion concentrations, whereas *S. atrovirens* seemingly prefers freshwater habitats having low concentrations of salts. Other examples of geographic co-existence of species in these two genera occur in the western states. Thus, *S. durani* and *E. packardi* Wirth co-exist in southern Arizona, and *S. needhami* occurs with *E. hians* and *E. packardi* in Washington (Zack, personal communication). Once again, however, it is possible that each of these sympatric species is segregated into shallow-water habitats having different water quality. It is significant that neither W. N. Mathis (personal communication), nor R. S. Zack (personal communication), nor I have collected species of both genera regularly in the same habitat.

Setacera larvae undoubtedly play several ecological roles in lentic ecosystems. The mechanical damage caused by the burrowing larvae probably accelerates the disruption and eventual decomposition of floating algal mats. Thus, the feeding activities of the larvae must be important in nutrient cycling. The larvae, particularly when abundant, are certainly involved in food chains, as they are utilized by predacious and parasitoid insects and may be consumed by fishes and birds. More practically, the utilization of such heterocystous blue-green algae as *Anabaena, Cylindrospermum,* and *Nos-*

toc by *Setacera* larvae and adults probably have unsuspected effects on the nitrogen economy of shallow water habitats, as these algae are important nitrogen-fixers (Peters, 1978). Finally, it should be mentioned that the bacterium responsible for Legionnaires disease has been found in floating mats of blue-green algae, where it apparently utilizes algal extracellular products as carbon and energy sources (Tison et al., 1980). This suggests that adults of *Setacera* and other genera of alga mat-visiting Ephydridae could serve as dispersal agents for this pathogenic bacterium.

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LITERATURE CITED

Aldrich, J. M. 1912. The biology of some western species of the dipterous genus *Ephydra*. J. N.Y. Entomol. Soc. 20: 77–90.

Beyer, A. 1939. Morphologische, ökologische und physiologische Studien an den Larven der Fliegen: *Ephydra riparia* Fallén, *E. micans* Haliday und *Cänia fumosa* Stenhammar. Kiel. Meeresforsch. 3: 265–320.

Brock, M. L., R. G. Wiegert, and T. D. Brock. 1969. Feeding by *Paracoenia* and *Ephydra* (Diptera: Ephydridae) on the microorganisms of hot springs. Ecology 50: 192–200.

Cogan, B. H. 1980. 71. Family Ephydridae, pp. 655–669. *In* Crosskey, R. W., ed., Cataloque of the Diptera of the Afrotropical Region. Brit. Mus. Nat. Hist., London.

Collins, N. 1975. Population biology of a brine fly (Diptera: Ephydridae) in the presence of abundant algal food. Ecology 56: 1139–1148.

———. 1977. Mechanisms determining the relative abundance of brine flies (Diptera: Ephydridae) in Yellowstone thermal spring effluents. Can. Entomol. 109: 415–422.

———. 1980a. Population ecology of *Ephydra cinerea* Jones (Diptera: Ephydridae), the only benthic metazoan of the Great Salt Lake (USA). Hydrobiologia 68: 99–112.

———. 1980b. Developmental responses to food limitation as indicators of environmental conditions for *Ephydra cinerea* Jones (Diptera). Ecology 61: 650–661.

Deonier, D. L. 1965. Ecological observations on Iowa shore flies (Diptera, Ephydridae). Proc. Iowa Acad. Sci. 71: 496–510.

———. 1972. Observations on mating, oviposition, and food habits of certain shore flies (Diptera: Ephydridae). Ohio J. Sci. 72: 22–29.

———. 1979. Introduction—A prospectus of research in Ephydridae, pp. 1–19. *In* Deonier, D. L., ed., First Symposium on the Systematics and Ecology of Ephydridae (Diptera). North Am. Benthol. Soc.

Foote, B. A. 1977. Utilization of blue-green algae by larvae of shore flies. Environ. Entomol. 6: 812–814.

———. 1981a. Biology and immature stages of *Lytogaster excavata*, a grazer of blue-green algae (Diptera: Ephydridae). Proc. Entomol. Soc. Wash. 83: 304–315.

———. 1981b. Biology and immature stages of *Pelina truncatula*, a consumer of blue-green algae (Diptera: Ephydridae). Proc. Entomol. Soc. Wash. 83: 607–619.

Grigarick, A. A. 1959. Bionomics of the rice leaf miner, *Hydrellia griseola* (Fallén) in California (Diptera: Ephydridae). Hilgardia 29: 1–80.

Hennig, W. 1943. Übersicht über bisher bekannten Metamorphosestadien der Ephydriden, mit Neubeschreibungen nach Material der Deutschen Limnologischen Sunda-Expedition. Arb. Morph. Taxon Entomol. Berlin-Dahlem 10: 105–138.

Johannsen, O. A. 1935. Aquatic Diptera. Part II. Orthorrhapha-Brachycera and Cyclorrhapha. N.Y. Agric. Exp. Stn. Mem. 177: 1–62.

Mathis, W. N. 1982. Studies of Ephydrinae (Diptera: Ephydridae), VII: Revision of the genus *Setacera* Cresson. Smithson. Contrib. Zool. 350, 57 pp.

Mathis, W. N. and K. W. Simpson. 1981. Studies of Ephydrinae (Diptera: Ephydridae), V: The genera *Cirrula* Cresson and *Dimecoenia* Cresson in North America. Smithson. Contrib. Zool. 329: 1–51.

Nemenz, H. 1960a. Beiträge zur Kenntnis der biologie von *Ephydra cinerea* Jones 1906 (Dipt.). Zool. Anz. 165: 218–226.

———. 1960b. On the osmotic regulation of the larvae of *Ephydra cinerea*. J. Insect Physiol. 4: 38–44.

Ping, O. 1921. The biology of *Ephydra subopaca* Loew. Mem. Cornell Univ. Agric. Exp. Stn. 49: 557–616.

Peters, G. A. 1978. Blue-green algae and algal associations. Bioscience 28: 580–585.

Rohdendorf, B. 1974. The Historical Development of Diptera. Univ. Alberta Press. xv + 360 pp.

Scheiring, J. F. and B. A. Foote. 1973. Habitat distribution of the shore flies of northeastern Ohio. Ohio J. Sci. 73: 152–166.

Simpson, K. W. 1973. Biology and immature stages of certain Ephydridae (Diptera) occurring in North America. Ph.D. Diss., Cornell Univ.

———. 1976. The mature larvae and puparia of *Ephydra* (*Halephydra*) *cinerea* Jones and *Ephydra* (*Hydropyrus*) *hians* Say (Diptera: Ephydridae). Proc. Entomol. Soc. Wash. 78: 263–269.

———. 1979. Evolution of life histories in the Ephydrini, pp. 99–109. *In* Deonier, D. L., ed., First Symposium on the Systematics and Ecology of Ephydridae (Diptera). North Am. Benthol. Soc.

Spieth, H. T. 1974. Courtship behavior in *Drosophila*. Annu. Rev. Entomol. 19: 385–405.

Starr, R. C. 1978. The Culture Collection of Algae at the University of Texas at Austin. J. Phycol. 14(Suppl.): 47–100.

Trägårdh, I. 1903. Zur Anatomie und Entwicklungsgeschichte der Larve von *Ephydra riparia* Fallén. Arkiv. Zool. I; 1–42.

Tison, D. L., D. H. Pope, W. B. Cherry, and C. B. Fliermans. 1980. Growth of *Legionella pneumophila* in association with blue-green algae (Cyanobacteria). Appl. Environ. Microbiol. 39: 456–459.

Wirth, W. W. 1965. Family Ephydridae, pp. 734–759. *In* Stone, A., et al., eds., A Catalog of the Diptera of America North of Mexico. U.S. Dep. Agric., Agric. Handb. 276.

———. 1968. Family Ephyridae, pp. 1–43. *In* Papavero, N., ed., A Catalogue of the Diptera of the Americas South of the United States. Dep. Zool. Sec. Agric. São Paulo, Brazil.

———. 1971. The brine flies of the genus *Ephydra* in North America (Diptera: Ephydridae). Ann. Entomol. Soc. Am. 64: 357–377.

———. 1975. A revision of the brine flies of the genus *Ephydra* of the Old World (Diptera: Ephydridae). Entomol. Scand. 6: 11–44.

Zack. R. S. and B. A. Foote. 1978. Utilization of algal monocultures by larvae of *Scatella stagnalis*. Environ. Entomol. 7: 509–511.

Zavattari, E. 1921. Ricerche morfologiche ed etologiche sul dittero alofilo *Ephydra bivittata* Loew. R. Comit. Talassogr. Ital. Venezia Mem. 83, 58 pp.

PROC. ENTOMOL. SOC. WASH.
84(4), 1982, pp. 845–848

CONICOBRUCHUS ALBOPUBENS (PIC) (COLEOPTERA: BRUCHIDAE) AND ITS HOST *CYAMOPSIS TETRAGONOLOBA* (L.) (LEGUMINOSAE), WITH THE DESIGNATION OF A LECTOTYPE

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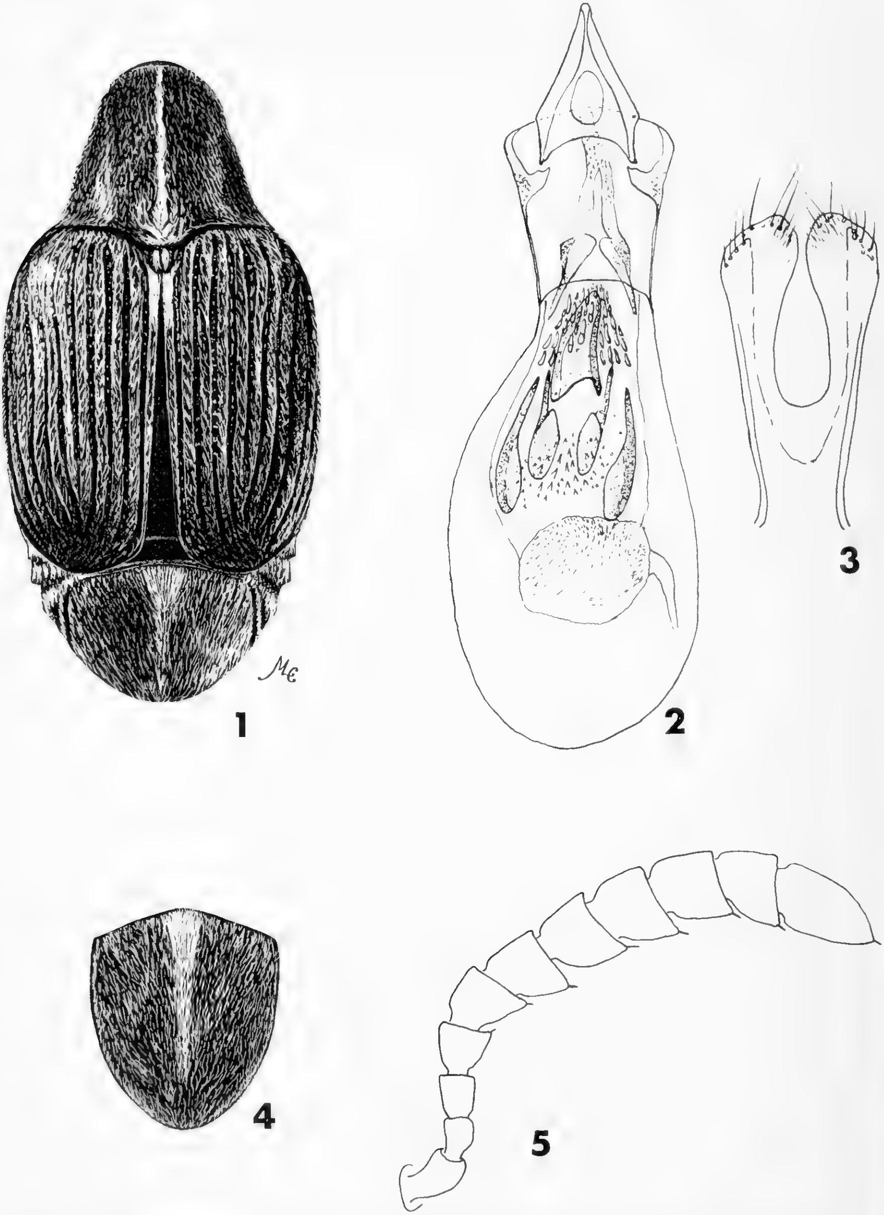
Abstract.—*Conicobruchus albopubens* attacks seeds of Guar (*Cyamopsis tetragonoloba*) in India and Pakistan but has not yet been found in the guar-growing areas of south central United States. To facilitate identification, illustrations of salient characters are provided. The lectotype of *albopubens* is selected.

Guar (*Cyamopsis tetragonoloba* (L.), also known as *C. psoraloides* DC.) is widely grown in northern India and Pakistan. The legume fruits are used as a vegetable, the foliage is fed to cattle, and fruits and foliage have medicinal value. Growing plants provide shade for ginger plants, and foliage is used as green manure and as a cover crop. In recent years, this plant has been successfully grown in southwestern Oklahoma and north central Texas but in fairly small acreages (50,000 acres in 1978). The seed produced from U.S. cultivation and from more than 40,000 metric tons imported into the U.S. from India and Pakistan is used in paper manufacturing, as a thickener and binder in various processed foods and in cosmetics, and in a number of other applications (Whistler and Hymowitz, 1979). Small acreages of guar are also grown in Australia, Brazil, and South Africa.

On the Indian subcontinent, seeds of guar are attacked by the bruchid *Conicobruchus albopubens* (Pic). Arora (1977) listed this plant (as *Cyamopsis psoraloides*) as the only host of *C. albopubens*, and most of the specimens in the National Museum of Natural History (USNM) are labeled with this host. One series of specimens from Coimbatore, S. India, however, was reared from indigo seeds (*Indigofera* prob. *tinctoria* L.). *Indigofera* is closely related to *Cyamopsis*.

S. R. Wadhi, National Bureau of Plant Genetic Resources, New Delhi, recently sent to me for confirmation specimens of *C. albopubens* that his



Figs. 1–5. *Conicobruchus albopubens*. 1, Habitus, dorsal. 2, ♂ genitalia, median lobe. 3, ♂ genitalia, lateral lobes. 4, Pygidium. 5, Antenna, ♂.

laboratory had identified using Arora's key to species (1977). They are identical to specimens sent to the USNM by Arora. Because this bruchid was described from the Sudan, I requested the loan of type-material from the British Museum, and R. D. Pope kindly sent two cotypes. In all details including those in the male genitalia, the specimens from India and the type-specimens are identical.

Although the geographical origin of *C. tetragonoloba* is obscure, Whistler and Hymowitz (1979) suggest that the cultivar may have developed from fodder supplies of *C. senegalensis* Guill. and Perrin brought into India by Arabs for their horses during the eighth century. This theory, if correct, could explain the Sudan-India distribution of the beetle, assuming that it remained constant throughout the changes in the host plant from *C. senegalensis* to its present cultivar *C. tetragonoloba*. Only one species of *Cyamopsis* (*C. senegalensis*) is known from Sudan and Senegal (Brown and Massey, 1929), but there is no evidence that the type-specimens of *Conicobruchus albopubens* were associated with this plant in the Sudan.

The following short redescription of *C. albopubens* is given for convenience although Pic's description (1931) is unusually informative and Arora's redescription (1977) is definitive despite the poorly reproduced habitus drawings (Figs. IXA, IXB).

***Conicobruchus albopubens* (Pic)**

Figs. 1–5

Bruchus albopubens Pic, 1931: 26.
Conicobruchus albopubens: Arora, 1977: 34.

Description.—Body length, 2.0–2.5 mm; body width, 1.0–1.3 mm. Integument black except pro- and mesolegs and 3 proximal antennal segments red to reddish yellow. Vestiture of densely placed, pure white slender setae more or less evenly distributed over body except narrow white stripe in middle of pronotum and middle of pygidium (Figs. 1 and 3); antenna slender, serrate, longer in male than in female (Fig. 5); body shape as in Fig. 1; metafemur without subapical ventral armature; male genitalia (Fig. 3) with median lobe short, ventral valve acutely triangular, armature of internal sac as shown (Fig. 2). (See also Arora, 1977, figs. 17 and 18.)

Type.—Lectotype ♂, with labels R. F. Medani, H. W. Bedford 173-25, Cotton, Sudan Govt., Ent. Coll. C8065, *Bruchus albopubens* n. sp. (in Pic's handwriting), red circular type label. This specimen is hereby designated and labeled as LECTOTYPE. In British Museum (Natural History), London.

Discussion.—Although *Conicobruchus albopubens* is not known from the United States, it remains a potential threat to the guar industry in this country, especially if seed stocks for breeding purposes were to be imported from the Indian subcontinent. Imported industrial guar is in the form of broken or split seeds, and this rules out almost completely the importation of live immature or adult beetles.

Conicobruchus albopubens seems out of place among the other much larger species of Indian *Conicobruchus* but appears to be more closely related to unidentified African species in the USNM collection. A thorough taxonomic study of this Old World tropical genus would be necessary to more clearly determine its relationships. Vats (1979) described the larva of *C. albopubens*.

Acknowledgments

My thanks to S. R. Wadhi for sending the specimens that launched this small study, and to R. D. Pope for loan of type-material from the British Museum collections. Mary Lou Cooley drew the habitus and pygidium.

Literature Cited

Arora, G. L. 1977. Taxonomy of the Bruchidae (Coleoptera) of northwest India. Part 1. Adults. Orient. Insects Suppl. No. 7, 32 pp.

Brown, A. F. and R. E. Massey. 1929. Flora of the Sudan. London. 502 pp.

Pic, M. 1931. Nouveautes diverses. Mel. Exot.-Entomol. 57: 1–36.

Vats, L. K. 1979. On the larvae of *Conicobruchus* Decelle (Coleoptera: Bruchidae). Res. Bull. Panjab Univ. Sci. 27(1/2): 111–113.

Whistler, R. L. and T. Hymowitz. 1979. Guar: Agronomy, production, industrial use, and nutrition. Purdue Univ. Press, W. Lafayette, Indiana. 124 pp.

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84(4), 1982, pp. 849–854

TWO NEW SPECIES OF *HETEROSPILUS* (HYMENOPTERA: BRACONIDAE) FROM MEXICO BEING INTRODUCED AGAINST THE COTTON BOLL WEEVIL, *ANTHONOMUS GRANDIS* (COLEOPTERA: CURCULIONIDAE)

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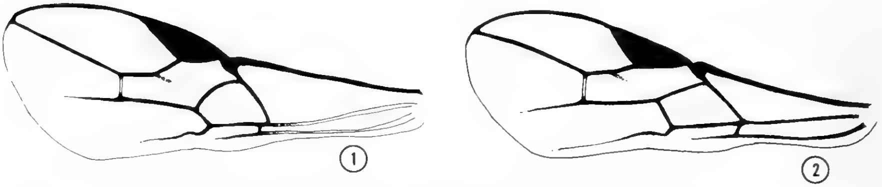
Abstract.—Descriptions are provided for two new species of the braconid genus *Heterospilus*: ***annulatus***, n. sp., from Corregidora, Tabasco, Mexico; and ***megalopus***, n. sp., from Cardenas, Tabasco, Mexico. Both species have been reared from the cotton boll weevil, *Anthonomus grandis* Boheman, and possibly from its close relative *A. hunteri* Burke and Cate, and are being cultured and released in Texas.

The genus *Heterospilus* Haliday belongs in the braconid subfamily Doryctinae, most species of which parasitize wood-boring beetle larvae. However, species of *Heterospilus* exhibit an unusually wide range of hosts covering three insect orders: Coleoptera (Anobiidae, Bostrichidae, Bruchidae, Buprestidae, Cerambycidae, Curculionidae, Languriidae, Mordellidae, Scolytidae); Lepidoptera (Gelechiidae, Incurvariidae, Olethreutidae, Pyralidae); and Hymenoptera (Cephidae, Tenthredinidae). In nearly all of these records, the hosts have cryptic boring habits in stems. In addition there are two unusual records: one species is parasitic on larvae of the genus *Microstigmus* (Hymenoptera: Sphecidae); the other is recorded from galls of *Eurosta solidaginis* (Fitch) (Diptera: Tephritidae) on ragweed. In spite of this diverse host range, the genus is morphologically homogeneous. The single character that distinguishes *Heterospilus* from all but one of the other genera in the Doryctinae is the absence or weakness of the first intercubital vein of the forewing, thus making the first and second cubital cells confluent (Fig. 1). The genus has not been studied in the Western Hemisphere, but apparently there are several species groups based on a variety of other characters. None of these groups seems to be correlated with a particular host group from the above list.



Figs 1, 2. Wings of *Heterospilus*. 1, *H. megalopus*. 2, *H. annulatus*.

The two species described here are being studied by James R. Cate, B. J. Porter, and associates at Texas A&M University, College Station. The species were collected at localities in the state of Tabasco, Mexico, where they were definitely reared from larvae of *Anthonomus grandis* Boheman in *Hampea nutrica* Fryxell. In addition to the specimens examined by me, both species were collected at other localities in the state of Campeche where they were reared from what was assumed to be *A. hunteri* Burke and Cate (J. R. Cate, personal communication). However, since there is some difficulty in distinguishing larval remains of *A. grandis* from those of *A. hunteri*, which is restricted to *Hampea trilobata* Standley, I therefore assume that the host of specimens of the *Heterospilus* species reared from *Anthonomus* on *Hampea trilobata* in Campeche is *A. hunteri*.

Both species of *Heterospilus* have been released in areas around College Station, Brownsville, Elsa, and Rosebud, Texas.

Heterospilus annulatus Marsh, New Species

Figs. 2, 5, 6, 7, 10, 11

Female.—Length of body, 2.5–3.5 mm; ovipositor, 0.50–0.75 mm. Color: Head dark brown, face and mandibles often light brown to honey yellow, palpi white; scape and pedicel yellow with longitudinal brown stripe laterally, flagellum brown except flagellomeres 16–19 which are white, numbers 16 and 19 sometimes partially to completely brown; thorax dark brown, mesonotum, scutellum, propodeum, and anterior part of mesopleuron frequently light brown; abdomen dark brown, terga 1 and 2 yellow medially, terga 3–7 sometimes light brown, entire venter yellow; legs light yellow, coxae and trochanters nearly white, apical tarsomeres brown; tegula yellow, wing base white.

Head: Coriaceous,[1] vertex sometimes imbricate behind ocelli (Fig. 5), face often rugulose; eyes large, malar space ¼ eye height; ocellocular dis-

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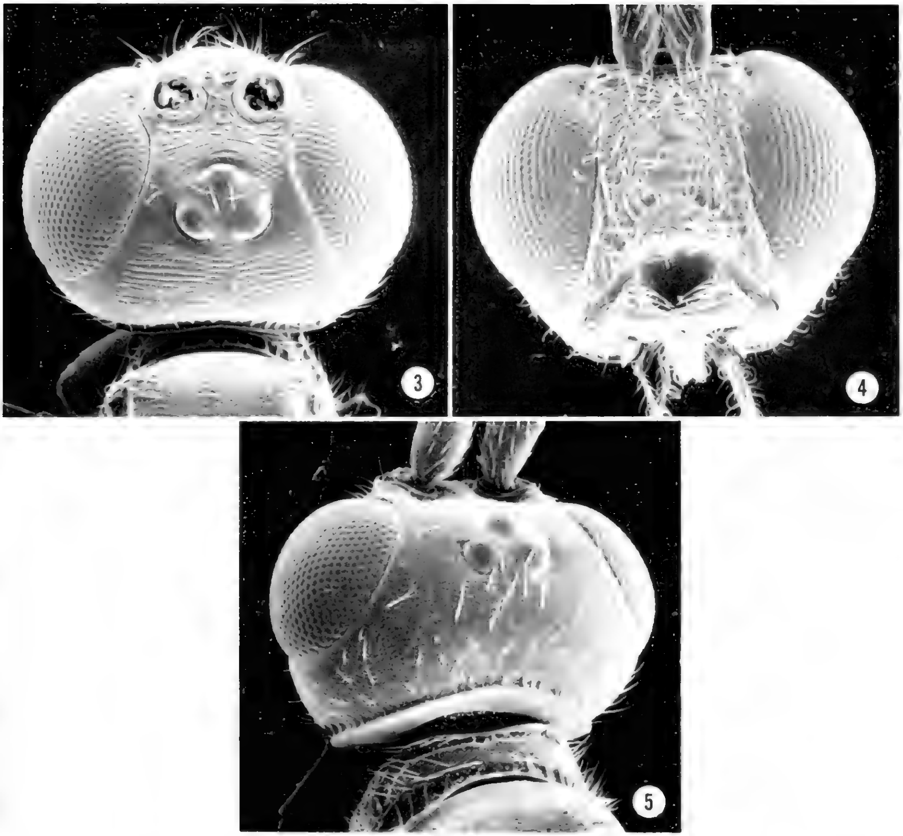
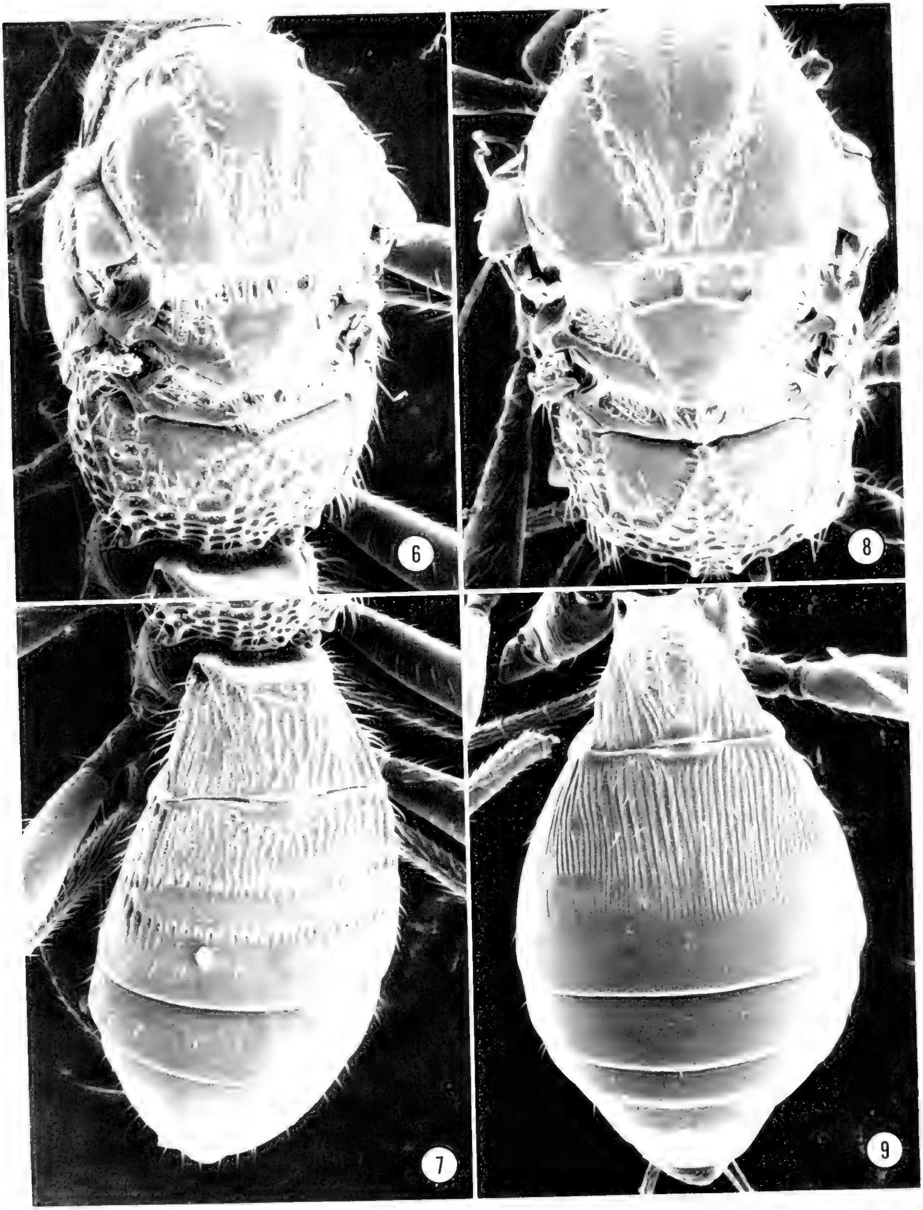
[1] All terms for sculpturing are based on Harris, 1979, Calif. Dep. Food Agric., Entomol. Occas. Pap. No. 28, 31 pp.

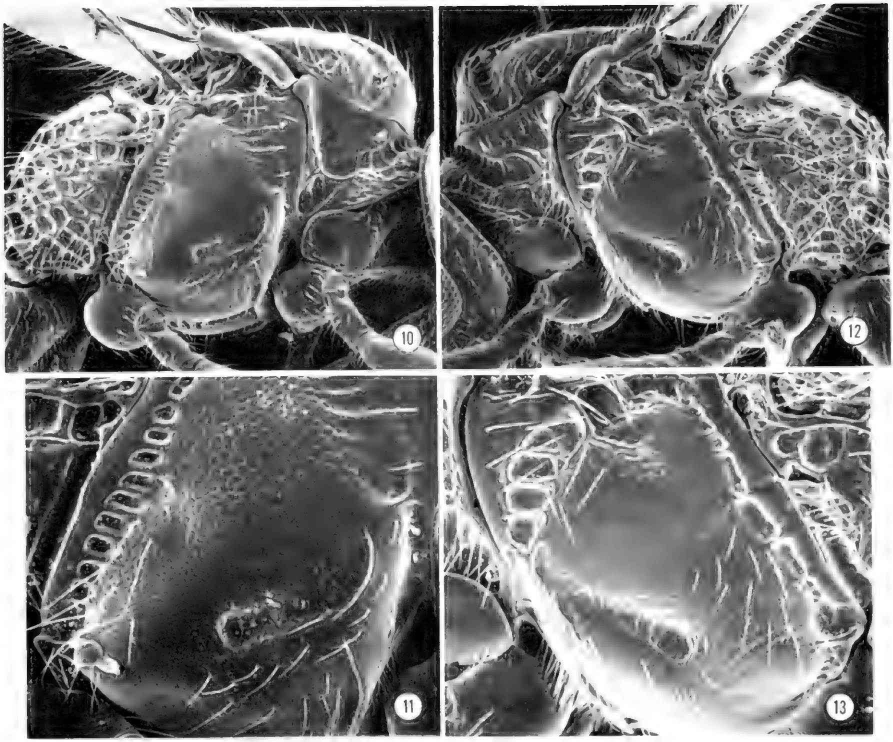


Figs. 3–5. Heads of *Heterospilus*. 3, *H. megalopus*, dorsal view. 4, *H. megalopus*, anterior view. 5, *H. annulatus*, dorsal view.

tance 2.5× diameter of lateral ocellus; antenna with 24–27 flagellomeres. Thorax: Mesonotal lobes (Fig. 6) coriaceous, notauli scrobiculate and meeting posteriorly in a wide porcate area, scutellar disc coriaceous but sometimes nearly smooth in small specimens, scutellar furrow with 4 or 5 cross carinae; mesopleuron (Figs. 10, 11) coriaceous, subalar furrow scrobiculate; propodem areolate-rugose with 2 small triangular coriaceous areas at base. Abdomen (Fig. 7): First tergum short and broad, 1.5× as wide at apex as long, costate-rugose, strongly arched with anterior elevation smooth; terga 2+3 with 2 transverse scrobiculate furrows, costate-rugose on basal ½ before 1st transverse furrow, remainder coriaceous; remainder of terga coriaceous, terga 4 and 5 with transverse scrobiculate furrow at base (usually hidden under apex of preceeding tergum); ovipositor about as long as terga



Figs. 6–9. Thoraces and abdomens of *Heterospilus*, dorsal views. 6, 7, *H. annulatus*. 8, 9, *H. megalopus*.



Figs. 10–13. Thoraces of *Heterospilus*, lateral views. 10, 11, *H. annulatus*. 12, 13, *H. megalopus*.

1–3 or about ⅓ as long as forewing. Wings (Fig. 2): First segment of radius ⅔ length of 2nd segment, 2nd segment of radius ⅔ length of 2nd intercubitus, 1st intercubitus indicated only by light infuscation near radius; nervulus slightly postfurcal.

Male.—Essentially similar to female; length of body 2–3 mm; antenna with 22–26 flagellomeres; stigma in hindwing about as long as its distance from wing base, broad, greater than ½ width of wing at stigma location.

Holotype.—♀, Corregidora, Tab., Mexico, August 1979, J. R. Cate collector, ex. *Anthonomus grandis*. Deposited in USNM (National Museum of Natural History, Washington, D.C.).

Paratypes.—24 ♀, 25 ♂, same data as type. Deposited in USNM and Texas A&M University.

Remarks.—This species is distinguished from all other described U.S. species by the white annulus on the antenna in both sexes. It is similar to *annulicornis* Muesebeck from Brazil, which also has a white annulus on the female antenna, but *annulatus* is distinguished from *annulicornis* by the yellow and brown markings on the abdomen and thorax, the brown stripe on the scape and pedicel, and by the fact the male of *annulicornis* does not have the white annulus on the antenna.

This species also is apparently similar to *ashmeadi* Shenefelt but the unique holotype is missing both antennal flagella and some characters are obscured by glue. However, *ashmeadi* appears to have a smooth mesonotum, smooth notauli, and is entirely dark brown or black.

Heterospilus megalopus Marsh, New Species

Figs. 1, 3, 4, 8, 9, 12, 13

Female.—Length of body, 3.5 mm; ovipositor, 1.25 mm. Color: Head honey yellow, antenna yellow, apical flagellomeres light brown, palpi white; thorax brown, black markings around scutellum, prothorax sometimes lighter brown; abdomen brown, often with dark brown or black on abdominal terga 2–4, venter honey yellow; tegula and wing base yellow; legs light yellow, nearly white.

Head: Vertex and frons strigate (Fig. 3), face rugulose, temples smooth; eyes large (Fig. 4), malar space about $^1/_{12}$ eye height, temples about $^1/_4$ eye width, face narrow, about ¾ eye width; ocellocular distance equal to diameter of lateral ocellus; antenna with 26 flagellomeres. Thorax: Mesonotal lobes (Fig. 8) coriaceous, notauli scrobiculate, meeting posteriorly in a wide rugose area; scutellar disc smooth, scutellar furrow broad and with one median cross carina; mesopleural disc (Figs. 12, 13) smooth, subalar furrow scrobiculate; propodeum rugose with 2 large triangular smooth areas at base. Abdomen (Fig. 9): First tergum slightly longer than apical width, costate; terga 2+3 costate on basal ¾, smooth on apical ¼, transverse sutures at most indicated by weak lines laterally, remainder of abdominal terga smooth; ovipositor about ½ as long as abdomen or slightly less than ½ of forewing length. Wings (Fig. 1): First segment of radius equal to 2nd, 2nd segment of radius slightly longer than 1st intercubitus; nervulus postfurcal by about its own length.

Male.—Essentially as in female; length of body, 2.5–3.5 mm; antenna with 22–24 flagellomeres; stigma in hindwing as long as its distance from wing base, broad, nearly as broad as wing base near stigma.

Holotype.—♀, Cardenas, Tab., Mexico, July 1979, J. R. Cate collector, ex *Anthonomus grandis*. Deposited in USNM.

Paratypes.—3 ♀, 16 ♂, same data as holotype. Deposited in USNM and Texas A&M University.

Remarks.—This species is similar to *fasciatus* Ashmead from St. Vincent and Grenada because of the single carina in the scutellar furrow, but *megalopus* is distinctive by its large eyes, the heights of which are nearly 12 times as long as the malar space.

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NOTE

Insect Label Production Using a Personal Computer

A personal computer and an "inexpensive" dot matrix printer make it possible to prepare small runs of insect and other labels in a very efficient manner. The system I use is a CROMEMCO Z2D® computer with a Texas Instruments 820® printer.

The TI820® compressed print option fits 9 characters on the width of a 0.5 inch wide label; three lines of print occupy 0.5 inch. I have found these labels to be of the proper dimension for use of point-mounted Coleoptera. The system is fast since the printer runs at 150 characters per second.

The print quality of the label is about that of a good typewriter except that each letter is formed from a series of 7 vertical dots instead of being fully formed as with a typewriter. The listing of the program will indicate the general legibility of the print. The TI820® uses dual tractors with pin feed so that only computer forms can be printed. I use a continuous computer form which is card stock containing 3 × 5 inch cards such as is used by libraries in cataloging their holdings.

The computer program presented here uses a BASIC interpreter and will run on most personal computers (with BASIC) except that the procedure to fill a string is unique to the CROMEMCO 16K BASIC® which was used to develop and run the program.

The program assumes that input from the user comes from the keyboard of the printer. A CRT terminal keyboard could be used for input but then statements 340 through 360 of the program must be changed so that the output is written to the printer instead of to the CRT.

The program produces eight (8) 10-spaced labels as a group with a blank space between each label. The number of lines per label is here limited to three but the number of lines and the width of the label can be changed by the user upon modifying the program.

The user first specifies how many groups of 8 labels is wanted by supplying a "REPLICATION FACTOR." For instance, if he wants 80 labels he would enter "10." Next, the user supplies information for each line of the label following the prompt from the program. A small label of one or two lines can be prepared by entering a "*" as indicated by the program. After producing the labels wanted the program loops back to the beginning and asks for the next REPLICATION FACTOR. Any negative number, i.e. −1, will stop the program.

A listing of the program and an example of its use is shown in Fig. 1.

```
 10   Rem PROGRAM TO PRODUCE INSECT LABELS
 20   Rem AUTHOR:  D. G. Kissinger
 30   Rem
 40   Rem PRODUCES 8 LABELS ON A LINE EACH LABEL 9 CHARACTERS WIDE AND
 50   Rem SEPARATED FROM ADJACENT LABELS BY A SPACE.
 60   Rem
 70   Rem SET UP TO PRODUCE LABELS WITH AT MOST 3 LINES
 80   Rem
 90   Dim A$(79),B$(79),C$(79),N$(9),Z$(9) : Rem DIMENSION STRINGS
100   Z$(-1)=" "+Z$(-1) : Rem SET Z$ TO ALL BLANKS
110   Rem BEGIN MAIN LOOP OF PROGRAM - STATEMENTS 120 THROUGH 400
120   Input"WHAT REPLICATION FACTOR (EXIT WITH -1)   ",G
130   If G<0 Then Stop
140   Input"DATA FOR LINE 1  ",N$(0,8) : Rem ENTER UP TO 9 CHARACTERS
150   N$(Len(N$))=Z$ : Rem SET UNUSED PORTION OF LINE TO BLANKS
160   A$(-1)=N$+A$(-1) : Rem PRODUCE 8 COPIES OF FIRST LINE
170   L=1 : Rem THERE IS AT LEAST ONE LINE IN THE LABEL
180   N$="" : Rem EMPTY THIS STRING
190   Input"DATA FOR LINE 2 (END LABEL WITH *)   ",N$(0,8)
200   If N$(0,0)="*" Then 310
210   L=2 : Rem THERE ARE TWO LINES IN THE LABEL
220   N$(Len(N$))=Z$
230   B$(-1)=N$+B$(-1)
240   N$="" : Rem EMPTY THIS STRING
250   Input"DATA FOR LINE 3 (END LABEL WITH *)   ",N$(0,8)
260   If N$(0,0)="*" Then 310
270   L=3 : Rem LABEL CONTAINS 3 LINES
280   N$(Len(N$))=Z$
290   C$(-1)=N$+C$(-1)
300   Rem LOOPS TO PRINT G GROUPS OF LABELS EACH WITH L LINES
310   Print
320     For J=1 To G
330       For K=1 To L
340       If K=1 Then Print A$
350       If K=2 Then Print B$
360       If K=3 Then Print C$
370       Next K
380     Next J
390   Print : Rem END GROUP OF LABELS WITH A BLANK LINE
400   Goto 120
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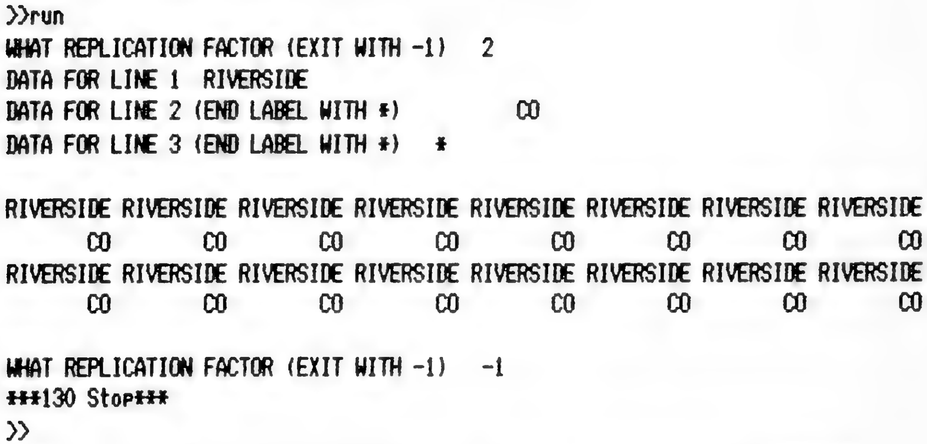

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WHAT REPLICATION FACTOR (EXIT WITH -1)   2
DATA FOR LINE 1  RIVERSIDE
DATA FOR LINE 2 (END LABEL WITH *)         CO
DATA FOR LINE 3 (END LABEL WITH *)   *

RIVERSIDE RIVERSIDE RIVERSIDE RIVERSIDE RIVERSIDE RIVERSIDE RIVERSIDE RIVERSIDE
       CO        CO        CO        CO        CO        CO        CO        CO
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       CO        CO        CO        CO        CO        CO        CO        CO

WHAT REPLICATION FACTOR (EXIT WITH -1)   -1
***130 Stop***
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Fig. 1. Listing of the program and an example of its use. Labels shown are actual size.

David G. Kissinger, *Department of Biostatistics and Epidemiology, School of Health, Loma Linda University, Loma Linda, California 92350.*

PROC. ENTOMOL. SOC. WASH.
84(4), 1982, pp. 857–858

NOTE

Ferrisia lobdellae, a New Name for *Ferrisia setosa* (Lobdell, 1930) (Homoptera: Pseudococcidae)

Ferrisia setosa (Lobdell) is presently without a valid name. This mealybug was originally discovered on the roots of *Liquidambar styraciflua* at Durant, Mississippi, by Lobdell (1930. Ann. Entomol. Soc. Am. 23: 209–236) and named *Trionymus setosus*. Ferris (1950. Atlas of the Scale Insects of North America, Series V: The Pseudococcidae, Pt. I, pp. 85–95) treated it as a valid species and transferred it to the genus *Ferrisiana*. But the generic name *Ferrisiana* is now considered as an unjustified change for *Ferrisia* Fullaway, 1923 (*vide*, Morrison and Morrison. 1966. U. S. Dep. Agric. Misc. Publ. 1015: 1–206). Therefore, this species presently is called *Ferrisia setosa* (Lobdell).

However prior to Lobdell's 1930 paper, Hempel (1900. Rev. Mus. Paulista, São Paulo 4: 386) described a mealybug on *Ficus* in Brazil as *Dactylopius setosus*, and he mentioned it again in a second publication (Hempel. 1900. Ann. Mag. Nat. Hist. (7) 6: 396). Hempel's mealybug was referred to as *Pseudococcus setosus* (Hempel) by Fernald (1903. Mass. Agric. Exp. Stn. Spec. Bull. 88: 109) and by MacGillivray (1921. The Coccidae. Scarab Co., Urbana, Illinois, p. 133), was later placed in the genus *Ferrisia*, and presently has been sunk as a synonym of *F. virgata* (Cockerell) (*vide,* Mohammed Ali. 1970, Indian Mus. Bull. 5(2): 108).

Thus the *setosus* of Lobdell (1930), which is a valid species, is a junior secondary homonym of the *setosus* of Hempel (1900), and both are presently included in the genus *Ferrisia*. There being no other available name for the species discovered by Lobdell, *Ferrisia lobdellae* Varshney, **New Name**, is here proposed as a replacement name.

The holotype of *Trionymus setosus* Lobdell, 1930, is in the Collection of the Entomological Museum, Mississippi State (Richard L. Brown, personal communication). Four "type material" slides are deposited in the Coccoidea Collection, University of California, Davis; and one paratype slide (not in good condition) is in the Collection of the National Museum of Natural History, Beltsville, Maryland.

The replacement name is in honor of Ms. Gladys Hoke Lobdell, the discoverer of the species.

Incidentally, it may also be pointed out here that Ferris (1950: 88) and McKenzie (1967. Mealybugs of California with Taxonomy, Biology, and Control of North American species (Homoptera: Coccoidea: Pseudococcidae). Univ. Calif. Press, Berkeley, p. 179) have made a minor unintentional error by stating that Takahashi "in 1927" changed *Ferrisia* to *Ferrisiana*. In fact, Takahashi proposed this change in 1929 (Trans. Formosa Nat. Hist. Soc. 19(104): 425–431).

I am grateful to the Director, Zoological Survey of India, Calcutta, for providing facilities and permission to publish this note. I also thank D. R. Miller and M. B. Stoetzel, Systematic Entomology Laboratory, IIBIII, Agric. Res. Serv.. USDA, Beltsville, Maryland, for making useful suggestions on this manuscript.

Rajendra K. Varshney, *Zoological Survey of India, 34, Chittaranjan Avenue, Calcutta, 700 012, India.*

PROC. ENTOMOL. SOC. WASH.
84(4), 1982, pp. 858–859

NOTE

Distributional Records of Platypodidae (Coleoptera) in Maryland

In the recent Catalog of North American Platypodidae (S. L. Wood. 1979. U.S. Dept. Agric., Agric. Handb. 529–141) no species are listed as occurring in Maryland. Three species, *Platypus compositus* Say, *P. flavicornis* (Fabricius), and *P. quadridentatus* (Olivier), are recorded from surrounding states and would be expected to occur in Maryland.

From examining the collections of the Maryland Department of Agriculture, University of Maryland, E. J. Ford, and C. L. Staines, the following records were observed:

Platypus compositus: Prince Georges Co., Laurel, 24/VIII/1977; Wicomico Co., 16/VIII/1976.

Platypus flavicornis: Wicomico Co., Koppers, 24/VIII/1976; Worcester Co., 16/X/1980.

Platypus quadridentatus: Baltimore City, Leakin Park, 7/VI/1976; Prince Georges Co., College Park, 2/IV/1946; Somerset Co., Shelltown, 10/V/1969; Worcester Co., Berlin, 9/XII/1977.

I thank C. Mitter (University of Maryland), and E. J. Ford for allowing me to examine the collections under their care.

C. L. Staines, Jr., *3302 Decker Place, Edgewater, Maryland 21037.*

PROC. ENTOMOL. SOC. WASH.
84(4), 1982, pp. 859–860

NOTE

An Oriental Fly Found in Trinidad (Diptera: Platystomatidae)

Among specimens of Richardiidae sent to me by Fred D. Bennett, Director of the Commonwealth Institute of Biological Control, was found a female specimen that I at first thought was a member of the widespread American genus *Senopterina*. However, the specimen showed characters, one of which was a well-developed mesopleural bristle, that forbade my placing it in *Senopterina*. Further study soon revealed that it was *Plagiostenopterina dubiosa* Malloch, 1931, Proc. U.S. Natl. Mus. 78 (art. 15): 13–15. The type specimen from Singapore and others from that locality and from Colombo, Sri Lanka; Mindanao, Philippines; Selangor Gombak Forest Reserve, Malaya; Chiengmai, Thailand; and Sarawak are in the U.S. National Museum and have been compared with the specimen Bennett took from his laboratory window in Curepe, Trinidad, in March 1982. Bennett had done some very interesting rearing of Richardiidae in the laboratory, but inasmuch as there was nothing in the laboratory from southern Asia that might have yielded the platystomatid and as nothing is known about the life history of

Plagiostenopterina species, we cannot even guess what brought the species to Trinidad.

George C. Steyskal, *Cooperating Scientist, Systematic Entomology Laboratory, IIBIII, Agricultural Research Service, USDA, % National Museum of Natural History, Washington, D.C. 20560.*

Announcement

Back issues of the *Index-Catalogue of Medical and Veterinary Zoology* are available free of charge by requesting them from:

Index-Catalogue of Medical & Veterinary Zoology
Animal Parasitology Institute
Building 1180, BARC-East
Beltsville, Maryland 20705 USA

Users and libraries should complete their sets now as reprinting of back issues is not planned.

A compendium of the world's literature on human and animal parasitology, the catalogues are divided into seven parts: Part 1, authors; Part 2, Protozoa; Part 3, Trematoda and Cestoda; Part 4, Nematoda and Acanthocephala; Part 5, Arthropoda and Miscellaneous Phyla; Part 6, Subject Headings and Treatment; Part 7, Hosts. Several Special Publications are also available: No. 1: Checklist of the Internal and External Parasites of Deer; No. 2: Bibliography of Chagas Disease (1909–1969); No. 3: Ticks and Tickborne Diseases; No. 4: Checklist of Types in the U.S. National Parasite Collection; No. 5: List of Translations; No. 6: Nematoda and Nematode Diseases (and its companion publication, a reprinted edition of the Stiles and Hassall Roundworm Catalogue), and an unnumbered Special Publication, Trematoda and Trematode Diseases.

PROC. ENTOMOL. SOC. WASH.
84(4), 1982, pp. 861–862

BOOK REVIEW

The North American Grasshoppers. Volume I, Acrididae: Gomphocerinae and Acridinae. By Daniel Otte. Harvard University Press, Cambridge, Massachusetts. 275 pp., illus. 76 figs. 1981. Cost: $45.00, hardback.

In 1961 James A. G. Rehn and Harold J. Grant, Jr. published the first systematic revision of the grasshoppers of North America. In that volume, which appeared as Monograph No. 12 of the Academy of Natural Sciences of Philadelphia, the authors focused only on the Tetrigidae, Eumastacidae, Tanaoceridae, and Romaleinae, and dealt only with species occurring in North America, north of Mexico. Daniel Otte succeeded Rehn and Grant at the Academy of Natural Sciences and undertook the task of completing the monograph. His approach has been drastically different from that of Rehn and Grant and may well prove to be much more successful, not only in scope and aesthetics, but also in the breadth of audience that will be receptive to it.

This book is the first of a three-volume set on the Orthoptera of North America. Volume II will cover the band-winged grasshoppers of the subfamily Oedipodinae, and volume III will cover all the grasshopper groups not covered in volumes I and II.

The format of this volume is well-organized, easy to read, and concise. It treats all species of gomphocerine and acridine grasshoppers that have been described from North America, including Canada, Mexico, and Central America. Otte includes helpful identification keys for each genus and provides excellent figures and distribution maps as well. For each species, the distribution, recognition characters, information on behavior, ecology, and life history, and pertinent references are detailed. The phylogenetic relationships of genera are discussed as well.

Additional valuable information is compiled neatly within five appendices, including taxonomic changes made in the book, a list of the genera and species of Gomphocerinae and Acridinae and their synonymy, a comparison of the various classification systems of the treated genera, and a pronunciation guide for the genera. Also included is a glossary and fairly complete list of references.

But the highlight of this text is the showy display of color habitus figures of every species of gomphocerine and acridine grasshoppers in North America. These figures, rendered by the author in colored pencil and pastel, permit nearly anyone to quickly identify a grasshopper simply by overviewing the plates, which are conveniently clustered in the center of the book.

There are, in fact, few detracting qualities about this book. Some of the figures do not agree in number with the text (e.g., on p. 15, Fig. 19D should read "Figure 16D"). Also, "carina" and "carinula" are incorrectly used interchangeably in the text and on Fig. 26. These shortcomings are minimal, however, compared with the tremendous utility this book will provide to all persons interested in acridology.

David A. Nickle, *Systematic Entomology Laboratory, IIBIII, Agricultural Research Service,* USDA, *℅ National Museum of Natural History, Washington, D.C. 20560.*

PROC. ENTOMOL. SOC. WASH.
84(4), 1982, pp. 862–863

Book Review

Faunal Affinities, Systematics and Bionomics of the Orthoptera of the California Channel Islands. By D. C. F. Rentz and David B. Weissman. University of California Publications, Entomology, University of California Press, Berkeley. Volume 94, xiv + 240 pp., 337 figs. 1982.

Because they provide a microcosmic view of the complexity of the nature of environments, islands have a special appeal to zoologists and botanists for studies in biogeography. The California Channel Islands are well suited for such studies. The eight islands in the chain lie between 21 and 94 kilometers off the coast of southern California. They are divided into two groups, the northern four islands, which are close in proximity to one another and were connected to the mainland about 400,000 years ago, and the southern islands which are more distant from each other and lack early geophysical affinities with the mainland.

David C. F. Rentz and David B. Weissman together have an extensive background in studies of the Orthoptera of North America and are probably the world's most knowledgeable orthopterists of the California fauna. Their joint interest in the Orthoptera began more than ten years ago, and in this volume they have provided us with the first comprehensive study of the insect fauna on this remarkable island chain. They have spent more than six years collecting Orthoptera on the islands and the adjacent mainland and, during the course of their collecting, have made detailed studies of populations, behavior, and ecology of the insects.

Their research approach is diverse, employing several techniques to gain information on the faunal affinities of the Orthoptera of the study area. For example, testes were removed from adult male Orthoptera specimens in each area to compare karyotypes of populations on the various islands. Immature insects were reared to adulthood to establish their identity and to obtain such information about the insect's biology as the number of moults during its development, the presence and duration of periods of diapause, and the occurrence of parasites. Most of the sound-producing Orthoptera were tape-recorded and their songs analyzed and described. Wind tunnel tests of several Orthoptera were made to evaluate whether it were possible for these species to have used flight to achieve their present distribution. Finally, collecting sites on each island were described ecologically, and the species collected at these sites were listed.

The authors then use their faunal survey to evaluate zoogeographic relationships of the islands and the adjacent California mainland. They indicate that 23% of the 52 Orthoptera of the Channel Islands are endemic and that of the 39 species of nonendemic Island species, 34 also occur on the adjacent mainland. They suggest that the endemism is autocthonous, that species evolved anew on the islands and do not represent relic populations of species that were once more widespread. What is important here is that Rentz and Weissman offer a hypothesis or model based on their research on Orthoptera that other researchers can employ or test.

The second half of this comprehensive volume is devoted to the systematics and bionomics of the island fauna of Orthoptera. An excellent key is provided for the identification of all species on the islands and adjacent mainland. For each species, recognition characters, geographic distribution, karyotype, habitat (and often food preferences), seasonal occurrence, and discussion are given. Twelve new species and ten new subspecies are described for the first time. On the basis of calling songs, six species of crickets of the genus *Gryllus* are identified, though they are not given names.

The excellent figures include photographs of collecting sites and karyotypes and line drawings of island maps and morphological features of the island species.

The work of Rentz and Weissman is a major contribution to the biogeography of the Channel Islands. In scope and presentation of information pertinent to the concepts of island biogeography, it is a model for other researchers to follow.

David A. Nickle, *Systematic Entomology Laboratory, IIBIII, Agricultural Research Service, USDA, % National Museum of Natural History, Washington, D.C.* 20560.

PROC. ENTOMOL. SOC. WASH.
84(4), 1982, pp. 864–866

OBITUARY

LUELLA WALKLEY MUESEBECK
1905–1981

Luella Walkley Muesebeck was born May 22, 1905, in McClure, Pennsylvania, as Luella May Walkley. Her father was a career Army man, and the family moved frequently. Luella's only brother, Charles, was born in New Jersey and her only sister, Orlena, in Rhode Island. When Luella was six years old, the family moved to the West Coast, her father having been assigned to Fort Worden, in the Puget Sound area of Washington, and they lived on the base. Here they remained until 1915 when they moved to New York State where they lived until Luella's father returned from Europe at the end of the First World War and was reassigned to Fort Worden. The family again lived on the base until 1923 when the father retired from the Army and built a home for them at nearby Port Townsend.

Luella attended the high school in Port Townsend 1919–1923 and Western

Washington College of Education 1924–25. During the following several years she taught in public schools in Burlington and Dabob, Washington, and Crowheart, Wyoming. With the rest of the family still in Port Townsend, she then attended the University of Washington in Seattle, graduating in 1933 with a major in zoology and a minor in journalism. Here she came under the influence of Dr. Trevor Kincaid, head of the Department of Zoology, and developed a keen interest in biology and natural history. She participated in numerous field excursions involving study of water and shore biology of the Puget Sound region and of the biology of the nearby Cascade Mountains.

Soon after this she went to Washington, D.C., and for several years taught in the public schools there. In 1942 she was appointed Naval Research Analyst in the Office of Censorship, and in 1946 she transferred to the Department of Agriculture, being appointed to a subprofessional position in the Division of Insect Identification of the old Bureau of Entomology and Plant Quarantine. Although originally assigned to the cataloging section of the Division she was soon placed on the professional staff. Her first responsibility here was in bibliographical research, in which she excelled. In this connection she coauthored with me certain sections of the Catalog of the Hymenoptera of North America north of Mexico, published by The Department of Agriculture in 1951 (U.S. Dep. Agric., Agric. Monogr. 2), and also a work entitled "Type species of the genera and subgenera . . . of the superfamily Proctotrupoidea," published in 1956 (Proc. U.S. Natl. Mus. 105: 319–419). Her familiarity with the International Rules of Zoological Nomenclature and the Opinions of the International Commission, together with unusual aptitude in the interpretation and application of them, contributed significantly to the success of the latter project. Soon after this she was appointed specialist in the hymenopterous family Ichneumonidae with responsibility for supplying needed identifications and conducting research in the systematics of the group. Intermittently she also continued study of the small coleopterous family Lathridiidae which she had begun while at the University of Washington.

Luella retired in January 1969 and continued to make her home in the outskirts of Silver Spring, Maryland, where she had more than two acres of lawn, garden, and woodland. She was devoted and skillful in rose culture and sometimes exhibited her roses in the annual exhibitions sponsored by the Potomac Rose Society, winning a number of prizes. She knew and loved the song birds and saw to it that those in her area had food in winter and summer. Her knowledge of the local wildflowers also was exceptional; she even cultivated some of these in a natural setting at the edge of her woodland.

For many years Luella had suffered from a respiratory ailment, which became seriously aggravated in 1976. She attributed her worsening condition to the increased air pollution in her area, and eventually she decided to return to the Puget Sound region of Washington where she had spent her youth. Efforts to become readjusted and settled here weakened her further, but she acquired a comfortable and nicely situated home on Camano Island. She and I were married there in April 1980. Her health continued to worsen, however, and on March 12, 1981 she suffered a stroke which was followed by her death on March 21. Besides me, her husband, only a sister, Orlena W. Braun, of Jensen Beach, Florida, survives her. Her passing left an especial void in the lives of both of us, but it also has grieved a large number of friends for all who knew her loved her. Luella was a member of the Entomological Society of Washington.

Carl F. W. Muesebeck, *715 North E11 Road, Camano Island, Washington 98292.*

PROC. ENTOMOL. SOC. WASH.
84(4), 1982, pp. 867–872

SOCIETY MEETINGS

883rd Regular Meeting—January 7, 1982

The 883rd Regular Meeting of the Entomological Society of Washington was called to order by President Margaret S. Collins at 8:00 PM on January 7, 1982 in the Naturalist Center, National Museum of Natural History. Twenty-five members and three guests attended.

Minutes of the previous meeting were read and approved. No new members were reported for the month.

President Collins introduced a motion to increase membership dues to $13 and change Article 4, Section 1 of the Constitution to read "thirteen" instead of "eight," as recommended by the treasurer at the previous meeting. The motion was properly seconded and unanimously approved by voice vote.

Membership Chairman Joyce Utmar produced the names of the persons making up the membership committee. In addition to herself, they are Victor Adler and Thomas Wallenmaier.

President-elect Manya Stoetzel noted that the annual banquet will be held on June 3, 1982. Various alternate sites for the banquet were discussed.

The speaker for the evening was Jack E. Lipes of the Office of International Cooperation and Development, USDA, who presented a talk entitled "Selected Insects—Their Distribution, Economic Importance, and Biological Control Potential." Most of the talk centered on Central America and included Mediterranean Fruit Fly, Citrus Blackfly, Citrus Whitefly, Coconut Palm Weevil, and various Lepidoptera whose larval forms have urticating setae. Slides of the Middle East were also shown.

There were no notes or exhibitions. Visitors were introduced and the meeting was adjourned at 9:15 PM, after which refreshments were served.

Thomas E. Wallenmaier, *Recording Secretary*

884th Regular Meeting—February 4, 1982

The 884th Regular Meeting of the Entomological Society of Washington was called to order by President Margaret S. Collins at 8:00 PM on February 4, 1982 in the Naturalist Center, National Museum of Natural History. Seventeen members and four guests attended.

Minutes of the previous meeting were read and approved.

The speaker for the evening was Dr. Luther P. Brown of the Department of Biology, George Mason University. His talk was entitled "Behavioral Ecology and Life History of a Horned Beetle—*Bolitotherus cornutus* (Panzer).'' The behavior of this tenebrionid beetle was studied extensively by Dr. Brown at the Mountain Lake Biological Station in Virginia, to test whether resource defense polygamy was being practiced by members of the population. Details were given on life history, including courtship behavior, oviposition, and larval and pupal descriptions. This species was found to feed on three species of bracket fungi, and the adult males are noted for horns extending from the pronotum. An interesting question and answer period followed the talk.

Notes and Exhibitions

President Collins announced that a field research station has been established at Kartabo, Guyana, and inquiries from interested scientists are welcome. T. J. Spilman announced the death of Marion R. Smith at age 87 on December 29, 1981. Dr. Smith received degrees from Clemson College, Ohio State University, and the University of Illinois, and from 1921 to 1937 taught at Mississippi State College. He was a specialist on the systematics of ants and from 1937 to 1964 worked for the U.S. Department of Agriculture, being best known as the author of ''House Infesting Ants of the Eastern United States.''

Visitors were introduced and the meeting was then adjourned at 9:30 PM, after which refreshments were served.

Thomas E. Wallenmaier, *Recording Secretary*

885th Regular Meeting—March 4, 1982

The 885th Regular Meeting of the Entomological Society of Washington was called to order by President Margaret S. Collins at 8:00 PM on March 4, 1982 in the Naturalist Center, National Museum of Natural History. Twenty-six members and nine guests attended.

Minutes of the previous meeting were read and approved. T. J. Spilman read the names of the following applicants for membership:

Robert W. Kelley, Department of Entomology, Fisheries and Wildlife, Clemson University, Clemson, S.C. 29631.

John D. Pinto, Department of Entomology, University of California, Riverside, Calif. 92521.

President Collins read a letter from the Smithsonian Archives asking whether the Society would want to place its inactive records in their custody. The question will be brought up at the next executive committee meeting and then voted on at a regular meeting subsequent to the former. President Collins gratefully acknowledged a gift of $1000 from Bennet A. Porter. President Collins also noted that she is now the delegate from the Society to the

Washington Academy of Sciences. The Hospitality Committee was given an acknowledgment of appreciation for its dedicated service throughout the year.

The speaker for the evening was Dr. Howard G. Sengbusch, Professor Emeritus of Biology, State University College of Buffalo. His talk was entitled "Starting from Scratch, or Some Ectoparasites of Increasing Medical and Veterinary Importance." Dr. Sengbusch discussed various species of lice and mites that are important ectoparasites of man. Recent studies on the prevalence of the head louse, *Pediculus humanus* Linnaeus, in different groups of children were discussed. Many excellent slides accompanied the talk.

NOTES AND EXHIBITIONS

A member noted the death of Elmer L. Mayer, an entomologist with the Department of Agriculture's Plant Industry Station in Beltsville, Maryland, for 33 years. Mr. Mayer passed away on February 4, 1982.

Visitors were introduced and the meeting was adjourned at 9:20 PM, after which refreshments were served.

Thomas E. Wallenmaier, *Recording Secretary*

886th Regular Meeting—April 1, 1982

The 886th Regular Meeting of the Entomological Society of Washington was called to order by President Margaret S. Collins at 8:00 PM on April 1, 1982 in the Naturalist Center, National Museum of Natural History. Thirty-six members and twenty-two guests attended.

President-elect Manya Stoetzel reported details of the forthcoming annual banquet.

Membership Chairman Joyce Utmar read the names of the following applicants for membership:

R. M. Hendrickson, Jr., Beneficial Insects Research Laboratory, USDA-ARS, 501 South Chapel Street, Newark, Del. 19713.
H. G. Larew, Florist and Nursery Crops Laboratory, BARC-East, Beltsville, Md. 20705.
W. P. Mackay, 1300 Elmhurst Drive, El Paso, Tex. 79925.
M. J. Raupp, Department of Entomology, University of Maryland, College Park, Md. 20742.
G. Stephens, Route 2, Box 29, Laramie, Wyoming 82070.
G. M. Stonedahl, Department of Entomology, Oregon State University, Corvallis, Oregon 97331.
E. A. Thomas, 537 Wilson Bridge Drive, Apt. C2, Oxon Hill, Md. 20745.

Minutes of the previous meeting were read and approved.

The speaker for the evening was Donald R. Davis, a Smithsonian Institution scientist. His talk was entitled ''Entomological Research on Taiwan.'' Dr. Davis began his talk with a discussion of the biogeography of Taiwan. He then discussed the details of his 1980 visit to Taiwan where he visited several entomology research institutions. He also collected more than 21,000 Lepidoptera specimens and described the details of his collecting. Dr. Davis also collected one specimen of a rare family of Lepidoptera, the Neopseustidae, and he described the unique morphology of these small moths.

NOTES AND EXHIBITIONS

Dr. Barris exhibited local termite specimens.

Dr. Anderson displayed the newly published ''Bark and Ambrosia Beetles of North and Central America'' by Stephen L. Wood. This monumental work represents the most complete treatment of this group of beetles; its 1300 pages cover more than 1400 species.

Visitors were introduced and the meeting was adjourned at 9:30 PM, after which refreshments were served.

Thomas E. Wallenmaier, *Recording Secretary*

887th Regular Meeting—May 6, 1982

The 887th Regular Meeting of the Entomological Society of Washington was called to order by President Margaret S. Collins at 8:00 PM on May 6, 1982 in the Naturalist Center, National Museum of Natural History. Twenty-nine members and sixteen guests attended.

Membership Chairman Joyce Utmar read the names of the following applicants for membership:

Nathan Bacon, 14282 Molly Pitcher Hwy., Greencastle, Pa. 17225.
Tohko Y. Kaufmann, 1211 Crown Point Ave., Apt. 107, Norman, Okla. 73069.
Juan M. Mathieu Veillard, Hildago No. 1328 Pte., Col. del Valle, Cd Obregon, Sonora, Mexico.
Michel Padiou, 8 Rue du Cdt. L. Bouchet, Cressely—Nagny les Mameaux, 78470 Saint Remy Les Chevreuse, France.
George Butler Wilson, Entomology and Plant Pathology, University of Tennessee, P.O. Box 1071, Knoxville, Tenn. 37901.
Richard Zack, Department of Entomology, Washington State University, Pullman, Wash. 99164.

The speaker for the evening was Dr. Donald H. Messersmith of the Department of Entomology, University of Maryland, whose talk was entitled

"Insect Collecting in Belize." Dr. Messersmith led a group which camped at the Desmond B. Slattery Field Biology Station on Blue Creek in Belize. More than 25,000 insect specimens were collected. Dr. Messersmith described the day to day living of the collecting expedition with many interesting slides and lively anecdotes. He also showed slides of some of the insects found as well as other forms of wildlife. At the conclusion of his talk he introduced Warren Steiner and Joseph Anderson who accompanied him on the trip and who spoke briefly on their collecting. Dr. Margaret Collins also accompanied Dr. Messersmith on the expedition and she concluded by describing her success collecting termites, especially members of the genus *Armitermes*.

NOTES AND EXHIBITIONS

T. J. Spilman showed a new book entitled "The Gypsy Moth: Research Toward Integrated Pest Management" edited by Charles C. Doane and Michael L. McManus. It is USDA Technical Bulletin 1584, 757 pages, published in 1981 and sells for $30.00. This book contains a wealth of information on every aspect of this forest pest.

G. Steyskal showed a new book entitled "A Revisionary Study of Leafmining Flies (Agromyzidae) of California," published in 1981.

T. J. Spilman regretfully brought to our attention the recent death of J. L. Gressitt, age 67, and his wife in a plane crash in China. Gressitt—a great figure in entomology—was most noted for his works on cerambycid and chrysomelid beetles. It was also noted that Maurice T. James, a Diptera specialist, died recently in Pullman, Washington.

Visitors were introduced and the meeting was adjourned at 9:45 PM, after which refreshments were served.

Thomas E. Wallenmaier, *Recording Secretary*

888th Regular Meeting—June 3, 1982

The Entomological Society of Washington and the Plant Pest Society of Washington Joint Annual Banquet was held on June 3, 1982, in the Chesapeake Room on the College Park campus of the University of Maryland. Manya B. Stoetzel and Albert B. DeMilo were banquet chairmen and Eugene F. Wood was master of ceremonies. After the social hour and dinner Dr. Allen L. Steinhauer, Chairman of the University of Maryland Department of Entomology spoke on the subject "A Look at IPM in the Third World."

The banquet was attended by 105 persons. After the talk by Dr. Steinhauer drawings were conducted for door prizes. Door prizes were donated by: William Bickley, Chevron Chemical Company, CIBA-GEIGY Corporation, John A. Davidson, John W. Kennedy Consultants, Inc., Mansanto Agricultural Products Company, National Agricultural Chemicals Association, and Kjell Sandved, Smithsonian Institution.

Table centerpieces were provided by Dr. John W. Neal, Jr., and Mr. Bobby Taylor, Beltsville Agricultural Research Center, U.S. Department of Agriculture.

Thomas E. Wallenmaier, *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 *Dermatophagoides*, by Jay R. Traver	1.00
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