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THE FOSSIL PELECINIDS *PELECINOPTERON* BRUES AND *ISCOPINUS* KOZLOV (HYMENOPTERA: PROCTOTRUPOIDEA: PELECINIDAE)

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Abstract.—The status of the two described genera of fossil Pelecinidae is reviewed. The type material of *Pelecinopteron tubuliforme* Brues has apparently been lost or destroyed. A single partial male specimen from Paleocene amber is known. On the basis of this specimen and the illustrations in the original description, the placement of *Pelecinopteron* within the Pelecinidae is corroborated. Synapomorphies uniting the two are an extremely elongate, tubular female metasoma; basal segment of the hind tarsus shorter than second segment; hind tibiae of female swollen; Rs with two long branches. The association of the lower Cretaceous species *Iscopinus baissicus* Kozlov with Pelecinidae is not supported. The purported branch of Rs_2 is interpreted as the crossvein r-m, a plesiomorphic feature. The subfamily Iscopininae is removed from Pelecinidae and considered as the family Iscopinidae **new status** within Proctotrupoidea *s. str.*

Key Words: Cretaceous, Jurassic, Eocene, Paleocene, paleontology

The family Pelecinidae (Hymenoptera: Proctotrupoidea *s. str.*) today consists of only a single extant genus, *Pelecinus* Latreille. No fossils of *Pelecinus* are known, but two other genera have been assigned to the family: *Pelecinopteron* Brues and *Iscopinus* Kozlov. As part of a review of pelecinids, I have re-examined these fossil taxa and discuss their relationship with modern *Pelecinus.*

The superfamily Proctotrupoidea *s. str.* (Hymenoptera) is comprised of some ten distinctive extant families. Of these, only the Diapriidae and Proctotrupidae contain large numbers of species. The remainder are small, probably relict taxa. However, the fossil history of the superfamily is relatively rich, with 70 species described and the extinct family Mesoserphidae represented already in the lower Jurassic (Darling and Sharkey 1990, Rasnitsyn 1980, 1990, 1994).

Modern *Pelecinus* are characterized by a number of distinctive apomorphic characters among living Hymenoptera (terminology of wing veins and cells follows Goulet and Huber 1993): Rs of the fore wing is branched (see more extensive discussion of this feature below); the female metasoma is extremely elongate, with the lateral edges of the terga of metasomatic segments 2–5 meeting and fused together along the midventral line, the sterna of these segments are divided into anterior and posterior sclerites allowing rotational movement (Mason 1984); the hind tibiae of the female are apically swollen and bear a lateral orifice; and the hind basitarsi of both sexes are strongly reduced, shorter than the second segment. The limits of the family traditionally have been based upon these characteristics of the extant species. Incorporation of fossil taxa into a monophyletic Pelecinidae requires some relaxation of these defining characteristics.

Pelecinopteron tubuliforme Brues
(Fig. 1)

Pelecinopteron tubuliforme Brues, 1933: 20, ♂, ♀.

Pelecinopteron tubuliforme: Kozlov, 1974: 145.

Brues described this species on the basis of three specimens, one female (the holotype) and two males, from Eocene Baltic amber. This material was part of a much larger collection of specimens belonging to the University of Königsberg (present-day Kaliningrad, Russia) that formed the basis for a series of papers published over a period of 18 years (Brues 1923, 1933, 1940a, 1940b, 1940c). I have had no success in locating the specimens of *Pelecinopteron* from this material. It is quite possible that it was destroyed during World War II, but it is unclear when, or if the specimens were ever returned. Unfortunately, many of the specimens had no identification numbers associated with them, rendering their recognition even more difficult. All that is available for many of these taxa are the published descriptions and illustrations.

These sources of information appear to support the placement of *P. tubuliforme* within the Pelecinidae. In a comparison with *Monomachus* Klug, Brues (1933) characterized the wing venation as "Pelecinus type," presumably referring to the lack of closed cells and most venation in the hind wing, and the long apical branches of Rs in the fore wing. These branches follow a very similar course to those in *Pelecinus,* and Brues also remarked that the veins are "hyaline and scarcely chitinized." The long tubular metasoma is very similar to that of *Pelecinus,* although Brues remarked that segments 1–3 possessed large sterna. He emphasized the short fourth segment of the hind tarsus, but his illustration (Plate 3, Fig. 8) also appears to show that the basal segment is relatively short. The supposed male of *Pelecinopteron,* however, differs rather markedly from male *Pelecinus.* The metasoma (Fig. 1) is elongate rather than clavate, and the fifth segment (according to Brues) is swollen medially and followed by a falcate sixth segment. The published illustration of the wing venation differs rather markedly between the male and female. On the basis of this evidence, Kozlov (1974) was quite justified in treating *Pelecinopteron* as a pelecinid.

In a footnote to his paper on *Iscopinus* (see below), Kozlov (1974) mentioned a specimen of *Pelecinopteron* in Paleocene amber from Sakhalin Island. This specimen (Fig. 1) consists of a detached male metasoma of eight visible segments and exserted genitalia and is remarkably similar to the illustration in Brues. The swollen and laterally compressed segment is metasomatic segment six (not five). The difference in position of the segments between the published illustration and this specimen suggests that the segments are capable of extensive movement. The male genitalia are quite narrow, with elongate parameres and the aedeagal lobe extends a considerable distance beyond the digiti. Each metasomatic segment is clearly divided into terga and sterna. Despite the lack of head, mesosoma, and appendages I am quite comfortable confirming Kozlov's determination of this as a specimen of *Pelecinopteron.*

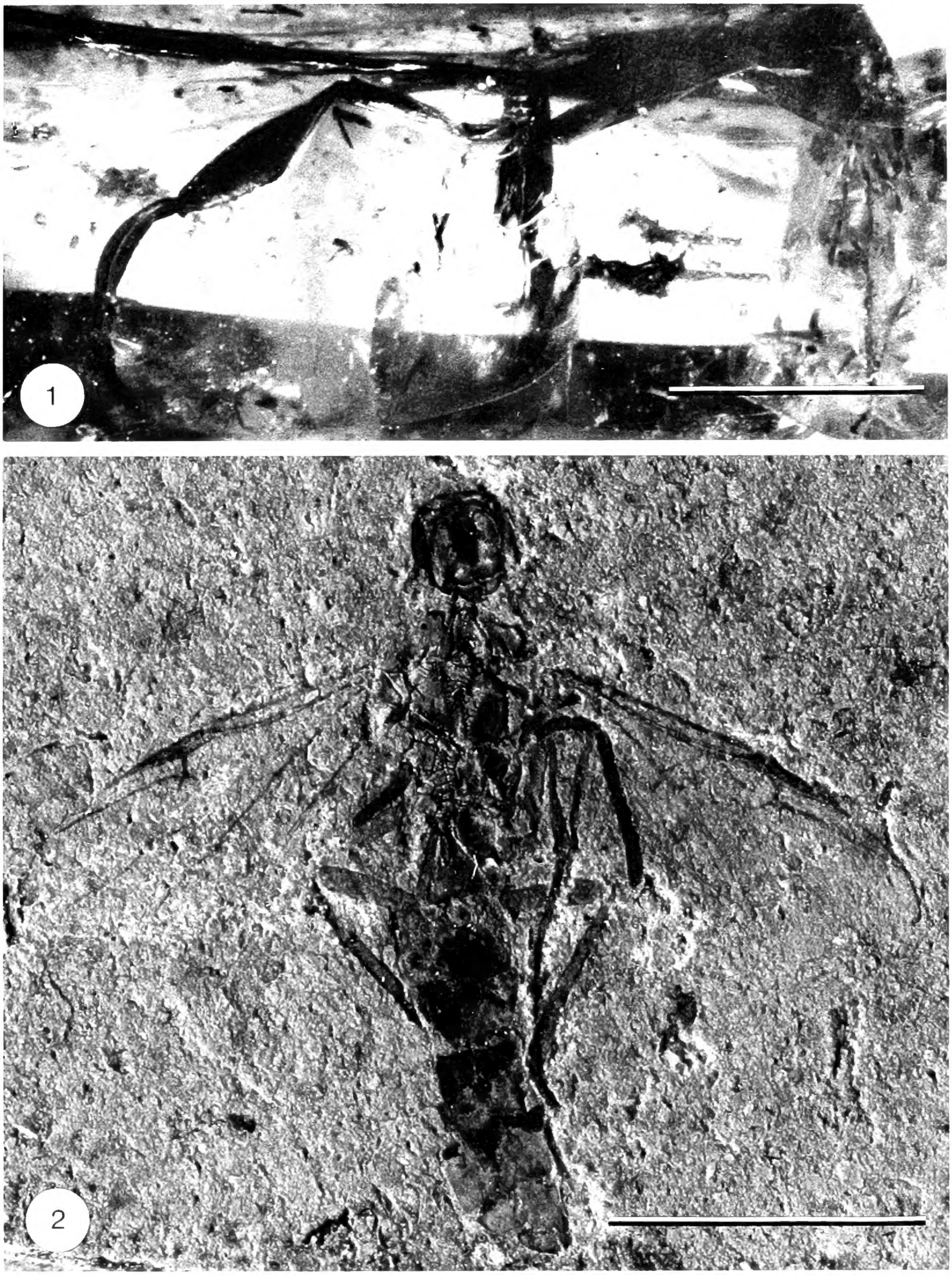
Material examined.—"PIN No. 3387/4; Pelecinopteron ?tubuliforme Brues, M. Kozlov det., 1972 (Paleont. Zhurn. 1974 #1:145); Sakhalin amber (Paleocene), V. V. Zherikhin leg., 1972 (data from specimen)." Kozlov (1974) adds the following information: " . . . material washed ashore at the settlement of Starodubskoye (Dolinsk district, Sakhalin province)."

Iscopinus baissicus Kozlov
(Figs. 2, 4)

Iscopinus baissicus Kozlov, 1974: 145. Holotype in Paleontological Institute, Russian Academy of Sciences, Moscow.

Total length.—13.2 mm.

Head.—Width 1.77 mm, height 1.97 mm (measured to lower tip of mandibles); ratio



Figs. 1–2. Specimens of fossil Pelecinidae. 1, *Pelecinopteron tubuliforme*, lateral view of metasoma; scale line = 2 mm. 2, *Iscopinus baissicus*, holotype.; scale line = 5 mm.

of height to width = 1.1; occipital carina incomplete, apparently not extending ventrally to base of mandibles or to merge with hypostomal sulcus; both hypostomal and genal bridges lacking, labium extending dorsad to occipital foramen; hypostomae paralleling labium and extending quite far dorsally, not approximated medially; mandibles overlapping, large, both tridentate, teeth acute, subequal in size, arrayed vertically; clypeus transverse, with small apical protuberance; width = 1.13 mm, measured at level of anterior tentorial pits laterally to mandibular articulations; height = 0.33 mm; ratio of width to height = 3.4; frons appears to be slightly protuberant above, with medial longitudinal keel; no antennal insertions visible in lower half of frons.

Antennae.—8 and 17 antennomeres visible; longest antenna broken, with apical portion composed of 12 antennomeres; basal segment of longest antenna not modified into an identifiable scape; apical antennomere rounded, slightly shorter than preceding segment; third segment the longest, but overall antennae are filiform, with no differentiated clava.

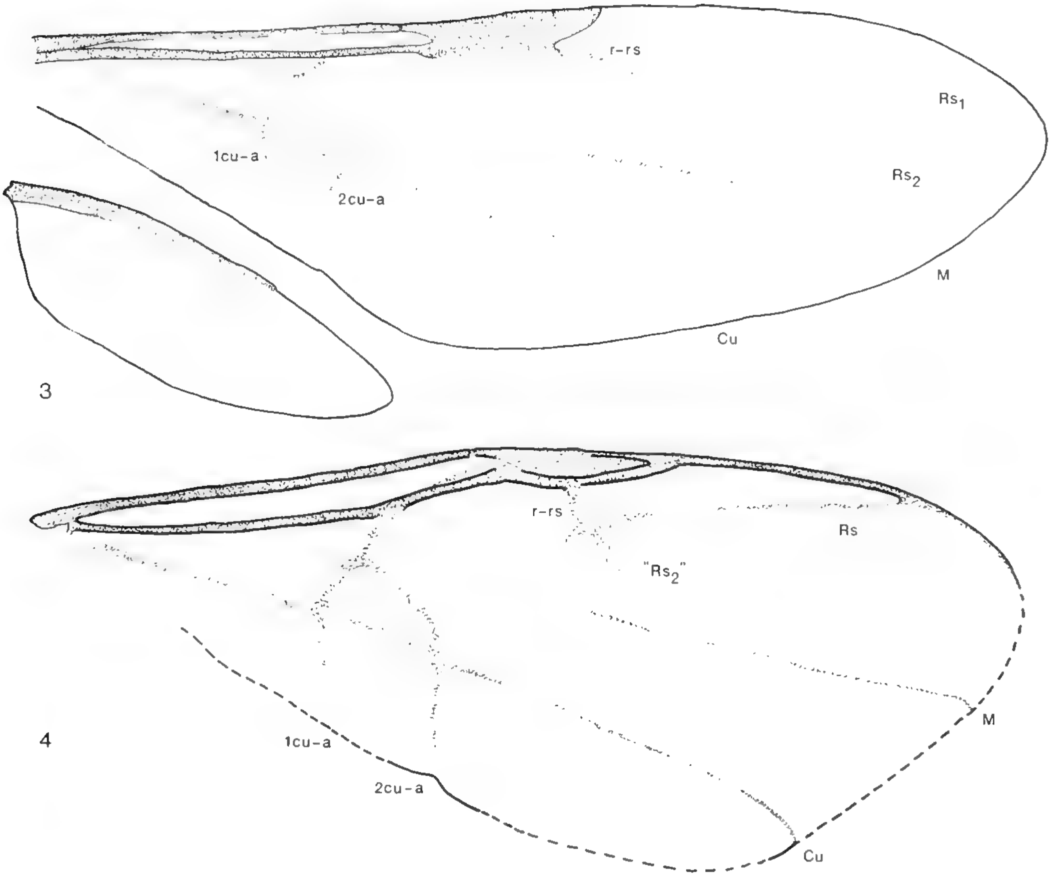
Mesosoma.—Length = 3.5 mm; pronotum appears to reach posteriorly to tegula, narrowed dorsally, but with short "neck" extending toward head; mesoscutum with narrow, transversely fusiform prescutum; central disk of mesoscutum with complete notauli, these converging, but not fusing posteriorly, transscutal articulation complete, narrow; behind transscutal articulation with medial transverse depression; scutellum strongly convex, delimited anteriorly by deeply crenulate furrow; axillae broadly separated medially; surface of propodeum apparently quite rugulose; mesopleuron with deep femoral scrobe, mesepimeron narrow, fusiform, delimited by deep crenulations; all legs gracile; hind basitarsus elongate.

Wings (Fig. 4).—Fore wing length = 7.1 mm; cell C present; pterostigma narrow, elongate, width = 0.27 mm, length = 1.68 mm, ratio of length to width = 6.53; radial cell ($2R_1$) closed, narrow, length = 2.52 mm, width = 0.54 mm, ratio of length to width = 4.70; Cu more or less straight and continuous to wing margin; M extends from wing margin basad beyond apex of r-rs; r-rs arising obliquely from pterostigma, 0.30 mm in length; Rs continues apically to wing margin from apex of r-rs, with short vein ("Rs_2,") arising posteriorly, length of Rs_2 = 0.26 mm; Rs basad of intersection with r-rs extending posteriorly and fading, with weak indication of extending as far as to intersect M; cell 1M large, more or less 4-sided, apex much shorter than basal side; 1cu-a arising opposite first free abscissa of M; 2cu-a arising opposite m-cu; 1cu-a and 2cu-a more or less parallel, posterior ends apicad of intersections with Cu; hind wing not clearly visible.

Metasoma.—8 segments visible; apex of abdomen without recognizable genitalia; segment 1 strongly narrowed anteriorly, trapezoidal, basal width = 0.39 mm, apical width = 1.34 mm, medial length = 1.46 mm, ratio of length to greatest width = 1.09; following 5 segments subequal in size, slightly wider than long.

Material examined.—Holotype: "Paleontological Inst. AN SSSR; Iscopinus baissicus Kozlov, 1974; P. Zh., n. 1, 1974, pg. 145, fig. 1; holotype; No. 1989/2596±; Locality: Buryatskaya ASSR, Yeravnenskii area, left bank of Vitim R., below mouth of Baysa River; Coll. Zabaikalskii Branch, PIN, 1964."

This species was described on the basis of a single fossil specimen, both an upper and lower impression, from lower Cretaceous deposits in the Transbaikal region of eastern Russia. Kozlov assigned the species to Pelecinidae on the basis of the wing venation, which he simply described as being unique in the Hymenoptera. Presumably, he referred to the presence of the short vein arising posteriorly from Rs just beyond r-rs, the so-called Rs_2 (Fig. 4). Rasnitsyn (1980) reviewed the definition and relationships of pelecinids and published a more detailed illustration of *Iscopinus*. He con-



Figs. 3–4. Wings of Pelecinidae. 3, Fore, hind wing of *Pelecinus polyturator*; fore wing length = 13.9 mm. 4, Fore wing of *Iscopinus baissicus*; length = 7.1 mm. Dashed line in wing margin represents interpreted edge of wing (not observable in specimen).

cluded that its differences from *Pelecinus* and *Pelecinopteron* were so fundamental as to warrant the establishment of a separate subfamily, Iscopininae.

Both Kozlov and Rasnitsyn identified the branching of the apical portion of Rs as the only character defining the Pelecinidae. In *Pelecinus* (Fig. 3) Rs is a nebulous vein (Mason 1986), indicated only by a line of darker pigmentation. The anterior branch reaches the apex of the fore wing, curving away from the costal margin. The posterior branch curves toward the costal margin and is quite long, but only rarely reaches the wing margin. The posterior "branch" of Rs of *Iscopinus* is quite short, and it is impossible to determine if it is a tubular vein. Rasnitsyn (1980) noted several living examples of Hymenoptera in which Rs_2 is present as either a nebulous or tubular vein and concluded that this feature is a commonly occurring secondary formation. Remarkably, he continued to employ it as a means of defining pelecinids! He also cited the elongate abdomen and the lack of a long, exposed ovipositor as characters allying the *Iscopinus* with Pelecinidae. The metasoma of this specimen clearly is not elongate on the scale observed in either *Pelecinus* or *Pelecinopteron*. Further, the apex of the abdomen of the specimen is not clearly preserved. A reasonable argument can be made that this specimen is, in fact, a male.

It appears that the Rs_2 visible in the type of *Iscopinus* is identical with the crossvein r-m (probably 2r-m). This forms the apical side of the areolet of many Ichneumonoidea and is fully developed in the middle Jurassic *Beipiaosirex parva* Hong, placed in the Roproniidae (Proctotrupoidea) by Rasnitsyn (1994). The illustration of an undescribed Cretaceous specimen attributed to Mesoserphidae in Darling and Sharkey (1990, their Fig. 5) also has the suggestion of a short posterior branch arising from Rs. In *Iscopinus* the vein is either incomplete, i.e. not reaching M, or the venation in that part of both wings of this specimen has been destroyed. I suspect the former to be true, as traces of M are visible below the base of the apical abscissa of Rs. Is it the same vein that is expressed in *Pelecinus*? Rasnitsyn's argument that the so-called Rs_2 in extant insects is a secondary development, especially associated with species of large body size, has a good deal of merit to it. The possession of the crossvein r-m seems to be best interpreted as a plesiomorphic character. Thus, I find no evidence supporting the purported relationship of *Iscopinus* with the Pelecinidae.

How should *Iscopinus* be treated? It seems reasonable to continue to consider it to belong to the Proctotrupoidea *s. str.* by virtue of the presence of cell C, the lack of the areolet, the elongate and narrow cell 2R1 (radial cell), the straight Cu, and the basal position of cell 1M. The name Iscopininae Rasnitsyn is a valid family-group name and I believe it should be treated as Iscopinidae **new status** within the Proctotrupoidea until such time as more material becomes available to shed light on the relationships of this wasp with other taxa.

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A REVIEW OF THE WEST INDIAN SPECIES OF *MIMAPSILOPA* CRESSON (DIPTERA: EPHYDRIDAE)

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Abstract.—Five species of *Mimapsilopa* are reported from the West Indies (including Trinidad and Tobago), including three that are new: ***M. cubensis*** (Cuba. Pinar del Rio: Soroa (2 km NW, 22°48.6′N, 83°1.0′W); ***M. dominicana*** (Dominican Republic. La Vega: Salto Guasara (near Jarabacoa; 19°04.4′N, 70°42.1′W; 680 m); and ***M. bacoa*** (Dominican Republic. La Vega: Jarabacoa (5 km S; 19°05.8′N, 70°36.5′W; 640 m). Two of the new species, *M. cubensis* and *M. dominicana*, are sister species, forming a monophyletic lineage within *Mimapsilopa* that is characterized by the wide face and greatly enlarged antenna of the male. The third new species is closely related to *M. cressoni* Lizarralde de Grosso.

Key Words: Review, Diptera, Ephydridae, shore flies, *Mimapsilopa, M. cubensis, M. dominicana, M. bacoa,* West Indies

Sexual dimorphism in shore flies, although evident, is not usually expressed phenotypically in overt manners (Zatwarnicki 1994). Frequently the only distinction and appearance of sexual dimorphism are in structures of the male and female terminalia. In two species of *Mimapsilopa* Cresson, however, both undescribed and from the Greater Antilles, the males have greatly enlarged antennae and a widened face. These features, coupled with the flies' generally shiny black appearance, make them among the more attractive and interesting of shore flies. Herein we describe these two unusual species and a third species that is closely related to *M. cressoni* Lizarralde de Grosso within the context of a revised generic description and a review of the other species of *Mimapsilopa* that occur on islands of the eastern Caribbean. We are also providing several new characters that were discovered in our study from structures of the male terminalia, which are fully illustrated.

Mimapsilopa is not a commonly used generic name even among shore-fly workers. Cresson (1941) proposed the name, but five years later he (Cresson 1946) treated the included species in *Helaeomyia,* a genus Cresson also described in the same 1941 paper but a page earlier. *Mimapsilopa* was considered a junior synonym of *Helaeomyia* (Cresson 1946, Wirth 1968) until Lizarralde de Grosso (1982) revised the species related to *Helaeomyia,* including recognition of *Mimapsilopa* as a separate genus. Lizarralde de Grosso's revision comprised six species, four being newly described. In our world catalog (Mathis and Zatwarnicki 1995) we followed Lizarralde de Grosso's precedent and recognized *Helaeomyia* and *Mimapsilopa* as distinct genera. Our listing in the catalog was based on Zatwarnicki's research, especially on structures of the male terminalia, that indicates the species placed in these two genera form monophyletic and separate lineages.

The descriptive terminology, with the exceptions noted in Mathis (1986) and Mathis and Zatwarnicki (1990a), follows that published in the *Manual of Nearctic Diptera* (McAlpine 1981). Because specimens are small, usually less than 3.5 mm in length, study and illustration of the male terminalia required use of a compound microscope. Although we followed the terminology for most structures of the male terminalia that other workers in Ephydridae have used (see references in Mathis 1986, Mathis and Zatwarnicki 1990a, 1990b), Zatwarnicki (1996) now uses alternative terms (medandrium, transandrium) that are based on the "hinge" hypothesis for the origin of the eremoneuran hypopygium. The terminology for structures of the male terminalia is provided directly on Figures 11–15 and is not repeated for comparable illustrations of other species. The species descriptions are composite and not based solely on the holotypes. One head and two venational ratios that are used in the descriptions are defined below (all ratios are based on three specimens (the largest, smallest, and one other). Gena-to-Eye ratio is the genal height measured at the maximum eye height divided by the eye height. Costal vein ratio: the straight line distance between the apices of R_{2+3} and R_{4+5}/distance between the apices of R_1 and R_{2+3}. M vein ratio: the straight line distance along vein M between crossveins (dm-cu and r-m)/distance apicad of dm-cu.

Although most specimens for this study are in the National Museum of Natural History, Smithsonian Institution, Washington, D.C. (USNM), we also studied numerous specimens that are deposited in the American Museum of Natural History (AMNH), New York, the Academy of Natural Sciences of Philadelphia (ANSP), Pennsylvania, and in the Natural History Museum (BMNH), London. A few specimens are also in the collection of the second author (TZ).

KEY TO WEST INDIAN GENERA OF DISCOMYZINI

1. A postsutural supra-alar seta much reduced (no larger than surrounding setulae) or absent 2
– A postsutural supra-alar seta present, size subequal to presutural seta 5
2. Pseudopostocellar setae well developed, length about ½ that of ocellar setae, orientation divergent at usually less than 90° . . . . *Clasiopella* Hendel
– Pseudopostocellar setae weakly developed, length considerably less than ½ that of ocellar setae, orientation variable 3
3. Face conspicuously and deeply, transversely rugose; only the reclinate fronto-orbital seta well developed . . . . *Discomyza* Meigen
– Face at most with shallowly impressed, transverse striae; at least 1 proclinate fronto-orbital seta in addition to reclinate seta well developed 4
4. Eye appearing bare; 1 well-developed proclinate fronto-orbital seta (2nd seta greatly reduced), inserted anterior to reclinate seta; prescutellar acrostichal setae well developed; presutural supra-alar seta weakly developed, length less than anterior notopleural seta (except in *M. cressoni* Lizarralde de Grosso); legs bicolored . . . . *Mimapsilopa* Cresson
– Eye conspicuously setulose; 2 well-developed proclinate fronto-orbital setae, anterior proclinate seta at about same level as large, reclinate seta, posterior proclinate seta inserted posterior of reclinate seta; prescutellar acrostichal setae greatly reduced or lacking; presutural supra-alar seta well developed, length longer than anterior notopleural seta; legs unicolorous, blackish brown . . . . *Helaeomyia* Cresson
5. Mesofrons bearing strong pair of intrafrontal setae inserted well in front of ocellar setae; fronto-orbital setae with 1 large and 1 small upper, lateroclinate setae and 2 large proclinate lower setae . . . . *Paratissa* Coquillett
– Mesofrons lacking intrafrontal setae; fronto-orbital setae proclinate and reclinate, but not lateroclinate . . . . *Guttipsilopa* Wirth

Genus *Mimapsilopa* Cresson

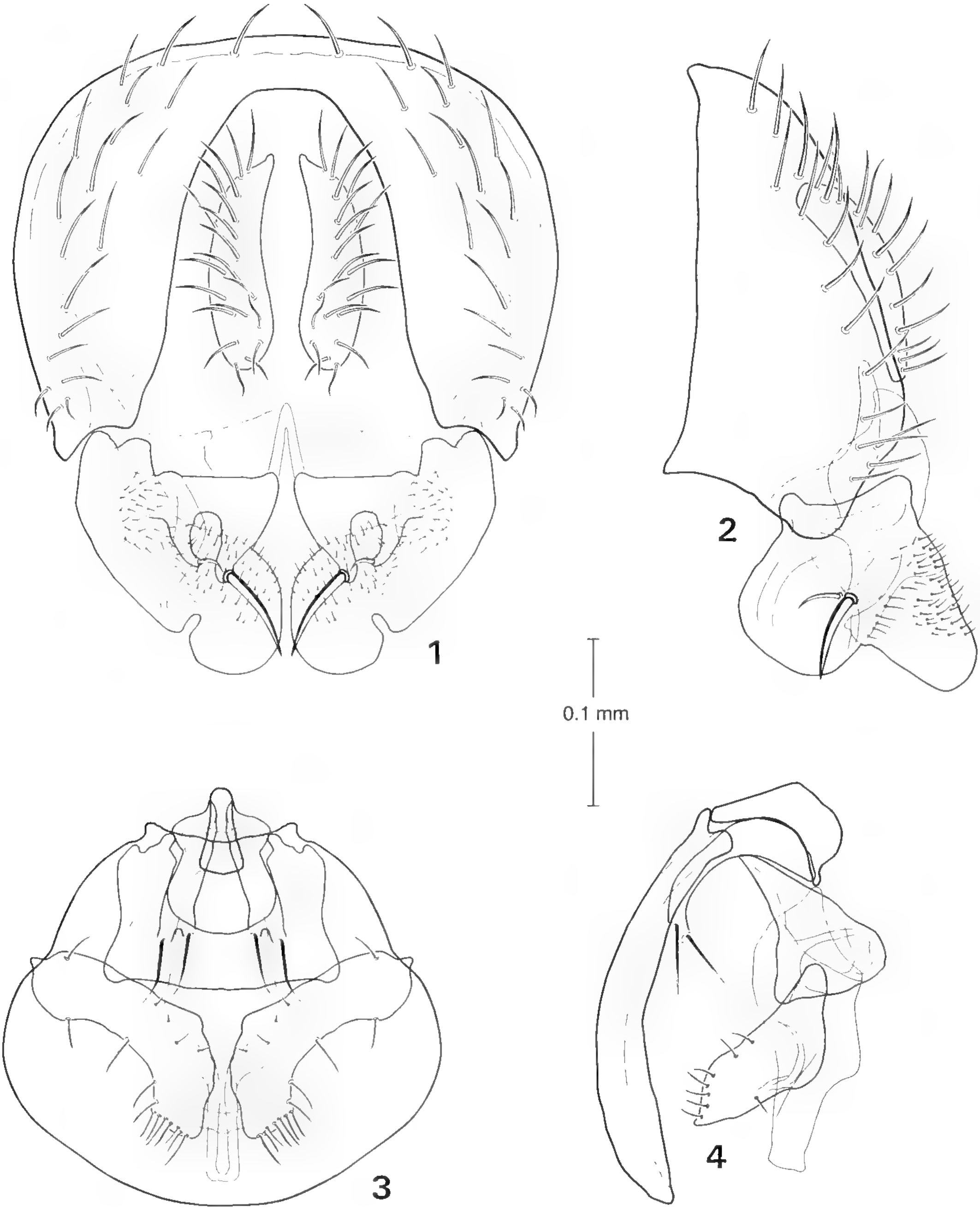
Mimapsilopa Cresson, 1941:36. Type species: *Clasiopella metatarsata* Cresson, 1939, original designation.—Cresson, 1946:153 [synonymy with *Helaeomyia* Cresson].—Lizarralde de Grosso, 1982: 121–128 [revision].—Zatwarnicki, 1992: 87 [placement of genus in Discomyzini].—Mathis and Zatwarnicki, 1995:27–28 [world catalog].

Diagnosis.—Small to medium-sized shore flies, length 1.30–3.40 mm; generally black species, many surfaces subshiny to shiny.

Head: Normally developed not triangular or with bulging eyes; antenna inserted at dorsal ⅓ of head height; frons conspicuously wider than long, microgranulose or sparsely microtomentose, contrasted from subshiny to shiny face, vertex distinctly to somewhat angulate, not broadly rounded; intrafrontal setae absent; well-developed fronto-orbital setae 2 (2nd proclinate seta greatly reduced, inserted posterior of larger proclinate seta), proclinate seta usually smaller, inserted anterior of reclinate seta; ocellar setae well developed, inserted behind level of anterior ocellus, orientation usually proclinate and slightly divergent; pseudopostocellar setae weakly developed, divergent and slightly proclinate; both inner and outer vertical setae well developed, outer seta shorter than inner seta. Antennal shape quite variable; arista pectinate, bearing 5–11 dorsal rays. Eye irregularly elliptical, higher than wide, interfacetal setulae sparse, appearing bare. Face swollen medially, mostly to entirely bare, shiny, smooth to microsculptured, lacking pits; well-developed facial setae 2, level of insertion variable, inclinate and usually slightly upcurved; proboscis normally developed, not elongate; palpus black.

Thorax: Generally black, mesonotum, including postpronotum and notopleuron sparsely microtomentose, thereafter ventrally, including most of pleural area, mostly bare of microtomentum, shiny black; scutellum more or less triangular, posterior angle bluntly rounded. Chaetotaxy as follows: prescutellar acrostichal setae well developed, inserted far anteriad, slightly anteriad of level of single, large, dorsocentral seta, distance between dorsocentral setae more than that between apical scutellar setae; presutural supra-alar seta variable, well developed or greatly reduced; postsutural supra-alar seta lacking; postalar seta 1; scutellar disc moderately setulose; basal scutellar seta over ½ length of apical seta; notopleuron lacking setulae but bearing anterior and posterior setae, these equidistant from notopleural suture; anepisternum with 2 large setae at posterior margin, ventral seta only slightly longer to nearly twice length of dorsal seta; katepisternum with 1 large seta. Halter with knob white to yellowish. Wing variable, hyaline or with pattern of infuscation, especially toward anterior margin, along crossveins, and apically; vein R_{2+3} extended normally to costal margin, well separated from costa, lacking a stump vein, moderately long, making section II about 1.5 length of section III; R stem vein bearing 2–4 setulae dorsally; crossvein dm-cu straight. Tarsi, at least basitarsi, white to yellow, contrasted sharply from dark colored tibiae and femora; forefemur with dorsal surface uneven, slightly emarginate.

Abdomen: Mostly shiny, blackish, microtomentum generally sparse; 5th tergite of male shinier than preceding tergites, almost devoid of microtomentum, anterior margin with broad, shallow emargination dorsomedially, bearing longer setae along posterior margin. Male genitalia mostly symmetrical; epandrium U-shaped in posterior view, arms projected ventrad, posterior surface generally setulose, generally thickly formed, especially dorsal portion, arms tapered gradually toward ventral apex; cercus in posterior view broadly lunate, especially ventrally, dorsal apex more narrowly pointed; presurstyli large structures at ventral margin of epandrium, median surface with a small emargination dorsally, thereafter ventrally on apical ⅔ shallowly concave and bearing numerous, short setulae, external surface arched; postsurstyli longer than wide, bearing numerous setulae, symmetrical or asymmetrical at apex, apex sometimes bilobed, mediobasal surface bearing an internal, medially directed, usually rodlike postsurstylar process; subepandrial plate broadly U-shaped, base longer



Figs. 1–4. *Mimapsilopa cressoni.* 1, Male terminalia (epandrium, cercus, presurstylus), posterior view. 2, Same, lateral view. 3, Internal male terminalia (aedeagus, aedeagal apodeme, pregonite, postgonite, postsurstylar process, hypandrium, and subepandrial plate), ventral view. 4, Same, lateral view. Scale = 0.1 mm.

than length of arms; aedeagus longer than wide, variously shaped; aedeagal apodeme in lateral view more or less triangular, angle at attachment with hypandrium thicker; hypandrium in lateral view angulate, becoming much wider toward anterior margin, concavity moderately deep.

Phylogenetic relationships.—There are two species groups within *Mimapsilopa* that are characterized as follows:

(1) The *metatarsata* Group: face smooth, polished; dorsoapical seta of pedicel moderately long, length less than width of pedicel; presutural supra-alar seta greatly reduced, much shorter than notopleural setae; ventral anepisternal seta at posterior margin only slightly larger than dorsal seta; anepisternum, anterior ⅔ of katepisternum, and lateral surface of forecoxa polished, shiny, contrasted with microtomentose mesonotum, including notopleuron; forebasitarsomere white, remainder of foreleg black, epandrium thickened and wider dorsally, presurstylus with median surface shallowly concave on ventral ⅔, bearing numerous short setulae; postsurstylus bearing rodlike process; gonites separate.

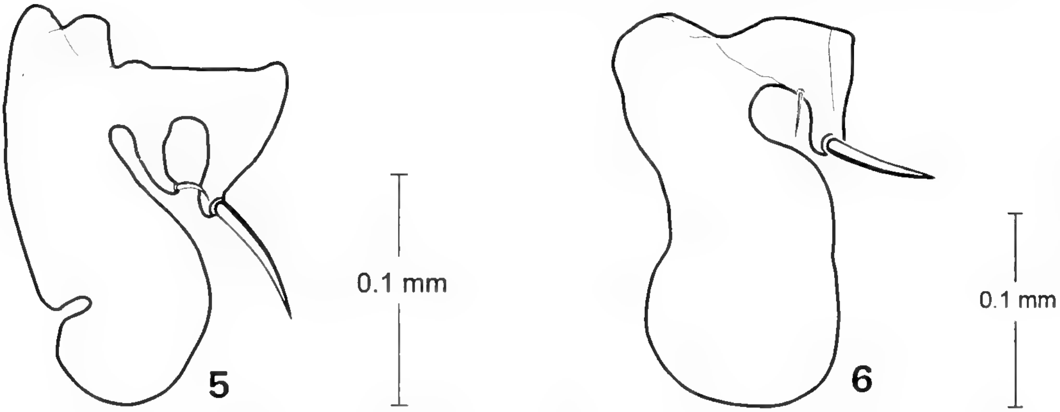
(2) The *cressoni* Group: face finely granulose and with some shallow, transverse rugosity; dorsoapical seta of pedical long, length greater than width of pedicel; presutural supra-alar seta well developed, length subequal to notopleural setae; ventral anepisternal seta at posterior margin nearly twice length of dorsal seta; dorsal and posterior margins of anepisternum microtomentose, similar to notopleuron; forecoxa sparsely microtomentose; forebasitarsomere yellow, similar to mid- and hindtarsi; epandrium with high cercal cavity, making dorsal portion of epandrium narrow; and presurstylus with large, median seta and median surface rounded, not concave; postsurstylus lacking rodlike process; pre- and postgonites fused and enlarged.

Two of the new species from the West Indies, *M. cubensis* and *M. dominicana,* are members of the *metatarsata* group, and within that group they are a monophyletic lineage that is characterized by the wide face and greatly enlarged antenna of the male, especially the pedicel and 1st flagellomere, and the longer setulae on the dorsum of the apical 2–3 tarsomeres of the foreleg. The third new species, *M. bacoa,* is the sister species of *M. cressoni.* Synapomorphies that corroborate this relationship are those that characterize this species group, as noted previously.

Discussion.—Considerable intraspecific size variation is evident, even in populations from the same locality. Males from a single site and collected at the same time can vary from 1.30 to 2.25 mm in total body length. As we know virtually nothing about the life cycle of this genus, particularly the immature stages, it is speculative to suggest the causes of this variation, although experience in rearing other groups of shore flies suggests that nutrition plays a major role.

KEY TO WEST INDIAN SPECIES OF MIMAPSILOPA

1. Antenna of ♂ greatly enlarged, especially pedicel and 1st flagellomere (combined length of these 2 segments almost equal to height of eye); length of 1st flagellomere of ♀ over twice width 2
– Antenna of ♂ normally developed, combined length far less than eye height; length of 1st flagellomere of ♀ not more than twice width . . . 3
2. Antenna mostly yellow, especially scape and pedicel; forefemur lacking comblike row of setae along anteroventral surface; foretarsus with basal 2 white, apical 3 black . . . . *M. cubensis,* new species
– Antenna black; forefemur with comblike row of short, stout setae along anteroventral surface; forebasitarsus white, apical 4 black . . . . *M. dominicana,* new species
3. Wing with costal margin, apex, and crossvein dm-cu infuscate; face smooth, shiny; presutural supra-alar seta greatly reduced, much shorter than notopleural setae; ventral anepisternal seta at posterior margin only slightly larger than dorsal seta; forebasitarsomere white . . . . *M. schildi* (Cresson)
– Wing hyaline; face finely granulose and with mostly transverse, fine rugosity; presutural supra-alar seta well developed, length subequal to notopleural setae; ventral anepisternal seta



Figs. 5–6. Presurstylus, posterior view (artifically flattened for better comparison). 5, *Mimapsilopa cressoni.* 6, *M. bacoa.* Scale = 0.1 mm.

at posterior margin nearly twice length of dorsal seta; forebasitarsomere yellow 4

4. First flagellomere with length comparatively longer than width, gradually and evenly tapered from wider base to narrow and more acutely rounded apex, yellow basoventrally, black dorsoapically . . . . *M. cressoni* Lizarralde de Grosso

– First flagellomere with length comparatively shorter and more bluntly rounded apex, mostly yellow with only some specimens usually faintly black along dorsoapical margin . . . . *M. bacoa,* new species

Mimapsilopa cressoni
Lizarralde de Grosso
(Figs. 1–4, 6)

Helaeomyia nigra.—Cresson, 1942:124 [misidentification of *Psilopa nigra* Williston].

Mimapsilopa cressoni Lizarralde de Grosso, 1982:127 [USA. Florida: Pinellas County, Dunedin; HT ♂, USNM].—Mathis and Zatwarnicki, 1995:27–28 [world catalog].

Specimens Examined from the West Indies.—*BAHAMAS. Andros:* Driggs Hills (near South Bight), 27 Apr 1953, E. B. Hayden, L. Giovannoli (1 ♀; USNM). *Rum Cay:* near Port Nelson, 16 Mar 1953, E. B. Hayden, L. Giovannoli (3 ♂; USNM). *CUBA. Havana:* Havana (beach; 23°5.8′N, 82°27.7′W), 2–14 Dec 1994, W. N. Mathis (2 ♀; USNM). *DOMINICAN REPUBLIC. Barahona:* Cabral (canals E of Cabral; 18°15.2′N, 71°13.4′W), 16 May 1995, W. N. Mathis (2 ♂, 1 ♀; USNM). *GRAND CAYMAN.* Frank Sound Road (19°18.9′N, 81°10.9′W), 28 Apr 1994, W. N. Mathis (1 ♀; USNM). Governor Gore Bird Sanctuary (19°16.7′N, 81°18.5′W), 25 Apr 1994, W. N. Mathis (1 ♂; USNM). Savannah (4 km NE; 19°18′N, 81°17′W; mangrove), 20 Feb 1993, F. J. Burton, W. E. Steiner, J. M. Swearingen (2 ♂, 3 ♀; USNM). *GRENADA. St. John:* Palmiste Lake (12°08.3′N, 61°44′W), 19 Sep 1996, W. N. Mathis (1 ♀; USNM). *St. Patrick:* Bathway Beach (12°12.6′N, 61°36.7′W), 18–20 Sep 1996, W. N. Mathis (1 ♂; USNM). *JAMAICA. Clarendon:* Milk River Bath (mangroves), 11 Mar 1970, T. Farr, W. W. Wirth (2 ♂, 3 ♀; USNM); Salt River (4 km N; 17°52.1′N, 77°09.5′W), 13 May 1996, D. and W. N. Mathis, H. Williams (6 ♂, 9 ♀; USNM). *Manchester:* Mandeville (18°03.5′N, 77°31.9′W), 7–13 May 1996, D. and W. N. Mathis, H. Williams (1 ♂, 1 ♀; USNM). *St. Andrew:* Ferry River, 12 May 1941, E. Chapin (1 ♂; USNM); Kingston, Fresh River, 24 Feb 1969, W. W. Wirth (1 ♂, 3 ♀; USNM). *St. Ann:* Runaway Bay, Feb 1969, W. W. Wirth (1 ♂, 2 ♀; USNM). *St. Catherine:* Port Henderson (bay shore), 24 Feb 1969, W. W. Wirth (1 ♀; USNM). *St. Eliz-*

abeth: Brae River (18°05.2′N, 77°39.3′W), 10 May 1996, D. and W. N. Mathis, H. Williams (1 ♂; USNM); Brae River (2 km S; 18°04.2′N, 77°39.5′W), 10 May 1996, D. and W. N. Mathis, H. Williams (2 ♂; USNM); Elim (18°07.1′N, 77°40.6′W), 10 May 1996, D. and W. N. Mathis, H. Williams (4 ♂; USNM); Port Kaiser (17°51.9′N, 77°35.7′W), 8 May 1996, D. and W. N. Mathis, H. Williams (1 ♀; USNM); near Port Kaiser (17°52.3′N, 77°34.9′W), 8 May 1996, D. and W. N. Mathis, H. Williams (1 ♀; USNM). *St. Thomas:* Yallahs River (mouth; 17°53′N, 76°35.6′W), 14 May 1996, D. and W. N. Mathis, H. Williams (1 ♂; USNM). *Westmoreland:* Negril (5 mi E; freshwater marsh), 13 Mar 1970, W. W. Wirth (1 ♀; USNM). *TRINIDAD.* Port of Spain, Ujhelyi (1 ♂; ANSP).

Distribution.—*Nearctic:* USA (FL). *Neotropical:* Bahamas, Ecuador, Guyana, Trinidad, West Indies (Cuba, Dominican Republic, Grand Cayman, Grenada, Jamaica).

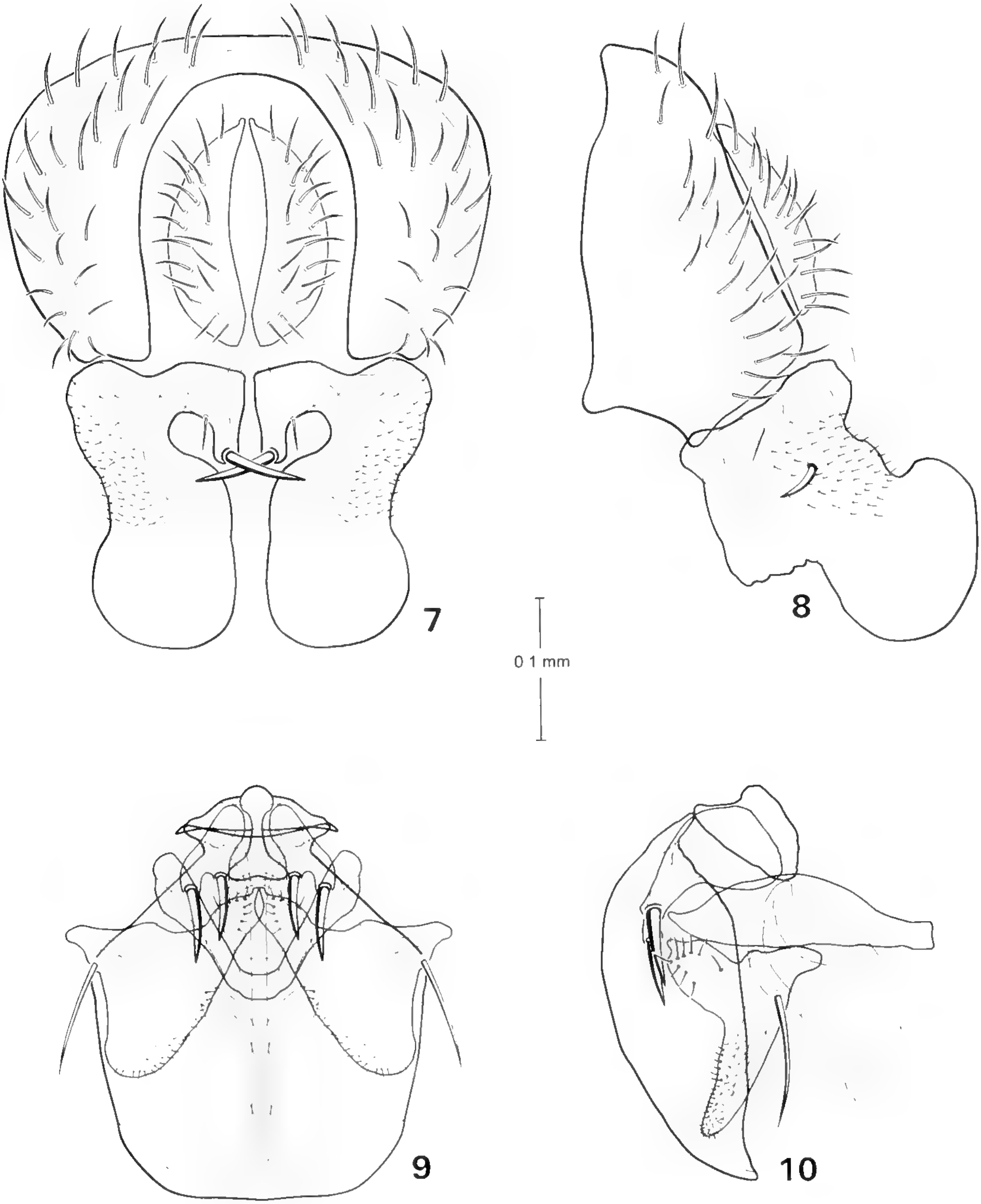
Diagnosis.—This species is distinguished from congeners by the following combination of characters: antenna normally developed and not sexually dimorphic; 1st flagellomere black around margins, apex acutely rounded; face microsculptured, finely granulose and with incomplete transverse and vertical rugosity, especially dorsally; presutural supra-alar seta well developed, length subequal to notopleural setae; ventral anepisternal seta at posterior margin nearly twice length of dorsal seta; wing entirely hyaline; forefemur bearing a comblike row of short, stout, peglike setulae along anteroventral surface; foretarsus including forebasitarsomere yellow.

Male terminalia (Figs. 1–4): Epandrium in posterior view (Fig. 1) as an upside down, thin to thick-walled U, dorsal portion narrowed between dorsal margin of cercal cavity and anterodorsal margin, arms widest basally, gradually tapered toward ventral margin; epandrium in lateral view (Fig. 2) with height slightly more than twice width, dorsal margin sloped posteroventrally, anterodorsal angle pointed and shallowly projected, widest at basal fourth; thereafter abruptly narrowed to broadly rounded ventral margin; cercus in posterior view (Fig. 1) allantoid with dorsal margin pointed and ventral margin broadly rounded; presurstylus symmetrical, in posterior view (Figs. 1, 6) bearing a lobe directed anteromedially, with broadly rounded anterior margin and subapical incision of external margin, bearing mediobasally U-shaped attachment with arms directed anteriorly and bearing strong setae, internal seta 3× as large as external; presurstylus in lateral view (Fig. 2) more or less bluntly bilobed, anterior lobe longer but slightly narrower; postsurstyli symmetrical (Fig. 3), sparsely setulose on lateral surfaces, both about 3.5× longer than wide, more or less parallel sided, obtusely angulate, apex bearing numerous setulae; aedeagal apodeme in lateral view (Fig. 4) crescent shaped, apex attached to base of aedeagus more narrowed, digitiform; external margin comparatively little produced, forming an angle slightly more than 90°, median margin concave; aedeagus (Figs. 3–4) pointed basally in lateral view and with apical third narrowed to less than half median width, apex truncate; subepandrial plate in ventral view (Fig. 3) broadly U-shaped, basal portion nearly flat, basal angles narrowly rounded; gonites (Fig. 4) fused, forming distinct rodlike structure, digitiform, bearing 2 long setulae apically; hypandrium shallowly pocketlike, in lateral view shallowly arched, slightly narrowed basally at attachment with aedeagal apodeme, more or less parallel sided thereafter to apex.

Mimapsilopa bacoa Mathis and Zatwarnicki, new species

(Figs. 5, 7–10)

Diagnosis.—This species is distinguished from congeners by the following combination of characters: antenna normally developed and not sexually dimorphic; 1st flagellomere mostly yellow, with some black along dorsal margin, apex broadly rounded; face microsculptured, finely granulose and



Figs. 7–10. *Mimapsilopa bacoa*. 7, Male terminalia (epandrium, cercus, presurstylus), posterior view. 8, Same, lateral view. 9, Internal male terminalia, ventral view. 10, Same, lateral view. Scale = 0.1 mm.

with incomplete transverse and vertical rugosity, especially dorsally; presutural supra-alar seta well developed, length subequal to notopleural setae; ventral anepisternal seta at posterior margin nearly twice length of dorsal seta; wing entirely hyaline; forefemur bearing a comblike row of short, stout, peglike setulae along anteroventral surface; foretarsus, including forebasitarsomere, yellow except for black, apical 2 tarsomeres.

Description.—Moderately small shore flies, body length 2.35–2.50 mm.

Head: Scape and pedicel black; flagellomere 1 broadly rounded. Antenna; arista bearing 9–11 dorsal hairs. Face microsculptured, finely granulose and with incomplete, transverse and vertical rugosity, especially dorsally. Gena-to-eye ratio 0.08–0.11.

Thorax: Presutural supra-alar seta well developed, length subequal to notopleural setae; ventral anepisternal seta at posterior margin nearly twice length of dorsal seta. Wing hyaline, faintly golden brown; costal vein ratio 0.72–0.75; M vein ratio 0.75–0.78. Femora and tibiae black; tarsi yellow except for black, apical 2 tarsomeres; forefemur bearing row of short, peglike setulae along anteroventral surface.

Abdomen: Male terminalia (Figs. 5, 7–10): Epandrium in posterior view (Figs. 5, 7) as an upside down, thin to thick-walled U, narrowed dorsally between dorsal margin of cercal cavity and anterodorsal margin, lateral arms widest basally, gradually tapered toward ventral margin; epandrium in lateral view (Fig. 8) with height about twice width, dorsal margin sloped posteroventrally, anterodorsal angle slightly pointed and very shallowly projected, widest at ventral fourth, thereafter abruptly narrowed to broadly angulate ventral margin; cercus in posterior view (Fig. 7) allantoid with dorsal margin pointed and ventral margin more broadly rounded; presurstylus symmetrical, in posterior view (Figs. 5, 7) as a bilobed structure, with median lobe much smaller, rodlike, bearing a long, stout seta apically that is oriented medially and a much longer and wider lateral lobe that extends ventrally as a wide, broadly rounded projection; presurstylus in lateral view (Fig. 8) with base quadrate and apical portion equally wide, broadly rounded ventrally, forming an angulate steplike shelf where the basal and apical portion meet; postsurstyli symmetrical (Fig. 9), in ventral view, irregularly and roughly triangular, gradually becoming narrower, more projected posteromedially, medioapical margin more or less broadly pointed, falcate, and bearing short setulae; aedeagal apodeme in lateral view (Fig. 10) roughly and irregularly triangular, short and wide, apex (attached to base of aedeagus) more broadly rounded than angle that attaches with hypandrium; external margin of aedeagal apodeme comparatively little produced, forming more or less a right angle, median margin straight; aedeagus (Figs. 9–10) in lateral view pointed basally and with apical two thirds rectangular, apex steplike; subepandrial plate in ventral view (Fig. 9) V-shaped with arms directed posterolaterally; pregonite (Fig. 10) a moderately narrow, moderately long rodlike sclerite bearing 2 long setulae apically; hypandrium moderately shallowly pocketlike, in lateral view moderately shallowly arched, slightly narrowed basally at attachment with aedeagal apodeme, more or less deeply sided immediately thereafter to apex.

Type material.—The holotype ♂ is labeled "DominicanRp. LaVega: Jarabacoa (5 km S) 19°05.8′N, 70°36.5′W 640 m, 8–20 May 1995[,] Wayne N. Mathis." The holotype is double mounted (minuten in block of plastic), is in excellent condition, and is deposited in the USNM. Paratypes are as follows: *Puerto Rico.* San Juan, 14 Mar 1963, A. B. Cochram (2 ♂; USNM).

Distribution.—*Neotropical:* West Indies (Dominican Republic, Puerto Rico).

Etymology.—The specific epithet, *bacoa,* is based in part on the site where the holotype was collected.

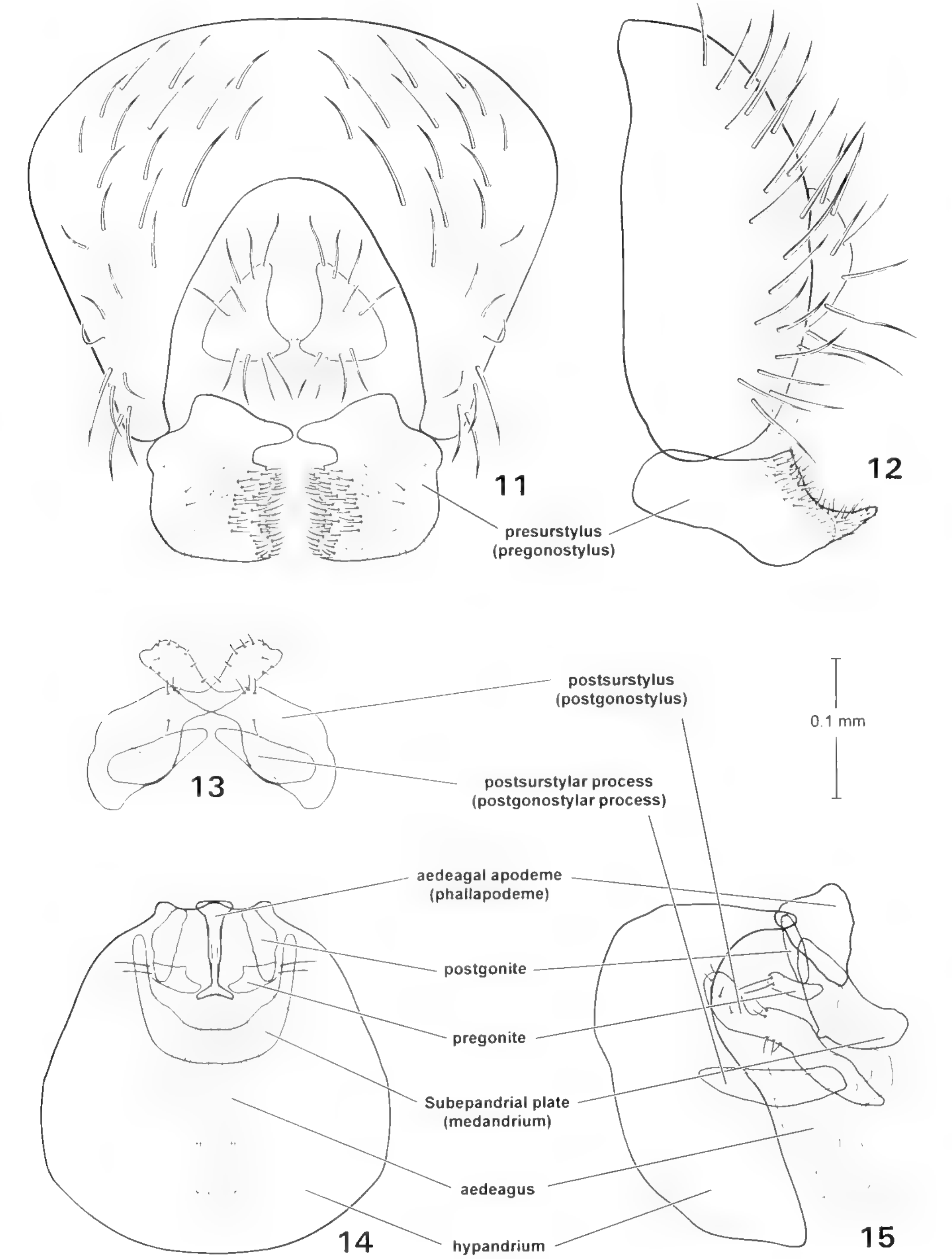
Mimapsilopa schildi (Cresson)
(Figs. 11–15)

Psilopa schildi Cresson, 1944:5 [Costa Rica. La Suiza; HT ♂, ANSP (6663, apparently lost)].

Helaeomyia schildi: Cresson, 1946:153 [generic combination].

Mimapsilopa schildi: Lizarralde de Grosso, 1982:127 [revision, generic combination].—Mathis and Zatwarnicki, 1995:28 [world catalog].

Specimens Examined from the West Indies.—*GRAND CAYMAN.* near George-



Figs. 11–15. *Mimapsilopa schildi.* 11, Male terminalia (epandrium, cercus, presurstylus), posterior view. 12, Same, lateral view. 13, Internal male terminalia, ventral view. 14, Postsurstyli, ventral view. 15, Internal male terminalia, lateral view. Scale = 0.1 mm.

town, J. Farradame (1 ♂, 1 ♀; BMNH). *TRINIDAD. St. George:* Filette (1 km SE; 10°47′N, 61°21′W), Yarra River, 25 Jun 1993; W. N. Mathis (3 ♂, 4 ♀; USNM).

Distribution.—*Neotropical:* Costa Rica, Ecuador, Guyana, Mexico, Panama, Peru, Trinidad, West Indies (Grand Cayman).

Diagnosis.—This species is distinguished from congeners by the following combination of characters: antenna normally developed and not sexually dimorphic; 1st flagellomere entirely yellow, apex bluntly rounded; face smooth, shiny; presutural supra-alar seta greatly reduced, much smaller than notopleural setae; ventral anepisternal seta at posterior margin only slightly longer than dorsal seta; wing with costal margin, apex, and crossvein dm-cu infuscate; forebasitarsus white.

Male terminalia (Figs. 11–15): Epandrium in posterior view (Fig. 11) as an upside down, thick-walled U, especially dorsal portion above cercal cavity, that becomes gradually narrower toward the ventral apex of the arms, in lateral view (Fig. 12) with height slightly more than 2.5× width, dorsal margin slightly sloping ventrad posteriorly, anterodorsal angle bluntly pointed and shallowly projected, widest at midheight, thereafter narrowed to broadly formed point at ventral margin; cercus in posterior view (Fig. 11) lunate with anterior half more narrowly formed, pointed and with ventral margin shallowly curved; presurstylus symmetrical, in posterior view (Fig. 11) more or less squarish, with median surface shallowly concave on ventral half and bearing numerous short setulae, dorsal portion with deep, narrow, U-shaped emargination that is bounded dorsally by a digitiform process; lateral view (Fig. 12) more or less slipperlike, rectangular basally, becoming wider posteriorly to a pointed process dorsally and a rounded angle ventrally, posterodorsal margin distinctly concave and bearing numerous setulae, posteriormost portion pointed; postsurstyli symmetrical (Fig. 13), setulose on lateral surfaces, both about 2.5× longer than wide, each wider at basal half, thereafter becoming narrow before slightly widened apex that is shallowly notched apically; each postsurstylus bearing a rodlike process that extends from near base; subepandrial plate in ventral view moderately broadly U-shaped, basal portion nearly flat; aedeagal apodeme in lateral view roughly triangular, external margin comparatively more produced, forming an angle slightly less and a right angle, median margin essentially straight; aedeagus (Figs. 14–15) with basodorsal emargination shallow but comparatively long, apicodorsal emargination slightly deeper and longer, ventral surface nearly straight with apical surface nearly flat; pregonite (Figs. 14–15) a small rodlike sclerite bearing 2 long setulae apically; hypandrium deeply pocketlike, in lateral view angulate, narrowed basally at attachment with aedeagal apodeme, becoming wider toward anterior margin.

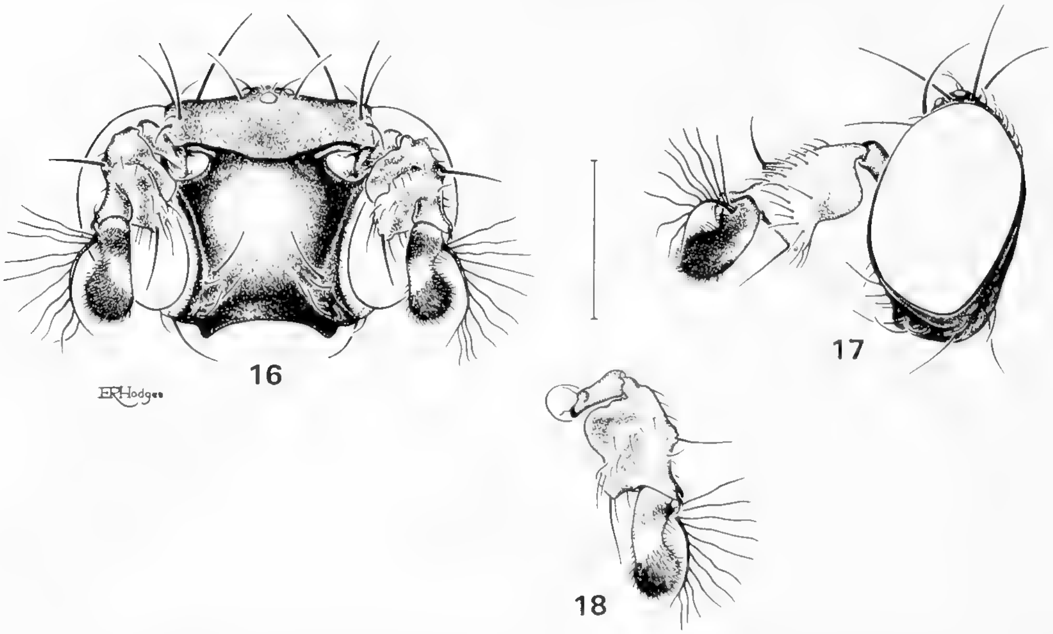
Mimapsilopa cubensis Mathis and Zatwarnicki, new species

(Figs. 16–24)

Diagnosis.—This species is distinguished from congeners by the following combination of characters: wing hyaline; antenna of male greatly enlarged (combined length of pedicel and 1st flagellomere almost equal to height of eye); antenna mostly yellow, especially scape and pedicel; face smooth, shiny; presutural supra-alar seta greatly reduced, much smaller than notopleural setae; ventral anepisternal seta at posterior margin only slightly longer than dorsal seta; forefemur lacking comblike row of setae along anteroventral surface; foretarsus with basal 2 white, apical 3 tarsomeres black.

Description.—Small to moderately small shore flies, body length 1.40–2.50 mm.

Head (Figs. 16–18): Frons of male wide, length-to-width ratio averaging 0.4, moderately densely microtomentose, subshiny, bronzish, similar to mesonotum. Antenna mostly yellow, especially pedicel; antenna of male (Fig. 18) greatly enlarged, combined length of pedicel and 1st flagellomere almost equal to height of eye; scape rodlike,

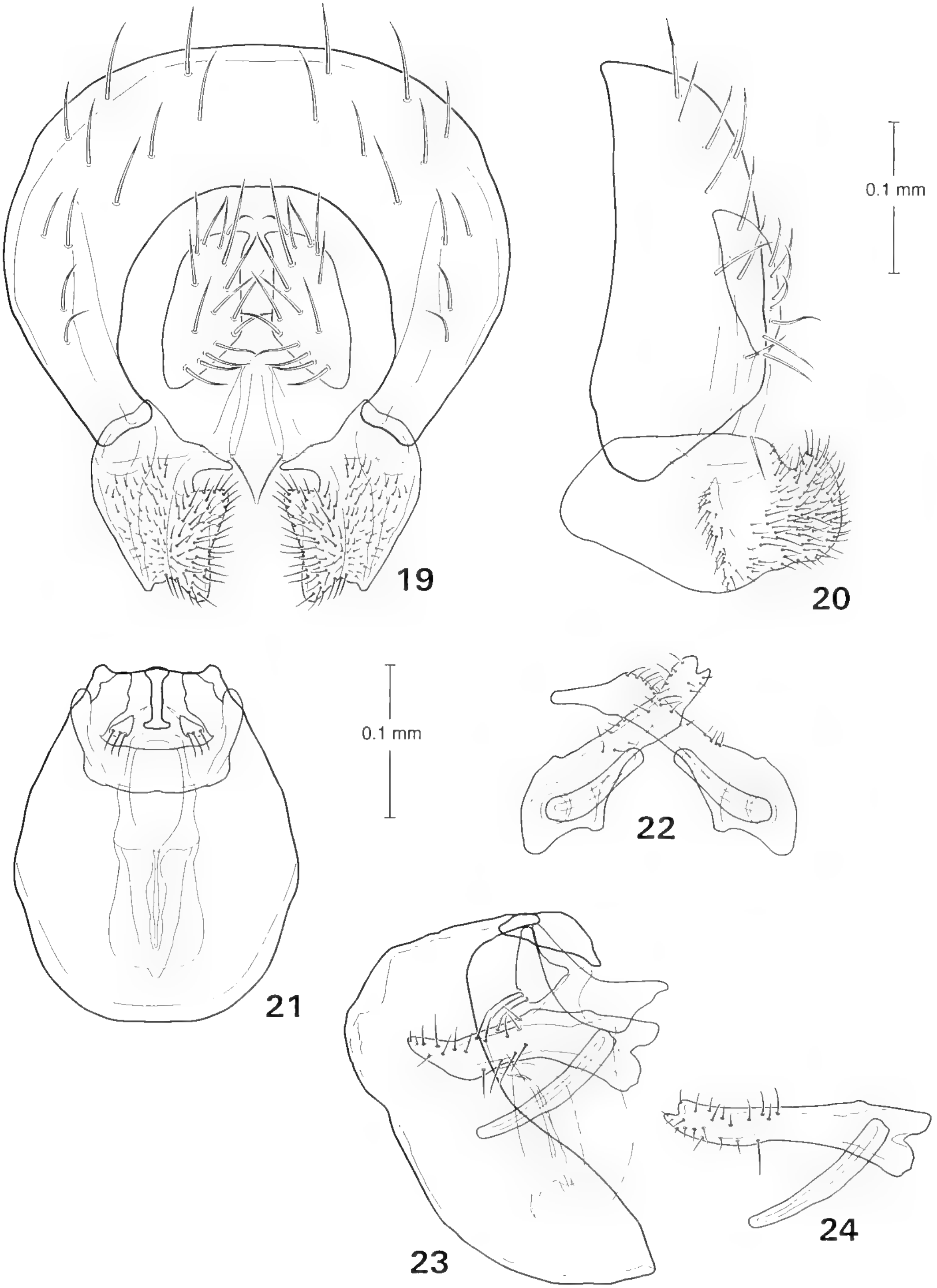


Figs. 16–18. *Mimapsilopa cubensis.* 16, Head, anterior view. 17, Same, lateral view. 18, Left antenna, median view. Scale = 0.1 mm.

whitish microtomentose on lateral surface; 1st flagellomere parallel sided and shallowly curved, bluntly rounded apically, apex black; arista bearing 9 dorsal hairs. Face polished, shiny black, shallowly swollen over much of middle. Parafacial below level of antenna whitish microtomentose. Eye oval, much higher than wide, width-to-height ratio 0.67. Mouthparts, including maxillary palpus, black.

Thorax: Mesonotum moderately densely microtomentose, bronzish; pleural areas from anepisternum ventrad mostly shiny black, with only small areas bearing microtomentum. Presutural supra-alar seta greatly reduced, much smaller than either notopleural seta; ventral anepisternal seta at posterior margin only slightly longer than dorsal seta. Wing hyaline; costal vein ratio 0.73–0.88; M vein ratio 0.52–0.61. Femora black; foretibia black, other tibiae mostly brownish yellow to yellow; forefemur lacking comblike row of setae along anteroventral surface; foretarsus with basal 2 tarsomeres white, apical 3 tarsomeres black and bearing several long, crooked setulae dorsally, other tarsi mostly whitish yellow to yellow except for apical, blackish tarsomere.

Abdomen: Tergites black; tergites 1–4 of male becoming progressively longer posteriorly; 5th tergite short, length similar to 1st; tergites moderately densely dark brownish microtomentose medially, becoming more sparsely so toward lateral margins, which are shiny black. Male terminalia (Figs. 19–24): Epandrium in posterior view (Fig. 19) as an upside down, thick-walled U, especially dorsal portion above cercal cavity, that becomes gradually narrower toward the ventral apex of the arms; epandrium in lateral view (Fig. 20) with height slightly more than 2.5× width, dorsal margin slightly sloping ventrad posteriorly, anterodorsal angle bluntly pointed and shallowly projected, widest at basal ¼, thereafter narrowed to broadly formed point at ventral margin; cercus in posterior view (Fig. 19) irregularly trapezoidal with ventral surface longer than dorsal surface and



Figs. 19–24. *Mimapsilopa cubensis.* 19, Male terminalia (epandrium, cercus, presurstylus), posterior view. 20, Same, lateral view. 21, Internal male terminalia, ventral view. 22, Postsurstyli, ventral view. 23, Internal male terminalia, lateral view. 24, Left postsurstylus, lateral view. Scale = 0.1 mm.

the dorsolateral angle broadly rounded; presurstylus symmetrical, in posterior view (Fig. 19) with median surface very shallowly concave on ventral half, dorsal portion with deep, narrow, U-shaped emargination that is bounded dorsally by an acutely pointed, median directed process; ventral margin of presurstylus in posterior view bifid, with median process much larger than toothlike lateral process; presurstylus in lateral view (Fig. 20) more or less rectangular, especially basal half that becoming slightly wider medially along ventral margin, apical half with dorsal surface as a rounded U-shaped emargination, ventral margin opposite dorsal emargination very shallowly concave; postsurstyli asymmetrical (Fig. 22), setulose on lateral surfaces, both about 3× longer than wide, each with a median, rodlike process that extends from near base; right postsurstylus (Fig. 22) with basal third widest, thereafter more or less parallel sided until narrowly tapered apical ¼; left postsurstylus (Fig. 22, 24) similar but with apical third with slightly angulate orientation and with apex shallowly but distinctly bifurcate; subepandrial plate in ventral view (Fig. 21) broadly U-shaped, basal portion nearly flat, lateral arms slightly spatulate; aedeagal apodeme in lateral view irregularly triangular, external margin forming a rounded right angle, median margin essentially straight; aedeagus (Figs. 21, 23) longer than wide, dorsal margin with a single emargination at basal third along dorsal margin, middle portion parallel sided, thereafter apically with dorsal margin curved to meet ventral margin; pregonite (Fig. 23) a small sclerite bearing 3 long setulae; hypandrium (Fig. 23) deeply pocketlike, in lateral view angulate, narrowed basally at attachment with aedeagal apodeme, becoming wider toward anterior margin.

Type material.—The holotype ♂ is labeled "CUBA. Pinar del Rio: Soroa, 2 km NW, 22°48.6′N, 83°1.0′W, 4–5Dec1994, WMathis." The allotype female and 13 paratypes (13 ♂; USNM) bear the same label data as the holotype. The holotype is double mounted (minuten in block of plastic), is in excellent condition, and is on long-term deposit in the USNM. Other paratypes are as follows: *CUBA. Pinar del Rio:* Soroa (22°47.7′N, 83°W), 27–28 Apr 1983, W. N. Mathis (3 ♂; USNM). *Sancti Spiritus:* Topes de Collantes (21°55.2′N, 80°02′W; 350 m), 10 Dec 1994, W. N. Mathis (3 ♂; USNM).

Distribution.—*Neotropical:* West Indies (Cuba).

Etymology.—The specific epithet, *cubensis,* refers to the island where this species is apparently endemic.

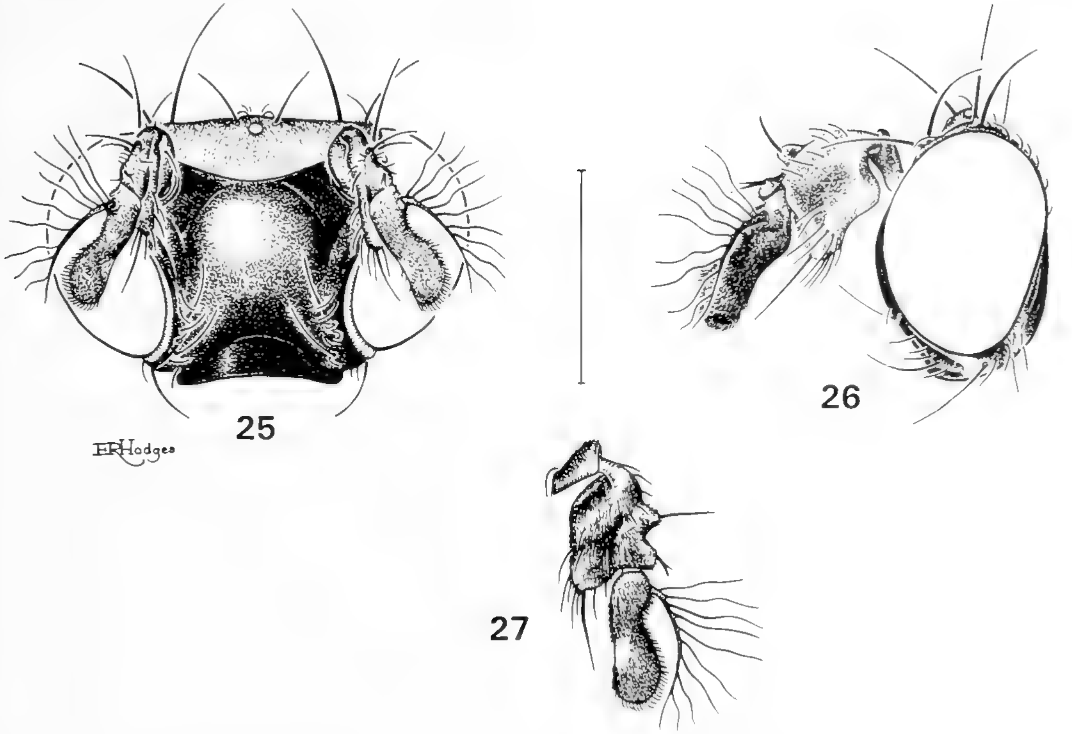
Mimapsilopa dominicana Mathis and Zatwarnicki, new species

(Figs. 25–33)

Diagnosis.—This species is distinguished from congeners by the following combination of characters: wing hyaline; antenna of male greatly enlarged (combined length of pedicel and 1st flagellomere almost equal to height of eye); antenna black; face mostly polished, shiny black; presutural supra-alar seta greatly reduced, much smaller than notopleural setae; ventral anepisternal seta at posterior margin only slightly longer than dorsal seta; forefemur bearing a comblike row of short, stout setae along anteroventral surface; forebasitarsus white, apical 4 tarsomeres black.

Description.—Small to moderately small shore flies, body length 1.50–2.30 mm.

Head (Figs. 25–27): Frons of male wide, length-to-width ratio averaging 0.4, moderately densely microtomentose, subshiny, bronzish, similar to mesonotum. Antenna mostly black, especially scape and pedicel; antenna of male (Fig. 27) greatly enlarged, combined length of pedicel and 1st flagellomere almost equal to height of eye; scape rodlike, whitish microtomentose on lateral surface; 1st flagellomere parallel sided and shallowly curved, bluntly rounded apically, mostly black except for basoventral portion; arista bearing 9 dorsal hairs. Face polished, shiny black, shallowly swollen over much of middle. Parafacial below level of antenna

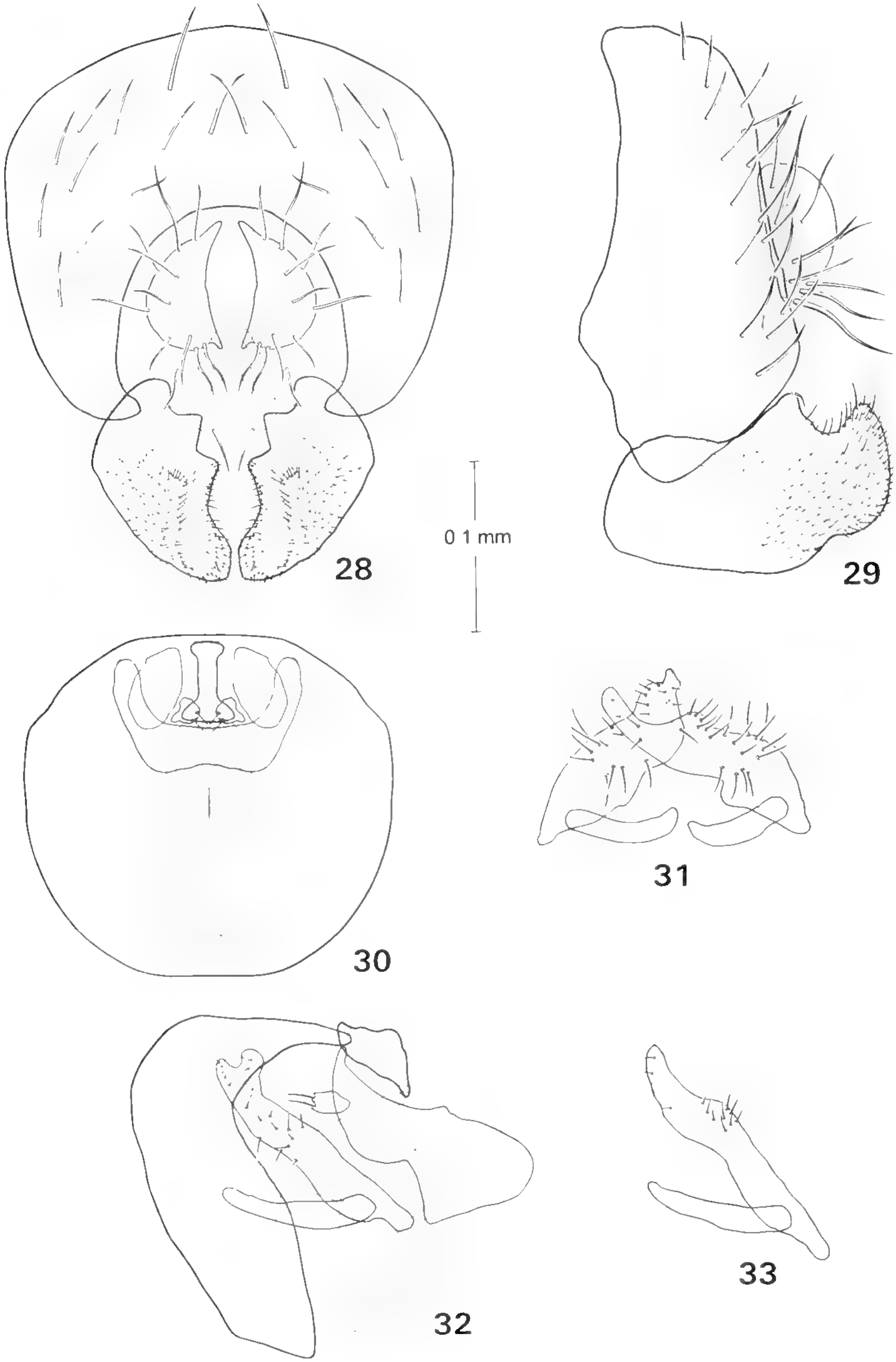


Figs. 25–27. *Mimapsilopa dominicana.* 25, Head, anterior view. 26, Same, lateral view. 27, Left antenna, median view. Scale = 0.1 mm.

whitish microtomentose. Eye oval, much higher than wide, width-to-height ratio 0.68. Mouthparts, including maxillary palpus, black.

Thorax: Mesonotum moderately densely microtomentose, bronzish; pleural areas from anepisternum ventrad mostly shiny black, with only small areas bearing microtomentum. Presutural supra-alar seta greatly reduced, much smaller than either notopleural seta; ventral anepisternal seta at posterior margin only slightly longer than dorsal seta. Wing hyaline; costal vein ratio 0.74–0.83; M vein ratio 0.56–0.58. Femora and tibiae black, apex of tibiae sometimes yellowish; forefemur bearing comblike row of short stout setae along anteroventral surface; forebasitarsomere white, apical 4 tarsomeres black and bearing several long, crooked setulae dorsally; other tarsi mostly whitish yellow to yellow except for apical, blackish tarsomere.

Abdomen: Tergites black; tergites 1–4 of male becoming progressively longer posteriorly; 5th tergite short, length similar to 1st; tergites moderately densely dark brownish microtomentose medially, becoming more sparsely so toward lateral margins, which are shiny black. Male terminalia (Figs. 28–33): Epandrium in posterior view (Fig. 28) as an upside down, thick-walled U, especially dorsal portion above cercal cavity, that becomes gradually narrower toward the ventral apex of the arms; epandrium in lateral view (Fig. 29) with height slightly more than twice width, dorsal margin slightly sloping ventrad posteriorly, anterodorsal angle bluntly pointed and shallowly projected, widest at basal third, thereafter narrowed to broadly formed point at ventral margin; cercus in posterior view (Fig. 28) lunate with anterior half more narrowly formed, pointed and with ventral margin recurved just before medioventral,



Figs. 28–33. *Mimapsilopa dominicana.* 28, Male terminalia (epandrium, cercus, presurstylus), posterior view. 29, Same, lateral view. 30, Internal male terminalia, ventral view. 31, Postsurstyli, ventral view. 32, Internal male terminalia, lateral view. 33, Left postsurstylus, lateral view. Scale = 0.1 mm.

acutely formed angle; presurstylus symmetrical, in posterior view (Fig. 28) more or less triangular, with median surface shallowly concave on ventral half, dorsal portion with steplike angles, lateral margin shallowly and angularly arched, in lateral view (Fig. 29) more or less rectangular, especially basal half, apical half produced dorsally on dorsal surface, bifurcate with rounded U-shaped emargination, ventral margin opposite dorsal emargination with shallow indentation; postsurstyli asymmetrical (Fig. 31–33), setulose on lateral surfaces, both about 3× longer than wide, each with a median, rodlike process that extends from near base; left postsurstylus (Figs. 31, 33) with posterior surface on apical third concave, forming a digitiform, parallel-sided, bluntly rounded, apical process; right postsurstylus (Fig. 31–32) becoming wider at apical fourth, apex shallowly bifurcate; subepandrial plate in ventral view broadly U-shaped, basal portion nearly flat; aedeagal apodeme in lateral view irregularly triangular, external margin forming nearly a right angle, median margin shallowly produced toward attachment with hypandrium; aedeagus (Figs. 30, 32) longer than wide, dorsal margin with 2 symmetrically sided emarginations, basal one deeper, pocketlike, apex shallowly arched to a posteroventral point, ventral surface with a wide, moderately shallow, irregular-sided emargination, basal surface shallowly concave; pregonite (Fig. 32) a small sclerite bearing 2 long setulae; hypandrium deeply pocketlike, in lateral view angulate, narrowed basally at attachment with aedeagal apodeme, becoming wider toward anterior margin.

Type material.—The holotype ♂ is labeled "DominicanRp.LaVega: nr.Jarabacoa, Salto Guasara, 19°04.4′N, 70°42.1′W,680m,9May 1995, Wayne N. Mathis." The holotype is double mounted (minuten in block of plastic), is in excellent condition, and is deposited in the USNM. The allotype female and six paratypes (4 ♂, 2 ♀; USNM) bear the same label data as the holotype. Other paratypes are as follows: *DOMINICAN REPUBLIC. La Vega:* Jarabacoa (6.5 km NE; 1700 ft; banana trap), 28 Jul 1991, D. A. Grimaldi, J. Stark (6 ♂, 1 ♀; AMNH, TZ); Salto de Jimenoa (19°06′N, 70°35.9′W; 575 m), 20 May 1995, W. N. Mathis (7 ♂; USNM).

Distribution.—*Neotropical:* West Indies (Dominican Republic).

Etymology.—The specific epithet, *dominicana,* refers to the island where this species is apparently endemic.

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NYSIUS AA (HETEROPTERA: LYGAEIDAE), A NEW SPECIES OF MICROPTEROUS WEKIU BUG FROM THE SUMMIT OF MAUNA LOA VOLCANO, HAWAII

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Abstract.—***Nysius aa,*** a micropterous lygaeid bug, is described from the upper slopes of Mauna Loa volcano on the island of Hawaii. This new species appears to be the sister species of *Nysius wekiuicola* Ashlock and Gagné, which is endemic to aeolian desert habitats in the summit region of adjacent Mauna Kea volcano. Detailed morphological comparisons between the two species are presented, accompanied by a distribution map and figures of key characters.

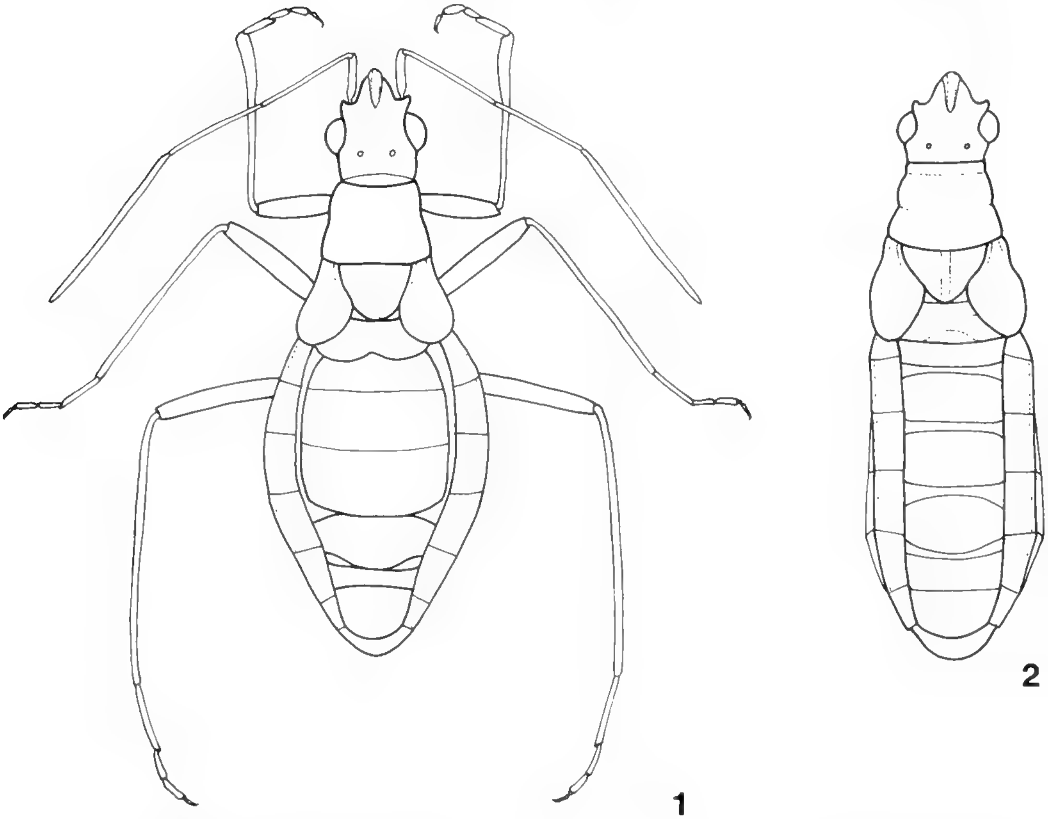
Key words: Lygaeidae, micropterous, alpine, aeolian, Hawaii, Mauna Kea, Mauna Loa

The Wekiu Bug, *Nysius wekiuicola,* a micropterous lygaeid endemic to the aeolian deserts surrounding the 4206 m (13,796 ft.) summit of Mauna Kea volcano on the island of Hawaii, was described by Ashlock and Gagné (1983). In the same paper, these authors commented on anecdotal accounts of similar bugs occurring on the 4170 m (13,680 ft.) summit of Mauna Loa volcano to the southwest. In 1985, Frank Howarth of the Bishop Museum and Fred Stone of the Hawaii Community College at Hilo emplaced pitfall traps at 3450 m (11,316 ft.) elevation on Mauna Loa, and were able to capture a short series of micropterous lygaeids. In general appearance these Mauna Loa bugs were similar to the Wekiu Bugs from Mauna Kea, and the material was not analyzed further at that time. In the mid-1990's, with the continuing expansion of observatory facilities on the summit of Mauna Kea, concerns were raised regarding the progressive destruction of Wekiu Bug habitat on that mountain due to construction activities. The possible presence of additional Wekiu Bug populations on Mauna Loa thus became a question of some importance in terms of conservation planning, and the existence of the Howarth and Stone material from the latter mountain was brought to the author's attention by Betsy Gagné, of the State of Hawaii's Natural Area Reserves System, a unit of which includes portions of the Mauna Kea summit. The Mauna Loa specimens were subsequently located in the collections of the Bishop Museum and analyzed in detail; they have proven to represent a distinct new species, described below.

All measurements in the following description are in millimeters.

Nysius aa Polhemus, new species
(Figs. 1, 3, 4, 7, 9)

Diagnosis.—A small, fuzzy, dark-colored micropterous lygaeid bug, similar in general appearance to *N. wekiuicola* Ashlock and Gagné, but easily separable on the basis of the following characters: body in males pear-shaped, with sides of abdomen distinctly outwardly convex (versus nearly parallel sided in *N. wekiuicola*; compare



Figs. 1–2. Wekiu Bugs, males, dorsal habitus. 1, *Nysius aa.* 2, *N. wekiuicola,* showing overall body shape for comparison to Fig. 1 (appendages omitted). As noted by Ashlock and Gagné (1983), the abdomens of Wekiu Bugs are strongly physogastric, swelling after feeding, and collapsing drastically in all dry mounted specimens except those which have been run through a critical point drier. As a result, these insects are difficult to illustrate, with the best results coming from specimens in alcohol immersion. Fig. 1 of Ashlock and Gagné (1983) depicts a specimen of *N. wekiuicola* with the abdomen swollen, while this figure depicts the abdomen in a more relaxed state that better displays the actual shapes of the lateral paratergites for comparison with *N. aa.*

Figs. 1 and 2); female abdominal ventrite IV with only a weak medial incision at base of ovipositor (versus incised for nearly half its length in *N. wekiuicola*; compare Figs. 3 and 4); female abominal tergite VIII consisting of two roughly quadrate plates with the lateral margins straight (versus plates of a different shape with the lateral margins angulate in *N. wekiuicola*; compare Figs. 5 and 6); and male paramere with a narrow pointed tip (versus a broader, more rounded tip in *N. wekiuicola*; compare Figs. 7 and 8).

Description.—*Micropterous male:* Overall length 3.75; maximum width (across abdomen) 1.50. General coloration dark to medium brown, head and pronotum blackish, appendages yellowish brown distally.

Head: Length 0.75, width 0.75, general coloration black, with a yellowish brown longitudinal median line, this line most prominent on posterior half of head, often becoming obscure ahead of eyes, small dark yellowish marks also present along inner margins of eyes; dorsal surface slightly elevated between eyes, lightly rugose, thickly clothed with recumbent to semi-recumbent pale pubescence; apex of clypeus with erect pale hairs; anteocular length 0.37, nearly 1.7× length of an eye; eyes reddish brown, eye length 0.22, width 0.15; interocular space 0.42; ocelli small, dark yellow; buccula low, gradually tapering in height without abrupt change in width to base of head; rostrum brown, reaching to hind coxae, segment I nearly reaching to base of head, segment lengths (from base) 0.57, 0.55, 0.40, 0.30; antennae long, slender, segments I and IV only slightly thicker than segments II and III, segments I–III brown, bearing erect pale setae, these setae slightly longer than diameters of these segments, segment IV yellowish brown, bearing erect pale setae intermixed with a dense covering of short, semi-recumbent pale setae, lengths of segments I–IV = 0.44, 0.80, 0.56, 1.37.

Pronotum: Length (midline) 0.50, maximum width 0.75, dark brown to blackish, narrowly dark yellow along extreme anterior margin; dorsal surface thickly clothed with recumbent to semi-recumbent pale pubescence; disc deeply and coarsely rugose; lateral pronotal margins weakly constricted near middle, barely defining anterior and posterior lobes.

Scutellum: Length (midline) 0.25, maximum width 0.50, dark brown to blackish, bearing a raised, brown, longitudinal medial carina; surface thickly clothed with recumbent to semi-recumbent pale pubescence.

Hemelytra: Micropterous, brown, lighter near tips, length 0.50, reaching only to abdominal tergite I, not touching along body midline; clavus weakly distinct from corium basally, venation obscure except for extreme basal portion of subcosta; surface dull and impunctate, bearing recumbent to semi-recumbent pale pubescence.

Abdomen: Lateral margins outwardly convex, length 2.27, maximum width 1.73; tergites brown, with I, VI and VII darker, all tergites bearing scattered fine, pale, semi-recumbent, setae, and separated by membranous areas; lengths of tergites I–VII (midline) = 0.25, 0.20, 0.42, 0.45, 0.27, 0.12, 0.31; paratergites dark brown, bearing recumbent to semi-recumbent pale pubescence; ventral surface dark brown, shining, bearing scattered long, fine, pale, semi-recumbent setae.

Legs: Long and slender, femora brown; coxae, trochanters, tibiae and tarsi yellowish brown; all segments clothed with fine, pale, semi-recumbent setae intermixed with scattered longer erect pale setae; fore tibia slightly expanded on distal ⅕. Lengths of leg segments as follows: fore femur, tibia, tarsal I, tarsal II, tarsal III = 1.07, 1.27, 0.37, 0.16, 0.25; middle femur, tibia, tarsal I, tarsal II, tarsal III = 1.25, 1.35, 0.37, 0.17, 0.25; hind femur, tibia, tarsal I, tarsal II, tarsal III = 1.50, 1.80, 0.52, 0.21, 0.25.

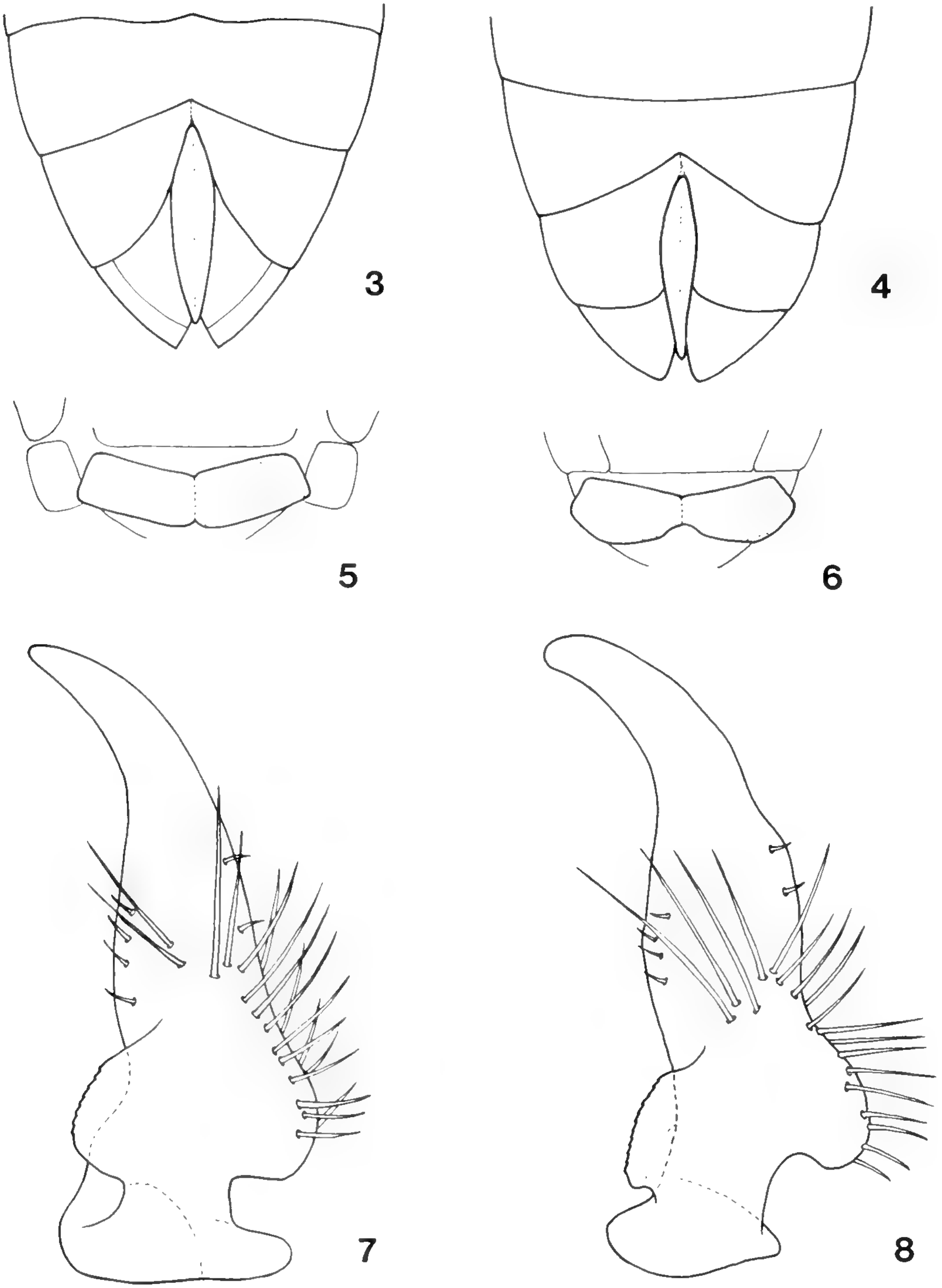
Male paramere coming to an elongate, pointed tip, shape as in Fig. 7.

Micropterous female: Length 4.30; maximum width 1.90. Similar to male in general structure and coloration with following exceptions: abdominal tergite VIII narrow and transverse, consisting of a pair of quadrate plates (Fig. 5); abdominal ventrite IV weakly indented medially on its posterior margin ahead of base of ovipositor, this indentation less than half length of segment as taken along its lateral margin (Fig. 3); abdominal ventrite V deeply cleft for nearly its entire length to accomodate ovipositor sheath (Fig. 3).

Etymology.—The name "*aa*" is a noun in apposition and refers to the flows of a'a lava where this species dwells.

Material examined.—Holotype, micropterous ♂: HAWAIIAN ISLANDS, Hawaii Is., N. side of Mauna Loa, above MLO [Mauna Loa Observatory], 3450 m (11,316 ft.), 30 March–13 April 1985, from baited pitfall trap #3, F. G. Howarth, D. G. Howarth, V. M. C. Howarth and F. D. Stone, deposited in the Bishop Museum, Honolulu (BPBM). Paratypes (all micropterous): 4 ♂, 3 ♀, same data as holotype, deposited in the Bishop Museum and the National Museum of Natural History, Smithsonian Institution, Washington, D.C.

Discussion.—The flightless lygaeids inhabiting the highest summits of Hawaii island have come to be commonly referred to as "Wekiu Bugs" by Hawaiian entomologists, "*wekiu*" meaning "summit" in the Hawaiian language. Within the large and speciose genus *Nysius* the Wek-



Figs. 3–8. Female abdominal structures (3–6) and male parameres (7–8) of Hawaiian alpine *Nysius* species. 3, *Nysius aa,* terminal abdomen, ventral view (note degree of medial incision on ventrite IV at base of ovipositor). 4, *N. wekiuicola,* terminal abdomen, ventral view. 5, *N. aa,* abominal tergite VIII. 6, *N. wekiuicola,* abominal tergite VIII. 7, *N. aa.* 8, *N. wekiuicola.*

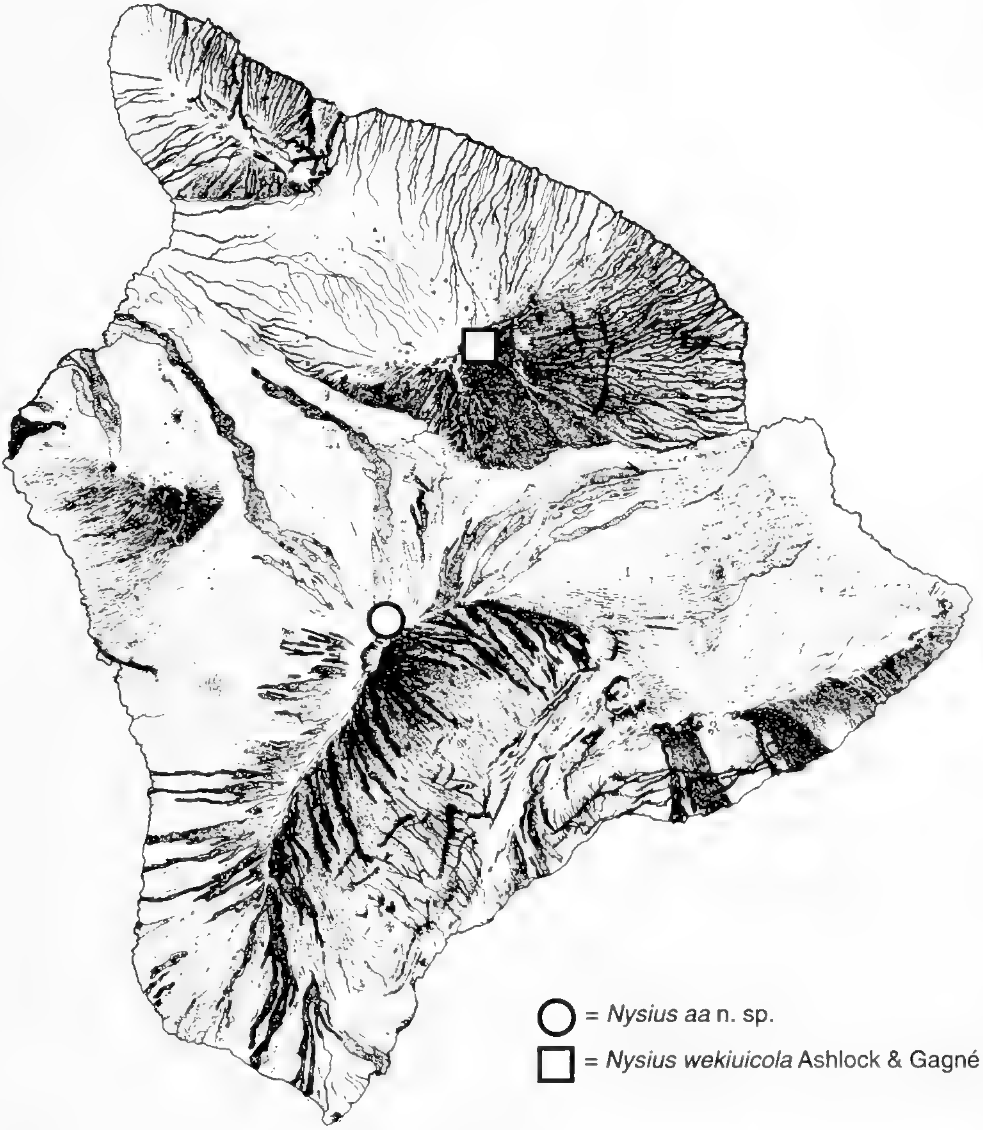


Fig. 9. Distribution of alpine *Nysius* species on Hawaii Island. Circle = *N. aa*; square = *N. wekiuicola*.

iu Bugs are an interesting insular segregate, characterized by restriction to high elevations (Fig. 9), micropterous wings, and a scavenging lifestyle. *Nysius aa* presumably feeds on dead insects that melt out of the margins of retreating snow fields on the upper slopes of Mauna Loa during the summer season, a habit documented for its close relative *N. wekiuicola* on Mauna Kea (Howarth and Montgomery 1980). A seed feeding existence for *N. aa* seems unlikely, since the aeolian deserts at the elevations it inhabits consist of utterly barren lava flows devoid of seed bearing plants that elsewhere constitute the typical food source for the overwhelming majority of the world's Lygaeidae (Ashlock and Gagné 1983).

During the Pleistocene the summit of Mauna Kea was glaciated (Porter 1979 a, b, c), and given the consequent depression of life zones on the mountains during this period, it is likely that the two currently allopatric populations of Wekiu Bugs were intermingled via a continuous belt of aeolian desert extending across the Humuula Saddle. The separation of *N. aa* and *N. wekiuicola* on different mountains is thus an event that is probably no more than 20,000 years old, and begs the interesting question as to whether speciation has proceeded from a common ancestor within this short time frame.

Ashlock and Gagné, in their 1983 paper, predicted that the closest relative of their *N. wekiuicola* would be discovered in the Hawaiian islands, and with the discovery and description of *N. aa* this prediction has indeed been borne out. A more interesting subject for future research, however, is to locate the closest relatives of the Wekiu Bugs *per se*. It seems likely that the colonization of the high mountain summits on Hawaii was accomplished from the bottom up, and that putative Wekiu Bug sister groups might be found in similar aeolian-supplied ecosystems in a'a lava flows at lower elevations. Already, in a scenario strangely reminiscent of what transpired on Mauna Loa several decades ago, a few specimens of an unusual and apparently undescribed *Nysius* have come to light from baited pitfall traps set in a'a flows near 600 meters elevation in the Manuka Natural Area Reserve, on the southwest rift zone of Mauna Loa. Although insufficient to allow a species description, the single female and immature so far obtained indicate that the nearest relatives of the Wekiu Bugs may well be close at hand.

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This project has built upon years of effort by many dedicated researchers who worked in harsh and difficult conditions to obtain specimens and ecological data. Prime among these are Frank Howarth, Bill and Mae Mull, Fred Stone, and Steve Montgomery, who were the first to bring the remarkable alpine insect communities of Mauna Kea to the attention of the scientific world. No less important are the contributions of the late Wayne Gagné and his wife Betsy; the former an indefatigable and creative collector who greatly advanced our knowledge of Hawaiian Heteroptera, and the latter a tireless champion for the conservation of native Hawaiian ecosystems and their irreplacable biota. This paper is very much a distillation of their years of work, and I thank them all very much for openly sharing the results of their labors.

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REDESCRIPTION OF *MACROSIPHUM IMPATIENTIS* (WILLIAMS), ANOTHER ROSE APHID FROM EASTERN NORTH AMERICA, WITH A KEY TO RELATED SPECIES (HEMIPTERA: APHIDIDAE)

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Abstract.—A poorly known species of aphid, *Macrosiphum impatientis* (Williams) is redescribed. Illustrations are provided, along with a key to North American *Macrosiphum* species with black siphunculi, and notes on biology and distribution. The potential of this species as a pest of roses is discussed.

Key Words: Aphididae, *Macrosiphum,* hosts, roses, *Impatiens*

Macrosiphum Passerini is one of the larger aphid genera, with more than 55 described endemic North American species, excluding species placed in *Sitobion* Mordvilko, which is here considered to be a separate, valid genus, following Eastop and Hille Ris Lambers (1976) and Remaudière and Remaudière (1997). Taxonomy of the group is challenging because many of the species have rarely been collected, and their life cycles and sexual stages are often entirely unknown. One of the most ubiquitous pest aphids in North America is *Macrosiphum euphorbiae* (Thomas), an extremely variable, polyphagous species whose taxonomy and biology are far from completely understood. It is possible that some of the other nominal North American species of *Macrosiphum* are host races of *M. euphorbiae,* or that what is currently regarded as *M. euphorbiae* is actually any number of very similar, more host specific species. Understanding this and the other pest species of the genus requires that they be put in the context of all North American species.

Currently there are no keys for the identification of North American species of *Macrosiphum.* In order to construct comprehensive keys or to complete a meaningful revision of the group much biological information and recently collected material will be required. Therefore, it is prudent for aphidologists to study individual species of the genus when the opportunity presents itself, so that when a revisionary study of the genus is finally attempted, adequate material and information will be available. This paper describes the biology and taxonomy of a particularly enigmatic species, *Macrosiphum impatientis* (Williams), which feeds on *Impatiens* spp. (Balsaminaceae) and *Rosa* spp. (Rosaceae) in eastern North America.

Macrosiphum is a member of the tribe Macrosiphini (Aphididae: Aphidinae). The species are usually large (> 2.0 mm), with antennae longer than the body; legs and siphunculi are also long. Members of *Macrosiphum* can be separated from other genera of Macrosiphini that possess these general features by siphunculi that almost always have several rows of distinct apical polygonal reticulation and show very little or no swelling medially (Fig. 7), abdominal tergite VIII with 5 or more setae in all adult morphs, tarsal segments I with 3 (very rarely 4) setae in adults and all nymphal instars. Predominant color in life is usually a shade of green, yellow, or pale pinkish to red, sometimes lightly dusted with wax or with mottling of red or pink on the green background color, but some species very pale to white.

MATERIALS AND METHODS

The aphids used in this study were mounted on microscope slides in Canada balsam, and observed under phase contrast microscopy. Terminology follows Miyazaki (1987) except that the base of antennal segment VI is referred to as antennal segment VIa, while the processus terminalis is referred to as antennal segment VIb. Drawings were made by myself using a camera lucida. Abbreviations and terms used are as follows:

a.s. = antennal segment
a.s. VIa = basal part of antennal segment VI
a.s. VIb = apical part of antennal segment VI, often called the processus terminalis
u.r.s. = ultimate rostral segment
metatarsal II = second segment of the hind tarsus
siphunculus = cornicle of earlier authors

Host plant transfers were accomplished by moving winged adult aphids to a potential host plant, then caging them in the field by enclosing a small section of branch in a fine cloth bag, tied securely to prevent predator entry and aphid escape. Transferred aphids were left in the field for about one week before the first check. If live aphids remained in the transfer bags, they were again left for one week. Transfers were considered successful only when transferred aphids produced offspring that survived to adulthood. Aphids reared in the laboratory were kept on cuttings or whole plants in a vase near a window. Fresh plant material was provided twice each week, or as needed.

Macrosiphum impatientis (Williams)

Siphonophora carnosa var. *impatientis* Williams, 1911: 158.

Siphonophora carnosa var. *impatientis*, incertae sedis, Eastop and Hille Ris Lambers, 1976.

Macrosiphum carnosa subsp. *impatientis*, Smith and Parron, 1978 (placement and identity uncertain).

History

Williams (1911) described this aphid from material collected in Nebraska on *Impatiens pallida* Nutt. He considered it to be a variety of *Siphonophora carnosa* Buckton (=*Microlophium carnosum*), a Palearctic *Urtica*-feeding species. *Macrosiphum impatientis* has not been mentioned again outside of several species lists and host-plant indexes (Wilson and Vickery 1918, Patch 1938, Eastop and Hille Ris Lambers 1976, Smith and Parron 1978). The specimens of *Macrosiphum* from *Impatiens* mentioned by MacGillivray (1968) in her discussion of *Macrosiphum pallidum* (Oestlund), were in fact *M. impatientis*. Correspondence records in the Systematic Entomology Laboratory show that MacGillivray understood the correct placement and identity of *M. impatientis*, but was unable to complete her study of it. MacGillivray designated paralectotypes from the cotypic material in the National Collection of Aphidoidea (located at the Systematic Entomology Laboratory, USDA, Beltsville, Maryland, USA), and these were examined during this study.

Biology

Until now, *M. impatientis* has been collected only from species of *Impatiens*, but studies of *M. impatientis* in Maryland in the summer and fall of 1996 and spring 1997 showed it clearly has a heteroecious life cycle. Several generations of apterous and alate viviparae were studied in two locations in Beltsville, Maryland, from 24 July through November, 1996. The aphids were found on *Impatiens capensis* Meerb. and generally occurred in small aggregations composed of one or two adults and several nymphs. In October a generation of apterous viviparae, which had been brought into the laboratory, produced first a series of alate viviparae, then males. About the same time, a single alate vivipara was collected in the field on *Rosa multiflora* Thunb., a common exotic shrub. Therefore, alate viviparae were transferred to *R. multiflora* and several other common broadleaf shrubs to test the aphid's host acceptance on potential primary hosts. Alate viviparae were also transferred to *Vaccinium, Sambucus,* and *Cornus,* as well as two other unidentified shrubs located near *I. capensis* plants. Only the aphids on *R. multiflora* successfully reproduced, their nymphs developing into oviparous females. Fundatrices of this species were then discovered on many different *R. multiflora* plants during April 1997. Progeny of one of these fundatrices were successfully transferred to *I. capensis* in May 1997. The success of this transfer along with the discovery of many naturally colonizing alate viviparae proved that *M. impatientis* has a heteroecious life cycle between *Rosa* and *Impatiens.* The discovery on *Impatiens* of a small colony composed of oviparae suggested that this species may sometimes overwinter on its secondary host, much as does *M. euphorbiae.*

The historical rarity of this species is evidenced by the paucity of older material in the National Collection of Aphidoidea. Prior to this study, there were several collections made, but these amounted to only a handful of slides. Examination of all available material collected from *Rosa* or *Impatiens* and identified as *Macrosiphum* sp. or *M. euphorbiae* uncovered a few specimens from *Impatiens,* and only one specimen from rose. It appears, however, that the rarity of this species may be changing. It was common and easily found on *I. capensis* during the summer of 1996 in Maryland, and in the spring of 1997 it was common and abundant on *R. multiflora* and *Rosa carolina* L. growing near *I. capensis.* These were the only rose species growing in areas where this aphid was commonly found in 1996 and 1997, the former being a much more common, invasive exotic, and the latter a small, uncommon, native rose. *Rosa multiflora* is becoming more widespread in disturbed and undisturbed habitats. It is likely that *M. impatientis* has become more common in Maryland as *R. multiflora* has invaded *Impatiens* habitat.

Further biological work should be done to determine the pest potential of this aphid on cultivated roses. No transfers of this aphid were made to cultivated roses, but considering that *M. impatientis* can feed on the exotic *R. multiflora,* it is quite likely that it could also feed on other species of exotic cultivated roses.

Distribution

Macrosiphum impatientis is known from Illinois, Maryland, Missouri, Nebraska, Ohio, Pennsylvania, Virginia, and Wisconsin. Given this extensive known distribution, it is likely to live in much of northeastern and midwestern North America.

Description of morphs

Descriptions provided by Williams were extremely brief, and did not mention the vast majority of characters used in modern aphid taxonomy. Descriptions of all adult morphs are provided below to supplement those given by Williams (1911).

Fundatrix (description based on 5 specimens; see Table 1).—Color when alive: dark green, slightly darker than *Rosa* leaf, with black siphunculi. Color when macerated: as in apterous vivipara.

Morphology: body length 3.02–3.32 mm excluding cauda. Antennae about as long as body; a.s. III 0.90–1.02 mm, a.s. IV 0.59–0.71 mm, a.s. V 0.51–0.65 mm, a.s. VIa 0.17–0.19 mm, a.s. VIb 0.78–0.92 mm in length; a.s. III with 8–14 secondary rhinar-

Table 1. Measurements of one side of individual specimens of *Macrosiphum impatientis* fundatrices. All measurements in millimeters, columns of integers represent counts of rhinaria or setae. A ‡ indicates missing data. Label data of specimens studied: 1. MD, Beltsville, ex *R. multiflora,* 16-iv-1997; 2, 3. MD, Beltsville, ex *R. multiflora,* 18-iv-1997; 4. MD, Beltsville, ex *R. multiflora,* 24-iv-1997; 5. MD, Beltsville, ex *R. multiflora,* 25-iv-1997.

Specimen No.	Antennal Segments					2° Rhin. a.s.III	URS	URS setae	Metafemur	Metatibia	Metatarsal II	Siph.	Cauda		Terg VIII setae	Body
	III	IV	V	VIa	VIb								Length	Setae		
1	1.02	0.71	0.65	0.19	0.87	14	0.13	7	1.29	2.29	0.14	0.83	0.50	8	6	3.02
2	1.01	0.68	0.64	0.19	0.92	10	0.13	8	1.24	2.32	0.14	0.85	0.55	10	6	3.28
3	0.95	0.65	0.54	0.18	0.82	10	0.14	‡	1.24	2.21	0.14	0.84	0.53	8	6	3.25
4	0.90	0.59	0.51	0.17	0.78	11	0.13	8	1.32	2.34	0.14	0.90	0.52	8	6	3.28
5	0.95	0.61	0.61	0.18	0.80	8	0.13	8	1.22	2.26	0.13	0.85	0.56	10	6	3.32

ia. Ultimate rostral segment 0.13–0.14 mm long, with 7–8 accessory setae. Metafemur 1.22–1.32 mm long. Metatibia 2.21–2.34 mm long. Metatarsal II 0.13–0.14 mm long. Abdominal tergite VIII with 6 setae. Cauda 0.50–0.56 mm long, with 8–10 setae. Otherwise as in apterous vivipara.

Apterous viviparous female (description based on 25 specimens; see Table 2).—Color when alive: shiny green to dark green, usually slightly darker than *I. capensis* leaf, siphunculi strikingly black. Color when macerated: a.s. I sometimes brown medially and laterally; a.s. III usually with region surrounding rhinaria dark brown, and areas basal and apical to rhinaria much paler, with extreme tip dark brown (Fig. 1); a.s. IV usually with extreme base dark brown, and apical ¼ gradually darkening to brown, or entire segment brown; a.s. V–VI uniformly brown. Ultimate rostral segment dusky to brown. Apical ½ of femora darkening to brown. Tibiae usually with base brown, gradually lighter to pale middle, with apex darkening to brown. Tarsi brown. Siphunculi brown to black, often with extreme base paler (Fig. 7). Other parts pale.

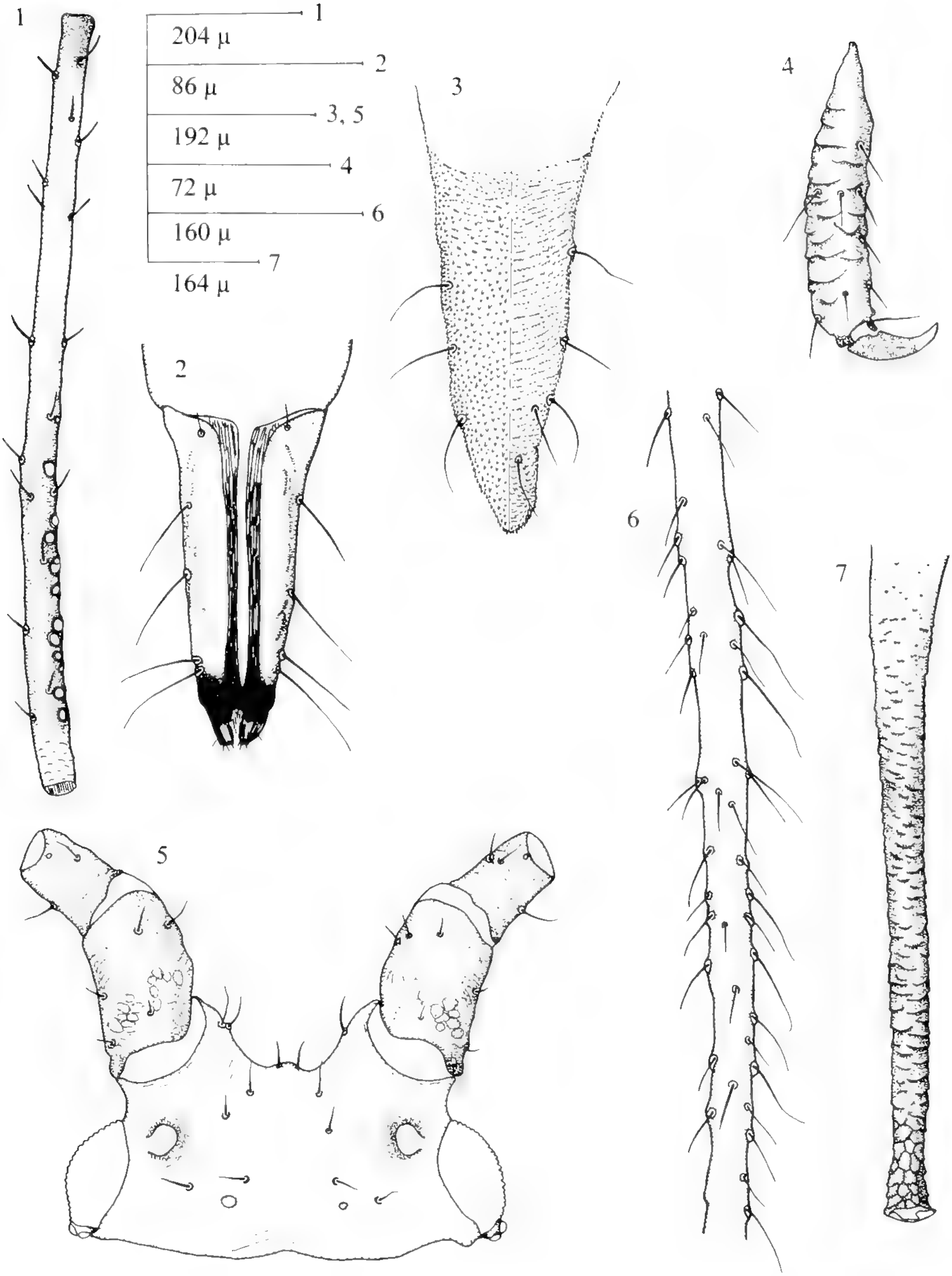
Morphology: body length 1.68–3.75 mm excluding cauda. Antennae longer than body; a.s. III 0.78–1.15 mm, a.s. IV 0.62–0.97 mm, a.s. V 0.53–0.80 mm, a.s. VIa 0.15–0.20 mm, a.s. VIb 0.84–1.39 mm in length; a.s. III with 5–18 secondary rhinaria, with imbrications only on basal pale area, remainder of segment smooth; longest setae on a.s. III about equal to basal width of segment; a.s. I–II smooth, setae about as long as on a.s. III. Head capsule entirely smooth, without ventral protuberance on antennal tubercle; setae about equal to or longer than basal width of a.s. III; at least 1 small spinal tubercle usually present; antennal tubercles very large, far exceeding the negligible median prominence, with 2–4 setae. Rostrum reaching slightly beyond mesocoxae; u.r.s. 0.12–0.14 mm long, with 6–10 accessory setae. Thorax with dorsal setae shorter than basal width of a.s. III; prothorax usually with small marginal tubercles; mesosternal furca stalked. Femora with longest setae longer than basal width of a.s. III, about as long as on antennal tubercles; apical ½ with variable ornamentation composed of raised spinules or imbrications, on pro- and mesofemora absent or very reduced and restricted to anteroventral region, on metafemur much more extensive on anterior surface, sparsely extending into basal ½ of femur; metafemur 0.96–1.56 mm long. Basal ½ of pro- and mesotibiae with longest dorsal setae equal to or slightly longer than longest dorsal setae in apical ½; basal ½ of metatibia with dorsal setae shorter than longest setae on apical ½, the latter setae are unusually long and fine, often appearing bent or twisted (Fig. 6); metatibia 1.84–2.91 mm long. Tarsal segments I with 3 setae, segments II with 2 pairs of dorsal setae (Fig. 4); metatarsal II 0.13–0.16 mm long. Abdominal segments anterior to siphunculi with dorsal setae about ½ basal width of a.s. III; small marginal tubercles sometimes present on these segments; setae

Table 2. Measurements of one side of individual specimens of *Macrosiphum impatientis* apterous viviparae. All measurements in millimeters, columns of integers represent counts of rhinaria or setae. A ‡ indicates missing data. Label data of specimens studied: 1, 2, 3, 13, 14, 15, 16, 17, 18, 19, 20. MD, Beltsville, ex *Impatiens capensis*, x-1996; 4. OH, Wooster, ex *Impatiens aurea*, 19-viii-1920; 5, 6. NH, Durham, ex Spotted touch-me-not, 26-viii-1921; 7. WI, Milwaukee, ex *Impatiens* sp., 19-ix-1933; 8. PA, State College, *Impatiens*, 21-ix-1942; 9. PA, State College, ex *Impatiens*, 24-viii-1946; 10. MD, Beltsville, ex *Impatiens* sp., 5-viii-1996; 11. MD, Greenbelt, ex *I. capensis*, 27-vii-1997; 12. WI, Douglas Co., Waino, ex *I. capensis*, 20-viii-1996; 21, 22. MD, Beltsville, ex *Rosa multiflora*, 22-iv-1997; 23. MD, Beltsville, ex *R. multiflora*, 25-iv-1997; 24. MD, Beltsville, ex *R. multiflora*, 30-iv-1997; 25. MD, Beltsville, ex *I. capensis*, 30-iv-1997.

Specimen No.	Antennal Segments					2° Rhin. a.s.III	URS	URS Setae	Meta-femur	Meta-tibia	Meta-tarsal II	Siph.	Cauda		Terg VIII Setae	Body
	III	IV	V	VIa	VIb								Length	Setae		
1	1.11	0.87	0.74	0.19	1.37	16	0.13	8	1.44	2.65	0.14	0.88	0.55	8	6	3.02
2	1.09	0.76	0.71	0.19	‡	14	0.14	8	1.39	2.60	0.14	0.85	0.56	8	6	2.94
3	1.15	0.83	0.75	0.19	‡	17	0.14	8	1.45	2.61	0.14	0.87	0.56	8	7	3.28
4	1.03	0.82	0.69	0.18	‡	13	‡	‡	1.40	2.58	0.14	0.82	0.50	‡	‡	2.62
5	0.94	0.69	0.62	0.20	‡	9	0.14	7	1.13	2.06	0.14	0.72	0.42	8	‡	1.98
6	0.87	0.63	0.58	0.15	0.84	6	0.13	‡	1.07	1.91	0.13	0.77	0.39	8	6	2.31
7	1.06	0.97	0.78	‡	‡	11	0.14	10	1.55	2.91	0.16	1.05	0.62	10	6	3.75
8	1.07	0.88	0.67	0.19	1.12	13	0.13	8	1.42	2.56	0.15	0.83	0.51	7	6	2.95
9	1.03	0.79	0.72	0.20	1.22	12	0.13	8	1.44	2.57	0.14	0.91	0.52	9	5	3.14
10	0.78	0.63	0.55	0.15	0.89	9	0.13	8	0.96	1.85	0.13	0.60	0.35	8	‡	1.68
11	0.82	0.62	0.53	0.17	1.08	9	0.13	8	1.00	1.84	0.13	0.62	0.38	10	6	2.31
12	0.96	0.68	0.59	0.17	1.01	5	0.12	8	1.21	2.19	0.13	0.84	0.49	7	7	2.82
13	1.03	0.71	0.67	0.20	1.24	11	0.13	6	1.24	2.38	0.14	0.79	0.49	8	6	2.44
14	1.10	0.87	0.76	0.19	‡	12	0.13	8	1.45	2.65	0.14	0.88	0.57	8	8	3.16
15	1.06	0.78	0.73	0.20	1.26	11	0.13	9	1.39	2.59	0.14	0.85	0.51	8	6	3.14
16	1.12	0.86	0.69	0.16	1.37	13	0.13	8	1.41	2.60	0.13	0.88	0.54	8	7	3.18
17	1.10	0.77	0.76	0.19	1.24	12	0.13	9	1.40	2.61	0.14	0.89	0.50	12	7	2.73
18	1.15	0.85	0.76	0.19	1.37	14	0.13	8	1.45	2.75	0.15	0.92	0.55	10	7	3.03
19	1.15	0.94	0.80	0.20	1.39	18	0.13	9	1.56	2.80	0.14	1.00	0.59	12	7	2.99
20	1.00	0.89	0.69	0.19	1.22	14	0.13	9	1.30	2.48	0.14	0.83	0.51	9	5	3.08
21	0.97	0.76	0.68	0.18	‡	12	0.13	10	1.31	2.37	0.13	0.86	0.50	8	6	3.04
22	0.94	0.73	0.63	0.19	‡	9	0.13	8	1.18	2.25	0.13	0.82	0.50	7	6	2.67
23	0.98	0.70	0.65	0.18	0.98	15	0.13	9	1.25	2.27	0.13	0.87	0.50	10	6	2.84
24	0.94	0.67	0.64	0.18	1.01	14	0.13	8	1.33	2.36	0.14	0.91	0.53	7	6	3.27
25	1.02	0.67	0.62	0.19	0.88	10	0.13	8	1.27	2.39	0.13	0.87	0.59	10	5	3.36

on tergites VI, VII, and VIII progressively longer, those on VIII numbering 5–8, longer than basal width of a.s. III, about as long as setae on antennal tubercles. Siphunculi very gradually tapering from base to apex, 0.60–1.05 mm long, with 4–8 rows of rather large polygonal reticulations; reticulated area not noticeably constricted, with small apical flange; remainder of siphunculi imbricated except extreme base, which is merely spinulose to smooth (Fig. 7). Cauda broad, 0.35–0.62 mm long, with 7–12 setae; ventral surface densely covered with small spinules, many of which are bifurcate (Fig. 3). Abdominal tergite VIII occasionally with 1 or 2 very small spinal tubercles.

Alate viviparous female (description based on 25 specimens; see Table 3).—Color when alive: dark green, with thorax brownish tinged, siphunculi and antennae dark brown to black. Color when macerated: antennae entirely brown to dark brown, except extreme base of a.s. III, which is more or less pale, a.s. III darker than other segments. Head capsule dusky, with dark brown rings around lateral ocelli (Fig. 5). Rostrum with u.r.s. dusky to brown. Apical ½ of femora gradually



Figs. 1–7. *Macrosiphum impatientis*. 1, Antennal segment III of apterous vivipara. 2, Ultimate rostral segment. 3, Cauda of apterous vivipara, left side ventral surface, right side dorsal surface. 4, Second segment of front tarsus. 5, Alate vivipara, dorsum of head and antennal segments I and II. 6, Portion of metatibia of apterous vivipara, showing structure of setae. 7, Siphunculus of apterous vivipara.

Table 3. Measurements of one side of individual specimens of *Macrosiphum impatientis* alate viviparae. All measurements in millimeters, columns of integers represent counts of rhinaria or setae. Label data of specimens studied: 1, 18, 20. MD, Beltsville, ex *Impatiens capensis,* x-1996; 2. Paralectotype, NE, Wabash, ex *Impatiens pallida,* 22-viii-1890; 3, 4, 5, 6. VA, Jackson City, ex *Impatiens fulva,* 17-x-1901; 7, 8, 9. OH, Wooster, ex *Impatiens aurea,* 19-viii-1920; 10. NH, Durham, ex Spotted touch-me-not, 26-viii-1921; 11. WI, Milwaukee, ex *Impatiens* sp., 19-ix-1933; 12. PA, State College, ex *Impatiens,* 21-ix-1942; 13. PA, State College, ex *Impatiens,* 24-viii-1946; 14. VA, Purcellville, ex *Impatiens* sp., 24-vii-1960; 15, 17. MD, Beltsville, ex *Impatiens* sp., 5-viii-1996; 16. MD, Beltsville, ex *Impatiens* sp., 24-vii-1996; 19. MD, Beltsville, ex *Rosa multiflora,* 15-x-1996; 21. MD, Beltsville, *R. multiflora,* 25-iv-1997; 22, 23. MD, Beltsville, ex *I. capensis,* 30-iv-1997; 24. MD, Beltsville, ex *R. multiflora,* 30-iv-1997; 25. MD, Beltsville, *I. capensis,* 7-v-1997.

Specimen No.	Antennal Segments					2° Rhin. a.s.III	URS	URS Setae	Meta-femur	Meta-tibia	Meta-tarsal II	Siph.	Cauda		Terg VIII Setae	Body
	III	IV	V	VIa	VIb								Length	Setae		
1	1.03	0.86	0.78	0.19	1.22	35	0.13	9	1.36	2.66	0.15	0.75	0.43	9	6	2.65
2	0.95	0.78	0.66	0.18	1.23	25	0.13	7	1.24	‡	0.13	0.67	0.43	9	6	‡
3	0.92	0.74	0.68	0.17	1.17	30	‡	‡	1.14	2.28	0.13	0.65	0.39	8	‡	2.20
4	0.92	0.74	0.72	0.16	1.22	29	‡	‡	1.24	2.44	0.13	0.75	0.39	8	6	2.90
5	0.91	0.78	0.61	‡	‡	31	0.14	‡	1.21	2.38	0.14	0.69	0.44	7	‡	‡
6	0.83	0.75	0.60	0.16	‡	31	‡	‡	1.20	2.35	0.14	0.71	0.43	8	‡	2.99
7	0.79	0.66	0.65	0.18	1.36	26	‡	‡	1.02	2.06	0.13	0.59	0.32	10	‡	2.01
8	0.95	0.92	0.74	0.20	1.20	31	0.13	10	1.39	2.60	0.15	0.79	0.44	9	‡	2.46
9	0.95	0.83	0.77	0.20	1.25	28	0.13	8	1.28	2.48	0.13	0.73	0.47	9	‡	2.46
10	0.85	0.79	0.70	0.18	1.14	27	‡	‡	1.12	2.21	0.14	0.64	0.41	7	‡	2.61
11	0.91	0.79	0.73	0.19	1.33	30	0.13	8	1.29	2.50	0.15	0.72	0.41	9	8	2.91
12	0.93	0.82	0.69	0.18	1.22	33	0.14	8	1.24	2.36	0.13	0.68	0.38	9	6	2.68
13	0.94	0.92	0.76	0.21	1.27	27	0.13	‡	1.30	2.53	0.13	0.74	0.44	10	5	2.85
14	0.93	0.83	0.76	0.21	‡	30	0.13	‡	1.31	2.46	0.14	0.73	0.44	7	6	2.60
15	0.81	0.71	0.60	0.16	1.20	24	0.13	8	1.00	1.92	0.13	0.55	0.32	9	6	1.94
16	0.72	0.65	0.60	0.17	1.22	28	0.12	‡	1.01	1.90	0.13	0.53	0.27	10	‡	2.22
17	0.79	0.68	0.65	0.14	1.19	20	0.12	8	1.03	2.06	0.13	0.54	0.33	9	6	1.94
18	1.01	0.82	0.74	0.19	‡	34	0.13	‡	1.28	2.57	0.14	0.64	0.40	10	6	2.67
19	1.01	0.83	0.77	0.19	1.34	26	0.13	‡	1.32	2.58	0.14	0.76	0.42	8	6	3.08
20	1.11	0.89	0.80	0.20	1.38	33	0.13	8	1.42	2.70	0.14	0.82	0.46	11	5	3.09
21	0.88	0.70	0.62	0.16	0.92	19	0.13	8	1.12	2.18	0.13	0.61	0.39	10	5	3.09
22	0.92	0.77	0.71	0.17	1.08	29	0.13	‡	1.21	2.34	0.13	0.73	0.43	9	6	2.90
23	0.92	0.74	0.71	0.17	1.03	27	0.12	8	1.19	2.29	0.14	0.74	0.44	10	5	3.07
24	0.93	0.78	0.74	0.17	1.13	29	0.13	8	1.22	2.34	0.14	0.70	0.40	10	7	3.09
25	1.04	0.74	0.74	0.20	1.26	32	0.14	7	1.24	2.50	0.15	0.78	0.44	9	5	3.17

darkening to dark brown or black. Tibiae and tarsi pigmented as in apterous vivipara. Sclerotized thoracic plates dusky. Wing veins dusky, with brown bordering only on base of radial sector. Marginal sclerites on abdominal segments II–V sometimes dusky to light brown. Siphunculi dark brown. Other parts pale.

Morphology: body length 1.94–3.17 mm excluding cauda. Antennal segment III 0.72–1.11 mm, a.s. IV 0.65–0.92 mm, a.s. V 0.60–0.80 mm, a.s. VIa 0.14–0.21 mm, a.s. VIb 0.92–1.38 mm in length; a.s. III with 19–35 secondary rhinaria extending nearly to apex of segment. Rostrum reaching to rear of mesothorax; u.r.s. 0.12–0.14 mm long, with 7–10 accessory setae. Thoracic sclerotized plates normal. Femoral ornamentation similar to apterous viviparae, except with metafemur ornamentation extending onto posterior surface; metafemur 1.00–1.42 mm long. Metatibia 1.90–2.70 mm long. Metatarsal II 0.13–0.15 mm long. Abdominal tergite VIII with 5–8 setae, which are somewhat longer than the basal width of a.s. III. Siphunculi 0.53–0.82 mm long, otherwise as in apterous viviparae, except often with a few more rows of retic-

Table 4. Measurements of one side of individual specimens of *Macrosiphum impatientis* oviparae. All measurements in millimeters, columns of integers represent counts of rhinaria or setae. A ‡ indicates missing data. Label data of specimens studied: 1, 2, 3, 4, 5. MD, Beltsville, ex *Impatiens capensis,* 29-x-1996; 6, 7, 8, 9, 10. MD, Beltsville, ex *Rosa multiflora,* 14-xi-1996.

Specimen No.	Antennal Segments					2° Rhin. a.s.III	URS	URS Setae	Metafemur	Metatibia	Metatarsal II	Siph.	Cauda		Terg VIII Setae	Body
	III	IV	V	VIa	VIb								Length	Setae		
1	0.75	0.54	0.50	0.16	0.95	5	0.12	9	0.90	1.68	0.13	0.55	0.35	8	6	2.17
2	0.82	0.58	0.58	0.19	1.09	9	0.13	8	1.03	1.84	0.14	0.65	0.38	11	6	2.62
3	0.70	0.47	0.51	0.16	0.95	5	0.12	7	0.87	1.64	0.13	0.56	0.32	7	7	2.08
4	0.75	0.43	0.49	0.17	0.92	4	0.12	8	0.81	1.51	0.12	0.53	0.32	9	‡	2.14
5	0.76	0.49	0.54	0.16	0.93	6	0.13	8	0.91	1.69	0.13	0.60	0.35	9	6	2.22
6	0.66	0.46	0.45	0.15	0.85	6	0.12	8	0.74	1.40	0.11	0.46	0.29	10	6	1.98
7	0.67	0.39	0.48	0.14	0.94	7	0.12	‡	0.76	1.44	0.12	0.46	0.29	9	6	1.86
8	0.70	0.44	0.44	0.13	0.88	6	0.12	8	0.74	1.48	0.12	0.46	0.30	8	6	1.95
9	0.68	0.44	0.46	0.14	0.93	4	0.11	6	0.76	1.39	0.11	0.48	0.28	9	6	1.87
10	0.70	0.44	0.47	0.14	0.83	6	0.12	8	0.78	1.50	0.12	0.50	0.32	11	6	2.10

ulations. Cauda 0.27–0.47 mm long, with 7–11 setae. Otherwise as in apterous viviparae.

Oviparous female (description based on 10 specimens; see Table 4).— Color when alive: bright reddish orange, with a faint greenish spinal stripe, siphunculi and metatibiae strikingly black. Antennal segments III–VI entirely brown except extreme base of a.s. III, area of rhinaria and joints between segments III and IV and IV and V darker brown; a.s. I dusky, darker medially. Metatibia entirely dark brown. Otherwise pale.

Morphology: body length 1.86–2.62 mm excluding cauda. Antennal segment III 0.66–0.82 mm, a.s. IV 0.39–0.58 mm, a.s. V 0.44–0.58 mm, a.s. VIa 0.13–0.19 mm, a.s. VIb 0.83–1.09 mm in length; a.s. III with 4–9 secondary rhinaria. Head capsule usually without spinal tubercles. Ultimate rostral segment 0.11–0.13 mm long, with 6–9 accessory setae. Metafemur 0.74–1.03 mm long. Metatibia 1.39–1.84 mm long, with numerous scent plaques (=pseudosensoria) covering most of its length; area covered by scent plaques slightly swollen. Metatarsal II 0.11–0.14 mm long. Abdominal tergite VIII with 6–7 setae. Siphunculi almost entirely cylindrical, tapering only at extreme base, 0.46–0.65 mm long, with 2–5 rows polygonal reticulations. Cauda 0.28–0.38 mm long, with 7–11 setae. Otherwise as in apterous vivipara.

Alate male (description based on 10 specimens; see Table 5).—Color when alive: reddish with many brown cuticular markings, black siphunculi and antennae. Color when macerated: antennae entirely brown, with a.s. II and III darker than other segments. Head capsule brown, with areas surrounding all 3 ocelli darker brown. Rostral segment III and u.r.s. brown. Prothorax brown, mesothoracic plates dark brown. Apical ½ of femora darkening to very dark brown. Tibiae entirely brown, but with middle part lighter brown than base and apex. Tarsi brown. Wing veins as in alate vivipara. Abdomen with these parts dusky to light brown: marginal sclerites on segments I–VII, ante- and postsiphuncular sclerites, 5 pairs of pleural intersegmental muscle attachment plates, and irregular spinal blotches or spots on tergites II-V and sometimes VII. Siphunculi dark brown. Claspers variably dusky to light brown. Other parts pale.

Morphology: body length 2.23–2.76 mm excluding cauda. Antennal segment III 0.89–1.05 mm, a.s. IV 0.78–0.89 mm, a.s. V 0.65–0.80 mm, a.s. VIa 0.16–0.21 mm, a.s. VIb 1.26–1.50 mm in length; longest setae on a.s. III slightly shorter than basal width of the segment. Secondary rhinaria on antennal segments: III, 63–77; IV, 0–2;

Table 5. Measurements of one side of individual specimens of *Macrosiphum impatientis* alate males. A ‡ indicates missing data. All measurements in millimeters, columns of integers represent counts of rhinania or setae. Label data of specimens studied: 1, 2, 3. VA, Jackson City, ex *Impatiens fulva,* 17-x-1901; 4, 5, 6, 7, 8, 9, 10. MD, Beltsville, ex *I. capensis,* x-1996.

Specimen No.	Antennal Segments					2° Rhin			URS	URS Setae	Metafemur	Metatibia
	III	IV	V	VIa	VIb	III	IV	V				
1	0.89	0.79	0.65	0.16	1.34	64	0	12	‡	‡	1.09	2.14
2	0.94	0.80	0.71	0.16	1.26	68	2	13	‡	‡	1.14	2.22
3	0.94	0.84	0.70	0.16	1.36	67	0	18	‡	‡	1.14	2.25
4	1.00	0.86	0.77	0.19	1.47	77	0	17	0.13	8	1.25	2.33
5	1.05	0.88	0.72	0.18	1.39	70	0	21	0.13	8	1.28	2.34
6	0.99	0.87	0.75	0.19	1.50	77	0	18	0.13	‡	1.26	2.36
7	0.99	0.86	0.80	0.19	1.42	64	0	17	0.14	8	1.27	2.31
8	0.96	0.78	0.73	0.18	1.48	75	0	18	0.13	8	1.16	2.24
9	1.00	0.82	0.74	0.21	1.31	63	0	19	0.13	9	1.28	2.38
10	1.00	0.89	0.76	0.19	1.42	69	0	14	0.13	6	1.20	2.30

V, 12–21. Head capsule often with 1 or 2 small spinal tubercles. Rostrum reaching to rear of mesothorax; u.r.s. 0.13–0.14 mm long, with 6–9 accessory setae. Metafemur 1.09–1.28 mm long. Metatibia 2.14–2.38 mm long. Metatarsal II 0.13–0.15 mm long. Abdominal segments anterior to siphunculi with dorsal setae about as long as longest setae on a.s. III; tergite VIII with 5–9 setae. Siphunculi 0.59–0.72 mm long. Cauda broad at base, strongly tapering apically, 0.22–0.31 mm long, with 7–13 setae. Claspers and aedeagus normal. Otherwise as in apterous vivipara.

KEY TO NORTH AMERICAN *MACROSIPHUM* WHOSE APTEROUS VIVIPARAE HAVE BLACK SIPHUNCULI AND PALE, MEMBRANOUS ABDOMINAL TERGA

Construction of an effective key to the species of *Macrosiphum* is made difficult by our poor knowledge of the biology, distributions, and ranges of variation of most of the species in the genus. This key treats only a few of the many *Macrosiphum* known in North America, and is based only on slide-mounted material in the National Collection of Aphidoidea. Future collecting and biological work may show that there are other species that belong in this key, or that characters used in the key are not valid when the full ranges of variation for these species are examined. All *Macrosiphum* species known to feed on roses in North America are included in this key except *M. euphorbiae,* the most common pest species in the genus. It can be separated from all species in this key by its siphunculi, which are pale or have the apical ¾ or less pigmented. Despite previous placement in *Sitobion,* the species *Macrosiphum salviae* Bartholomew is here considered to belong to *Macrosiphum,* following the suggestion in Jensen (1997). Characters refer to alate and apterous viviparous females, except when one or the other is specified.

1. Apterous viviparae with dark brown to black postsiphuncular sclerites; alate viviparae with dark brown ante- and postsiphuncular sclerites 2

– Apterous viviparae with pale postsiphuncular sclerites; alate viviparae without ante- or postsiphuncular sclerites, or with one sclerite but not the other 3

2 (1). Cauda pale; apterous viviparae with rhinaria limited to basal ½ of a.s. III; a.s. III smooth in middle; widely distributed, on Rosaceae, Dipsacaceae, Valerianaceae and sometimes other plants . . . . *Macrosiphum rosae* (L.)

– Cauda brown to black; apterous viviparae with rhinaria covering nearly the full length of a.s. III; a.s. III imbricated throughout; known from New York, on *Smilacina racemosa* (Liliaceae) . . . . *Macrosiphum pechumani* MacGillivray

Table 5. Extended.

Metatarsal II	Siph.	Cauda		Terg VIII setae	Body
		Length	Setae		
0.14	0.60	0.27	10	6	2.37
0.14	0.59	0.26	10	6	2.63
0.15	0.59	0.31	9	‡	2.23
0.14	0.62	0.25	7	5	2.70
0.13	0.61	0.26	13	8	2.46
0.13	0.72	0.26	8	8	2.76
0.14	0.60	0.24	11	9	2.48
0.13	0.59	0.24	11	8	2.70
0.13	0.61	0.22	9	7	2.52
0.13	0.72	0.25	8	‡	‡

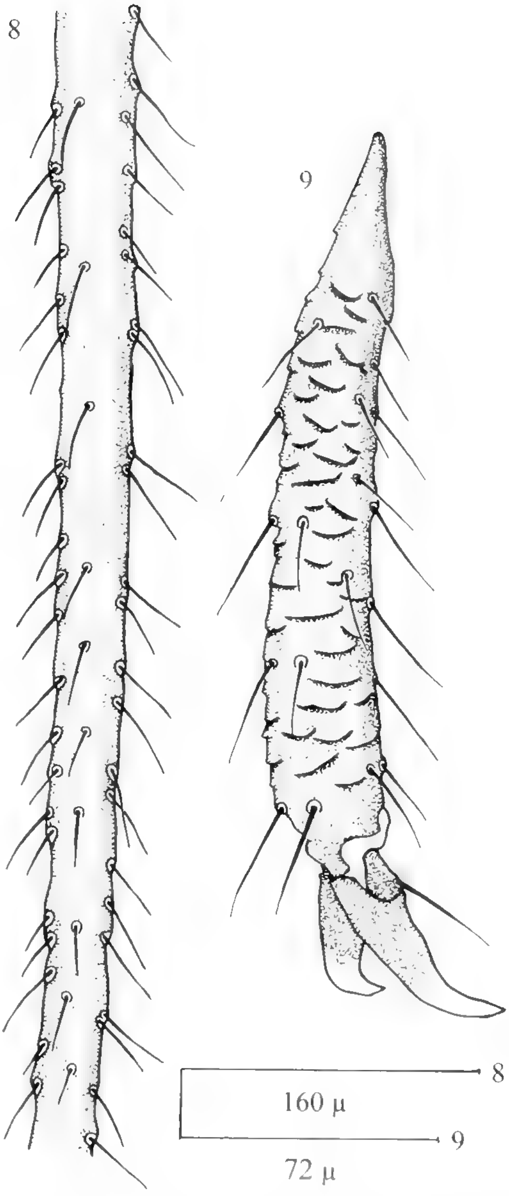
3 (1). Second segment of the protarsi with 3 or more pairs of dorsal setae (Fig. 9) 4

– Second segment of the protarsi with 2 pairs of dorsal setae (Fig. 4) 5

4 (3). Antennal segment III imbricated throughout; large, golden yellow aphids on *Lupinus* or *Thermopsis* (Fabaceae) in Idaho, Oregon and Utah . . . . *Macrosiphum zionense* Knowlton

– Antennal segment III smooth, at least in middle; on various plants, in western USA to Manitoba, Canada . . . . *Macrosiphum kiowanepus* (Hottes)
Macrosiphum potentillicaulis Miller
Macrosiphum subarcticum Robinson

These three species are morphologically indistinguishable based on the material at hand. They share several important characters: legs and siphunculi dark brown to black; cauda usually with 4 pairs of setae; apterous viviparae with lightly pigmented intersegmental muscle attachment plates and post- and antesiphuncular sclerites; alate viviparae with rhinaria covering about basal ¾ of a.s. III; marginal tubercles usually absent, small when present. The first species is known from Liliaceae and Rosaceae in Colorado, Utah, Washington, and Alberta, the second species from *Potentilla* (Rosaceae) in Idaho, and the third species from *Epilobium* spp. (Onagraceae) in northern Manitoba.



Figs. 8–9. 8, *Macrosiphum pallidum*, section of metatibia of apterous vivipara, showing structure of setae. 9, *Macrosiphum zionense* , second segment of front tarsus.

5 (3). Head without spinal tubercles and alate viviparae with rhinaria on more than basal ½ of a.s. III 6

– Head with spinal tubercles (Fig. 5) or alate viviparae with rhinaria restricted to basal ½ of a.s. III 8

6 (5). Cauda with 4 or 5 pairs of setae; apterous viviparae with tips of femora and bases of tibiae black; a.s. III of apterous viviparae with basal area surrounding rhinaria much darker than area immediately distad; alate viviparae with tibiae pale in the middle; on Liliaceae, Balsaminaceae, and Rosaceae in eastern North America 7

– Cauda usually with 3 pairs of setae; apterous viviparae with tips of femora and bases of tibiae medium brown, not dramatically darker than bases of femora; apterous viviparae with a.s. III more or less uniformly brown; alate viviparae with tibiae dark throughout; on various Lamiaceae in subtropical North America and in Central and South America . . . . *Macrosiphum salviae* Bartholomew

7 (6). Siphunculi entirely black; a.s. III of apterous viviparae with fewer than 8 rhinaria; hind tibia with normal setae; alate viviparae with fewer than 20 rhinaria on a.s. III; on lilies (Liliaceae), including cultivated varieties, in eastern North America . . . . *Macrosiphum lilii* (Monell)

– Siphunculi with very narrow pale area at extreme base (Fig. 7); apterous viviparae almost always with more than 8 rhinaria on a.s. III; hind tibiae with some dorsal setae in apical ½ unusually long and fine, often appearing bent or twisted; alate viviparae with more than 20 rhinaria on a.s. III; on *Impatiens* (Balsaminaceae) and *Rosa* (Rosaceae) in eastern North America . . . *Macrosiphum impatientis* (Williams)

8 (5). Forewing of alate viviparae with anal and cubital veins thick, bordered in brown; cauda usually with 3 pairs of setae; a.s. III imbricated throughout 9

– Forewing of alate viviparae with anal and cubital veins thinner, pale, not bordered with brown; cauda usually with 4–5 pairs of setae; a.s. III usually smooth in middle 10

9 (8). Alate viviparae with 10 or more rhinaria scattered over about basal ¾ of a.s. III; on *Rumex*, other Polygonaceae, and sometimes Convolvulaceae, widely distributed in eastern North America . . . . *Macrosiphum venaefuscae* Davis

– Alate viviparae usually with fewer than 10 rhinaria restricted to basal ½ of a.s. III; on wild and cultivated geraniums (Geraniaceae), apparently widely distributed east of the Rocky Mountains, but also recorded from California . . . . *Macrosiphum geranii* (Oestlund)

10 (8). Tergites VII and VIII with spinal tubercles; apterous viviparae with tibiae usually entirely dark brown to black; a.s. III of apterous viviparae usually with fewer than 10 rhinaria (MacGillivray 1968); hind tibia with dorsal setae normal (Fig. 8); on Rosaceae, usually *Rosa* and perhaps sometimes on other plants, in eastern North America . . . . *Macrosiphum pallidum* (Oestlund)

– Tergites VII and VIII without spinal tubercles, or if present on VIII, small; apterous viviparae with tibiae usually pale in middle; a.s. III of apterous viviparae usually with more than 10 rhinaria; hind tibia with some dorsal setae in apical ½ unusually long and fine, often appearing bent or twisted (Fig. 6); on *Impatiens* (Balsaminaceae) and *Rosa* (Rosaceae) in eastern North America . . . . *Macrosiphum impatientis* (Williams)

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DESCRIPTION OF *STROPHOTINA*, NEW GENUS, FROM CENTRAL AND SOUTH AMERICA (LEPIDOPTERA: TORTRICIDAE)

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Abstract.—***Strophotina,* new genus,** is described to accommodate *S. strophota* (Meyrick 1926), **new combination,** type species, from Colómbia, Venezuela, Perú, and Ecuador, and ***S. curvidagus,* new species,** from Costa Rica. The new genus is most similar to *Anopinella* Powell, *Seticosta* Razowski, and *Galomecalpa* Razowski in general facies and characters of the genitalia. *Strophotina* may represent the sister group of *Galomecalpa* on the basis of the shared possession of extremely elongate, narrow, short-scaled socii; a short, uniformly slender uncus; and the absence of the male foreleg hairpencil. Putative autapomorphies for *Strophotina* include the greatly expanded patch of spinelike setae subbasally on the costa of the valva, the highly modified, elongate mesal processes of the transtilla, and the narrow, elongate, curved aedeagus.

Key Words: Neotropical, phylogeny, Euliini, systematics

Since the turn of the century, approximately 75 species of Neotropical tortricid moths have been described in the polyphyletic genus *Eulia* Hübner by Meyrick (1912, 1926, 1932), Clarke (1949), and others. While there has been considerable taxonomic progress in Euliini, many species of *Eulia* have little in common, and their appropriate generic and tribal assignments have remained obscure (Powell, Razowski, and Brown 1995). Under current concepts, the genus *Eulia* includes only the single species *E. ministrana* (Linnaeus), which has a holarctic, boreal distribution; consequently, all other species of "*Eulia*" lack meaningful generic assignment. In recent years, Powell (1986), Razowski (1982, 1986, 1987, 1988, 1990a, 1990b, 1991, 1995), Brown (1990b), and Brown and Powell (1991) have defined a large number of genera from this assemblage of Neotropical species that can be assigned to Euliini either on the basis of a unique male foreleg hairpencil (Brown 1990a) or the suspected phylogenetic relationship to genera possessing this structure. The purpose of this paper is to describe *Strophotina,* new genus, to accommodate "*Eulia*" *strophota* Meyrick and *S. curvidagus,* new species, from Costa Rica.

MATERIALS AND METHODS

Specimens were obtained from the following institutions: The Natural History Museum, London, England (BMNH); Instituto Nacional de Biodiversidad, Santo Domingo, Costa Rica (INBio); National Museum of Natural History, Smithsonian Institution, Washington, D.C. (NMNH); and Essig Museum of Entomology, University of California, Berkeley (UCB).

Dissection methodology followed that summarized in Brown and Powell (1991). Illustrations of genitalia were drawn with the aid of a microprojector. Forewing measurements were made with the aid of an ocular micrometer mounted in a dissecting microscope. Terminology for wing venation and genitalic structures follows Horak (1984). Abbreviations are as follows: FW = forewing; HW = hindwing; DC = discal cell.

SYSTEMATICS

Strophotina J. Brown, new genus

Eulia Hübner (in part); Meyrick, 1926: 252; Clarke, 1958: 139; Powell, Razowski and Brown, 1995: 144.

Type species.—*Eulia strophota* Meyrick, 1926.

Description.—*Head:* Antennal cilia in male approximately 1.7 times flagellar segment diameter, cilia extremely short in female. Labial palpus elongate, 1.6–1.8 times horizontal diameter of eye in male, 2.6–2.8 times horizontal diameter of eye in female; segment II weakly upturned, slightly expanded distally by scaling; segment III 0.3–0.4 as long as II, smooth-scaled, exposed. Maxillary palpus rudimentary. Proboscis well developed. Frons with overhanging tuft of scales. Ocelli present. Chaetosema present. *Thorax:* Smooth-scaled. Legs unmodified, male foreleg hairpencil absent. *Forewing:* Length 2.3–2.4 times width; length of DC about 0.55 FW length; width of DC about 0.20 DC length; CuA_2 originates about 0.60 along length of DC; all veins separate beyond DC; chorda and M-stem absent. No upraised scale tufts; male without costal fold. *Hindwing:* Sc+R and Rs closely approximate; M_3 and CuA_1 closely approximate; CuP present; M-stem absent; tuft of hairlike scales along 1A+2A, originating near base of wing. *Abdomen:* Dorsal pits absent; no modified corethrogyne scaling in female. *Male genitalia* (Figs. 3–4): Uncus simple, uniformly slender. Socius narrow, extremely elongate, with dense, fine, hairlike scales; not fused to gnathos. Gnathos simple, non-dentate, arms narrow, joined distally. Subscaphium and hami absent. Transtilla a pair of extremely elongate, narrow, sclerotized arms, not joined mesally. Valva somewhat ovate, broadest subbasally; a row of long, strong, spinelike setae on costa; sacculus confined to basal one-fourth. Pulvinus absent. Vinculum complete, well developed. Juxta a broad, sclerotized plate. Aedeagus long, slender, strongly arched; phallobase simple; vesica with two small, curved cornuti (suspected to be deciduous). *Female genitalia* (Figs. 5–6): Papillae anales slender. Apophyses anteriores and posteriores extremely long. Sterigma a simple scobinate band. Ductus bursae moderately long, sclerotized in caudal 0.5. Corpus bursae subrectangular, with a faint patch of sclerotization caudally; spicules and signum lacking. Accessory bursa from near junction of corpus and ductus. Ductus seminalis from proximal region of corpus.

Diagnosis.—Superficially, adults of *Strophotina* are similar to *Anopinella* Powell, *Seticosta* Razowski, and *Galomecalpa* Razowski on the basis of the long, slender labial palpi, the elongate antennal cilia of the male, and the distinctive broad, dark, semicircular patch bordering the costa of the forewing. *Strophotina, Anopinella,* and *Galomecalpa* lack the characteristic euliine male foreleg hairpencil (Brown 1990a), which is retained in *Seticosta.* The male genitalia of *Strophotina* can be distinguished from those of *Anopinella, Seticosta,* and *Galomecalpa* by the following characters (see Figs. 3–4): (1) valva shorter and ovate compared to the long and narrow valva of *Anopinella* and *Seticosta,* and without the acute apex of *Galomecalpa*; (2) a row of spinelike setae subbasally on the costa of the valva, lacking in *Anopinella* and *Galomecalpa* but present in *Seticosta*; (3) extremely elongate, narrow socii, which are unmodified in *Anopinella* and *Seticosta* but similar to *Galomecalpa*; and (4) a highly modified transtilla, which is simple in *Anopinella, Seticosta,* and *Galomecalpa.* The female genitalia of these genera, with the exception of *Galomecalpa* of which no fe-

Figs. 1–2. Adults. 1, *Strophotina strophota*, 2, *S. curvidagus*.

male is known, possess an accessory bursa that arises from a slender ductus from the proximal portion of the corpus bursae. *Strophotina* may represent the sister group of *Galomecalpa* on the basis of the shared possession of extremely elongate, narrow, short-scaled socii and a uniformly slender uncus. However, in the absence of females of *Galomecalpa,* this hypothesis is only provisional. Putative autapomorphies for *Strophotina* include the greatly expanded patch of spinelike setae subbasally on the costa of the valva (which is much less extensive in *Seticosta*), highly modified, elongate mesal processes of the transtilla, and the narrow, elongate, curved aedeagus (see Figs. 3–4).

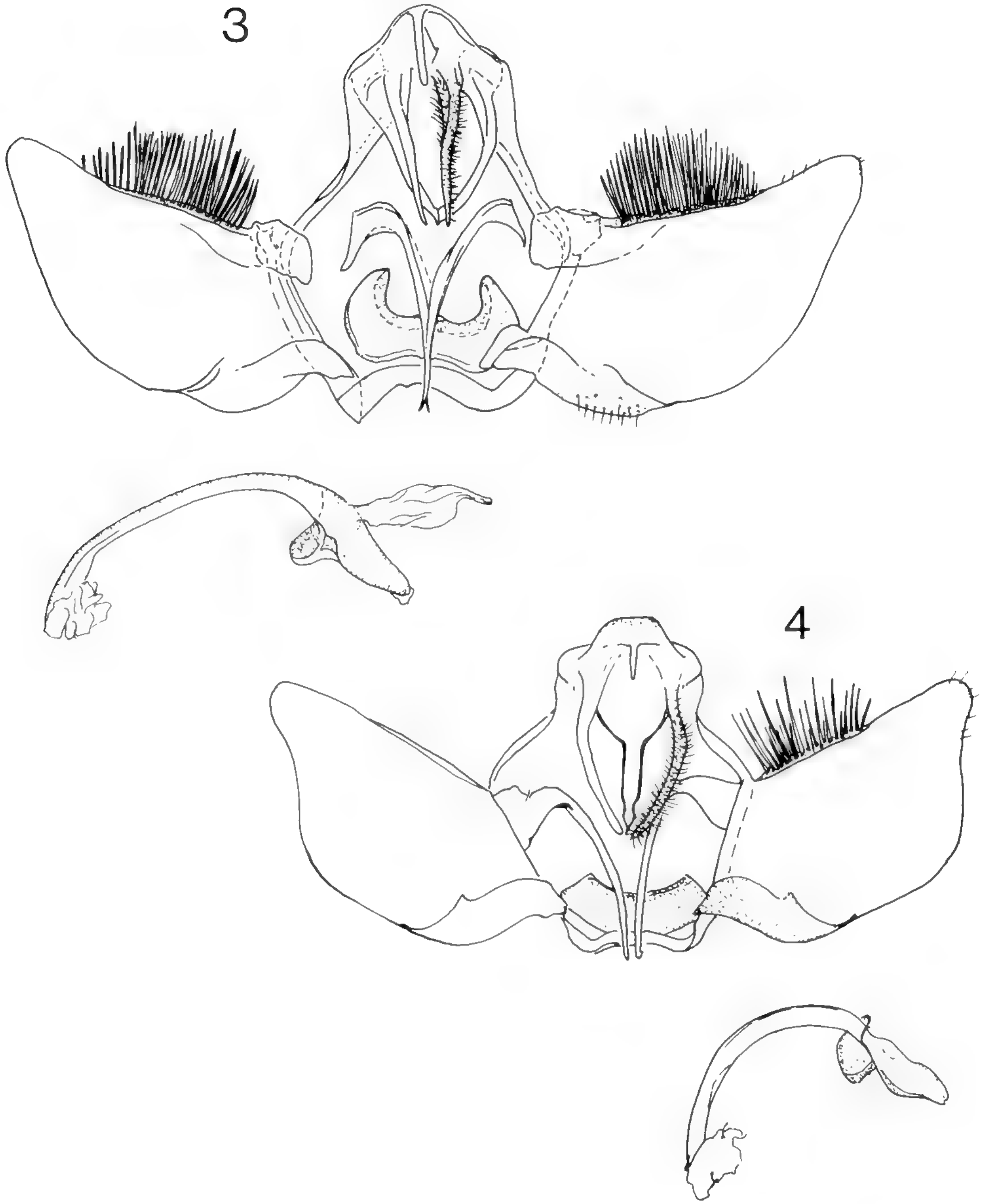
Distribution and biology.—*Strophotina* is known from montane forest habitat at mid-elevations (1100–1400 m) in Costa Rica, and from higher elevations (1500–3850 m) in Colómbia, Venezuela, Ecuador, and Perú. Nothing is known of the early stages.

Etymology.—The name of the new genus is derived from the name of the type species; it is interpreted to be masculine in gender.

Strophotina strophota (Meyrick), **new combination**
(Figs. 1, 3, 5)

Eulia strophota Meyrick, 1926: 252; Clarke, 1958: 139; Powell, Razowski and Brown, 1995: 144.

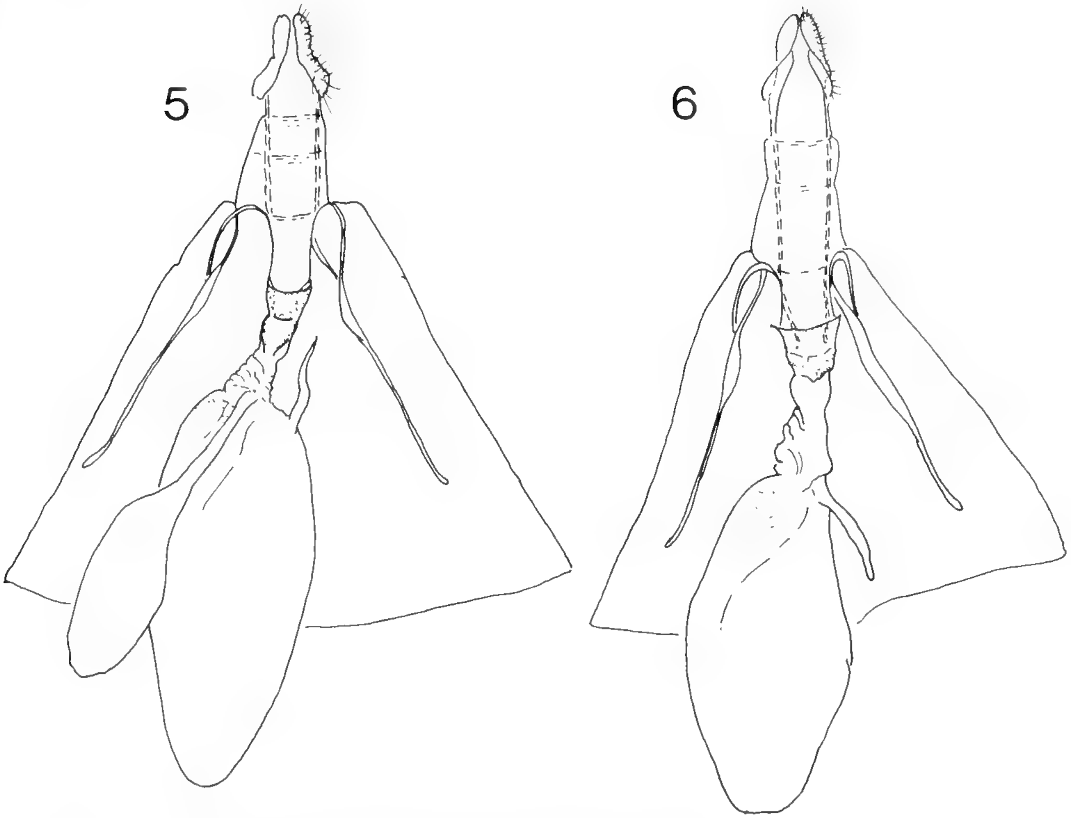
Redescription.—Male. FW length 9.0–9.5 mm ($\bar{x}$ = 9.1 mm; n = 3). *Head:* Frons tan-brown, with sparse, smooth scaling below mid-eye, vertex roughened above, concolorous with frons. Labial palpus off white mesally, brown mixed with tan laterally. Antenna brown. *Thorax:* Tan-brown. *Forewing* (Fig. 1): Upperside light gray-brown with large, semicircular, purple-brown patch bordering costa ca. 0.45–0.85 distance from base; termen slightly darker than ground color; slender light brown line in subterminal area parallel to termen, narrowly bordered by light gray. Underside uniform dark tan with faint indication of upperside markings. *Hindwing:* Upperside light gray-brown with slightly darker gray-brown mottling. Underside light gray-brown with darker mottling. *Genitalia:* As in Fig. 3 (drawn from JWB slide 287, Ecuador; n = 2). Essentially as described for the genus. Gnathos arms uni-



Figs. 3–4. Male genitalia. 3, *Strophotina strophota*, 4, *S. curvidagus*.

form in width, gently curved from base to mesal junction. Juxta with two rounded excavations dorsally, roughly rounded w-shaped. Aedeagus with straight subapical region.

Female.—FW length 8.0–12.5 mm ($\bar{x}$ = 10.4 mm; n = 8). Superficially as in male, except larger average forewing length, labial palpus conspicuously longer, and lacking elongate antennal cilia. *Genitalia:* As in



Figs. 5–6. Female genitalia. 5, *Strophotina strophota*, 6, *S. curvidagus*.

Fig. 5 (drawn from USNM slide no. 69904, Venezuela; n = 6) (Clarke 1958:139 provides a photograph of the female genitalia of the lectotype). As described for the genus.

Type.—Lectotype, ♀, Colómbia, Mt. Tolima, 12,500′ [3850 m], 10.20 [October 1920] (BMNH). Designated by Clarke (1958).

Additional specimens examined.—COLOMBIA: Cuaca Province: 17 km SE Popayan, 2000 m, 1♀, 10-I-1959 (J. F. G. Clarke, NMNH). ECUADOR: Napo Province: via Santa Barbara-La Bonita, km 23, 2400 m, blacklight, 3 ♂, 4 ♀, 7/9-IV-1986 (S. McKamey, UCB). PERU: Divisoria, Route 15 [between Tingo Maria and Aguaytia], 6200′ [1908 m], 1 ♀, 20/28-VI-1982 (C. Covell, NMNH). VENEZUELA: Lara Province: Yacambu National Park, 13 km SE Sanare, 4800′ [1477 m], cloud forest, 1 ♀, 4/7-III-1978, bl[acklight] (J. B. Heppner, NMNH).

Comments.—It is possible that more than one species is represented in the material cited above. However, until additional male specimens become available, subtle differences in the female genitalia are assumed to reflect infraspecific variation in *S. strophota*.

Strophotina curvidagus J. Brown, new species

(Figs. 2, 4, 6)

Description.—Male. FW length 6.0–7.0 mm (n = 2). *Head:* Frons tan-brown, with sparse, smooth scaling below mid-eye, roughened above. Labial palpus off white mesally, brown mixed with tan laterally. Antenna brown. *Thorax:* Tan-brown. *Fore-*

wing (Fig. 2): Upperside light gray-brown with large, semicircular, purple-brown patch bordering costa ca. 0.45–0.85 from base; termen slightly darker than ground color; slender light brown line in subterminal area parallel to termen, narrowly bordered by light gray. Underside uniform tan with faint indication of upperside markings. *Hindwing:* Upperside light gray-brown with slightly darker gray-brown mottling. Underside light gray-brown with darker mottling. *Genitalia:* As in Fig. 4 (drawn from JWB slides 810 and 846; n = 2). Essentially as described for the genus. Gnathos arms angulate with short apical process at mesal junction. Ventral margin of valva with slightly undulate portion just before apex. Juxta with dorsal edge slightly rounded, lacking dorsal excavations present in *strophota.* Aedeagus evenly curved.

Female.—FW length 8.0–9.5 mm ($\bar{x}$ = 9.0 mm; n = 3). Essentially as described for male. *Genitalia:* As in Fig. 6 (drawn from JWB slide 747; n = 2). As described for the genus, except sclerotization of ductus bursae restricted to antrum.

Types.—Holotype, ♂, Costa Rica, Puntarenas Province, Sector Altamira, 1 km SW Cerro Biolley, A.C. Amistad, 1300 m, 2/20-IV-1995, L. Angulo (INBio).

Paratypes, 1 ♂, 3 ♀ as follows: COSTA RICA: Alajuela Province: N slope Volcán Poas, 8 km N Vara Blanca, 1400 m, 1 ♀, 25-VII-1990 (S. Meredith & J. Powell, UCB). Cartago Province: Quebrada Segunda Ref., Nac. Fauna Silv. Tapantí, 1250 m, 1 ♀, III-1992 (G. Mora, INBio), 1150 m, 1 ♂, V-1994 (E. Mora, INBio). Puntarenas Province: Estac. Biol. Las Alturas, 12 air km NE San Vito, 1550 m, 1 ♀, 22/24-I-1993 (J. Powell, UCB).

Diagnosis.—*Strophotina curvidagus* is virtually indistinguishable from *S. strophota* in facies, although the two males of *S. curvidagus* examined are conspicuously smaller in forewing length than the three males of *S. strophota. Strophotina curvidagus* can be distinguished from *S. strophota* by its evenly curved aedeagus (that of *strophota* has a straight portion subapically), the more simple juxta (the dorsal edge evenly rounded rather than w-shaped), the more complex shape of the arms of the gnathos, and the general shape of the distal portion of the valva. In the female, the ductus bursae of *S. curvidagus* has the sclerotization restricted to a well-defined antrum.

Etymology.—The specific epithet is derived from the evenly curved aedeagus in the male genitalia.

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REEXAMINATION OF *SIMULIUM* (*PSILOPELMIA*) ENDERLEIN (DIPTERA: SIMULIIDAE) OF AMERICA NORTH OF MEXICO

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Abstract.—Ten species in the black fly subgenus *Psilopelmia* of *Simulium* in the United States and Canada are treated taxonomically. *Simulium notatum* Adams, known only from two females collected in western Arizona at the turn of this century, has been rediscovered; the female is redescribed, and the remaining life stages after the egg are described for the first time. *Simulium clarum* Dyar and Shannon, known only from three cotype males, is resurrected from synonomy; the male is redescribed, and the remaining life stages above the egg are described for the first time. *Simulium longithallum* Díaz Nájera and Vulcano, not previously known from the United States, is reported from two locations in eastern Arizona, and all life stages after the egg are redescribed. At least one life stage of these additional species of *Psilopelmia* Enderlein can easily be confused with those of the eight currently recognized species recorded from the contiguous United States and Canada. Updated keys are provided that will facilitate separation of pupae and both adults. Diagnoses are provided for larvae in the rare instances where identification is relatively straightforward for all instars.

Key Words: North America, aquatic insects, Simuliidae, streams, rivers

Peterson (1993) and Coscarón et al. (1995, 1996) revised the Nearctic and Neotropical species of *Psilopelmia* Enderlein, respectively. Peterson (1993) described two unusual species, *S. robynae* and *S. labellei,* from the Rio Grande River system, redescribed six others, and provided keys for the separation of all life stages after the egg. Coscarón et al. (1995) treated eight species known from the Caribbean Islands and Central and South America and provided keys for the identification of all life stages after the egg. Coscarón et al. (1996) treated 21 species known from the Americas south of the United States. In this work, they redescribed 20 species; described one species, *S. bobpetersoni,* as new to science; established synonymies of six species; provided well illustrated keys to all life stages after the larva; and inferred a phylogeny of the group using morphological characters.

Two views exist on the placement of species within the related subgenera *Psilopelmia* and *Ectemnaspis* Enderlein. Crosskey's (1988) definition of *Psilopelmia* is broad compared to that of Coscarón et al. (1995, 1996), whereas his concept of *Ectemnaspis* is more restricted. The limits set for the subgenus by Coscarón et al. (1995) reduce the size of *Psilopelmia* to approximately one half that recognized by Crosskey (1988). The majority of species removed by Coscarón (1987) and Coscarón et al. (1995) were transferred to four species groups of *Ectemnaspis* (Coscarón 1984, 1990). Coscarón et al. (1995) defined *Psilopelmia* predominantly on color patterns of the male and female scutum and female abdomen.

Evidence for a *Psilopelmia* plus *Ectemnaspis* clade includes similar cibarial armature and features of the anal lobe (Coscarón et al. 1996). The subgeneric status of all North American species previously assigned to *Psilopelmia* remains unchanged.

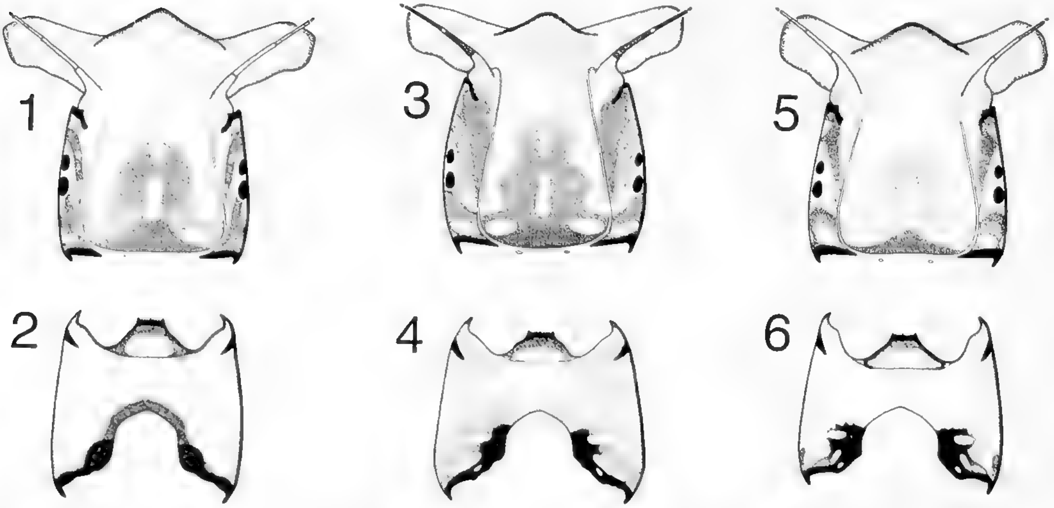
Females of *Psilopelmia* are mammalophilic and pests of livestock, and more rarely humans, in western North America. Anderson and Voskuil (1963) reported a significant reduction in milk production in cattle in Merced County, California, caused by the aggressive feeding behavior of a species they identified as *S. trivittatum* (= *S. clarum*). They estimated 500–800 females per animal at some periods in the late afternoon. Anderson and Yee (1995) observed *S. clarum* (as *S. trivittatum*) and *S. griseum* feeding on horses in northern California. Females were predominantly seen taking blood from the undersides of horses, although substantial numbers were attracted to ears of animal models. Peak catches occurred from September through October. Francy et al. (1988) isolated vesicular stomatitis virus (VSV) in Colorado from a pooled sample of simuliids that contained *S. bivittatum.* Two Nearctic species, *Simulium bivittatum* and *S. clarum* (as *S. trivittatum*), have been reported feeding upon humans in substantial numbers in Oregon and California, respectively (Cole and Lovett 1921, Essig 1938, Anderson and Voskuil 1963, Peters and Womeldorf 1966).

This manuscript is intended to provide the means to identify species of the subgenus *Psilopelmia* in North America and to facilitate the inclusion of *S. clarum* and *S. longithallum* in a book on the black flies of North America being prepared by P. H. Adler, D. C. Currie, and D. M. Wood. In light of current investigations revolving around species of *Psilopelmia* as potential vectors of vesicular stomatitis virus, it is important that keys, particularly those to females, be updated with respect to new taxonomic data.

MATERIALS AND METHODS

Life-stage descriptions follow those of Adler and Currie (1986). Taxonomic terms predominantly follow those of Peterson (1981). Preimaginal material initially fixed in Carnoy's solution was transferred to 80% ethanol for permanent storage. Adults were either dried in a frost-free freezer at −20°C or dehydrated with absolute ethanol and dried using Peldri II (Ted Pella, Inc.) or hexamethyldisilazane (HMDS) (Polysciences, Inc.). Full series of *S. clarum, S. longithallum,* and *S. notatum* are deposited in the National Museum of Natural History, Smithsonian Institution, Washington, D.C.; The Natural History Museum, London; the Canadian National Collection, Ottawa; the Snow Entomological Museum, Lawrence, Kansas; and the University of Arizona Insect Collection, Tucson, Arizona. Additional material is housed in the author's personal collection. Institutions that furnished material for examination are denoted as follows: Canadian National Collection (CNC), Los Angeles County Museum (LACM), National Museum of Natural History, Smithsonian Institution (USNM), University of Arizona (UAZ); and University of Idaho (UID). The synonymies provided for each species include only misidentifications of either systematic or medical/veterinary importance. County names in the material examined sections of this paper enclosed by parentheses are not present on the locality labels accompanying the specimens and were inferred by the author.

Some of the keys rely heavily upon content and, to a lesser extent, illustrations in Peterson (1993). Although there appear to be interspecific differences in larval coloration in Carnoy's-fixed larvae, limited availability of such material precludes incorporation of this information into these keys. Additional characters, such as polytene chromosome rearrangements, are sorely needed to more adequately identify larvae of *Psilopelmia.* Line drawings were rendered by the author with the aid of an



Figs. 1–6. Larval head capsules. 1, *Simulium clarum*, dorsal view. 2, *S. clarum*, ventral view. 3, *S. longithallum*, dorsal view. 4, *S. longithallum*, ventral view. 5, *S. notatum*, dorsal view. 6, *S. notatum*, ventral view.

MTI CCD72 imaging system connected to an Olympus SZH10 stereo microscope. Length and width measurements were made either using this imaging system or an ocular micrometer in an Olympus SZH zoom stereomicroscope. Terminalia, mouthparts, and legs were cleared in hot 85% lactic acid to facilitate visibility and interpretation. The pupae used to make the scanning electron micrographs were dehydrated with absolute ethanol, dried using HMDS, mounted on brass pegs covered with glue, and sputter-coated with gold. The micrographs of pupal gills were made with an International Scientific Instruments model DS-130 scanning electron microscope.

SPECIES ACCOUNTS

Simulium (*Psilopelmia*) *bivittatum* Malloch
(Figs. 8, 21, 48, 54)

The larva is not reliably distinguished from those of other species unless mature and the gill is dissected out and examined. The anteriorly directed dorsal filament and anteroventrally directed petiolate pair of filaments of the middle group of gill filaments and thickened base of the dorsal group of filaments (Figs. 8, 21) distinguish the pupa from the others treated herein. The female is separated from those of all species, except *S. clarum*, by the combination of scutal coloration and length of the ventral process of the anal lobe. Females are not reliably separated from those of *S. clarum*, though dark-striped females are much rarer in *S. bivittatum* (see discussion under *S. clarum*). Males are separated from all others, except *S. clarum*, by the matte black scutum (rarely glabrous orange) with anterior crescent-shaped silvery blue stripes extended ⅓–½ the distance to the base of the wing, yellow stem vein setae, and shape of the ventral plate.

Color variation in this and other species was commonly observed and might be attributable to the water temperature of the preimaginal habitat, as was observed by Wilson et al. (1992) with *S.* (*Edwardsellum*) *sirbanum* Vajime and Dunbar. Orange variants (typically males) are much more common during the summer months, and dark variants (typically females) are much more common during the spring and autumn months.

The pupal keys in Peterson (1993) and Peterson and Kondratieff (1995) rely heavily on the shape and weaving of the cocoon for separation of the pupae of *S. bivittatum*, *S. griseum*, and *S. venator*. I have observed variation in the thickness of the anterior collar between populations of *S. bivittatum* and *S. notatum* inhabiting slow-flowing versus fast-flowing habitats. The degree of strengthening in the anterior portion of the cocoon seems directly proportional to water velocity. Therefore, these characters are not suitable for taxonomic use. *Simulium bivittatum* is widely distributed across western North America, but its presence in California remains unconfirmed, as all material examined from there is *S. clarum*.

Material examined.—CANADA: ALBERTA: Milk River, 4 July 1964, G. C. & D. M. Wood—2 ♂ & 1 ♀ (dark) w/exuviae (CNC). St. Mary's River nr. Lethbridge, 29 June 1982, B. V. Peterson—1 ♂ & 1 ♀ (CNC). USA: ARIZONA: Cochise Co., San Pedro River at US Rt. 90, 7.5 miles E of Sierra Vista, 17 January 1991, E. W. Cupp & F. R. Ramberg—3 ♂, 2 ♀; 6 May 1991, C. A. Olson—3 ♂, 1 ♀, 18 March 1992—C. A. Olson—2 ♀; 20 August 1992—J. K. Moulton—2 ♂, 2 ♀; 17 October 1992, J. K. Moulton—13 ♂, 8 ♀; 14 November 1992, J. K. Moulton—6 ♂, 6 ♀; 21 November 1992, J. K. Moulton—4 pupae, 6 ♂ & 9 ♀ w/exuviae; 28 April 1993—J. K. Moulton—4 ♂, 6 ♀. Pima Co., Arivaca Creek at Arivaca Rd., 22 September 1992, C. A. Olson—3 ♂, 4 ♀; 3 October 1992, C. A. Olson—2 ♂, 2 ♀; 10 October 1992, J. K. Moulton—37 larvae, 29 pupae, 10 ♂ & 8 ♀ w/exuviae. Pinal Co., Aravaipa Creek at Aravaipa Rd., 5 September 1992, J. K. Moulton—1 ♂. Yavapai Co., 1 mi S of Boynton Cyn., 34°51′N, 111°50′W, 15 April 1991, N. L. Evenhuis—1 ♀ (CNC). Verde River at I-10, 16 June 1994, J. K. Moulton and D. G. Mead—184 larvae, 22 pupae. COLORADO: Yuma Co., Wray, 6 June 1963, G. C. & D. M. Wood—4 ♂ & 2 ♀ w/exuviae (CNC). IDAHO: Elmore Co., 3.5 mi. W of Hammett, 20 June 1964, W. F. Barr—1 ♀ (USNM); 7 mi. S of Sunnyside, 18 July 1967, L. S. Hawkins, Jr.—4 ♀ (USNM). Franklin Co., Treasureton Res., 17 June 1970, W. F. Barr—2 ♀ (USNM). Gooding Co., 6.5 mi. N of Gooding, W. F. Barr—2 ♀ (USNM). Blue Gulch, Hagerman, wind vane trap, 23 September 1932, 1 ♀ (USNM). NEW MEXICO: Catron Co., San Francisco River at US Rt. 180, 15 May 1995, J. K. Moulton—6 ♂ & 9 ♀ w/exuviae. UTAH: Uinta Co., Uinta River at Gusher, 1 July 1963, G. C. & D. M. Wood—2 ♂ (1 w/exuviae), 2 ♀ (CNC). WYOMING: Crook Co., Belle Fource River at Devil's Tower, 21 May 1993, K. Pruess—8 larvae, 3 pupae, 3 ♂ & 3 ♀ w/exuviae.

Simulium (*Psilopelmia*) *clarum* Dyar and Shannon

(Figs. 1, 2, 7, 23–25, 30, 34, 39, 47, 53)

Eusimulium clarum Dyar and Shannon 1927: 21 (female, male, key, original description, figs. 38, 52–53), three "cotype" males.

Simulium (*Lanea*) *bivittatum* Wirth and Stone 1956: 405 (*nec* Malloch 1914), males, females, pupae, larvae, keys.

Simulium (*Lanea*) *trivittatum* Wirth and Stone 1956: 404 (*nec* Malloch 1914), males, females, pupae, larvae, keys.

Simulium (*Psilopelmia*) *bivittatum* Anderson and Voskuil 1963: 127 (*nec* Malloch 1914), biting cattle.

Simulium (*Psilopelmia*) *trivittatum* Anderson and Voskuil 1963: 127 (*nec* Malloch 1914), biting cattle and humans.

Simulium trivittatum Peters and Womeldorf 1966: 41 (*nec* Malloch 1914), biting humans.

Simulium (*Psilopelmia*) *trivittatum* Cole 1969: 110 (*nec* Malloch 1914), California records.

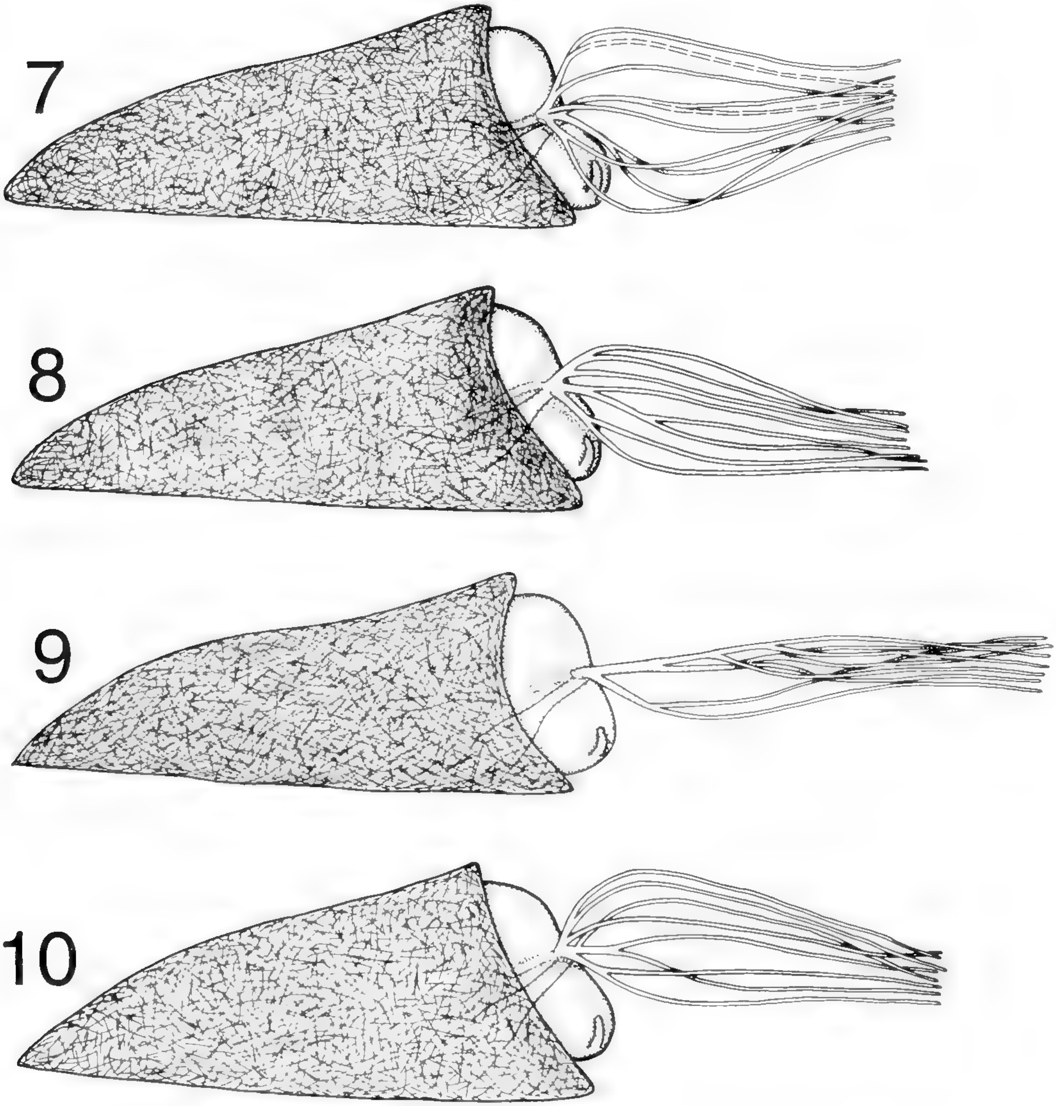
Simulium bivittatum Hall 1974: 65 (*nec* Malloch 1914), biology.

Simulium trivittatum Hall 1974: 65 (*nec* Malloch 1914), biology.

Simulium (*Psilopelmia*) *bivittatum* Peterson 1993: 308 (*nec* Malloch 1914), California records.

Simulium (*Psilopelmia*) *trivittatum* Peterson 1993: 341 (*nec* Malloch 1914), California records.

Simulium (*Psilopelmia*) *trivittatum* Ander-



Figs. 7–10. Pupae. 7, *Simulium clarum*. 8, *S. bivittatum*. 9, *S. longithallum*. 10, *S. notatum*.

son and Yee 1995: 28 (*nec* Malloch 1914), ex. horses, models, and flight traps.

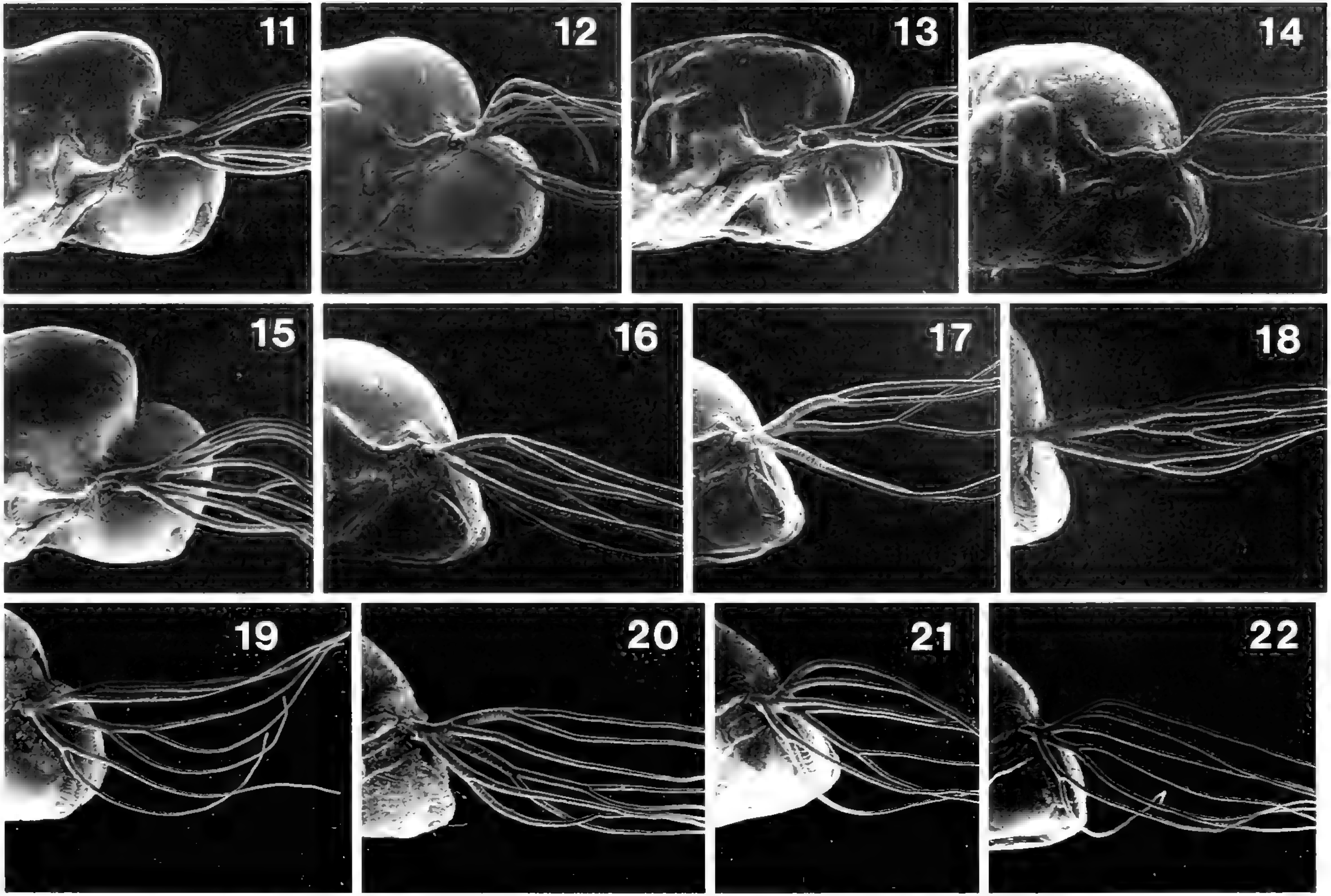
Simulium (*Psilopelmia*) *trivittatum* Yee and Anderson 1995: 7 (*nec* Malloch 1914), ex. horses, models, and flight traps.

Larva.—Length 5.0–5.8 mm ($\bar{x}$ = 5.6, *n* = 20). Body coloration variable, either pale green or gray with distinct, white intersegmental areas. Head capsule (Figs. 1, 2) pale yellowish brown; cephalic apotome variable, ranging from pale brown with dark brown areas restricted to area formed by the anteromedian, posteromedian, and anterolateral headspots and between posterolateral headspots (green larvae) to mostly dark brown in the region surrounding headspots (gray larvae); headspots paler than cephalic apotome; intensity of cephalic apotome pigmentation positively correlated with that of larval color. Antenna pale yellowish brown. Labral fan with 35–46 primary rays ($\bar{x}$ =

39, $n = 20$). Postgenal cleft oval, sometimes slightly pointed apically, extended about ⅓ distance to hypostomal groove, and with or without distinct brown border. Mandible with 6 apical teeth and 7–8 smaller subapical teeth; inner subapical ridge with bifid sensillum; upper time twice length and breadth of lower tine. Maxillary palpus cylindrical, moderately sclerotized, about 3 times longer than wide. Hypostoma (dorsal wall) with 13 teeth; a median tooth and 6 lateral teeth per side as follows: 3 small, subequally sized sublateral teeth, a corner tooth subequal in size to median tooth, and one pair of paralateral teeth; ventral hypostomal wall with 3–4 setae and 2–3 lateral serrations along lateral margin. Subesophageal ganglion darkly pigmented. Thoracic proleg with lateral sclerite lightly sclerotized, roughly square. Body of normal shape, with abdomen gradually expanded after segment-V. Anal papillae consisting of three simple lobes. Ventral tubercles approximately ⅛ depth of abdomen at attachment points. Anal sclerite X-shaped with anterior arms ½ length of posterior arms. Posterior proleg bearing 68–77 rows of 11–18 hooks.

Pupa (Fig. 7).—Length 2.5–3.0 mm ($\bar{x} = 2.8$, $n = 20$). Cephalic plate with numerous, uniformly distributed granules. Anterodorsum of thorax with numerous granules and horizontal row of 3–4 simple or bifid trichomes. Gill (Figs. 23–25) ⅔–¾ length of pupa, comprised of 8–10 filaments; filaments branching 2+1, 2+1, 1+1 when 8-filamented (Fig. 25), 2+1, 1, 1+2, 1+1 when 9-filamented (Fig. 24), and 2+1, 1, 2+2, 1+1 when 10-filamented (Fig. 23); filaments uniformly thin, shallowly furrowed; middle group of 3–4 filaments with dorsal filament(s) directed slightly dorsally and ventral pair directed anteriorly or only very slightly anteroventrally. Tergites with randomly spaced microdenticles anteriorly. Tergite I with 2 fine setae per side; tergite II with 5–6 fine, scarcely perceptible setae per side, arranged in two closely spaced groups, two medial of lateral group of 3–4; tergite III with 4 retrorse hooks and three hook-like setae per side, hook-like setae consisting of two situated anterior to and one lateral to lateralmost retrorse hooks; tergite IV with 4 retrorse hooks and 1 lateral hook-like seta per side; tergite V with one lateral hook-like setae per side; tergite VI with 1 latitudinal row of spine-like setae and 1 lateral hook-like seta per side; tergite VII with median, latitudinal row of spine-like setae and 1 lateral hook-like seta per side; tergite VIII with latitudinal row of spine-like setae extended length of sclerite and 1 lateral hook-like seta; tergite IX with latitudinal row of spine-like setae and one, small terminal spine per side. Sternite IV with 1 spine-like seta per side; sternite V with 2 closely paired bifid spine-like setae near midline; sternites VI–VII each with 1 bifid and 1 simple spine-like seta per side, these distantly spaced. Cocoon slipper shaped, well formed, with straight anterior margin lacking distinct anterior collar.

Female.—Length: thorax, 1.0–1.2 mm ($\bar{x} = 1.1$, $n = 20$); wing, 2.3–2.7 mm ($\bar{x} = 2.5$, $n = 20$). Head gray-blue, pollinose. Frons about twice as long as broad, broadest at middle. Antennal scape and pedicel brown; flagellum with basal article yellowish brown, distal articles brown. Haustellum pale brown. Labellum brown. Mandible with 32–40 ($\bar{x} = 36$, $n = 10$) serrations. Lacinia with 21–28 ($\bar{x} = 25$, $n = 10$) retrorse teeth. Maxillary palpus brown. Sensory vesicle ovate, about ⅓ as long as its segment, positioned slightly proximal of middle; mouth small, centrally positioned, about ⅓ length of vesicle. Median proximal space of cibarium broadly U-shaped, with two, rounded, elevated groups of small denticles. Proepisternum and proepimeron pale brown. Postpronotal lobes pale brown. Scutum orange or dark brown-black, clothed in golden decumbent pile, and with four silvery blue longitudinal stripes; mediolateral pair of silvery blue stripes with light brown spot anteriorly and extended to concolorous posteriorly declivity; lateral pair extended along superalar region to posterior declivi-



Figs. 11–22. SEM micrographs of pupal gills. 11. *Simulium robynae* (male). 12. *S. notatum* (male). 13. *S. robynae* (female). 14. *S. notatum* (female). 15. *S. robynae* (male). 16–17. *S. trivittatum* (females). 18. *S. longithallum* (female). 19. *S. mediovittatum* (male). 20. *S. mediovittatum* (female). 21. *S. bivittatum* (female). 22. *S. venator* (female).

ty; stripe of background color (orange or brown-black) between mediolateral and lateral silvery blue stripes, when orange, usually with posteriormost portion dark brown; interface of orange or brown-black and silvery blue stripes ragged. Scutellum pale brown, with long, golden brown setae posteriorly. Anepisternum pale brown; anepisternal membrane pale brown. Katepisternum brown, with rich blue pollinosity. Mesepimeron pale brown, with golden tuft. Meron brown, with blue pollinosity. Anatergite and katatergite pale brown. Setae and spinules of basicosta golden. Setae and spinules of costa and radius brown distal to wing base. Stem vein with golden setae. Subcosta bare ventrally. Fringes of calypter and anal region pale, golden. Halter yellow, with stem pale brown. Legs bicolored, mostly pale yellowish brown with distal portions usually brown. Prothoracic leg with coxa, trochanter, femur, and tibia pale yellowish brown with golden setae; foretarsus dark brown-black, with dark brown setae. Mesothoracic leg similar to prothoracic one except coxa brown, basitarsus with proximal ⅚–⅘ yellow brown, and second tarsomere with distal ½ brown. Metathoracic leg similar to prothoracic one except femur with distal ⅕–¼ brown, distal ⅙–⅓ of tibia brown, and basitarsus with proximal ½ pale yellow brown. Claws simple. Abdominal segment I pale brown, fringed with long golden setae; abdominal tergite II with dark brown spot medially; abdominal tergites III–IV with dark brown median and one lateral spot per side; abdominal tergites V–VI with dark brown median and two lateral spots per side; lateral spots of tergites III–VI decreasing in size and increasing in distance from median spot posteriorly; abdominal tergites VII–IX shiny pale brown. Pleural region pale yellow brown. Genitalia: Figs. 30, 34. Genital fork with arms forming angle of approximately 90°; inner margin of proximal space with one, oval, flattened, expansion per side; anteriorly directed apodemes well sclerotized. Spermatheca ovoid, lacking noticeable sculpturing. Anal lobe with slender, anteromedially directed ventral process about ⅓ height of lobe; in ventral view, apices of anal lobes not crossed and posteromedian process digitiform. Cercus rounded.

Male.—Length: thorax, 1.0–1.2 mm ($\bar{x} = 1.1$, $n = 20$); wing 2.1–2.3 mm ($\bar{x} = 2.2$, $n = 20$). Not differing from female except as follows. Scutum matte black with two crescent-shaped silvery blue areas anteriorly, longitudinal silvery blue stripe along superalar region, and posterior declivity silvery blue; anterior silvery blue areas with pale brown anteromedian spot. Legs more uniformly brown. Setae of wing base (stem vein) brown. Abdomen: tergite II with circular, dark brown median spot and adjacent silvery area on each side; tergites III–V with large black rectangular spot medially; tergites V and VI each with silvery area lateral to median brown spot; tergite VI with square, dark brown median spot; tergites VII–IX each with rectangular, dark brown spot, that of tergite VII smallest. Genitalia: Figs. 39, 47, 53. Gonocoxa rectangular, slightly longer than wide. Gonostylus slightly shorter than gonocoxa, with large posterolateral flange and one stout spinule apically. Ventral plate in ventral view somewhat rectangular; plate in lateral view with arms directed upward, anterior margin slightly concave, middle of posterior margin roughly parallel to anterior margin, and lip narrowed apically and slightly upturned; plate in terminal view with lip rounded.

Lectotype—♂, slide-mounted. CALIFORNIA: (Fresno Co.), Fresno, May 12, 1923, M. E. Phillips (USNM).

Paralectotypes.—CALIFORNIA: (Fresno Co.), Fresno, 24 April 19?? (year unrecorded), A. E. Schwarz—1 ♂ (slide-mounted); Fresno, May 12 1923, M. E. Phillips—1 ♂ (slide-mounted) (USNM).

Additional material examined.—USA: CALIFORNIA: Fresno Co., Fresno, 4 June 1948, light trap, T. Raley—1 ♀; Riverdale, July 1948, T. Raley—1 ♀. (Kern Co.), Kern River Park, 1 July 1948, B. Bookman—3

♂, 1 ♀ (USNM). Bakersfield, about horses, 29 June 1959, Monji—2 ♀ (USNM). Merced Co., Snelling Ct., September 1947, Ed Smith—1 ♀; Merced River at Oakdale Rd., 18 km NW of Merced, 15 May 1993, J. K. Moulton—6 larvae, 1 ♂ & 1 ♀ w/exuviae; 19 May 1993, J. K. Moulton—6 larvae; 2 October 1993, J. K. Moulton—33 larvae, 8 pupae, 6 ♂ & 15 ♀ w/exuviae. (Riverside Co.), Riverside, 28 May 1945, A. L. Melander—3 ♀. San Joaquin Co., Mokelumne River at Bruella Rd., ca. 9 km NE of Lodi, 2 October 1993, J. K. Moulton—103 larvae, 33 pupae, 101 ♂ & 99 ♀ w/exuviae. Tulare Co., Visalia, 9 June 1969, W. D. Murray—4 ♀.

Remarks.—The series from which Dyar and Shannon (1927) described this species contained 15 adults. Of these, seven were designated as types. Four were females belonging to the subgenus *Hellichiella* (= paratypes) and three were males belonging to the subgenus *Psilopelmia* (= cotypes). The whereabouts of these females is unknown, but fortunately the males were deposited in the United States National Museum in Washington. Peterson (1993) designated one of these males as the lectotype.

This species is only known from California, where the immatures are common in medium-sized streams to large rivers. Collection data suggests this species may further be restricted to the San Joaquin Valley and southward. Trailing grasses and leaves are seemingly preferred as substrate, although rocks were the only suitable substrate at the Merced River site.

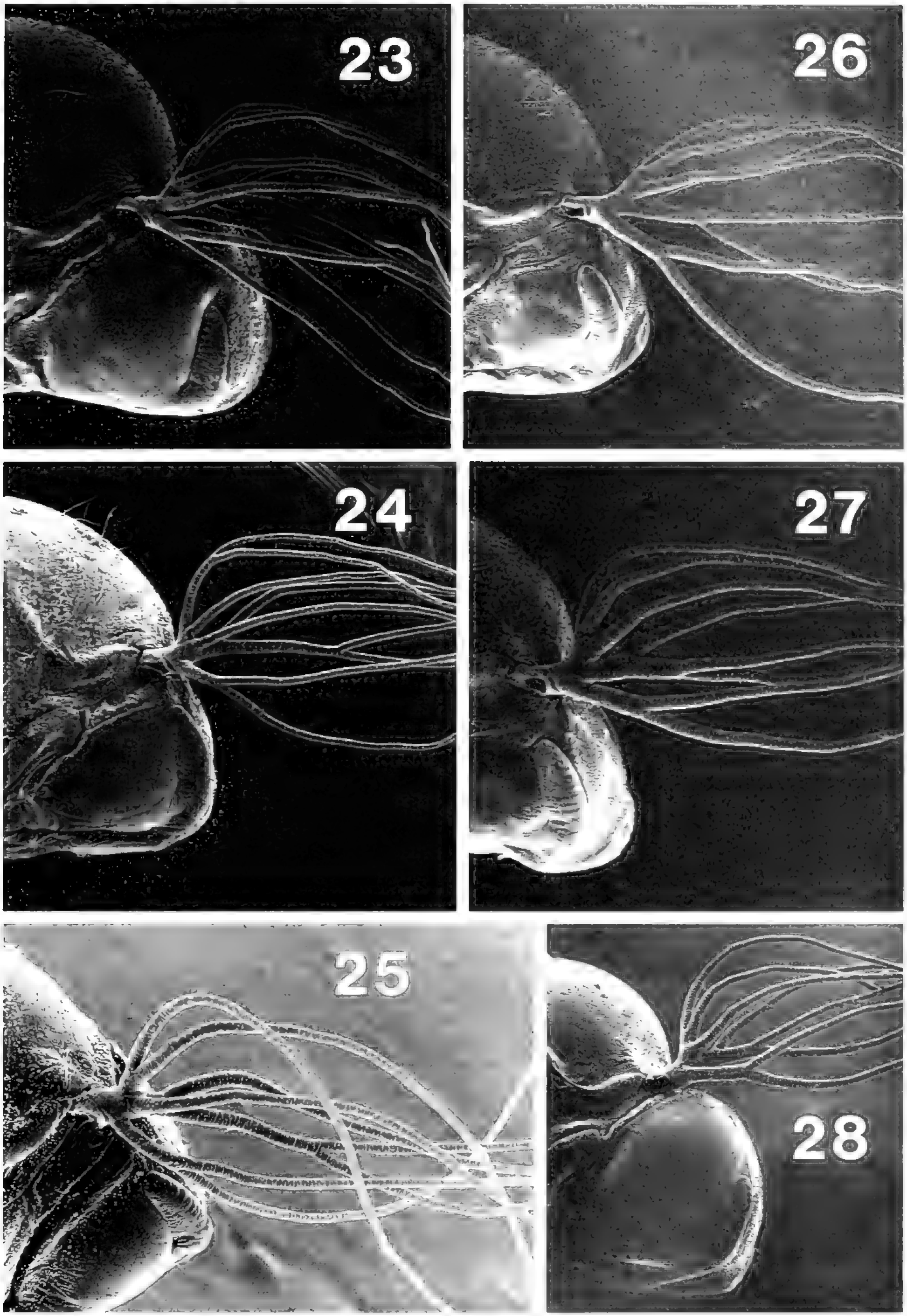
This species has been erroneously referred to as *S. trivittatum* on numerous occasions in the literature. The vast majority of these misidentifications are based upon field-collected females. The female scutum is variable in color and, depending upon the degree of darkness, resembles those of *S. bivittatum, S. longithallum,* and *S. trivittatum.* The latter two species are easily separated from *S. bivittatum* and *S. clarum* by terminalia characters. Orange females of *S. clarum* have blue scutal stripes whereas those of typical *S. bivittatum* have white stripes. Dark females of both species have blue stripes. Although I can find no obvious way to distinguish individual females of *S. clarum* from those of *S. bivittatum* with confidence, the key to females allows tentative separation based upon scutal coloration and geographic location of the specimens. Collections in California, and possibly Oregon, in which dark-colored females abound are at least predominately of this species.

The male closely resembles that of *S. bivittatum,* but differs slightly in several aspects as mentioned in the following key; males of this species, unlike *S. bivittatum,* were not observed to have orange scutum variants. This species is the only one in the subgenus with a gill of nine or ten filaments, although individuals with eight filaments are occasionally encountered. No other species treated in this work has strictly green and gray larvae when fixed in Carnoy's solution. The gray larvae typically have darker infuscation of the posterior half of the cephalic apotome than do the greenish ones. This color variation is not absolutely attributable to sexual dimorphism, although most gray larvae are males. Some, but not all, larvae have a distinct brown border surrounding the postgenal cleft.

Simulium (*Psilopelmia*) *griseum* Coquillett

Simulium griseum is widespread in lowland areas throughout most of the western United States and the prairie of Canada (Peterson 1993), where it is occasionally a pest of humans and large mammals (MacNay 1952, 1958; Undeen 1973; Jones et al. 1977). D. G. Mead (pers. comm.) observed numerous females of this species biting his ankles between 4:00 and 5:30 PM in Trail Canyon, Montezuma County, Colorado, on 11–12 August 1996.

The immature stages generally occur in siltier watercourses than other species in the subgenus and irrigation ditches are a typical habitat. All life stages after the egg resemble those of *S. notatum,* with only males



Figs. 23–28. SEM micrographs of pupal gills. 23–25, *Simulium clarum* (male, female, female). 26–28, *S. notatum* (female, female, male).

and, to a lesser extent, larvae being separable with confidence. Practically all larvae in the lone available collection of Carnoy's-fixed material of this species were creamy white; a few were very pale whitish green or gray. This is not the case for any other species of *Psilopelmia* treated herein except *S. robynae,* which also is represented by a single, though large collection. Similarly preserved larvae of *S. griseum* are needed from across its considerable range before the utility of this character can be fully ascertained.

Although females of this species and *S. notatum* are inseparable, I tentatively accept all southern California records of grayish green colored *Psilopelmia* females as being *S. griseum* since males of this species have been confirmed from there. This region is the most likely place where these species may be sympatric.

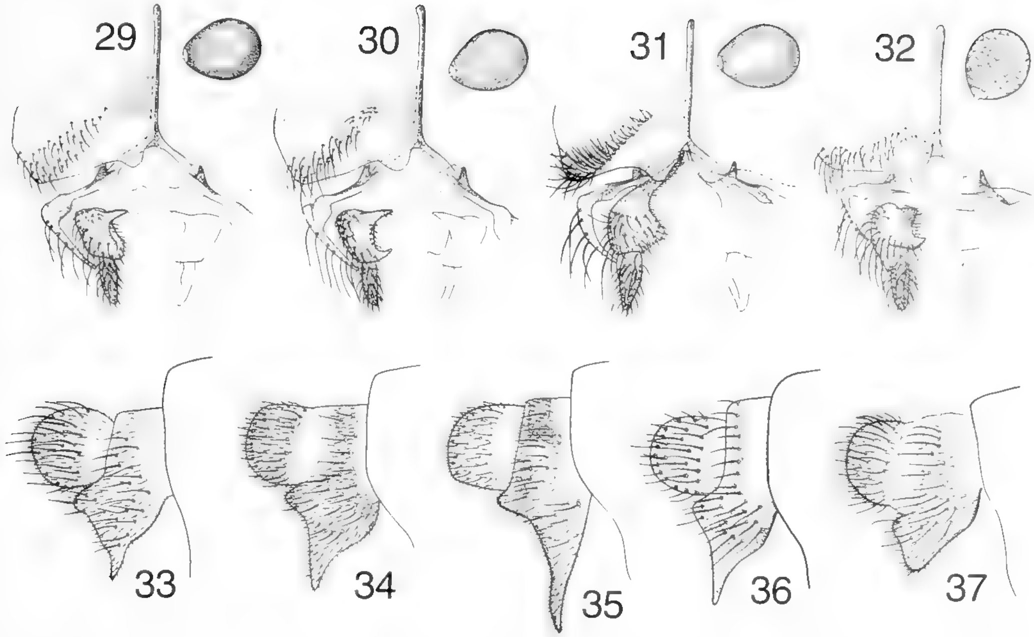
The male ventral plate of *S. griseum* as rendered in Figures 25a and 299a in Peterson (1993) and Peterson and Kondratieff (1995), respectively, is atypical in that it is more squared than normal, which makes it look much like that of *S. venator.* The illustrations of the female terminalia in ventral view, Figures 26a and 300a in Peterson (1993) and Peterson and Kondratieff (1995), respectively, may not be those of *S. griseum* and are possibly those of either *S. bivittatum* or *S. clarum*; this hypothesis is based upon the pointed rather than squared posteromedian process of the anal lobe that characterizes females of this species and *S. notatum.* Unfortunately, the terminalia of the holotype female of *S. griseum* are missing and presumed lost (Holly Williams, personal communication).

Material examined.—CANADA: ALBERTA: Milk River, 4 July 1964, G. C. & D. M. Wood—13 ♂ & 14 ♀ w/exuviae (CNC). USA: CALIFORNIA: Imperial Co., Palo Verde, 8 April 1949, W. W. Wirth—1 ♀ (USNM); Laguna Lake, 10 June 1950, J. N. Belkin—2 ♀ (USNM). Riverside Co., Blythe, 1 May 1947, A. L. Melander—1 ♀ (USNM). Blythe, 20 May 1950—2 ♂, 3 ♀ (USNM). San Bernadino Co., Vidal, light trap, April 1948, R. W. Coleman—3 ♀ (USNM). NEW MEXICO: (Dona Ana Co.) Las Cruces, 12 June 1950, R. H. Beamer—1 ♀ (USNM); Las Cruces, 12 August 1962, C. P. Hibler—1 ♀ (USNM); Radium Hot Springs, Las Cruces, ex. horse, 29 July 1972, USDA—1 ♀ (USNM). Rio Grande at Rt. 28, ca. 10km S of Las Cruces, 16 March 1993, J. K. Moulton—58 larvae, 1 pupa. Taos Co., Rio Grande, 6 July 1953, W. W. Wirth—1 ♀ (USNM). Valencia Co., irrigation canal off of Rio Grande River near Los Lunas, 7 June 1995, J. K. Moulton—25 larvae, 30 ♂ & 22 ♀; ex. horses, 8 June 1995, M. Schmidtmann, G. Hunt, D. Mead, J. K. Moulton—18 ♀. UTAH: (Daggett Co.), Manilla, 5 September 1939, G. F. Knowlton & F. C. Harmston—1 ♀ (USNM). Duchesne Co., Myton, 2 July 1963, G. C. & D. M. Wood—1 ♂ & 3 ♀ w/exuviae (CNC). (San Juan Co.), San Juan River, Bluff, 30 August 1942, G. F. Knowlton—2 ♀ (USNM). (Sevier Co.), Richfield, 21 September 1929, David E Fox—1 ♀ (USNM). Elsinore, 5 October 1929, David E. Fox—1 ♀ (USNM).

Simulium (*Psilopelmia*) *labellei* Peterson

Mature larvae are tentatively separable from other species treated herein by the number of hooklet rows in the posterior proleg (>110 rows versus <100 rows in the other species). Pupae can be confused only with those of *S. robynae,* which also have an exaggerated angle at the cephalothoracic junction. Slight chaetotaxonomic differences allow separation of these closely related, sympatric species. The adults are separated from *S. robynae* by their larger size and gray, rather than orange-brown, scutum. No significant genitalic differences were detected between this species and *S. robynae.* This species is apparently restricted to southernmost Texas and adjacent Mexico. It possibly undergoes a single generation during mid-winter, as material is only known from December through April.

Material examined.—USA: TEXAS:



Figs. 29–37. Female terminalia (29–32 = terminalia in ventral view; 33–37 = right anal lobe and cercus in lateral view). 29, *Simulium notatum*. 30, *S. clarum*. 31, *S. longithallum*. 32, *S. mediovittatum*. 33, *S. notatum*. 34, *S. clarum*. 35, *S. longithallum*. 36, *S. venator*. 37, *S. mediovittatum*.

Presidio Co., Presidio, 12 January 1949—3 ♂, 4 ♀ (paratypes); Presidio, 12 January 1944, 1 ♂ (paratype). MEXICO: 13 January 1940—1 ♂ (paratype).

Simulium (*Psilopelmia*) *longithallum* Díaz Nájera and Vulcano
(Figs. 3, 4, 9, 18, 31, 35, 40, 45, 49, 55)

Larva.—Length 4.3–5.8 mm ($\bar{x}$ = 5.2, *n* = 20). Not differing from that of *S. clarum* except as follows. Body coloration variable, ranging from pale green, gray, purple, to reddish brown with pale whitish, intersegmental areas. Head capsule (Figs. 3, 4) pale brown. Frontoclypeal apotome with varying amounts and degrees of infuscation posteriorly, contrasting sharply from pale whitish yellow headspots. Antenna mostly dark brown, noticeably darker than stalk of labral fan; segment I pale yellowish brown; segment II dark brown except for distal end; segment III entirely dark brown. Labral fan with 32-36 primary rays ($\bar{x}$ = 32, *n* = 20). Area between hypostoma and postgenal bridge (as in Fig. 4) noticeably paler than surrounding portion of head capsule, forming an oval to round spot. Posterior proleg bearing 10–13 hooks in 67–73 rows.

Pupa (Fig. 9).—Length 2.3–3.4 mm ($\bar{x}$ = 2.8, *n* = 20). Not differing from that of *S. clarum* except as follows. Gill (Fig. 18) 0.9–1.25 times length of pupa, comprised of 8 filaments branching 2+1, 2+1, 1+1; dorsal two groups of three filaments branching distal to gill base on swollen petiole approximately 2.5–3.0 times diameter of ventral petiole bearing two filaments.

Female.—Length: thorax, 0.9–1.2 mm ($\bar{x}$ = 1.0, *n* = 20); wing, 2.0–2.8 mm ($\bar{x}$ = 2.5, *n* = 20). Not differing from that of *S. clarum* except as follows. Mandible with 32–44 ($\bar{x}$ = 38, *n* = 10) serrations. Lacinia with 21–27 ($\bar{x}$ = 23, *n* = 10) retrorse teeth. Scutum orange-brown to dark brown-black, clothed with golden decumbent pile, and with four longitudinal silvery blue (rarely silvery yellow) stripes extended length of scutum forming a median and a pair of mediolateral stripes of orange-black; one pair of longitudinal silvery blue stripes bordering the superalar region; the other pair separating median and mediolateral stripes; mediolateral stripes reaching posterior declivity; median stripe not reaching posterior declivity. Scutellum pale yellow brown, with long, golden setae posteriorly. Anepisternum and anepimeron brown, with faint blue pollinosity. Katepisternum and katepimeron dark brown, with faint blue pollinosity. Meron brown, with faint blue pollinosity. Prothoracic tibia with distal ⅕ dark brown with brown setae. Abdominal tergite II with dark brown median spot and one faint brown dorsolateral spot per side; abdominal tergites III–VI with dark brown median spot and 2 accompanying dorsolateral spots per side, lateralmost dorsolateral spot smaller than the other; abdominal tergite VII with 2 dorsolateral spots per side. Abdominal dorsum and pleural region clothed with brown setae. Genitalia: Figs. 31, 35. Anal lobe with slender, ventral, digitifom process that is as long as height of lobe; apices of lobes crossed in ventral view.

Male.—Length: thorax, 0.9–1.1 mm ($\bar{x}$ = 0.9, n = 20); wing 2.0–2.6 mm ($\bar{x}$ = 2.3, n = 20). Not differing from female except as follows. Scutum with black stripes slightly wider than silvery blue stripes. Prothoracic leg with distal ¼ of tibia dark brown. Meso- and metathoracic thoracic legs with trochanter brown. Metathoracic leg with femur almost entirely brown and tibia with distal ½ brown. Genitalia: Figs. 40, 45, 49, 55. Gonostylus with large posterolateral flange. Ventral plate in ventral view somewhat squared, with prominent, anteriorly directed flange; plate in lateral view with prominent, gently sloped anterior margin (lip) and nearly vertical posterior margin; plate in terminal view with lip roughly triangular.

Material examined.—USA: ARIZONA: Cochise Co., San Pedro River at Rt. 90, 6 May 1991, C. A. Olson—1 larva; 17 January 1992, E. W. Cupp & F. Ramberg—3 pupae, 1 ♀ w/exuviae; 2 February 1992, E. W. Cupp & F. Ramberg—2 exuviae; 14 June 1992, J. K. Moulton—1 ♂ w/exuviae; 14 November 1992, J. K. Moulton and D. G. Mead—117 larvae, 19 pupae, 12 ♂ & 18 ♀ w/exuviae; 28 April 1993, J. K. Moulton—3 larvae. Gila Co., Coon Creek at Cherry Creek Rd. off Rt. 388, 13 May 1993, J. K. Moulton—436 larvae, 36 pupae, 44 ♂ & 37 ♀ w/exuviae.

Remarks.—This species is closely related to a host of other species in the group, especially *S. escomeli* Roubaud, *S. gonzalezherrejoni* Díaz Nájera, and *S. trivittatum* Malloch. These species are characterized by the dark antennae of the larva, the long ventral projection of the female anal lobe, and the pronounced anterodorsal flange of the ventral plate and posterolateral flange on the gonostylus of the male. On the basis of the unique structure of the pupal gill, the sister species of *S. longithallum* is *S. gonzalezherrejoni.*

Previously, this species was known only from Morales and Guadalahara, Mexico (Díaz Nájera and Vulcano 1961; Coscarón et al. 1995). It is now known from two streams in the United States, the San Pedro River and Coon Creek, which are located in the southeastern and eastcentral portions of Arizona, respectively. The San Pedro River is moderately fast flowing, has a bottom of sand and silt and trailing green vegetation, and is approximately 2–5 m in width and 0.5 m in depth, except following periods of heavy rain. Coon Creek is slightly narrower and shallower, is strewn with rocks, and has little trailing green vegetation.

Large numbers of immatures of this species occur in the San Pedro River by November, when it is the dominant simuliid species. The population remains fairly stable through February, but by April or May it dwindles considerably. During the heat of late summer and early autumn, typically June through October, this species all but disappears from the San Pedro River. This phenomenon also appears to occur in Coon Creek although not as pronounced. The immatures seem to prefer trailing green vegetation as substrate but will attach to sticks and rocks. This species probably overwinters as eggs or larvae in Coon Creek but apparently has continuous development through the winter in the San Pedro River.

Simulium (*Psilopelmia*) *mediovittatum* Knab
(Figs. 19, 20, 32, 37, 43, 51, 57)

Simulium mediovittatum is most closely related to *S. dugesi* and *S. ochoai,* neither of which have not been reported north of Mexico. The pupa of *S. mediovittatum* is separated from those of species treated in this work with similarly shaped gills by the middle group of gill filaments branching 2+1 rather than 1+2. The female is immediately separated from all North American species by the light gray scutum with its median red-brown to black stripe. The male is separated from all other species with a predominantly black scutum by the silvery blue stripes tapering much more dramatically as they meet the posterior declivity. This species is not known to occur anywhere in the United States other than southcentral Texas.

Material examined.—TEXAS: Kinney Co., Pinto Creek at US Rt. 90, E of Del Rio, 18 March 1992, J. K. Moulton—7 larvae, 9 pupae, 6 ♂ and 14 ♀ w/exuviae.

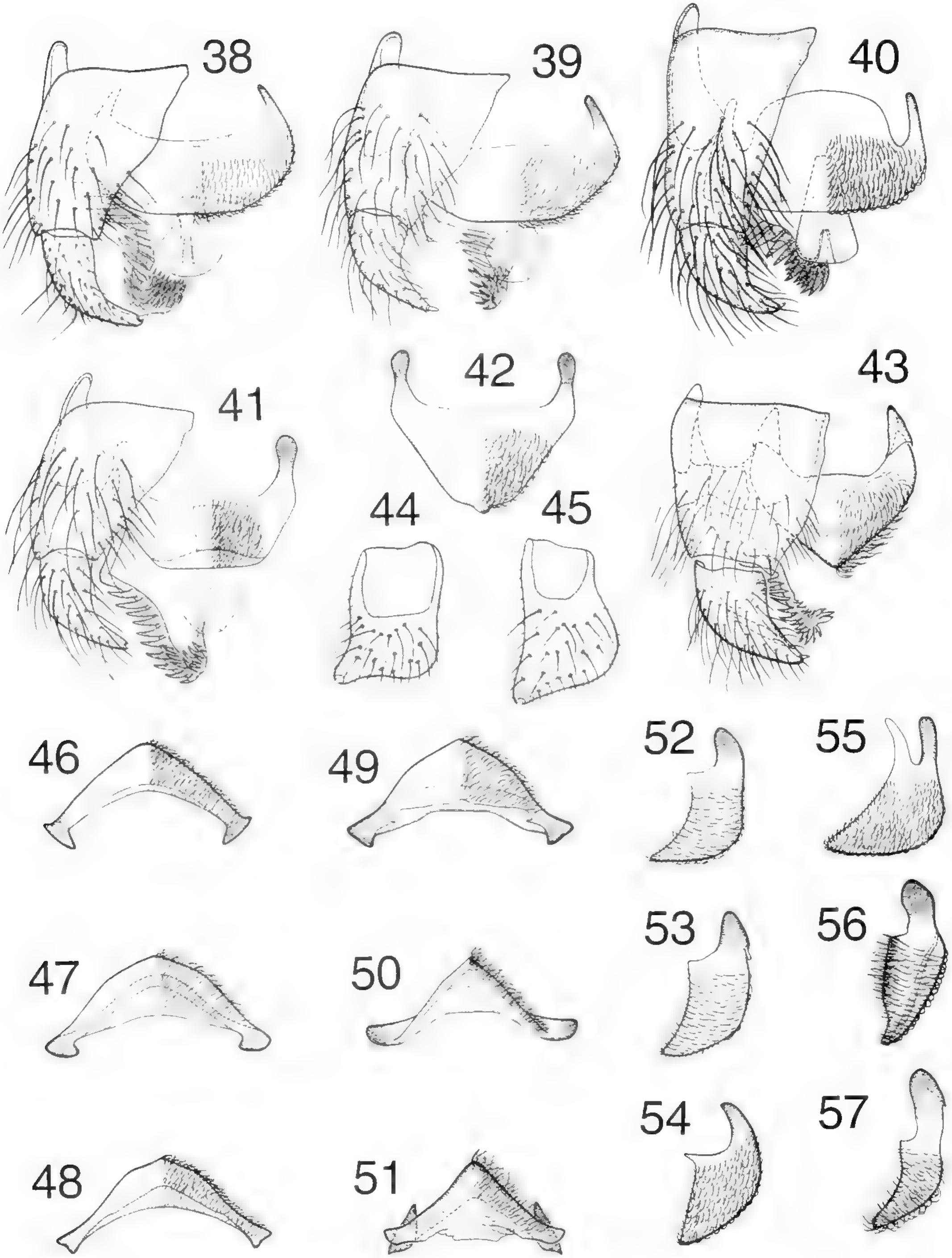
Simulium (*Psilopelmia*) *notatum* Adams
(Figs. 5, 6, 10, 26–28, 29, 33, 38, 44, 46, 52)

Simulium (*Psilopelmia*) *griseum* Peterson 1993: 34 (*nec* Malloch 1914), in part (AZ records)

Larva.—Length 4.3–5.5 mm (x̄ = 5.0, n = 20). Not differing from that of *S. clarum* except as follows. Body coloration variable, ranging from pale green, gray, purple, to reddish brown with distinct, pale whitish intersegmental areas. Testes of male dark, clearly evident through integument. Headspot pattern (Fig. 5) negative, usually very faint; sometimes only discernible infuscation a pair of semicircular spots immediately adjacent to area between anteromedian and posteromedian headspots. Labral fan with 48–55 primary rays (x̄ = 52, *n* = 20). Postgenal cleft (Fig. 6) oval, sometimes slightly pointed apically, and extended ⅓ distance to hypostomal groove; width of postgenal cleft variable, ranging from about as wide as long to 1.3 times longer than broad. Posterior proleg bearing 11–15 hooks in 75–82 rows.

Pupa (Fig. 10).—Length 2.3–2.8 mm (x̄ = 2.5, *n* = 20). Not differing from that of *S. clarum* except as follows. Gill (Figs. 26–28) ⅔–¾ length of pupa, comprised of eight filaments branching 2+1, 1+2, 1+1; dorsalmost pair of filaments arising from short petiole, not widely separated from lone filament arising at their base; median group of filament comprised of a strongly arched dorsal filament usually hidden behind proximal filament of dorsal trio and that arises basally from a petiolate pair that bifurcate approximately at midlength of gill; petiole of median pair of filaments distal to lone filament slightly sinuous and directed anteriorly or only slightly downward; ventral pair of filaments branching along proximal ⅛ of gill's length. Abdominal tergite II with 5–6 strong, distinctly noticeable setae per side.

Female.—Length: thorax, 0.9–1.2 mm (x̄ = 1.1, *n* = 20); wing, 2.1–2.6 mm (x̄ = 2.4, *n* = 20). Not differing from that of *S. clarum* except as follows. Mandible with 38–45 (x̄ = 40, *n* = 10) serrations. Lacinia with 24–28 (x̄ = 26, *n* = 10) retrorse teeth. Scutum color variable, ranging from bright orange to orange-brown with two thin, pale white longitudinal, stripes on either side of orange-brown median stripe that is slightly darkened anteriorly to gray with two thin, pale beige longitudinal stripes on either side of dark brown-black median stripe; scutum clothed in golden decumbent pile; anteriormost portion of scutum medial to postpronotal lobes pale brown, continuing as



Figs. 38–57. Male terminalia (38–41, 43 = ventral view, left gonostylus removed; 44–45 = right gonostylus, dorsal view; 46–51 = ventral plate in terminal view; 52–57 = ventral plate in lateral view). 38, *Simulium notatum.* 39, *S. clarum.* 40, *S. longithallum.* 41, *S. venator.* 42, *S. venator* (ventral plate alone). 43, *S. mediovittatum.* 44, *S. bivittatum.* 45, *S. longithallum.* 46, *S. notatum.* 47, *S. clarum.* 48, *S. bivittatum.* 49, *S. longithallum.* 50, *S. venator.* 51, *S. mediovittatum.* 52, *S. notatum.* 53, *S. clarum.* 54, *S. bivittatum.* 55, *S. longithallum.* 56, *S. venator.* 57, *S. mediovittatum.*

stripe that borders superalar area along entire length of scutum. Scutellum with long, golden setae posteriorly. Mesothoracic tarsomeres with distal ⅓ brown. Metathoracic femur with distal ⅕–¼ brown. Genitalia: Figs. 29, 33. Anal lobe in ventral view with posteromedian process squared.

Male.—Length: thorax, 0.8–1.1 mm ($\bar{x} = 1.0$, $n = 20$); wing, 1.8–2.5 mm ($\bar{x} = 2.2$, $n = 20$). Not differing from that of *S. clarum* except as follows: Scutum matte black (rarely orange), bordered laterally and posteriorly with iridescent silvery blue; black area with pair of large, anterior, triangular, iridescent coppery blue-green areas that are broadly contiguous anteriorly with iridescent lateral areas and extended to just short of posterior declivity. Genitalia: Figs. 38, 44, 46, 52. Ventral plate roughly rectangular: plate in lateral view with anterior margin moderately concave and lip narrowed terminally; lip in terminal view inverted V-shape with blunt apex.

Material examined.—USA: ARIZONA: Cochise Co., San Pedro River at Rt. 80 near St. David, 21 November 1992, J. K. Moulton—2 larvae, 2, pupae, 1 ♂ & 2 ♀ w/exuviae; SPR at Rt. 90, ca. 14 km east of Sierra Vista, 28 April 1993, J. K. Moulton—numerous larvae (mixed with *S. bivittatum*), 12 pupae, 55 ♂ & 67 ♀ w/exuviae. Gila Co., San Carlos River at Rt. 103, ca. 2 km NE of Peridot, 5 September 1992, J. K. Moulton—133 larvae, 52 pupae, 32 ♂ & 30 ♀ w/exuviae. Coolidge Dam Area, 3 December 1937, C. C. Deonier—4 ♀ (USNM). Pinal Co., Aravaipa Creek at Aravaipa Rd., 11 July 1993, J. K. Moulton—497 larvae, 9 pupae; 18 October 1992, J. K. Moulton—173 larvae; Gila River at Winkleman, 5 September 1992, J. K. Moulton—78 larvae, 25 pupae, 37 ♂ & 43 ♀ w/exuviae. Santa Cruz Co., Nogales, no host trap, 10 March 1961, Allen—1 ♀ (USNM). Yavapai Co., Santa Maria River at Rt. 93, July 1993, J. K. Moulton—213 larvae, 27 pupae, 57 ♂ & 54 ♀ w/exuviae.

Remarks.—*Simulium notatum* is a common species in small to large, fast flowing streams and rivers of southern Arizona. It is probable that *S. notatum* ranges into northern Mexico. The immatures seem to prefer trailing vegetation for substrate, but rocks are used when such substrate is lacking. The Gila River at Winkleman, San Carlos River near Peridot, and Aravaipa Creek near the Aravaipa Canyon Wilderness Area, are nearly pure populations *S. notatum*, with *S. bivittatum* a rare cohabitant. Further upstream in the Gila River, however, in Catron County, New Mexico, *S. bivittatum* is the only species of *Psilopelmia* present. *Simulium argus* and *S. encisoi* are the other dominant simuliids in these streams. Aravaipa Creek is the opposite to the Gila River in that *S. notatum* is practically the only species of *Psilopelmia* in the upper reaches of the stream, whereas *S. bivittatum* is the dominant species in the lower reaches.

The immatures are creamy green-gray or red banded in the field and when freshly fixed, but many become brilliant purple with thin intersegmental areas after 2–3 weeks in Carnoy's solution. Larvae have a variable, negative headspot pattern and cannot be separated from those of several species unless mature. The pupa is separable from that of *S. bivittatum*, the only consubgeneric species with which it is known to be associated, by the structure of the gill. If additional collecting demonstrates association with *S. griseum* (most likely in eastern CA or western NM) then these pupae will not be separable.

Simulium notatum most closely resembles *S. griseum*, which was evident to Adams (1904) when he described it. The colors of the male scutum are consistently different from those of *S. griseum*, although the underlying pattern is very similar. Occasionally, the typically black median stripe of males of *S. notatum* is orange. Males of *S. venator* also sometimes have a wide orange median stripe, but the areas lateral to it are black rather than iridescent coppery blue-green as in *S. notatum*. Greased males of *S. notatum* superficially resemble those of *S. venator*, but these specimens can easily be separated using the ventral plate. The terminalia of both sexes of *S. notatum* and *S. griseum* are inseparable. When fixed in Carnoy's solution, larvae of *S. notatum* range from green to brilliant purple, whereas those of a nearly sympatric population of *S. griseum* are pale, creamy white. Mature larvae of *S. notatum* have 75–83 rows of hooklets in the posterior proleg, whereas those of *S. griseum* have fewer than 60 (Peterson 1993). Females and pupae of *S. notatum* are inseparable from those of *S. griseum.* Very cursory cytological observations show differences among the two species (P. H. Adler, pers. comm.), however, the samples were small and the populations geographically disjunct. Directed heteroduplex analysis using partial mitochondrial gene sequences (Tang et al. 1997) and partial nucleotide sequences of ND4 (K. Pruess, in litt.) from several related species of *Psilopelmia* clearly differentiate *S. notatum* and *S. griseum.* Based upon these differences, *S. notatum* is recognized as a valid species. Nothing is known about the feeding habits of females of this species other than presumably they are not frequent human biters.

Simulium (*Psilopelmia*) *robynae* Peterson
(Figs. 11, 13, 15)

The sharp angle of the cephalothoracic region and exaggerated, humpbacked scutum separates the pupa and adults, respectively, from all others except those of *S. labellei.* Pupae of the two species can be separated by slight chaetotaxonomic features. The adults of *S. robynae* are orange to brown whereas those of *S. labellei* are gray.

This species breeds in the lower reaches of the Rio Grande River system of Texas and adjacent Mexico. Large numbers of larvae and pupae were found on trailing vegetation and filamentous algae in the Rio Grande River in March 1993. In 1895, large numbers of females of this species were observed attacking a horse in the Mesilla Valley of New Mexico (Cockerell 1897). No other incidents of this nature had been or have been reported since.

Material examined.—USA: TEXAS: Brewster Co., Rio Grande at Big Bend National Park nr. Hot Springs area, 17 March 1993, J. K. Moulton—123 larvae, 31 pupae, 16 ♂ & 27 ♀ w/exuviae.

Simulium (*Psilopelmia*) *trivittatum* Malloch
(Figs. 16, 17)

The larva of this species is separable from those of all other North American relatives, except *S. longithallum,* by the dark antennae. The region between the postgenal cleft and hypostoma is concolorous with the remainder of the head capsule in this species, whereas it is notably paler in larvae of *S. longithallum.* Pupae of this species typically have gills of 6 filaments, but individuals with 7 and 8 filaments are not uncommon. It is quite possible *S. bobpetersoni* Coscaron, Ibanez-Bernal, and Coscaron-Arias is synonymous with *S. trivittatum,* and the difference in gill filament number, 8 versus 6, which is one of the primary differences between the two forms, represents a cline in which southern populations have a greater number of individuals with eight-filamented gills.

The distribution of *S. trivittatum* is more restricted than previously thought. The Arizona records are based upon males of *S. argus,* and the California records are based upon males of *S. argus* and males and females of *S. clarum.* At least one of the New Mexico records (Catron County) listed in Peterson (1993) is also based on males of *S. argus.* Since all life stages after the egg were present in the collection from Eddy County, this record is considered valid. The Oklahoma record listed in Peterson (1993) remains unconfirmed, but *S. trivittatum* is known from the Honey Creek area (Reisen 1974, 1975a, 1975b, 1977). This species is not as serious of a pest as the literature would indicate because all such reports actually refer to *S. clarum.*

Material examined.—USA: TEXAS:

Kinney Co., Pinto Creek at US Rt. 90, E of Del Rio, 18 March 1993, J. K. Moulton—77 larvae, 500+ pupae (89 w/7 filaments, 60 w/8 filaments), 200+ ♂ & 200+ ♀ w/exuviae.

Additional material examined (= misidentifications of *Simulium* (*Psilozia*) *argus* Williston).—ARIZONA: (Cochise Co.), S. W. Res. Sta., 5 mi SW of Portal, 5400 ft., Malaise trap, June 1967, C. W. Sabrosky—2 ♂ (USNM). (Pinal Co.), Superior, 13 April 1935, A. L. Melander—2 ♂ (USNM). NEW MEXICO: Catron Co., Whitewater Cyn., Malaise trap, 1 June 1972, W. W. Wirth—3 ♂ (USNM).

Simulium (*Psilopelmia*) *venator*
Dyar and Shannon
(Figs. 22, 36, 41, 42, 50, 56)

The larva of this species is not reliably separated from those of other species treated herein. The pupa most closely resembles that of *S. bivittatum* in that the petiolate pair in the middle group of gill filaments is directed anterodorsally, but a subtle difference in the thickness of the petiole of the dorsal group of filaments provides a means for their separation. Females are easily separated from those of all other species by the median stripe of the scutum and prominent, ventrally directed projection of the anal lobe.

The vast majority of females of *Simulium venator* from west of the Sierra Nevada Mountains have a black median stripe, whereas most of those from east of there have an orange median stripe. When orange-striped females are cleared in hot lactic acid, the underlying cuticle is lightly colored and a pair of widely separated dark stripes are evident. When black-striped females are cleared, three dark stripes are evident. Other than these correlated characters, I cannot find any significant differences between these populations. Without more convincing evidence, I hesitate to recognize more than a single species here especially since the type specimens of both *S. beameri* and *S. venator* are black-striped females. The median stripe of female *S. mediovittatum* also varies from red-orange to brown-black. The sparse number of reports indicate this species is not serious pest.

Males are similar to those of *S. bivittatum* and *S. clarum*, but the silvery blue markings on the scutum are longer in the latter species and their ventral plates noticeably more rectangular. The ventral plate of *S. venator* varies considerably when viewed ventrally. When the ventral lip is tilted dorsally (Fig. 41), the plate appears somewhat squared, whereas when directed ventrally (Fig. 42), the plate has a pronounced truncate anterior margin with a small, terminal nipple-like projection. Figure 76a in Peterson (1993) and Figure 315a in Peterson and Kondratieff (1995) is intermediate on the continuum between these two extremes. Figures 76b and 315b in Peterson (1993) and Peterson and Kondratieff (1995), respectively, do not clearly show the concavity just anterior (towards the ventral plate arms) to the apex of the ventral lip, a diagnostic feature of the ventral plate of this species when this structure is viewed laterally.

Material examined.—USA: CALIFORNIA: Inyo Co., Cottonwood Creek, 29 May 1970, C. L. Hogue—20 ♀, 12 ♂ (LACM). Glacier Lodge, 10 June 1968, S. M. Hogue & R. L. Penrose—13 ♀. Lone Pine Creek, 30 May 1963, Eric Fisher - 20 ♀ (LACM). Saline Valley, Salt Lake, 1060′, site 7, 1 July 1976, D. Giuliani—1 ♂ (LACM). Near Owens Lake, swarm on car at dusk, 9 July 1984, Dave Heyward—3 ♂ (USNM). San Bernadino Co., Sp. [Spring] Valley Lake, 4 mi. SE of Victorville, 4 May 1977, L. A. Lacey—1 ♀ (USNM). IDAHO: Elmore Co., Glenns Ferry, 10 May 1933, David E. Fox—7 ♀ (UID). 7 mi S of Sunnyside, 18 July 1967, L. S. Hawkins, Jr.—2 ♂ (UID). Franklin Co., Dayton Cyn., 16 June 1970—6 ♀ (UID); Treasureton Res., 17 June 1970, W. F. Barr—1 ♂ (UID). Gooding Co., 5 mi SW of Tuttle, 18 July 1957, R. A. Mackie—1 ♂ (UID); 6.5 mi. N of Gooding, 8 September 1964, W. F. Barr—1 ♂ (UID); 6

mi. E of Gooding, 11 June 1974, J. K. Wangberg—3 ♀. Owyhee Co., 5 mi. N of Murphy, 4 August 1955, W. F. Barr—1 ♀ (UID); Indian Cove, 13 September 1965, A. R. Gitting—4 ♂ (UID). (Twin Falls Co.), Twin Falls, wind vane trap, pole 27, trap 3, 9 September 1932—1 ♀ (UID). Castleford, 16 July 1929, Beets—1 ♀ (UID). (Washington Co.), Weiser, 2 September 1940, F. C. Harmston—1 ♀ (CNC). NEVADA: Elko Co., Elko, 27 June 1983, R. C. Bechtel—1 ♀ (UID). Humboldt Co., Golconda, 2 July 1963, R. C. Bechtel—1 ♀ (UID); Golconda, CO2-octanol trap 2, 12–13 July 1995, R. Gray—48 ♀. Winnemucca 31 May 1958, T. R. Haig—2 ♂ (USNM); 5 mi N of Winnemucca, 11 June 1976—2 ♀ (USNM). Lander Co., Battle Mtn., Muleshoe Bridge, 12 August 1995, R. D. Gray—17 larvae, 9 pupae. (Washoe Co.), Reno, 7 October 1915, H. G. Dyar—1 ♀ (USNM); 7 July 1916, H. G. Dyar—1 ♀ (holotype). OREGON: Baker Co., Dixie, 2 September 1940, F. C. Harmston—8 ♂, 4 ♀ (USNM). Snake River above Huntington, 13 December 1946, J. E. Davies—2 ♂, 1 ♀; 10 mi. S of Huntingdon, 12 September 1949, J. E. Davies—3 ♂, 3 ♀ (USNM). UTAH: (Cache Co.), Richmond, 13 June 1958, Keith C. Tilley—1 ♀ (CNC). Grand Co., Harley Dome, 13 August 1958, W. L. Nutting—1 ♀, 2 ♂ (UAZ). WYOMING: (Sublette Co.), Pinedale, W. L. Jellison—2 ♀ (USNM).

KEYS TO SPECIES OF *SIMULIUM* (*PSILOPELMIA*) of America North of Mexico

Pupae

1. Head and anterodorsum of thorax disjunct, their intersection forming an angle of nearly 90 degrees (Figs. 11, 13, 15) 2

– Head and anterodorsum of thorax more continuous, gradually sloping in lateral view (Figs. 12, 14) 3

2. Thorax with a multibranched trichome just posterior to base of respiratory organ and 2 fan-like (more than 6 rays) and 1–3 simple trichomes per side anteriorly . . . . *labellei*

– Thorax without multibranched trichome just posterior to base of respiratory organ; anterior row of multibranched trichomes with 5 or fewer branches . . . . *robynae*

3. Gill of 6 (rarely 7 or 8) filaments, with middle pair or trio of filaments arising from long petiole (Figs. 16, 17) . . . . *trivittatum*

– Gill of 8–10 filaments, with middle trio of filaments arising from short petiole (Figs. 11–15, 18–28) 4

4. Dorsal and median groups of filaments arising from long, swollen trunk that is at least twice width of ventral petiole (Fig. 18) . . . *longithallum*

– Dorsal and median groups of filaments not arising from swollen trunk (Figs. 11–17, 19–28) 5

5. Median group of filaments branching 2+1 (Figs. 19, 20) . . . . *mediovittatum*

– Median group of filaments branching 1+2 or 2+2 (Figs. 11–15, 21–28) 6

6. Gill of 8 filaments; middle group of filaments with petiolate pair directed anteroventrally (Figs. 21, 22) 7

– Gill of 8–10 filaments; middle group of filaments with petiolate pair (lower pair if 2+2) directed anteriorly (Figs. 23–28) 8

7. Gill filaments, especially the dorsalmost group, slightly swollen basally; middle group of filaments with proximal filament directed anteriorly (Fig. 21) . . . . *bivittatum*

– Gill filaments consistently thin in diameter; middle group of filaments with proximal filament usually slightly arched anterodorsally (Fig. 22) . . . . *venator*

8. Gill of 8–10 (usually 9 or 10) filaments (Figs. 23–25); tergite II with weakly sclerotized, pale setae. Known only from CA . . . . . *clarum*

– Gill of 8 filaments (Figs. 26–28); tergite II with strong dark setae. Widespread in W Nearctic (combined distribution) . . . . . . *griseum, notatum*

Females

1. Thorax, in lateral view, strongly arched, its anterior face nearly perpendicular to top of head (Figs. 110, 112 in Peterson 1993). . . . 2

– Thorax, in lateral view, not strongly arched, its anterior face forming an obtuse angle with top of head 3

2. Scutum orange-brown or at least trimmed with orange-brown . . . . *robynae*

– Scutum entirely dark gray-black . . . . . . *labellei*

3. Scutum lacking well defined stripes, varying from dull yellowish-orange with very thin, pale beige longitudinal stripes to gray with faintly visible brown to dull black median stripe anteriorly. Anal lobe in ventral view with postero-median process squared (as in Fig. 29) . . . . *griseum, notatum*

– Scutum with distinct median stripe or with seven stripes of alternating color, either orange or brown-black and silvery white-blue. Anal lobe in ventral view with posteromedian process digitiform (as in Figs. 30, 32) to broadly triangular (as in Fig. 31) 4

4. Scutum with single reddish brown or black median stripe 5

– Scutum with three orange-brown to black stripes against silvery white-blue background 6

5. Scutum gray, with thin dark red-brown to black median stripe. Anal lobe with spiniform process (Fig. 36) . . . . *venator*

– Scutum orange-brown with thin dark red-brown to black median stripe. Anal lobe with short, blunt ventral process (Fig. 37) . . . . *mediovittatum*

6. Process of anal lobe spiniform, its length three times its basal width (Fig. 35). Scutum with median stripe reaching posterior declivity of scutum. Katepisternum with faint blue pollinosity 7

– Process of anal lobe blunt or spiniform, its length equal to its basal width (Figs. 33, 34, 36). Scutum with median stripe not reaching posterior declivity. Katepisternum with considerable blue pollinosity 8

7. Known from southeastern AZ south to Jalisco and Morales, Mexico . . . . *longithallum*

– Known from Oklahoma and Texas south to Escoahuila, Mexico . . . . *trivittatum*

8. Scutum usually orange with silvery white longitudinal stripes (rarely dark brown-black with silvery blue stripes). Widely distributed in W Nearctic . . . . *bivittatum*

– Scutum orange to dark brown-black with silvery-blue longitudinal stripes. Known only from CA . . . . *clarum*

Males

1. Thorax, in lateral view, strongly arched, its anterior face nearly perpendicular to top of head (Figs. 111, 113 in Peterson 1993). . . . 2

– Thorax, in lateral view, not strongly arched, its anterior face forming an obtuse angle with top of head 3

2. Scutum orange-brown, or at least trimmed with orange . . . . *robynae*

– Scutum entirely gray-black . . . . *labellei*

3. Scutum grayish green with variably visible, faint, dull black median stripe and lacking anterior silvery markings; spots (one/side) immediately mesad of postnotal lobes orange . . . . *griseum*

– Scutum black (rarely solid orange) or black with thick median orange stripe and with anterior crescent-shaped, oval, or triangular silvery markings; spots immediately mesad of postnotal lobes pale brown 4

4. Scutum with pair of broadly triangular, iridescent coppery blue-green markings anteriorly extended just short of posterior declivity and broadly joined anteriorly to concolorous lateral areas . . . . *notatum*

– Scutum with variably shaped, anterior, silvery blue (never coppery green) markings that, if extended near posterior declivity, are separated anteriorly from concolorous lateral areas . . . 5

5. Scutum with silvery blue (rarely silvery yellow) linear markings, not noticeably tapered, and extended to posterior declivity. Ventral plate in ventral view with posterior margin broadly rounded and with pronounced anterodorsal flange (Fig. 40). Gonostylus with pronounced posterolateral flange (Fig. 45) 6

– Scutum with silvery blue markings linear, crescent-shaped, or narrowly triangular, and if extended to posterior declivity, then only barely perceptible. Ventral plate (as in Figs. 38, 39, 41–43) and gonostylus (Fig. 44) lacking flanges 7

6. Scutum with silvery blue (rarely silvery yellow) stripes nearly parallel-sided, not tapered posteriorly . . . . *longithallum*

– Scutum with silvery blue (rarely silvery yellow) stripes broadest anteriorly, slightly tapered posteriorly . . . . *trivittatum*

7. Scutum with silvery blue stripes tapered strongly posteriorly, usually reaching posterior declivity. Ventral plate in ventral view triangular, with pointed, inwardly directed arms and pointed lip (Fig. 43). Known only from Texas . . . . *mediovittatum*

– Scutum with silvery blue areas linear, crescent-shaped, triangular or oval, rarely reaching posterior declivity. Ventral plate in ventral view roughly squared (Fig. 41), rectangular (Figs. 38, 39), or if, roughly triangular (Fig. 42), then arms and apex of lip blunt. Widespread 8

8. Scutum with silvery blue areas narrowly oval to triangular, contiguous anteriorly with concolorous lateral areas. Stem vein setae yellow. Ventral plate in ventral view roughly square (Fig. 41) to roughly triangular with blunt ventral lip (Fig. 42); arms of ventral plate rounded apically and dramatically darker than remainder of structure (Figs. 41, 42, 56) . . . . *venator*

– Scutum with silvery blue areas linear to crescent-shaped, separated from concolorous lateral areas. Stem vein setae yellow or golden brown to brown. Ventral plate in ventral view roughly rectangular (Figs. 38, 39); arms of ventral plate acute, not noticeably darkened 9

9. Ventral plate in terminal view arctate with ventral margin not strongly concave (Fig. 47). Ventral plate in lateral view with dorsal margin concave (Fig. 53). Setae of stem vein and

wing base pale golden brown to brown. Silvery blue stripes of scutum regularly extended ½ the distance to base of wing and rarely to posterior declivity . . . . *clarum*

– Ventral plate in terminal view arctate with ventral margin strongly concave (Fig. 48). Ventral plate in lateral view with dorsal margin not noticeably concave (Fig. 54). Setae of stem vein and wing base invariably pale yellow. Silvery blue stripes of scutum never extended more than about ½ distance to base of wing . . . . *bivittatum*

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THE GENUS *DILOCANTHA* (HYMENOPTERA: EUCHARITIDAE)

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Abstract.—Five species of *Dilocantha* are described from South and Central America: ***D. albicoma, n. sp., D. bennetti, n. sp., D. flavicornis*** (Walker), ***D. lachaudii, n. sp.,*** and ***D. serrata, n. sp.*** *Dilocantha* are unique within Eucharitidae for having extreme sexual dimorphism and a patch of specialized setae filling a deep depression of the scutellum at the scutoscutellar sulcus. The patch of scutellar setae is associated with external secretions that may act as an ant appeasement structure similar to trichomes of ant-associated Staphylinidae. The first-instar of *D. serrata* is described.

Key Words: Eucharitidae, taxonomy, Neotropical, *Dilocantha*

All members of the Eucharitidae (Hymenoptera: Chalcidoidea) are specialized parasitoids of ants (Clausen 1940ab, Heraty 1994). Adults deposit their eggs into or on plant tissue, and the active first-instar larva is responsible for gaining access to the ant host, often by phoretic attachment to foraging ants (Clausen 1940a, 1941). One species is newly recorded as a parasite of *Ectatomma tuberculatum* (Olivier) (Formicidae: Ponerinae). *Dilocantha* are nested within a monophyletic group of New World Eucharitini (Eucharitinae) with *Kapala* Cameron and *Isomerala* Ashmead, species of which are known to attack larger ponerine ants of the genera *Pachycondyla, Ectatomma* and *Odontomachus* (Heraty 1994).

Dilocantha was first recognized for the species *Thoracantha flavicornis* Walker by Shipp (1894). Only the female of this one species from Brazil has been described, and its characteristic features do not readily apply to females of the other species or to the distinctive sexually dimorphic males. The sexes of Eucharitidae are readily separated by features of the antennae and metasoma, but usually the mesosoma does not exhibit much dimorphism. Males of *Dilocantha* have a much narrower and more highly vaulted mesosoma than females, and the postscutellar spines are more typical of the genus *Kapala* (thin and cylindrical) than the flattened and carapace-like spines of the female. Within Eucharitidae, similar postscutellar spines are known only for *Dicoelothorax* Ashmead and *Galearia* Brullé, both belonging to the same monophyletic group but not considered as sister taxa by current analyses of relationships (Heraty, unpublished).

All species of *Dilocantha* possess a unique patch of setae filling a deep lateral depression of the scutellum at the scutoscutellar sulcus (Figs. 1–4); the depressions on each side are completely separated medially. The setae within the depression are long and hooked or bent apically, resembling the hooks found in velcro© fabric. Each hair has minute longitudinal striations along most of its length, no externally visible pores, and is gold-brown basally and white or clear apically. The base of each hair is seated in a pronounced socket, which are interspersed by minute pores in the cuticle (Fig. 3). In museum specimens, the depression and hairs are often associated with a silvery exudate covering the cuticle within the cavity and enveloping the base of the hairs (Figs. 3, 4). The structure and associated secretion are unique to Eucharitidae. The shape of the hairs and distribution of pores is similar to the trichomes of the staphylinid *Xenodusa reflexa* (Walker) (Kistner 1979, his fig. 2b), which are used for appeasement and adoption by the host ants. In staphylinids, the pores are associated with flask-like glandular cells and are characteristic of the ant-associated Aleocharinae (Jordan 1913, Kistner 1979). The secretory pores of Aleocharinae open into a cribriform plate (Pasteels 1968, Kistner 1979), which in *Dilocantha* are not apparent on either slide-mounts or SEMs of the cuticle. Dissections did not reveal glandular cells associated with the pores or setae; however all of the material dissected was preserved in alcohol and either critical-point-dried or chemically dried with hexamethydisilazane, which preserves muscles and nerve tissue but possibly not glandular tissue. Minute pores associated with the scutoscutellar sulcus occur in the closely related genus *Kapala* but without an associated depression, setal patch or exudate.

In all Eucharitinae, larvae develop on the host pupa and emerge from the host cocoon within the ant nest; Oraseminae have similar habits but usually attack Myrmicinae, which lack a pupal cocoon (Heraty 1994). Adults obviously must encounter the ant hosts before leaving the nest to mate and deposit eggs. In the few cases observed, the interaction is usually favorable, with the ants fondling or feeding the adult wasp and often protecting them when the nest is disturbed (Wheeler 1907, Clausen 1941, Ayre 1962, Vander Meer et al. 1989, personal observations). In *Kapala,* a genus closely related to *Dilocantha,* worker ants within nest colonies of *Ectatomma* have been observed carrying adults by their elongate postscutellar spines (Lachaud and Pérez-Lachaud, pers. comm.), again treating the adults amicably. In *Orasema xanthopus* (Cameron) (Oraseminae) parasitic on *Solenopsis invicta* Buren, immatures and newly emerged adults possess a cuticular hydrocarbon profile similar to the host, allowing them to go undetected within the nest (Vander Meer *et al.* 1989). Acquisition of the similar cuticular hydrocarbon profile was presumed to be from social interactions and contact with the host brood. The protection is not permanent, and a few days after emerging in laboratory cultures the adults of *Orasema* are recognized and destroyed (personal observations). Under some conditions it may be advantageous for adult eucharitids to remain in the nest beyond a period considered acceptable to the ant hosts. Various behaviors for remaining with hosts which can include structural or chemical defences have been documented in other myrmecophilous insects. The morphology of some eucharitid genera, such as *Galearia* (cf. Guérin-Méneville 1845, fig. 8), which have a fusiform body shape and can withdraw the gaster under the carapace-like scutellar spines, appear as if they would be protected from the ants. The patch of hairs and exudate found in *Dilocantha* could function as an appeasement structure similar to the trichomes of staphylinids, but no biological observations exist to support this idea.

TERMS AND METHODS

Important terms are indicated in Figs. 1 and 5, but generally follow Heraty (1985, 1989, 1994). The first antennal flagellomere is labelled as F2 to reflect the loss of F1 (anellus) in Eucharitini. MPS refer to the multiporous plate sensillae. Mt refers to the metasomal tergites (Mt1 = petiole); Ms refers to the metasomal sternites. Material was borrowed from the following: CNCI, Canadian National Collection, Ottawa (G. Gibson); BMNH, Museum of Natural History, London (J. Noyes); FLA, Florida State Collection of Arthropods, Gainesville (R. Stange); HOND, Departmento de Protección Vegetal, Tegucigalpa, Honduras (R. Cave); IZW, Institut Zoologique, Academie

Polonaise des Sciences, Warsaw, Poland (E. Kierych); LACM, Los Angeles County Museum of Natural History, Los Angeles (B. Brown); MADR, Museo Nacional de Ciencias Naturales, Madrid, Spain (J. Nieves-Aldrey); MCZ, Museum of Comparative Zoology, Cambridge (D. Furth); UCD, University of California, Davis (S. Heydon); UCLA, University of California, Los Angeles (H. Hespenheide); UCR, University of California, Riverside (S. Triapitsyn); USNM, National Museum of Natural History, Smithsonian Institution, Washington (E. Grissell).

Dilocantha Shipp

Dilocantha Shipp, 1894: 188. Type species: *Thoracantha flavicornis* Walker, by monotypy and original designation.

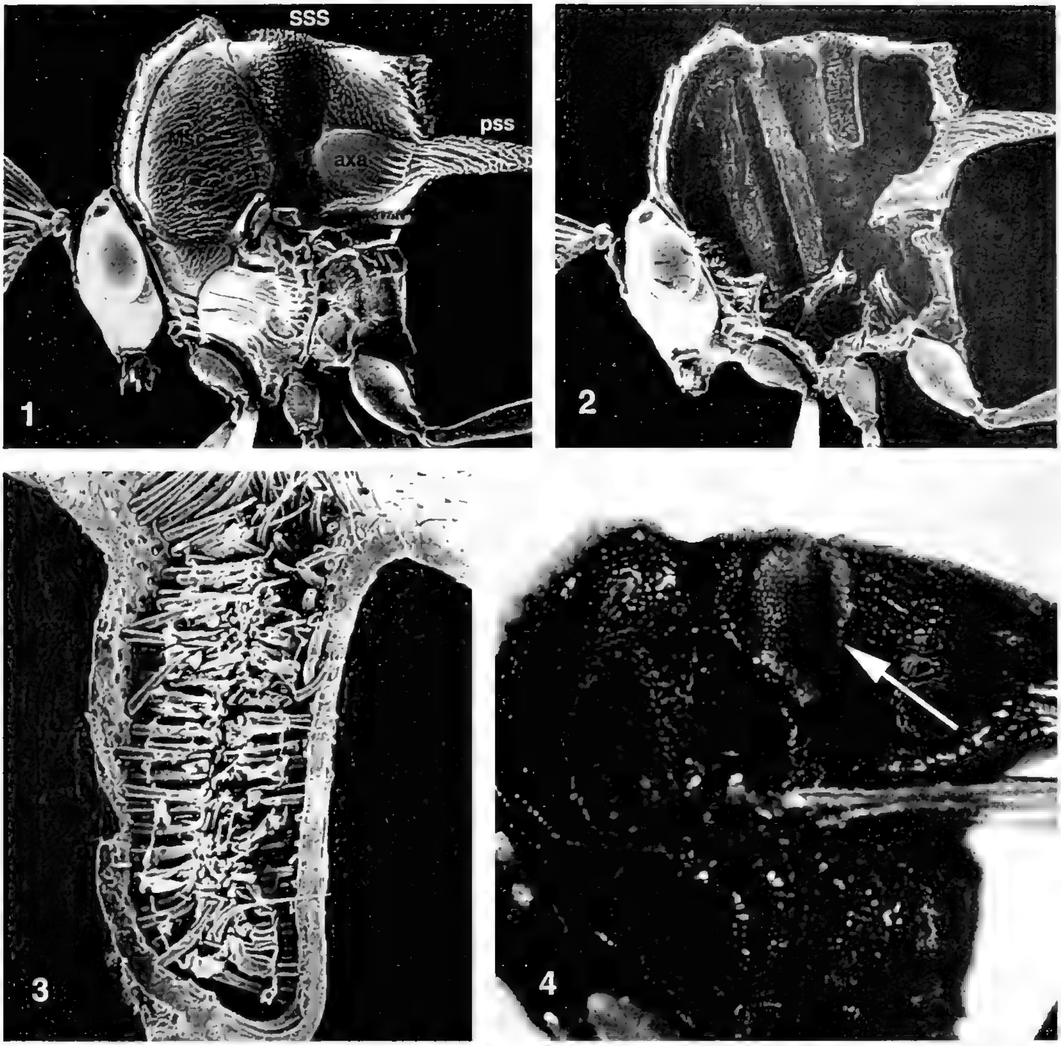
Dilocantha; Ashmead, 1904: 268, 270, 471 (in key). Schmeideknecht 1909: 68, 70, 77–78 (key and description).

Diagnosis.—Recognized by having a dense patch of long hook-tipped hairs filling the scutoscutellar sulcus (Figs. 1–4, 5, 8–9, 14, 18, 19). The scutellar spines of females are usually broad and flat (Figs. 6, 13, 19) but can be narrow and cylindrical (Fig. 14). In males the spines are always cylindrical and thin (Figs. 10, 15, 21). In both sexes the mesoscutum is vaulted (Figs. 1, 4, 5, 8–9, 24) with strong transverse carinae on the midlobe. Both sexes are presented in the key to genera by Ashmead (1904) that includes New World genera (duplicated by Schmiedeknecht 1909). Males do not key adequately as Ashmead appears to have made the assumption that males would have scutellar spines similar to the female (broad, contiguous and flat) rather than long and slender (his couplet 32).

Description.—Length 3.2–4.8 mm. General body color black; female antenna yellowish brown, male antenna darker; legs beyond coxa light yellow; wings hyaline or infuscate, forewing venation brown, postmarginal vein transparent.

Head: In frontal view subquadrate, eyes rounded and bare; median ocellus in line with lateral ocelli and included within scrobes, frons extending slightly above ventral margin of lateral ocelli. Occiput vertical and weakly aciculate to smooth, dorsal margin with prominent carina. Frons reticulate or granulate, usually with fine oblique carinae lateral to scrobes, lower face similarly sculptured; scrobal depression shallow and broadly impressed. Clypeus with distinct anteclypeus, clypeal margin transverse or only slightly rounded; supraclypeal area present, lateral margins vague. Genal depression absent; hypostomal lobes broadly separated. Mandibles falcate. Labrum with six digits. Antenna of female with 10 segments (Figs. 7, 8, 11, 16, 17), male with 12 segments (Figs. 9, 24); anellus absent; funicle of female with 7 segments, F2L:F2W less than 3 times as long as broad, funicular segments simple or serrate; funicular segments of male each with an elongate dorsal ramus, rami progressively slightly shorter and alternating in origin on each side of midline. MPS of female small and recessed into depressions, MPS of male minute and restricted to outer lateral margin of ramus.

Mesosoma: Pronotum abutting mesoscutum, no overlap of sclerites. Mesosoma robust and strongly vaulted above head (Figs. 5, 8, 9, 24), height of mesoscutum 1.4–1.5 times height of head, anterior margin of mesoscutum reflected behind head; posterolaterally with large plate-like flange extending over tegula; dorsum pilose; notauli deeply impressed and broadly separated posteriorly; posterodorsal margin of midlobe bilobed in frontal view. In male, midlobe of mesoscutum with median carinae bordered laterally by a strong vertical carina extending dorsally 0.8 times the distance up the vertical face of the midlobe to a strong transverse shelf dorsally, carinae never extending more than 0.2 times height of mesoscutum in female. Scutoscutellar sulcus (SSS) transverse, strongly impressed laterally (nearly to midline) and filled with dense patch of long bent-tipped



Figs. 1–4. 1–3, *Dilocantha bennetti*, male. 1, Head and mesosoma, lateral view. 2, Mesosoma, sagittal section, longitudinal flight muscles removed. 3, Cross section of invagination of scutoscutellar sulcus, left side of specimen midline. 4, *D. serrata*, mesosoma of female, lateral view. Abbreviations: axa = axillula, Msc = mesoscutum, pss = postscutellar spine, SSS = scutoscutellar sulcus. Arrow points to exudate

hairs (Figs. 1–4, 5, 8, 9, 14, 18); lateral axillar lobe small; axillular sulcus present as distinct channel. Frenal groove distinct laterally but absent medially; posterior margin of scutellum broadly rounded or flat anterior to frenal line, or elevated and abrupt posteriorly; frenum with pair of long spines reaching to or beyond apex of gaster and separated to base; scutellar spines of female broad and dorsoventrally flattened (Figs. 6, 13, 19) or narrow and cylindrical (Fig. 14), spines longitudinally carinate, carinae much finer and sculpture more rugose medially, ventral surface of spines obliquely carinulate; scutellar spines of male cylindrical and broadly separated basally (Figs. 10, 15, 21). Propodeum, petiole, coxae and most of mesepimeron colliculate to very finely reticulate or shagreened; propodeal disc flat and bordered by a strong carina (Fig. 23); metapleuron strongly areolate-rugose; callus with dense, fine, white setae; spiracle with elongate and narrow emargination of ventral margin; metepimeral groove absent. Femoral groove absent, mesepimeron flat or only slightly impressed (Fig. 1); mesepimeron evenly sculptured, finely striate to granulate, transepimeral sulcus absent; acropleuron deeply grooved for reception of upper corner of prepectus; mesepisternum with anteromedial margin overlapping posterior margin of prepectus; ventral margin of mesepisternum wedge-shaped and extending vertically anterior to the midcoxa (Fig. 1). Prepectus fused with pronotum and in the same plane; prepectus triangular, apex of prepectus narrowly separated from tegula; pronotal spine present; spiracle narrowly enclosed dorsally. Coxae bare except for few minute ventral setae, mesocoxa without lateral groove or carina; calcar bifid and slightly bent apically; hind tibia with 1 spur, tibiae and tarsi with sparse reclinate setae. Forewing of female 2.6–2.9 times as long as broad (Fig. 25), costal cell with moderate covering of fine ventral setae, disc with moderate covering of fine, short setae, dorsal setae sparse and minute, venation mostly distinct but postmarginal vein slightly longer than the stigmal vein; forewing of male 2.4–2.7 times as long as broad (Fig. 9), costal cell with dense covering of long ventral setae, disc with dense covering of long setae on both surfaces; both sexes without marginal fringe. Hind wing venation incomplete medially; short marginal fringe along posterior margin and disc with moderate covering of fine setae.

Metasoma: Petiole of female triangular in cross section, flat dorsally and with dorsolateral carina, 1.3–1.8 times as long as hind coxa; petiole of male cylindrical, 5.4–7.7 times as long as hind coxa; base of petiole truncate, with basal carina and not overlapping nucha; gastral terga smooth, and glabrous. Ms2 smooth, in males articulating with apex of petiole. Hypopygium with 6 long hairs on each side of midline. Valvulae acicular; apex of first valvula smooth; gonostylus fused. Posterior margin of Mt2 with one longitudinal line of weakness.

Phylogenetic affinities.—*Dilocantha* is a distinctive member of the Eucharitini (Heraty 1994) in the kapaline clade, a New World group recognized by the following synapomorphic features: 1) presence of a distinct anteclypeus, 2) scutellar spines generally exceeding the metasoma and divided almost to their bases, 3) lateral axillar lobe minute and hidden behind tegula, and 4) propodeal spiracle emarginate. Its position within the kapaline clade as closely related to the genera *Liratella* Girault, *Isomerala* Shipp, *Galearia* and *Thoracantha* is indicated by possession of 1) short F2 (basal flagellomere less than 3 times as long as broad), 2) absence of a metepimeral groove, and 3) labial palpus 1 or 2 segmented. The presence of strongly impressed notaular grooves and a pilose callus, both plesiomorphic with respect to the above-mentioned genera, suggest that *Dilocantha* is the potential sister group of these taxa. The presence of a metepimeral sulcus in *Kapala* would place this genus as the sister group of the above taxa. Notably, none of the three other kapaline genera with carapace-like scutellar spines (*Dicoelothorax, Galearia* and *Thoracantha*) are placed as the sister group of *Dilocantha,* and current analyses of generic relationships suggest at least three independent origins of this feature (unpublished). This would reinforce the notion that *D. lachaudii,* with cylindrical spines, is plesiomorphic to the other species. Other characteristics such as serrate flagellomeres and rounded scutellar apex are autapomorphic in the other taxa and no characteristics appear to indicate relationships among the remaining species in which females have a distinct carapace. The extreme sexual dimorphism is unusual in Eucharitidae, but occurs to a similar degree in *Galearia.* The patch of setae in the scutoscutellar sulcus is unique within Eucharitidae.

Distribution.—Neotropical, ranging from Central America to Argentina.

Biology and hosts.—Unknown.

KEY TO SPECIES OF *DILOCANTHA*

1\. Female (Figs. 5, 8). Antennal flagellum cylindrical or serrate 2
– Male (Fig. 9). Antennal flagellum with elongate rami (not known in *albicoma*) 6
2\. Scutellar spines narrow, cylindrical and broadly separated medially (Fig. 14) . . . . *lauchaudii*, n. sp.
– Scutellar spines broad and flattened, carapace-like and narrowly separated medially (Figs. 6, 13, 19) 3
3\. Apex of scutellum broadly rounded in profile (Fig. 12) . . . . *flavicornis* (Walker)
– Apex of scutellum abrupt in profile with strong marginal carina (Figs. 4, 5, 8, 18) . . . 4
4\. Basal flagellomeres serrate (Fig. 17) . . . . *serrata*, n. sp.
– Basal flagellomeres cylindrical (Figs. 7, 11) 5
5\. Scutellar spines narrowly separated, basal separation of spines wider than medial separation (as in Fig. 19); flagellum short, 0.83 times height of head; petiole stout, 3.4 times as long as broad and 1.3 times as long as hind coxa . . . . *bennetti*, n. sp.
– Scutellar spines more broadly separated medially, basal separation narrower than medial separation (Fig. 6); flagellum length 0.86–1.0 times height of head; petiole longer, 3.5–4.0 times as long as broad and 1.5–1.8 times as long as hind coxa . . . . *albicoma*, n. sp.
6\. Scutellar spines very narrow and tapering to a fine blunt point apically (Figs. 9, 10) . . . . *bennetti*, n. sp.
– Scutellar spines evenly cylindrical to apex (Figs. 15, 21) 6
7\. Antennal rami short, ramus of F2 as long as height of head . . . . *flavicornis* (Walker)
– Antennal rami long, ramus of F2 1.28–1.3 times as long as height of head (Fig. 24) . . 8
8\. Spines broadly separated basally, spines narrow and diverging (Fig. 15); frons evenly reticulate without striae; apex of scutellum bilobed in posterior view; wings hyaline . . . . *lachaudii*, n. sp.
– Spines separated by less than twice the spine width basally (Fig. 21); frons reticulate with numerous irregular striae; apex of scutellum rounded in posterior view; wings weakly infuscate . . . . *serrata*, n. sp.

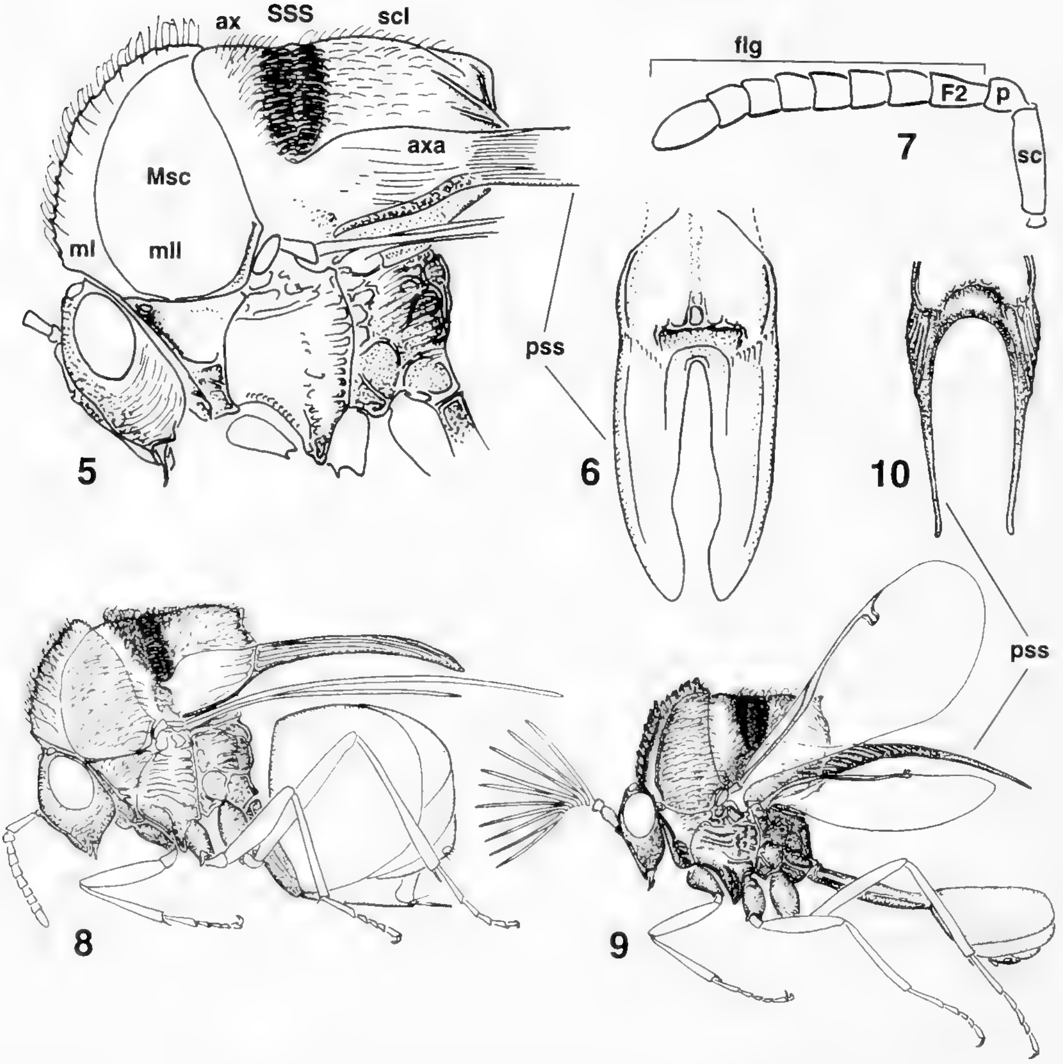
Dilocantha albicoma **Heraty, new species**

(Figs. 5–7)

Type material.—Holotype, ♀, "MEX [Mexico]: Campeche, 4 mi E Francisco Escarcega, 23.vii.83, R. Anderson." Deposited in CNCI. Paratypes (4 ♀): MEXICO: Campeche, 6 km W Francisco Escarcega, 110 m, El Tormento, Res. Sta., 23.vii.83, M. Kaulbars (1, UCR). Veracruz, 36 km W Las Choapas, 9.ix.1975, R. Villegas (1, UCD). GUATEMALA: Sacatepequez, Volcan Agua, 1700m above Antigua Guatemala, 23.xi.1986, M. Sharkey, sweep (1, CNC). HONDURAS: Atlantida Tela, Lancetilla, 5.vii.1990, R. Cave (1, HOND).

Diagnosis.—Female recognized by the simple antennal flagellomeres, angulate apex of the scutellum, broad separation of the postscutellar spines medially so that the basal separation is the narrower, flagellum more than 0.86 times the height of the head, and petiole 1.5–1.8 times as long as hind coxa. Males are unknown.

Female.—Length, 3.2–3.3 mm. Body black, apex of Mt2 and following tergites brown. Wings weakly infuscate, forewing venation light brown to translucent. Head 1.46–1.6 times as broad as high. Frons and face very finely reticulate with few fine striae lateral to scrobes and across genae, nearly smooth adjacent to eyes. Occipital carina weak and extending just beyond lateral ocellus. Eyes separated by 2.32–2.5 times their height. Malar space 1.05–1.19 times height of eye. Labrum with 6 elongate digits, each terminated by a long spatulate seta. Mouthparts relatively large, galea able to extend beyond clypeus by a distance about equal to height of clypeus; maxillary palpus with 2 segments, apical segment short, only twice as long as broad; labial palpus 2-segmented, apical segment short and only slightly longer than broad. Antennal scape reaching 0.7 times distance to median ocellus; length of flagellum 0.88–1.0 times height of head, F2 tapering, following segments cylindrical (Fig. 7), F2 1.2 times as long as F3, apical flagellomere slightly longer than broad and rounded apically; MPS numerous on all flagellomeres and recessed into deep broad depressions, surface of each flagellum strongly scalloped, sculpture finer toward base of each flagellum.



Figs. 5–10. 5–7, *Dilocantha albicoma*, female. 5, Head and mesosoma, lateral view. **6,** Scutellum and postscutellar spines, dorsal view. 7, Antenna. 8–10, *D. bennetti*. 8, Female habitus. 9, Male habitus. 10, Postscutellar spines of male, dorsal view. Abbreviations: ax = axilla, axa = axillula, F2 = second flagellomere, flg = flagellum, ml = midlobe of mesoscutum, mll = lateral lobe of mesoscutum, Msc = mesoscutum, p = pedicel, pss = postscutellar spine, sc; eq scape, scl = scutellum, SSS = scutoscutellar sulcus.

Mesoscutal height 1.25 times head height (Fig. 5). Midlobe of mesoscutum with dense covering of fine setae, sparser medially and dense laterally; median area of midlobe with strong transverse carinae and median weak longitudinal carina, the strong carina bordering the anterior declivous face of the midlobe continuing dorsally only to level of second transverse carina; lateral lobes of mesoscutum smooth and covered with fine, long setae (0.25 mm) that have the extreme apices very thin and bent. Scutellum medially with shallow longitudinal impression, at SSS the median channel bordered by two distinct raised knobs; SSS impression filled with erect, golden to whitish apically, bent-tipped setae (0.15 mm in length), longer, white setae covering most of axilla except narrow anterior band, setae finer dorsally and more bent than hooked, scutellum excluding axillula with finer and shorter white setae; axillula bare and smooth; posterior margin of scutellar disc carinate and abruptly angled in profile, posterior declivous face of scutellum angled about 80–90° to dorsum, posterior face irregular and shagreened; scutellar spines relatively narrow, dorsoventrally flattened and broadly separated medially (Fig. 6), spines not strongly bent apically. Femora smooth and with sparse semi-erect setae. Upper prepectus smooth and densely setose, apex separated from tegula, anterior margin of prepectus carinate. Marginal vein of forewing with few minute setae apically, but otherwise bare. Marginal fringe of hind wing short. Petiole 3.9–4.0 times as long as broad,1.6–1.8 times as long as hind coxa.

Male.—Unknown.

Etymology.—Latin *albicomus* for white-haired, referring to the predominance of whitish setae on the mesosoma.

Dilocantha bennetti Heraty, new species
(Figs. 1–3, 8, 9)

Type material.—Holotype, ♀, "Trinidad: Cumuto Arepo". Deposited in MCZ. Paratypes (50 ♂): TRINIDAD: Curepe, 9.vi.1978 (1) 26.vi.1978 (1), 5.vii.1978 (3), 7.vii.1978 (1), 11.vii.1978 (1), 10.vii.78 (4), 11.vii.1978 (1), 21.vii.1978 (1), 31.vii.1978 (1), 17.xi.1978 (1), 17.xii.1978 (5), malaise trap (all CNCI); Curepe, 23.i.1978, F.D. Bennett, Malaise trap (1, UCR); Curepe, CIBC lab. Grounds, 13.vii-31.viii.1974, M.N. Beg (1, CNCI); Curepe, Santa-Margarita Circular Road, 24–27.xi.1977, W. Mason (1, CNCI); St. Augustine, 15.vii-15.viii.1976, J.S. Noyes (1, BMNH); D'Abadie, 15.x.1918, A-761, H. Morrison (1, USNM); Simla Field Sta., Arima Valley [northern range], 8–9.iii.1977, P. Feinsinger, Malaise trap, rain forest (1, FLA); 13 km N of Arima, Andrews Trace, 7–24.vi.1993, 620m, malaise, upper montane rainforest, S. Peck, 93–13 (2, CNCI); 13 km S of Arima, Talparo, Quesnell Farm, 12–22.vi.1993, 50m, malaise, rainforest, S.&J. Peck, 93–27 (12, UCR); Tunapuna Mt., St. Benedict, Mt. Tabor summit, 5–21.vi.1993, 550m, malaise, rainforest, S.&J. Peck (9, CNCI). TOBAGO: 1 mi ESE Adelphi, 20–21.vii.1977, P. Feinsinger, Malaise trap in small stream in second. Forest (1, FLA).

Diagnosis.—Female recognized by the simple antennal flagellomeres, angulate apex of the scutellum, narrow separation of the postscutellar spines along the entire length so that the basal separation is the widest, flagellum 0.83 times the height of the head, and petiole 1.3 times as long as hind coxa. Males have evenly cylindrical spines that are longitudinally carinate along their length and weakly emarginate at the tip, and the antennal ramus of F2 is 1.3 times as long as height of head.

Female.—Length, 3.5 mm. Body black, apex of Mt2 and following tergites of gaster brown. Wings hyaline, forewing venation light brown. Head 1.45–1.5 times as broad as high. Frons and face very finely reticulate with few fine striae lateral to scrobes and across genae. Occipital carina pronounced and extending just beyond lateral ocellus. Eyes separated by 2.3–2.6 times their height. Malar space 1.17–1.24 times height of eye. Labrum with 6 elongate digits, each terminated by a long spatulate seta. Mouthparts relatively large, galea able to extend beyond clypeus by a distance about equal to height of clypeus; maxillary palpus with 2 segments, apical segment 5 times as long as broad; single labial palpus short, 3 times as long as broad. Antenna with 10 segments; scape reaching 0.7 times distance to median ocellus; length of flagellum 0.84 times height of head, F2 subconical, and the following segments cylindrical (Fig. 8), F2 as long as F3, apical flagellomere slightly longer than broad and subovate; MPS numerous on all flagellomeres and recessed into shallow depressions. Mesoscutum height 1.2 times head height (Fig. 8). Midlobe of mesoscutum with dense covering of fine seta, sparser and shorter on anterior vertical face; median area of midlobe with strong transverse carinae and median weak longitudinal impression, carinae bordered laterally by a short vertical carina that extends dorsally 0.15 times the distance up the vertical face or the midlobe and ventrolaterally continues as a border of the anterior declivous face of the midlobe; lateral lobes of mesoscutum smooth and covered with fine, long setae (0.18 mm) that have the extreme apices bent. Scutellum medially with shallow longitudinal impression, deeply impressed at SSS and forming a distinct pit, at SSS the median channel bordered by slightly raised knobs; SSS depression filled with erect, golden, bent-tipped setae (0.12 mm in length), longer, white setae covering most of axilla except for narrow anterior band, setae finer dorsally and more bent, scutellum excluding axillula with finer and shorter white setae; axillula weakly longitudinally carinulate and bare; posterior margin of scutellar disc carinate and abruptly angled in profile, posterior declivous face of scutellum angled about 90° to dorsum, posterior face vertically carinate and finely reticulate, scutellar spines broad, dorsoventrally flattened and narrowly separated medially (as in Fig. 19), gently arched in lateral profile; ventral surface of spines obliquely carinulate; declivous face of scutellum ventral to spines finely reticulate with a strong median carina. Femora smooth and with sparse adpressed setae. Upper prepectus smooth apically, granulate anteriorly and moderately setose, apex narrowly separated from tegula, anterior margin of prepectus carinate. Marginal vein of forewing with few minute setae apically, but otherwise bare. Hind wing with short marginal fringe. Petiole 3.4–3.6 times as long as broad,1.3–1.5 times as long as hind coxa.

Male.—Length, 3.0–4.7 mm. Differs from female in the following features: antenna brown, apical half of scape dark brown. Forewing weakly infuscate. Head 1.46–1.66 times as broad as high. Facial reticulations shallow, frons with few irregular carinae. Eyes separated by 2.11–2.44 times their height. Malar space 1.0–1.11 times height of eye. Labial palpus with one segment. Antennal scape reaching 0.7 times distance to median ocellus; F2 as long as broad basally, ramus of F2 1.05–1.32 times as long as head height (Fig. 9), terminal segment (clavus) undifferentiated and as long as ramus of penultimate flagellomere. MPS absent; setae along rami long, about equal to width of ramus. Posterior margin of scutellar disc abruptly angled in profile (Figs. 1, 9), apex emarginate and projection bifid in posterior view; scutellar spine abruptly narrowed to a very thin elongate process, broadly separated along entire length, basally with strong oblique carinae, apically with few fine longitudinal carinae (Fig. 10), spines broadly curved in profile, apex of spine rounded. Forewing with speculum closed basally. Petiole 1.9–2.4 times as long as broad, 5.7–7.5 times as long as hind coxa. Dorsal length of gaster slightly shorter than petiole, Ms8 broadly rounded and pilose. Genitalia; parameres with 4 long setae, digitus rounded with 5–6 marginal spines; tip of aedeagus acute.

Comments.—A morphologically similar female collected in Argentina (Tucuman, San Javier, 1100m, FLA) appears to be a different species based on having the scutellum distinctly bilobed and the spines more evenly spaced basally and broadly spaced apically. This female lacks a complete antennal flagellum and was not described.

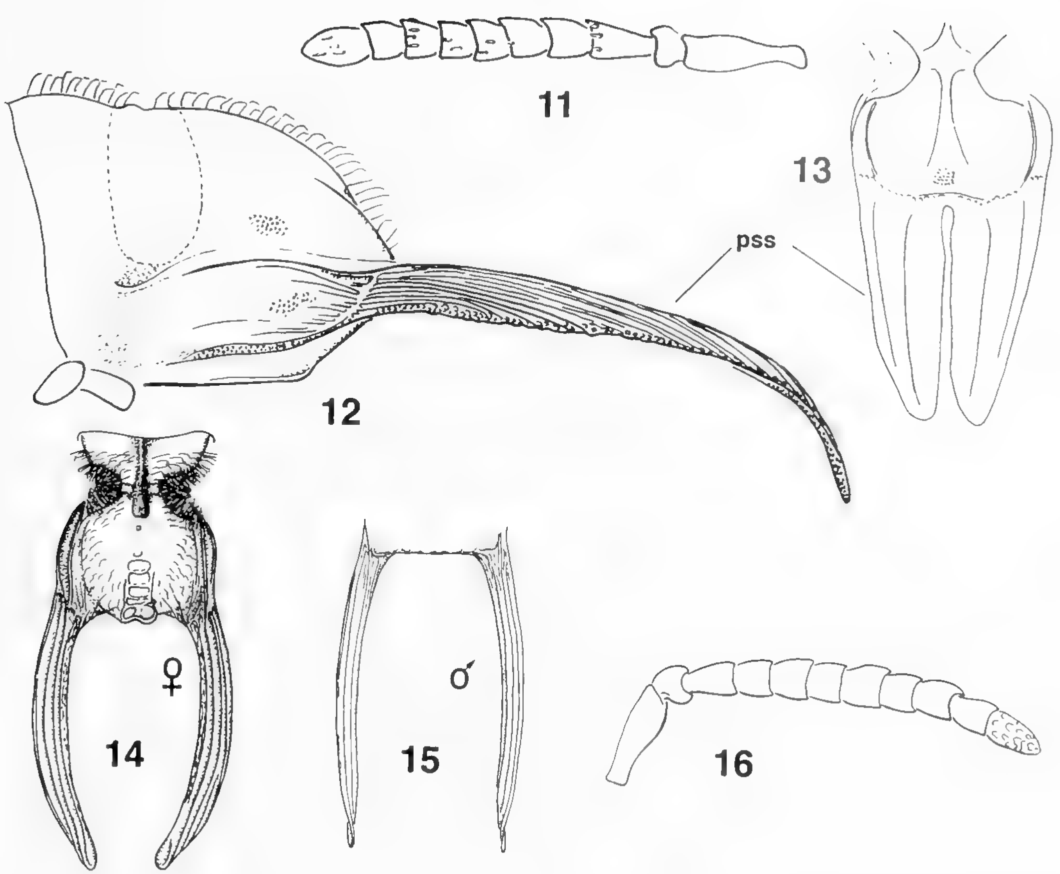
Etymology.—Named on honor of Dr. Fred Bennett, former director of the Commonwealth Institute of Biological Control and collector of many of the specimens.

Dilocantha flavicornis (Walker)
(Figs. 11–13)

Thoracantha flavicornis Walker, 1862: 382. Type data: Brazil: Villa Nova. Type female, BMNH, type no. 5.630 (examined). Described: female.

Schizaspidia flavicornis; Walker, 1871: 66. Change of combination.

Thoracantha flavicornis; Westwood, 1874: 153. Illust. Subsequent description.



Figs. 11–16. 11–13, *Dilocantha flavicornis*, female. 11, Antenna. 12–13, Scutellum and postscutellar spines (pss). 12, Lateral view. 13, Dorsal view. 14–16, *D. lachaudii*. 14, Scutellum of female. 15, Scutellar spines of male. 16, Antenna of female.

Dilocantha flavicornis; Shipp, 1894: 188. Change of combination.

Type material.—Lectotype, ♀ (here designated), "Type; Villa Nova; Kapala flavicornis Walker; B.M. Type—5.630". Deposited in BMNH (examined).

Diagnosis.—Female recognized by the simple antennal flagellomeres and rounded apex of the scutellum. Males have evenly cylindrical spines that are longitudinally carinate along their length and strongly emarginate at the tip, the antennal ramus of F2 is 1.05 times as long as the height of the head, and the frons has numerous fine irregular carinae lateral to the scrobes. Unlike *D. flavicornis,* the male and female of *D. bennetti* both have very long fine setae on the mesoscutal lateral lobe and the facial sculpture is very fine and shallow. Otherwise it is difficult to make a direct association between the different sexes, especially on the basis of specimens from such widely divergent localities in eastern Brazil. However, *D. bennetti* is the only other South American species known, and both sexes are distinct from *D. flavicornis.*

Female [measurements do not include the type].—Length, 3.7 mm. Body black, apical tergites of gaster brown. Wings infuscate, forewing venation light brown. Head 1.55 times as broad as high. Frons and face very finely reticulate and without any striae lateral to scrobes or on genae. Occipital carina weak and extending just beyond lateral ocellus. Eyes separated by 2.05 times their height. Malar space 0.96 times height of eye. Labrum with 4 elongate digits [not clearly visible], each terminated by a long spatulate seta. Mouthparts relatively small, galea not extending beyond margin of clypeus; maxillary palpus with 2 segments, apical segment 3 times as long as broad; single labial palpus minute. Antennal scape reaching 0.8 times distance to median ocellus; length of flagellum 0.90 times height of head, at least the basal 3 flagellomeres weakly serrate, following segments progressively more cylindrical (Fig. 11), F2 1.2 times as long as F3, apical flagellomere slightly longer than broad and rounded apically; MPS numerous on all flagellomeres and recessed into shallow depressions. Mesoscutum height 1.04 times head height. Midlobe of mesoscutum medially with dense covering of fine long setae, sparser and shorter on anterior vertical face; median area of midlobe with transverse carinae, these carinae not bordered laterally by a vertical carina but with a weak carinae bordering the declivous face laterally; lateral lobes of mesoscutum smooth and covered with fine, long setae (0.3 mm) that have the extreme apices bent. Scutellum medially with shallow longitudinal impression, at SSS the median channel not bordered by distinct raised knobs; SSS depression filled with erect, golden to whitish apically, bent-tipped setae (0.15 mm in length), longer, white setae covering most of axilla except narrow anterior band, setae finer, relatively long, and more bent than hooked, scutellum excluding axillula with finer, relatively long white setae [continuing to base of spines]; axillula bare with few longitudinal striae; posterior margin of scutellar disc broadly rounded in profile to base of spine (Fig. 12), posterior face with broad shallow depression and finely reticulated (colliculate) as rest of scutellum; postscutellar spines broad and somewhat dorsoventrally flattened but with lateral margins very thick and medially thin and platelike, lateral margins tapered to apex, spines narrowly separated medially (Fig. 13), strongly bent apically; declivous face of scutellum ventral to spines finely reticulate with several strong median carinae. Femora smooth and with sparse adpressed setae. Upper prepectus smooth and moderately setose, apex separated from tegula, anterior margin of prepectus carinate. Marginal vein of forewing with few minute setae along entire length, but otherwise bare. Marginal fringe of hind wing relatively long. Petiole 4.2 times as long as broad,1.4 times as long as hind coxa.

Male.—Length, 3.7 mm. Differs from female in the following features: scape and pedicel dark brown, rest of antenna yellowish brown. Forewing hyaline. Head 1.53 times as broad as high. Facial reticulations shallow, smooth adjacent to margin of eye. Eyes separated by 2.2 times their height. Malar space 0.9 times height of eye. Labrum with 6 digits. Labial palpus with one segment. Antennal scape reaching 0.6 times distance to median ocellus; F2 slightly broader than long basally, ramus of F2 1.05 times as long as head height, terminal segment (clavus) undifferentiated, shorter in length than ramus of penultimate flagellomere by more than its width. MPS present as single row along outer lateral margin in apical two-thirds of each ramus, MPS recessed in shallow depression; setae along rami long, slightly shorter than width of ramus. Posterior margin of scutellar disc abruptly angled in profile, apex weakly bilobed; scutellar spines evenly cylindrical along entire length and broadly separated, strong longitudinal carinae along entire length, apical quarter of spines bent ventrally in profile, apex of spine emarginate. Forewing with speculum open basally. Petiole 1.9 times as long as broad, 5.4 times as long as hind coxa. Dorsal length of gaster slightly shorter than petiole, 1.3 times as long as petiole; Ms8 broadly rounded and pilose. Genitalia not observed.

Additional specimens examined.—BRAZIL: Para, 12.12.1893 (1 ♀, IZW); Rio De Janeiro, Silva Jardin, viii.1974, F.M. Oliviera (1 ♀, CNCI); Rio Grande do Norte, Baixa Verde, [no date], W.M. Mann (1 ♂, LACM).

Dilocantha lachaudii Heraty, new species
(Figs. 14–16)

Type material.—Holotype, ♀, "Mexico: Chiapas, Finca Santa Elena, Municipio Tapachula, 22.i.1994, J.P. Lachaud, ex: Ectatomma ruidum". Deposited in USNM.

Diagnosis.—This is the only known species of *Dilocantha* in which the scutellar spines are cylindrical and not carapace-like. The female also has cylindrical antennal flagellomeres and angulate apex of the scutellum. Males have evenly cylindrical spines that are separated basally by 3.0 times the basal width of the scutellar spines, the spines are longitudinally carinate along their length and weakly emarginate at the tip, and the antennal ramus of F2 is 1.28 times as long as the height of the head.

Female.—Length, 4.6 mm. Body black, Mt2 entirely black, following tergites brown. Wings infuscate, forewing venation dark brown. Head 1.46 times as broad as high. Frons and face very finely reticulate, without fine striate. Occipital carina pronounced and extending barely beyond lateral ocellus. Eyes separated by 2.6 times their height. Malar space 1.1 times height of eye. Labrum with 6 elongate digits, each terminated by a long spatulate seta. Mouthparts relatively small, galea not extending beyond margin of clypeus; maxillary palpus with 2 segments, apical segment 3 times as long as broad; two labial palpomeres. Antenna with 10 segments; scape reaching 0.7 times distance to median ocellus; length of flagellum 0.91 times height of head, all segments cylindrical (Fig. 14), F2 1.3 times as long as F3, apical flagellomere slightly longer than broad and rounded apically; MPS numerous on all flagellomeres and recessed into shallow depressions. Mesoscutum height 1.1 times head height. Midlobe of mesoscutum with moderately dense covering of fine setae, sparser and shorter on anterior vertical face; median area of midlobe with strong transverse carinae, carinae bordered laterally by a strong carina that extends dorsally 0.3 times the distance up the vertical face of the midlobe and ventrally continues as a border of the anterior declivous face of the midlobe; lateral lobe of mesoscutum smooth and covered with fine, long setae (0.30 mm) that have the extreme apices hooked or bent. Scutellum with deep, medial longitudinal impression anteriorly, broad and crenulate posteriorly, at SSS the median channel bordered by distinct raised knobs; SSS depression filled with erect, golden, hook-tipped setae (0.14 mm in length), longer, white setae covering most of axilla except narrow anterior band, setae finer dorsally and more bent than hooked, scutellum excluding axillula with finer and shorter white setae; axillula smooth and bare; posterior margin of scutellar disc carinate and abruptly angled in profile, posterior declivous face of scutellum angled 90° to dorsum, posterior face shagreened; scutellar spines cylindrical and broadly separated medially (Fig.14), only slightly bent apically; declivous face of scutellum ventral to spines finely reticulate with strong median carina. Femora smooth and with sparse adpressed setae. Upper prepectus smooth and moderately setose, apex separated from tegula, anterior margin of prepectus carinate. Forewing with speculum small and closed basally; marginal vein bare. Hind wing with short marginal fringe. Petiole 4.2 times as long as broad, 2.2 times as long as hind coxa.

Male.—Length, 4.4 mm. Differs from female in the following features: antenna dark brown, scape black. Forewing hyaline. Head 1.5 times as broad as high. Facial reticulations shallow, without carinae. Eyes separated by 2.6 times their height. Malar space 1.0 times height of eye. Labrum with 6 digits. Antennal scape reaching 0.6 times distance to median ocellus; F2 about as broad as long basally and with an elongate dorsal ramus, ramus of F2 1.28 times as long as head height, terminal segment (clavus) undifferentiated, as long as ramus of penultimate flagellomere. MPS present as single or double row along outer lateral margin in apical two-thirds of each ramus, MPS recessed in shallow depression; setae along rami slightly shorter than width of ramus. Posterior margin of scutellar disc abruptly angled in profile, apex projecting and truncated in posterior view; scutellar spines evenly cylindrical along entire length and separated basally by 3 times the basal width of the spines (Fig. 18), strong longitudinal carinae along entire length, apical third of spine bent ventrally in profile, apex of spine weakly emarginate. Petiole 6.7 times as long as broad, 2.5 times as long as hind coxa. Dorsal length of gaster as long as petiole; Ms8 and genitalia not observed.

Etymology.—Named after Jean-Paul Lachaud and Gabriela Lachaud-Perez.

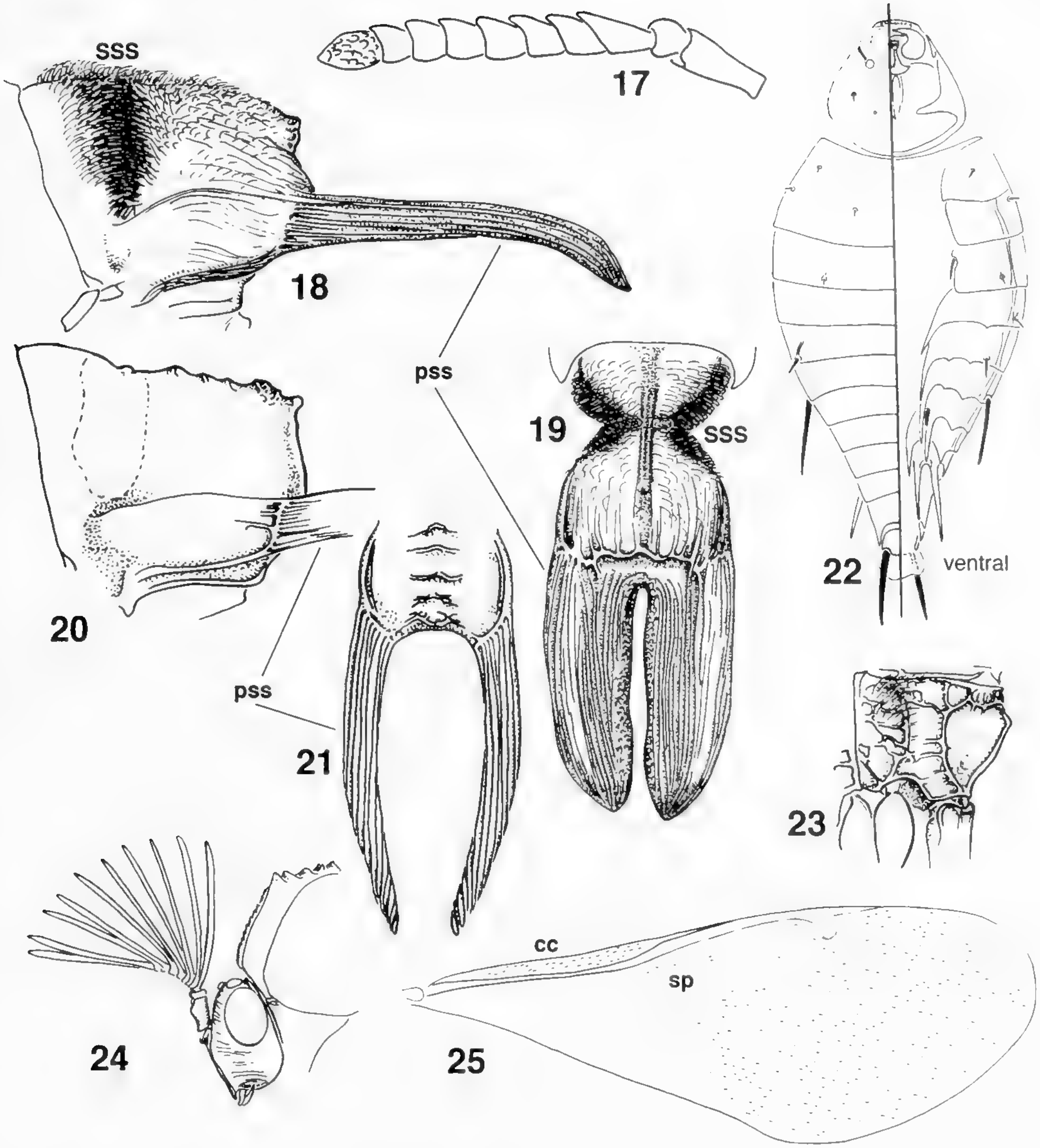
Dilocantha serrata Heraty, new species

(Figs. 4, 18–25)

Type material.—Holotype, ♀, "COSTA RICA: Prov. Heredia, F. La Selva, 3 km S Pto. Viejo, 10°26″N 84°01′W; 28.vi.1996, H.A. Hespenheide." Deposited in USNM. Paratypes (15 ♀, 1 ♂): COSTA RICA: Heredia: F. La Selva, 3 km S Pto. Viejo, 10°26′N 84°01′W, 15.vii.1982 (1), 23.vii. 1982 (1), 30.vii.1982 (1), 18.vi.1985 (1), 19.vi.1985 (1), 28.vi.1986 (2), 4.iv.1987 (2), 5.iv.1987 (1), 10.vii.1993 (1), H.A. Hespenheide (2 females UCR, 8 ♀ UCLA); Alejuela, Rio-Laguna de Arenal, 500m, 14.viii.1988, Paul Hanson (1 ♀, UCR); Puntarenas Prov., Osa Peninsula, 2.5 mi SW Rincon, 08°42′N 83°29′W, 21–28.ii.1967, OTS course (1 ♀, MCZ). HONDURAS: La Ceiba, x.29.1916, F.J. Dyer, no. 20810 (1 ♀, USNM). PANAMA: Canal Zone, Farfan to Palo Seco, 4 km S of Balboa, 08°56′N 79°34′W, 20.vii.1978, H.A. Hespenheide (1♀, UCLA); Canal Zone, Plantation Rd C29, 6.5 km ENE Gamboa, 09°8′N 79°39′W, 5.viii.1978, H.A. Hespenheide (1 ♀, UCR); Coiba, Estacion Biol., Malaise, 21–23.i.1994, J.L. Nieves (1 ♂, MADR).

Diagnosis.—Female recognized by the serrate antennal flagellomeres and angulate apex of the scutellum. Males have evenly cylindrical spines that are longitudinally carinate along their length and weakly emarginate at the tip, and the antennal ramus of F2 is 1.3 times as long as the height of the head.

Female.—Length, 3.5–4.8 mm. Body black, Mt2 entirely black, following tergites brown. Wings infuscate, forewing venation dark brown. Head 1.46–1.6 times as broad as high. Frons and face very finely reticulate with few fine striae lateral to scrobes and across genae. Occipital carina pronounced and extending to or almost to margin of eye. Eyes separated by 2.3–2.55 times their height. Malar space 1.1–1.2 times height of eye. Labrum with 5–6 elongate digits, each terminated by a long spatulate seta. Mouthparts relatively large, galea able to extend beyond clypeus by a distance about equal to height of clypeus; maxillary palpus with 2 segments, apical segment 5–6 times as long as broad; single labial palpus long and thin. Antenna with 10 segments; scape reaching 0.7–0.8 times distance to median ocellus; length of flagellum 0.78–1.0 times height of head, at least the basal 3–4 flagellomeres strongly serrate, the following segments progressively more cylindrical (Fig. 17), F2 1.2 times as long as F3, apical flagellomere slightly longer than broad and acuminate; MPS numerous on all flagellomeres and recessed into shallow depressions. Mesoscutum height 1.4–1.5 times head height. Midlobe of mesoscutum with dense covering of fine seta, sparser and shorter on anterior vertical face; median area of midlobe with strong transverse carinae and median weak longitudinal carina, carinae bordered laterally by a strong carina that extends dorsally 0.3–0.5 times the distance up the vertical face of the midlobe and ventrally continues as a border of the anterior declivous face of the midlobe; lateral lobe of mesoscutum smooth and covered with fine, long setae (0.18–0.21 mm) that have the extreme api-



Figs. 17–25. *Dilocantha serrata.* 17, Antenna of female. 18–19, Scutellum and postscutellar spines of female: 18, lateral view, 19, dorsal view. 20, Scutellum of male, lateral view. 21, Scutellum and postscutellar spines of male. 22, First-instar larva, dorsal and ventral views. 23, Propodeum of female, oblique view. 24, Head of male, lateral view. 25, Forewing of female. Abbreviations: cc = costal cell, sp = speculum, pss = postscutellar spine, SSS = scutoscutellar sulcus.

ces hooked or bent. Scutellum with deep, medial longitudinal impression (rarely shallow with a strong longitudinal carinae), at SSS the median channel bordered by distinct raised knobs; SSS depression filled with erect, golden, hook-tipped setae (0.10–0.15 mm in length), longer, white setae covering most of axilla except narrow anterior band, setae finer dorsally and more bent than hooked, scutellum excluding axillula with finer and shorter white setae; axillula weakly carinulate, rarely smooth, and bare;

posterior margin of scutellar disc carinate and abruptly angled in profile, posterior declivous face of scutellum angled about 60° to dorsum (Fig. 18), posterior face usually vertically carinate; scutellar spines broad, dorsoventrally flattened and narrowly separated medially (Fig. 19), strongly bent apically; declivous face of scutellum ventral to spines finely reticulate with strong median carina. Femora smooth and with sparse adpressed setae. Upper prepectus smooth and moderately setose, apex separated from tegula, anterior margin of prepectus carinate. Forewing (Fig. 25) with speculum small and open basally; marginal vein with few minute setae apically, but otherwise bare. Hind wing with short marginal fringe. Petiole 3.3–3.9 times as long as broad, 1.4–1.6 times as long as hind coxa.

Male.—Length, 4.2 mm. Differs from female in the following features: antenna brown, apical half of scape and rami dark brown to black. Forewing weakly infuscate. Head 1.6 times as broad as high. Facial reticulations shallow, frons with numerous irregular carinae. Eyes separated by 2.1 times their height. Malar space 0.86 times height of eye. Labrum with 8 digits. Labial palpus with two segments. Antennal scape reaching 0.7 times distance to median ocellus; F2 about as broad as long basally and with an elongate dorsal ramus (Fig. 24), ramus of F2 1.3 times as long as head height, terminal segment (clavus) undifferentiated, as long as ramus of penultimate flagellomere. MPS present as single or double row along outer lateral margin in apical two-thirds of each ramus, MPS recessed in shallow depression; setae along rami slightly shorter than width of ramus. Posterior margin of scutellar disc abruptly angled in profile (Fig. 20), apex projecting and rounded in posterior view; scutellar spines evenly cylindrical along entire length and broadly separated (Fig. 21), strong longitudinal carinae along entire length, apical third of spine bent ventrally in profile, apex of spine weakly emarginate. Petiole 2.4 times as long as broad, 7.7 times as long as hind coxa. Dorsal length of gaster as long as petiole; Ms8 and genitalia not examined.

Immature.—The description of the first-instar (planidium) is based on two larvae attached to one adult female from La Selva (4.iv.1987). The indiscriminent attachment of planidia to adults of the same species is common among parasitoids of large ponerine ants and virtually unknown in any of the other groups of Eucharitidae. Presumably this behavior is correlated with very active larvae and probable phoretic attachment of larvae to foraging workers for transport to the host brood (cf. Clausen 1940b), or in this case, attachment to females visiting a site used for oviposition by a previous female. The first instar of *D. serrata* (Fig. 22) is similar to other Eucharitini (Heraty 1994). Larvae are 0.16–0.18 mm in length, possess a distinct labial plate, dorsal fusion of tergites I and II, a distinct tergopleural line separating the pleural region on tergites II–VIII, and two ventral setae on tergite III. The prominent narrow and rounded ventral margin of the cranium, elongate ventral process on tergites IV to IX and relative lengths of setae are the same as for *Kapala* (see Heraty and Darling 1984). *Kapala* has only two minute dorsal cranial sensillae; *D. serrata* has three pairs of sensillae: the anterior pair are relatively large and connected to the lateral margin by a thin line of desclerotization; the medial pair give rise to a minute setae, which is unknown in other Eucharitidae; the posterior pair are minute as in *Kapala.*

Comments.—One female paratype from Panama is distinct from the other specimens in having almost completely clear forewings, a shorter flagellum (0.78 times height of head), laterally smooth scutellum and axillula, medial carina on the scutellum, and no lateral carinae on the petiole, but these were considered as extremes of acceptable variation. A smooth scutellum and axillula, medial carina bordering one side of the median scutellar channel, weak petiolar carinae and only slightly infuscate wings occur in the female paratype from the Osa peninsula that is otherwise more similar to all of the other Costa Rican specimens.

Etymology.—Latin *serra* for saw—referring to the serrate antennal flagellomeres.

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Dave Hawks (UCR) helped with the measurements and photographs, and critiqued the manuscript. Chris Darling and one anonymous reviewer also provided helpful comments on the manuscript. This research was sponsored by a National Science Foundation Grant BSR-96–29515 to the author.

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DESCRIPTION OF THE THIRD INSTAR LARVA OF *CERATITIS ROSA* KARSCH (DIPTERA: TEPHRITIDAE)

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Abstract.—The mature third instar larva of *Ceratitis rosa* Karsch is described and illustrated. It is distinguished from the larva of the Mediterranean fruit fly, *Ceratitis capitata* (Wiedemann), by the presence of a minute subapical tooth on the mandible, the shape of the anterior and posterior spiracles, and the shape of the cephalic segment. Numbers of oral ridges and anterior spiracular tubules are similar for the two species.

Key Words: Natal fruit fly, Mediterranean fruit fly, immatures, diagnostic characters, scanning electron microscopy, morphology

The Natal fruit fly, *Ceratitis rosa* Karsch, is a major pest that is widespread in Africa, and has been introduced onto the islands of Mauritius and Reunion. It is polyphagous, and infests at least 27 of the same hosts infested by the Mediterranean fruit fly, *Ceratitis capitata* (Wiedemann) (White and Elson-Harris 1992). The only existing description of the immature stages of this species to date consists of a figure of the anterior spiracles (Orian and Moutia 1960). The mature third instar larva of *C. rosa* is here described and characters for distinguishing it from *C. capitata* are discussed, because of their economic importance, and the danger of misidentification.

MATERIALS AND METHODS

Preserved mature third instar larvae of *C. rosa* were obtained from culture (see Specimens Examined). Series of specimens were prepared for study by dissecting, compound, and scanning electron microscopy. Slide mounted specimens (n = 7) were first slit along one side and around three-quarters of the caudal segment, macerated in 10% cold KOH, rinsed with water, passed through an alcohol series, and mounted from 95% alcohol into Euparal or Hoyer's medium. Specimens examined by SEM (n = 14) were rinsed in clean alcohol, pricked in the side with a minuten pin, passed through an alcohol series to absolute alcohol, then critical-point dried. Dried specimens were mounted on points of foil electrical tape, then carbon paint was applied to the connection between specimen and point to ensure good conductivity. Specimens were coated with gold or gold-palladium and examined with a JEOL-25 or AMRAY 1810 scanning electron microscope at 10 to 12.5 KeV.

Numbers of oral ridges and anterior spiracular tubules, dorsal spinule rows, and anal lobes were examined by dissecting microscope at a magnification of 240×, with the specimen (n = 30) removed from alcohol and dried until liquid had drained out of the oral ridges. Spinule rows were counted as the number of lines of spinules crossed by a longitudinal transect in the mid-dorsal region of the anterior margin of the segment. Measurements for anterior and posterior spiracles were made on slide-mounted specimens at a magnification of 250×. All measurements were calibrated with a stage micrometer. Specimens were compared with samples of *C. capitata,* ex culture from Programa Moscamed, Metapa, Chiapas, Mexico (n = 30, counts of oral ridges and anterior spiracular digits) and ex culture from the Tropical Fruit and Vegetable Research Laboratory, USDA, ARS, Honolulu, Hawaii (n = 10, SEM). Terminology for larval morphology follows Teskey (1981), Carroll and Wharton (1989) and White and Elson-Harris (1992, accessory plates). Voucher specimens are deposited at the National Museum of Natural History, Washington, D.C. (USNM) and Texas A&M University, College Station (TAMU).

RESULTS

Ceratitis rosa Karsch
(Figs. 1–11)

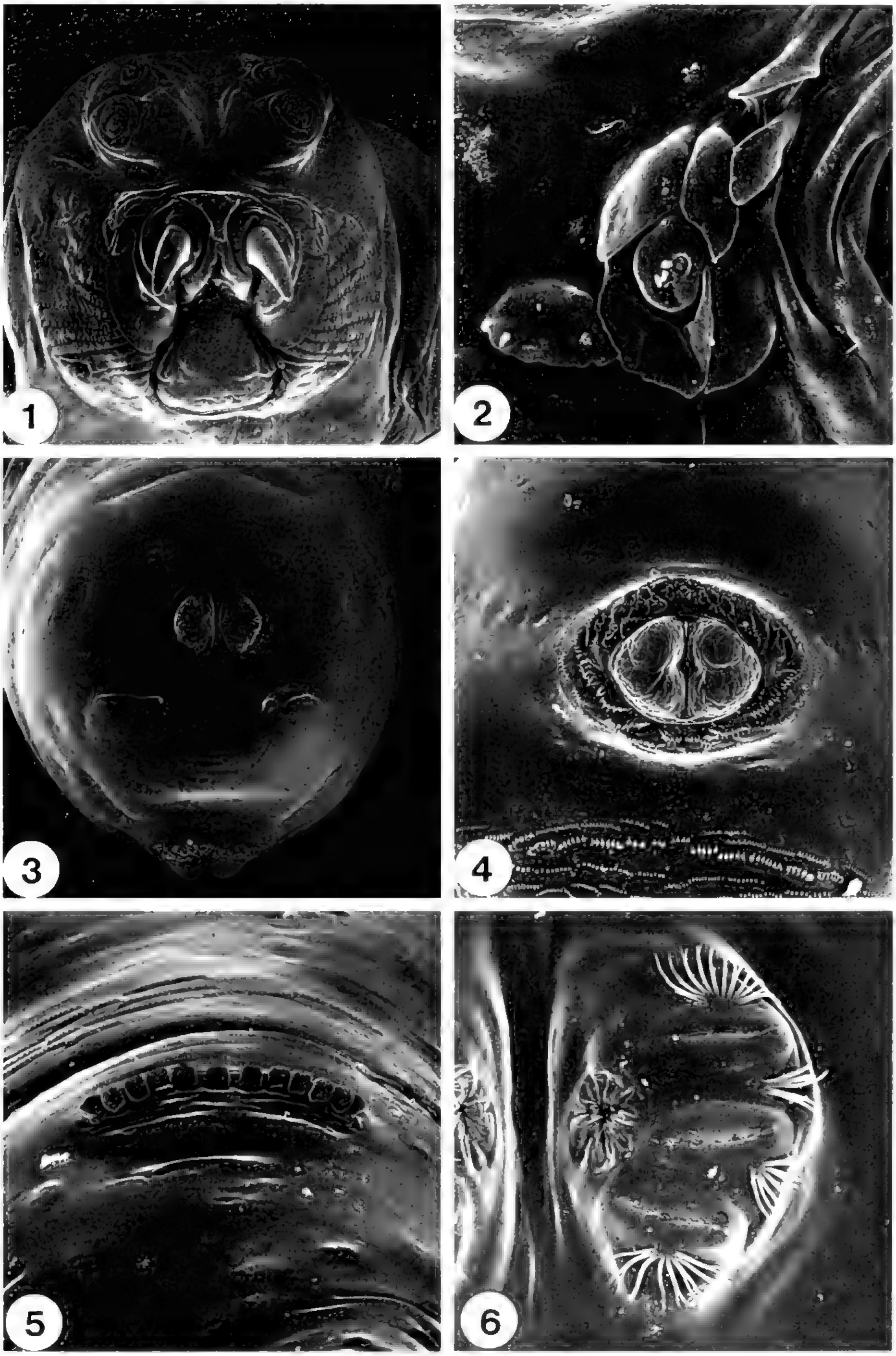
Ceratitis rosa Karsch 1887:22
Pterandrus flavotibialis Hering 1935:158

Diagnosis of third instar.—Medium-sized muscidiform larvae with minute subapical mandibular tooth; usually with 9–11 (rarely 8 or 12) oral ridges; accessory plates absent; leaf-like secondary stomal lobes present, sclerotized stomal guards absent; dorsal spinules present on segments T1-A1; anterior spiracles usually with 9–10 (rarely 7–8 or 11–12) tubules in a single straight row; base of anterior spiracle cylindrical, half as wide as apical width; posterior spiracles with rimae 2.75–3.8 times as wide as long; spiracular processes mostly unbranched; caudal ridge present; anal lobes entire.

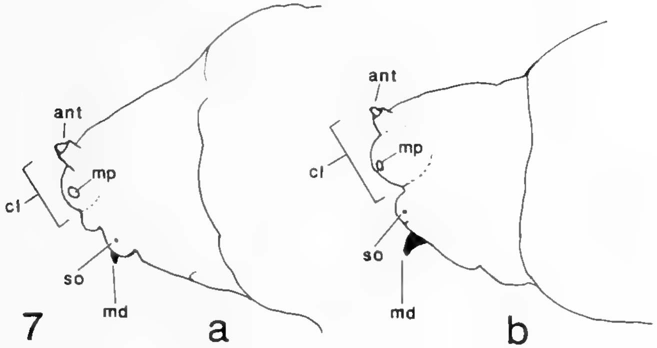
Description of third instar.—Length 7.7–9.6 mm; width 1.4–1.7 mm; creamy-white, subcylindrical, tapering gradually to cephalic segment; apparently amphipneustic (vestigial spiracular openings visible at high magnification on segments T3-A7 in slide-mounted material).

Head: (Figs. 1, 7) with *cephalic lobes* moderately developed, in lateral view more rounded and protuberant than in *C. capitata* (Fig. 7); *antenna* (Fig. 8) 2-segmented, both segments with sclerotized walls, the distal segment apically thin-walled and conical; *maxillary palp* (Fig. 8) with 2 large and 9 small sensilla visible in slide mounted material (visible by SEM as 3 papilla sensilla and 2 knob sensilla, the remainder as pits); dorsolateral group of sensilla with 2 papilla sensilla and a pit sensillum, adjacent to but distinct from palp; *stomal organ* (Fig. 2) with primary lobe small, bearing 3–4 unbranched peg sensilla, 1 campaniform sensillum, and 2 pit sensilla; 6 secondary lobes present: a broad, flat subtending lobe and a lobe medial to it; usually 2 additional lobes immediately surrounding the primary lobe anteriorly, and usually 2 lobes anteromedial to these, all with edges entire; none of these secondary lobes is strikingly similar to oral ridges; sclerotized stomal guards absent; *labium* short, triangular, with narrow lateral lobes; the median portion with 2 pairs of sensory organs; 6 pairs of other minute pit sensilla on the cephalic segment similar in arrangement to those of *Anastrepha ludens* (see Carroll & Wharton 1989), with one medial and two posterior to the cephalic lobes, and one each at the anterodorsal, posterodorsal, and posteroventral corners of the oral ridge region. *Oral ridges* usually 9–11 (but two had 8 and three had 12 ridges on one side only), well developed with margins scalloped to ¼–⅕ of their depth (visible by SEM), located on a semicircular region laterad of mandible; accessory plates (supernumerary ridges) and other reticulation absent.

Cephalopharyngeal skeleton (Fig. 9) well developed; *mandible* black to dark brown, apical tooth pointed, with a small subapical tooth (visible in slide-mounted material); *hypopharyngeal sclerite* black in anterior half, bridge and posterior processes brown; *tentoropharyngeal sclerite* with dorsal and ventral cornua broadly joined, with strongly pigmented anterior and posterior margins, becoming less pigmented dorsally and ventrally; dorsal cornu split posteriorly;



Figs. 1–6. *Ceratitis rosa*, third instar. 1, Head (frontal view). 2, Stomal organ and associated lobes. 3, Caudal segment. 4, Anal lobes (caudal at top). 5, Anterior spiracles (anterolateral view). 6, Posterior spiracles (dorsal at top).



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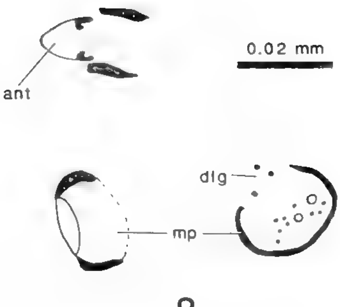

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Figs. 7–8. Third instar. 7, Head (lateral view), a, *Ceratitis capitata*; b, *C. rosa* (ant, antenna; cl, cephalic lobe; md, mandible; mp, maxillary palp; so, stomal organ). 8, *C. rosa* (ant, antenna (lateral view); dlg, dorsolateral group of sensilla; mp, maxillary palp (lateral and frontal views).

ventral cornu with a slight hump midway along dorsal margin, pigmented along dorsal margin and ventrally to slightly more than half its length, with an incomplete window; *parastomal sclerite* long, stout, brown, slightly hooked apically; other sclerites as follows: *dental sclerite* dark brown, narrow in profile, free from and distinctly posterior to base of mandible; *labial sclerites* dark brown, slightly shorter than length of hypopharyngeal sclerite bridge, broadly connected to one another to form a pale W-shaped or quadrate sclerite; *epipharyngeal sclerite* small, faintly pigmented, amorphous; *anterior sclerite* (Exley 1955) present in mature larvae; *pharyngeal filter* present, with 7 lamellate ridges extending the length of the pharynx.

Anterior spiracle (Figs. 5, 10) pale golden brown, projecting, usually with 8–10 tubules (but one had 7 and one had 11 on one side only; one had 11 on both sides) closely spaced in a single straight row; distal width 0.145–0.166 mm (n = 4), base cylindrical, about half as wide as distal width; tubules about as long as wide, rounded apically, each with a slitlike opening; felt chamber as in Fig. 10; unpigmented ecdysial scar posterior to tubules.

Segments T1–T3 and usually A1 with broken rows of weak, conical spinules on dorsal anterior margin, with 3–5, 3–5, 1–4, and 1–2 rows of spinules, respectively, at dorsal midline; on T1 and T2 the spinulose area encircles the body, while on T3 the ventral spinulose area is separated from that of the dorsum; dorsal spinules absent on A2–A8; ventral spinulose areas on T1 with 10–12 rows, T2 and T3 with 3–7 rows each, and A1 with 4–7 rows of posteriorly directed spinules; ventrally, segments A2–A7 with 9–11 rows and A8 with 6–9 rows of spinules that are alternately arranged in groups of anteriorly and posteriorly directed rows, typically arranged as follows: 1–3 rows of small (approximately 0.005 mm long), anteriorly directed spinules that appear to overlap segmental lines and actually pertain to the preceding segment; 2–4 rows of small, posteriorly directed spinules; 1–2 rows of anteriorly directed spinules, and 2–5 rows of posteriorly directed spinules, some of which may reach 0.014 mm in length.

Thoracic segments with *Keilin's organ* (pedichaete) present as a trifid sensillum; other body sensilla exceedingly minute.

Caudal segment (Fig. 3) with a caudal ridge on the intermediate region, without a dark transverse line in the medial region; 10 pairs of sensilla present as follows: dorsal area with D1 and D2 on separate papillae very close to one another; lateral area with I3 and L on separate papillae; intermediate area with intermediate tubercle well developed, bearing the following sen-

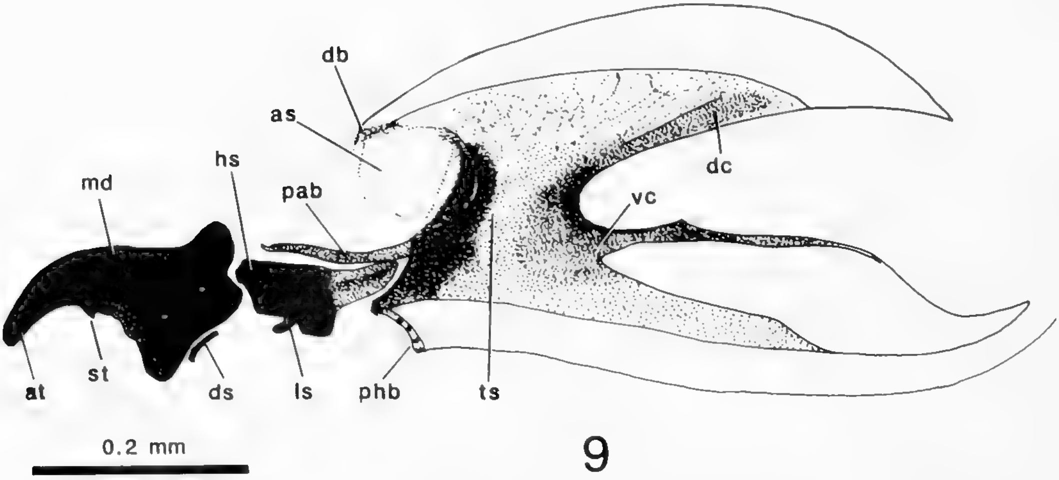


Fig. 9. *Ceratitis rosa*, third instar, cephalopharyngeal skeleton (as, anterior sclerite; at, apical tooth; dc, dorsal cornu; db, dorsal bridge; ds, dental sclerite; hs, hypopharyngeal sclerite; ls, labial sclerite; md, mandible; pab, parastomal bar; phb, pharyngeal bar; st, subapical tooth; ts, tentoropharyngeal sclerite; vc, ventral cornu).

silla: I1a and I1b (on the same papilla or very close together, near medial end of caudal ridge), and I2 (below caudal ridge); ventral area with 3 V sensilla (one as a papilla sensillum and two as pit sensilla).

Posterior spiracle (Figs. 6, 11) above midline, with 3 slit-like openings, dorsal and central slit subparallel, ventral slit more medial and at an angle to the other two; rimae about 2.75–3.8 times longer than wide (0.065–0.082 mm long; 0.021–0.025 mm wide), separated from midline by approximately 2–3 times the length of the rima; spiracular processes well-developed, about half as long as rimae, mostly unbranched, some with 1–2 branches; numbers of trunks and tips as follows: I (dorsal) (8–9, 10–12), II (3, 5–6), III (4–7, 7–11), IV (ventral) (9–10, 11–14).

Anal lobes (Fig. 4) well-developed, protruding, entire (rarely grooved), surrounded by 2–4 broken rows of spinules.

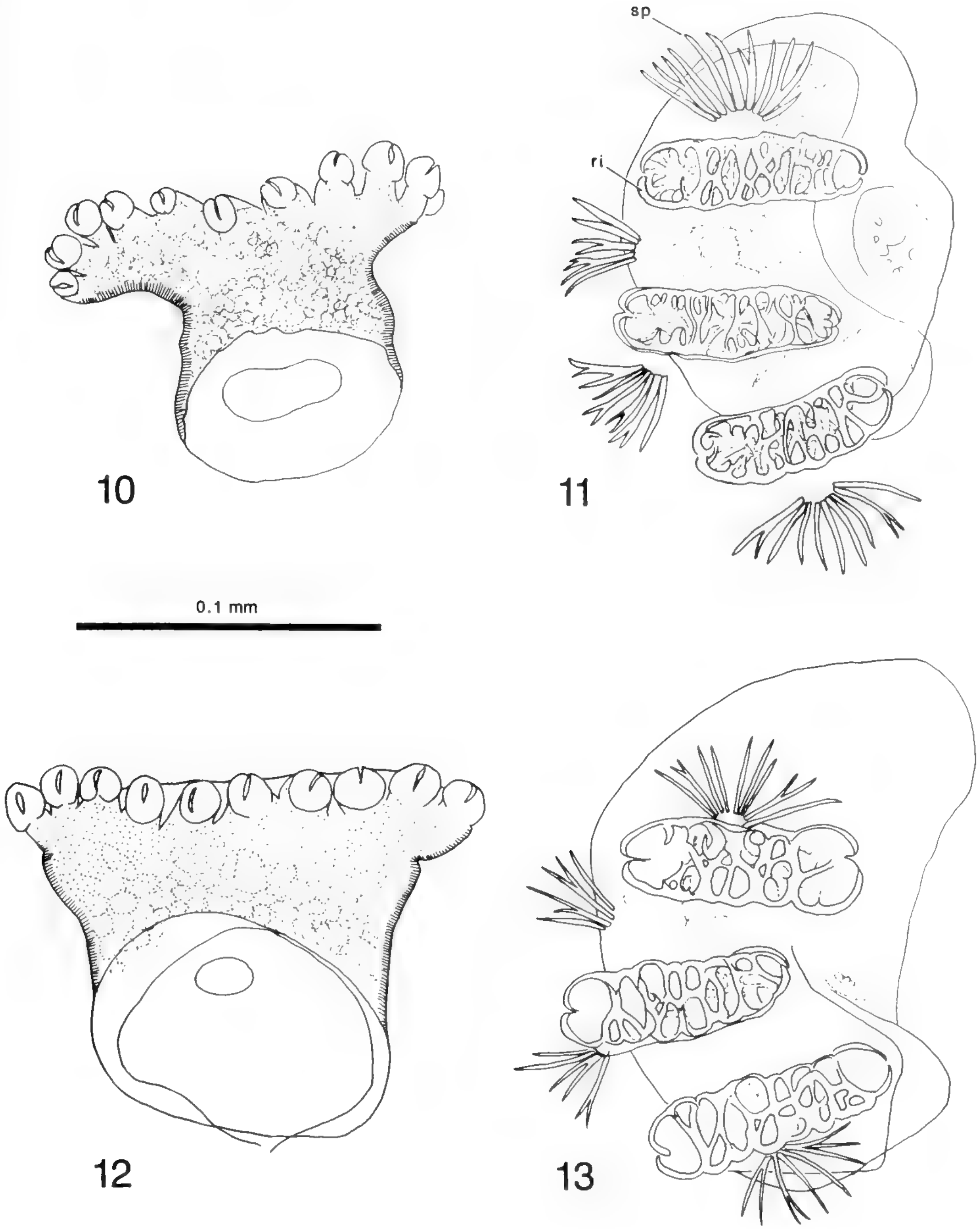
Specimens examined.—SOUTH AFRICA: ex culture, Brian Barnes (n = 40, USNM, TAMU).

Discussion

The larva of *Ceratitis rosa* shares the following characteristics with other Dacini for which larvae have been described: 1) a well-developed caudal ridge on the intermediate region of the caudal segment, 2) a stomal organ borne on a small primary lobe that is surrounded by secondary stomal lobes, 3) no sclerotized stomal guards below the stomal organ, and 4) dental sclerites present posterior to the base of the mandible.

Like other Ceratitidina, it has: 1) the area lateral to the oral ridges without accessory plates and 2) the secondary stomal lobes broad, flat, and leaf-like (as also in *Bactrocera (Bactrocera)*), rather than having the medial secondary stomal lobes similar to oral ridges (as in *Dacus, B. (Zeugodacus)* and related subgenera). Aside from the dental sclerites (which require slide-mounting), all these structures are sufficiently discernible in mature larvae in good condition, with a dissecting microscope at a magnification of approximately 750×, to allow identification to the generic level.

Numbers of oral ridges and anterior spiracular tubules, in addition to the caudal ridge (described as a row of papillae by Phillips (1946) and Berg (1979)), have been among the characters most commonly used for the identification of larvae of *C. capi-*



Figs. 10–13. Third instar spiracles of *Ceratitis rosa* and *C. capitata*. 10–11, *C. rosa*. 12–13, *C. capitata*. 10, 12, Anterior spiracles, 11, 13 Posterior spiracles (ri, rima; sp, spiracular processes).

tata. However these characters are not useful in distinguishing the larva of *C. capitata* from that of *C. rosa*, due to virtually complete overlap in numbers of oral ridges (usually 9–11, rarely 8 or 12 in both species) and anterior spiracular tubules (usually 8–10, rarely 7 or 11 in both species). Extremes of oral ridge count data in the sample of *C. capitata* included one specimen with 8 ridges and six specimens with 12 ridges on one side only, and one specimen with 12 ridges on both sides. Extremes of anterior spiracular tubule count data for *C. capitata* included a single specimen with 6 tubules on one side (spiracle plainly deformed), three with 7 tubules and two with 11 tubules on one side only.

The larva of *C. rosa* is distinguishable from that of *C. capitata* by having the area of the cephalic lobes around the maxillary palps more round and protuberant, rather than slightly flattened in lateral view (Fig. 7), anterior spiracles basally narrower, with sides subparallel (Fig. 10), rather than flaring from the base (Fig. 12), and posterior spiracular slits (Fig. 11) generally less robust than in *C. capitata* (Fig. 13). It also has a minute subapical tooth on the mandible (Fig. 9), which is clearly visible by SEM and in slide-mounted material, which is never present in *C. capitata. Ceratitis rosa* lacks spinules on the dorsal anterior margin of segment A2, while *C. capitata* frequently has one or two isolated lines of spinules on this segment.

ACKNOWLEDGMENTS

I am grateful to Dr. Brian Barnes, Fruit and Fruit Technology Research Institute, Stellenbosch, South Africa, for providing larvae of *Ceratitis rosa* from South Africa ex culture; to Marianne Wong and the Tropical Fruit and Vegetable Research Laboratory, USDA, ARS, Honolulu, Hawaii, for providing larvae of *C. capitata* from Hawaii ex culture; to personnel of Programa Moscamed, Tapachula, Chiapas, Mexico for providing larvae of *C. capitata* from Chiapas, Mexico ex culture, and to Drs. Robert Wharton, Gary Steck, and Alma Solis for reviewing the manuscript.

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A NEW SPECIES OF *DIPLOCHEILA* BRULLÉ FROM NORTH AMERICA, WITH NOTES ON FEMALE REPRODUCTIVE TRACT CHARACTERS IN SELECTED LICININI AND IMPLICATIONS FOR EVOLUTION OF THE SUBGENUS *ISOREMBUS* JEANNEL (COLEOPTERA: CARABIDAE: LICININI)

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Abstract.—***Diplocheila* (*Isorembus*) *crossi*, new species**, is described, from central and southeastern United States. Genitalic and internal female reproductive tract structures for Licinini are presented for exemplars of Dicaelina, Licinina and, Lestignathina. An evagination of the bursa common to *Diplocheila* and *Dicaelus* is a synapomorphy for Dicaelina. The spermatheca and appended gland in the subgenus *Isorembus* provide characters that are congruent with Ball's 1959 phylogeny for the group and suggest resolution for several ambiguous relationships. Apparent transformations of the female reproductive tract morphology include a shift from an elongate spermathecal gland and a spermatheca with a strongly differenciated tip to a spherical spermathecal gland and more uniform spermatheca. Other aspects of the tract appear to be highly conserved among the licinine taxa examined.

Key Words: character evolution, morphology, systematics

The tribe Licinini and in particular, species of *Diplocheila* have been thoroughly treated (Ball 1959, 1966, 1992). The clear diagnoses presented in those works allows for the recognition of new taxa when they are encountered. I recognize an additional specific member of the North American fauna using the criteria as defined by Nixon and Wheeler (1990), " . . . diagnosable by a unique combination of character states in comparable individuals".

In addition to the description of the new *Diplocheila* I present character data from the female reproductive tract. This character system has not been explored previously for the tribe Licinini although its utility for inferring phylogenetic relationships in carabids has been demonstrated in previous studies (Liebherr 1988, 1991; Liebherr and Will, in press). A cladistic parsimony analysis combining female reproductive tract characters and characters presented by Ball (1959) was not done because the female tract was examined only for exemplars from the major clades. A complete reanalysis of *Isorembus* would require the development of a cladistic character matrix including many character systems and more taxa. This is beyound the scope of this study. In order to investigate character transformation the female reproductive tract characters are mapped onto the existing phylogenentic hypothesis. Characters were found largely congruent with Ball's hypotheses for Licinini (Ball 1959, 1966, 1992). Characters supporting relationships within the *striatopunctata* group were ambiguous in Ball's (1959) work and so female tract characters used here provide synapomorphies for sister-group relationships among those taxa.

METHODS

External structures of the type series of *Diplocheila crossi* were examined using a dissecting stereo-microscope at magnification of 100× or less. Male genitalia were removed after softening the specimens in near boiling soapy water and then gently cleared in cold 10% KOH. Females were softened in near boiling soapy water, whole abdomens removed and placed in a ceramic spot plate in 10% KOH at either room temperature for 24 hours or in warm 10% KOH for 5–10 minutes. Further dissection was then done in a 10% acetic acid solution. The neutralized abdominal apex plus reproductive tract was then place in a saturated Chlorazol Black® dye and methyl cellosolve solution. Stained tracts were examined with the dissecting microscope under glycerine in a ceramic spot plate to determine the three dimensional aspects of structures. Tracts were then slide mounted in glycerine and examined using a phase-contrast compound microscope. Drawings were made using an ocular grid. Nomenclature of female reproductive tract structures follows Liebherr and Will (in press).

***Diplocheila* (*Isorembus*) *crossi* Will, new species**

(Figs. 1, 2A–2C, 3, 4, 10)

Diagnosis.—In contrast to other species of North American *Diplocheila,* this species and *D. striatopunctata* LeConte share a prominent tubercle on the dorsal surface of the left mandible. The distinct shape of the relatively larger pronotum (Fig. 1), widest behind the middle with the sides smoothly arcuate almost to the base, together with the form of the aedeagus, which is blunter at the tip and lacks any sign of a depression vertrally, (Fig. 2 a–d) separates *D. crossi* from *D. striatopunctata.*

Description.—Overall length 12.5–14.5 mm (anterior tip of labrum to apex of elytra).

Head (Fig. 1): Broad, rather quadrate, ocular ratio (greatest width over eyes/greatest width between eyes) 1.47–1.50, piceous, shiny, microsculpture very faint isodiametric with scattered punctulae visible at >60×, glabrous except for normal pair of supra-orbital setae over each eye, 1 seta at anterolateral corner of clypeus and 4 setae on labrum, Clypeus, margin of labrum, maxillary and labial palps and antennae paler, rufopiceous, sometimes slightly infuscated but never as dark as vertex of head; labrum deeply and asymmetrically emarginate, right side more prominently produced; mandibles broad, asymmetrical, right smooth, left with prominent dorsal protuberance; labial and maxillary palpomeres fusiform, glabrous except for stout pair of medial setae and a minute terminal seta on penultimate labial palpomere, Antennae reaching well past base of pronotum, basal antennomeres with 1 long subterminal seta, third with a ring 4–5 smaller setae, segments IV–XI densely pubescent except for thin, interior and exterior glabrous stripes, segments elongate, length 3.7–3.9× width.

Thorax (Fig. 1): Pronotum distinctly wider than long, median length/width at widest point 1.34–1.50, widest just behind midpoint; piceous, all margins thinly paler rufo-piceous, shiny, slightly duller than head due to more evident microsculpturing and punctulae, lateral margins smoothly curved to hind angles, hind angles slightly more obtuse than right, weakly or not produced, lateral bead slightly widening to apical margin, base unmargined and produced at inner basal impressions; inner basal impressions distinct and linear, outer impressions broadly and weakly impressed, lateral setae at apical third, basal setae set close to corner of hind angle, Proepisternum dull from strong isodiametric sculpticells, Prosternal process with a slight medial depression, tip of process strongly margined, Elytra broad, l/w 1.47–1.50, depressed, piceous, feebly shiny, microsculpture as in pronotum, epipleura with apical-two thirds paler, rufopiceous; humeri with minute tooth, shoulders prominent, stria 1–6 im-

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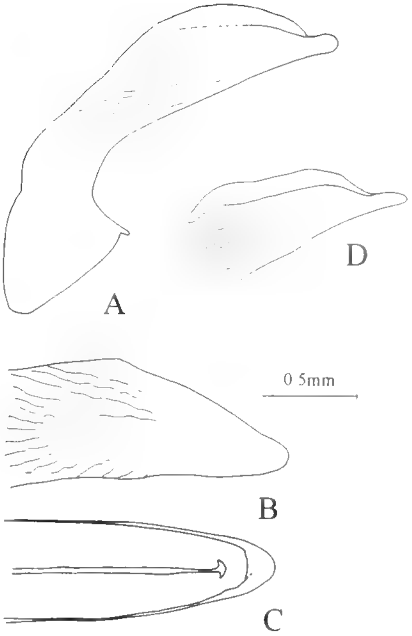

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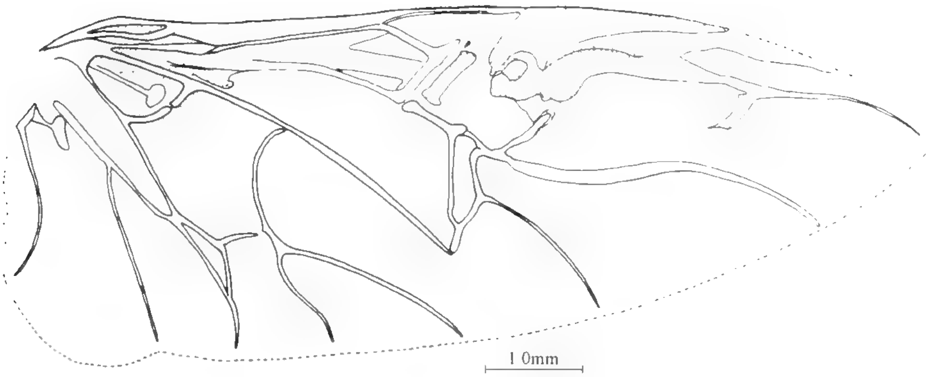

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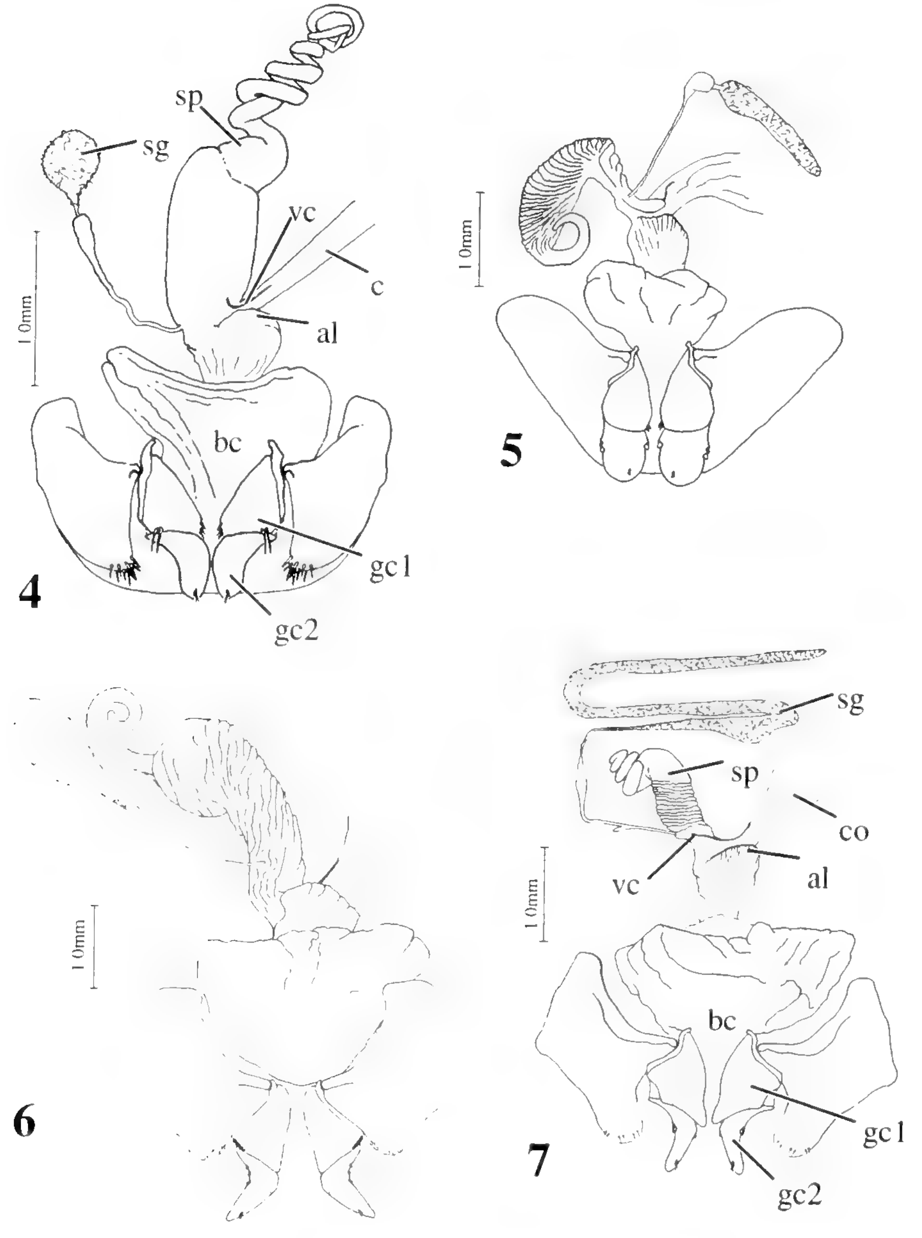
Figs. 1–3. 1, 2A–C, 3, *Diplocheila crossi.* 2D, *D. striatopunctata.* 1, Head and pronotum. 2A, Median lobe, left lateral. 2B, Median lobe, ventral. 2C, Median lobe, dorsal. 2D, Tip of median lobe, left lateral. 3, Metathoracic wing.

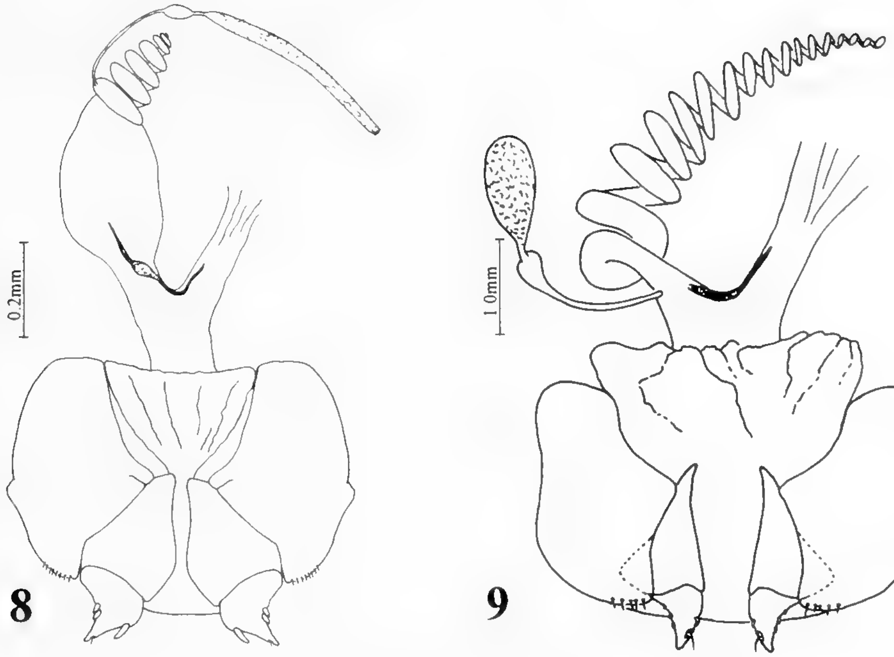
pressed, though often weaker apically and/or not reaching elytral base, striae smooth or with weak, elongate punctures, stria 7 faintly impressed, a single dorsal puncture on each elytron just behind midline on third interval or touching second stria; Flight wing (Fig. 3) large, length from axil to tip/width at widest point 2.57 (n = 1), fully reflexed at tip, Ventral pterothorax with strong microsculpture, isodiametric laterally, stretched mesh medially; metepisternum elongate, anterior width/length ratio 1.60, Hind tibia with 3–4 spines in posterior median row, Tarsomere V glabrous ventrally.

Abdomen: Ventrites with strong isodiametric microsculpture, male with 2, and female with 4 setae at apical margin of last visible ventrite, Male genitalia (Fig. 2 a–c):



Figs. 4–7. Female reproductive tract, ventral view. 4, *Diplocheila crossi*. 5, *D. polita*. 6, *D. zeelandica*. 7, *Dicaelus teter*. (bc = bursa copulatrix; co = common oviduct; al = apical lobe; gc1 = gonocoxite 1; gc2 = gonocoxite 2; sg = spermathecal gland; sp = spermatheca; vc = villous canal)

Aedeagus with tip rounded, shaft with apical half ventrally and laterally smooth, basal half weakly strigous, smoothly convex medio-ventrally, ostium dorsal, Female genitalic and reproductive tract (Fig. 4): Laterotergite IX triangular with prominent apical setae. Gonocoxite-I with 3 medial and 2 ventral setae. Gonocoxite-II without ensiform setae, and with 2 nematiform setae. Bursa copulatrix forming a cup with junction of spermatheca and common oviduct telescoped within. Bursa with distinct



Figs. 8–9. Female reproductive tract, ventral view. 8, *Badister reflexus*. 9, *Siagonyx* sp.

ventral lobe at base of oviduct. Spermatheca with broad base and long ribbon-like apical horn. Base and apex of similarly thin cuticle. Villous canal well developed, running from near base of spermatheca and terminating well up common oviduct. Spemathecal gland duct inserts basally into spermatheca; Gland has a distinct ampulla and spherical reservoir.

Types.—Holotype: 33°10′07″N, 90°18′36″W, USA, MISSISSIPPI, Washington Co., Leroy Percy S.P., 23-V-1995, Cols. K. Will & R. Androw. (♀, CUIC) Allotype: Florida, Jackson Co., Spring Lake, 10 Jul[y] 1981, W. H. Cross, Collected at artificial light (♂, MUIC) Paratypes: Same data as holotype (♀, KWW collection); same locality data as allotype plus second label with "blacklight trap in deciduous woods" (♀, MUIC); ILLINOIS, Henry Ulke Coll. (2 ♂, 2 ♀, CMNH); Johnson Co., Heron Pond, May 1 1976, L. R. Davis Jr. (2 ♀, 1 ♂, CMNH); Alexander Co., Horseshoe Lake, 30 April 1976, L. R. Davis Jr. (♂, CMNH); MISSISSIPPI, Washington Co. Leroy Percy St. Pk., 5 mi. W. Hollendale, D., M. & E. Hildebrandt, T15N, R7W, Sec. 5, under logs, boards in hardwood swamp (12 April 1997, 2 ♂, 5 ♀; 14 April 1997, 3 ♀, D. Hildebrandt Collection), TENNESSEE, Shelby Co., Meeman Biolog. Sta., 20 km N Memphis, July 1–10 1991, R. Ritke (♀, CMNH).

Etymology.—The species is named in honor of William H. Cross, an excellent general collector, from Mississippi State University. R. A. Androw and I were on our way to participate in a collecting expedition in his name when the holotype and one paratype were collected. Additionally, the allotype and one paratype were collected in 1981 by Dr. Cross.

Affinities.—*Diplocheila crossi* shares characteristics of the head, concave front and clypeus and asymmetrically emarginate labrum, with other members of *Isorembus* and it shares the following apomorphies with the *striatopunctata* group as defined by Ball (1959): gonocoxite-II without ensiform setae, prosternal apex margined, and tarsomere V without ventral setae. The appended gland is spherical as in *D. major major* and *D. striatopunctata*. The dorsal tubercle of the left mandible and the strigous medial lobe are synapomorphies for

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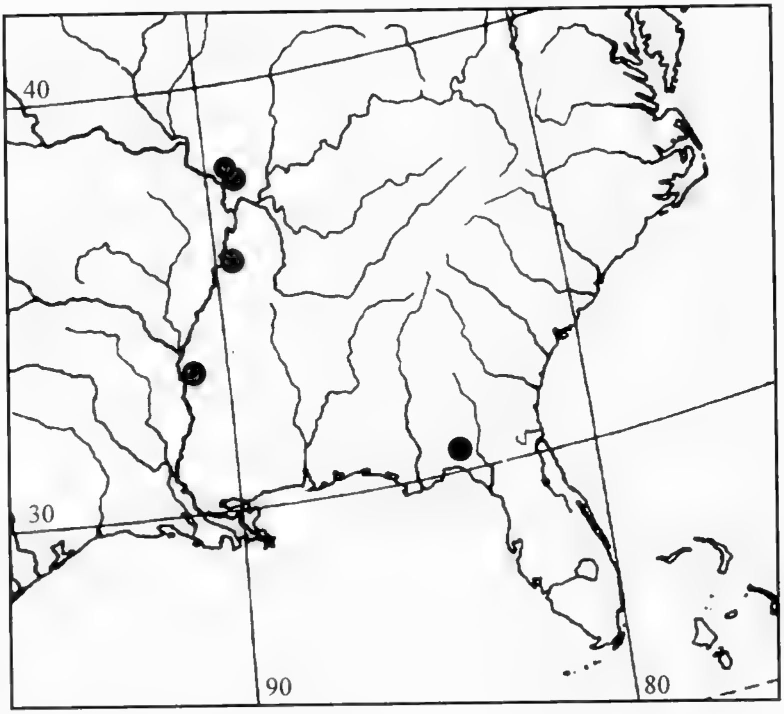

Fig. 10. Distributional records for *Diplocheila crossi*.

D. crossi and *D. striatopunctata* (Fig. 11, characters 5–6).

Geographic range.—The 23 specimens in the type series suggest a range (Fig. 10) that is restricted to the Gulf coast and lowlands of the Mississippi drainage.

Ecology.—The holotype and one paratype were collected in a swampy area with highly organic soil. Several species of *Brachinus, Chlaenius, Loxandrus* and, *Lophoglossus* were also collected in this same habitat.

ANALYSIS AND DISCUSSION OF CHARACTERS OF THE FEMALE REPRODUCTIVE TRACT

Taxa and methods.—Females were examined for the following species; *Badister reflexus* LeConte, *Licinus punctatulus* F., *Dichrochile goryi* Boisduval, *Siagonyx* sp., *Dicaelus polita* Dejean, *D. teter* Bonelli, *Diplocheila* (s.str.) *polita* F., *D.* (*Isorembus*) *zeelandica* Redtenbacher, *D.* (*I.*) *cordicollis* Laferté, *D.* (*I.*) *aegyptiaca* Dejean, *D.* (*I.*) *obtusa* LeConte, *D.* (*I.*) *striatopunctata* LeConte, *D.* (*I.*) *crossi* new species, *D.* (*I.*) *nupera* Casey, and *D.* (*I.*) *major* LeConte.

The licinine female reproductive tract morphology is conserved in all taxa examined (Figs. 4–9). The basic arrangement includes a thick walled, cup-shaped bursa. The common oviduct and spermatheca apically join the bursa and are telescoped into the concavity of the cup. The spermatheca is curled or coiled, at least at the tip. The villous canal runs between the base of the spermatheca and onto the common oviduct. This canal can be more or less developed, but is present at least as a small patch. A gland is appended to the spermatheca with its duct entering into the basal third of the spermatheca.

The reproductive tract of Dicaelina (Figs. 4–6). Ball (1992) provides synapomorphies for all the licinine subtribes except for Dicaelina. He stated that characters were ambiguous regarding resolution of the basal polytomy of *Diplocheila, Dicaelus* and (Licinina (Lestignathina + Dicrochilina). He posited a working hypothesis that *Diplocheila* + *Dicaelus* form a monophyletic Dicaelina and suggested that characters systems other than those previously explored may yield synapomorphies for the clade. Among taxa examined only *Diplocheila* and *Dicaelus* were found to have a apical lobe on the bursa copulatrix (al, Figs. 4, 7). This character is considered a synapomorphy for the subtribe (Fig. 11, character 1).

The differentiated tip of the spermatheca is several times longer than the spermathecal base in *Dicaelus* and most *Diplocheila* species. However, both *D. polita* and *D. zeelandica* have a very short tip relative to the base (Fig. 11 character 2). This could be interprted as a synapomorphy of these taxa making *Isorembus* paraphyletic relative to *Diplocheila* s.str. However, given the suite of characters supporting the monophyly of the subgenus *Isorembus* (i.e., modifications of clypeus, labrum, mandibles [Ball 1959, 1992] and ovoid or spherical appended spermathecal gland) the striking similarity of spermathecae in *Diplocheila* (s.str.) *polita* and *D.* (*I.*) *zeelandica* can be interpreted as convergence. Shortening of the spermathecal tip in *Diplocheila* s.str + *Isorembus* and then the reaquasition of a long tip in *Isorembus* minus *D. zeelandica* is an equally possible optimization of this character transformation. Convergence to the reduced form is preferred as a working hypothesis based on the assumption that reduction to a simpler form seems more plausible than the reappearance of the elongate coil. Sampling of more taxa from *Diplocheila* s.str. and the *zeelandica* group may provide an unambiguous optimization for this character without the need for assumption of process.

The shape of the spermathecal gland varies from elongate, many times longer than wide (Fig. 7); to ovoid, 2–4 time longer than wide (Fig. 6); to spherical, of approximately equal length and width (Fig. 4). *Dicaelus* and *Diplocheila polita* have elongate glands. Members of *Isorembus* have ovoid or spherical glands (Fig. 11, character 3). The ovoid state is found in the basal *Isorembus* species (*zeelandica* group, *aegyptiaca* group, *D. obtusa, D. nupera*). A spherical gland is a synapomorphy for *Diplocheila major major, D. crossi, and D. striatopunctata* (Fig. 11, character 3′).

In all Dicaelina the base of the spermatheca is expanded relative to its tip. A similar condition is found in *Badister* (Fig. 8) and *Dicrochile*. Long, undifferentiated and spiral spermathecae are found in *Licinus* and *Siagonyx* (Fig. 9). Possible adelphotaxa to Licinini, e.g. Panagaeini, Orthogonini, and Melanochitonini do not have spiral form spermathecae and do not show any differentiation between the base and tip of the spermatheca (Liebherr and Will, in press). The primative condition of the spermatheca in licinines is ambiguous. The base-tip differentiation could be interpreted as a synapomorphy for Dicaelina. However, since discrete states are difficult to assign, assesment of homology remains unclear at this taxonomic level.

Within Dicaelina, *Dicaelus, Diplocheila polita, D. zeelandica,* and species of the *aegyptiaca* group have the spermathecal base well developed, thick, highly sculptured (when without spermatophore) and sharply contrasting with a smooth, horn-like spiral tip. The spermatheca of the *striatopunctata* group (Fig. 11, character 4) has an expanded basal area, but this is not of a fundamentally different composition from that of the spiral horn-shaped tip.

CONCLUSIONS

The addition of new taxa and characters provides the only real test of phylogenetic hypotheses. The addition of *D. crossi* and examination of characters of the female reproductive tract increases the robustness of previous phylogenetic hypotheses for licinines. Morphological studies have been and will continue to be the basis for the vast majority of stable, natural classifications. New character systems and new methods of interpretation are the bricks and mortar of systematics. With careful dissection and in-

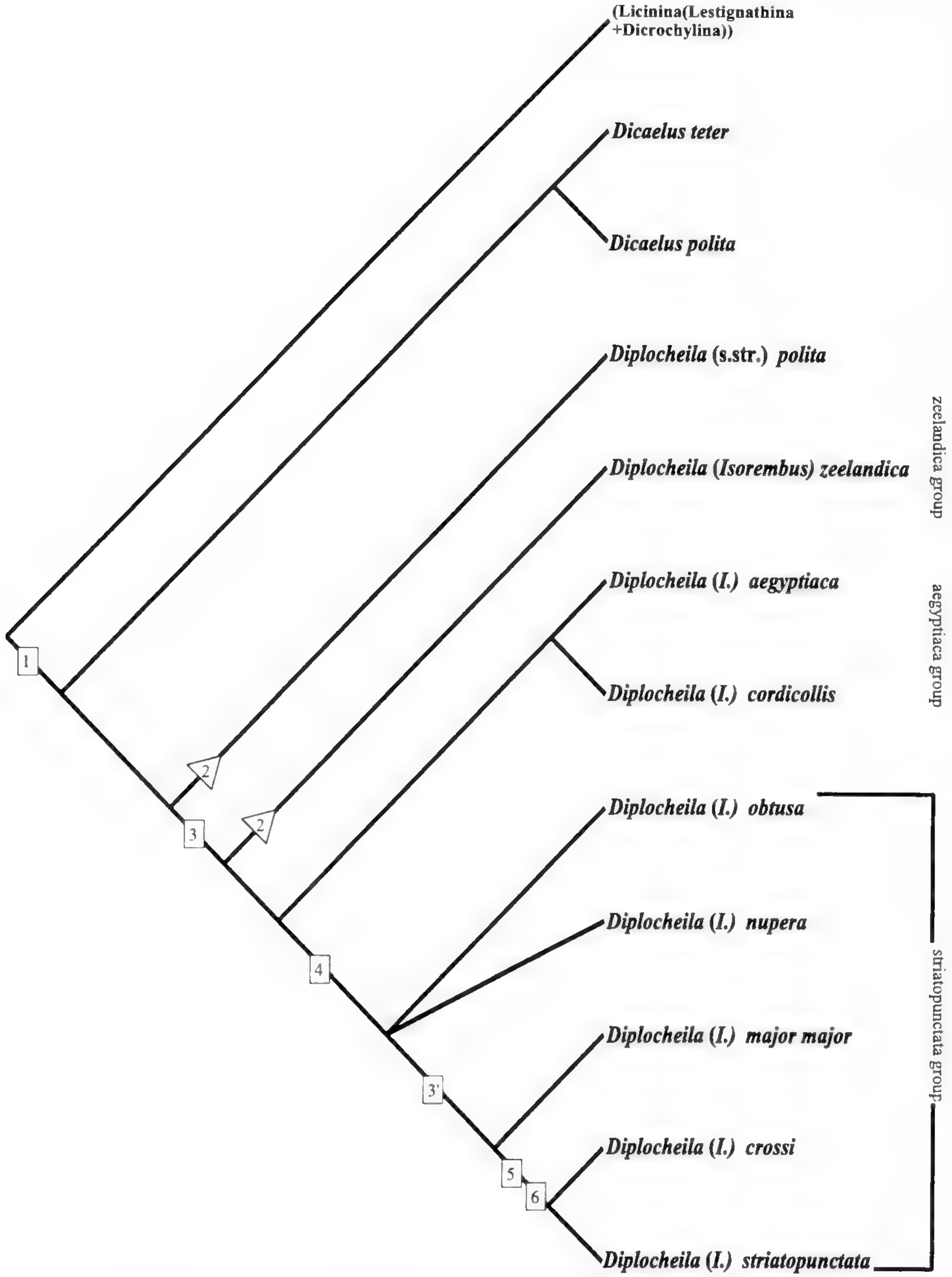

Fig. 11. Cladogram of selected Licinini. Characters: 1 = ventral lobe of bursa present; 2 = spermatheca with short tip; 3 = appended gland ovoid; 3′ = appended gland spherical; 4 = spermathecal base and tip differentiated; 5 = mandible with prominent tubercle; 6 = median lobe strigous. See text for explanation of characters.

terpretation, the female reproductive tract of carabids can provide characters useful for the building or buttressing of phylogenetic hypotheses.

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I thank D. H. Kavanaugh, California Academy of Sciences, San Francisco, CA, and J. K. Liebherr and Q. D. Wheeler, Cornell University (CUIC), Ithaca, NY, for reviewing the original manuscript. Robert Davidson, Carnegie Museum of Natural History (CMNH), Pittsburgh, PA, and R. Brown and D. Hildebrandt, Mississippi State University (MUIC), State College, MS, provided loans of material.

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TWO NEW SPECIES OF CENTRAL AMERICAN *HEDYCHRIDIUM* ABEILLE DE PERRIN (HYMENOPTERA: CHRYSIDIDAE)

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Abstract.—Two new species, ***Hedychridium costaricae*** and ***H. elisar,*** are described from Costa Rica. These are the first species of *Hedychridium* recorded for the Neotropical Region.

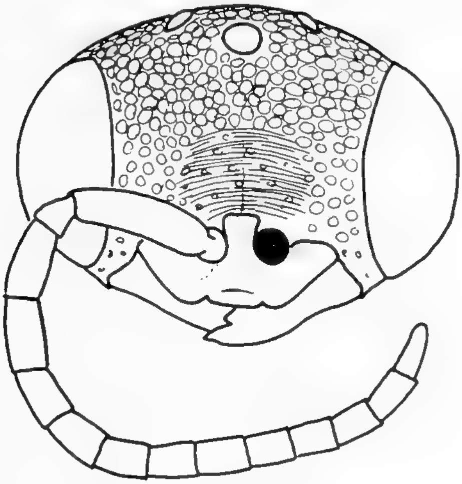
Key Words: *Hedychridium, costaricae, elisar,* Chrysididae, Hymenoptera, Neotropical Region

Bohart and Kimsey (1978) and French (1985) reevaluated the generic placement of known Neotropical species of *Hedychridium* Abeille de Perrin and determined that all actually belonged in the genera *Pseudolopyga* Krombein (*Hedychridium chilensis* (Mocsáry)) and *Exallopyga* French (*H. difficilis* Spinola and *H. guatemalensis* Cameron). As a result, *Hedychridium* species were only known in the Western Hemisphere from North America. However, intensive collecting by Frank Parker and INBio (Instituto Nacional de Biodiversidad) personnel in Costa Rica have discovered many biotic surprises not the least of which are two previously unknown species of *Hedychridium,* described below. These Costa Rican *Hedychridium* species have all of the features typical of *Hedychridium* including having tarsal claws with a single perpendicular submedial tooth, a simple mesopleuron without scrobal sulcus or omaulus and pronotal anterior margin with sublateral carina.

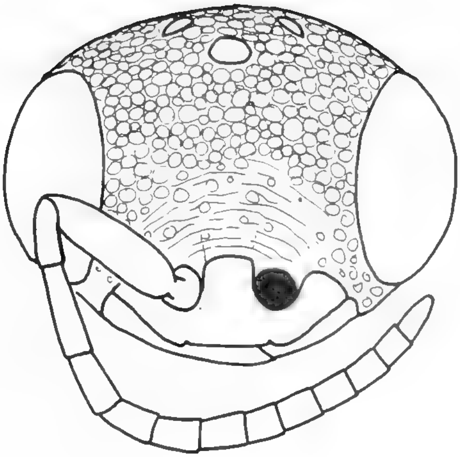
Specimens were obtained for this study from the Utah State University Collection, Logan (LOGAN), which is where material collected by Frank Parker has been deposited, and from INBio, Santo Domingo de Heredia, Costa Rica (SANTO DOMINGO). Some paratypes have also been deposited in the Bohart Museum of Entomology, University of California, Davis (DAVIS). Type deposition is indicated in capital letters enclosed in parentheses.

Hedychridium costaricae Kimsey, new species
(Figs. 1, 3, 4)

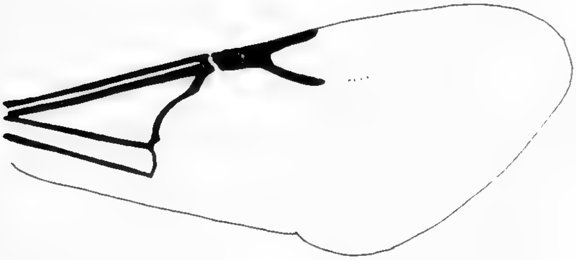
Male.—Body length 2.0–3.5 mm; face (Fig. 1); malar space 1 midocellus diameter; subantennal space one midocellus diameter, face and vertex with dense nearly contiguous punctures; scapal basin with narrow medial, sparsely punctate zone covered with dense transverse striae; flagellomere I twice as long as broad and more than twice as long as pedicel; flagellomeres II–III 1.4–1.5× as long as broad; flagellomere XI 2.6–2.7× as long as broad; thoracic dorsum with contiguous, medium punctures, becoming slightly less dense medially; pronotal side densely punctate; mesopleuron with dense, contiguous medium-sized punctures; forefemur without ventral carina or angle; forewing R1 and Rs extending equally far toward wing tip, medial vein joining MCu at a right angle (Fig. 3); propodeal



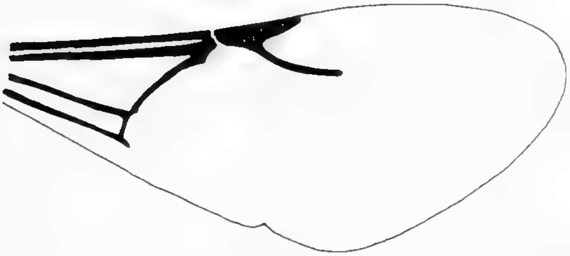
1. *costaricae*



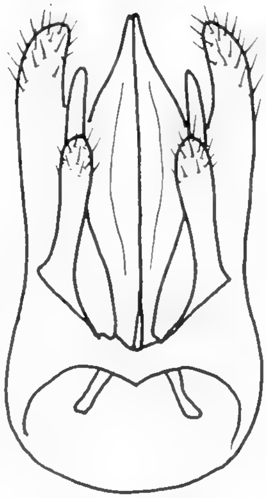
2. *elisar*



3. *costaricae*



4. *elisar*



5. *costaricae*

Figs. 1–5. 1, 2, Front view of face with one antenna removed. 3, 4, Forewing venation. 5, Male genital capsule, ventral view.

tooth narrowly triangular; tergal punctures 0.5–1.0 puncture diameters apart; apical tergum with apical margin appearing rolled under; genital capsule (Fig. 4); digitus slender and slightly clubbed apically, half as long as gonostylus; aedeagus without apical bristles. Head and thorax blue with purplish band across face; terga blue, tergum II medially with large purple spot; tegula blue; coxae, femora and tibiae blue with non-metallic red joints and tarsomeres; scape and pedicel dark blue; flagellum black; sterna I–III blue; wing membrane whitish, veins brown. Pubescence sparse, erect and pale; scapal basin without dense appressed pubescence.

Female.—Body length 2.5–3.5 mm; same as male except body color bluish green.

Type material.—Holotype ♂: Costa Rica, Guanacaste Prov., s Cañas, 11–15 March 1989, F. D. Parker (LOGAN). Paratypes (LOGAN, DAVIS, SANTO DOMINGO): 8 ♂, 25 ♀: same data as holotype except collection dates 21 Jan.–25 March 1989; 4 ♀: 14 km s Cañas, 12–17 Feb. 1989, F. D. Parker; 1 ♂: 4 March 1989, F. D. Parker; 1 ♀ Santa Rosa National Park, 28 Dec.–15 Jan. 1986, Gauld/Janzen.

Discussion.—This species belongs to the *crassum* group (Bohart and Kimsey 1978) and shares many similarities with *H. purum* Kimsey, including the short pedicel, whitish wings, similar wing venation and unmodified gastral tergum II and forefemur. However, *H. costaricae* can be distinguished from *H. purum* and other members of the *crassum* group by the long flagellomere I, shorter flagellomere XI and punctate pronotal side.

Etymology.—The species name, *costaricae,* refers to the country of collection.

Hedychridium elisar Kimsey, new species
(Figs. 2, 4)

Female.—Body length 2–3 mm; face (Fig. 2); malar space 1.2 midocellus diameters; subantennal space one midocellus diameter; scapal basin with coarse contiguous punctures and medial zone of dense transverse striae; vertex and thoracic dorsum with contiguous medium-sized punctures, becoming larger on scutellum; flagellomere I 3×, as long as broad, less than twice as long as pedicel; flagellomere II 1.9–2.0× as long as broad; flagellomere III 1.4× as long as broad; flagellomere XI 2.8–3.0× as long as broad; pronotal lobe punctate laterally; mesopleuron with medium-sized contiguous punctures except for densely cross-ridged zone above midcoxa; forefemur without ventral carina or angle; forewing Rs twice as long as R1, medial vein joining MCu at an obtuse angle (Fig. 4); propodeal tooth narrowly triangular; tergal punctures small and contiguous and transversely striatiform; apical tergum with apical margin appearing rolled under. Head, thorax and abdomen bluish green, becoming black on vertex, between notauli, on a transverse band across pronotum, medially on scutellum, medially and the lower half of propodeum, and the middle of terga I–III; tegula brown, with slight green tint; coxae, femora, tibiae and scape greenish; tarsomeres, pedicel and flagellum dark brown; sterna brown; wing membrane brownish, veins dark brown. Pubescence sparse, erect and pale; scapal basin without dense appressed pubescence.

Type material.—Holotype ♀: Costa Rica, Guanacaste Prov., s Cañas Exp. Sta., 8–18 March 1988, F. D. Parker (LOGAN). Paratypes (LOGAN, DAVIS): 2 ♀, same data as holotype.

Discussion.—Ordinarily males are chosen as holotypes in *Hedychridium* because they have more diagnostic features. However, in this case a single male specimen included in the Frank Parker material was so badly discolored and greasy, with mutilated wings, that it was not included even in the paratype series. *Hedychridium elisar* belongs to the *amabile* group and keys out to *H. rasile* Bohart and *H. solierellae* Bohart and Brumley in Bohart and Kimsey (1978), based on the long pedicel and flagellomere I and long Rs vein. The distinctive coloration of the body and punctation of gastral tergum II being contiguous and slightly striatiform will distinguish *H. elisar,* from both *H. costaricae* and other members of the *amabile* group.

Etymology.—The name *elisar* is an arbitrary combination of letters suggested by the species that most closely resembles this one, *rasile*; *elisar* is a noun in apposition.

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DESCRIPTIONS OF TWO NEW SPECIES OF SOUTH AMERICAN *OLIARUS* STÅL (HOMOPTERA: FULGOROMORPHA: CIXIIDAE), INCLUDING A RICE-ASSOCIATED SPECIES FROM PERU

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Abstract.—Two new species of *Oliarus* are described, ***O. oryzicola*** from Peru and ***O. kindli*** from French Guyana. Biological notes are given for *O. oryzicola* which feeds on rice.

Key Words: *Oliarus,* Peru, French Guyana, rice-associated

The majority of planthopper (Fulgoroidea) species that occur on rice (*Oryza sativa*) throughout the world are members of the family Delphacidae (Wilson and Claridge 1991). This is, perhaps, not surprising because so many delphacid species are associated with Graminae. When individuals of some other planthopper families are found on rice, including the family Cixiidae, they are usually considered to be 'casuals' and have little or no importance as pests.

The extensive literature search of Wilson et al. (1994) lists only one species of cixiid, *Pentastiridius apicalis* (Uhler) on rice. In this paper we report a new species of *Oliarus* on rice in Peru. In the course of investigations on this species we found a second closely related species and take the opportunity to also describe it.

Abbreviations of depositories are BMNH: The Natural History Museum, London, U.K.: MNHN: Muséum National d'Histoire Naturelle, Paris, France; USNM: National Museum of Natural History, Smithsonian Institution, Washington, D.C. U.S.A.

THE GENUS *OLIARUS*

Members of the genus *Oliarus* Stål, as currently diagnosed, are found in almost all parts of the world. Species discrimination depends entirely on examination of the male genitalia, in particular on the structure of the aedeagus. Mead and Kramer (1982) revised the *Oliarus* species in North America (north of Mexico) and recognized 51 species. These authors were conservative in their treatment of the genus and did not use any of the current subgenera but did recognize a series of species groups based on the structure of the aedeagus. We follow the same principles here, and, in the absence of any phylogenetic analysis of *Oliarus,* we indicate possible phylogenetical links of the two new species with a previously described one. Over 20 *Oliarus* species have been recorded from Central and South America and from the Galapagos islands. Unfortunately many of the species are based on female type specimens and until characters based on the female are fully investigated we cannot compare them with any degree of confidence. We accept the possibility that the two species described here may become synonyms with further revisionary study of the South American cixiid fauna.

The morphological terminology follows Mead and Kramer (1982). According to Bourgoin and Huang (1990) the male periandrium ends at level of the process 5 (aedeagal joint level in Mead and Kramer 1982) where the ligamentary processes are fused with the aedeagus (= flagellum, Mead and Kramer 1982). The dorsal membranous part of the periandrium corresponds to endotheca in direct prolongation with the sclerotinized part or phallotheca. The aedeagus sensus stricto is followed by a membranous endosoma.

Oliarus oryzicola Bourgoin, Wilson, and Couturier, new species

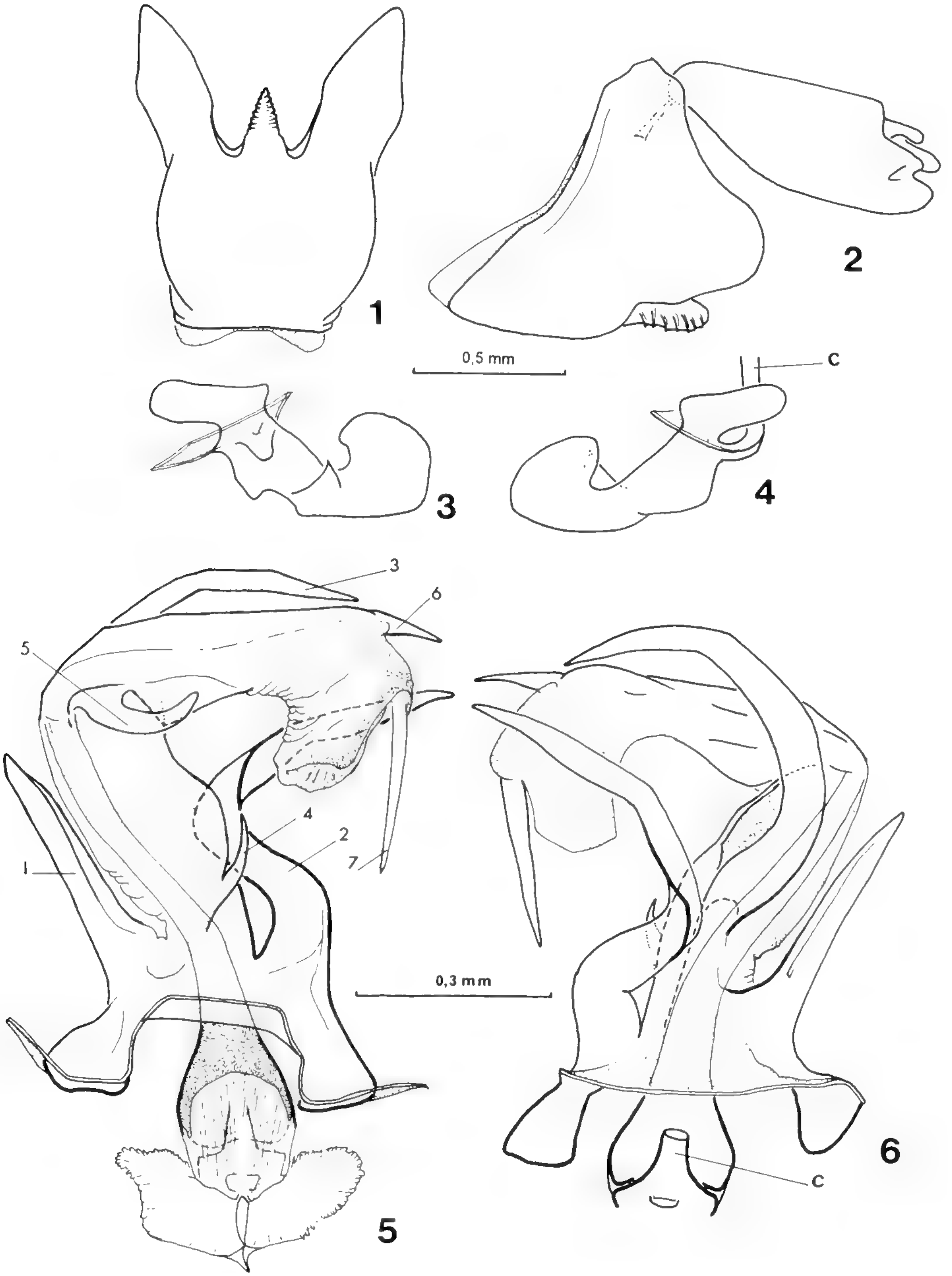
(Figs. 1–6)

Diagnosis.—*Oliarus oryzicola* can be separated from other *Oliarus* spp. by the combination of the following male genitalia characters: anal segment without posterior process, medioventral process of the pygofer shorter than the lateral lobes; in ventral view: apex of aedeagus facing anteriorly but not passing behind dorsal side of periandrium; in ventral view three long spine-like periandrium processes (Fig. 5: 1, 2, 3) and one subapical endosomal process (Fig. 5: 7). All these characters lead to *O. humilis* (Say) (Mead and Kramer, 1982) and to the two new species described here. From *O. humilis* it can be separated by the presence of a long lateral aedeagal process (Fig. 5: 6) not separated from the aedeagus. From *O. kindli* sp. nov. *O. oryzicola* is separated by the comma-like basal aedeagal process (Fig. 5: 5) which is S-shaped in *O. kindli.*

Description.—Length, male 5.6–6 mm; female 7.7–7.9 mm. Vertex longer at lateral margin than broad at level of anterior margin of eyes; posterior margin strongly notched, lateral margins elevated; media carina feebly marked on its basal half. Frons with media carina prominent; intercarinal areas dark in color; carinae tawny; basal fork of media carina short. Rostrum surpassing metacoxa; apically black. Pronotum with intermediate carina attaining pale band of posterior margin; medium to dark brown. Mesonotum with median carina prominent; intermediate, arcuate, and lateral pairs weaker, diverging distally; medium to dark brown; tegula paler. Tegmina hyaline; tubercules very short, concolorous with pale yellow veins; stigma pale brown. Legs yellowish, generally 4 tibial (3–5) spines: two small basal ones, and others longer. Metatibiotarsal formula 6/7/7. Male anal segment in dorsal view subovate; longer than broad; posterior margin concave; lateral margin of anal foramen clearly elevated and thickened.

Male genitalia: Pygofer as in Figs. 1, 2; medioventral process conical, triangular in ventral view, clearly marked with little parallel ridges on each side; extending posteriorly slightly less than half as far as lateral lobes of the pygopher in ventral view. Lateral lobes well produced, nearly symetrical, diverging distally in ventral aspect. Aedeagal complex as in Figs. 5 and 6. In dorsal view, periandrium with right process (1), strong, moderately long, more or less short; not surpassing posterior margin of periandrium; distally spinose. Left process longer (2); basally wider, slightly turning right then produced left in a strong spinose process. A short medio-dorsal acute process (4), sometimes very short, tooth-like. At aedeagus base level a stronger process, transversal and comma-like (5). In ventral view a strong medio-ventral spinose process (3), turning left, surpassing posteriorly aedeagus and reaching base of the subapical aedeagal process (6); this process strong and short, directed left. Subapical endosomal process (7), spinose, short, slender and long, directed cephalad. Gonostyli (Figs. 3 and 4) apically rounded and recurved; a short internal rounded process basally; an acute blade-like tooth pointing dorsad more apically.

Etymology.—Named for the rice association.



Figs. 1–6. *Oliarus oryzicola,* male genitalia. 1, Pygofer from below. 2, Pygofer and anal segment, lateral view. 3, Paramere, left view. 4, Paramere, right view. 5, Aedeagus, dorsal view. 6, Aedeagus, ventral view.

Material examined.—Holotype ♂: Perù—Loreto, Jenaro Herrera, 12.VI.92, G. Couturier col., Systema agrofor. H.i.s., ex larva, on roots of rice, MNHN-HF-93-2. Paratypes as follows: 8 ♂, 2 ♀ same data as holotype (5 ♂, 2 ♀, MNHN) (1 ♂, 1 ♀, Universidad National Agraria La Molina, Lima, Peru); (1 ♂, 1 ♀, BMNH); (1 ♂, USNM). The specimens were collected 500 m from the River Ucayali, close to the village Jenaro Herrera (4°55′ S, 73°40′ W), 200 km southwest of Iquitos, at an experimental field of the "Instituto de Investigacion de la Amazona peruana" (IIAP).

Other specimens examined.—4 nymphs, same data as holotype.

Distribution.—Peru

Biology.—Specimens were found on *Oryza sativa,* local variety "Inti." Between 5–20 nymphs were found on each clump of rice plants, living on the roots (Couturier et al. 1995). The fields are annually flooded for several months and called "restinga" in Peruvian amazonia. The rice is sown as the waters recedes. Nymphs of cixiids are normally found feeding on the roots of a wide range of host plants. The analysis of Wilson et al. (1994) showed that most records of nymphal feeding by cixiids originated from grasses while most adult records were from woody plants.

Remarks.—The name of the species but without any description was mentioned by Couturier et al. (1995).

Oliarus kindli Bourgoin, Wilson, and Couturier, new species

(Figs. 7–9)

Diagnosis.—*Oliarus kindli* may be isolated from other *Oliarus* species by the same combination of male genitalia characters listed for *O. oryzicola,* which leads to *O. humilis* (Say) using Mead and Kramer's key (1982). From *O. humilis* this species can be separated by the presence of a long lateral aedeagal process (Fig. 8: 6) not separate from the aedeagus and similar to the one observed in *O. oryzicola,* but stronger and longer. The S-shaped basal aedeagal process (Fig. 8: 5) is very distinctive.

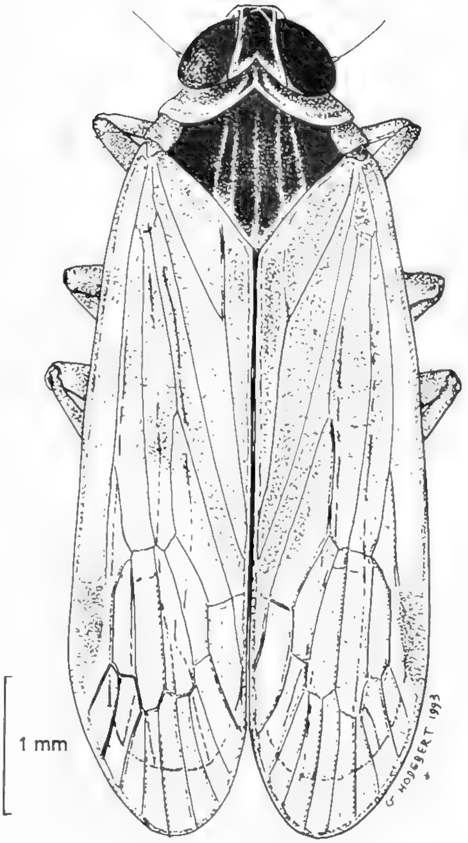


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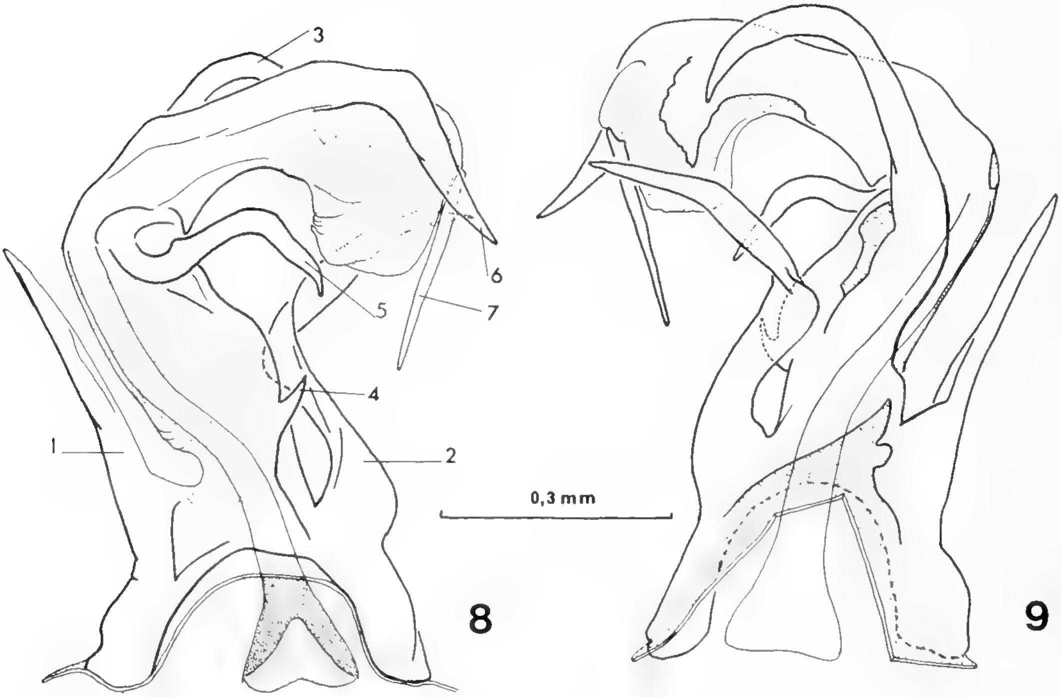
Fig. 7. *Oliarus kindli,* habitus

Description.—Length, male 5.5–6.2 mm; female 6.5–8 mm. Externally very similar in appearance to *O. oryzicola.*

Male genitalia: Anal segment in dorsal view subovate; longer than broad; posterior margina clearly concave; lateral margin of anal foramen clearly elevated and thickened. Pygofer as in previous species. Aedeagal complex as in Figs. 8, 9. In dorsal view, periandrium with right process (1), strong, long and stout, reaching level of aedeagus; distally spinose. Left process (2) longer; basally wider, slightly turning right then produced left in a strong spinose process. A short medio-dorsal acute process (4), sometimes very short. At aedeagus base level (posterior margin of periandrium) a twice recurved spinose



Figs. 8–9. *Oliarus kindli*, male genitalia, aedeagus. 8, Dorsal view. 9, Ventral view.

process (5), transverse, S-shaped: turning first latero-posteriorly at 90° then turning cephalad at 90°. In ventral view a strong medio-ventral spinose process (3), turning left, surpassing posteriorly aedeagus and turning left again pointing more or less anteriorly. Subapical endosomal aedeagal process (6) strong, in direct prolongation of aedeagus, directed left and cephalad. Subapical endosomal process spinose, short, slender and long, directed cephalad. Gonostyli apically rounded and recurved; a short rounded internal and dorsal process basally; an acute blade-like tooth pointing dorsad more apically, stronger than in previous species.

Etymology.—Named for the collector, P. Kindl.

Material examined.—Holotype ♂: labelled: Guyane Française, Piste Coralie pk 02-28.I.1993, P. Kindl rec., Museum Paris, Holotype, MNHN-HF-93-3. Paratypes as follows: 15 ♂, 17 ♀ same data as holotype (12 ♂, 14 ♀ all with sex label, red paratype label and MNHN-HF-93-3, MNHN) (2 ♂, USNM) (1 ♂, 3 ♀, BMNH).

Other specimens examined.—133 specimens from French Guyana, Pk 2 Piste Coralie, L. Sénécaux rec. (various date) and 26 specimens: Guyane Française, Piste Dégrad Corréze, RN2, pk 62-26.XI.1992, P. Kindl rec. (MNHN). 2 ♂ and 1 ♀ from Brazil: env. de Belèm, Sao Antonio, 27.IX.1975/ Moyen Xingu (Brésil), Mission M. Boulard, P. Jauffret & P. Pompanon, Muséum Paris (MNHN).

Distribution.—French Guyana, Brazil.

Remarks.—This species is very similar to the previous species and the two obviously belong to the same species group. The form of the apical periandrium process (Figs 5, 8: 5) and of the subapical aedegal process (Figs 5, 8: 6) give the best characters to separate the two. In the Brazilian specimens the apical periandrium process is a little shorter than in the Guyanan ones.

CONCLUSIONS

These two new species have a similar pygofer and male genitalia conformation to *O. humilis* (Say) as figured by Mead and Kramer (1982) with the exception that the medio-dorsal periandrium process is absent in the two South American species. The possession of this character seems too important to allow the recognition of a '*humilis*' species-group in a way similar to that proposed by Mead and Kramer (1982) for several other *Oliarus* species. Moreover, *O. humilis* is distributed mainly in the northern half of the United States and southern Canada; in Southern United States it only reaches northern Arizona (Flagstaff) and New Mexico (Albuquerque). However, it is interesting to note that both *O. oryzicola* and *O. kindli* share also several characters with another species-group distributed in the Galapagos as figured by Fennah (1967). Fennah has related this species, represented by *O. galapagensis* Van Duzee to *O. concinnulus* Fowler and *O. franciscannus* Stål.

ACKNOWLEDGMENTS

The study and collection of *O. oryzicola* was made under the framework of the agreement IIAP-ORSTOM. We thank H. Inge Sanchez and E. Tanchiva Flores for assistance in the field.

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A REVISION OF THE GENUS *LAMYRISTIS* MEYRICK (LEPIDOPTERA: PSYCHIDAE) AND PROPOSAL OF A NEW RELATED GENUS *ACOREMATA* FROM SOUTHEAST ASIA

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Abstract.—The southeast Asian genus *Lamyristis* Meyrick 1911, including its synonym *Parameristis* Meyrick 1919, is revised. Previously assigned by various authors to the families Plutellidae, Yponomeutidae, or Tineidae, its proper placement within the Psychidae was recognized recently by Robinson and Tuck (1996). Included species are *L. leucopselia* Meyrick, *L. eremaea* (Meyrick), and ***L. bruneiensis,* new species**. A new genus and species, ***Acoremata aquila,*** is also described and illustrated. At least one synapomorphy, the broad, flattened scale vestiture of the foreleg, closely associates the two genera.

Key Words: Arrhenophanidae, bagworm moth, *Acoremata, Lamyristis, Parameristis*

Determining the family relationships of psychid species with fully winged females was a consistent problem for early lepidopterists such as Edward Meyrick, who tended to include such taxa in the Tineidae or even non tineoid superfamilies such as the Yponomeutoidea. For example, the principal genus treated in this report, *Lamyristis,* was placed by Meyrick (1911) in the Plutellidae and subsequently listed by Fletcher (1929) in the Yponomeutidae. *Parameristis* was described by Meyrick (1919) in the Tineidae, and was recently synonymized under *Lamyristis* and properly placed in the Psychidae by Robinson and Tuck (1996).

Meyrick's (1895) early concept of the Psychidae essentially agreed with most accounts published down to the middle of this century in restricting the family to those species lacking a haustellum and possessing apterous females. Only recently have the true affinities of some of the most primitive psychid genera been established (Gozmany and Varí 1979; Robinson and Nielsen 1993). Until all of the previously named tropical yponomeutoid and tineoid genera have been re-examined, the diversity of the Psychidae at the generic level, and even the subfamily classification, will remain uncertain.

During the course of my study of the tineoid family Arrhenophanidae, I had the opportunity to examine a series of mostly unidentified moths from southeast Asia that superficially resembled the Arrhenophanidae recently reported from Taiwan (Davis 1991). After dissecting the specimens, I discovered that approximately half of the species represented Arrhenophanidae and the remainder were Psychidae. Among the Psychidae examined, two genera are recognized: *Lamyristis* and the new genus *Acoremata.* Both genera can now be added to the recently published checklist of the Southeast Asian Psychidae (Norman et al. 1994).

One possible synapomorphy linking *Lamyristis* and *Acoremata* is the broadly flattened scale vestiture of their forelegs. Two plesiomorphies (for Psychidae) shared by both genera are the retention of three-segmented maxillary palpi and a short haustellum. Until recently (Davis, in press) either one or both of these structures were considered absent in Psychidae (Common 1990). Both *Lamyristis* and *Acoremata* possess a typical psychid thoracic metafurca with a complete furcal bridge (Robinson 1988). Their male genitalia are also typically psychoid in possessing a large saccular lobe and a membranous, non-articulated anellar tube. Arrhenophanid aedoeagi are distinct in being tightly enclosed by a sclerotized anellar tube that articulates via the juxta to the vinculum. The female genitalia of Psychidae differ most notably from that of some Arrhenophanidae by the absence (Fig. 33) of a distinct lamella postvaginalis, which is well developed and actually projects free of the eighth sternum in the latter family.

Lamyristis and *Acoremata* can be distinguished by characters provided in the following key.

KEY TO THE GENERA OF PSYCHIDAE TREATED IN THIS PUBLICATION

- Forewing with R4 and R5 long-stalked. Eighth abdominal segment of male with a bilateral pair of short coremata (Fig. 24). Male genitalia with vinculum Y-shaped; saccus well defined, nearly the length of valva or longer . . *Lamyristis*
- Forewing with R4 and R5 separate. Male with coremata absent; vinculum V-shaped; saccus poorly defined . . . . *Acoremata*

***Acoremata* Davis, new genus**

Type species.—*Acoremata aquila*, new species

Male.—Length of forewing 4.9–5.2 mm. *Head* (Fig. 7): Vestiture of vertex semi-appressed, with a pair of prominent, lateral occipital tufts; scales slender, dense, with minutely bi-tridentate apices; scales more raised over frons. Eyes smooth, reduced; interocular index (vertical diameter of eye/minimal frontal distance between eyes) ca. 0.7. Ocelli absent. Antenna filiform, short, ca. 0.25 length of forewing; scape and pedicel fully scaled, pecten absent; flagellum densely scaled dorsally, with one row of scales per segment; venter naked except for dense piliform sensilla ca. 1.5 as long as diameter of flagellomere. Mandible absent. Maxillary palpi short, total length approximately equal to basal segment of labial palpus, 3-segmented; segments increasing in size distally. Haustellum reduced, equalling length of maxillary palpus. Labial palpus 3-segmented, with prominent ventral tuft from slightly swollen segment II; length ratio of segments from base: 1:1:0.85. *Thorax:* Mesonotum with anterior portion smoothly scaled; caudal half with a prominent mid dorsal scale tuft. Forewing (Fig. 10) moderately broad, L/W index 2.7. Apex more rounded, not falcate. All veins present and arising separate from discal cell; accessory cell present; base of M undivided in cell; retinaculum similar to *Lamyristis*, an elongate subcostal fold. Hindwing nearly equal to forewing in width, apex much more tapered; all veins arising separate; frenulum a single stout bristle. Foreleg (Fig. 12) short; foretibia equal to basal tarsomere in length; epiphysis elongate, ca. 0.8 length of tibia; vestiture of foretibia and tarsus similar to *Lamyristis*, with scales broad and flat. Hindleg elongate; tibia 1.8 length of basal tarsomere. Tibial spurs well developed with one member of pair typically twice the length of other; pattern 0–2–4. Tarsomeres of all legs relatively shorter and stouter than those of *Lamyristis*; tarsomeres 2–5 of hindleg especially short, together ca. 0.7 length of basal tarsomere (1). *Abdomen:* Eighth segment without coremata.

Male genitalia.—Apex of tegumen either with or without median notch. Vinculum V-shaped, with saccus indistinct and only slightly constricted. Valva slightly less than half total length of genital capsule (vinculum + tegumen); sacculus forming a short, prominent lobe bearing 8–12 short, stout spines from distal half. Aedoeagus a slender, straight, simple cylinder without cornuti.

Female.—Length of forewing 6–7 mm. Color pattern as described for male. Frenulum consisting of 4 slender bristles. Seventh abdominal segment with dense corethrogyne arising from three tergal and two sternal clusters (Fig. 31).

Female genitalia.—Posterior apophyses extremely long, nearly twice length of anterior apophyses. Lamella antevaginalis deeply concave. Signum absent.

Etymology.—The generic name is derived from the Greek prefix *a*—(*without*), added to coremata, the paired scale tufts of the male abdomen. It is considered feminine in gender.

Discussion.—*Acoremata* is believed to be most closely allied to *Lamyristis* on the basis of the similarly flattened vestiture of the foreleg. It differs from the latter in possessing forewings with all veins arising separate; apex rounded, not falcate; male genitalia with a more Y-shaped vinculum and distinct saccus; aedoeagus more slender and straight; and the loss of abdominal coremata in the male. Diagnosis of the female is based on an unnamed species illustrated in Fig. 30.

Acoremata aquila **Davis, new species**

(Figs. 1, 7, 10, 12, 14–16; Map)

Male (Fig. 1).—Length of forewing 4.9–5.2 mm. *Head:* Vestiture mostly black, scales faintly tipped with pale gray uniformly over head, maxillary and labial palpi. Antennal vestiture black, scales often faintly tipped with pale gray. *Thorax:* Mesonotum and tegula uniformly black; venter pale buff. Forewing mostly dark fuscous with three equally spaced, pale brown costal spots, and a sinuate, indistinct band of pale brown extending irregularly across wing from each costal spot; termen fuscous, irrorated with pale gray. Hindwing uniformly paler fuscous. Legs pale buff ventrally, heavily suffused with fuscous dorsally; foretibia and most of tarsus covered with a broad, compressed layer of black, white-tipped scales. *Abdomen:* Dark fuscous dorsally, pale buff ventrally.

Male genitalia (Figs. 14–16).—Tegumen with shallow apical notch. Vinculum broadly V-shaped, median length ca. 0.7 that of greatest width. Valva with cucullus curving mesally; apex evenly rounded; sacculus with apex irregularly swollen.

Female.—Unknown.

Holotype.—♂; BRUNEI: Ulu Temburong, Kuala Belalong FSC, Site 1a, 100 m, lowland dipt. forest, 4–16 Jul 1991, 7 July, G. S. Robinson (BMNH).

Paratype.—1 ♂; same data as holotype except: 4 July, BM slide 27909 (BMNH).

Distribution (Map).—Known only from the type locality, located in lowland dipterocarp forest.

Etymology.—The specific epithet is derived from the Latin *aquilus* (dark colored, swarthy).

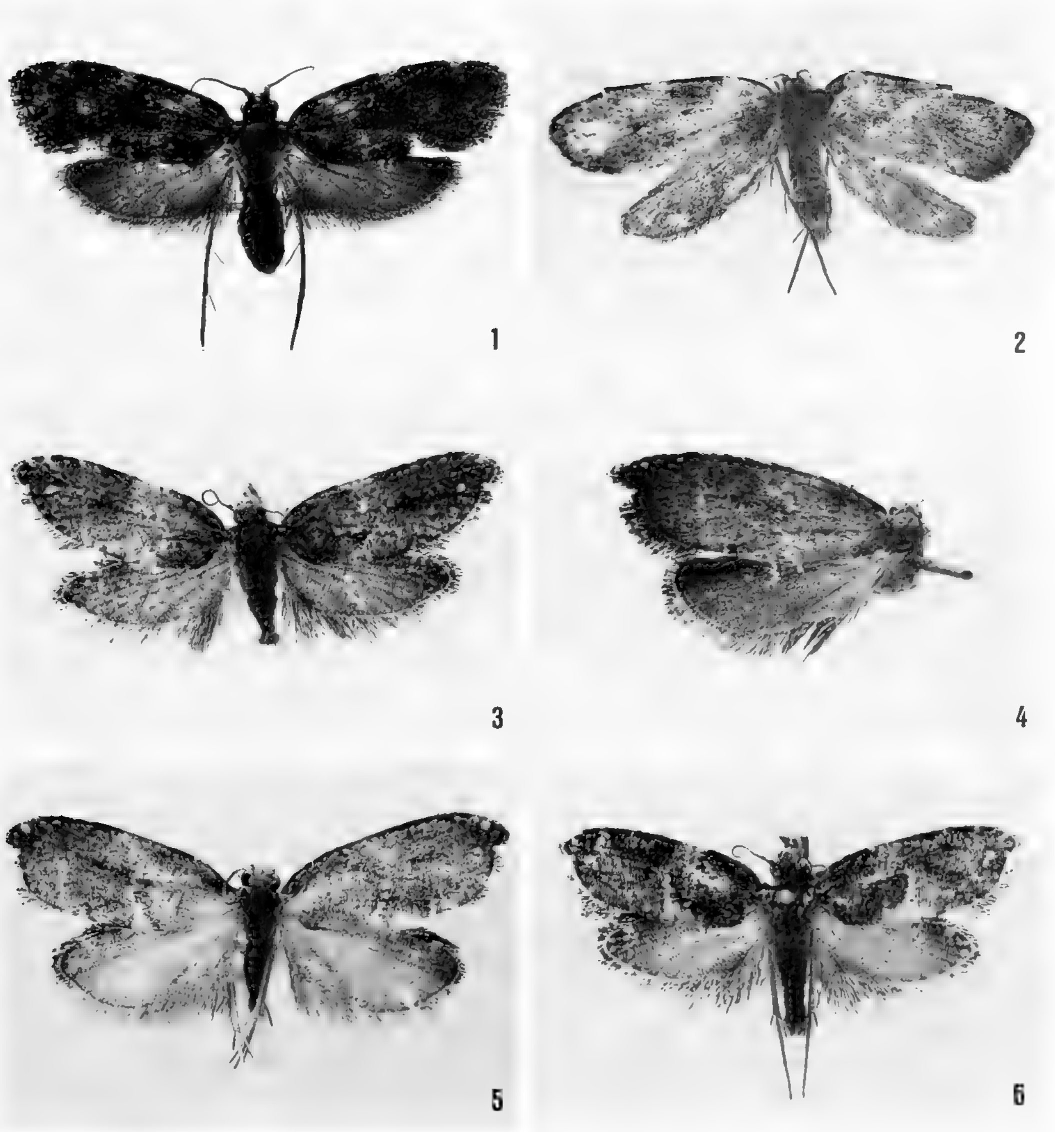
Discussion.—The dark swarthy pattern with buff markings is diagnostic of this species. The irregularly swollen knob at the apex of the sacculus distinguishes the males from all other Psychidae.

Acoremata species

(Figs. 2, 30, 31; Map)

Male.—Length of forewing 5.2 mm. Vestiture of head, maxillary and labial palpi uniformly fuscous, densely irrorated with white-tipped scales. Antenna 0.25 length of forewing; scape similar to head in color, smoothly scaled but with anterodorsal scales projecting over pedicel; flagellum with single dorsal row of dark fuscous scales, faintly tipped with white, per segment; venter densely covered with pale, piliform sensilla, ca. 1.5 diameter of flagellomere in length. *Thorax:* Mesonotum smooth, brownish fuscous; mid dorsal tuft and tegula dark fuscous, with white tipped-scales. Venter shiny cream. Forewing dark fuscous with small, isolated patches of silvery scales scattered over wing; three relatively large, pale yellowish costal spots at basal ¼, middle, and distal ⅓; an elongate patch of golden brown near apex of discal cell; termen uniformly dark fuscous. Hindwing paler, more gray. Legs fuscous dorsally, cream ventrally. *Abdomen:* [missing].

Male genitalia.—Not examined.

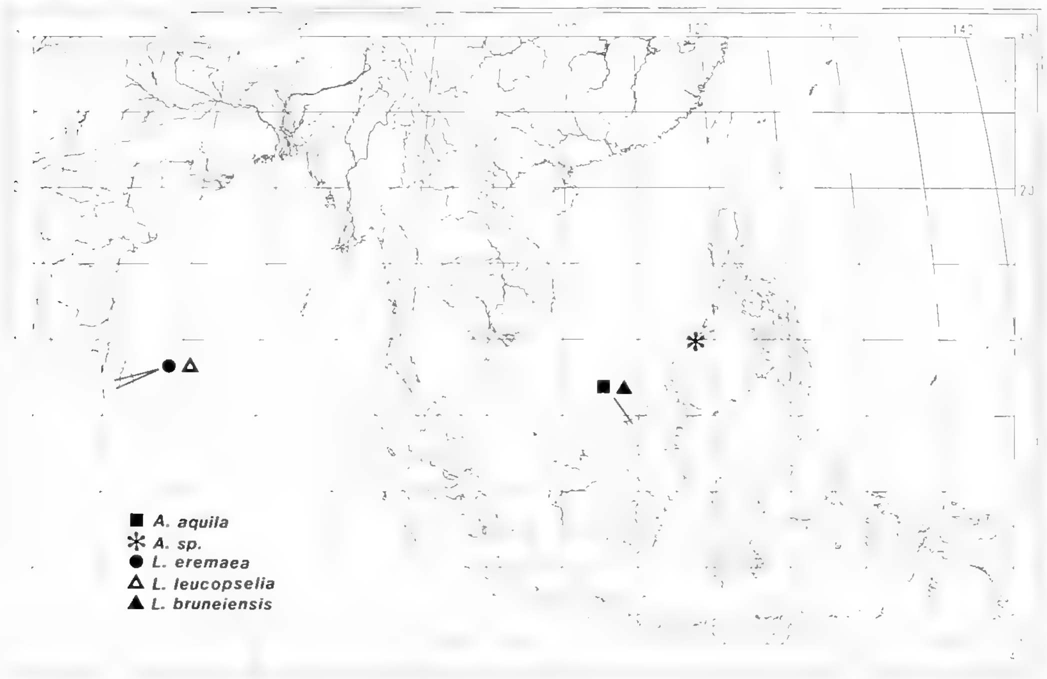


Figs. 1–6. Adult moths. 1, *Acoremata aquila,* holotype ♂, (5.2 mm). 2, *A.* sp., ♀, (7 mm). 3, *Lamyristis eremaea,* holotype ♂, (5.3 mm). 4, *L. leucopsilia,* lectotype ♀, (9.2 mm). 5, *L. leucopsilia,* ♂, (6.1 mm). 6, *L. bruneiensis,* holotype ♂, 5 mm. (Forewing length in parentheses.)

Female (Fig. 2).—Forewing length 6–7 mm. Similar to male except: Generally paler [due to more rubbed condition]. *Abdomen:* Fuscous, mottled with white dorsally, with white scales concentrated along hind margin of segments 4–6; corethrogyne brownish fuscous with bronzy hue.

Female genitalia (Fig. 30).—As described for genus. Ductus bursae extremely slender, gradually enlarging to corpus; length about twice that of corpus bursae; antrum triangular, short, length ca. equal to maximum width.

Material examined.—PHILIPPINES: Palawan: Irawan, 700′ [215 m]: 1 ♂, 2 ♀, 19–22 Jan 1988, J. H. Martin, [collected in alcohol in Malaise trap], BM slides 27919, 27922 (BMNH, USNM).



Map. Distribution of *Acoremata* and *Lamyristis*.

Distribution (Map).—Known only from the island of Palawan, Philippines.

Discussion.—This species has not been named because of the poor condition of the three known specimens and the absence of the male abdomen.

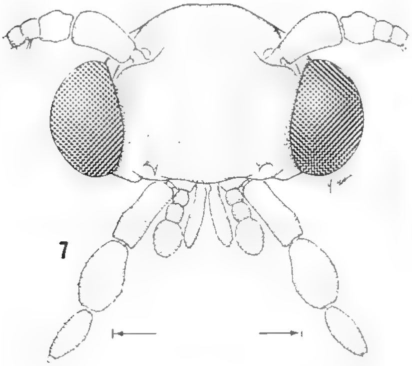
Lamyristis Meyrick

Lamyristis Meyrick 1911:131.—Fletcher 1929:122.—Clarke 1965:340.—Nye and Fletcher 1991:167.—Robinson and Tuck 1996:17. Type species: *Lamyristis leucopselia* Meyrick 1911:131, by monotypy.

Lampristis Neave 1939:859, (misspelling)

Parameristis Meyrick 1919:256.—Fletcher 1929:162.—Nye and Fletcher 1991:222.—Robinson and Tuck 1996:17 (synonym of *Lamyristis*). Type species: *Parameristis eremaea* Meyrick 1919:257, by monotypy.

Male.—Length of forewing 4.2–6.1 mm. *Head* (Figs. 8,9).—Vestiture of vertex semi-appressed, with that of occipital area more erect and thrust forward to form a low ridge more or less between antennal bases; occipital tufts present but reduced; scales of lower frons reduced, appressed; those of upper frons more erect and dense; all scales minutely bi-tridentate. Eyes smooth, reduced; interocular index ca. 0.8. Antenna filiform, less than ⅓ length of forewing; scape and pedicel fully scaled, pecten present; flagellum with single row of scales dorsally, naked ventrally except for dense piliform sensilla ca. 1–1.2 diameter of flagellomere in length. Mandible absent. Haustellum greatly reduced, less than maxillary palpus in length. Maxillary palpus reduced, 2–3-segmented, apical segment greatly reduced (Fig. 9) or absent. Labial palpus 3-segmented, curving slightly dorsad, with prominent scale tuft from venter of segment II; length ratio of segments from base: 1:1.7:0.7. *Thorax:* Mesoscutellum with a prominent, raised mid dorsal scale tuft. Forewing (Fig. 11) moderately broad, L/W index 2.6, with apex slightly produced to form falcate termen; falcation accentuated by presence of white spot in fringe below apex;



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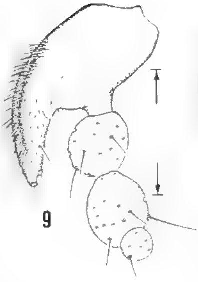

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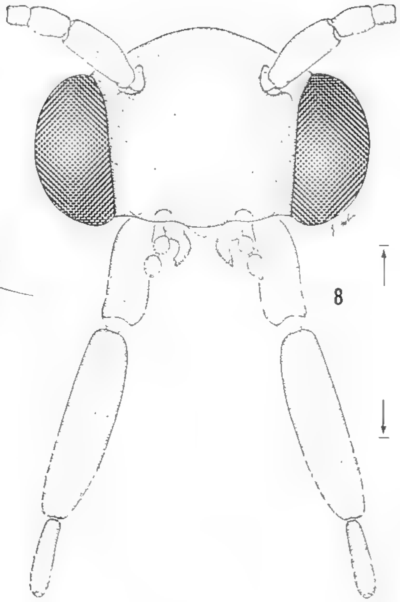

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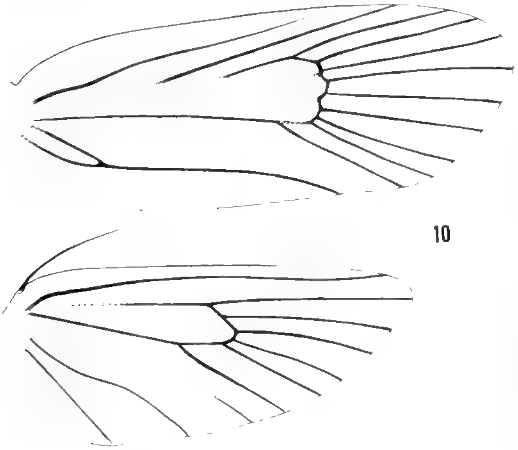

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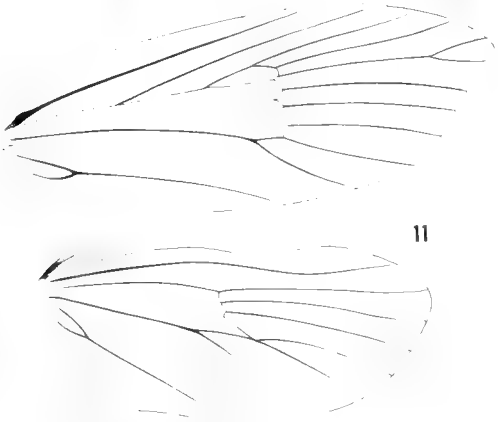

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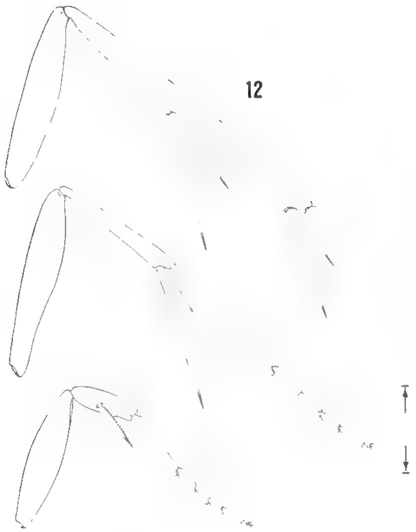

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Figs. 7–13. 7, *Acoremata aquila*, head, (0.5 mm). 8, *Lamyristis leucopsilia*, head, (0.5 mm). 9, *L. leucopsilia*, maxilla, (0.1 mm). 10, *A. aquila*, venation. 11, *L. leucopsilia*, venation. 12, *A. aquila*, legs, (0.5 mm). 13, *L. leucopsilia*, legs, (0.5). (Scale lengths in parentheses.)

all veins arising separately from discal cell except for R4 and R5 which are long-stalked; accessory cell present; M forked close to end of cell. Retinaculum an elongate subcostal fold curving over base of Sc. Hindwing nearly equal to forewing in width; all veins arising separate except M3 and Cula sometimes connate; frenulum a single stout bristle. Foreleg (Fig. 13) short, equal to basal tarsomere in length; epiphysis elongate, ca. 0.8 length of tibia and surpassing apex of tibia; foretibia and tarsus with scale vestiture broad and flat. Tarsomeres of all legs relatively slender and elongate compared to those of *Acoremata*, with tarsomeres 2–5 of hindleg nearly 1.3 length of basal tarsomere (1). Tibial spurs well developed with one member of pair nearly twice the length of other; pattern 0–2–4. *Abdomen:* Eighth segment with a bilateral pair of short coremata (Figs. 24, 29).

Male genitalia.—Caudal apex of tegumen with shallow median notch. Vinculum Y-shaped, with elongate saccus 0.9–1.6 length of valva. Valva 0.5 or less length of genital capsule; sacculus with a short, prominent, shortly spinose lobe arising from basal to distal ⅓. Aedoeagus relatively stout, nearly as long as genital capsule; basal fourth curved ventrally from lateral view; cornuti absent.

Female.—Length of forewing 9.2 mm. Color pattern as described for male. *Hindwing:* Frenulum consisting of 4–6 slender bristles. *Abdomen:* Seventh segment with elongate corethrogyne exceeding length of segment 7 and grouped in clusters similar to *Acoremata.*

Female genitalia.—Posterior apophyses extremely long, twice length of anterior pair. Lamella antevaginelis convex. Signum absent.

KEY TO THE SPECIES OF *LAMYRISTIS* BASED ON MALE GENITALIA

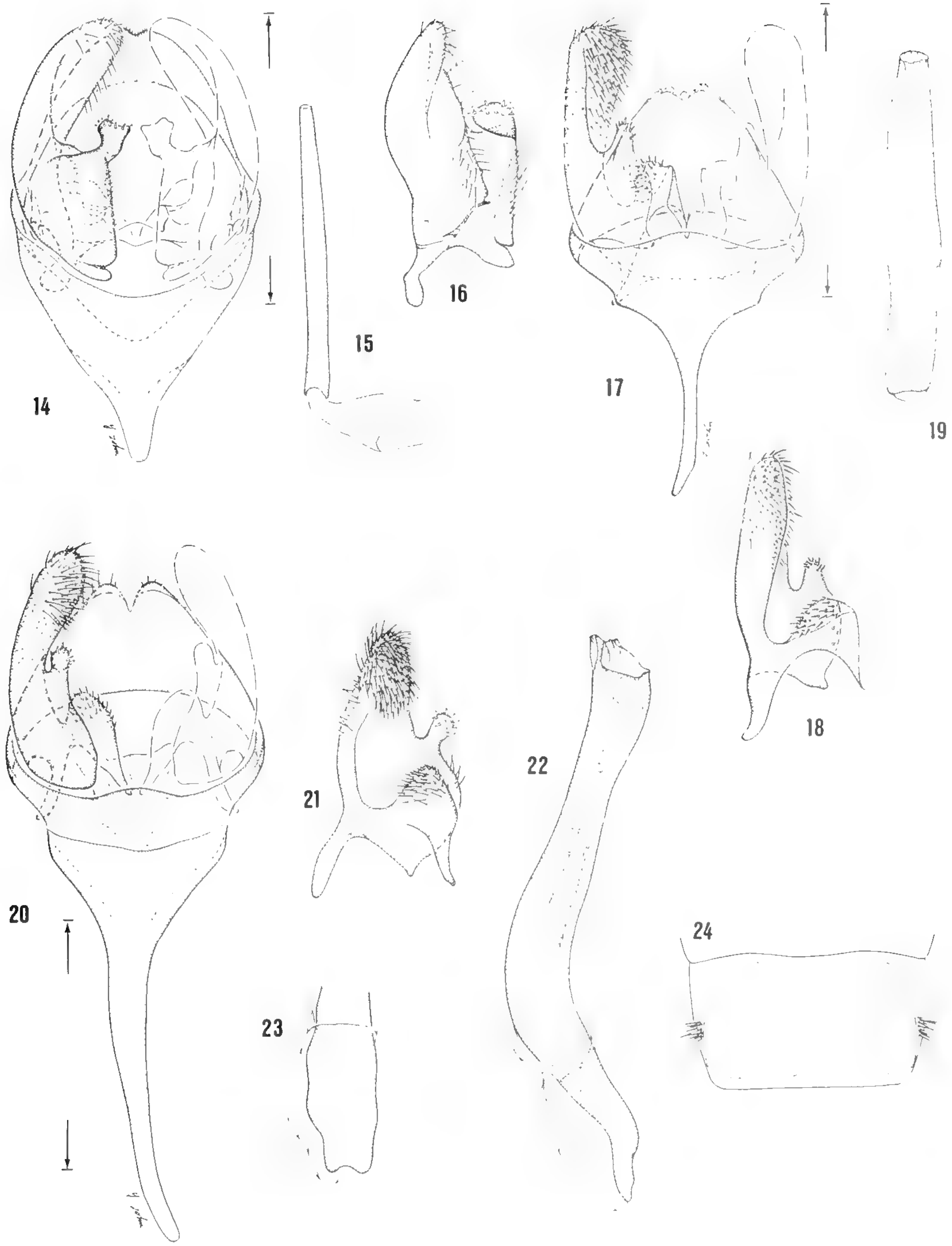
1. Saccus shorter than valva; saccular lobe arising basal to middle of valva (Figs. 17, 18) . . . . *eremaea*
– Saccus exceeding length of valva in length; saccular lobe arising at or beyond middle of valva. 2
2. Saccus 1.6 length of valva; saccular lobe arising near middle of valva, base of lobe slightly constricted (Figs. 20, 21) . . . . *leucopselia*
– Saccus 1.25 length of valva; saccular lobe arising beyond middle of valva, base of lobe not constricted (Figs. 25, 26) . . . . *bruneiensis*, new species

Lamyristis eremaea (Meyrick)
(Figs. 3, 17–19; Map)

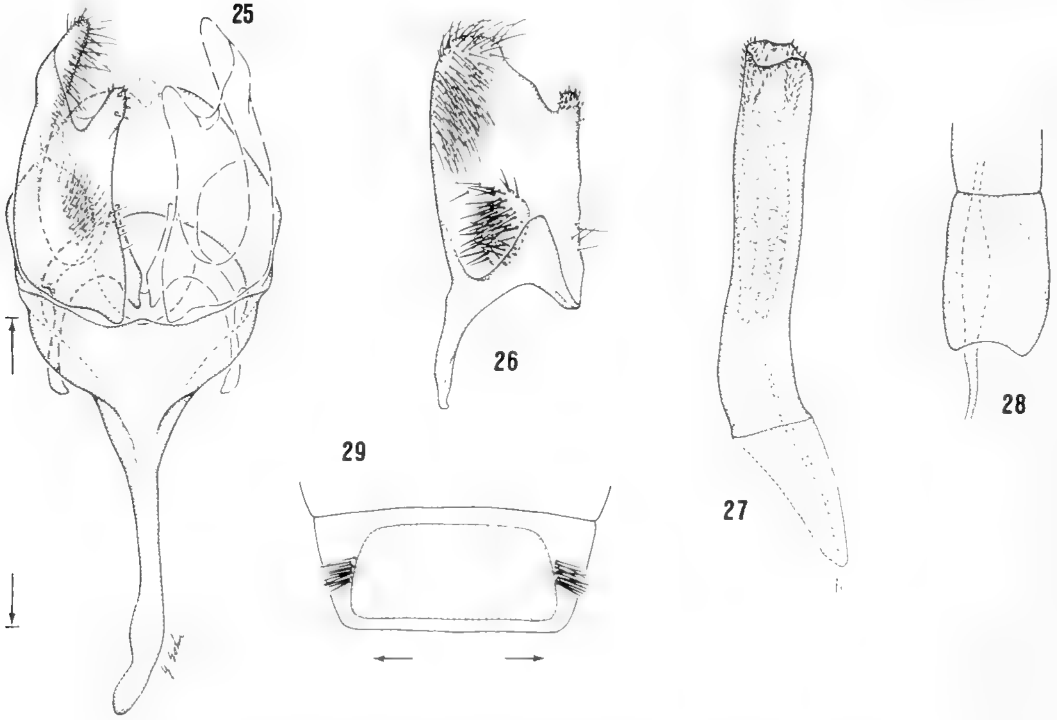
Parameristis eremaea Meyrick 1919:257.
Lamyristis eremaea: Robinson and Tuck 1996:17.

Male (Fig. 3).—Length of forewing 4.2–5.3 mm. Vertex predominantly brown with paler scales intermixed. Frons mostly white with a narrow, transverse band of brown below antennae and scattered brown scales laterally. Antenna ca. ⅓ length of forewing; flagellum with a single row of light brown to fuscous scales per segment; ventral sensilla pale buff, length ca. 2.0–3.0 diameter of flagellomere. Labial palpus dark brown laterally, white to cream dorsally and mesally; segment II with a prominent ventral tuft of dark brown-tipped scales, white dorsally; dorsal surface of III cream. *Thorax:* Mesonotum and tegula fuscous; venter buff. Forewing predominantly dark purplish fuscous with scattered, pale yellowish white spots of various size; an elongate, pale yellowish white spot at basal ⅖ of costa, with a similar but smaller spot opposite on dorsal margin—perhaps representing a remnant of an incomplete fascia; five smaller whitish spots along distal ⅖ of costa; termen with a subapical white spot; fringe irrorated with fuscous and pale gray. Hindwing mostly bronzy gray with darker apex. Legs predominantly cream to light brown, heavily suffused with fuscous dorsally on fore and midleg, paler on hindleg; tarsi banded with fuscous dorsally. *Abdomen:* Dark brown dorsally with slight bronzy luster; venter dull white.

Male genitalia (Figs. 17–19).—Saccus moderately long, ca. 0.9 length of valva. Lobe of sacculus slightly tapered distally, arising below middle of valva. Aedoeagus with base slightly curved.



Figs. 14–24. Male genitalia. 14–16, *Acoremata aquila*. 14, Ventral view. 15, Aedoeagus, ventral view. 16, Valva, mesal view. 17–19, *Lamyristis eremaea*. 17, Ventral view. 18, Valva, mesal view. 19, Aedoeagus, ventral view. 20–24, *Lamyristis leucopsilia*. 20, Ventral view. 21, Valva, mesal view. 22, Aedoeagus, lateral view. 23, Base of aedoeagus, ventral view. 24, Eighth tergum. (All scales = 0.5 mm.)



Figs. 25–29. Male genitalia, *Lamyristis bruneiensis*, 25, Ventral view. 26, Valva, mesal view. 27, Aedoeagus, lateral view. 28, Base of aedoeagus, ventral view. 29, Eighth tergum. (All scales = 0.5 mm.)

Female.—Unknown.

Holotype.—♂; SRI LANKA: Maskeliya, October, Pole, BM slide 27908 (BMNH).

Material examined.—SRI LANKA: Maskeliya: 1 ♂, holotype, (BMNH). Udawattakele Sanctuary, 1800 ft [550 m] Kandy: 1 ♂, 23–25 Sep 1980, K. Krombein, P. Karunaratne, L. Jayawickrema, V. Gundawardane, P. Livanage, USNM slide 31786 (USNM).

Distribution (Map).—Known from montane, south-central Sri Lanka.

Discussion.—This species is most easily distinguished from the other Sri Lankan species, *L. leucopselia,* by the shorter and more slender saccus of the male genitalia (Fig. 17).

Lamyristis leucopselia Meyrick
(Figs. 4, 5, 8, 13, 20–24, 32, 33; Map)

Lamyristis leucopselia Meyrick 1911: 131.—Clarke 1965:340.—Robinson and Tuck 1996:17.

Male (Fig. 5).—Length of forewing 6.1 mm. *Head:* Vestiture predominantly dull white to cream with a bilateral pair of fuscous patches on frons beneath antenna along rim of eye. Antenna pale brown dorsally with fuscous suffusion laterally on most flagellomeres. Labial palpus broken; basal segment fuscous laterally, cream mesally and dorsally. *Thorax:* Mesonotum dark fuscous with white fringe of scales laterally on tegula; venter buff to white. Forewing predominantly fuscous, with a small white costal spot near apex and another on termen below apex; a relatively large triangular white spot near middle of dorsal margin. Hindwing pale gray with fuscous suffusion along costal margin and apex. Legs typically dark brown dorsally, cream to light brown ventrally. *Abdomen:* Light golden brown dorsally, cream ventrally. Eighth tergum partially divided.

Male genitalia (Figs. 20–24).—Saccus greatly elongated, ca. 1.6 length of valva.

Lobe of sacculus slightly swollen distally, arising near middle of valva. Aedoeagus with base strongly curved.

Female (Fig. 4).—Length of forewing 6.5–9.2 mm. *Head:* Vestiture with more fuscous scaling than male. Labial palpus fuscous laterally, pale brown to cream mesally and dorsally. *Thorax:* Similar to male except with forewing more uniformly darker and with more purplish luster; mid-dorsal spot reduced. Hindwing darker bronzy fuscous and more uniform in color; costal margin sinuate. *Abdomen:* Dark fuscous dorsally. Corethrogyne light brown.

Female genitalia (Fig. 32, 33).— Lamella antevaginalis strongly arched. Ductus bursae gradually tapering, equalling length of corpus bursae; length of entire bursa copulatrix ca. 0.65 length of posterior apophyses.

Lectotype.—♀; SRI LANKA: Maskeliya, [19] 04, Alston, BM slide 7476 (BMNH).

Material examined.—SRI LANKA: Maskeliya: 2 ♀ (paralectotypes), May 1904, Pole, BM slides 27923, 27926 (BMNH). Pundaloya, 3500–4500′ [1070–1370 m]: 1 ♂, Green, BM slide 27910 (BMNH).

Distribution (Map).—Known only from montane, south-central Sri Lanka.

Discussion.—The identification of the single male associated with *L. leucopselia* is tentative. Although this specimen is more rubbed and consequently appears paler in color, the predominantly paler head vestiture and more uniform wing pattern are most similar to that of the female lectotype. The male genitalia are distinct in possessing the longest saccus of any member of the genus.

Lamyristis bruneiensis **Davis, new species**

(Figs. 6, 25–29; Map)

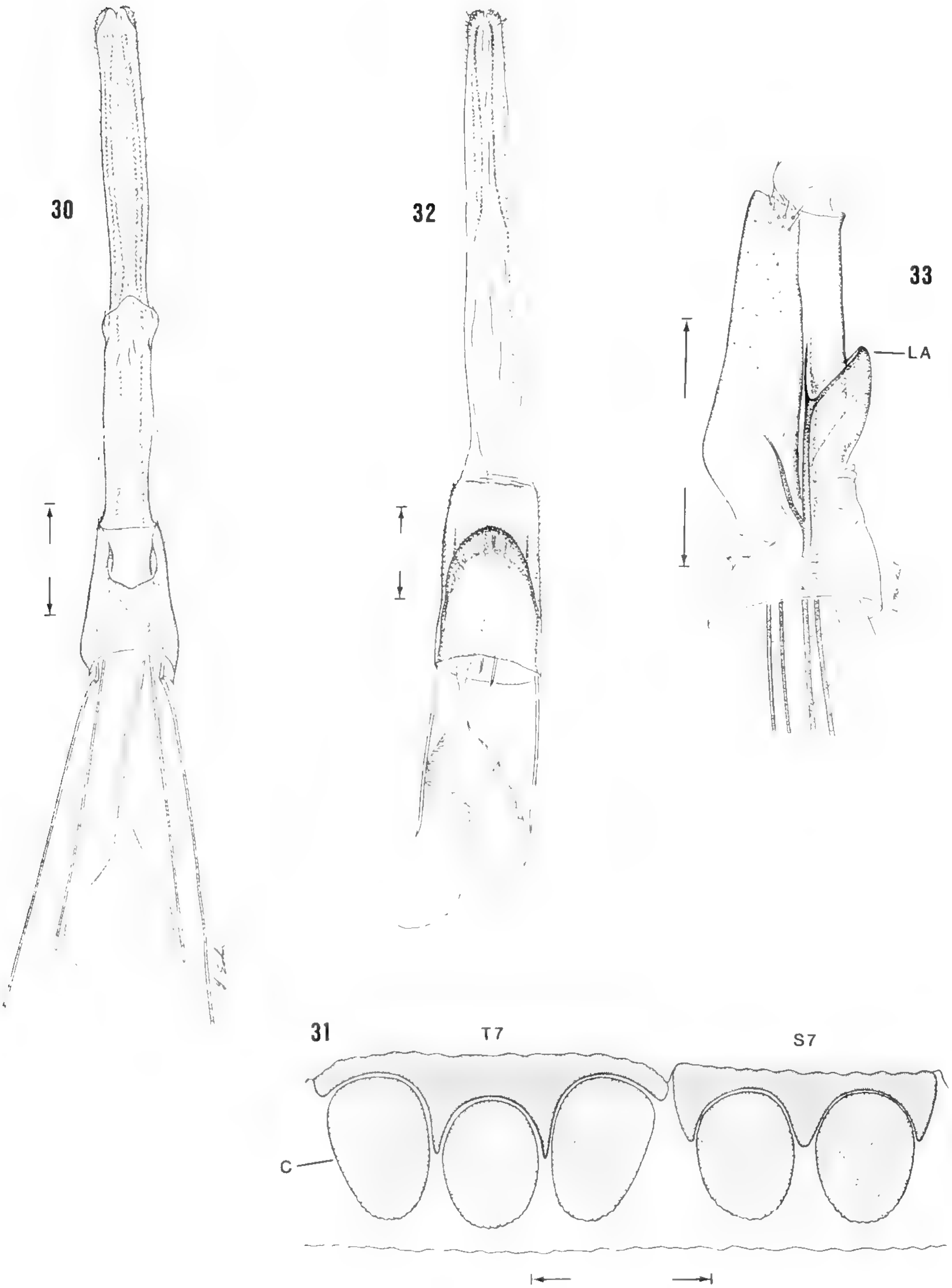
Male (Fig. 6).—Length of forewing 5 mm. *Head:* Vestiture predominantly pale buff to cream, heavily suffused with fuscous as a raised band across vertex and below antennae near front rim of eye; occipital scales white, continuing as a fringe around caudal margin of eye. Antenna less than 0.3 length of forewing; scape smooth except for pecten of ca. 8 elongate piliform scales, predominantly buff with mostly fuscous and less white suffusion dorsally; flagellum mostly buff with scattered fuscous and whitish scales dorsally; ventral sensilla approximately equal to diameter of flagellomere in length. Maxillary palpus cream, terminating in a few black scales. Labial palpus mostly buff to cream, heavily suffused with fuscous laterally and on prominent ventral brush of segment II. *Thorax:* Mesonotum fuscous lightly irrorated with white, epecially at margin of tegula; cream ventrally. Forewing mostly fuscous at basal third, heavily mottled with light brown and fuscous scales over distal ⅔; costal margin with at least five cream spots including an elongate spot at basal third that curves inward as a white bar; a slender triangular white spot extends from middle of dorsal margin halfway to costa; a subapical band of nearly contiguous white spots parallel to termen with the largest in size near apex; termen with a subapical white spot; fringe white terminating in fuscous. Hindwing mostly pale gray with fuscous suffusion at apex; a series of 3–5 small cream spots also visible in fuscous area. Legs mostly buff to cream, heavily suffused with fuscous dorsally on foreleg. *Abdomen:* Predominantly fuscous dorsally, cream to buff ventrally. Eighth tergum undivided, with a bilateral pair of short coremata (Fig. 29).

Male genitalia (Figs. 25–28).—Saccus elongate, ca. 1.25 length of valva. Lobe of sacculus cylindrical, arising beyond middle of valva. Aedoeagus with slightly curved base.

Female.—Unknown.

Holotype.—♂; BRUNEI: Rampayoh River, 300′ [90 m], LP 195, GR 960785, 11–19 Mar 1989, G. S. Robinson, BM slide 27913 (BMNH).

Distribution (Map).—Known only from the type locality, located in lowland dipterocarp forest.



Figs. 30–33. Female genitalia. 30–31, *Acoremata* sp. 30, Ventral view. 31, Seventh abdominal segment (C = corethrogyne cluster, S = sternum, T = tergum). 32–33, *Lamyristis leucopsilia*. 32, Ventral view. 33, Detail of eighth segment of fig. 32, lateral view (LP = lamella antevaginalis). (All scales = 0.5 mm.)

Discussion.—The male genitalia of this species are diagnostic in possessing the broadest valvae of the genus, with the saccular lobe reduced and arising beyond the middle of the valva (Fig. 26).

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LIFE HISTORY AND DESCRIPTION OF IMMATURE STAGES OF *TRUPANEA JONESI* CURRAN (DIPTERA: TEPHRITIDAE) ON NATIVE ASTERACEAE IN SOUTHERN CALIFORNIA

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Abstract.—*Trupanea jonesi* Curran is a multivoltine, florivorous fruit fly (Diptera: Tephritidae) infesting at least 104 species of host plants in 42 genera, eight tribes, and 17 subtribes in California and other western United States. Accordingly, this tephritid is the species most commonly reared from mature flower heads of native Asteraceae throughout California. Records for three new host genera and eight new host species are reported. The egg, first-, second- and third-instar larvae, and puparium are described and figured. The abdominal, lateral spiracular complex of the third instar consists of a spiracle and a single placoid sensillum and thus differs from other third instar *Trupanea* spp. reported to date. A subdorsal sensillum on the gnathocephalum is reported for the first time from the third instar of a *Trupanea*. The life cycle of *T. jonesi* in California is of the aggregative type. Eggs were laid in closed, preblossom flower heads through or between the overlapping phyllaries into or between the florets. First and second instars fed on the ovules and florets, while the third instars principally fed on the soft achenes. The receptacles of infested flower heads were scored (visibly abraided) by the mouth hooks or not depending in part on larval densities and host-plant species. Infested flower heads in samples from 10 different hosts contained an average of 1.7 ± 0.1 (±SE) (range, 1–15) puparia and an average total of 80 ± 2 (25–119) soft achenes/florets, of which an average of 7.3 ± 0.5 (range, 2–40) soft achenes/florets, or 16% (range, 1–15%), were damaged by larval feeding. Courtship and copulation behaviors are described, including a characteristic, unique wing display combining rapid wing hamation with supination by males approaching females. Male-male combat using mouthparts and legs also is described. Five species of Hymenoptera were reared from individual puparia and mature flower heads bearing puparia of *T. jonesi* as solitary, larval-pupal endoparasitoids: *Eurytoma obtusiventris* Gahan, *E. veronia* Bugbee (Eurytomidae), *Halticoptera* sp. (Pteromalidae), *Mesoplobus* sp. (Pteromalidae), and *Pteromalus* sp. (Pteromalidae) Other possible primary parasitoids or hyperparasitoids reared along with *T. jonesi* from mature flower heads were *Eupelmus* sp. (Eupelmidae), *Pachyneuron* sp. (Pteromalidae) and one, unidentified species each of Cynipidae and Eulophidae.

Key Words: Insecta, *Trupanea*, Asteraceae, nonfrugivorous Tephritidae, biology, taxonomy of immature stages, mating behavior, flower-head feeding, host-plant range, parasitoids

Trupanea jonesi Curran (Diptera: Tephritidae) is the most common species of indigenous, nonfrugivorous fruit fly encountered in California, belonging itself to a genus which occurs worldwide and that is one of the larger and more widespread genera of nonfrugivorous fruit flies in North America and California (Foote and Blanc 1963, Foote et al. 1993). However, being of little or no economic importance, most species of *Trupanea* remain little known (Foote 1960, Foote et al. 1993). Detailed life histories of six species of *Trupanea* from southern California have been published (Cavender and Goeden 1982; Goeden 1987, 1988; Goeden and Teerink 1997c; Headrick and Goeden 1991; Knio et al. 1996b), and the immature stages of four of these species also described (Cavender and Goeden 1982, Goeden and Teerink 1997c; Headrick and Goeden 1991, Knio et al. 1996a). This paper describes the life history of a seventh species, *T. jonesi,* and its immature stages.

MATERIALS AND METHODS

This study began in 1991 and was based in large part on dissections of selected subsamples of flower heads of Asteraceae infested by *T. jonesi* from among many samples collected annually throughout California in the manner described by Goeden (1985, 1992). One-liter samples of excised, immature and mature flower heads from known hosts potentially containing eggs, larvae, and puparia were transported in cold-chests in an air-conditioned vehicle to the laboratory and stored under refrigeration for subsequent dissection, photography, description, and measurement. Fourteen eggs, 3 first-, 12 second-, and 7 third-instar larvae, and 3 puparia dissected from flower heads were preserved in 70% EtOH for scanning electron microscopy (SEM). Additional puparia were placed in separate, glass shell vials stoppered with absorbant cotton and held in humidity chambers at room temperature for adult and parasitoid emergence. Specimens for SEM were hydrated to distilled water in a decreasing series of acidulated EtOH. They were osmicated for 24 h, dehydrated through an increasing series of acidulated EtOH and two, 1-h immersions in Hexamethlydisilazane (HMDS), mounted on stubs, sputter-coated with a gold-palladium alloy, and studied with a JEOL JSM C-35 SEM in the Department of Nematology, University of California, Riverside.

Most adults reared from isolated puparia were individually caged in 850-ml, clear-plastic, screened-top cages with a cotton wick and basal water reservoir and provisioned with a strip of paper toweling impregnated with yeast hydrolyzate and sucrose. These cages were used for longevity studies in the insectary of the Department of Entomology, University of California, Riverside, at 25 ± 1°C, and 14/10 (L/D) photoperiod. Virgin male and female flies obtained from emergence vials were paired ($n = 16$) in clear-plastic petri dishes provisioned with a flattened, water-moistened pad of absorbant cotton spotted with honey (Headrick and Goeden 1991, 1994) for observations of their courtship and copulation behavior.

Plant names used in this paper follow Munz (1974), as updated by Hickman (1993) and Bremer (1994); tephritid names and nomenclature follow Foote et al. (1993). Terminology and telegraphic format used to describe the immature stages follow Knio et al. (1996a) and Goeden and Teerink (1996a, b, c; 1997a, b, c) and our earlier works cited therein. Means ± SE are used throughout this paper. Voucher specimens of *T. jonesi* and its parasitoids reside in the research collections of RDG; preserved specimens of eggs, larvae and puparia are stored in a separate collection of immature Tephritidae maintained by JAT.

RESULTS AND DISCUSSION

Taxonomy

Adult.—*Trupanea jonesi* was described by Curran (1932) (as *Trypanea*) from a female holotype and three female paratypes reared from *Aster subspicatus* Nees van Esenbeck (as *douglasi*) at Corvallis, Oregon. Foote (1960), Foote and Blanc (1963), and Foote et al. (1993) pictured the strikingly different, sexually dimorphic, wing patterns of the female and male.

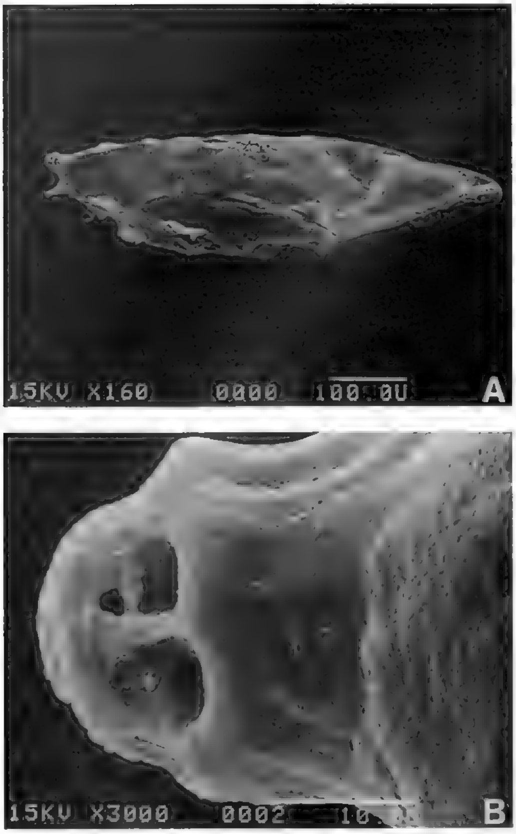

Fig. 1. Egg of *Trupanea jonesi:* (A) habitus, pedicel to left; (B) egg pedicel.

Immature stages.—The third instar of *T. jonesi* was described and the anterior spiracle, cephalopharyngeal skeleton, last abdominal segment, and posterior stigmatic chamber were drawn by Phillips (1946). Otherwise, the eggs, first and second instars, and puparium heretofore have not been described nor illustrated.

Egg: Twenty-seven eggs of *T. jonesi* dissected from heads of *Aster integrifolius* Nuttall were white, opaque, smooth; elongate-ellipsoidal, 0.73 ± 0.006 (range, 0.65–0.80) mm long, 0.21 ± 0.002 (range, 0.17–0.23) mm wide, smoothly rounded at tapered basal end; pedicel 0.02 mm long (Fig. 1A), with a single row of aeropyles (Fig. 1B).

The egg of *T. jonesi* is similar in shape to the eggs of other *Trupanea* species previously described, larger in width and length than *T. californica* Malloch, similar in size to *T. imperfecta* (Coquillett) and *T. signata* Foote, and shorter than *T. conjuncta* (Adams), *T. bisetosa* (Coquillett) and *T. nigricornis* (Coquillett) (Goeden 1987, 1988; Headrick and Goeden 1991; Knio et al. 1996a; Goeden and Teerink 1997c). A single row of aeropyles circumscribes the pedicel of *T. nigricornis* and *T. signata,* but the aeropyles of the latter are subrectangular; whereas, *T. bisetosa* has 1–2 rows of larger, circular to irregularly rounded aeropyles (Knio et al. 1996a).

Third instar: White, barrel-shaped, tapering anteriorly, rounded posteriorly; minute acanthae circumscribe thoracic and abdominal intersegmental lines (Fig. 2A); gnathocephalon conical (Fig. 2B), rugose pads dorsally and laterally, rugose pads laterad of mouth lumen serrated on ventral margin (Fig. 2B-1, C-1); six verruciform sensilla posteriorad of rugose pads (Fig. 2B-2); dorsal sensory organ a single dome-shaped papilla (Fig. 2B-3, C-2); subdorsal sensillum laterad of dorsal sensory organ (Fig. 2C-3), anterior sensory lobe (Fig. 2B-4) bears terminal sensory organ (Fig. 2C-4), pit sensory organ (Fig. 2C-5), lateral sensory organ (Fig. 2C-6), and supralateral sensory organ (Fig. 2C-7); stomal sense organ ventrolaterad of anterior sensory lobe (Fig. 2C-8); mouth hooks tridentate (Fig. 2B-5, D-1); median oral lobe laterally flattened, tapering anteriorly (Fig. 2D-2); labial lobe attached to median oral lobe, with two pore sensilla (Fig. 2D-3); prothorax circumscribed anteriorly by minute acanthae (Fig. 2E-1), rugose pads (Fig. 2E-2) and verruciform sensilla (Fig. 2E-3); a single stelex sensillum located dorsomedially on prothorax (Fig. 2E-4); anterior thoracic spiracles on posterior margin of prothorax bear 3–4 rounded papillae (Fig. 2E-5); meso- and metathoracic lateral spiracular complexes consist of a spiracle, a stelex sensillum (Fig. 2E-6), and a single verruciform sensillum (Fig. 2E-7); abdominal lateral spiracular complex consists of a spiracle (Fig. 2F-1), and placoid-type sensillum (Fig. 2F-2); caudal segment circumscribed by minute acanthae (Fig. 2G-1), and stelex sensilla in a 2-dorsal, 4- ventral arrangement (Fig. 2G-2); posterior spiracular plates, with three ovoid rimae, ca. 0.038 mm in length (Fig. 2G-3), and four interspiracular processes each with 3–6 branches, longest measuring 0.013 mm (Fig. 2G-4); intermediate sensory complex ventrad of posterior spiracular plates among the minute acanthae (Fig. 2G-5) consists of a medusoid sensillum (Fig. 2H-1), and a stelex sensillum (Fig. 2H-2).

Trupanea jonesi is similar in general appearance to other previously described species, i.e., *Trupanea californica* (Headrick and Goeden 1991), *T. bisetosa, T. nigricornis* (Knio et al. 1996a), and *T. signata* (Goeden and Teerink 1997c). Differences among the *Trupanea* species described to date are found in the abdominal lateral spiracular complex. This complex in *T. californica* includes a single verruciform sensillum; in *T. nigricornis,* two verruciform sensilla; in *T. jonesi,* a placoid sensillum; in *T. signata,* one verruciform sensillum and a placoid-type sensillum, and in *T. bisetosa,* two verruciform sensilla and a placoid-type sensillum (Headrick and Goeden 1991, Knio et al. 1996a, Goeden and Teerink 1997c). *Trupanea jonesi* is similar to *T. signata* and *T. nigricornis* in having 3-6 branches in the interspiracular processes (Knio et al. 1996a, Goeden and Teerink 1997c); whereas, *T. californica* and *T. bisetosa* possess 6–8 branches (Headrick and Goeden 1991, Knio et al. 1996a). Phillips (1946) described *T. jonesi* with bidentate mouth hooks and anterior thoracic spiracles having 10 papillae; however, we show that *T. jonesi* has tridentate mouth hooks and 3–4 papillae. Knio et al. (1996a) first reported the subdorsal sensillum in first instars of *T. bisetosa* and *T. nigricornis*; our report is the first to verify this sensillum in a third instar of *Trupanea.*

Second instar: White, cylindrical, tapering slightly anteriorly, rounded posteriorly; weakly defined minute acanthae circumscribe thoracic and abdominal intersegmental lines; gnathocephalon smooth, few rugose pads laterad of anterior sensory lobe (Fig. 3A-1); dorsal sensory organ a dome-shaped papilla (Fig. 3A-2, B-1); subdorsal sensillum laterad of dorsal sensory organ (Fig. 3B-2); anterior sensory organ bears all four sensory organs (Fig. 3A-3, B-3); stomal sense organ ventrolaterad of anterior sensory lobe (Fig. 3B-4); mouth hooks bidentate (Fig. 3C-1); median oral lobe laterally flattened, tapered anteriorly (Fig. 3C-2); prothorax circumscribed anteriorly by minute acanthae, rugose pads and verruciform sensilla; anterior thoracic spiracles consist of 3–4 papillae (Fig. 3D); lateral spiracular complexes were not seen; caudal segment circumscribed by minute acanthae and stelex sensilla (Fig. 3E-1); posterior spiracular plates consist of three ovoid rimae, ca 0.026 mm in length (Fig. 3E-2), and four interspiracular processes, each with 3–6 branches, longest measuring 0.015 mm (Fig. 3E-3); intermediate sensory complex (Fig. 3E-4) consists of a stelex sensillum (Fig. 3F-1) and a medusoid sensillum (Fig. 3F-2).

The second instar differs from the third instar in general habitus, being more cylindrical than barrel-shaped. The gnathocephalon has fewer rugose pads, none of which are serrated. The mouth hooks are bidentate, with the medial tooth being very reduced. The minute acanthae which circumscribe the intersegmental lines are less defined than in the third instar. Because of the wrinkled nature of the prepared specimens, the lateral spiracular complexes were not observed. The ovoid rimae of the second instar are slightly smaller in size than those of the third instar.

First instar: White, cylindrical, tapering slightly anteriorly, rounded posteriorly, 2–3 rows of minute acanthae circumscribe each intersegmental line; gnathocephalon smooth, lacking rugose pads (Fig. 4B); dorsal sensory organ a dome-shaped papilla (Fig. 4A-1, B-1); subdorsal sensillum laterad of dorsal sensory organ (Fig. 4A-2); anterior sen-

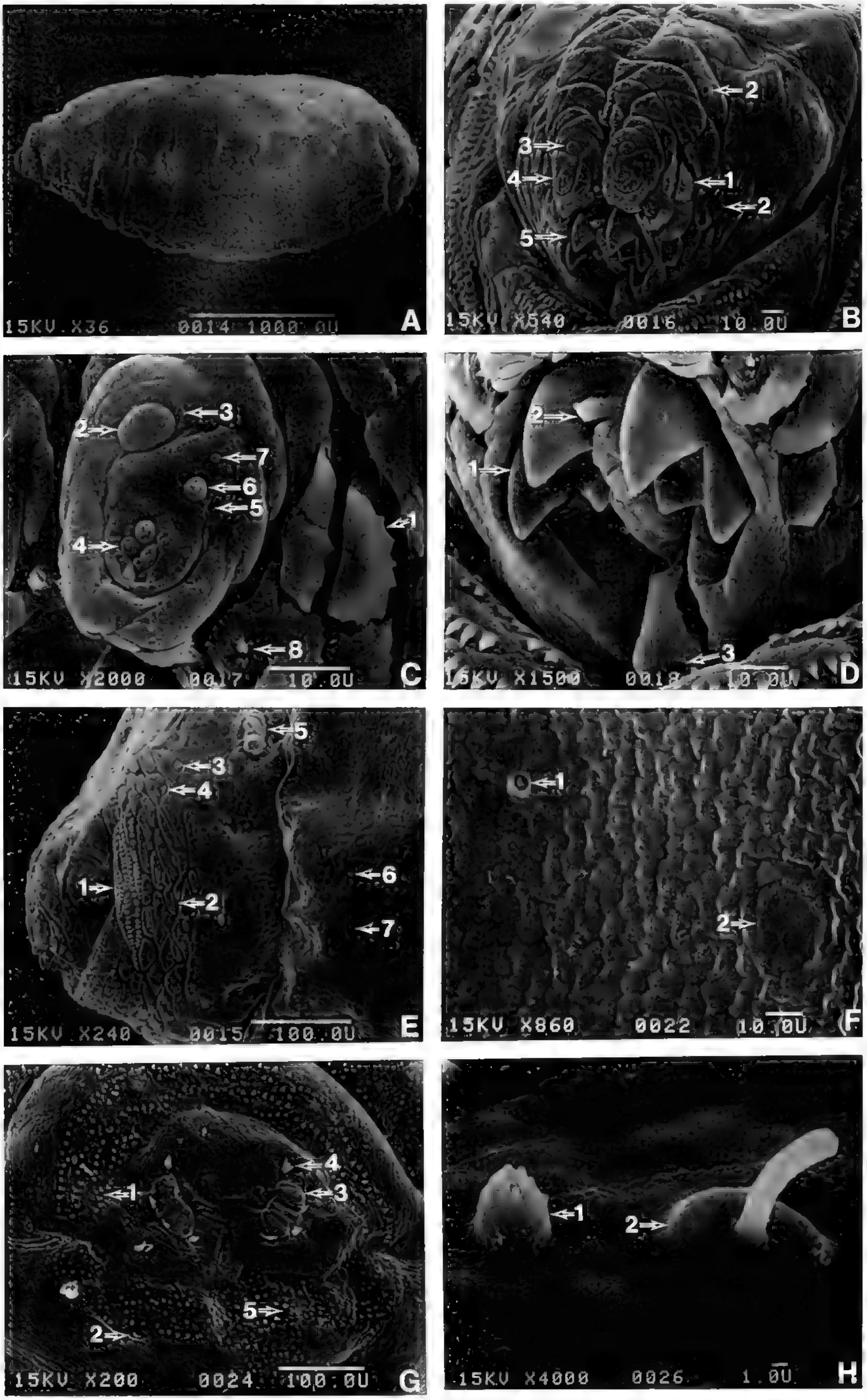

Fig. 2. Third instar of *Trupanea jonesi:* (A) habitus, anterior end to left; (B) gnathocephalon, anterior view, 1—serrated rugose pads, 2—verruciform sensilla, 3—dorsal sensory organ, 4—anterior sensory lobe, 5—mouth hooks; (C) 1—serrated rugose pad, anterior sensory lobe, 2—dorsal sensory organ, 3—subdorsal sensory sensillum, 4—terminal sensory organ, 5—pit sensory organ, 6—lateral sensory organ, 7—supralateral sensory organ, 8—stomal sense organ; (D) gnathocephalon, ventral view, 1—mouth hooks, 2—median oral lobe, 3

sory lobe bears all four sensory organs (Fig. 4A-3, B-2); stomal sense organs indistinct (Fig. 4B-3); mouth hooks bidentate (Fig. 4B-4); median oral lobe laterally flattened (Fig. 4B-5); labial lobe attached to median oral lobe, bears two pore sensilla; minute acanthae on ventral margin of prothorax; anterior thoracic spiracles not present; lateral spiracular complex not seen; caudal segment bears the posterior spiracular plates, posterior spiracular plates with two ovoid rimae, ca. 0.004 mm in length (Fig. 4C-1), and four rudimentary interspiracular processes (Fig. 4C-2).

The first instar differs from the previous two instars in lacking rugose pads on the gnathocephalon and the prothorax. There are also fewer minute acanthae circumscribing each intersegmental line. The dorsal, subdorsal and anterior sensory lobe sensilla are similar to the later instars, but the stomal sense organs are greatly reduced. Lateral spiracular complexes have been recorded for first instars of *Trupanea* spp. (Knio et al. 1996a), but because the *T. jonesi* specimens were wrinkled, these structures were not observed. First instar *T. jonesi* differs from *T. bisetosa* and *T. nigricornis* in having greatly reduced interspiracular processes (Knio et al. 1996a).

Puparium: Most puparia of *T. jonesi* are elongate-ellipsoidal (Fig. 5A), shiny black; anterior end bears the invagination scar (Fig. 5B-1) and anterior thoracic spiracles (Fig. 5B-2); caudal segment bears the posterior spiracular plates (Fig. 5C-1), a band of minute acanthae (Fig. 5C-2), and the intermediate sensory complex (Fig. 5C-3). Fifteen (4%) of 341 puparia dissected from flower heads (see below) were unpigmented medially (Fig. 5A, 6G). The 341 puparia averaged 2.76 ± 0.01 (range, 1.82–3.44) mm in length; 1.26 ± 0.01 (range, 0.86–1.65) mm in width.

The puparia of *T. jonesi* are similar in size to *T. nigricornis*, larger than *T. californica* and *T. imperfecta*, and smaller than *T. bisetosa*, *T. conjuncta* and *T. signata* (Goeden 1987, 1988; Headrick and Goeden 1991; Knio et al. 1996a; Goeden and Teerink 1997c).

Distribution and Hosts

The distribution of *T. jonesi* mapped by Foote et al. (1993) included the western third of the U.S. north of Mexico and Canada, with this species recorded from several locations each in Arizona, California, Colorado, Idaho, Montana, Nevada, New Mexico, Oregon, Texas, Utah, Washington, and Wyoming; from single locations in Iowa and Nebraska as well as from southern British Columbia.

Wasbauer (1972) and Goeden (1985, 1992) reported *T. jonesi* from eight tribes, 37 genera, and 86 species of Astereae in North America. Eight new rearing records for *T. jonesi* are listed below in the manner of Goeden (1992), that along with taxonomic changes in Hickman (1993) increase the reported host range to include eight tribes, 17 subtribes (Bremer 1994), 42 genera, and 104 species. All flies were reared from ca. 1-liter samples of mature flower heads from California.

New host genera.—*Chaetopappa, Orochaenactis, Syntrichopappus*

New host records.—*Artemisia rothrockii* Gray; 4 ♀; Horseshoe Meadow at 2870-m elevation, Inyo Nat. Forest, Inyo Co.; 14.ix.1993; *Chaetopappa aurea* (Nuttall) Keck; 1 ♂, 1 ♀; Spillway Canyon at 1400 m, San Bernardino Nat. Forest (S. Section), Riverside Co.; 21.v.1996; *Erigeron breweri*

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labial lobe sensilla; (E) gnathocephalon, prothorax, mesothorax, lateral view, 1—minute acanthae, 2—rugose pads, 3—verruciform sensilla, 4—stelex sensilla, 5—anterior thoracic spiracle, 6—stelex sensillum, 7—verruciform sensillum; (F) second abdominal segment, 1—spiracle, 2—placoid-type sensillum; (G) caudal segment, 1—minute acanthae, 2—stelex sensillum, 3—rima, 4—interspiracular process, 5—intermediate sensory complex; (H) intermediate sensory complex, 1—medusoid sensillum, 2—stelex sensillum.

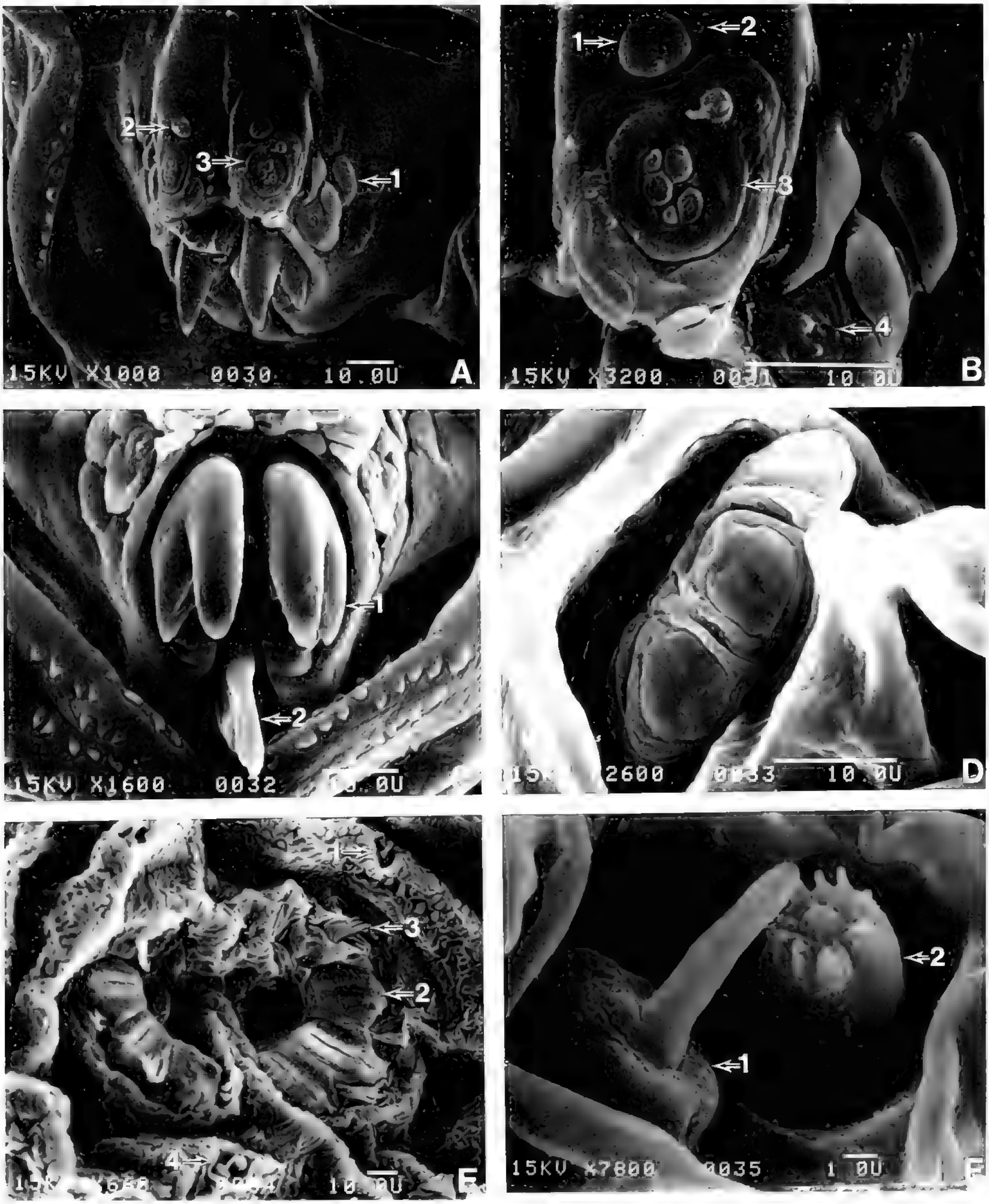

Fig. 3. Second instar of *Trupanea jonesi*. (A) gnathocephalon, anterior view, 1—rugose pads, 2—dorsal sensory organ, 3—anterior sensory lobe; (B) gnathocephalon, anterior view, 1—dorsal sensory organ, 2—subdorsal sensillum, 3—anterior sensory lobe, 4—stomal sense organ; (C) gnathocephalon, ventral view, 1—mouth hooks, 2—median oral lobe; (D) anterior thoracic spiracles; (E) caudal segment, 1—stelex sensillum, 2—rima, 3—interspiracular process, 4—intermediate sensory complex; (F) intermediate sensory complex, 1—stelex sensillum, 2—medusoid sensillum.

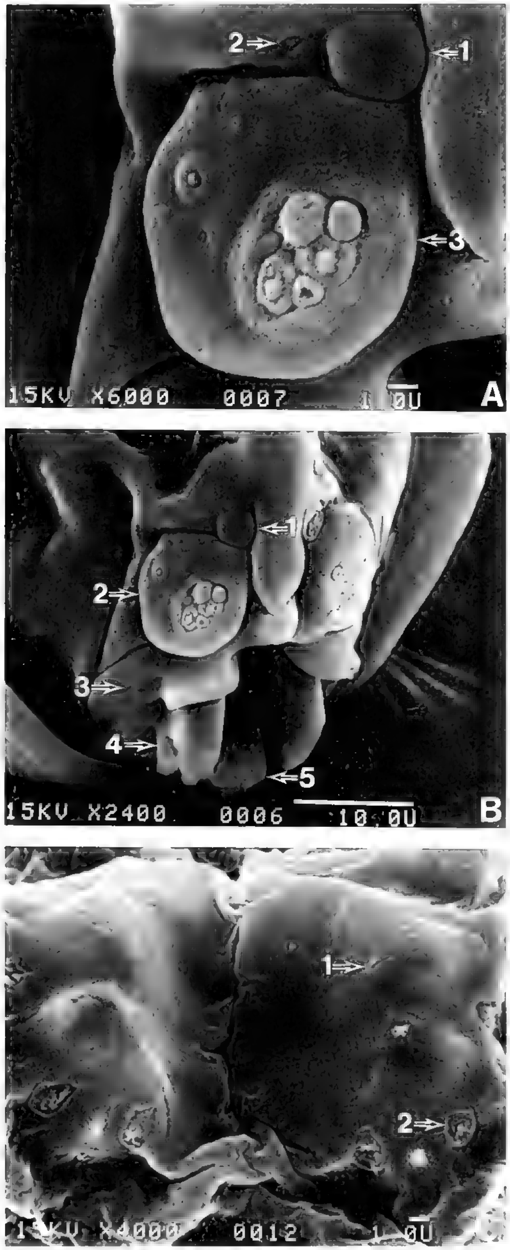

Fig. 4. First instar of *Trupanea jonesi*: (A) gnathocephalon, anterior view, 1—dorsal sensory organ, 2—subdorsal sensillum, 3—anterior sensory lobe; (B) gnathocephalon, anterior view, 1—dorsal sensory organ, 2—anterior sensory lobe, 3—stomal sense organ, 4—mouth hooks, 5—median oral lobe; (C) caudal segment, 1—rima, 2—interspiracular process.

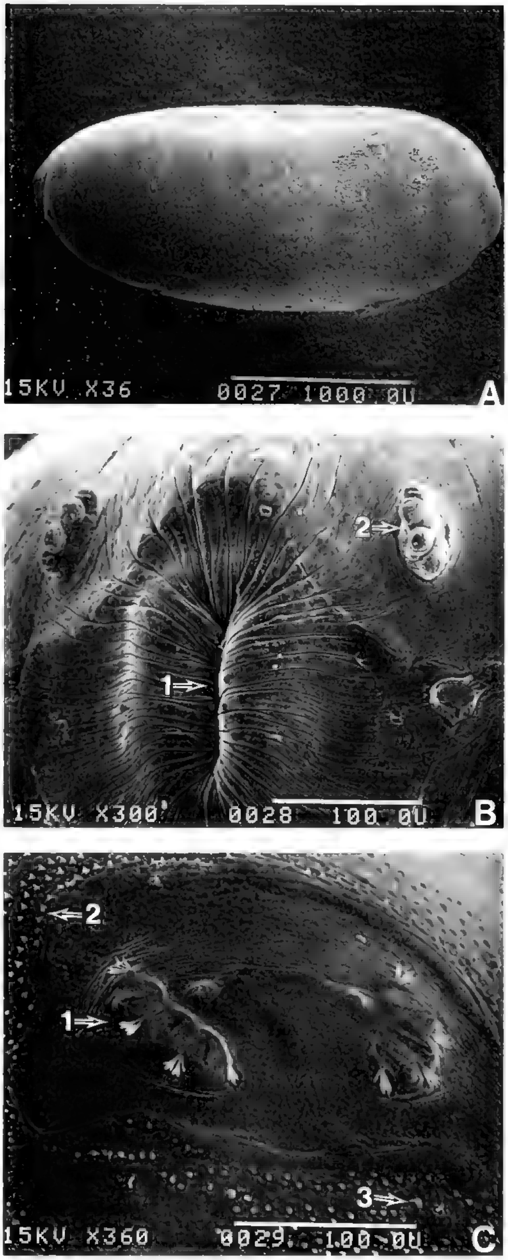

Fig. 5. Puparium of *Trupanea signata*: (A) habitus, anterior end to left; (B) anterior end, 1—invagination scar, 2—anterior thoracic spiracles; (C) caudal end, 1—posterior spiracular plates, 2—minute acanthae, 3—intermediate sensory complex.

Gray; 2 ♂, 1 ♀; W of Carson Pass at 2470 m along St. Hwy. 88, Eldorado Nat. Forest, Alpine Co.; 18.viii.1993; *Orochaenactis thysanocarpha* (Gray) Coville; 1 ♂, 1 ♀; SE of Powell Meadow at 2440 m, Sequoia Nat. Forest (N Section), Tulare Co.; 15.vii.1993; *Senecio fremontii* Torrey and Gray; 1 ♀; 1 km S of Osa Mountain at 2610 m, Sequoia Nat. Forest (N. Section), Tulare Co.; 15.vii.1996; *S. hydrophilus* Nuttall; 1 ♂; Pimentel Meadows at 2210 m along St. Hwy. 395, Mono Co.; 18.viii.1993; *Syntrichopappus fremontii* Gray; 15 ♂, 18 ♀; N of Saddleback Butte at 927 m, W Mojave Desert, NW Los Angeles Co.; 16.iii.1996; *Tetradymia canescens* deCandolle; 1 ♂, 1 ♀; SW of Smith Mountain at 2440 m, Sequoia Nat. Forest (N Section), Tulare Co.; 14.vii.1993.

The host record for *Helenium hoopesii* Gray in Wasbauer (1972) was confirmed by us since publication of Goeden (1992). All 104 of the reported hosts of *T. jonesi* are from California, and all but 15 of these represent our or RDG's rearing records, including four from Wasbauer (1972) which we have confirmed to date. Thus, as previously noted, *T. jonesi* retains its distinction as having the broadest host range in terms of known genera and species attacked of any native tephritid from California, and from North America (Wasbauer 1972; Goeden 1985, 1992; Foote et al. 1993). Again, most hosts of *T. jonesi* in California belong to the Astereae, with good representation also in the tribes Helenieae, Heliantheae, and Senecioneae (Munz 1974, Hickman 1993, Bremer 1994). Similarly, the subtribes Asterinae, Chaenactidinae, Senecioninae, and Solidagininae of Bremer (1994) include the most host species.

Biology

Egg.—In 17 closed, preblossom, immature flower heads of *Aster integrifolius* Nuttall, eggs were inserted pedicel-last through the phyllaries, and deposited either parallel to the receptacle (n = 15, 88%; Fig. 6A), or perpendicular to it in two heads. In four preblossom heads of *A. alpigenus* (Torrey and Gray) Gray, the long axes of single eggs lay perpendicular to the receptacle in two heads (Fig. 6B), or at 15° from the perpendicular in the other two heads. The passage of the aculeus was marked by small round punctures in the phyllaries (Fig. 6C). The diameters of the receptacles of 16 of these heads containing eggs averaged 2.9 ± 0.2 (range, 1.6–4.0) mm, and 21 such heads contained an average of 3 ± 0.4 (range, 1–6) eggs oviposited singly or side by side in pairs by one or more females. An average of 2.4 ± 0.5 (range, 1–5) ovules were damaged by an aculeus during oviposition in seven of these heads.

Larva.—Upon eclosion, first instars tunneled into and fed on the ovule and unelongated floral tube of a single floret, then moved into an adjacent, more centrally located floret. An average of 1.8 ± 0.3 (range, 1–6) first instars were found feeding within 21 closed, preblossom heads from *A. integrifolius* and *A. alpigenus.* The receptacles of these two *Aster* spp. averaged 3.9 ± 0.2 (range, 1.4–5.7) mm in diameter with an average of 70 ± 3 (range, 48–89) ovules/florets, of which an average of 4.6 ± 1.0 (range, 1–17) ovules/florets, or 6% (range, 1–28%), were damaged. Receptacles within these 21 infested flower heads were not scored (visibly abraided) by larval feeding.

Second instars fed mainly on ovules of preblossom flower heads or soft achenes of open heads, and usually at or near the centers of these flower heads (Fig. 6D). A few second instars were found at the margins of flower heads of *A. alpigenus* and *Helenium hoopesii* Gray (Fig. 6E). Again, neither seven, closed, preblossom flower heads of *A. alpigenus* nor six, open flower heads of *Chaenactis douglassi* (Hooker) Hooker and Arnott, averaging 4.2 ± 0.1 (range, 3.4–4.7) mm in diameter had receptacles that were scored by larval feeding (see below). These 13 flower heads contained an average of 1.5 ± 0.3 (range, 1–4) larvae that had destroyed an average of 3.3 ± 0.9 (range, 1–10) ovules/soft achenes, or 7.3% (range, 2.5–14.3%) of an average total of 47 ± 8.2 (range, 18–89) ovules/soft achenes in these infested flower heads.

Third instars confined their feeding to soft achenes or florets in the centers of open or postblossom heads, respectively (Fig. 6F). In 85 infested flower heads from 10 different host species averaging 3.8 ± 0.1 (range, 1.9–7.8) mm in diameter and containing an average of 1.4 ± 0.8 (range, 1–3) third instars (Fig. 6F), an average of 5.9 ± 0.5 (range 1–22) soft achenes/florets were damaged, or 15% (range, 2.2–76%). Most third instars fed with their long axes oriented perpendicular to, and mouthparts directed toward the receptacles, within the lower parts of the floral tubes and upper parts of the soft achenes, well above the receptacles. The receptacles were scored in only six (7%) of the 85 heads; i.e. in one of two infested heads of *Coreopsis californica* (Nuttal) H. K. Sharsmith; two of 31 (6%) heads of *A. integrifolius*; one of two heads of *H. hoopseii* (Fig. 6E); and three of four heads of *Chaenactis xantiana* Gray. Three of the six heads with scored receptacles contained two or three larvae each, which suggests a positive trend toward receptacle scoring at higher larval density and a greater propensity for scoring within heads of certain hosts, for example, as reported among larvae of *Paracantha gentilis* Hering in flower heads of native *Cirsium* thistles (Headrick and Goeden 1990). (Receptacle scoring also is analyzed in greater detail below within heads containing puparia.) Upon completing feeding, the larvae oriented with their anterior ends away from the receptacles, retracted their mouthparts, and pupariated.

Pupa.—Flower heads containing puparia (Fig. 6G, H) reflected the greatest amount of damage that the seed-feeding larvae of *T. jonesi* caused within heads of hosts sampled. Accordingly, 434 flower heads of 10 host species in six genera found to contain puparia were analyzed altogether, and by host genus and species (Table 1). The receptacles of infested flower heads of all 10 hosts averaged 4.4 ± 0.1 (range, 2.5–6.1) mm in diameter and bore an average total of 80 ± 2 (25–119) soft achenes/florets, of which an average of 7.3 ± 0.5 (range, 2–40) soft achenes/florets or 16% (range, 1–15%) were damaged. These heads contained an average of 1.7 ± 0.1 (range, 1–15) puparia. Most puparia of *T. jonesi* were found in the centers of the heads, all had their anterior ends facing away from the receptacles, and their long axes were perpendicular to the receptacles (Fig. 6G, H). *Trupanea jonesi* generally infested only a small proportion of the flower heads sampled and damaged only a small proportion of the immature achenes of the hosts listed in Table 1.

Receptacle scoring by *T. jonesi* larvae during feeding apparently was not obligatory, as it was absent in all infested flower heads of *Aster breweri* (Gray) Semple, *Chaenactis douglasii* (Hooker) Hooker and Arnott, *Chaenactis xanthiana* Gray, and *Layia glandulosa*; whereas, the receptacles of all 28 infested flower heads of *Coreopsis californica* examined were scored (Fig. 6G). The receptacles also were scored in three of 77 (4%) infested flower heads of *Arnica chamissonis* Lessing (Fig. 6H); three of four (75%) infested flower heads of *Aster alpigenus*; eight of 47 (17%) flower heads of *Aster integrifolius*; one of 29 (3%) infested flower heads of *Chaenactis fremontii* Gray; and nine (26%) of 35 infested flower heads of *Eriophyllum lanatum* (Pursh) Forbes. Two of three (66%) infested flower heads each of *Arnica chamissonis* and *Aster alpigenus,* six of eight (75%) flower heads of *Aster integrifolius,* and seven of eight (88%) with scored receptacles contained more than one puparia, which again suggests a positive correlation of larval densities and incidence of receptacle scoring (Headrick and Goeden 1990).

Adult.—The duration of the larval and pupal stages together approximated the duration of flower head development. Adults emerged from mature flower heads, and were long-lived under insectary conditions, as eight males averaged 63 ± 6 (range, 42–

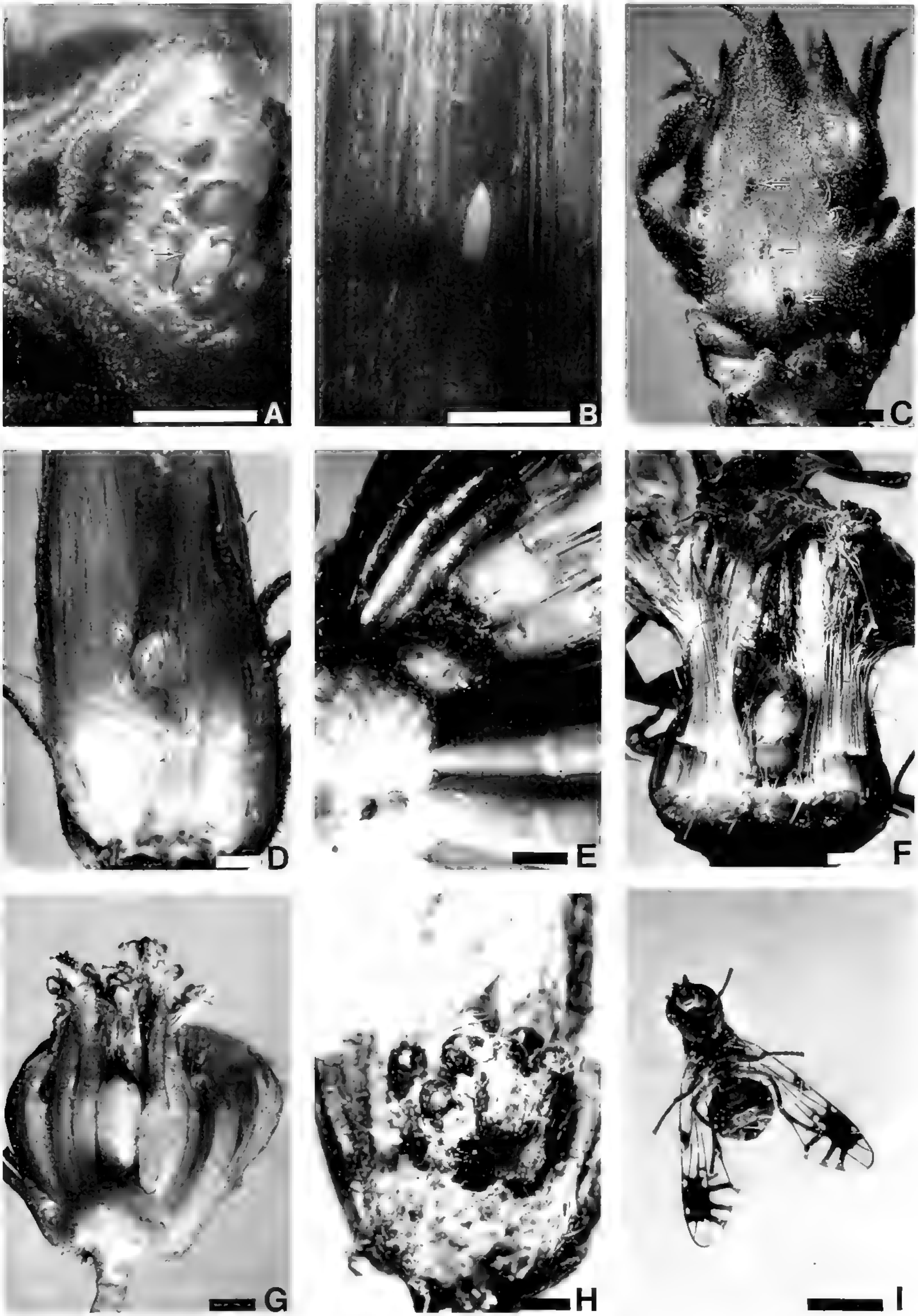

Fig. 6. Life stages of *Trupanea jonesi:* (A) pair of eggs (arrow) inserted in closed, preblossom flower head of *Aster integrifolius,* (B) egg inserted in central floret in flower head of *Aster alpigenus,* (C) ovipositional punctures (arrows) in phyllary of closed, preblossom, flower head of *A. integrifolius,* (D) second instar feeding on central floret in open head of *Aster breweri,* (E) second instar feeding on soft achene and scoring receptacle at margin of flower head of *Helenium hoopesii,* (F) two third instars in common, central, feeding cavity in

91) days, and 26 females averaged 76 ± 5 (range, 29–120) days.

Wing displays: Both sexes displayed synchronous and asynchronous supinations with vibrations (Headrick and Goeden 1994); however, their wing displays were imprecise and showed no observable rhythm. Males exhibited a unique hamation display during courtship (Headrick and Goeden 1994), which is described below.

Courtship: Male courtship displays were observed at all times throughout the day beginning at ca. 0700 h, and into the night under artificial lighting; however, adults were most active in the mornings. The abdominal pleura of males were distended for most of the display period (Fig. 6I) concurrently with asynchronous wing displays. Males spent most of the display period upside down under the covers of arenas and visually tracking (facing toward) walking females.

Male courtship displays consisted of abdominal pleural distension and a unique wing display. Slow analysis with video-recording playback of this wing display was required to fully describe its components. As one wing was held over the dorsum the other wing was extended forward with supination up to ca. 90°, then the extended wing was brought back flat over the dorsum. As the first wing was brought back, the other wing was extended forward at exactly the same rate and distance, (= hamation), but with supination. The first wing was held over the dorsum until the second wing began to return, then the first wing was extended again and in time with the return of the second wing. This display increased in the arcs of extension and supination as the male moved closer to a female. This display was rapid such that the wing blades were blurred at normal viewing speeds. The wing display climaxed as the male neared the female, his wings were held extended at 90° from the midline of the body, supinated 90° with respect to the substrate, but rapidly moved together, back-and-forth through only a few degrees. Then, the wing blades began to rise up and down in a plane parallel to the supinated blade and perpendicular to the substrate. If a female moved away from a displaying male, the intensity of the wing display diminished.

Males displayed hamation if they stood near a female and the intensity increased with proximity. If a female remained in place, a male moved toward her and attempted mounting. If she moved away, he followed her while raising his front legs and placing his tarsi onto her wings. If she still remained, he then climbed onto her dorsum, typically from behind (n = 5).

Copulatory induction behavior: A mounted male ceased his wing display and quickly grasped the female and began to drum his epandrium against the apex of her ovipositor. If the female was receptive, she exserted her aculeus and intromission was gained. If a female remained unreceptive and did not exsert her aculeus, the mounted male used his front legs to drum on the top of her abdomen. Males remained on unreceptive females for up to ca. 10 min before dismounting. Unreceptive females used their hind legs to push at mounted males in attempting to dislodge them.

Copulation: In the final copulatory position, a male grasped the female with his front legs on top of her abdomen near her thorax, his middle legs around the middle of her abdomen with the tarsal claws hooked onto her pleura and his hind legs around her oviscape with the tarsi pressed together beneath, or projected posteriad

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flower head of *Malacothrix glabrata* Gray, (G) medially unpigmented puparium in flower head of *Coreopsis californica,* (H) 14 black puparia clustered in center of flower head of *Arnica chamissonis,* (I) ventral view of male with abdominal pleura distended. Lines = 1 mm.

Table 1. Achene feeding by larvae of *T. jonesi* in flower heads of native Asteraceae in southern California.

Host-Plant Genera and Species Sampled	No. of Heads Dissected	No. (%) Heads Infested	Mean No. (Range) [%[a]] Achenes Damaged	Mean No. (Range) Total Achenes in Infested Heads
Arnica chamissonis	448	90 (20.1%)	7 (3–30) [10.3%]	80 (25–119)
Aster spp.	863	145 (16.8%)	9 (2–40) [18.3%]	54 (20–109)
Aster alpigenus	215	25 (11.6%)	4 (2–8) [4.4%]	86 (70–104)
Aster breweri	148	9 (6.1%)	4 (3–5) [17.9%]	23 (21–25)
Aster integrifolius	500	111 (22.2%)	9 (2–28) [19.3%]	50 (20–94)
Chaenactis spp.	1000	129 (12.9%)	6 (2–15) [16.1%]	41 (16–82)
C. douglasii	200	41 (20.1%)	3 (2–5) [13.9%]	23 (16–23)
C. fremontii	600	48 (8%)	8 (5–15) [15.9%]	55 (30–82)
C. xantiana	200	40 (20%)	6 (2–12) [17.1%]	36 (18–50)
Coreopsis californica	600	28 (4.7%)	5 (3–10) [14.7%]	41 (15–60)
Eriophyllum lanatum	200	35 (17.5%)	11 (6–20) [22.5%]	49 (35–70)
Layia glandulosa	200	7 (3.5%)	10 (3–19) [26.4%]	42 (18–84)

[a] Mean % achenes damaged in all infested heads examined per host genus and species.

without touching the oviscape. A mounted male displayed hamation as an agitation response to the female or to moving objects. His wings were typically held flat over his dorsum, with their costal margins parallel. The female's wings were spread at ca. 45°. Copulation lasted an average of 10 min (n = 5).

Before disengagement, a male pressed his hind tarsi against the apex of a female's ovipositor. Rubbing with the hind legs continued and became more vigorous as the termination of copulation neared. The male then turned and stepped off the female, moved behind her and walked away while quickly pulling the aedeagus from her aculeus. The aedeagus then was recoiled around the epandrium during grooming. Females moved away from the dismounted male and groomed while the aculeus was retracted. Males remained very active and the wing display changed from hamation to asynchronous supination.

After disengagement, males re-approached females with the abdominal pleura distended and displaying wing hamation. Females were observed to copulate only once with the same male while confined to arenas. Females also showed aggression toward males after copulation.

Male-male interactions: Two trials were conducted in which two males and a single female were confined to an arena. Males interacted similarly to that observed with *Tephritis stigmatica* and *Rhagoletis completa* (Boyce 1934, our unpublished data). A total of 11 interactions were recorded. Males faced each other and displayed synchronous supinations, during which the wings were held extended from the body at 100–110° and supinated ca. 90° with respect to the substrate. The males moved towards one another with their wings in this position. When they were within 2 mm, they raised up on their hind and middle legs and grappled with their front legs. During this upraised grapple, they fully extended their mouthparts and placed their labella together, holding onto each other with their front legs. The labella were pressed firmly together. In some battles, the mouthparts of the males were pressed together with such force that the labella slipped past each other and the heads of the two males knocked together, at which point both males immediately tried to place their labella together again (n = 2). Battling males also momentarily released their labella and rose completely vertically, venter to venter, with their front legs stretched above their heads and asynchronously boxing them. Then, they dropped down to the substrate and placed their mouthparts together again or they stopped and moved away from each other with their wings still outstretched. As they moved away from each other, they switched to hamation displays. No male was observed to successfully copulate with a female after battling with another male. In one episode, two males faced each other with their wings extended 90° perpendicular to their bodies and to the substrate, then moved toward each other. One male grabbed onto the wings of the other with his front legs, inducing the latter male to pull away. The male gripped the wings firmly, but the other male was able to wrest free. They faced each other again and locked their mouthparts together and grappled with their front legs. They remained together for ca. 30 sec, then finally broke apart and began hamation displays again.

Seasonal history.—The life cycle of *T. jonesi* in southern California follows an aggregative pattern in which the long-lived adults in reproductive diapause overwinter (probably in riparian habitats) and aggregate to mate on preblossom host plants in late winter and early spring. They reproduce, at first in the low-elevation, Colorado (upper Sonoran) Desert, then in the high elevation Mojave Desert, interior valleys, and coastal areas (Headrick and Goeden 1994). Reproduction by subsequent generations of this multivoltine tephritid continues thereafter throughout the spring, summer, and fall on a wide range of alternate host plants, as flowering of Asteraceae continues at ever higher elevations and more northerly latitudes in California.

Natural enemies.—Five species of Hymenoptera were reared from individual puparia and mature flower heads bearing puparia of *T. jonesi* as solitary, larval-pupal endoparasitoids: *Eurytoma obtusiventris* Gahan, *E. veronia* Bugbee (Eurytomidae), *Halticoptera* sp. (Pteromalidae), *Mesoplobus* sp. (Pteromalidae), and *Pteromalus* sp. (Pteromalidae). Specimens similar to *E. obtusiventris* or *E. veronia*, and either variations or undescribed species, currently are under study by Michael Gates, Department of Entomology, University of California, Riverside. Additional, possible primary parasitoids or hyperparasitoids reared from mature flower heads along with *T. jonesi* were identified as *Pachyneuron* sp. (Pteromalidae), *Syntomopus* sp. (Pteromalidae), *Eupelmus* sp. (Eupelmidae), and one, unidentified, apparent species each of Cynipidae and Eulophidae.

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A DESCRIPTION OF THE MALE OF *JORDANOPSYLLA ALLREDI* TRAUB AND TIPTON, 1951, AND CHARACTERIZATION OF THE TRIBES WITHIN ANOMIOPSYLLINAE (SIPHONAPTERA: CTENOPHTHALMIDAE)

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Abstract.—The male of *Jordanopsylla allredi* Traub and Tipton, 1951 is described, observations recorded, and distributional records noted. Tribes of the subfamily Anomiopsyllinae are reviewed and descriptions of each are provided. A key to the tribes is included for the subfamily Anomiopsyllinae.

Key Words: Siphonaptera, Ctenophthalmidae, *Jordanopsylla allredi*

Jordanopsylla allredi Traub and Tipton, 1951 was described from two females from Southwestern Utah. Subsequently, three males and two females were reported by Beck and Allred (1966) from the Nevada Test Site, Nevada, as *J. allredi.* These latter specimens constitute an undescribed species. A third female was reported by Augustson and Durham (1961) from northwestern Arizona (see Distributional Records). Males of *J. allredi* were independently collected in Southwestern Utah by all three authors, but were never described. The purpose of this paper is to review the systematic position of the genus *Jordanopsylla* and other genera within the subfamily Anomiopsyllinae, describe the male of *J. allredi,* record some observations, and document the rare distributional records of *J. allredi.*

Anomiopsyllinae Baker, 1905

A description of Anomiopsyllinae, in which *Jordanopsylla* is placed, can be reviewed in Holland (1985). It is one of nine subfamilies in the family Ctenophthalmidae (Anomiopsyllinae, Ctenophthalminae, Dinopsyllinae, Doratopsyllinae, Listropsyllinae, Liuopsyllinae, Neopsyllinae, Rhadinopsyllinae, and Stenoponiinae). Some confusion exists as to what genera belong in Anomiopsyllinae. Ioff and Argyropulo (1934) erected *Wagnerina* and placed it in the subfamily Ceratophyllinae, but later Ioff and Scalon (1954) treated *Wagnerina* as a distinct subfamily (Wagnerinae) of Ctenophthalmidae. Hopkins and Rothschild (1962) attributed the genus to the tribe Jordanopsyllini, while Yu et al. (1990) included it in Anomiopsyllinae without tribal designation. Comparison of *Wagnerina* (Table 1 of Traub and Tipton 1951) with *Anomiopsyllus, Callistopsyllus, Conorhinopsylla, Jordanopsylla, Megarthroglossus,* and *Stenistomera* indicate it clearly belongs to the Anomiopsyllinae, but warrants assignment to its own tribe, Wagnerinini Ioff and Argyropulo, 1934. Although Ioff and Argyropulo (1934) did not designate, or provide a description of the tribe Wagnerinini, they did erect the genus upon which the tribal name is based. *Jordanopsylla* remains assigned to Jordanopsyllini. *Eopsylla* has traditionally been placed in the Anomiopsyllini, however, specimens were not available for study and it is not addressed here.

Key to the Tribes of Anomiopsyllinae

1. Pleural arch vestigial, or absent; lateral metanotal area absent; metepimeron fused to metanotum (Nearctic) . . . . Anomiopsyllini
– Pleural arch well developed; lateral metanotal area present; metepimeron and metanotum not fused 2
2. Pronotal comb present, plantar bristles displaced onto sole of metatarsus v (eastern Palearctic) . . . . Wagnerinini
– Pronotal comb absent, plantar bristles absent on sole of metatarsus v (southern Nearctic) . . . . Jordanopsyllini

Anomiopsyllini Baker, 1905

The genera *Anomiopsyllus, Callistopsyllus, Conorhinopsylla, Megarthroglossus,* and *Stenistomera* belong to this tribe.

Number of preantennal rows of bristles 2 or more, apex of maxillary lobe acute, males without occipital groove (except *Megarthroglossus,* slight indication), pronotal comb present (except *Anomiopsyllus*), dorsal margin of mesonotum distinctly longer than metanotum by at least ⅓, lateral metanotal area and pleural arch absent, dorsoanterior margin of metasternum concave, squamulum present (except in males of *Megarthroglosssus*), metepimeron fused with metanotum, anteromesal setae of coxae II and III absent on upper fourth, tarsi V with 5 pairs of plantar bristles, first displaced onto plantar surface, abdominal tergites with a single row of setae (except *Conorhinopsylla* which has 2 rows), and 4 or more spinelets on T-I.

Wagnerinini Ioff and Argyropulo, 1934

Preantennal area with 2 distinct rows of setae, large seta at apex of rounded genal lobe, 3 rows of setae in occipital area (anterior 2 rows reduced to minute setae), disjunct row of thin setae along dorsal margin of antennal fossa apposed to traditional minute spiniform setae, tentorial arch anterior to vestigial eye. Pronotal comb present, dorsal margin of mesonotum longer than metanotum by at least ⅓, well developed lateral metanotal area, dorsal anterior margin of metasternum convex and ventral anterior margin truncate, metepimeron not fused with metanotum. Anteromesal setae of coxae II and III absent on upper fourth, tarsus V of all legs with 5 pairs of plantar bristles, first pair displaced onto plantar surface. All abdominal tergites with 2 rows of setae, marginal spinelets on T-I-III, 1–3 antesensilial bristles in female and T-VII of male with caudally projecting lobes in traditional position of antesensilial bristles, the latter indiscernible or reduced to minute hairs (except *Wagnerina schelkovnikovi* Ioff and Argyropulo, 1934, which is without lobes and possessing a single antesensilial bristle), spiracle on T-VIII remote from sensillium, anal stylet reduced, hardly longer than wide, with single long bristle. Sternites VIII and IX fused and tendon of St-IX lost.

Jordanopsyllini Traub and Tipton, 1951

The erection of Jordanopsyllini (in the absence of males) was based on the presence of a lateral metanotal area, a moderately well developed pleural arch, metepimeron not fused with the metanotum, dorsoanterior margin of metepisternum convex, and absence of squamulum. *Jordanopsylla,* although most closely allied to *Anomiopsyllus* (see Barnes et al. 1977 for a review of the affinities within Anomiopsyllini), does not share the same tribal affinities. The availability of males confirms the tribal characteristics as seen in the female with some clarifications and additions.

Maxillary lobe not reduced (as stated by Traub and Tipton 1951), but well developed and bluntly rounded in both males and females. Distal portion of lobe hyaline and difficult to see (Fig. 1). Maxilla acuminate in all other genera within Anomiopsyllinae. Depth of occipital groove subequal to width of incrassation at oral angle. Dorsal margin of meso- and metanota subequal in length (mesonotum ⅓ or greater than length of metanotum in other genera). Anteromesal setae of coxae II and III extending from base to apex. Tarsal segments V of all legs

Figs. 1–6. *Jordanopsylla allredi.* 1, Head of male. 2, Male clasper. 3, Ninth sternum with fused lateral lobe of aedeagus, male. 4, Aedeagus. 5, Sixth sternum, female holotype. 6, Eighth sternum, male. Scale = 100 μ.

with only lateral plantar bristles, whereas other genera in Anomiopsyllinae have first pair displaced onto plantar surface. Lateral lobe of aedeagus fused to distal portion of St-IX. Tendon of St-IX vestigial.

Jordanopsylla Traub and Tipton, 1951

Generic characters annotated in Traub and Tipton (1951) are expanded with the availability of males. These include the presence of a well developed pleural arch, lateral metanotal area, metepimeron free from fusion to the metanotum, metasternum with a convex anterior margin (all characteristics shared by *Wagnerina*), and absence of genal or pronotal combs (also shared by *Anomiopsyllus*). Characters shared by no other genus in the subfamily include: dorsal margin of mesonotum subequal in length to that of the metanotum and anteromesal setae of coxae II and III from base to apex. Females have a sinus in the caudal margin of the sixth sternum also peculiar to the genus (Fig 5). No males and females examined possess a striarium on the second abdominal sternum, or mesal bristles on the metatibia as was indicated in Traub and Tipton (1951). The second abdominal sternum does possess fine reticulations (not considered striaria) and the metatibia has a lateral row of setae opposed to a mesal row. Additional male characters that typify the genus include a clasper with a very small movable process, an aedeagus with two lateral lobes (distolateral and lateral lobes), and fusion of the apical lobes of St-IX with the lateral lobes of the aedeagus. An additional large lobe occupying a medial position between the lateral lobes might appear as a well developed disto-lateral lobe (typical of many Leptopsyllidae), or as crochet, but the structure is not paired. For lack of better understanding of this prominent structure, it will be hereafter referred to as the end chamber (see under Aedeagus below).

Jordanopsylla allredi Traub and Tipton

Voucher specimens.—♂, ex ♀ *Neotoma lepida* Thomas, Grafton, Washington Co., Utah, 37°10′30″N, 113°05′30″W, M. W. Hastriter, January 13, 1997, deposited in the National Museum of Natural History, Smithsonian Institution, Washington, D.C. 2 ♂, same data, but collected January 11, 1997, deposited in collection of senior author.

Male description.—*Head* (Fig. 1): Frontoclypeal region evenly rounded, incrassation at oral angle. Depth of occipital groove equal to width of incrassation at oral angle. Setae in ocular row 3, ventralmost stoutest and placed at margin of genal area just posterior to origin of maxillary palpus, postoccipital row of 5. Minute punctations throughout head capsule with 3–4 marginal placoids and one in lateral occipital area. Dense line of minute spiniform setae along dorsal margin of antennal fossa. Scape with 3–4 minute setae, 3–4 bristles of pedicel ⅔ length of clavus. Antenna extending onto proepisternum. Well developed arch of tentorium anterior to eye. Eye moderately developed, partially pigmented, and notched ventrally. Genal process subacuminate, maxillary palpus with 4 segments extending to apex of trochanter. Labial palpus with 5 segments, penultimate shortest and apical longest, base of penultimate nearly exceeding trochanter. Laciniae minutely serrate apically, subequal in length to labial palpi. Sclerotized proximal half of maxillary lobe projecting beyond prementum of labial palpus, distal half hyaline, subacuminate, its apex extending to middle of first segment of labial palpus.

Thorax: Indistinguishable from female.

Legs: Lengths of segments comparable to those of female and setation similar. Coxae II and III with slender anteromesal setae extending from base to apex. Segment V of all tarsi with 4 lateral plantar bristles, none displaced onto plantar surfaces.

Unmodified abdominal segments: Tergites I–II each bearing one marginal spinelet per side. Two rows of setae on tergites I–IV. Only one seta in main row extending below spiracles on tergites II–VII. One antesensilial bristle per side. Tergite VIII with one dorsal seta anterior to vermiform spiracle, second seta just posterior to spiracle subequal in size to antesensilial bristle. Each side of St-II with one lateral seta, St-III–VII with 2 each and St-VIII with 4. Caudoventral margin of St-VIII with sclerotized extension (Fig. 6).

Modified abdominal segments (Figs. 2–3): Fixed process of clasper with small movable process pivoting at fovea. Length of movable process (3 times its width above fovea) just exceeds dorsocaudal apex of fixed process. Radial lines originating at fovea and at ventral apex of finger. Anterior margin of manubrium forming a smooth semicircle, apically subtruncate. Conical, V-shaped apodeme interconnects left and right claspers. Dorsal body of clasper with 6–7 small marginal setae, 2 larger submarginal setae, 2 large lateral setae near fovea, mesal group of 6–7 minute setae below acetabulum and 3 mesal setae aligned between 2 large acetabular bristles. Movable process with 10–12 minute submarginal setae. Paired St-IX fused at junction of proximal and distal arms, apical lobe enveloped by and fused to lateral lobe of aedeagus, apodemal rod present, although vestigial (Fig. 3). Heel of proximal and distal arms of St-IX with lateral patch of 6–7 minute setae and apical lobe of distal arm bearing 10–12 minute submarginal setae.

Aedeagus (Fig. 4): Aedeagal apodeme broadest medially, tapering to a narrow neck near fulcral lobes. Paired penis rods exceeding aedeagal apodeme, but not coiled. Median dorsal lobe nipple-like, laterally expanded into paired distolateral lobes, lateral lobes, and a single median lobe (end chamber). Apical lobes of distal arm of St-IX envelop end chamber and are enveloped by and fused to lateral lobes. Sclerotized inner tube bears a dorsal tooth basally. Crochets absent.

Size: (Total length mm, mounted specimens) (N = 8) Range = 1.7–2.0, Average = 1.9. Unmounted specimens observed dorsally appear laterally broad with a wide, bluntly rounded head.

Distributional records.—All specimens known to the authors were examined during this study except for the original female paratype (with asterisk). ARIZONA: (1 ♀), Wolf Hole, Mojave Co., ex *Peromyscus eremicus* Baird, 9/4/1959 (sic!), elev. 1070 m [specimen reported by Augustson and Durham (1961) as *J. allredi* were examined and identified as *Thrassis aridis* ssp.]. UTAH: (1 ♀), Grafton (37°10′N, 113°04′W), Washington Co., ex *P. eremicus,* December 17, 1950, elev. 1110 m, A. E. Beck and D. M. Allred - Holotype; (1 ♂), same data but 37°10′30″N, 113°05′30″W January 11, 1997, elev. 1150 m, M. W. Hastriter; (2 ♂), same data but ex *N. lepida,* January 13, 1997; (1 ♂), Snow Canyon (37°10′30″N, 113°38′30″W), Washington Co., ex *Peromyscus maniculatus* (Wagner), December 28, 1963, elev. 940 m, A. D. Stock; (4 ♂), same data but ex *N. lepida monstrabilis,* December 8, 1989, H. J. Egoscue; *(1 ♀), Springdale (37°11′15″N, 113°00′15″W), Washington, Co., ex *P. eremicus,* November 4, 1950, elev. 1190 m, D. E. Beck and D. M. Allred—Paratype; (1 ♂), St. George (City Springs) (37°07′30″N, 113°35′10″W), Washington Co., ex *P. eremicus,* December 29, 1963, elev. 940 m, A. D. Stock.

DISCUSSION

Throughout the limited range of *J. allredi,* collections have been restricted to the winter months (4 November–13 January). This flea has only been collected on six different occasions within a narrow range of elevations (940–1140 m). The senior author collected it within one half mile of the type locality on a south facing slope characterized by slides and outcrops of basalt boulders. Vegetation included Snake Weed [*Gutierrezia microcephala* (de Candolle)], Brigham Tea (*Ephedra viridis* Coville), Rubber Rabbit Brush [*Chrysothamnus nauseosus* (Pallas)], Pale Cholla (*Opuntia echinocarpa* Engelmann and Bigelow), Common Prickly Pear (*Opuntia erinacea* Engelmann), and Cheatgrass (*Bromus tectorum* Linnaeus). This habitat primarily supports *Peromyscus eremicus, P. crinitis* (Merriam), and *Neotoma lepida.* It is noteworthy that *Jordanopsylla* has never been collected from *P. crinitis,* although the latter is commonly collected in the same habitat.

The terminal segments (clasper, St-IX, and aedeagus) of one of the males collected in January 1997 were dissected to gain a better understanding of this unusual genus. The aedeagus is not normally fused to the St-IX, but relatively free and easy to separate during dissections. The St-IX and aedeagus were clearly fused and could be separated only by tearing the extended lateral lobe from the aedeagus (Fig. 2). This fusion precludes independent movement of the St-IX and aedeagus relative to one another. This fusion also appears in an undescribed species from Nevada. It is therefore included as a character distinct to this genus not found in other Anomiopsyllinae. Although fine reticulations can be seen on the basal sternite of the holotype of *J. allredi,* a striarium is not discernible. A distinct sinus in the caudal margin of St-VI of the holotype female was not noted in the original description by Traub and Tipton (1951). This sinus is also present in the undescribed species of *Jordanopsylla* from Nevada.

Jordanopsylla is a characteristic nest flea, e.g., reduced eyes, absence of combs and reduced setation, appears to be a poor jumper (although the pleural arch is well developed), a rather slow crawler, and extremely reluctant to surface in the fur when disturbed, or exposed to a stream of compressed CO2 (observations of senior author). Only one of the three specimens was collected on initial examination of two hosts. The other two were retrieved 24 hours after the host was dead and even then were reluctant to leave the host pelage. These tenacious habits may account for infrequent collections of the species. Similar behavior was noted in *Stenistomera alpina* (Baker 1895) and *Anomiopsyllus amphibolus* Wagner, 1936 (the latter considered a nest flea) during the same expedition and may be a feature of true nest fleas, thus enhancing their survival.

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LEAF MINING AND GRAZING IN SPIDER BEETLES (COLEOPTERA: ANOBIIDAE: PTININAE): AN UNREPORTED MODE OF LARVAL AND ADULT FEEDING IN THE BOSTRICHOIDEA

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Abstract.—The first larval leaf mining and live-leaf feeding by adults is reported in the Anobiidae and the more inclusive superfamily Bostrichoidea. Larvae of *Pitnus antillanus* Bellés bore in leaves of *Tournefortia gnaphalodes* (L.) (Boraginaceae) and adults feed on leaves of the larval host plant. Larvae complete their development and pupation within a single leaf. It is suggested that leaf mining is a recently derived trait in *Pitnus.*

Key Words: leaf mining, Anobiidae, Ptininae, spider beetles, *Pitnus antillanus, Tournefortia gnaphalodes*

Compared to the very large number of species in the Coleoptera, relatively few are known to be leaf miners. The families Buprestidae, Chrysomelidae, and the Curculionidae, sensu lato, (i.e. Belidae, Attelabidae, and Curculionidae [Connor and Taverner 1997]) contain the majority of species (Hespenheide 1991) with smaller numbers in the Nitidulidae and Mordellidae (Paulian 1988). Nearly all species in the Anobiidae (including the Ptininae) feed exclusively on plant or fungal materials in their larval stages, with the majority boring in dead wood or bark (White 1962). There is, though, a large range of feeding habits and styles in this family. For example, most species of *Tricorynus* (= *Catorama*) feed in seeds, although a few have been reared from galls (White 1965, 1974). Many species of dorcatomine anobiids feed on fungi (White 1974, 1982) and members of the subfamily Ptininae mainly scavenge dry organic matter of plant or animal origin (Lawrence and Britton 1991). Specialized habits within the latter general category include species closely associated with human (Howe 1959, Hinton 1941) and bee (Linsley and MacSwain 1942 and references therein) stored products. Many others are ant associates (Lawrence and Reichardt 1969), and one species may be a termitophile (Zayas 1988). *Ptinus exulans* Erichson subsists mainly on the dried remains of insects and spiders and the dry eggs of spiders (Hickman 1974). No ptinines, or any other members of the Bostrichoidea, have ever been recorded to mine or feed on living leaves.

Leaf mines are channels created by insects (or possibly other organisms) within mesophyll or epidermal tissues. An insect must leave both layers of the epidermis or their outer walls intact in order to be considered a true miner (Hering 1951). This paper describes the life history of this type of miner, *Pitnus antillanus* Bellés, based on field and laboratory observations.

The biology of the 12 members of the genus *Pitnus, sensu stricto,* is poorly known (Bellés 1992). All published information is limited to data on specimen labels. A perusal of data reported by Bellés indicates that *Pitnus* is associated with succulent plants in beach or xeric habitats. Although single records exist for associations with *Cryptocarpus* sp. (Nyctaginaceae), fish poison tree (*Piscadia piscipula:* Fabaceae), sea grape (*Coccoloba uvifera:* Polygonaceae), *Djaleya* sp. [sic] and green leaf tobacco (*Nicotiana tabacum:* Solanaceae), repeated records exist for cacti (two records and species in southwestern North America) and *Tournefortia* (= *Mallontonia*) *gnaphalodes* (three records for two species in Florida and the West Indies). Several additional records mention shrubs or leaf litter on beaches (three records and species).

Pitnus antillanus is a rarely collected species known from Puerto Rico (including Mona Island and Cayo Solito) and the Virgin Islands (Bellés 1992). Observations to date are limited to label notes indicating specimens were extracted, via berlese funnels, from beach litter and dead leaves of *T. gnaphalodes* (Bellés 1992, Ivie unpublished).

MATERIALS AND METHODS

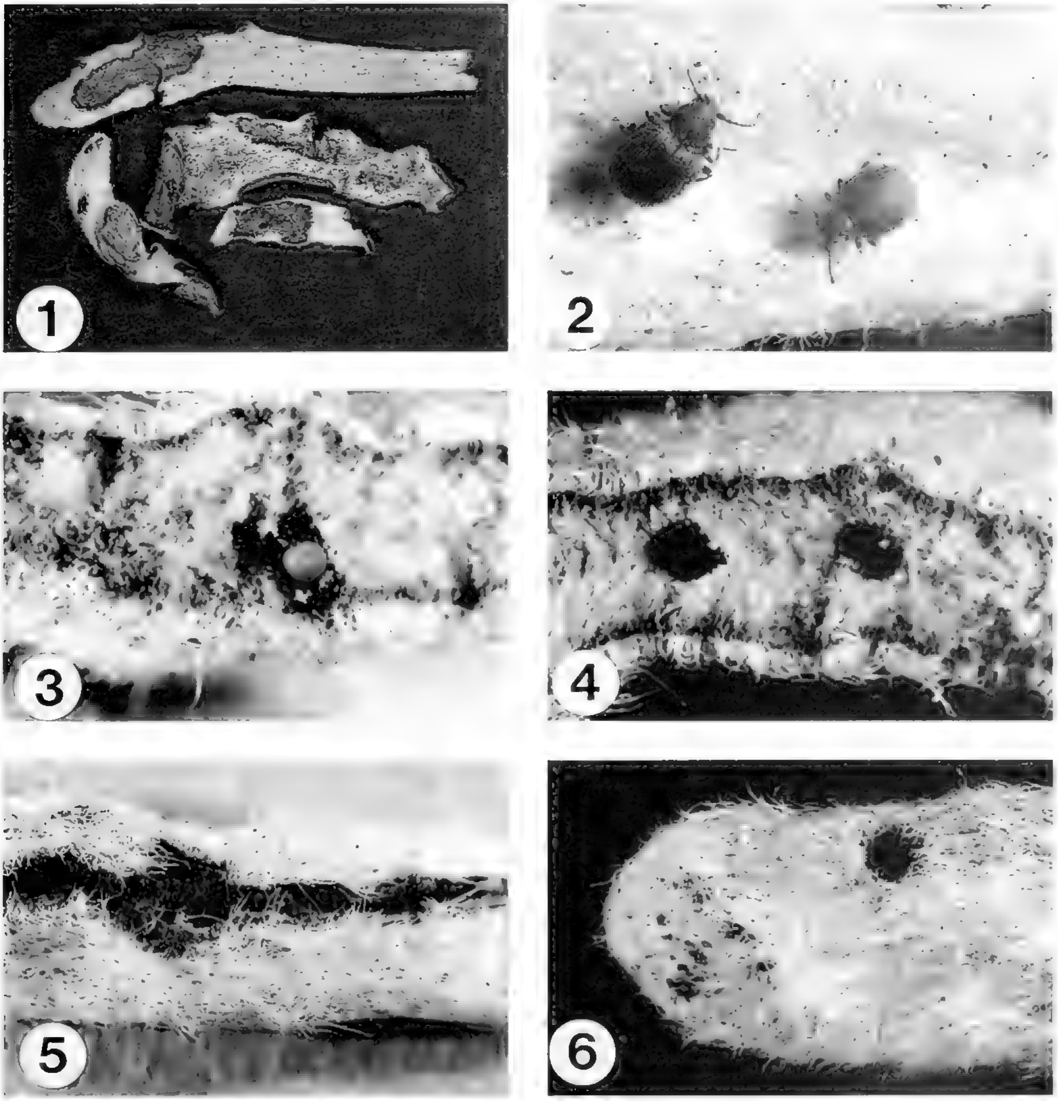
Pitnus antillanus specimens collected by two staff members of the Virgin Islands Beetle Fauna Project (D. S. Sikes and R. S. Miller) were noticed feeding on leaves of a living Boraginaceae on the east end of St. Croix in January, 1993. Following up on this observation of such a rare species, beetles were observed on two occasions (in August, 1995) by one of us (M.A.I.) on the host plant, *Tournefortia gnaphalodes* (Linneaus), Boraginaceae, at East Bay, (St. Croix) and Smith Bay, (St. Thomas) U.S. Virgin Islands. Host-plant branches with infested leaves also were collected for examination in the laboratory. These branches were preserved in 95% ethanol and each leaf and stem carefully examined for eggs, larvae, and pupae in the laboratory.

Fifty-eight individuals were collected on 28 August, 1995 at East Bay and used to establish colonies. Cultures were set up in plastic Petri dishes of two different sizes using dead leaves. A single large colony was kept in a 90 × 15 mm dish and smaller subcultures were maintained in 55 × 15 mm dishes. Leaves were scattered throughout the bottom of the large culture dish, one to two layers deep. Groups or individual leaves were used in the small Petri dishes. With isolated leaves, the development of individual larvae could be more carefully studied. Small pieces of apple were added periodically as a food and moisture source, and a 1-cm square piece of paper towel was moistened daily with distilled water to humidify the cultures.

Voucher specimens have been placed in the Virgin Islands Beetle Fauna Project Collection (Montana State University), The Ohio State University Insect Collection, and the collection of TKP.

RESULTS

Field observations.—Returning to the site of the Sikes and Miller collections on August 28, 1995, plants were examined for adult beetles. Visual searching was not productive as the beetles are tiny (1.0–1.4 mm) and are exceedingly difficult to see on the grey-green foliage covered with silvery trichomes. A sharp tap over a beating sheet, however, yielded *P. antillanus* in abundance. Closer examination showed a progression from healthy, firm, fleshy leaves at the top of each stem, down through wilted, shriveled ones, to dried hard brown obviously dead leaves at the bottom of the whorl. Bare stem, with leaf scars, occupied the remainder of the stem. Dead leaves laid in piles under the plant. Splitting open the woody stem (the expected larval habitat) showed no evidence of larval feeding. The leaves, however, showed evidence of leaf mining. Ptinine larvae were observed in several leaves with the leaf condition ranging from turgid to flaccid. Newly eclosed adults were found in dry leaves. A general progression of leaves with less-to-more ma-



Figs. 1–6. Host plant damage, egg, and adults of *Pitnus antillanus*. 1, Adult feeding damage on the host plant, *Tournefortia gnaphalodes*. 2, Adults on leaves of the host plant. 3, Exposed egg which had been oviposited through a split in the leaf surface. 4, Cross-section through a leaf exposing two mines in leaf mesophyll tissue 5, Exposed mine of late instar on a section of leaf. 6, Emergence hole of adult

ture larvae seemed to go from terminal to basal positions respectively, with adults in the lowest leaves. Examination of more *T. gnaphalodes* on St. Thomas yielded concurring observations. No larval mortality from either parasites or pathogens was observed in field collected leaves.

Adult behavior.—Adult beetles were repeatedly observed feeding on living leaves of the host plant, *T. gnaphalodes* in the Virgin Islands. Microscopic examination showed that beetles chewed leaf trichomes or hairs to gain access to the leaf surface and mesophyll tissue. Feeding damage was usually not so deep as to completely perforate leaves (Fig. 1). In culture, adults were observed to feed on dead leaves (and pieces of apple). Although the leaves are thickly covered with fine overlapping trichomes, they did not seem to impose any difficulties in feeding. Beetles consumed the trichomes as readily as epidermal or mesophyll plant tissue. The hairs did not create any difficulties for movement, as numerous individuals were observed walking quickly over leaf surfaces (Fig. 2). Adult feeding damage created discolored areas that were used as hiding places. Adults survived in colonies for as long as three months.

Oviposition.—Adults laid eggs directly on undamaged plant leaves and generally placed eggs among leaf hairs. They also used damaged areas such as feeding sites, cracks in leaves, or other potential hiding spots (Fig. 3). Only dead leaves were available in the lab, and were readily accepted for oviposition. Eggs are ovoid and white with a pointed tip. Egg length was 0.37 ± 0.03 mm and the width 0.25 ± 0.04 mm ($n = 10$). Eggs were laid singly, although several were found in small groups within approximately 3 mm of each other in particularly good hiding spots. It is not known how many females contributed eggs found in such locations. Eggs were inserted inside leaf tissues only if there was a break in the leaf surface to allow ovipositor access.

Larval development.—Complete larval development appears to take place within a single leaf. Larval mines were found in both mature leaves and smaller, immature leaves attached to within 3 cm of the apical meristems. Larval development can occur entirely within a dead leaf. Eclosion occurred as larvae chewed through their egg shells (egg shells were never completely consumed) and into the leaf epidermis. Larvae then proceeded to hollow out the inner leaf tissues, leaving the outer cells of both the upper and lower epidermal tissues intact. First instar larvae initially develop their mines as a single tract (Fig. 4) but later expand the tunnel as a full depth, blotch mine as they mature (Fig. 5) (terminology from Hering 1951). Blotch mines are formed by tunnel expansion in both a horizontal and vertical direction, with no particular sense of direction. Larvae were constrained somewhat by the elongate leaf shape but were not affected by leaf venation. As the leaf gradually narrows to the stem no distinct petiole exists and leaves were mined their entire lengths, but mining was never observed in the stem. No feces are removed or ejected and hence mines always contained a large quantity of frass. Only a single larva per leaf was observed in the field-collected leaves, but on several occasions, more than one larva was found within a leaf in lab colonies. This may be a result of captivity and overcrowding.

Compared to a typical scarabaeiform anobiid larva, *P. antillanus* larvae are very linear and almost eruciform. This modified form enhances their ability to move, as larvae appeared very mobile and can move easily within a mine or over flat surfaces. No carpeting of the mine cavity with silk was observed prior to pupation.

Pupation.—Pupation occurred within the mine created by larval feeding and no particular pupation mine or special burrow was made. No emergence holes or slits were made before larvae pupated, but emerging adults easily chewed small round holes through the leaf tissue to escape pupation chambers (Fig. 6). Thin-walled pupal cocoons were constructed with silk, but the amount of silk used appears to vary a great deal. In most cases the amount seemed to be small, as evidenced by the difficulty we had in locating old pupation sites. Chambers could be detected by the presence of the larval and pupal exuvia. In one case, a relatively large amount of silk was found and formed a thin but tightly woven cocoon. Pupal cocoons were surrounded with debris consisting almost entirely of black fecal pellets.

DISCUSSION

There are now eight families of beetles with known leaf miners (classification of Lawrence and Newton 1995). How these species evolved into leaf miners is unknown, but hypotheses have been presented by several authors. Although buprestids are mainly cambium borers, it has been noted that cambium tissue is not very different from the thin layer of tissue in a leaf (Needham et al. 1928). Therefore, this ancestral feeding mode may have preadapted species for leaf mining. Curculionoid miners are generally thought to have been derived from stem (Needham et al. 1928) or seed and fruit dwelling ancestors (Connor and Taverner 1997). Later they evolved into petiole borers and other forms that live and feed in the large ribs of leaves and remaining leaf tissue. Chrysomelids contain many species whose larvae and adults feed on leaves. A switch from exposed feeding to feeding within the leaf may have afforded added protection from predators or parasitoids (Needham et al. 1928).

Most Anobiidae and its sister group, the Bostrichidae, are wood borers. Crowson (1967) proposed that the evolution of the ptinines from within the anobiids may have been due to the switch from wood-boring to scavenging food of both plant and animal origin. He stated that the loss of wood-boring was "a fundamental factor conditioning the divergence of the Ptinidae as a family." Evidence against this hypothesis is that some *Ptinus* spp. are true wood-borers (Howe 1959, Bellés 1980). Unlike *Ptinus*, *Pitnus* is a very derived member of the Ptininae with a characteristic globular body form, fused elytra, and an absence of flight wings. They belong to a lineage of highly derived ptinines (such as *Sphaericus, Trigonogenius, Gibbium,* etc.) which feed upon accumulations of dead organic matter. Many members of this lineage are known to feed in animal dung, such as rodent pellets (Aalbu and Andrews 1992).

Hering (1951) considered species that do not live in fresh, green leaves but mine dead tissue to be transitional between true miners and saprophytes. *Pitnus antillanus* may represent both forms, as it is a species which may start mining in live tissue but can, if necessary, utilize or complete development in a dying or dead leaf. Adults inside shed leaves are probably the source of reported beach litter records for the species (Bellés 1992).

Selection for a mining lifestyle may be due to several factors. Mines afford protection from natural enemies and desiccation (Hering 1951) and can allow much higher feeding efficiencies compared to external feeding (Connor and Taverner 1997). The effect from desiccation may be particularly relevant for a small species like *P. antillanus,* which is less than 1.5 mm long (Bellés 1992). Additionally, this species lives in sea beach habitats exposed to high sun (UV radiation) and wind exposure. The succulent leaves of *T. gnaphalodes* provide cover and possibly moisture in a very dry habitat. Further, no parasites or pathogen induced larval mortality were observed in the field-collected leaves. However, we did not find any evidence that larvae are mining to avoid structural or chemical defences of the host plant, or that they are consuming more nutritious parts of the leaf. Indeed, some leaves were almost completely hollowed out by larval feeding.

Pitnus antillanus has a large parental investment in each egg produced. Each egg averages 0.37 mm in length, while adults range in size only from 1.0 up to 1.4 mm (Bellés 1992). Hence, total egg production is probably quite low. Although ptinines vary a great deal in total egg production (e.g. *Ptinus sexpunctatus* Panzer averages only 21 eggs per female while *P. tectus* Boieldieu can lay nearly 1000 [Howe 1959]), low fecundity in *Pitnus* may indicate reduced larval mortality associated with mining. The adults may also be long lived, as evidenced by their abundance when collected with a beating sheet, and the relatively large series (for anobiids) of 20 or 30 specimens used to describe several species (Bellés 1992).

The more linear body form of the larva, rather than the typical "C"-shaped scarabaeiform bostrichoid larva, probably enables *P. antillanus* to move more easily within a mine. In comparison, other ptinine larvae are capable of movement, but are relatively awkward when removed from their feeding site. This is particularly true in the large final instar. The only other bostrichoid larvae known to retain the ability to walk on a substrate are the fungivorous Endecatominae (Kompantsev 1978, Ivie 1985). Although we have no evidence for this, the mobility of the larvae of *P. antillanus* may also be an adaptation for moving from leaf to leaf via the plant exterior. Leaf miners of other families are known to wander on stems to select other leaves during the course of their development (Hering 1951, Ford and Cavey 1985). One general characteristic of mining larvae is a strongly thickened fore body to facilitate penetration into plant tissue (Hering 1951). These modifications were not observed in *P. antillanus.*

Adults are present throughout the year (records in Bellés 1992 and from museum specimens), as is the perennial host plant, so breeding potentially can occur at any time of the year. The host plant for *P. antillanus, Tournefortia gnaphalodes,* is a widespread coastal species. It is found at least as far south as Aruba, Bonaire, and Curaçao, throughout the West Indies and Florida, and along the coast of tropical Mexico (Boldingh 1914, Britton and Millspaugh 1920, Long and Lakela 1971). With this broad host distribution, it is likely that many more populations or species of *Pitnus* occur in coastal areas of the Caribbean, in addition to those listed by Bellés (1992).

It is possible that adult or larval feeding affects leaf tissue or causes leaf abscission, which might improve the leaf host as a food source. We suspect that these beetles may be introducing a fungus that affects the larval food source quality. More studies on the beetles and their hosts will need to be done before we can answer these questions.

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DESCRIPTIONS OF *MICROMYRMEX DARLINGTONI*, N. SP., FROM JAMAICA AND *MICROMYRMEX SPATULATA*, N. SP., FROM HISPANIOLA (COLEOPTERA: CURCULIONIDAE: OTIDOCEPHALINI)

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Abstract.—***Micromyrmex darlingtoni*, n. sp.** from Jamaica and possibly from Haiti, and ***Micromyrmex spatulata*, n. sp.** from the Dominican Republic, are described and illustrated. This represents the first record of the tribe Otidocephalini from Jamaica. *Micromyrmex darlingtoni* is distinguished from other described *Micromyrmex* by the orange-red elytra that contrast with the shining, black body. All other described *Micromyrmex* have black elytra. *Micromyrmex spatulata* is distinguished by the presence of spatulate setae on the elytra, which are lacking in all other described *Micromyrmex*.

Key Words: Curculionidae, Otidocephalini, *Micromyrmex*, new species, West Indies, Hispaniola, Jamaica, Dominican Republic, Haiti

The genus *Micromyrmex* Sleeper was redefined by Ivie and Sikes (1995) and enlarged from five to ten species. Weevils in this genus are known from the Greater Antilles, the Bahamas, Central America and the North American Mainland (O'Brien and Wibmer 1982, Ivie and Sikes 1995). No species of the tribe Otidocephalini was previously known from Jamaica. We take this opportunity to describe two new species from the West Indies, one of which is known from Jamaica.

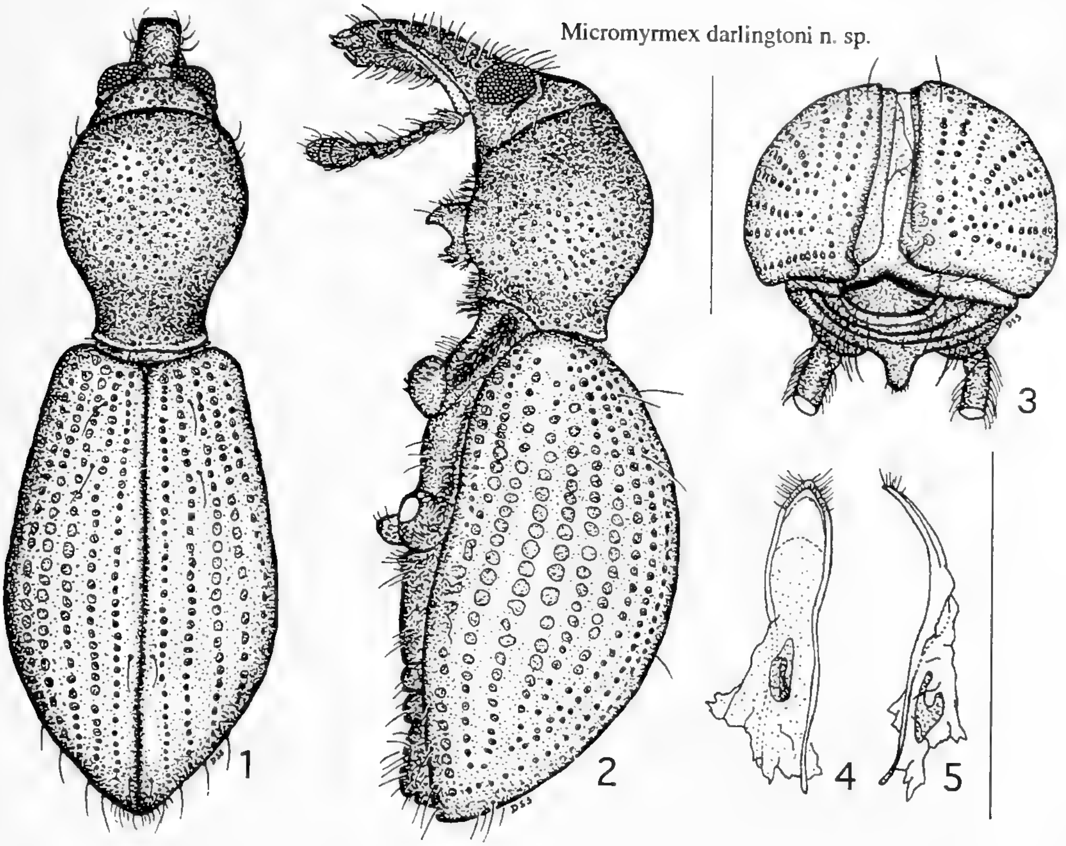
In the descriptions below, we follow the descriptive terminology of Ivie and Sikes (1995). Collection acronyms are as follows: Museum of Comparative Zoology (MCZC), Harvard University, Cambridge, MA, U.S.A.; Barry D. Valentine Collection (BDVC), Columbus, OH, U.S.A.; H. and A. Howden Collection (HAHC), Ottawa, Canada; Charles W. O'Brien Collection (CWOB), Tallahassee, FL, U.S.A.; and Michael A. Ivie Collection (MAIC), Bozeman, MT, U.S.A.

Micromyrmex darlingtoni Sikes and Ivie, new species

(Figs. 1–5)

Diagnosis.—The adults of this species can be differentiated from all described *Micromyrmex* by their orange-red elytra; black pronotum, head, annulae of antennae, basal tarsomere; lack of femoral teeth on the meso- and metafemora; and by the presence and shape of the large tubercle on ventrite I of the male (Fig. 3).

Description.—Holotype male. Length (elytral apex to anterior pronotal margin) 2.9 mm, width across humeri 0.8 mm. Head, annulae of antenna, basal tarsomere and pronotum shining black; antennal scape, mandible, and remainder of tarsi yellow; thoracic sterna, legs, and abdominal sterna rufus; elytra orange red, eyes silver; all setae and scales white.



Figs. 1–5. *Micromyrmex darlingtoni*, holotype male (scale = 1.0 mm). 1, Dorsal view. 2, Lateral view. 3, Posterior apical view. 4–5, Aedeagus (scale = 1.0 mm), length = 0.82 mm. 4, Dorsal view. 5, Lateral view.

Head (Figs. 1, 2): Upper mid-portion coarsely punctate, lacking setae, separated from lateral portion by a weakly defined supraocular sulcus. Eyes large, dorsal, separated dorsally by approximate width of antennal club; margined above and below with long, fine setae. Rostrum stout, curved in profile; width subequal to diameter of eye; fine setae throughout, not obscuring surface; scrobe lateral, directed below eye. Antenna (Fig. 2) with scape reaching anterior ⅓ of eye, funicle 7-segmented, first segment stouter and more setose than remainder; club ovate, annulate, length subequal to that of last 4 funicular segments combined.

Pronotum (Figs. 1, 2): Elongate, 1.25× longer than wide, globose anteriorly, widest just before middle, broadly constricted posteriorly; coarsely punctate; row of fine setae at lateral-anterior margin.

Meso- and metathoracic dorsal surface (Figs. 1, 2): Elytra with length 1.7× greater than width, widest near middle, with 10 punctate striae, punctures surrounded by disk-like darkened regions; humeri rounded and smooth; 2 setigerous punctures in basal ¼ of 2nd interstria, 2 others on suture near apex; smaller setigerous punctures on margin of apical ⅕, flange along left elytral suture fitting beneath right elytron, causing asymmetrical extreme apex (Fig. 3). Scutellum covered by dense white setae. Metathoracic wings fully developed.

Ventral surface: Prosternum thickly set with radiate-pectinate scales before, between and behind coxae. Mesosternum fringed posteriorly and mesepisternum completely covered with radiate-pectinate scales. Metasternum fringed posteriorly with radiate-pectinate scales; metepisternum completely covered with radiate-pectinate scales; remainder of metasternum with scattered fine setae. Abdomen with large tubercle on intercoxal process of ventrite I, tubercle subequal to length of antennal club (Fig. 3); line of radiate-pectinate scales behind coxae on ventrite I; ventrites I and II appear fused, and together equal length of ventrites III–V combined, ventrite II with long, fine setae posterolaterally, ventrite V with scattered, long, fine setae.

Legs: Procoxae subcontiguous; mesocoxae separated by width of funicle; metacoxae widely separated. Pro- and mesocoxae with radiate-pectinate scales; dorsal surface of femora sparsely covered with long, coarse setae. Profemur with distinct tooth at apical ¼; meso- and metafemora unarmed; protibia narrow, parallel-sided, minutely dentate internally in apical ½; meso- and metatibiae rugose interiorly in apical ½. Tibiae with long, moderately dense setae, densest internally and thickly covering internal apices, mucro buried within setae of internal apices. Tarsi thickly padded with setae; claws with quadrate teeth basally.

Aedeagus (Figs. 4, 5): Strongly curved in profile; numerous setae on broad apex; length 0.82 mm; internal sack bearing single large sclerite.

Female.—Lacking tubercle on the intercoxal process of abdominal ventrite I, (showing only a slight swelling in its place). Eyes smaller, more widely separated than of male.

Variation.—The type series ranges in length from 2.8–3.0 mm, and the width across the humeri from 0.8–0.9 mm. The setae on the 2nd elytral interstria and sutural margins vary in number and placement. Two paratypes collected at 2256m (7400′) on Blue Mountain, Jamaica, have much darker coloration, particularly the elytra which have the orange-red replaced by a dark mahogany.

Type material.—HOLOTYPE. ♂: Whitfield Hall; Blue Mts; nr 4500 ft.; Aug. 13–20/ Jamaica; 1934; Darlington [MCZC]. PARATYPES (5): 1 ♂, 1 ♀ [MCZC], 1 ♂ [MAIC]: same data as holotype. 1 ♂ [HAHC] and 1 ♀ [CWOB]: JAMAICA, 7400′; Blue Mt. Peak; VII. 27–28. 1966; Howden & Becker.

Additional material examined.—Four females from Furcy, Haiti, collected at 4000′ on VII-9-56 [9 July 1956] by B & B Valentine while sweeping bushy roadsides, are not included in the type series [BDVC & MAIC]. These four agree in all respects with the Jamaican type-series, but the lack of males leaves their identity in doubt. More material, particularly, males from Haiti is required to establish their identity.

Etymology.—The species is named in honor of one of the collectors, Philip J. Darlington, Jr.

Micromyrmex spatulata Sikes and Ivie, new species

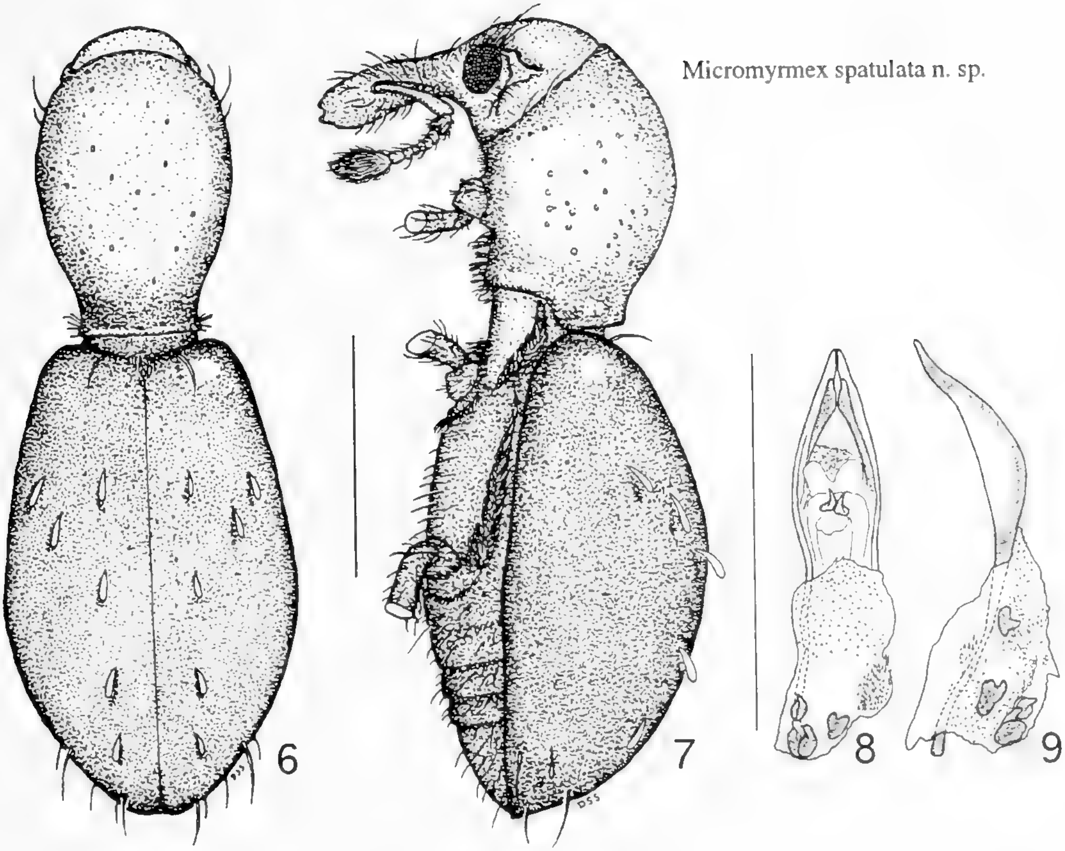
(Figs. 6–9)

Diagnosis.—The adults of this species can be differentiated from other described *Micromyrmex* by the presence of spatulate setae on the elytra (Figs. 6, 7) (shared by no other known *Micromyrmex*), their color, (only three described species have red-orange head/prothorax and black elytra), their size (only one of the three bicolored species is as small), and the total lack of femoral teeth (two of the bicolored species display femoral teeth).

This species most closely resembles *Micromyrmex pulicarius* (Boheman), but differs in the lack of elytral punctures and striae, and in the presence of spatulate setae.

Description.—Holotype male. Length (elytral apex to anterior pronotal margin) 2.9 mm, width across humeri 0.7 mm. Head (exclusive of rostrum), pro- and mesocoxae, prothorax, pro- and mesosterna rufus; legs, rostrum, annulae of antenna and elytra black; antennal scape orange; eyes silver; all setae and scales white.

Head (Figs. 6, 7): Upper mid-portion



Figs. 6–9. *Micromyrmex spatulata*, composite of female paratypes (scale = 1.0 mm). 6, Dorsal view. 7, Lateral view. 8–9, Aedeagus (scale = 1.0 mm), length = 1.1 mm. 8, Dorsal view. 9, Lateral view

weakly punctate, lacking setae, separated from lateral and posterior portion by a strong declivity becoming a deep supraocular sulcus. Supraocular sulcus undercutting dorsal and lateral margin of eyes, with a bi-evaginational bridge at middle of eye, posterior edge of channel curving caudally toward pronotal margin before turning medially as shallow groove joining groove from other side across vertex. Eyes separated dorsally by width of antennal club; ringed by long, fine setae along medial margins. Rostrum stout, curved in profile, width 1.25× diameter of eye, widest at apex; elongate fine setae throughout, not obscuring surface; scrobe lateral, directed below eye. Antenna (Fig. 7) with scape clavate, reaching anterior margin of eye; funicle 7-segmented, first segment stouter, ca. twice size of and more setose than each remaining segment, setal density increasing towards segment VII; club ovate, annulate, dense setae obscuring surface, length subequal to that of last 6 funicular segments combined.

Pronotum (Figs. 6, 7): Elongate, 1.43× longer than wide, globose anteriorly, widest at middle, broadly constricted posteriorly; densely, coarsely, shallowly punctate; with fine setae at anterio-lateral and posterio-lateral margins.

Meso- and metathoracic dorsal surface: Elytra 1.5× longer than wide, widest just behind middle, with weakly punctate, almost obsolete striae, humeri evident, rounded and smooth; large spatulate setae on interstriae 2, 4, and 6. On holotype, 4 setae are indicated on interstriae 2 and 1 seta each on interstriae 4 and 6; 4 to 5 elongate, thickened (not spatulate) setae per elytron, bordering inner and outer elytral margins near apex, flange along left elytral suture fits beneath right elytron, causing extreme apex of elytral suture to be asymetric (see Fig. 3). Scutellum covered by dense white setae.

Ventral surface: Prosternum thickly set with radiate-pectinate scales. Mesosternum fringed with radiate-pectinate scales along posterior margin and on intercoxal process; mesepisternum completely covered with radiate-pectinate scales. Metasternum with scattered simple setae and fringed anteriorly with radiate-pectinate scales, metepisternum completely covered with radiate-pectinate scales. Ventrites I and II appear fused, suture obsolete, and together equal length of ventrites II–V combined, with surfaces bearing scattered setae in line posterior from coxae, glabrous medially and laterally. Ventrites III and IV equal in length, with evenly scattered setae over entire surface. Ventrite V just longer than combined length of ventrites III and IV, with scattered setae, setae shorter and less dense than on previous ventrites.

Legs: Procoxae contiguous; mesocoxae separated by width of funicle, metacoxae widely separated. Procoxae set with radiate-pectinate scales intermixed with simple setae; mesocoxae and metacoxae with sparse radiate-pectinate scales; metacoxa with dense fringe of radiate-pectinate scales along posterior surface. Foretrochanter with few radiate-pectinate scales, all trochanters with sparse setae. Femora lacking indication of teeth; profemur weakly clavate, mesofemur less so, metafemur almost parallel-sided; pro- and mesofemora with evenly scattered long setae; metafemour with long setae crowded on ventral surface, with lateral surfaces subglabrous and dorsal surface with dense fringe of stout, almost clavate setae. Tibiae parallel-sided, very minutely dentate internally in apical ½, with evenly spaced setae, densest on internal apices, mucro buried within setae of internal apices. Tarsi thickly padded with setae, claws with quadrate teeth basally.

Aedeagus (Figs 8, 9): Large in proportion to body size, length 1.10 mm; median lobe long and slender, apex acute, glabrous; internal sack bearing numerous small sclerites, 4 large sclerites posterior, 2 centrad.

Type Material.—HOLOTYPE. ♂: DOM. REP., Peravia; 36km. NW. SanJose; de Ocoa, Aug. 9; 1979 C. W. O'Brien [CWOB]. PARATYPES (3). 2 ♀ with same data as holotype [HAHC, MAIC]. 1 ♀: DOM. REP., LaVega; 18km. E. El Rio, Aug. 10, 1979 crest, cloud forest C.W.O'Brien [CWOB].

Etymology.—The specific epithet refers to the autapomorphic spatulate setae of this species.

Remarks.—The description of these species brings the number of possible aposematic *Micromymex* to eight of eleven described. The discovery that the larvae of *Micromyrmex asclepia* Ivie and Sikes feed within the stems of *Asclepias nivea* L. (Ivie and Sikes 1995) suggested the hypothesis that these animals may sequester cardenolides for chemical protection. The greatly developed supraocular channels of *M. spatulata* are hypothesized to be associated with possible repugnatorial exudations and aposematism (Ivie and Sikes 1995). *Micromyrmex darlingtoni* has supraocular sulci that are less distinct than those of *M. asclepia,* and *M. spatulata,* but the distinctly contrasting coloration of the individuals collected near 4,500′ supports the prediction that adults of this species are either Batesian mimics or are themselves unpalatable to some degree. The series of females from Haiti that might be *M. darlingtoni* were collected from bushes along roads and were from the same collection event in which seven *M. asclepia* adults were captured. Because it is known that *M. asclepia* uses West Indian milkweed as a host it is worth noting that we have at least some evidence, albeit circumstantial, that these possible *M. darlingtoni* adults may also use milkweed as a host plant.

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A REVISION OF THE *ANASTREPHA DACIFORMIS* SPECIES GROUP (DIPTERA: TEPHRITIDAE)

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Abstract.—The *Anastrepha daciformis* species group is revised. Thirteen species are recognized: ***A. antilliensis,* n. sp.** (Puerto Rico, Dominican Republic); ***A. aquila,* n. sp.** (Costa Rica); ***A. avispa,* n. sp.** (Costa Rica); *A. bicolor* (Stone) (s. Texas to Costa Rica); ***A. castanea,* n. sp.** (Argentina and Brazil (Mato Grosso do Sul)); *A. daciformis* Bezzi (s. Brazil, Paraguay, Argentina); ***A. katiyari,* n. sp.** (Venezuela); *A. macrura* Hendel (w. Venezuela, Ecuador, Paraguay, Brazil (Bahia, Rio Grande do Norte)); ***A. maculata,* n. sp.** (Virgin Is., Mona I.); ***A. murrayi,* n. sp.** (Jamaica); *A. pallens* Coquillett (s. Texas to Honduras and El Salvador); *A. stonei* Steyskal (Florida, Bahamas, Dominican Republic); ***A. zucchii,* n. sp.** (Brazil (Roraima)). A key to the species and an analysis of their phylogenetic relationships is presented and a diagnosis, description and illustrations of each species are provided.

Key Words: *Anastrepha, daciformis,* species group, key, Neotropical, phylogeny

Resumen.—Se revisan las especies de *Anastrepha* del grupo *daciformis* en el cual se reconocen trece especies: ***A. antilliensis,* n. sp.** (Puerto Rico, Dominican Republic); ***A. aquila,* n. sp.** (Costa Rica); ***A. avispa,* n. sp.** (Costa Rica); *A. bicolor* (Stone) (sur de Texas a Costa Rica); ***A. castanea,* n. sp.** (Argentina y Brasil (Mato Grosso do Sul)); *A. daciformis* Bezzi (sur de Brasil, Paraguay, Argentina); ***A. katiyari,* n. sp.** (Venezuela); *A. macrura* Hendel (oeste de Venezuela, Ecuador, Paraguay, Brazil (Bahia, Rio Grande do Norte)); ***A. maculata,* n. sp.** (Virgin Is., Mona I.); ***A. murrayi,* n. sp.** (Jamaica); *A. pallens* Coquillett (sur de Texas a Honduras y El Salvador); *A. stonei* Steyskal (Florida, Bahamas, Republica Dominicana); ***A. zucchii,* n. sp.** (Brasil (Roraima)). Se presenta además una clave para la separación de las especies y un análisis de sus relaciones filogenéticas, y se proporcionan diagnosis, descripciones e ilustraciones de cada una de las especies estudiadas.

The *daciformis* species group includes some of the most distinctive species of *Anastrepha,* the largest New World genus of Tephritidae, with almost 200 species. The *daciformis* group includes 13 species, eight of which are described in this paper. Together these species range from the West Indies and southern Texas to Argentina. All 13 species have dark brown markings of some type, and all but three have uninterrupted marginal wing bands, presumably for mimicry of vespid or other wasps. Four

Table 1. M ratio (distance along M from bm-cu to r-m/distance from r-m to dm-cu) in the *daciformis* species group.

Species	n	Range	Average
antilliensis	5	1.75–2.06	1.91
aquila	7	1.64–1.89	1.75
avispa	10	1.50–1.92	1.68
bicolor	16	1.57–2.33	1.88
castanea	4	1.25–1.49	1.41
daciformis	9	1.52–2.00	1.76
katiyari	5	1.05–1.34	1.18
macrura	11	1.41–2.04	1.72
maculata	6	1.21–1.53	1.37
murrayi	1	1.74	1.74
pallens	15	1.27–1.95	1.58
stonei	8	1.27–1.40	1.32
zucchii	5	1.52–1.79	1.68

species in this group were placed in the subgenus or genus *Pseudodacus* by some authors (e.g., Hendel 1914a,b, Stone 1939, Blanchard 1961, Foote 1967), but Steyskal (1977a) synonymized this name with *Anastrepha* based on discovery of a fifth species intermediate in some characters used to differentiate *Pseudodacus*. Some of the new species described in this paper are also intermediate in additional characters between the previously described species and typical *Anastrepha* species, lending further support to Steyskal's decision.

MATERIALS AND METHODS

I follow the morphological terminology of McAlpine (1981), except as noted in Norrbom and Kim (1988a). Wing band terminology follows Stone (1942) and Steyskal (1977b). I use the term marginal informally to describe the uninterrupted band on the anterior margin of the wing in most species of the *daciformis* group formed by fusion of the C-band and the apical half of the S-band. The following names are used for the white or yellow stripes of the mesonotum (Fig. 7B): medial—unpaired and expanded posteriorly; dorsocentral—paired, usually only presutural, but also postsutural in *stonei*; sublateral—paired, covers transverse suture and extends posteriorly to intra-alar seta; lateral presutural—paired, usually extends from posteromesal corner of postpronotal lobe, on scutum along border of anterior part of notopleuron, then curves laterally to cover posterior part of notopleuron. I use the term pale to refer to these and other areas of the body that may vary, often intraspecifically, from white to yellow. The M ratio (medial vein ratio) is the distance along M from bm-cu to r-m/ distance from r-m to dm-cu. The values for each species are presented in Table 1.

The length of the female terminalia is a

Table 2. Mesonotum length in mm, syntergosternite 7 length in mm, and their ratio in the *daciformis* species group. Figures include the range, average and standard deviation.

Species	n	Mesonotum	Syntergosternite 7	Syntergosternite 7/Mesonotum
antilliensis	3	1.95–2.27, 2.14 ± 0.17	2.25–2.75, 2.50 ± 0.25	1.10–1.25, 1.17 ± 0.07
aquila	5	3.66–4.08, 3.91 ± 0.18	7.32–7.78, 7.54 ± 0.17	1.83–2.00, 1.93 ± 0.07
avispa	12	3.24–3.70, 3.49 ± 0.15	3.91–4.75, 4.36 ± 0.29	1.17–1.34, 1.25 ± 0.06
bicolor Total	24	2.81–3.79, 3.31 ± 0.31	3.58–6.45, 5.14 ± 1.03	1.17–1.86, 1.55 ± 0.22
bicolor Short	11	2.81–3.58, 3.09 ± 0.28	3.58–4.95, 4.13 ± 0.42	1.18–1.59, 1.34 ± 0.12
bicolor Long	13	3.16–3.79, 3.48 ± 0.22	5.41–6.45, 6.00 ± 0.40	1.57–1.86, 1.72 ± 0.09
castanea	3	2.29–3.16, 2.74 ± 0.44	2.95–3.49, 3.23 ± 0.27	1.11–1.29, 1.20 ± 0.09
daciformis	13	2.58–2.89, 2.76 ± 0.11	2.12–2.70, 2.43 ± 0.19	0.75–0.98, 0.88 ± 0.07
katiyari	11	2.70–3.12, 2.94 ± 0.15	3.95–4.99, 4.32 ± 0.29	1.27–1.64, 1.57 ± 0.11
macrura	9	3.41–3.79, 3.56 ± 0.24	4.99–6.66, 5.76 ± 0.65	1.43–1.89, 1.62 ± 0.15
maculata	4	2.25–2.70, 2.54 ± 0.20	2.58–2.85, 2.74 ± 0.13	1.03–1.15, 1.08 ± 0.05
murrayi	1	2.57	3.91	1.52
pallens	22	2.70–3.45, 3.08 ± 0.17	2.91–3.70, 3.26 ± 0.19	0.95–1.17, 1.06 ± 0.05
stonei	6	2.37–2.66, 2.50 ± 0.11	2.79–3.24, 3.09 ± 0.18	1.16–1.31, 1.23 ± 0.06
zucchii	2	3.16–3.37, 3.27 ± 0.15	4.62–5.28, 4.95 ± 0.47	1.46–1.57, 1.51 ± 0.08

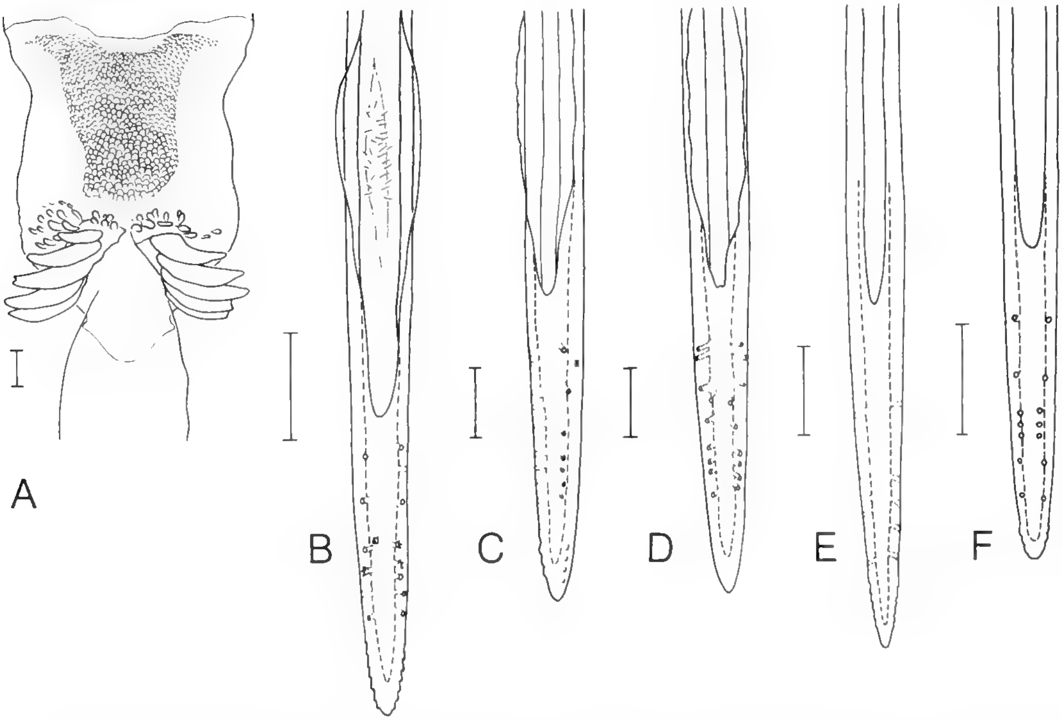

Fig. 1. Female terminalia. A, Scales of eversible membrane, *A. macrura* (San Bernardino, Paraguay). B–F, aculeus tip, ventral view (ventrolateral in C). B, *A. daciformis* (São Paulo, Brazil); C–D, *A. macrura* (Rancho Grande, Venezuela); E, *A. pallens* (Reynosa, Mexico); F, *A. stonei* (Bahamas Is.). Bar = 0.05 mm.

useful taxonomic character in this group. The length of syntergosternite 7 (= oviscape) and its relative length (compared to mesonotum length) are presented in Table 2.

Because the aculeus is so fine in this group, it is difficult to dissect, and it and the eversible membrane are easily damaged. For this reason, I usually dissected only one or several females per species for description of the aculeus, thus the characters may vary more than stated in the descriptions. The aculeus tip is oval or round in cross-section and difficult to orient for examination. Up to a third of the tip may be finely serrate in some species (*daciformis, pallens*), but the serrations are often difficult to see as they sometimes lie off the lateral plane (Fig. 1C–D).

The following acronyms are used for depositories of the specimens studied: AMNH—American Museum of Natural History, New York; CEEA—Comisión Ecuatoriana de Energía Atómica, Quito; CMP—Carnegie Museum of Natural History, Pittsburgh; DEBUG—Department of Environmental Biology, University of Guelph; FSCA—Florida State Collection of Arthropods, Gainesville; IEXV—Instituto de Ecología, Xalapa; INBio—Instituto Nacional de Biodiversidad, Santo Domingo de Heredia, Costa Rica; INPA—Inst. Nacional de Pesquisas da Amazônia, Manaus; INTA—Instituto Nacional de Tecnología Agropecuaria, Castellar, Argentina (via Norma Vaccaro); IZAM—Universidad Central de Venezuela, Maracay; López—Jorge López collection, Guatemala; MCSNM—Museo Civico di Storia Naturale, Milan; MNM—Magyar Természettudományi Múzeum, Budapest; NMW—Naturhistorisches Museum Wien; Riley—Don Riley, APHIS-PPQ, Brownsville, Texas; TAMU—Texas A&M University, College Station; UNAM—Universidad Nacional

Table 3. Characters used in phylogenetic analysis of the *daciformis* group.

1. Predominant body color, except for pale areas and brown spots—0) yellow to orange-brown; 1) red-brown to dark brown.
2. Frons color—0) with lateral brown spot along eye margin on dorsal part; 1) unicolorous, except ocellar tubercle brown; 2) with transverse brown band or spot including ocellar spot; 3) with transverse brown band, at least sometimes with lateral anterior extension, broadest along eye margin. Brown markings may be reduced or absent in teneral specimens. Coded as ordered.
3. Gena color—0) unicolorous; 1) with dark spot below eye (may be faint or absent in teneral specimens).
4. Occiput color—0) entirely yellow; 1) with brown stripes or triangular marks on or near sutures of median occipital sclerite; 2) mostly brown except anterior margin. Coded as ordered.
5. Number of orbital setae—0) 2; 1) 1, posterior orbital seta absent. This occurs as homoplasy in various other species of *Anastrepha*, e.g., see Norrbom (1991).
6. Antenna length—0) not elongate nor extended to level of ventral margin of face, first flagellomere <3 times as long as wide (measured on mesal side); 1) elongate, extended to or beyond level of ventral margin of face, first flagellomere usually >3 times as long as wide.
7. Mesonotum with dark brown markings—0) scutum and scutellum yellow to dark brown except for pale stripes and apex of scutellum (nonpale areas unicolorous); 1) scutum with triangular brown to dark brown markings, sometimes connected, near posterior margin and scutellum with lateral brown spots or transverse brown band at border of orange and white areas; 2) scutellum with black spots at border of orange and white areas, and scutum usually with dark brown spot mesal to postalar seta, sometimes with additional spots; 3) entire base of scutellum and large part of scutum black. Coded as unordered.
8. Mesonotal pale lateral presutural stripe, middle part (on scutum)—0) complete; 1) narrowly interrupted; 2) absent. May be poorly differentiated in predominantly yellow to orange species. Coded as ordered.
9. Mesonotal pale lateral presutural stripe, posterior part (on posterior part of notopleuron)—0) absent; 1) present. May be poorly differentiated in predominantly yellow to orange species.
10. Mesonotal pale presutural dorsocentral stripe—0) absent; 1) present and connected anteriorly with pale area on postpronotal lobe; 2) separated anteriorly from pale area on postpronotal lobe. This character was difficult to observe for *sagittata* and *antilliensis*, as the surrounding area is pale yellow in these species, but the stripe appears to be absent. Coded as unordered.
11. Scutal microtrichia pattern—0) entirely microtrichose, or at most with medial presutural bare area; 1) nonmicrotrichose medially, lateral and posterior margins microtrichose; 2) entirely or almost entirely nonmicrotrichose. Coded as unordered.
12. Scutellar microtrichia pattern—0) disc entirely microtrichose; 1) disc mostly or entirely without microtrichia.
13. Scutellum color—0) unicolorous or with dark markings only on extreme base; 1) bicolored, with at least basal third on sides and dorsum distinctly darker than apex.
14. Propleuron color—0) yellow; 1) at least partly dark orange or brown.
15. Mesopleuron with dark brown spots—0) without dark brown spots; 1) with small dark brown spot on anepimeron; 2) with small dark brown spots on anepisternum, katepisternum and anepimeron. Coded as ordered.
16. Cell r_1 with hyaline spot—0) with hyaline spot or band at apex of R_1 (usually small in *pallens*); 1) without hyaline spot at apex of R_1, costal and S-bands completely fused in this area.
17. Costal band in cell br—0) broadly extended to vein M along cell bm; 1) not extended to vein M.
18. Costal band in cell r_{2+3}—0) covering base of cell; 1) not covering base of cell.
19. S-band, basal section—0) without posterior extension toward wing margin in cell a_1; 1) with posterior extension to or towards wing margin in cell a_1. The extension is not as broad or long in some specimens of *stonei* and is not fully extended to the margin in *maculata*, but I tentatively coded these species state 1.
20. S-band, basal section—0) extended along vein Cu_1 beyond bm-cu, but no more than halfway to dm-cu, and cell bcu evenly infuscated; 1) not extended along vein Cu_1 beyond bm-cu, and posterior third or more of cell bcu hyaline or very faintly infuscated; 2) extended along vein Cu_1 to dm-cu, and cell bcu evenly infuscated. In teneral specimens of *pallens* and *stonei*, the band sometimes does not appear to extend along Cu_1 beyond bm-cu, but specimens with the wing pattern fully developed are clearly state 0, and I therefore coded these species 0. Coded as unordered.
21. S-band, middle section—0) continuous; 1) separated from basal and apical sections; 2) absent. In *bicolor* the basal section is sometimes faintly extended into cell dm, but never connects with the apical section; I coded it state 0. Coded as ordered.
22. S-band, apical section width—0) narrow or slightly broadened, apical half of cell r_{2+3} with large hyaline area; 1) very broad, all of cell r_{2+3} infuscated.

Table 3. Continued.

23. V-band, proximal arm—0) complete, extended to vein R_{4+5}; 1) reduced, extended to or slightly anterior to vein M; 2) reduced and paler than costal band or absent. Coded as ordered.
24. V-band, distal arm—0) present; 1) absent.
25. Medial vein ratio (distance along M from bm-cu to r-m/distance from r-m to dm-cu)—0) average greater than 1.5; 1) average less than 1.5. See Table for comparison of values.
26. Abdominal pattern—0) banded (often poorly differentiated in species with predominantly yellow to orange-brown abdomens); 1) intermediate between banded and with T-shaped mark; 2) brown with T-shaped mark. Coded as ordered.
27. Outer surstylus shape—0) long, somewhat truncate; 1) very short and rounded, extended only slightly beyond prensisetae.
28. Aedeagus—0) longer than female syntergosternite 7, distiphallus present; 1) short, less than 1.3 mm long, distiphallus absent; 2) extremely short, less than 0.30 mm long, distiphallus absent. Coded as ordered.
29. Eversible membrane, pattern of dorsobasal scales—0) at least 2 rows of similarly well sclerotized scales; 1) all scales weakly sclerotized; 2) weakly sclerotized except medially interrupted row of large, strongly sclerotized, scales. Coded as unordered.
30. Spermathecae—0) moderately sclerotized; 1) weakly sclerotized; 2) membranous. Coded as ordered.

Autonoma de Mexico, Mexico, D.F.; USNM—National Museum of Natural History, Washington, D.C.; USP—Museu de Zoologia, Universidade de São Paulo; ZMHU—Museum für Naturkunde der Humboldt Universität zu Berlin. Barcode numbers, consisting of an acronym + a number, are listed in the specimens examined or type data sections in place of or following the depository acronym if the code is not from the same institution.

Biology and Immature Stages

Host plants are unknown for most of the species of the *daciformis* group. Hosts have been reported for only four species. *Anastrepha daciformis* was reported to attack species of *Prunus* (Rosaceae), *Citrus* (Rutaceae), *Eugenia* and *Psidium* (Myrtaceae) (Rosillo 1953, Hayward 1960, Blanchard 1961), but all of these records are doubtful. The hosts of the other three species all belong to the Sa-

Table 4. Character state distributions in species of the *daciformis* group.

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
obliqua	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
sagittata	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1
antilliensis	0	1	0	0	0	0	3	0	0	0	2	1	1	0	1	0	0	0	1	0	0	0	0	1	0	0	1	2	2	2
murrayi	0	1	0	0	1	0	3	0	0	1	2	1	1	0	0	0	0	0	1	0	0	0	0	1	0	0	?	?	2	?
stonei	0	0	1	0	1	0	2	0	1	1	2	1	1	0	2	1	0	1	1	0	0–1	0	0	0	1	0	1	2	2	2
maculata	0	1	0	0	1	0	2	0	1	1	0	1	1	0	2	1	0	0	1	0	1	0	0	0	1	0	1	2	2	2
pallens	0	2	1	0	1	0	1	0	1	1	2	0	1	0	0	0	0	1	0	0	1	0	0	1	0	0	1	2	2	2
aquila	1	2	1	1	1	1	0	0–1	1	1	0	0	1	0	0	1	0	0	0	2	2	1	2	1	0	1	1	2	2	2
avispa	1	2	1	0–1	1	1	0	0	1	1	1	0	1	0	0	1	0	0	0	2	2	1	2	1	0	1	1	2	2	2
bicolor	1	2	1	0	1	1	0	0	1	1	1	0	1	0	0	1	1	0	0	0	2	1	2	1	0	0	1	2	2	2
macrura	1	2	1	1	1	1	0	2	1	1–2	0	0	1	1	0	1	1	0	0	0	2	1	2	1	0	2	1	2	2	2
zucchii	1	2	1	2	1	1	0	1	0	0	1	0	1	1	0	1	0	0	0	2	2	1	2	1	0	2	1	2	2	2
castanea	1	3	1	2	1	1	0	2	1	2	0	0	1	1	0	1	1	1	0	1	2	0	1	1	1	0	1	2	2	?
daciformis	1	3	1	2	1	1	0	0	1	2	0	0	1	1	0	1	1	1	0	1	2	0	1	1	0	0	1	2	2	2
katiyari	1	3	1	1	0–1	1	0	0	1	1	1	0	1	0	0	1	1	1	0	1	2	0	1	1	1	0	1	2	2	2

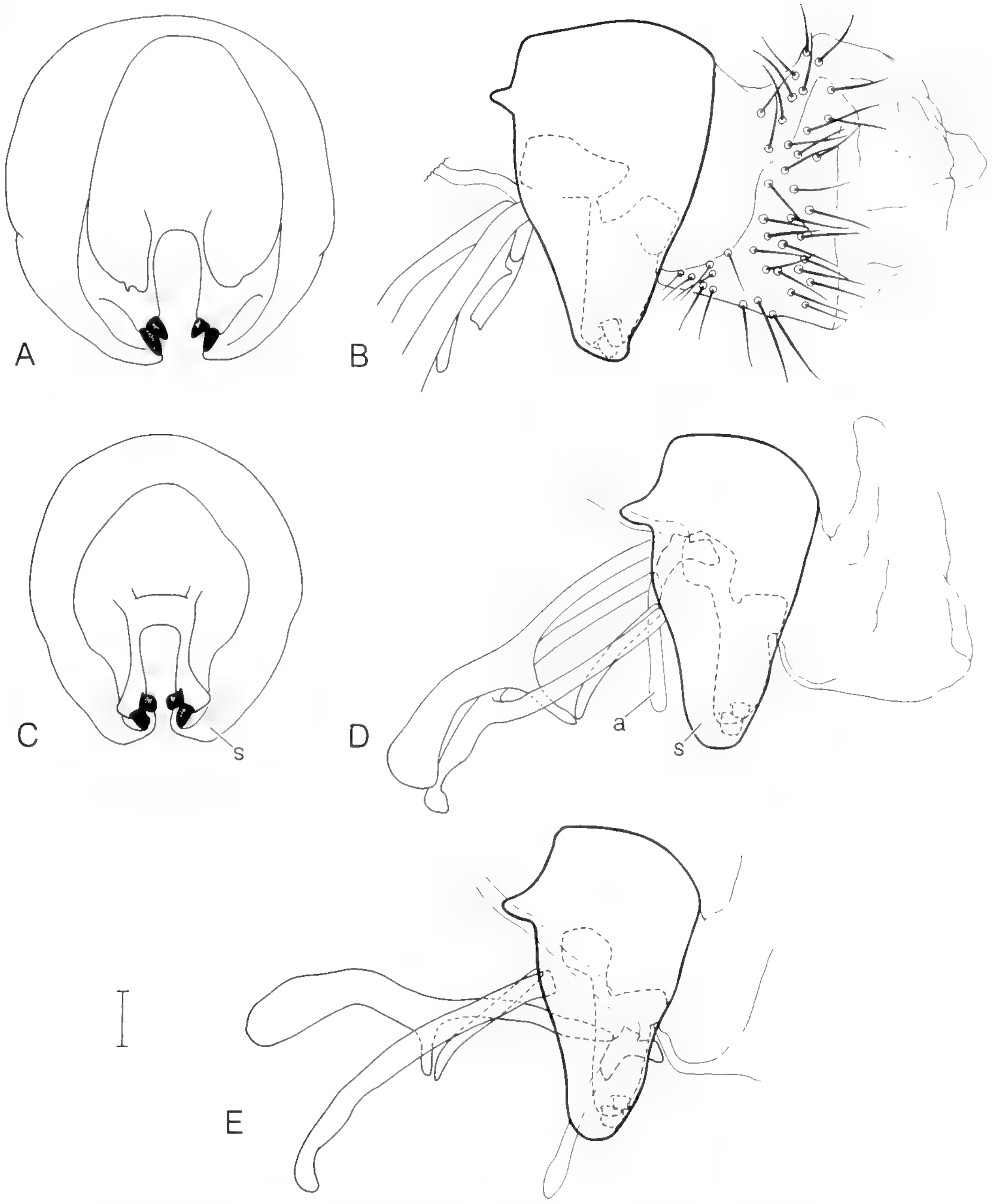

Fig. 2. Male terminalia. A, C, Epandrium and surstyli, posterior view (setae omitted). B, D–E, Epandrium, surstyli and cerci, lateral view (B, D with aedeagus retracted, E with aedeagus extended). A–B, *A. daciformis* (São Paulo, Brazil). C–E, *A. maculata* (Mona I.). a = aedeagus; s = outer surstylus. Bar = 0.05 mm.

potaceae: *A. katiyari* was reared from fruits of caimito (*Sideroxylon obtusifolium* (Roem. & Schult.)); *A. macrura* has been reared from *Chrysophyllum cainito* L. (Caraballo 1981) and *Pouteria lactescens* (Lima 1938, Bondar 1950); and *A. pallens* has been reared from fruits of two species of *Sideroxylon* (Greene 1934, McPhail and Berry 1936, Wasbauer

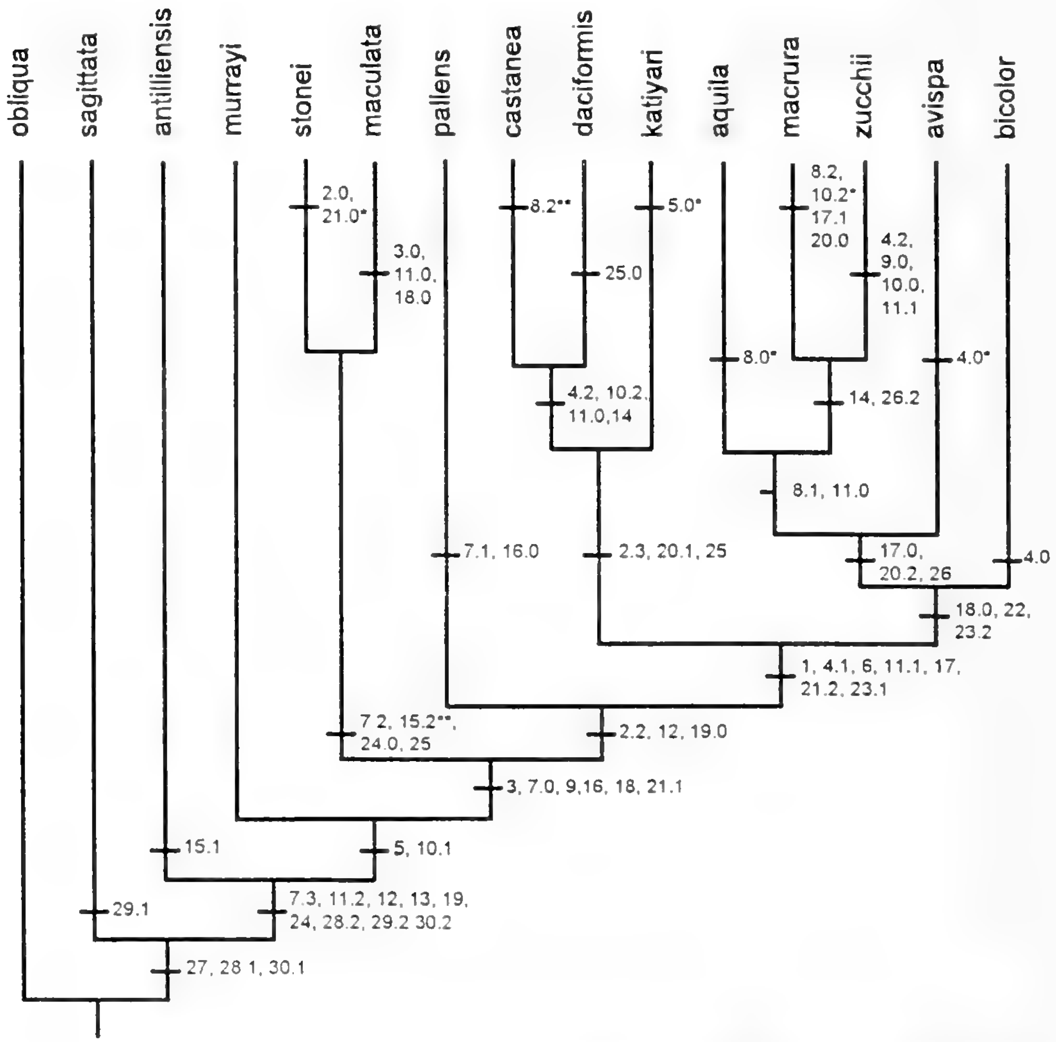

Fig. 3. Hypothesized phylogenetic relationships among species of the *daciformis* group. Character numbers refer to Table 3. * = polymorphic character within a species; ** = character state change of two steps.

1972). The larvae of *A. pallens* feed inside the single large seed within the fruit of *S. celastrinum* (McPhail and Berry 1936, Baker et al. 1944). For the *dentata* group, the sister group of the *daciformis* group, host data are known for only *A. obscura* Aldrich and *A. sagittata* (Stone), but both breed in species of Sapotaceae and at least the latter feeds only inside the seeds (Baker et al. 1944), suggesting that both species groups may specialize on this host family and on the seeds.

The immature stages of species of the *daciformis* group are poorly known. The egg and larvae have been described only for *A. pallens* (Phillips 1946, Norrbom 1985, Steck et al. 1990).

Relationships

Autapomorphies indicating the monophyly of the *daciformis* species group include: 1) scutellum bicolored, with at least basal third on sides and dorsum distinctly darker than apex (Fig. 7–8) (scutellar markings are present on a few other *Anastrepha* species, but in different patterns, and I do not believe they are homologous); 2) eversible membrane

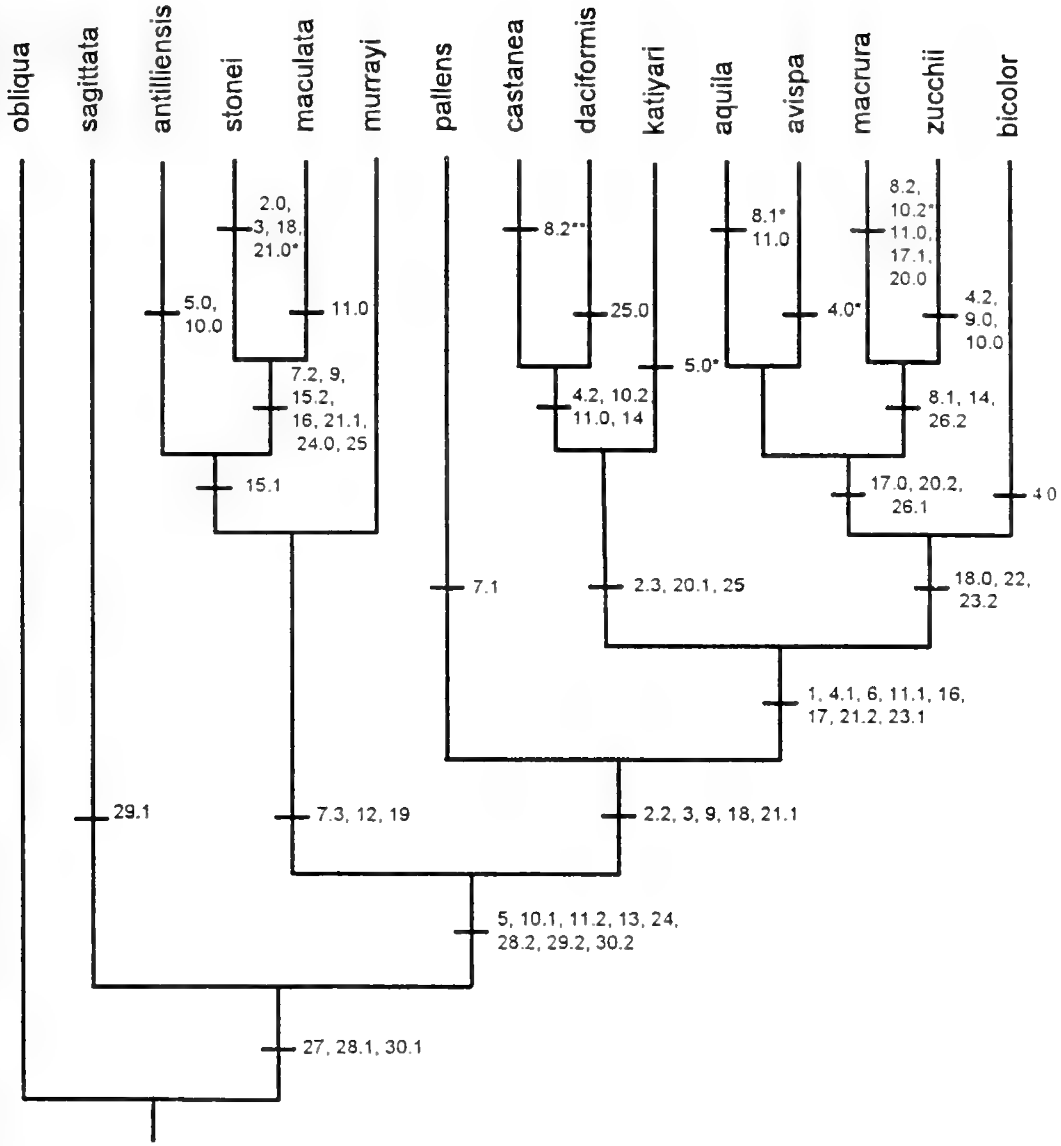

Fig. 4. Hypothesized phylogenetic relationships among species of the *daciformis* group. Character numbers refer to Table 3. * = polymorphic character within a species; ** = character state change of two steps.

with unique pattern of dorsobasal scales (Fig. 1A) (weakly sclerotized except medially interrupted row of large, strongly sclerotized, hooklike scales); 3) spermathecae membranous; 4) aedeagus extremely short, less than 0.30 mm long (Fig. 2B, D–E).

The *daciformis* group appears to be the sister group of the *dentata* group (Norrbom 1985). These two species groups share the following synapomorphies: 1) Outer surstylus very short and rounded, barely extended beyond prensisetae (Fig. 2), and interparameral sclerite relatively posterior in position, in lateral view its apex usually at posterior margin of epandrium (Fig. 2B, D–E); 2) aedeagus short, less than 1.2 mm long, and distiphallus absent; 3) aculeus extremely slender (Fig. 1B–F), less than 0.05 mm wide except at base (reduction in aculeus width has occurred in other *Anastrepha* species, but whether this is convergence or a synapomorphy for some of these species and the *daciformis* + *dentata* groups remains uncertain).

Another character of possible phylogenetic significance for the *daciformis* and *dentata* groups involves the third instar larvae, but this stage has been described for only one species in each group. In both *A. pallens* and *A. sagittata* (Stone), the hairs of the hind spiracle are shorter (Baker et al. 1944, Phillips 1946) than in other *Anastrepha* species that have been described, except for *A. interrupta* Stone (Norrbom 1985, Steck and Wharton 1988). The larvae of additional species must be studied to determine if this character state is a synapomorphy for the *daciformis* + *dentata* groups.

Relationships within the *daciformis* group were analyzed using PAUP version 3.1.1. The characters used are listed in Table 3, and the character state distributions are shown in Table 4. The outgroup used for determining character polarities included *Anastrepha sagittata* (Stone), which belongs to the *dentata* species group (the hypothesized sister group of the *daciformis* group), and *A. obliqua* (Macquart), a more distantly related member of the genus. The heuristic search option was used, with stepwise and random addition yielding the same set of six trees of 76 steps (consistency index excluding uninformative characters = 0.651, retention index = 0.783). Two of these trees are shown in Figs. 3–4. They show the accelerated transformation character optimization, but the delayed transformation optimization did not produce trees differing in topology (i.e., the relationships of the species). The following clades were always consistent: *maculata* + *stonei*; the *daciformis* complex (with *katiyari* as the sister taxon of *castanea* + *daciformis*); and the *macrura* complex (*aquila, avispa, bicolor, macrura,* and *zucchii,* with the latter two always clustered and *bicolor* the basal taxon). The major differences among the six trees involved the placement of *antilliensis, murrayi,* and *maculata* + *stonei,* which either arise as the basal clades in that order (Fig. 3), or together form a monophyletic group that is the sister group of the rest of the *daciformis* group (Fig. 4). The other variation occurred within the *macrura* complex; *avispa* is either the sister taxon of *aquila,* in a trichotomy with *aquila* and *macrura* + *zucchii,* or is the sister taxon of all three of those species.

Diagnosis of the *Daciformis* Species Group

Posterior orbital seta usually absent (except in *antilliensis* and rarely in other species). Body predominantly brown (Figs. 7B–H) or mostly yellow to orange with some brown markings on mesonotum and/or mesopleuron (Figs. 7A,I, 8A–E). Scutellum mostly dark brown or bicolored, with at least basal third on sides and dorsum orange to brown, distinctly darker than apex; basal seta within darker basal area (except in *avispa*). Katepisternal seta weak or absent. C- and S-bands often fused along costa, and cell r_1 often without hyaline marginal spot at apex of vein R_1. S-band often interrupted or with middle part absent. Eversible membrane, on expanded basal part, with most dorsal scales weakly sclerotized, but with one, medially interrupted row of large, strongly sclerotized, hooklike scales (Fig. 1A). Aculeus slender, less than 0.05 mm wide, except at base; tip needlelike, nearly circular in cross-section, with or without serrations apically (Fig. 1B–F). Outer surstylus very short, barely extended beyond prensisetae (Fig. 2). Aedeagus extremely short, less than 0.30 mm long; distiphallus absent (Fig. 2B, D–E).

Key to Species of the *Daciformis* Group

1. V-band complete, distal arm present (Figs. 6B, E–F). Body predominantly yellow to orange, with usually small, discrete dark brown areas, including: 2 dorsal and sometimes 1 posteroventral spot on anepisternum; anterodorsal and posteromedial spots on katepisternum; large medial spot on anepimeron; large area on laterotergite; 2–3 spots at margin of orange basal and white apical areas of scutellum; and often various spots or stripes on scutum (Figs. 7I, 6D–E). S. Florida and Bahamas to Dominican Republic 2

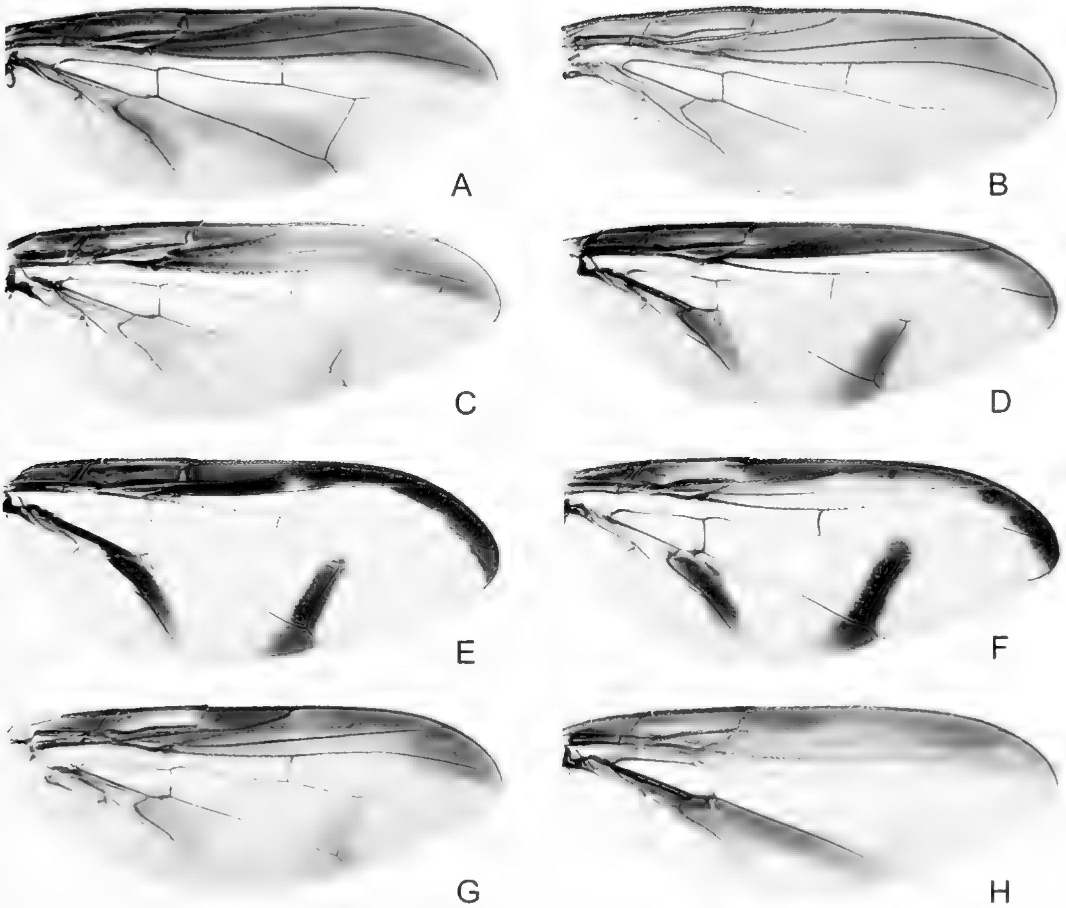

Fig. 5. Wings. A, *A. aquila* (20 km. S. Upala, Costa Rica). B, *A. avispa* (20 km. S. Upala, Costa Rica). C, *A. bicolor* (Cañon de Lobos, Mexico). D, *A. castanea* (Bella Vista, Argentina). E, *A. daciformis* (São Paulo, Brazil). F, *A. katiyari* (Mara, Venezuela). G, *A. macrura* (Bahia, Brazil). H, *A. zucchii* (Ilha de Maracá, Brazil).

– V-band incomplete or absent, distal arm absent (Figs. 5A–H, 6A, C–D). Body either predominantly yellow to orange, sometimes with large mesonotal brown areas (Figs. 7A, 8A–C), or predominantly red-brown to dark brown (Figs. 7B–H, 8F); without numerous small dark brown spots on mesopleuron and mesonotum. Widespread 3

2. C-band covering cell r_{2+3} to beyond level of r-m (Fig. 6B). Spot in cell dm (middle part of S-band) not extended anteriorly beyond vein M. Frons, except for small brown spot on ocellar tubercle, and gena entirely yellow. Scutellum with 3 dark brown spots (1 medial) between yellow basal and white apical areas (Fig. 7I). Virgin Is., Mona I. . . . *maculata*, n. sp.

– C-band not covering most of cell r_{2+3} basal to level of r-m (Figs. 6E–F). S-band complete (Dominican Republic ♀) or spot in cell dm extended anteriorly to vein R_{4+5} along r-m. Frons dorsally with narrow lateral brown spot along eye margin in addition to small brown spot on ocellar tubercle; gena with brown spot below eye. Scutellum with pair of dark brown lateral spots or short bands between yellow basal and white apical areas, sometimes almost connected medially (Fig. 8D–E). S. Florida, Bahamas, Dominican Republic . . . . *stonei* Steyskal

3. Wing without complete marginal band, interrupted by at least a small marginal hyaline area in cell r_1 at apex of vein R_1 (Figs. 6A, C–D). Body predominantly yellow to orange-brown, but mesonotum largely dark brown or with dark brown posterior markings (Figs. 7A, 8A–C). In lateral view, antenna usually not extended to level of ventral margin of

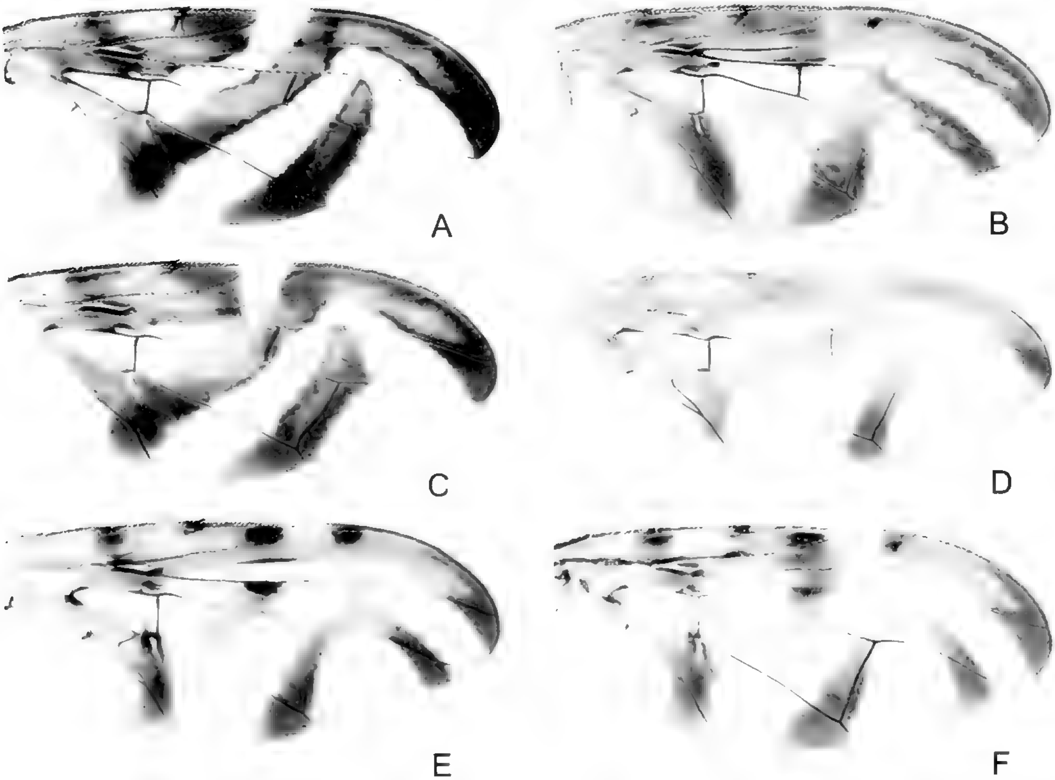

Fig. 6. Wings. A, *A. antilliensis* (37 km N Cabo Rojo, Dominican Republic). B, *A. maculata* (Guana Island, British Virgin Islands). C, *A. murrayi* (holotype). D, *A. pallens* (Pharr, Texas, USA). E, *A. stonei* (Nassau, Bahamas). F, *A. stonei* (Santo Domingo, Dominican Republic).

face; first flagellomere usually < 3 times as long as wide 4

Wing with complete marginal band, cell r_1 without hyaline marginal area at apex of vein R_1 (Figs. 5A–H). Body predominantly red-brown to dark brown and mesonotum similar in color to pleuron (Figs. 7B–H, 8F). Antenna usually extended to level of ventral margin of face; first flagellomere usually > 3 times as long as wide 6

4. S-band interrupted along vein R_{4+5} and in cell dm along vein Cu_1 (Fig. 6D); basal part without extension to posterior wing margin in cell cu_1. Frons with dorsal transverse brown band, and gena with brown spot below eye (both may be faint or absent in teneral specimens). Scutum posteriorly with 2–3 brown spots (Fig. 8C) or usually with trilobed brown band (Fig. 8B). Scutellum with lateral brown spot or complete transverse brown band bordering apical white area. S. Texas to Honduras and El Salvador . . . . *pallens* Coquillett

– S-band complete (Figs. 6A, C), basal part with extension to posterior wing margin in cell cu_1. Frons, except for small brown spot on ocellar tubercle, and gena entirely yellow. Scutum with broad dark brown area on posterior margin or more extensively dark brown (Figs. 7A, 8A). Scutellum dark brown except apical white area. Greater Antilles 5

5. Scutum, except for pale stripes, mostly orange, only posterior and postsutural lateral margins broadly dark brown; sublateral pale stripe not extended into dark brown area and not reaching intra-alar seta (Fig. 7A). C- and S-bands not connected along vein R_{4+5} (Fig. 6A). Usually 2 orbital setae. Puerto Rico, Dominican Republic . . . . *antilliensis*, n. sp.

– Scutum, except for pale stripes, mostly dark brown, orange only anteromedially; sublateral pale stripe extended to intra-alar seta (Fig. 8A). C- and S-bands broadly connected along vein R_{4+5} (Fig. 6C). Only 1 orbital seta, posterior seta absent. Jamaica . . . . . *murrayi*, n. sp.

6. Marginal wing band broad, all of cell r_{2+3} infuscated (Figs. 5A–C, G–H). Crossvein dm-cu without band (Fig. 5H) or bordered by diffuse band paler than marginal band (Figs.

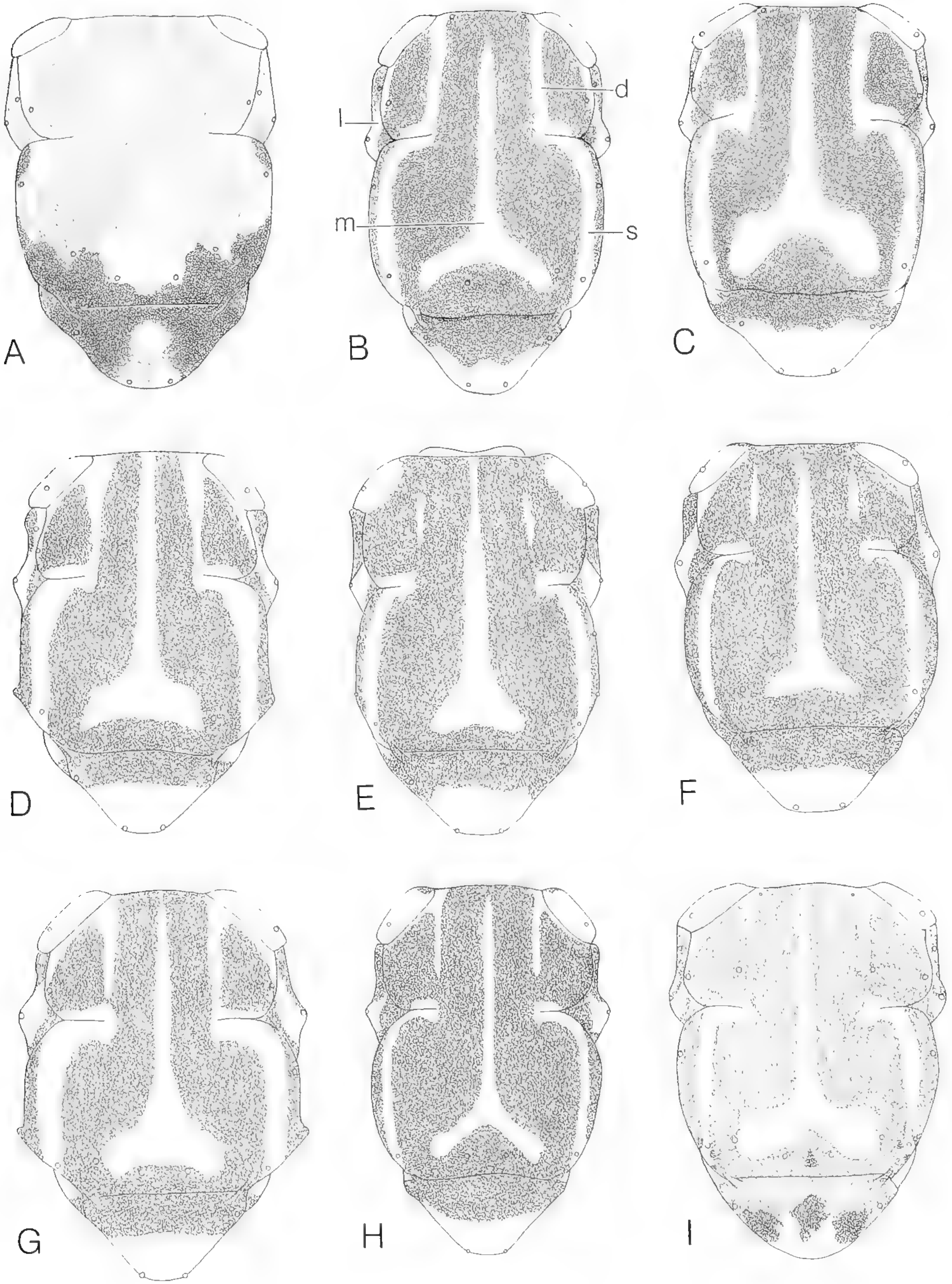

Fig. 7. Mesonotum, dorsal view (setae not shown). A, *A. antilliensis* (Puerta de Tierra, Puerto Rico). B, *A. aquila,* (Las Pailas, Costa Rica). C, *A. avispa* (20 km. S. Upala, Costa Rica. D, *A. bicolor* (Harlingen, Texas). E, *A. castanea* (Bella Vista, Argentina). F, *A. daciformis* (São Paulo, Brazil). G, *A. katiyari* (Prigamora, Venezuela). H, *A. macrura* (Bahia, Brazil). I, *A. maculata* (Great Camanoe I., British Virgin Islands). Abbreviations: d = dorsocentral stripe; l = lateral presutural stripe; m = medial stripe; s = sublateral stripe.

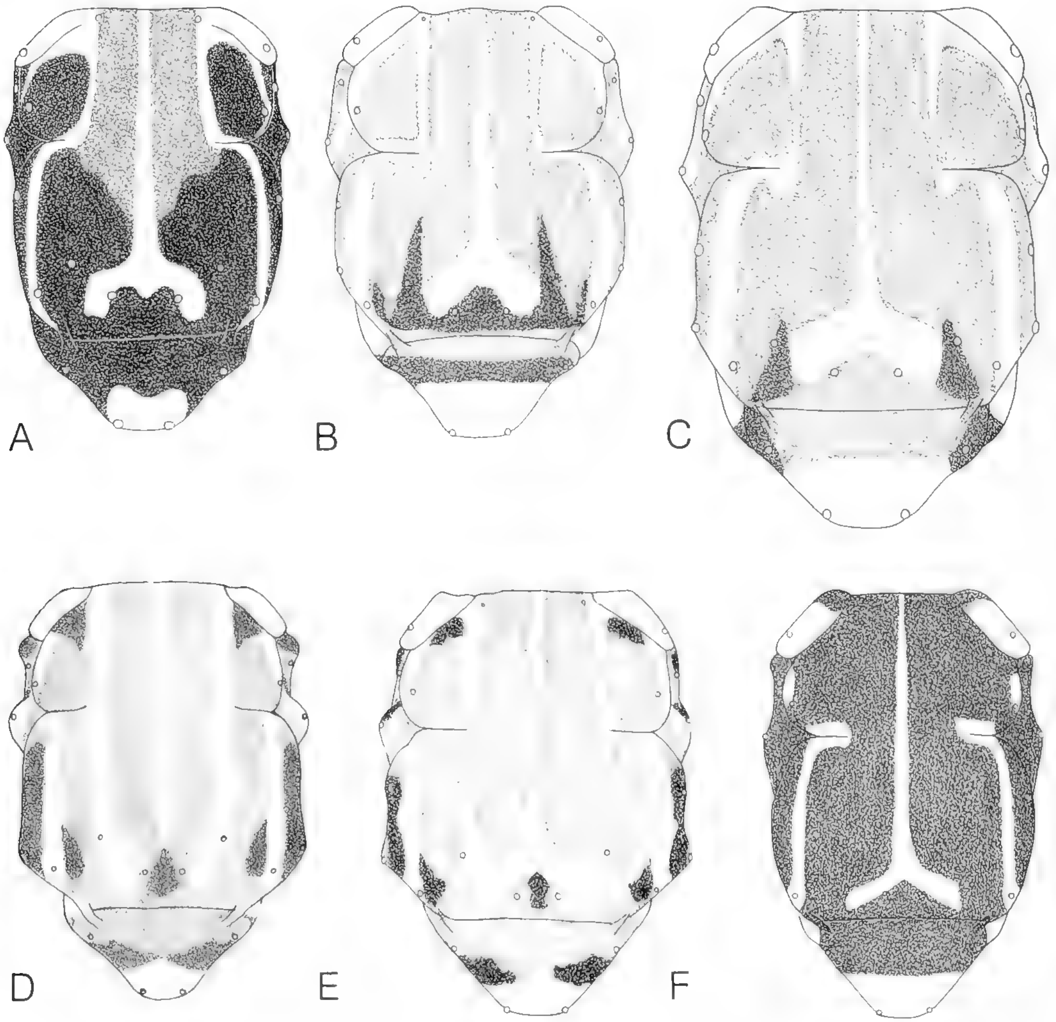

Fig. 8. Mesonotum, dorsal view (setae not shown). A, *A. murrayi* (holotype). B–C, *A. pallens* (Edinburg, Texas). D, *A. stonei* (Manalapan, Florida). E, *A. stonei* (New Providence, Bahamas). F, *A. zucchii* (Ilha de Maraca, Brazil).

5A–C, G). Basal section of S-band extended along vein Cu_1 beyond bm-cu, and cell bcu evenly infuscated. Widespread 7

– Marginal wing band narrow, cell r_{2+3} hyaline except apex (Figs. 5D–F). Crossvein dm-cu with distinct band as dark as marginal band. Basal section of S-band not extended along vein Cu_1 beyond bm-cu, and cell bcu with large posterior hyaline or very pale area. South America 11

7\. Abdominal tergites each with narrow median pale spot, forming parallel-sided stripe or T-shaped mark, uninterrupted except usually on middle of syntergite 1+2, which is brown basally (Figs. 9E–F, I). Occiput with large triangular brown areas along lateral sutures of median occipital sclerite or mostly brown. Mesonotum with presutural lateral pale stripe reduced to small spot on scutum (Fig. 8F) or small spot on posterior part of notopleuron (Fig. 7H). South America 8

– Abdominal tergites each with pale posterior band or triangular mark; if forming stripe, sides irregular and not parallel, and usually interrupted at least on tergite 3; base of syntergite 1+2 yellow (Figs. 9B–C). Occiput entirely yellow or with small brown spots or stripes on or near lateral sutures of median occipital sclerite. Mesonotum with presutural lateral pale stripe usually complete from posterior margin of postpronotal lobe to posterior part of notopleuron (Figs. 7B–D), rarely narrowly interrupted on scutum. S. Texas to Costa Rica 9

8. Notopleuron with pale posterior spot, but presutural lateral pale stripe absent on scutum (Fig. 7H). Dorsocentral pale stripe present. Wing with broad, faint brown band extended from cell bcu only to middle of cell cu_1 (Fig. 5G). Crossvein dm-cu with faint brown band. Abdomen with pale medial stripe at least slightly expanded on apical half of syntergite 1+2, never connected to transverse medial band on syntergite 1+2; tergites with narrow white lateral margins (Figs. 9E–F). W. Venezuela, Ecuador, Paraguay, Brazil (Bahia, Rio Grande do Norte) . . . . *macrura* Hendel

– Notopleuron entirely brown, but presutural lateral pale stripe present on scutum as spot anterolateral to presutural supra-alar seta (Fig. 8F). Dorsocentral pale stripe absent. Wing with broad, moderate brown band extended from cell bcu to apex of cell cu_1 (Fig. 5H). Crossvein dm-cu without faint brown band. Abdomen with pale medial stripe not expanded on apical half of syntergite 1+2, sometimes connected to transverse medial band on syntergite 1+2; tergites without narrow white lateral margins (Fig. 9I). Brazil (Roraima) . . . . *zucchii*, n. sp.

9. Wing in cell br with costal band broadly extended to vein M along entire length of cell bm (Figs. 5A–B); cell br mostly microtrichose including most or all of section bordering cell bm. Posterior pale marks on abdominal tergites 3 and 4 more or less triangular (Fig. 9B). Costa Rica 10

– Wing in cell br with costal band not extended to vein M along cell bm (Fig. 5C); cell br half microtrichose to mostly bare, section bordering cell bm with at least posterior half bare. Posterior pale marks on abdominal tergites 3 and 4 transversely elongate (Fig. 9C). S. Texas to Costa Rica . . . . *bicolor* (Stone)

10. Syntergosternite 7 less than 5 mm long, less than 1.5 times mesonotum length. Scutum with broad medial nonmicrotrichose area extended to expanded posterior part of medial pale stripe and sublateral stripes; medial pale stripe with posterior arms moderately slender and with anterolateral corners (Fig. 7C). Scutellum with basal seta at margin of brown area or within yellow area (Fig. 7C). Frons with orbital seta at margin or anterior to dorsal brown band . . . . *avispa*, n. sp.

– Syntergosternite 7 more than 7 mm long, more than 1.7 times mesonotum length. Scutum microtrichose except for medial presutural bare area and very narrow dorsocentral stripe; medial pale stripe with posterior arms very slender and usually without anterolateral corners (Fig. 7B). Scutellum with basal seta within brown area (Fig. 7B). Frons with orbital seta at margin or within dorsal brown band . . . . *aquila*, n. sp.

11. Scutum with pale dorsocentral stripe connected anteriorly to pale area on postpronotal lobe (Fig. 7G); microtrichose only on and lateral to sublateral stripe, and on and posterior to expanded posterior part of medial pale stripe. Occiput mostly yellow, usually with pair of small brown dorsal stripes. Propleuron and base of syntergite 1+2 yellow. Syntergosternite 7 length 3.95–5.00 mm, 1.25–1.65 times mesonotum length. Venezuela . . *katiyari*, n. sp.

– Scutum with pale dorsocentral stripe separated anteriorly from pale area on postpronotal lobe (Fig. 7E–F); microtrichose except for medial presutural bare area. Occiput mostly brown except anterior margin. Propleuron brown. Base of syntergite 1+2 orange to brown. Syntergosternite 7 length 2.10–3.50 mm, 0.75–1.30 times mesonotum length. S. Brazil, Paraguay, Argentina 12

12. Mesonotum with presutural lateral pale stripe complete, extended from postpronotal lobe to posterior part of notopleuron (Fig. 7F). Syntergosternite 7 length 2.10–2.70 mm, 0.75–1.00 times mesonotum length. Abdominal tergites 3 and 4 each with narrow apical white band. S. Brazil, Paraguay, Argentina . . . . *daciformis* Bezzi

– Mesonotum with presutural lateral pale stripe reduced to pale spot on posterior part of notopleuron, absent from scutum (Fig. 7E). Syntergosternite 7 length 2.95–3.49 mm, 1.10–1.30 times mesonotum length. Abdominal tergite 3 sometimes with small apical white band, tergite 4 without apical white band. Brazil (Mato Grosso do Sul), Argentina . . . . *castanea*, n. sp.

***Anastrepha antilliensis* Norrbom, new species**

(Figs. 6A, 7A, 9A)

Diagnosis.—This species differs from all other species of the *daciformis* group as follows: scutum (Fig. 7A) with medial pale stripe rounded posteriorly; and sublateral pale stripe not extended to intra-alar seta. The posterior orbital seta, usually absent in other species of the group, is usually present.

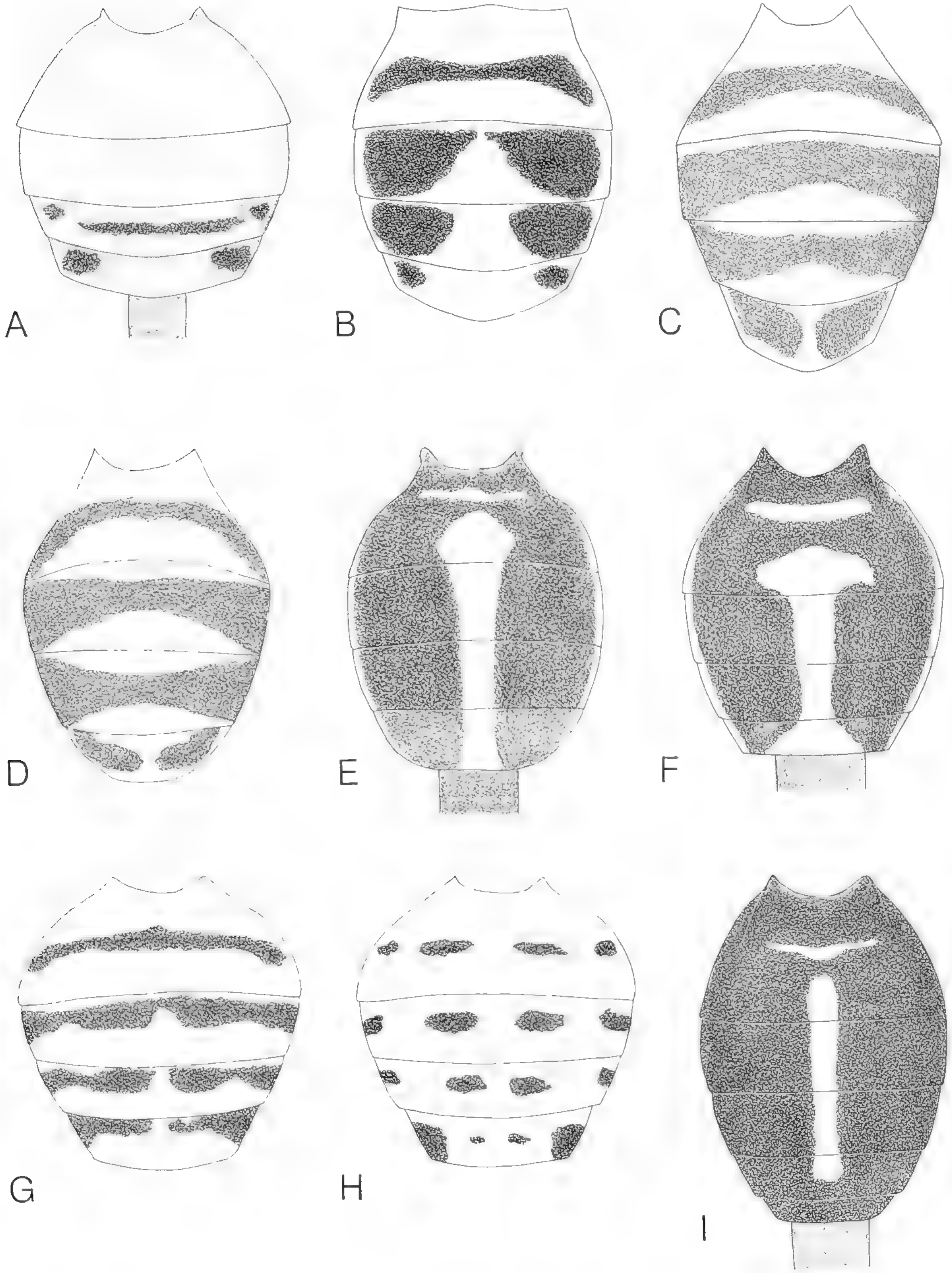

Fig. 9. Abdomen, dorsal view. A, *A. antilliensis* (♀ Fortuna Exp. Station, Puerto Rico). B, *A. avispa* (♀ 20 km. S. Upala, Costa Rica). C, *A. bicolor* (♂ Harlingen, Texas). D, *A. katiyari* (♂ Pringamora, Venezuela). E–F, *A. macrura* (♀ San Bernardino, Paraguay; ♀ Rancho Grande, Venezuela). G–H, *A. stonei* (♂ Holmes Rock, Bahamas; ♂ New Providence, Bahamas). I, *A. zucchii* (♀ Ilha de Maraca, Brazil).

Description.—Body predominantly yellow. *Head:* Entirely yellow except ocellar tubercle brown. 2 orbital setae (1♂ from Dominican Republic has 2 on right side, 1 on left). *Thorax* (Fig. 7A): Scutum with 2 dark brown lateral spots, one anterior to and one posterolateral to postsutural supra-alar seta, and with large, irregular dark brown area on posterior margin, extending to or almost to acrostichal and dorsocentral setae and including intra-alar setae. Medial pale stripe poorly differentiated anteriorly, rounded or acute posteriorly. Presutural dorsocentral pale stripe absent. Presutural lateral pale stripe poorly differentiated, appears to extend across scutum, but absent from notopleuron. Sublateral pale stripe ending at margin of dark brown area, not extended to intra-alar seta. Scutellum largely dark brown, often with small orange area around basal seta, and with medial and apical white area, sometimes divided, in Dominican Republic specimens diffuse and sometimes reduced to medial area. Anepimeron with medial dark brown spot, but pleuron otherwise without dark markings. Subscutellum and mediotergite entirely dark brown. Scutum nonmicrotrichose except lateral margin of postsutural part lateral to postsutural supra-alar seta; notopleuron mostly microtrichose; scutellum nonmicrotrichose. *Wing* (Fig. 6A): Bands yellow, orange and brown. C- and S-bands separated. S-band complete, basally with broad extension across vein Cu_2+A_1 to posterior wing margin; subapically narrow, hyaline area in cell r_{2+3} extended to vein R_{2+3}; apically broad, extended to apex of vein M. V-band extended anteriorly to vein R_{4+5}, not connected to S-band; distal arm absent. Vein M relatively weakly curved apically, sometimes meeting costa at slight angle; M ratio 1.75–2.06. *Abdomen* (Fig. 9A): Mostly yellow. Tergite 4 with nearly complete transverse brown stripe or with only paired lateral brown spot; tergite 5 with paired lateral brown spot. *Female terminalia:* Syntergosternite 7 length 2.25–2.75 mm, 1.10–1.25 times as long as mesonotum. Aculeus length 2.39 mm; tip with several minute apical serrations, length 0.16 mm, width 0.02 mm.

Remarks.—The species name refers to its known distribution, two islands of the Greater Antilles.

Distribution.—Dominican Republic, Puerto Rico.

Types.—Holotype: ♀ (USNM) PUERTO RICO: San Juan, Puerta de Tierra, 26.IV.1995, McPhail trap in mango, N. Martinez & A. Arche. Paratypes. DOMINICAN REPUBLIC: Pedernales: 37 km N Cabo Rojo [Las Abejas forest], 18°09'N 71°35'W, 1500 m, 11.VII.1987, R. Davidson & J. Rawlins, 1♂1♀ (CMP); Las Abejas cloud forest, 30 km N Cabo Rojo, 1300 m, 17.I.1989, J.E. Swann, 1♂ (DEBUG). PUERTO RICO: Ponce, Fortuna Exp. Station, "*Mangifera indica* McPhail trap", 28.III.1994, W. Vega, 1♀ (USNM).

Anastrepha aquila Norrbom, new species

(Figs. 5A, 7B)

Diagnosis.—This species, *avispa,* and *zucchii* differ from *bicolor* and *macrura* in having the costal band broadly extended in cell br to vein M and this section of br microtrichose. It and *avispa* are intermediate in abdominal pattern between the stripe or T-shaped mark found in *macrura* and *zucchii* and the banded pattern of *bicolor.* It differs from *avispa* by the characters listed in the key. See diagnosis of *zucchii* for characters to distinguish *aquila* from that species.

Description.—Body predominantly dark brown. *Head:* Mostly yellow. Frons with brown transverse dorsal band, usually more or less rectangular or rounded anteriorly, broad, orbital seta at margin or within band. Gena with large brown spot below eye. Occiput yellow with brown stripes on or near sutures of median occipital sclerite. Posterior orbital seta absent. *Thorax* (Fig. 7B): Medial pale stripe strongly bilobed posteriorly, lobes very slender, extended to or almost to dorsocentral seta, rarely with distinct anterolateral corner. Presutural dorsocentral pale stripe broadly connected anteriorly to pale area on postpronotal lobe, and connected to or narrowly separated from pale sublateral stripe. Presutural lateral pale stripe well differentiated, complete or rarely narrowly interrupted on scutum, but present on posterior part of notopleuron. Pleuron brown except following yellow areas: all of propleuron (except 1♀ with small dorsal brown spot); anteroventral corner and posterodorsal half of anepisternum; dorsal band, often narrowed medially, rarely interrupted, on katepisternum; katepimeron; anterior ¼ of meron; anterior ⅔ of katatergite; and most of anatergite. Subscutellum and mediotergite entirely dark brown. Scutum microtrichose except very narrow paired stripe from medial end of transverse suture to dorsocentral seta, and presutural area on, between and usually slightly lateral to dorsocentral pale stripes, at most extended to transverse suture medially; notopleuron microtrichose; scutellum microtrichose except small basal area on side. *Wing* (Fig. 5A): C- and S-bands completely fused along costa to form broad, uninterrupted, dark orange-brown marginal band; in cell br extended to vein M along cell bm; covering all of cells r_1 and r_{2+3} and anterior margin of cell r_{4+5}; well separated from apex of vein M. S-band incomplete, middle part between veins R_{4+5} and Cu_1 absent; basal part paler than C-band; extended over base of cell cu_1 and faintly and diffusely along both sides of vein Cu_1 to fuse with V-band. V-band pale and diffuse; extended anteriorly only slightly into cell r_{4+5}; distal arm absent. Vein M strongly curved apically; M ratio 1.64–1.89. Cell br mostly to entirely microtrichose. Cell bcu mostly to entirely microtrichose, posteroapical lobe entirely microtrichose. *Abdomen:* Syntergite 1+2 with base yellow and uninterrupted medial brown band. Tergites 3–5 with posteromedial yellow areas triangular; brown area on tergite 3 continuous, brown areas on tergite 4 usually separated; tergites 2–5 with distinct lateral yellow margins. *Female terminalia:* Syntergosternite 7 length 7.32–7.78 mm, 1.83–2.0 times as long as mesonotum. Aculeus length 6.41 mm; tip nonserrate, length 0.17–0.18 mm, width 0.040–0.045 mm.

Remarks.—The species name refers to its largely swarthy color.

Distribution.—Costa Rica.

Types.—Holotype: ♀ (INBio001908656), COSTA RICA: Guanacaste: P. N. Guanacaste, A. C. Guanacaste, Sector Las Pailas, 800 m., 6–26.VI.1994, K. Taylor. Paratypes. COSTA RICA: Alajuela: 20 km. S of Upala, 16.X.1990, F.D. Parker, 1♂ (USU). Guanacaste: P. N. Guanacaste, 9 km S Sta. Cecilia, Est. Ptilla, 700 m., 21.III-6.IV.1993, C. Moraga, 1♀ (USNM) (INBio001391700); Sector Hornillas, 1000 m, 15–20.VIII.Aug 1994, D. Garcia, 1♀ (USNM) (INBio002305488); Parq. Nac. Rincón de la Vieja, Est. Las Pailas, 800 m, 5–24.VIII.1994, D.G. Garcia, 1♀ (INBio002038585); 3.5 km SSW of Volcán Rincón de la Vieja, Sector Sendero Volcán, 1100 m, 9–10.VI.1994, D. Garcia, 1♂ (USNM) (INBio002130780). Puntarenas: Res. Biol. Monteverde, Est. La Casona, 1520 m, 3–24.IV.1995, A. Azofeifa, 1♂1♀ (INBio002452986, 002452990).

Anastrepha avispa Norrbom, new species

(Figs. 5B, 7C, 9B)

Diagnosis.—This species, *aquila,* and *zucchii* differ from *bicolor* and *macrura* in having the costal band broadly extended in cell br to vein M and this section of br microtrichose. It and *aquila* are intermediate in abdominal pattern between the stripe or T-shaped mark found in *macrura* and *zucchii* and the banded pattern of *bicolor.* It differs from *aquila* by the characters listed in the key. See diagnosis of *zucchii* for characters to distinguish *avispa* from that species.

Description.—Body predominantly dark brown. *Head:* Mostly yellow. Frons with brown transverse dorsal band, usually more or less rectangular, narrow to moderately broad, orbital seta at margin or anterior to band. Gena with large brown spot below eye. Occiput entirely yellow or with lateral brown spots or stripes on median occipital sclerite. Posterior orbital seta absent (of 18 specimens with intact head setae, present on one side only on 1♂). *Thorax* (Fig. 7C): Medial pale stripe strongly bilobed posteriorly, lobes extended to dorsocentral seta, moderately slender but broader than in *aquila* and with more distinct anterolateral corner. Presutural dorsocentral pale stripe broadly connected anteriorly to pale area on postpronotal lobe, and connected or narrowly separated from pale sublateral stripe. Presutural lateral pale stripe well differentiated, complete, including posterior part of notopleuron. Pleuron brown except ventral half or more of katepisternum orange, and following yellow areas: all of propleuron; anteroventral corner and posterodorsal half of anepisternum; dorsal band, often narrowed or interrupted medially, on katepisternum; katepimeron; anterior ¼ of meron; anterior ⅔ of katatergite; and most of anatergite. Scutellum with brown area relatively narrow, basal scutellar seta at margin of brown area or usually within yellow area. Subscutellum and mediotergite entirely dark brown. Scutum without microtrichia medially, microtrichose only on and narrowly bordering presutural lateral stripe, on and lateral to sublateral stripe, and posteriorly from level of expanded posterior part of medial stripe; notopleuron microtrichose; scutellum microtrichose except small basal area on side. *Wing* (Fig. 5B): C- and S-bands completely fused along costa to form broad, uninterrupted, moderate to dark orange-brown marginal band; in cell br extended to vein M along cell bm; covering all of cells r_1 and r_{2+3} and anterior margin of cell r_{4+5}; well separated from apex of vein M. S-band incomplete, middle part between veins R_{4+5} and Cu_1 absent; basal part paler than C-band; extended over base of cell cu_1 and usually faintly and diffusely (fainter than in *aquila*) along both sides of vein Cu_1 to fuse with V-band. V-band pale and diffuse; extended anteriorly only slightly into cell r_{4+5}; distal arm absent. Vein M strongly curved apically; M ratio 1.50–1.92. Cell br mostly to entirely microtrichose. Cell bcu mostly to entirely microtrichose, posteroapical lobe entirely microtrichose. *Abdomen* (Fig. 9B): Syntergite 1+2 with base yellow and uninterrupted medial brown band. Tergites 3–5 with posteromedial yellow areas triangular; brown area on tergite 3 usually continuous (separated in 2 of 21 specimens), brown areas on tergite 4 usually separated; tergites 2–5 with distinct lateral yellow margins. *Female terminalia:* Syntergosternite 7 length 3.91–4.75 mm, 1.17–1.34 times as long as mesonotum. Aculeus length 3.54–3.99 mm; tip with several minute apical serrations, length 0.17, width 0.04–0.05 mm.

Remarks.—The species name, from the Spanish for wasp, refers to the wasplike appearance of this species and its closest relatives.

Distribution.—Costa Rica. C.A. Korytkowski (pers. comm.) has examined specimens from Altos de Pacora, 800 m, Cerro Azul, Panama in the Universidad de Panama collection that may be this species.

Types.—Holotype: ♀ (INBio000410954), COSTA RICA: Guanacaste: P. N. Guanacaste, SW side Volcan Cacao, Est. Cacao, 1000–1400 m., 21–29.V.1992, M.A. Zumbado. Paratypes. COSTA RICA: Alajuela: 20 km. S of Upala, 11.XII.1990, F.D. Parker, 1♂1♀ (USU); same, 25.XII.1990, F.D. Parker, 1♀ (USU); same, 1–20.XI.1990, F.D. Parker, 1♀ (USU). Guanacaste: P. N. Guanacaste, Est. Cacao, 1100 m., 8–18.II.1995, M. Moraga, 1♂ (INBio002185179); same, 7–18.II.1995, F. Alvarado, 1♀ (INBio002196019); P. N. Guanacaste, 2 km SW Cerro Cacao, Est. Cacao, 1000–1400 m., 8–17.II.1995, M.A. Zumbado, 1♀ (INBio002324003); P. N. Guanacaste, 9 km S Sta. Cecilia, Est. Ptilla, 700 m., IX.1991, P. Rios, 1♀ (INBio000601097); same, VII. 1991, P. Rios, 1♂1♀ (INBio000336542, 000336553); same, 27.VII-14.VIII.1992, P. Rios, 1♀ (USNM) (INBio000778619); same, VII.

1988, GNP Biodiversity survey, 1♂ (INBio000129404); same, XII.1994, P. Rios, 2♀ (USNM) (INBio002136935, 002136941); same, XII.1995, M. Moraga, 1♀ (USNM) (INBio002379513); W side Volcan Orosi, Est. Maritza, 600 m., 27.II-10.III.1992, F.A. Quesada or R. Vargas, 1♂1♀ (USNM) (INBio000814582, 000468319); same, 28.II-10.III.1992, R. Guzman, 1♂ (INBio000441334); same, VI.1990, R. Blanco, 1♀ (USNM) (INBio000233969); 3 km. SE of Rio Naranjo, 1–9.VI.1993, F.D. Parker, 1♀ (USU).

Anastrepha bicolor (Stone)
(Figs. 5C, 7D, 9C)

Pseudodacus bicolor Stone 1939: 288 [description]; Baker et al. 1944: 118 [Mexico]; Aczél 1950: 236 [catalog]; Wasbauer 1972: 125 [list]; Foote 1965: 674 [catalog], 1967: 39 [catalog].

Anastrepha bicolor: Steyskal 1977b: 3 [key]; Norrbom 1985: 119 [taxonomy]; Norrbom and Kim 1988: 1 [classification]; Hernández-Ortiz 1992: 55 [Mexico]; Foote et al. 1993: 91 [USA].

Diagnosis.—This species differs from *macrura* and *zucchii* in having the presutural lateral stripe complete. It differs from *aquila, avispa* and *zucchii* in having the posterior half of the part of cell br bordering bm hyaline and bare of microtrichia. Its banded abdominal pattern clearly distinguishes *bicolor* from *macrura* and *zucchii,* in which the abdomen is brown with a pale stripe or T-shaped mark, and less so from *aquila* and *avispa,* which are intermediate in abdominal pattern.

Description.—Body predominantly dark orange-brown to dark brown. *Head:* Mostly yellow. Frons with brown transverse dorsal band, usually more or less rectangular, narrow to moderately broad, orbital seta at margin or anterior to band. Gena with large brown spot below eye. Occiput entirely yellow. Posterior orbital seta usually absent (of 38 specimens with intact head setae, absent except in 1♂ from Morelos, and on one side only on 1♀ from Sinaloa). *Thorax* (Fig. 7D):Medial pale stripe bilobed posteriorly, lobes moderately slender, often with distinct anterolateral corner, usually extended to dorsocentral seta. Presutural dorsocentral pale stripe connected anteriorly to pale area on postpronotal lobe and connected or narrowly separated from pale sublateral stripe. Presutural lateral pale stripe well differentiated, complete, including posterior part of notopleuron. Pleuron brown except following yellow areas: all of propleuron; anteroventral corner and posterodorsal half of anepisternum; dorsal band or 2 spots on katepisternum; katepimeron; anterior ¼ of meron; anterior ⅔ of katatergite; and most of anatergite. Subscutellum and mediotergite entirely brown, or mediotergite occasionally dark orange medially. Scutum without microtrichia except on anterior part of sublateral stripe, lateral to sublateral stripe and posterior to dorsocentral seta; notopleuron usually partly microtrichose; scutellum microtrichose except basal area on side. *Wing* (Fig. 5C): C- and S-bands completely fused along costa to form broad, uninterrupted, orange to dark orange-brown marginal band; in cell br at most covering anterior half of section bordering cell bm, not extended to vein M; covering all of cells r_1 and r_{2+3} and anterior margin of cell r_{4+5}; well separated from apex of vein M. S-band incomplete, middle part between veins R_{4+5} and Cu_1 absent; basal part paler than C-band; extended over base of cell cu_1 and faintly and diffusely along vein Cu_1 up to halfway to dm-cu, sometimes extended into cell dm towards r-m. V-band pale and diffuse; extended anteriorly only slightly into cell r_{4+5}; distal arm absent. Vein M strongly curved apically; M ratio 1.57–2.33. Cell br about half microtrichose (some Texas specimens) to mostly bare, section bordering cell bm with at least posterior half bare. Cell bcu with anterior margin and medial crease microtrichose, always with large bare areas anterior and posterior to crease, posteroapical lobe bare to entirely microtrichose. *Abdomen* (Fig. 9C): Tergites banded; base of syntergite 1+2 yellow; it and tergites 3–5 with posteromedial yellow areas broad, and, except often on tergite 5, with brown areas undivided medially; tergites usually without lateral yellow margins, but present in some Mexican and all Central American specimens. *Female terminalia:* Syntergosternite 7 length 3.58–6.45 mm, 1.17–1.86 times as long as mesonotum. Aculeus length 3.22–5.57 mm; tip nonserrate, length 0.15–0.21 mm, width 0.04–0.05 mm.

Remarks.—The length of the female terminalia is considerably greater among the specimens here recognized as *bicolor* than in any other species of the *daciformis* group (see Table 2). This does not appear to be due to sampling error, as the variation in the similar sized sample of *pallens* is much lower, although this species has a similar distribution to *bicolor.* Arbitrarily dividing the sample by syntergosternite 7 length greater than or less than 5 mm (see Table 2, "*bicolor* long", "*bicolor* short") yields samples with variation similar to that in other species. The "long" sample includes all of the Morelos females and single females from Chamela, Jalisco and Rosario, Sinaloa. It is possible that the individuals with longer terminalia represent a cryptic species, but without host data or better samples to support this hypothesis, I continue to recognize them as *bicolor.*

Distribution.—USA (southern Texas) to Costa Rica. In Mexico also reported from Nayarit (Hernández-Ortíz 1992).

Specimens examined.—Holotype ♀ (USNM, no. 53330), U.S.A.: Texas: Edinburg, 20.X.1937. Other specimens—COSTA RICA: Guanacaste: 8 km SW Cuajinquil, Est. Murcielago, 100 m., II.1989, GNP Biodiversity Survey, 1♂ (INBio001054196). GUATEMALA: Escuintla: Palín, Km. 36.5, Granja El Coronel, McPhail trap, 26.III.1992, J. López, 1♀ (López); same, I.1992, 1♂ (USNM). MEXICO: Chiapas: Mazapa de Madero, II.1984, E. Rios, 1♂ (USNM). Guererro: S.A. Ahuehuepan, 14.IV.1989, A.M. Real, E. Real & P. Santana, 1♀ (IEXV); Iguala, Finca Aurora, VII.1987, Z. Figueroa, 1♂ (UNAM); Tlaxmalac, 26.I.1989, A.M. Real, E. Real & P. Santana, 1♂ (IEXV). Jalisco: Est. Biol. Chamela, 1–8.IV.1992, E. Ramírez, 2♀ (IEXV); same, 8.VI.1992, 2♂4♀ (IEXV). Morelos: Cañon de Lobos, 5.I-2.II.1961, C. Benschoter, 3♂6♀ (USNM); Coatlán del Río, 4.III.1987, M.Y. Serna, 1♀ (UNAM); Cocoyoc Golf, V-VI.1957, 4♂3♀ (USNM); Cuernavaca, 1♀ paratype (USNM); Cuernavaca, Jardin Borda, I.1958, 1♂2♀ (USNM). Oaxaca: vic. Palomares, 11.VIII.1980, E. Giesbert, 1♀ (FSCA). Sinaloa: Rosario, I.1987, Rendón, 2♀ (IEXV). Sonora: Muatabampo, McPhail trap, 3.VIII.1988, E. Melchor Ocampo, IRL-130-88, 1♂ (Riley). Veracruz: Apazapan, 19.IV.1991, G. Quintero & L. Quiroz, 1♀ (IEXV); same, 24.VI.1992, 1♂ (IEXV); Apazapan, 26.VI.1991, V. Hernández & L. Quiroz, 1♀ (IEXV). U.S.A.: Texas: Cameron Co.: Harlingen, 28.I.1937 or 28.XII.1937, W.R. Head, 2♂ paratypes (USNM); Harlingen, 13.XII.1937, E.H. Achilles, 1♂ paratype (USNM); San Benito, 1♂ paratype (USNM). Hidalgo Co.: 11.XI.1935, F.C. Champion, 1♂ paratype (USNM); Alamo, 13.I.1937, 1♂ paratype (USNM); McAllen, 5.XI.1934, B.C. Stevenson, 1♂ paratype (USNM); Weslaco, 7.XI.1934, 1♀ paratype [genitalia slide only] (USNM).

***Anastrepha castanea* Norrbom, new species**

(Figs. 5D, 7E)

Diagnosis.—This species is most similar to *daciformis* and *katiyari,* but differs in having the lateral presutural pale stripe interrupted and absent from the scutum (i.e., pale area on postpronotal lobe not connected to pale area on posterior half of notopleuron), and in having the white markings of the abdomen reduced, with no apical band or spot on tergite 4. The female terminalia are longer than in *daciformis,* but shorter than in *katiyari* (see Table 2).

Description.—Body predominantly red-brown to dark brown. *Head:* Yellow and brown. Frons with brown transverse dorsal band, moderately broad, somewhat bilobed, broadest along eye margin where it extends anteriorly beyond level of orbital seta. Gena with large brown spot below eye. Occiput brown except anterior margin and narrowly dorsomedially. Posterior orbital seta absent. *Thorax* (Fig. 7E): Medial pale stripe bilobed or triangular posteriorly, not extended to dorsocentral seta. Presutural dorsocentral pale stripe isolated anteriorly from pale area on postpronotal lobe and not connected posteriorly to sublateral stripe along transverse suture. Presutural lateral pale stripe well differentiated, incomplete, middle part absent from scutum, but present on posterior part of notopleuron. Pleuron brown except following yellow areas: posterodorsal third of anepisternum; two small dorsal spots on katepisternum; katepimeron; anterior ⅔ of katatergite; and most of anatergite. Subscutellum and mediotergite entirely dark brown. Scutum microtrichose except for medial presutural bare area on and between dorsocentral stripes, at most extended halfway to transverse suture; notopleuron microtrichose; scutellum entirely microtrichose except for small basal area on side. *Wing* (Fig. 5D): C- and S-bands completely fused along costa to form narrow, uninterrupted, dark brown marginal band; in cell br not extended to vein M along cell bm; covering all of cell r_1, but cells r_{2+3} and r_{4+5} hyaline except apically; apically narrow, but extended to or almost to apex of vein M. S-band incomplete, middle part between veins R_{2+3} and Cu_1 absent; basal part as dark as C-band but hyaline or very faintly infuscated in posterior third or more of cell bcu. V-band as dark as C-band, extended anteriorly at most slightly into cell r_{4+5}; distal arm absent. Vein M strongly curved apically; M ratio 1.25–1.49. *Abdomen:* Tergites, including base of syntergite 1+2 and lateral margins of all tergites, dark red-brown except for medial and apical white bands on syntergite 1+2 and sometimes a medial white band on posterior margin of tergites 3 and anterior margin of tergite 4. *Female terminalia:* Syntergosternite 7 length 2.95–3.49 mm, 1.11–1.29 times as long as mesonotum. Aculeus not dissected in Argentine females; at least 2.66 mm long in Brazilian female, but broken and tip missing.

Distribution.—Southern Brazil, Argentina.

Types.—Holotype: ♀ (INTA), ARGENTINA: Corrientes: Bella Vista, "s/ citrus", XII.1944, Silbermann. Paratypes. Same data as holotype, 1♂ (INTA) 1♂1♀ (USNM). BRAZIL: Mato Grosso do Sul: Terenos, Colonia Jamic, Fazenda Varzea Alegre, McPhail trap in tangerine orchard, 31.XII.1995, M.A. Uchoa F., 1♀ (USP).

Anastrepha daciformis Bezzi
(Figs. 1B, 2A–B, 5E, 7F)

Anastrepha daciformis Bezzi 1909: 282 [description]; Greene 1934: 143 [taxonomy]; Blanchard 1937: 41 [Argentina]; Lima 1938: 64 [illustration]; Stone 1942: 10; Hayward 1942, 1960 [host]; Steyskal 1977b: 3 [key]; Zucchi 1978: 41 [taxonomy, Brazil]; Norrbom 1985: 115 [taxonomy]; Norrbom and Kim 1988: 1 [classification], 16 [host list]; White and Elson-Harris 1992: 163 [host list]

Anastrepha (Pseudodacus) daciformis: Hendel 1914a: 66 [key], 1914b: 13 [key]; Bezzi 1919a: 6, 1919b: 373 [Brazil]; Lima 1934: 493 [Brazil, type data].

Pseudodacus daciformis: Stone 1939: 286 [revision]; Aczél 1950: 237 [catalog]; Rosillo 1953: 105 [Argentina]; Blanchard 1961: 293 [Argentina]; Foote 1967: 39 [catalog].

Diagnosis.—This species most closely resembles *castanea* and *katiyari*, which differ as indicated in the key. *A. daciformis* also has a larger M ratio (see Table 1).

Description.—Body predominantly dark orange-brown to red-brown. *Head:* Mostly yellow. Frons with brown transverse dorsal band, moderately broad, usually bilobed, broadest along eye margin where it extends anteriorly beyond level of orbital seta. Gena with large brown spot below eye. Occiput brown except anterior margin and sometimes narrowly dorsomedially, in teneral specimens brown only dorsally. Posterior orbital seta absent (of 22 specimens with intact head setae, present on one side only on 1 ♀). *Thorax* (Fig. 7F):Medial pale stripe bilobed or triangular posteriorly, not extended to dorsocentral seta. Presutural dorsocentral pale stripe isolated anteriorly from pale area on postpronotal lobe and not connected posteriorly to sublateral stripe along transverse suture. Presutural lateral pale stripe well differentiated, complete, including posterior part of notopleuron. Pleuron brown except following yellow areas: posterodorsal third of anepisternum; two small dorsal spots on katepisternum; katepimeron; anterior ⅔ of katatergite; and most of anatergite. Subscutellum and mediotergite entirely brown. Scutum microtrichose except for medial presutural bare area on and between dorsocentral stripes, at most extended halfway to transverse suture; notopleuron microtrichose; scutellum entirely microtrichose except for small basal area on side. *Wing* (Fig. 5E): C- and S-bands completely fused along costa to form narrow, uninterrupted, brown to dark brown marginal band; in cell br not extended to vein M along cell bm; covering all of cell r_1, but cells r_{2+3} and r_{4+5} hyaline except apically; apically narrow, separated from or occasionally extended to apex of vein M. S-band incomplete, middle part between veins R_{2+3} and Cu_1 absent; basal part as dark as C-band but hyaline or very faintly infuscated in posterior third or more of cell bcu. V-band as dark as C-band, extended anteriorly at most slightly into cell r_{4+5}; distal arm absent. Vein M strongly curved apically; M ratio 1.52–2.00. *Abdomen:* Tergites, including lateral margins, red-brown; except for male tergite 5, each with narrow apical pale band. Syntergite 1+2 also with small medial pale band; brown or orange basally. *Female terminalia:* Syntergosternite 7 length 2.12–2.70 mm, 0.75–0.98 times as long as mesonotum. Aculeus length 1.79–2.20; tip finely serrate apically, length 0.11–0.15 mm, width 0.025–0.03 mm.

Host plants.—This species was reported to attack "duraznero" (presumably *Prunus persica* (L.) Batsch (Rosaceae)), "guayabo" (presumably *Psidium guajava* L.) and *Eugenia* sp. (Myrtaceae), and citrus (*Citrus* sp. (Rutaceae)) in Argentina (Hayward 1942, 1960, Rosillo 1953, Blanchard 1961), but all of these records are doubtful. Blanchard said that Rosillo and Hayward both reared specimens, but although Rosillo used the word "hospedero" in his tables, his data appear to be exclusively based on trap counts. I have not seen the Hayward papers, but I suspect that these records are also based on trap data.

Type data.—Bezzi described *daciformis* from "parecchi esemplari" (several specimens) of both sexes from "S. Paolo, Brasile" (São Paulo, Brazil) from G.G. Barbiellini in the "Mus. di Budapest e mia coll." The only specimens of *daciformis* now in the MNM are from Paraguay, so the MNM syntypes must have been lost or were never returned by Bezzi. The lectotype male in the MCSNM has only a small green label with "327" and "Anastrepha daciformis n. sp." in Bezzi's writing. The female paralectotype has only a small green label with "54." The specimens are accompanied by a label on a separate pin with "Anastrepha daciformis typ. Bezzi" in Bezzi's writing. I designate the male as lectotype because it is in good condition, whereas the female is slightly teneral and missing the right foreleg and most of both antennae.

Distribution.—Southern Brazil, Paraguay, Argentina. C.A. Korytkowski (pers. comm.) has examined a male from Pocitos, Salta, Argentina in the Universidad de Panama collection.

Specimens examined.—Lectotype ♂, here designated, and paralectotype ♀, (MCSNM), BRAZIL: São Paulo, G.G. Barbiellini. Other specimens—ARGENTINA: Jujuy: Ledesma, 1♀ (USNM). Salta: Oran, 9.VIII.1955, 2♀ (INTA). Tucumán: Tucumán, 6.I.1936, 2♂ (INTA). BRAZIL: Compere, 1♂1♀ (USNM). Mato Grosso, Rohde, 1♀ (ZMHU). Rio Grande do Sul: Santa Cruz, 10.VII.1895, Stieglmayr, 1♀ (NMW). São Paulo, 26.XII.1931, M. Kisliuk & C. Cooley, 11♂5♀ (USNM). PARAGUAY: Asuncion, 23.X.1904, Vezenyi, 2♂3♀ (MNM) 1♀ (USNM).

Anastrepha katiyari **Norrbom, new species**

(Figs. 5F, 7G, 9D)

Diagnosis.—This species is most similar to *daciformis* and *castanea,* but differs as follows: Presutural dorsocentral pale stripe broadly connected anteriorly to pale area on postpronotal lobe; propleuron yellow; female terminalia longer (see Table 2); base of syntergite 1+2 yellow; and scutum largely nonmicrotrichose.

Description.—Body predominantly dark orange-brown to dark brown. *Head:* Mostly yellow. Frons with brown transverse dorsal band, more or less rectangular and not extended beyond orbital seta or bilobed and broadest along eye margin where it extends anteriorly beyond level of orbital seta. Gena with large brown spot below eye. Occiput yellow, with lateral brown spots or stripes on median occipital sclerite or area bordering it. Posterior orbital seta usually absent (present on one or both sides in 3 of 13 ♂ and on one side only on 3 of 10 ♀). *Thorax* (Fig. 7G): Medial pale stripe bilobed posteriorly, lobes stout to moderately slender, not extended to dorsocentral seta. Presutural dorsocentral pale stripe broadly connected anteriorly to pale area on postpronotal lobe, and connected or narrowly separated from pale sublateral stripe. Presutural lateral pale stripe well differentiated, complete, including posterior part of notopleuron. Pleuron brown except following yellow areas: all of propleuron; anteroventral corner and posterodorsal half of anepisternum; two small dorsal spots on katepisternum, anterior one sometimes very small; katepimeron; anterior ¼ of meron; anterior ⅔ of katatergite; and most of anatergite. Subscutellum and mediotergite entirely brown or occasionally both orange medially. Scutum without microtrichia medially, microtrichose only on and lateral to sublateral stripe, and on and posterior to expanded posterior part of medial pale stripe; notopleuron microtrichose; scutellum entirely microtrichose except small basal area on side. *Wing* (Fig. 5F): C- and S-bands completely fused along costa to form narrow, uninterrupted, orange and brown marginal band; in cell br not extended to vein M along cell bm; covering all of cell r_1, but cells r_{2+3} and r_{4+5} hyaline except apically; apically narrow, but extended to apex of vein M. S-band incomplete, middle part between veins R_{2+3} and Cu_1 absent; basal part as dark as C-band but hyaline or very faintly infuscated in posterior third or more of cell bcu. V-band as dark as C-band, extended anteriorly no more than ⅓ distance across cell r_{4+5}; distal arm absent. Vein M strongly curved apically; M ratio 1.05–1.34. *Abdomen* (Fig. 9D): Syntergite 1+2 broadly pale basally; it and tergites 3–5 each with red-brown band that broadens laterally and extends to lateral margin; band on tergite 5 often interrupted medially. Tergites each with broad apical pale band. *Female terminalia:* Syntergosternite 7 length 3.95–4.99 mm, 1.27–1.64 times as long as mesonotum. Aculeus length 3.16–4.53; tip very finely serrate apically, length 0.13–0.14 mm, width 0.02 mm.

Distribution.—Venezuela.

Remarks.—This species is named for Katma P. Katiyar, Universidad de Zulia, who headed the survey in which most of the type series was reared.

Types.—Holotype: ♀ (IZAM) (USNM-48665), VENEZUELA: Zulia: Mara, 10°49′00″N 70°52′18″W, 60 m., ex. fruto del caimito *Sideroxylon obtusifolium* MFAKP-1062, 25.X.1995, K. Katiyar, J. Camacho, J. Oroño. Paratypes. VENEZUELA: Mérida: Sta. Rosa, trap #9, 28.VII.1983, 1♀ (USNM). Zulia: Same data as holotype, 1♂ (IZAM, USNM48666) 7♂7♀ (USNM48667–48680); Pringamosa, trap #7, 24.IV.1984, 3♂2♀ (USNM).

Anastrepha macrura Hendel
(Figs. 1A, C-D, 5G, 7H, 9E-F)

Anastrepha (Pseudodacus) macrura: Hendel 1914a: 66 [description in key], 1914b: 16 [description]; Lima 1934: 493 [Brazil].

Anastrepha macrura: Greene 1934: 143 [taxonomy]; Blanchard 1937: 41 [Argentina]; Lima 1937: 34 [host], 1938: 64 [illustration]; Stone 1942: 10; Bondar 1950: 13 [host]; Steyskal 1977b: 3 [key]; Zucchi 1978: 64 [Brazil]; Caraballo 1981: 151 [Venezuela, host]; Norrbom 1985: 117 [taxonomy]; Norrbom and Kim 1988: 1 [classification], 38 [host list]; White and Elson-Harris 1992: 142 [taxonomy, host list].

Pseudodacus macrurus: Stone 1939: 285 [taxonomy]; Aczél 1950: 237 [catalog]; Blanchard 1961: 294 [Argentina]; Foote 1967: 39 [catalog]; Silva et al. 1968: 585 [host list].

Pseudodacus macrura: Hardy 1968: 121 [type data].

Diagnosis.—This species differs from all other species of the *daciformis* group by the broad brown stripe on the facial carina (although other species sometimes have brown or gray subcuticular discolorations) and absence of the presutural lateral pale stripe from the scutum. The shape of the dorsal brown mark on the frons, usually triangular or semicircular and broadest medially, is also a useful character, although it is not fully developed in many of the specimens examined, which appear to be teneral.

Description.—Body predominantly red-brown to dark brown. *Head:* Mostly yellow. Frons with brown transverse dorsal band, usually somewhat semicircular or triangular and broadest in line with ocellar tubercle, orbital seta usually at margin of band. Facial carina with broad dark stripe on ventral 2/3–4/5. Gena with large brown spot below eye. Occiput with large triangular areas along lateral sutures of median occipital sclerite, sometimes with diffuse brown area ventrally. Posterior orbital seta absent. *Thorax* (Fig. 7H): Medial pale stripe strongly bilobed posteriorly, lobes moderately to extremely slender, usually extended to dorsocentral seta. Middle part of presutural lateral pale stripe absent, although lateral margin of scutum sometimes slightly paler than other dark areas; notopleuron with posterior third pale, including area around posterior notopleural seta. Presutural dorsocentral pale stripe connected to or narrowly separated from pale area on postpronotal lobe and pale sublateral stripe. Pleuron brown except following yellow areas: anterior and ventral margins of propleuron; anteroventral margin and posterodorsal third of anepisternum; two dorsal spots on katepisternum; katepimeron; anterior ¼ of meron; anterior ⅔ of katatergite; and most of anatergite. Subscutellum and mediotergite entirely dark brown. Scutum microtrichose except for medial presutural bare area on and between dorsocentral stripes, at most extended ⅔ distance to transverse suture; notopleuron microtrichose; scutellum entirely microtrichose except small basal area on side. *Wing* (Fig. 5G): C- and S-bands completely fused along costa to form broad, uninterrupted, orange to dark orange-brown marginal band; in cell br at most covering anterior half of section bordering cell bm, not extended to vein M; covering all of cells r_1 and r_{2+3} and anterior margin of cell r_{4+5}; well separated from apex of vein M. S-band incomplete, middle part between veins R_{4+5} and Cu_1 absent; basal part paler than C-band; extended over base of cell cu_1 and along vein Cu_1 at most halfway to dm-cu; not extended into cell dm. V-band pale and diffuse; extended anteriorly only slightly into cell r_{4+5}; distal arm absent. Vein M strongly curved apically; M ratio 1.41–2.04. Cell br 2/5 to 2/3 microtrichose, always with at least posterior half of section bordering cell bm bare. Cell bcu entirely microtrichose. *Abdomen* (Fig. 9E–F): Tergites, including base of syntergite 1+2 brown, except following white areas: extreme lateral margins of all tergites; small transverse band on basal half of syntergite 1+2; and medial stripe, slightly to broadly expanded on apical half of syntergite 1+2, not connected to basal band. *Female terminalia:* Syntergosternite 7 length 4.99–6.66 mm, 1.43–1.89 times as long as mesonotum. Aculeus length 4.49–5.72 mm; tip nonserrate or with a few fine apical serrations, length 0.17–0.23 mm, width 0.035–0.04 mm.

Host plants.—Reported hosts include two species of Sapotaceae: *Chrysophyllum cainito* L. (Caraballo 1981); and *Pouteria lactescens* (Vell.) Kuhlmann (Lima 1937, 1938, Bondar 1950, as *Pradosia lactescens*).

Remarks.—This species was described as a new species twice by Hendel (1914a,b), and as neither description mentions the other, technically there are two available names, that of Hendel (1914b) being a primary homonym. The 1914a name was described from an unstated number of females from Paraguay, the 1914b name from an unstated number of females from "Paraguay, S. Bernhardino" in the MNM. A female in the MNM with the following labels is here designated as lectotype for both names: "Paraguay Fiebrig", "S. Bernardino", "A. macrura H. typus [Hendel's writing] det. Hendel", and orange bordered "typus". Hardy (1968) regarded a female in the NMW as "Type female" of *macrura* Hendel (1914b). It bears the following labels: "Paraguay, Fiebrig", "A. macrura H. det. Hendel [Hendel's writing]", orange "type" [not Hendel's writing], and "Pseudodacus macrura (Hendel) [Hardy's writing]". Although it could have been a syntype, and Hardy's statement therefore construed as a lectotype designation by inference of holotype, the facts that it does not have a San Bernardino label and that Hendel did not mention his own collection as a depository (as he usually did for other species where he retained material) are sufficient to regard it as a nontype.

The ratio of female terminalia length to mesonotum length is greater in the Bahia and Venezuela females and appears to increase in a northerly direction in this species.

Distribution.—Western Venezuela, Ecuador, Peru, Paraguay, Brazil (Bahia, Rio Grande do Norte). C.A. Korytkowski (pers. comm.) has examined specimens in the Universidad de Panama collection with the following data: PERU: Cajamarca: Poterillo, 18.II.1968, C.A. Korytkowski, 1♂; Cochabamba, 18.II.1968, D. Ojeda, 1♀.

Specimens examined.—Lectotype ♀ (MNM), PARAGUAY: San Bernardino, Fiebrig. Other specimens—BRAZIL: Bahia: Agua Preta, "ex. *Pradosia lactescens*", G. Bondar 2154, 4♂1♀ (USNM). Rio Grande do Norte: Natal, Jiqui, McPhail [trap], 6.III.1993, Malavasi & Maia, 1♂1♀ (FSCA). ECUADOR: Loja: Gonzanamá, Nambacola, 4°18'S 79°27'W, Quebrada grande, 1238 m, trampa Harris, VII.1992, S. Soto & H. Ruíz, 1♀ (CEEA). PARAGUAY: "D6579", 10.VI, Fiebrig, 1♀ (ZMHU); Fiebrig, 1♀ (NMW); San Bernardino, III.1908, Fiebrig, 2♀ (MNM, USNM). VENEZUELA: Aragua: Rancho Grande, 23.VII, 1♀ (USNM); Rancho Grande, 10.VII.1945, 1♂ (AMNH); Rancho Grande, 12.VII.1967, R.W. Poole, 1♂ (USNM); Rancho Grande, 1100 m, 31.VII.1967, J. Salcedo & A. Montagne, 1♀ (IZAM).

Anastrepha maculata Norrbom, new species

(Figs. 2C–E, 6B, 7I)

Diagnosis.—This species differs from other species of the *daciformis* group except *stonei* in having the distal arm of the V-band present. It differs from *stonei* as indicated in the key and in the diagnosis for *stonei,* and by the following characters: Scutum entirely microtrichose (nonmicrotrichose except lateral margin in *stonei*); posterior half of anatergite dark brown (white except posteroventral corner in *stonei*); and subscutellum and mediotergite entirely dark brown, or latter sometimes dark orange with 3 dark brown stripes (in *stonei,* subscutellum orange, often with medial dark brown spot; mediotergite entirely orange). The female terminalia are relatively short compared to the other 3 Antillean species of the group (see Table 2).

Description.—Body predominantly yellow to orange. *Head:* Yellow except ocellar tubercle usually brown. Posterior orbital seta usually absent (weakly present on one side in 1♂). *Thorax* (Fig. 7I): Scutum usually with dark brown spot above postalar seta, sometimes with dark brown spot mesal to intra-alar seta and/or unpaired dark brown spot posterior to acrostichal setae. Medial pale stripe bilobed posteriorly, lobes stout, with distinct anterolateral corner, extended to dorsocentral seta. Presutural dorsocentral pale stripe connected anteriorly to pale area on postpronotal lobe and connected to or narrowly separated from pale sublateral stripe. Presutural lateral pale stripe poorly differentiated, appears to be complete, including posterior part of notopleuron. Scutellum with 3 dark brown spots, one medial and pair on margin between yellow basal and white apical areas. Pleuron with following dark brown spots: two dorsal spots on anepisternum; anterodorsal and posteromedial spots on katepisternum; medial spot on anepimeron; and posterior half of laterotergite. Subscutellum and mediotergite entirely dark brown, or latter sometimes dark orange with 3 dark brown stripes. Scutum and notopleuron entirely microtrichose; scutellum microtrichose basally, nonmicrotrichose on dark brown spots and apical white area. *Wing* (Fig. 6B): Bands yellow, orange and brown. C- and S-bands completely fused along costa, forming uninterrupted marginal band; cell R_1 without hyaline marginal area. C-band covering cell r_{2+3} to beyond level of r-m. S-band interrupted in medial cells and along vein Cu_1; basally with broad extension across vein Cu_2+A_1 almost to posterior wing margin; middle part not extended anteriorly beyond vein M, but often narrowly connected to V-band; subapically relatively broad, with large hyaline area in cell r_{2+3} but well separated from vein R_{2+3}; apically of medium breadth, extended to or almost to apex of vein M. V-band complete, not connected to S-band along vein R_{4+5}. Vein M strongly curved apically; M ratio 1.21–1.53. *Abdomen:* Tergites entirely yellow or orange, without dark brown marks. *Female terminalia:* Syntergosternite 7 length 2.58–2.85 mm, 1.03–1.15 times as long as mesonotum. Aculeus length 2.33 mm; tip with a few fine apical serrations, length 0.10 mm, width 0.025 mm.

Remarks.—The name of this species refers to the spots on its mesopleuron and scutellum.

Distribution.—Virgin Islands, Mona Island (between Puerto Rico and Hispaniola). This species presumably also occurs on Puerto Rico, which is between the Virgin Islands and Mona Island.

Types.—Holotype: ♀ (USNM), BRITISH VIRGIN ISLANDS: Guana Island, 0–80 m., 13–26.VII.1986, S.E. Miller & M.G. Pogue. Paratypes. BRITISH VIRGIN ISLANDS: Great Camanoe Isld., ⅓ mi. ESE Cam Bay, 20.III.1974, C.L. Remington, 1♂ (MCZ); Guana Island, 0–80 m., 13–26.VII.1986, S.E. Miller & M.G. Pogue, 1♂3♀ (USNM). PUERTO RICO: Mona Isld., Uvero, 19.X.1955, W.H. Cross, 1♂ (USNM).

Anastrepha murrayi Norrbom, new species

(Figs. 6C, 8A)

Diagnosis.—The extent of the dark brown area on the mesonotum, in combination with the mostly orange thoracic pleuron distinguishes this species from the other species of the *daciformis* group. Only it, *antilliensis*, and some *stonei* have the S-band complete. The female terminalia are relatively long compared to the other Antillean species of the group (see Table 2); in the other 3 species, the syntergosternite 7/ mesonotum length ratio is less than 1.35.

Description.—Body predominantly orange. *Head:* Yellow except ocellar tubercle brown. Posterior orbital seta absent. *Thorax*

(Fig. 8A): Mesonotum dark brown except pale stripes, postpronotal lobe, and anterior margin and medial half of anterior half of scutum. Medial pale stripe bilobed posteriorly, lobes moderately stout, with distinct anterolateral corner, not extended to dorsocentral seta. Presutural dorsocentral pale stripe connected anteriorly to pale area on postpronotal lobe and connected to pale sublateral stripe. Presutural lateral pale stripe incomplete, narrowly interupted at margin of scutum and postpronotal lobe, extended to level of presutural supra-alar seta, but absent from notopleuron. Scutellum dark brown except small white apical area. Pleuron mostly orange, without brown markings; dorsal margin of anepisternum and dorsal half of laterotergite white (other white markings, if present, not well differentiated in holotype). Subscutellum dark brown, mediotergite entirely orange. Scutum, notopleuron and scutellum nonmicrotrichose. *Wing* (Fig. 6C): Bands yellow orange and brown. C- and S-bands connected along vein R_{4+5}, but separated along costa (cells r_1, and r_{2+3} with marginal triangular hyaline mark). S-band complete, basally with broad extension across vein Cu_2+A_1 to posterior wing margin; subapically relatively narrow, hyaline area in cell r_{2+3} extended almost to vein R_{2+3}; apically moderately broad, extended to apex of vein M. V-band extended anteriorly to vein R_{4+5}, not connected to S-band; distal arm absent. Vein M moderately curved apically; M ratio 1.74. *Abdomen:* Tergites orange banded with posterior margins broadly white. Female terminalia: Syntergosternite 7 length 3.91 mm, 1.52 times as long as mesonotum. Aculeus length 3.24 mm; tip with apex broken, length at least 0.11 mm, width 0.03 mm. Spermathecae not studied.

Remarks.—This species is named for Roy Murray, who headed the survey in which the holotype was collected. The holotype was apparently pinned directly out of alcohol, as its head is shriveled, and its abdomen and genitalia were damaged by dissection prior to my examination of it, but most significant characters are observable.

Distribution.—Jamaica.

Holotype.—♀ (USNM), JAMAICA: Manchester, McPhail trap, 11.IV.1986, W. Greaves.

Anastrepha pallens Coquillett
(Figs. 1E, 6D, 8B–C)

Anastrepha pallens Coquillett 1904: 35 [description]; Hendel 1914a: 69 [key], 1914b: 14 [key]; Bezzi 1919a: 3, 1919b: 372 [list]; Dampf 1933: 262 [female terminalia]; Greene 1934: 154 [host, taxonomy]; Lima 1934: 511 [review]; Stone 1942: 10; Phillips 1946: 31, 106 [larva, host list]; Steyskal 1977b: 3 [key]; Norrbom 1985: 112 [taxonomy]; Norrbom and Kim 1988: 1 [classification], 51 [host list]; Steck et al. 1990: 343 [larval key]; Hernández-Ortiz 1992: 53 [Mexico]; White and Elson-Harris 1992: 163, 439 [host list]; Foote et al. 1993: 103 [USA].

Anastrepha (Pseudodacus) pallens: McPhail and Berry 1936: 405 [biology, host].

Pseudodacus pallens: Stone 1939: 283 [revision]; Baker et al. 1944: 115 [taxonomy, larva, biology]; Aczél 1950: 238 [catalog]; Wasbauer 1972: 17, 125 [hosts]; Foote 1965: 674 [catalog], 1967: 39 [catalog].

Anastrepha sp. 1: González and Tejada 1980: 126.

Diagnosis.—This species differs from other species of the *daciformis* group in having a hyaline basal marginal area in cell r_1 and the S-band interrupted along vein R_{4+5} and in cell dm along vein Cu_1 (Fig. 6D). The other species with a hyaline area in cell r_1 have the S-band complete. The brown posterior markings on the scutum (Fig. 8B–C) are also useful diagnosic characters.

Description.—Body predominantly orange to orange-brown. *Head:* Mostly yellow. Frons with brown transverse dorsal band, rectangular or often narrowed between ocellar tubercle and orbital plate, at most moderately broad, not extended anteriorly beyond orbital seta. Gena with brown spot below eye, sometimes faint, especially in teneral specimens. Occiput yellow. Posterior orbital seta absent (of 39 specimens examined with intact head setae, present only on 1♂ (BMNH)). *Thorax* (Figs. 8B–C): Scutum posteriorly with 2–3 brown spots or usually with trilobed brown band. Medial pale stripe bilobed posteriorly, lobes relatively stout, usually with distinct anterolateral corner, not extended to dorsocentral seta. Presutural dorsocentral pale stripe connected anteriorly to pale area on postpronotal lobe and connected, or rarely narrowly separated from, pale sublateral stripe. Presutural lateral pale stripe well differentiated, complete, including posterior part of notopleuron. Scutellum with lateral brown spot or complete transverse brown band bordering apical white area. Pleuron without brown markings; orange except following white areas, often not well differentiated: all of propleuron; anteroventral corner and posterodorsal half of anepisternum; dorsal band or 2 spots on katepisternum; katepimeron; anterior ¼ of meron; anterior ⅔ of katatergite; and most of anatergite. Subscutellum and mediotergite entirely orange. Scutum nonmicrotrichose except lateral margin lateral to postsutural supra-alar seta; notopleuron partly microtrichose; scutellum microtrichose except extreme base of disc and most of side. *Wing* (Fig. 6D): Bands yellow to orange and pale brown. C- and S-bands entirely separated or connected in cell R_1 along vein R_{2+3} (but not along vein R_{4+5}; most of cell r_{2+3} hyaline basal to r-m); cell r_1 with marginal hyaline mark, although sometimes small. S-band interrupted along vein R_{4+5} and in cell dm along vein Cu_1; middle part extended anteriorly to vein R_{4+5} along r-m; subapically narrow, hyaline area in cell r_{2+3} extended to vein R_{2+3}; apically relatively narrow, but usually extended to apex of vein M. V-band extended anteriorly to vein R_{4+5}, connected to or occasionally narrowly separated from apical part of S-band; distal arm absent. Vein M strongly curved apically; M ratio 1.27–1.95. *Abdomen:* Tergites each with complete broad orange or partially red-brown band that broadens laterally (pattern similar to Fig. 9A, but not as dark). *Female terminalia:* Syntergosternite 7 length 2.91–3.70, 0.95–1.17 times as long as mesonotum. Aculeus length 2.66–3.05 mm; tip finely serrate apically, length 0.12–0.14 mm, width 0.02–0.04 mm.

Host plants.—This species has been reported from fruits of two species of *Sideroxylon* (Sapotaceae): *S. celastrinum* (Kunth) T.D. Pennington (Greene 1934, Phillips 1946, as *Bumelia angustifolia*), commonly known as coma (Cronquist 1945); and *S. lanuginosa* Michx. (Wasbauer 1972, as *Bumelia lanuginosa*; confirmed by examined specimen). McPhail and Berry (1936) and Baker et al. (1944) also reported *Bumelia spiniflora* A.DC., with the common name "la coma", as a host. I have been unable to trace this name in the botanical literature (Cronquist 1945, Anonymous 1982) and it probably is a misspelling of *spinosa* A.DC., a synonym of *celastrinum*. Both McPhail and Berry (1936) and Baker et al. (1944) reported that the larvae feed inside the single large seed within the fruit.

Remarks.—Coquillett (1904: 31) said the type depository would be the Brooklyn Institute of Arts and Sciences, but it was either never returned or was transferred back to the USNM when much of the Brooklyn collection was sent here.

Distribution.—USA (southern Texas) to Honduras and El Salvador. In Mexico, also reported from Coahuila, Guerrero, and Nayarit (Hernández-Ortíz 1992).

Specimens examined.—Holotype ♂ (USNM, No. 1353), USA: Texas: Brownsville, VI.[1903, C. Schaeffer]. Other specimens—EL SALVADOR: Central, T-9, 29.VII.1992, SS-2, 1♀ (López). GUATEMALA: Baja Verapaz: Salamá, Asgrow, 16.VIII.1992, 1♂ (López); same, 3.IX.1992, 1♀ (USNM). Escuintla: Palín, Granja Sta.

Maria Xalapan, 25.VI.1992, J. López, 1♀ (USNM); Finca Maria Santisima, 29.V.1992, J. López, 1♀ (López). HONDURAS: Tegucigalpa, 29.II.1918, F.J. Dyer, 1♂ (AMNH); Tegucigalpa, F.J. Dyer, 1♀ (USNM); Tegucigalpa, 3.V.1957, A.S. Banegas, 1♂1♀ (USNM). MEXICO: Chiapas: Mazapa de Madero, 23.V.1986, 1♂ (USNM); Tapachula, 27.IV.1984, E. Rios, 1♀ (USNM). Jalisco: Tomatlán, 11.IV.1990, S. Robles, 1♀ (IEXV). Nuevo Leon: Allende, II.1986, E. Pinson, 1♀ (IEXV); nr. Allende, Quebradora, 9.I.1997, D. Thomas, 1♀ (USNM). Oaxaca: Chahuites, IV.1984, J. Garcia, 1♂ (USNM). Sinaloa: Los Mochis, 15.III.1954, C.O. Peterson, 1♀ (USNM); Los Mochis, 12.IV.1954, C.O. Peterson, 1♂ (USNM); Los Mochis, 26.IV.1954, 1♂1♀ (USNM). Sonora: Guaymas, IV.1927, Aranjuel, 1♀ (USNM). Tamaulipas: Reynosa, 15.VIII.1988, B. Chávez, 1♀ (IEXV); 61.6 S Reynosa, Ebony, 19.II.1936, H.S. Hensley, 2♀ (USNM); 62.8 S Reynosa, Mesquite, 27.XI.1935, H.S. Hensley, 1♀ (USNM); Santa Engracia, C.C. Plummer, 4♂6♀ (USNM); Santa Engracia, McPhail trap in yellow chapote, 11.IX.1987, J.L. Leyva, 1♀ (TAMU). Veracruz: Apazapan, 29.V.1991, G. Quintero & L. Quiroz, 1♂1♀ (IEXV). U.S.A.: Texas: Brooks Co.: Falfurrias, 30.III.1935, L.R.D., 1♀ (USNM). Cameron Co., XII.1934, N.O. Berry, 7♂10♀ (USNM); San Benito, 28.III.1932, G.M. Douglas, 1♂1♀ (USNM); Victoria, "bred *Bumelia languin.* berry", 22.VIII.1907, J.D. Mitchell, 1♂ (USNM). Hidalgo Co.: Donna, "reared from J.W. Monk", 16.V.1932, C.T. Greene, 3♂1♀ (USNM); Donna, 21.VI.1932, J.W. Monk, 2♂2♀ (BMNH); Edinburg, 12.I.1937, D.H.A., 3♂ (USNM); 1 mi. S Mission, C.J. Volz, 1♂ (USNM); Pharr, 12.II.1934, N.P. Patton, 1♀ (USNM); Pharr, 7.I.1935, W.P.P., 1♂ (USNM); Weslaco, 10.II.1932, G.V.H., 1♂ (USNM); Weslaco, 9.III.1932, G.M. Douglas, 1♂ (USNM). Starr Co.: Rio Grande City, 30.V.1935, R.V. Ray, 1♀ (USNM). Webb Co.: Laredo, McPhail trap, 8.VII.1988, 2♂1♀ (USNM).

Anastrepha stonei Steyskal
(Figs. 1F, 6E, 8D–E, 9G–H)

Anastrepha stonei Steyskal 1977a: 79 [description], 1977b: 3 [key]; Norrbom 1985: 110 [taxonomy]; Norrbom and Kim 1988: 1 [classification].

Diagnosis.—This species differs from all other species of the *daciformis* group in having the dorsocentral pale stripe extended posteriorly from the transverse suture to beyond the dorsocentral seta; the scutum with numerous discrete dark brown spots or stripes; and the wing with 3–4 dark brown marginal spots and another on r-m.

Description.—Body predominantly yellow to orange. *Head:* Mostly yellow. Frons with ocellar tubercle and elongate triangular spots along eye margin brown, these spots not connected. Gena with large brown spot below eye. Posterior orbital seta absent. *Thorax* (Figs. 8D–E): Scutum with following dark brown areas: spot posterior to middle of postpronotal lobe; stripe, sometimes interrupted, between sublateral pale stripe and postsutural supra-alar and postalar setae; usually spot mesal to intra-alar seta; and usually an unpaired spot between acrostichal setae. Medial pale stripe expanded posteriorly and connected to dorsocentral stripe or narrow and isolated. Presutural dorsocentral pale stripe connected anteriorly to pale area on postpronotal lobe, connected to pale sublateral stripe at transverse suture, and extended posteriorly to dorsocentral seta. Presutural lateral pale stripe well differentiated, complete, including posterior part of notopleuron. Scutellum with pair of dark brown lateral spots or short bands between yellow basal and white apical areas, sometimes almost connected medially. Pleuron with following dark brown areas: two dorsal spots and usually one posteroventral spot on anepisternum; anterodorsal and posteromedial spots on katepisternum; medial spot on anepimeron; posterior half of katatergite and extreme posteroventral corner of anatergite; and spot on metapleuron. Subscutellum orange, often with medial dark brown spot; mediotergite entirely orange. Scutum nonmicrotrichose except lateral margin lateral to postsutural supra-alar seta; notopleuron and scutellum entirely nonmicrotrichose. *Wing* (Fig. 6E): Bands yellow, orange and brown; also with small discrete brown spots, usually 4 along costal margin and 1 at anterior end of r-m. C- and S-bands completely fused along costa, forming uninterrupted marginal band; cell R_1 without hyaline marginal area. C-band not covering most of cell r_{2+3} basal to level of r-m. S-band complete (Dominican Republic ♀) or interrupted in cell r_{2+3} and along vein Cu_1; basally with broad extension across vein Cu_2+A_1 to or almost to posterior wing margin; middle part extended anteriorly to vein R_{4+5} along r-m; subapically moderately broad, hyaline area in cell r_{2+3} extended almost to vein R_{2+3}; apically narrow or of medium breadth, extended to or usually well separated from apex of vein M. V-band complete, not connected to S-band along vein R_{4+5}. Vein M strongly curved apically; M ratio 1.27–1.40. *Abdomen* (Figs. 9G–H): Tergites white to yellow, with medial dark brown bands or rows of spots. *Female terminalia:* Syntergosternite 7 length 2.79–3.24 mm, 1.16–1.31 times as long as mesonotum. Aculeus length 2.56–2.77 mm; tip with a few fine apical serrations, length 0.12–0.15 mm, width 0.025–0.03 mm.

Remarks.—The single female from the Dominican Republic differs from typical specimens of *stonei* in having a complete S-band. Most of its terminalia were lost by prior dissection. The female from Florida may have been a stray from the Bahamas, as no additional specimens have been collected, despite continuous fruit fly trapping surveys in the state.

Distribution.—Bahamas, Hispaniola, and possibly southern Florida.

Specimens examined.—Holotype ♂ (USNM), BAHAMAS: New Providence, Nassau, IX.1976, C. Smith. Other specimens—BAHAMAS: 6.IX.1977, 1♂3♀ (USNM, FSCA). Abaco, Bahama Star Grove, 28.X.1993, D. Tollett, 1♀ (USNM); Bahama Star Grove, XII.1994, 1♂ (FSCA). Grand Bahama, Freeport, Parker Groves, McPhail trap in guava tree, 9.VI.1986, 1♀ (USNM); Freeport, Holmes Rock, McPhail trap in *Manilkara zapota,* 28.VIII.1986, 1♂ (USNM). New Providence: 3.VI.1977, C.W. Smith, 1♀ (USNM); 4.VI.1977, J. Gilbert, 2♂ (USNM); Fox Hill Creek, 20.V.1977, J. Gilbert, 1♂ (USNM); Nassau, McPhail trap in guava tree, 1.X.1976, J. Gilbert, 1♂ (USNM); Nassau, IX.1976, C. Smith, 1♂ paratype (USNM); Nassau, Ocean Paradise I. Resort, McPhail trap, 15.VIII.1997, 1♂ (USNM). DOMINICAN REPUBLIC: Santo Domingo Int'l. Airport, McPhail trap, 14.III.1991, D. Jimenez, 1♀ (USNM). USA: Florida: Palm Beach Co., Manalapan, Jackson trap in seagrape, 8.VIII.1988, D.M. Leone, 1♀ (USNM).

Anastrepha zucchii **Norrbom, new species**

(Figs. 5H, 8F, 9I)

Diagnosis.—This species differs from other species of the *macrura* complex (*aquila, avispa, bicolor* and *macrura*) as follows: Notopleuron entirely dark, and presutural lateral pale stripe reduced to a spot anterolateral to presutural supra-alar seta that is isolated from pale area on postpronotal lobe; presutural dorsocentral pale stripe absent; wing with broad, moderate brown stripe from cell bcu to apex of cell cu_1, not extended into cell dm; V-band completely absent, crossvein dm-cu without faint brown border; and dorsal brown mark on frons usually bilobed and narrowest medially. It further differs from *macrura* as follows: pale medial stripe on abdomen not expanded on apical half of syntergite 1+2, sometimes connected to transverse band on base of syntergite 1+2; tergites without narrow white lateral margins; occiput dark except anterior margin; and facial carina entirely yellow.

Description.—Body predominantly dark brown. *Head:* Yellow and brown. Frons with brown transverse dorsal band, usually bilobed anteriorly and narrowest in line with ocellar tubercle, orbital seta within band. Gena with large brown spot below eye. Occiput brown except anterior margin and narrowly dorsomedially. Posterior orbital seta absent. *Thorax* (Fig. 8F): Postpronotal lobe with anteromedial 1/5–2/5 brown. Medial pale stripe strongly bilobed posteriorly, lobes extremely slender, relatively short, not extended to dorsocentral seta. Presutural dorsocentral pale stripe absent. Presutural lateral pale stripe incomplete, on scutum reduced to spot isolated from postpronotal lobe, and absent from notopleuron. Pleuron brown except following yellow areas: narrow anteroventral area and posterodorsal third of anepisternum; two dorsal spots on katepisternum; katepimeron; anterior ⅔ of katatergite; and most of anatergite. Subscutellum and mediotergite entirely dark brown. Scutum without microtrichia medially, microtrichose only lateral to sublateral stripe and posterior to acrostichal seta; notopleuron microtrichose; scutellum microtrichose except basal area on side. *Wing* (Fig. 5H): C- and S-bands completely fused along costa to form broad, uninterrupted, moderate to dark brown marginal band; in cell br extended to vein M along cell bm; covering all of cells r_1 and r_{2+3} and anterior margin of cell r_{4+5}; well separated from apex of vein M. S-band incomplete, middle part between veins R_{4+5} and Cu_1 absent; basal part almost as dark as C-band; extended over base of cell cu_1 and broadly and distinctly along posterior side of vein Cu_1 to its apex; not extended into cell dm. V-band completely absent. Vein M strongly curved apically; M ratio 1.52–1.79. Cell r_1 microtrichose bordering cell bm, with large bare area in apical half. Cell bcu entirely microtrichose. *Abdomen* (Fig. 9I): Tergites, including base of syntergite 1+2 and lateral margins of all tergites, entirely dark brown except for narrow transverse white band near middle of syntergite 1+2 and narrow medial white stripe from syntergite 1+2 to tergite 5, these two marks sometimes connected to form a T-shaped mark. *Female terminalia:* Syntergosternite 7 length 4.62–5.28 mm, 1.46–1.57 times as long as mesonotum. Aculeus length 4.78 mm; tip finely serrate apically, length 0.10 mm, width 0.05 mm.

Remarks.—This species is named for Roberto A. Zucchi, in recognition of his contributions to *Anastrepha* systematics.

Distribution.—Brazil (Roraima).

Types.—Holotype: ♂ (INPA) BRAZIL: Roraima: Rio Uraricoera, Ilha de Maracá, armadilha de Malaise, 2–13.V.1987, J.A. Rafael, J.E.B. Brasil & L.S. Aquino. Paratypes. Same data as holotype, 4♂ (INPA) 2♂1♀ (USNM).

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A NEW SPECIES OF ARMORED SCALE (HEMIPTERA: COCCOIDEA: DIASPIDIDAE) PREVIOUSLY CONFUSED WITH *HEMIBERLESIA DIFFINIS* (NEWSTEAD)

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Abstract.—A new species of armored scale, ***Hemiberlesia neodiffinis*** **Miller and Davidson,** is described and illustrated. It occurs in the eastern and midwestern United States and parts of Mexico and has been reported as a pest of tulip poplar and lilac. It previously has been misidentified as *H. diffinis* (Newstead), which is a tropical species from the Caribbean Islands, Central America, South America, and Mexico. Lectotypes are designated for *Aspidiotus diffinis* Newstead, *A. jatrophae* Townsend and Cockerell, and *A. jatrophae* var. *parrotti* Newell. *Aspidiotus fabernii* Houser is transfered to *Quadraspidiotus* (**new combination**).

Key Words: Armored scale, Coccoidea, Diaspididae, pest, tulip poplar, lilac, *Liriodendron, Syringa*

We currently are working on a book on the ecomonic armored scales of the United States. While analyzing the morphological and biological characteristics of *Hemiberlesia diffinis* (Newstead), it became obvious that two distinct species were involved. *Hemiberlesia diffinis* is a tropical species that does not occur in the United States; a second undescribed species is strictly temperate in distribution, occurring in the eastern and midwestern United States and northern Mexico. Although Borchsenius (1966) lists three junior synonyms of *H. diffinis* (*Aspidiotus jatrophae* Townsend and Cockerell, *A. jatrophae* var. *parrotti* Newell, and *A. fabernii* Houser), none are conspecific with the new species. Therefore, a new name must be provided.

The objectives of this paper are: 1) to provide a description and illustration of the new species (*Hemiberlesia neodiffinis* Miller and Davidson), 2) to redescribe and illustrate *H. diffinis* and provide a comparison of the two species, 3) to clarify the status of the three junior synonyms listed by Borchsenius (1966), and 4) to draw attention to a possible third species from Ontario, Canada.

METHODS

Terminology in the descriptions follows McKenzie (1956) and Miller et al. (1984). Measurements and numbers are from 10 representative specimens and are given in parentheses followed by the range. Enlargments on illustrations are not proportional. Specimens were examined and illustrated using a Leica DMRB compound microscope using 10× eyepieces and 20× and 40× objectives. Depositories of specimens are: The Natural History Museum, London (BMNH); California Department of Food and Agriculture, Sacramento (CDA); Florida State Collection of Arthropods, Gainesville (FSCA); Muséum National d'Histoire Naturelle, Paris (MNHN); University of California, Davis (UCD); National Museum of Natural History, Beltsville, MD (USNM).

The authors have contributed equally to the research effort for this paper and should be considered coauthors.

RESULTS

Hemiberlesia neodiffinis Miller and Davidson, new species

(Fig. 1)

Previous citations: *Aspidiotus diffinis* Newstead; Marlatt, 1899:75, 1900:425–427; Ferris, 1921:125; Bibby, 1931:191; Couch, 1935:16, 1938:107; Westcott, 1973: 411.

Hemiberlesia diffinis (Newstead); MacGillivray, 1921:437; Ferris, 1938:238; Schmidt, 1940:193; Ferris, 1942:446; Kosztarab, 1964:34; Dekle, 1965:69, 1976:71; McDaniel, 1969:107; Tippins and Beshear, 1970:9; Beshear et al., 1973:6; Stoetzel and Davidson, 1974:501; Stoetzel, 1976; Lambdin and Watson, 1980:80; Miller and Howard, 1981:166; Mead, 1982:4; Nakahara, 1982:41; MacGowan, 1983:7; Mead, 1984: 2; MacGowan, 1987:9; Miller and Davidson, 1990:302.

Type data.—The adult female holotype is mounted with a paratype on a microscope slide; the right specimen on the slide is the holotype. The slide is labelled as follows: Left label "*Hemiberlesia/neodiffinis*/on Liriodendron/tulipifera/Simpson, Ill./Aug. 7, 1969/J. E. Appleby"; right label "*Hemiberlesia/neodiffinis*/Miller & Davidson/HOLOTYPE &/PARATYPE" and includes a map of the location of the holotype (USNM). In addition, there are 47 paratypes on 17 slides deposited in BMNH, CDA, FSCA, MNHN, UCD, USNM.

Slide-mounted characters.—Adult female (Fig. 1) with 3 pairs of definite lobes, fourth lobes, when present, represented by small sclerotized swellings; paraphysis formula usually 2-2-0, with paraphyses in space between lobe 2 and median lobe, attached to medial margin of lobe 2, medial margin of lobe 3, and in space between lobes 2 and 3. Median lobes separated by space 0.1–0.2(0.2) times width of median lobe, with small paraphysis attached to medial margin, without basal sclerotization or yoke, medial margin usually slightly converging apically, lateral margins converging, with 1 lateral notch and 0–1(0) medial notch; second lobes sclerotized, pointed, usually with lateral notch, about one-third to one-quarter size of median lobes; third lobes sclerotized, pointed, without notches, or with weakly indicated lateral notch, lobe equal to or smaller than second lobe. Plates between median lobes and second lobe, between second lobes and third lobes, and between third lobes and fourth lobes with increasingly larger tines, sometimes with 2 or more simple plates anterior of fourth lobes, plates in first and second spaces apparently without microducts; plates in third space distinctly shaped, each with 1 microduct, plates anterior of seta marking segment 5 with single microduct; plate formula 2-3-3; median lobes each with 2 slender plates between them about 0.8–1.1(1.1) times as long as median lobes. Macroducts of 1 size, on segments 5 to 7 in marginal and submarginal areas, duct between median lobes absent, with 10–15(12) macroducts on each side of pygidium on segments 5–8, some macroduct orifices anterior of anal opening. Pygidial microducts on venter in submarginal and marginal areas of segment 5 and 6, with 6–13(9) ducts; prepygidial ducts of 2 sizes, longer size in submarginal and marginal areas of segments 1 to 3, also present submedially near spiracles, shorter size present along body margin from segment 3 or 4 to head; pygidial ducts absent on dorsum; prepygidial microducts of 2 sizes, larger size in submedial areas of any or all of mesothorax to 4, smaller size in submarginal areas of head or prothorax to segments 2 or 3. Perivulvar pores absent. Pores

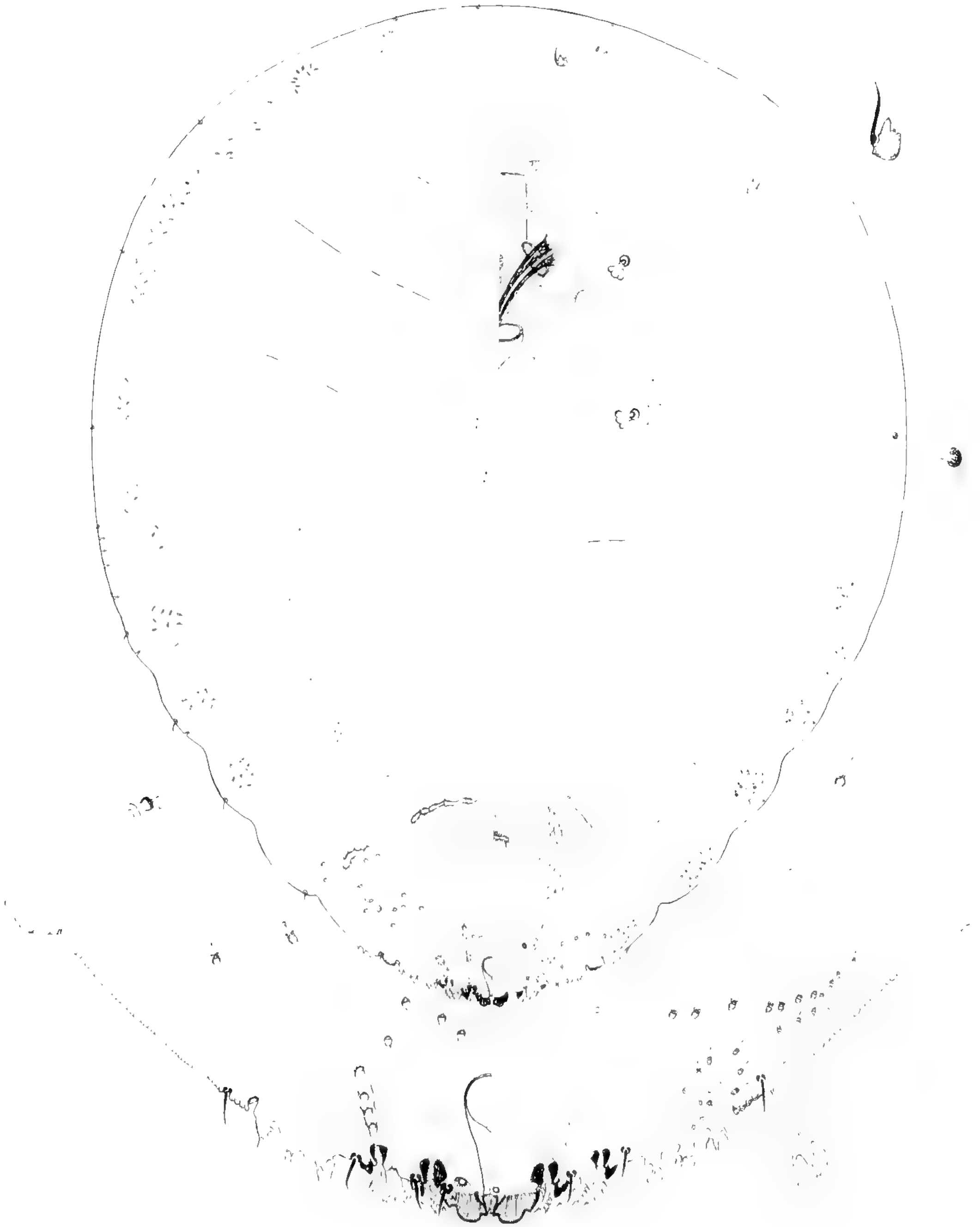

Fig. 1. Adult female holotype *Hemiberlesia neodiffinis*. Simpson, Illinois, August 7, 1969, on *Liriodendron tulipifera*, J. E. Appleby.

absent near spiracles. Anal opening located 1.1–1.6(1.3) times length of anal opening from base of median lobes, anal opening 17–30(23) μ long. Dorsal seta laterad of median lobes 1.0–1.4(1.2) times length of median lobe. Eyes usually represented by small sclerotized spur or dome on mesothorax. Antennae with 1 seta. Cicatrices usually present on prothorax and segment 1. Body pear shaped.

Specimens examined.—PARATYPES: USA—DISTRICT OF COLUMBIA: Southern Railway, IX-29-1929, no host, G. E. Murrell (3 ad ♀)USNM. FLORIDA: St. Petersburg, I-16-1964, *Persea* sp., E. W. Miller (1 ad ♀) FSCA. GEORGIA: Albany, I-25-1929, *Celtis* sp., J. B. Gill (3 ad ♀) CDA; No specific locality, IV-17-1987, *Carya illinoensis,* W. L. Tedders (3 ad ♀, 3 second-instar ♀) FSCA, USNM. ILLINOIS: Simpson, VIII-7-1969, *Liriodendron tulipifera,* J. E. Appleby (8 ad ♀) BMNH, MNHN, USNM. LOUISIANA: Baton Rouge, IV-14-1953, *Magnolia* sp., C. E. Smith (2 ad ♀) USNM. MISSISSIPPI: Pass Christian, IX-27-1922, *Ficus* sp., E. K. Bynum and K. Harnon (3 ad ♀) UCD. MISSOURI: Grayridge, Stoddard County, IX-3-1976, on "buttonbush," L. R. Hanning (1 ad ♀) USNM; Sikeston, City Park, VIII-11-1976, *Fraxinus* sp., L. R. Hanning (1 ad ♀) USNM. NEW JERSEY: Springfield, VII-26-1950, *Syringa* sp., S. W. Bromley (4 ad ♀) USNM. SOUTH CAROLINA: St. Helena's Island, III-21-1930, on "bay," J. H. Couch (5 ad ♀) USNM. TENNESSEE: McMinniville, V-18-1965, near Hammonton, *Liriodendron tulipifera,* B. Kemper (2 ad ♀) USNM. MEXICO—No locality, taken in quarantine at Nogales, VI-30-1960, *Spondias* sp., R. W. Beardmore (8 ad ♀) BMNH; no locality, taken in quaratine at Brownsville, XII-7-1954, *Persea* sp., "various collectors," (2 ad ♀) USNM.

Additional specimens examined.—(NOT PARATYPES) (All deposited in USNM unless otherwise indicated): USA—ALABAMA: Mobile, VII-13-1923, *Ficus* sp., J. S. Callaghan (1 ad ♀); Mobile, II-29-1932, *Ficus* sp., J. S. Callaghan (4 ad ♀); near Mobile, VI-21-1923, on "twig," A. E. Grontham (1 ad ♀, 1 second instar ♀). ARKANSAS: North Little Rock, VI-28-1930, host unknown, P. H. Millar (2 ad ♀). DISTRICT OF COLUMBIA: U.S. Department of Agriculture grounds, XI-4-1899 and V-12-1902, *Syringa* sp., C. L. Marlatt (5 ad ♀); U.S. Department of Agriculture grounds, V-17-1901, *Syringa* sp., Kotinsky (4 ad ♀); no locality, VII-6-1894, *Syringa* sp., Pergande (29 ad ♀, 3 scale covers); U.S. Department of Agriculture, no date, *Syringa* sp., no collector (5 ad ♀, 1 second ♀)(BMNH). FLORIDA: Tampa, 1920, host unknown, E. T. Spear (2 ad ♀). GEORGIA: Athens, X-20-41, *Ulmus americana,* B. S. Crandall (5 ad ♀); Fort Valley, IV-5-1921, *Nerium oleander,* O. I . Snapp (4 ad ♀); Macon, IV-17-1909, on "sugar berry," H. Burns (3 ad ♀); Savannah, X-31-1950, *Pterocarya steoptera,* N. Y. Gouldman (2 ad ♀); no locality, IV-17-1987, *Carya illinoensis,* W. L. Tedders (1 ad ♀, 3 second instar ♀). LOUISIANA: Alexandria, II-27-1909, *Phoradendron* sp., Tucker (2 ad ♀); New Orleans, Spanish Fort, III-9-1919, *Quercus* sp., E. R. Sasscer (3 ad ♀); New Orleans, IV-1921, *Cinnamomum camphora,* H. Morrison (3 ad ♀); New Orleans, VI-22-1933 and VI-23-1933, *Magnolia grandiflora, Salix* sp., and *Ulmus* sp., E. Latt (12 ad ♀). MARYLAND: College Park, III-16-1928, *Liriodendron tulipifera,* collector unknown (1 ad ♀, 1 second instar ♀). MISSISSIPPI: Baldwin Lodge, V-9-1925, *Ficus* sp., E. K. Bynum (1 ad ♀); Pass Christian, IV-4-1929, *Ficus* sp., E. K. Bynum and C. Lyle (2 ad ♀); Yazoo City, III-29-1929, *Syringa* sp., C. Hines (4 ad ♀). NEW YORK: Syracuse, V-1-1928, host unknown, A. H. MacAndrews (6 ad ♀). NORTH CAROLINA: Aberdeen, II-6-1904, on "shade tree," F. Sherman (6 ad ♀); Raleigh, VIII-10-1903, *Liriodendron* sp., F. Sherman (2 ad ♀); Raleigh, VIII-21-1903, on "shade tree," F. Sherman (8 ad ♀). OHIO: Clifton, VII-1956, *Tilia americana,* C. A. Reese (2 ad ♀); North Olmsted, VII-8-1942, *Syringa* sp., J. Houser (3 ad ♀). SOUTH CAROLINA: Columbia, V-21-1935, on *Juglans* sp., E. G. Seibels (2 ad ♀); St. Helena's Island, III-21-1930, on *Magnolia virginiana*, J. H. Couch (2 ad ♀). TENNESSEE: Greenbrier, VI-10-1908, *Syringa* sp., G. C. Dury (3 ad ♀). TEXAS: Houston, X-16-1917, *Ficus* sp., M. H. James, Jr. (2 ad ♀); Port Arthur, IV-12-1929, *Fraxinus Uhdei*, J. G. Sanders (4 ad ♀); San Antonio, X-8-1917, *Ficus* sp., M. H. James, Jr. (5 ad ♀); Sherman, VIII-11-1909, *Ulmus* sp., E. W. Mally (1 ad ♀). MEXICO—No locality, taken in quarantine at Brownsville, XI-12-1952, *Persea* sp., various collectors (1 ad ♀).

Hemiberlesia diffinis (Newstead)
(Fig. 2)

Aspidiotus affinis Newstead, 1893a:186 (junior homomym of *Aspidiotus affinis* Targioni Tozzetti, 1868:736).

Aspidiotus diffinis Newstead, 1893b:281 (replacement name for *Aspidioutus affinis* Newstead).

Aspidiotus (*Diaspidiotus*) *diffinis* Newstead; Cockerell, 1897:23.

Hemiberlesia diffinis (Newstead); Leonardi, 1898:119.

Aspidiotus jatrophae Townsend and Cockerell, 1898:178 (synonymized by Marlatt, 1900:425).

Aspidiotus jatrophae var. *parrotti* Newell, 1899:23 (synonymized by Marlatt, 1900: 425).

Hemiberlesia iatrophae (Townsend and Cockerell); Leonardi, 1900:339 (misspelling).

Aspidiotus diffinis parrotti (Newell); Fernald, 1903:258.

Hemiberlesia diffinis parrotti (Newell); MacGillivray, 1921:438.

Abgrallaspis diffinis (Newstead); Komosinska, 1969:60.

Borchsenius (1966) treated *Aspidiotus fabernii* Houser as a synonym of *Hemiberlesia diffinis;* we have examined type material of the former and find it to be a distinct species that is tentatively placed in *Quadraspidiotus* (**new combination**).

Type data.—We have examined the type series of *Aspidiotus diffinis* Newstead and here designate as lectotype the left specimen in the middle row which is an adult female mounted on a slide with 10 other specimens and labelled as follows: left label "No 129/13.iv, p. 119/R. Newstead"; right label "Aspidiotus/diffinis Newst./cotype ♀♀/Demerara./BM 1945, 121"; a separate label is on the back of the slide giving the position of the lectotype with the following designation "LECTOTYPE/PARALECTOTYPE." (BMNH). In addition, there are 5 slides containing 16 specimens that were part of the original series from Demerara but were mounted subsequently and were not used by Newstead for the original description (USNM). We have examined the type series of *Aspidiotus jatrophae* Townsend and Cockerell, and here designate as lectotype the right specimen which is an adult female mounted on a slide with 2 other adult females and labelled as follows: left label "7682: *Aspidiotus*/(*jatrophae* T.&C. Type)/*diffinis* Newst./On *Jatropha*/Frontera, Mex./(Twns.)/Ckll. Coll."; right label "*Aspidiotus jatrophae*/Townsend & Cockerell/ LECTOTYPE &/PARALECTOTYPE/" and provides a map of the position of the lectotype. In addition, there are 18 adult female paralectotypes and 7 second-instar exuviae paralectotypes on 2 additional slides in USNM and 2 adult females plus pieces of adults and several immatures on 1 slide in BMNH. There is a long series of specimens collected by Townsend and/or Koebele on *Jatropha* at several different localities during the same expedition to Mexico, but these have different Division of Entomology lot numbers and were not mentioned in the original description. We have examined the type series of *Aspidiotus jatrophae* var. *parrotti* Newell, and here designate as lectotype the left specimen which is an adult female mounted on a slide with 5 other adult females and labelled as fol-

Fig. 2. Adult female *Hemiberlesia diffinis*. Mazatlan, Mexico, July 26, 1979, on *Prunus domestica*, S. Ryan.

lows: left label "*Aspidiotus diffinis/parrotti* Newell/Type/ On "Barenjeno chiquito"/ Frontera, Mex./(Townsend)/June 9, 1897/ Ckll. Coll."; right label "*Aspidiotus jatrophae*/var. *parrotti* Newell/LECTOTYPE &/PARALECTOTYPE/"and provides a map of the position of the lectotype. In addition, there are 10 adult female paralectotypes on 4 additional slides in USNM and 4 adult females and 2 second-instar female on 1 slide in BMNH.

Slide-mounted characters.—Adult female (Fig. 2) with 3 pairs of definite lobes, fourth lobes, when present, represented by small sclerotized swelling; paraphysis formula usually 2-2-0, rarely 2-2-1, with paraphyses in space between lobe 2 and median lobe, attached to medial margin of lobe 2, medial margin of lobe 3, and in space between lobes 2 and 3. Median lobes separated by space 0.1–0.2(0.1) times width of median lobe, with or without small paraphysis attached to medial margin, without basal sclerotization or yoke, medial margin usually slightly converging apically, lateral margins strongly converging, with 1 lateral notch and 0–1(0) medial notch; second lobes sclerotized, pointed, with lateral notch, about one-third to one-quarter size of median lobes; third lobes sclerotized, pointed, without notches, equal to or slightly smaller than second lobes. Plates between median lobes and second lobe, between second lobes and third lobes, and between third lobes and fourth lobes with increasingly larger tines, sometimes with 3 or more simple plates anterior of fourth lobes, plates in first and second spaces apparently without microducts; plates in third space distinctly shaped, each with 2 or 3 large microducts, plates anterior of seta marking segment 5 with 2 or 3 microducts; plate formula 2-3-3; median lobes each with 2 slender plates between them about 0.8–1.1(1.1) times as long as median lobes. Macroducts of 1 size, on segments 5 to 7 in marginal and submarginal areas, duct between median lobes extending 1.9–3.7(2.4) times distance between posterior apex of anal opening and base of median lobes, 26–32(28) μ long, with 11–18(15) macroducts on each side of pygidium on segments 5–8, some macroduct orifices anterior of anal opening. Pygidial microducts on venter in submarginal and marginal areas of segment 5 and 6, with 5–14(10) ducts; prepygidial ducts of 2 sizes, longer size in submarginal and marginal areas of segments 1 to 3, also present submedially near spiracles, shorter size present along body margin from from segment 3 or 4 to head; on dorsum pygidial ducts absent; prepygidial microducts of 2 sizes, larger size in submedial areas of any or all of mesothorax to 4, smaller size in submarginal areas of head or prothorax to segments 2 or 3. Perivulvar pores absent. Pores absent near spiracles. Anal opening located 0.8–1.5(1.2) times length of anal opening from base of median lobes, anal opening 26–32(28) μ long. Dorsal seta laterad of median lobes 0.9–1.4(1.1) times length of median lobe. Eyes rarely absent, usually represented by small sclerotized spur or dome, on mesothorax. Antennae with 1 seta. Cicatrices usually present on prothorax and segment 1. Body pear shaped. Sometimes with sclerotization on thorax and head.

Specimens examined.—We have seen specimens from the following host genera: *Annona, Cocos, Couroupita, Bursera, Cassia, Dracaena, Drepanocarpus, Erythrina, Hevea, Hibiscus, Jatropha, Mammea, Manihot, Oncidium, Persea, Philodendron, Plumeria, Prunus, Psidium, Punica, Spondias,* and *Theobroma.*

We have examined specimens from the following countries: Brazil, Colombia, Costa Rica, Curaçao, Dominica, Ecuador, El Salvador, Guatemala, Guyana, Jamaica, Mexico, Nicaragua, Panama, and Peru.

DISCUSSION

Hemiberlesia diffinis differs from *H. neodiffinis* by having 3 unusually large plates in the third space which each have 2 or 3 associated microducts and by having a macroduct between the median lobes. *Hemiberlesia neodiffinis* has 3 smaller plates in the third space which each have 1 associated microduct and lacks a macroduct between the median lobes.

We have studied several collections of a species similar to *Hemiberlesia neodiffinis* on *Tilia* from Ontario, Canada. It differs by usually having a macroduct between the median lobes and by having at least 2 lateral notches on each median lobe. We have not described this species because we have insufficient material and have been unable to evaluate variation in critical characters. Jarvis (1911) quoted King as suggesting that "Mr. King thinks this species may prove to be a variety of A. diffinis." Lindinger (1932) agreed with King and called the Canadian population *Aspidiotus diffinis* var. King. The species also has been discussed by King (1901, 1902), Fletcher and Gibson (1908), and Gibson (1911).

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ADHEMARIUS DONYSA (DRUCE): IDENTIFICATION AND NOTES ON CLOSELY RELATED SPECIES (LEPIDOPTERA: SPHINGIDAE)

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Abstract.—Four closely related species of *Adhemarius*, occurring in southern Texas, Mexico, and Central America, have been cited as "*donysa*" in the literature. Using distinguishing characters and accompanying illustrations, we clarify this confusion.

Key Words: *Adhemarius dariensis, A. blanchardorum, A. globifer,* male genitalia

Adhemarius Oiticica, 1939, was shown by Fletcher and Nye (1982: 4, 10) to be the valid generic name for a group of species formerly placed in *Amplypterus* Hübner, 1819. *Adhemarius* is a New World genus of which six species occur in North and Central America: *Adhemarius blanchardorum* (Hodges), *A. dariensis* (Rothschild and Jordan), *A. donysa* (Druce), *A. gannascus* (Stoll, *in* Cramer), *A. globifer* (Dyar), and *A. ypsilon* (Rothschild and Jordan). *Adhemarius gannascus* and *ypsilon* are widely distributed in the Neotropics, easy to separate from the other four, and will not further be considered in this paper. The most recent treatment of *Adhemarius* (D'Abrera 1987) ignores *blanchardorum*, synonymizes *globifer* with *donysa* (with a question mark), and lists *dariensis* as valid, while conjecturing that it is a junior synonym of *donysa*.

TAXONOMIC TREATMENT

Adhemarius donysa (Druce)
(Figs. 1, 2, 15, 16)

Ambulyx donysa Druce 1889: 78.

Adhemarius donysa (Figs. 1, 2) appears to be restricted to a relatively small area on the Atlantic slope of central Mexico, comprising parts of the states of Hidalgo, Veracruz, and Oaxaca. Of the few specimens in collections, those with precise data have been collected at high elevations (1800 m and above).

Adhemarius donysa was described by Druce, apparently from a single male specimen collected at Cuesta de Misantla, Mexico by M. Trujillo. This specimen is in The Natural History Museum, London (subsequently referred to as BMNH), and was illustrated by D'Abrera (1987: [53]) as *A. donysa.* He inadvertently designated a lectotype (1987: 52) when he cited this syntype as the "holotype." It bears the following labels: 1) a round printed label with a purple circular margin: "Lecto-/type"; 2) a rectangular printed label: "Cuesta de-/Misantla,/Mexico./M. Trujillo"; 3) a rectangular handwritten label: "*Ambulyx/donysa*/Type Druce"; 4) a rectangular label with a black border at the top margin, two printed lines: "B.C.A. Lep. Het./Ambulyx" and two handwritten lines: "*donysa*/Druce"; 5) a rectangular printed label: "Presented by/J.J.Joicey Esq./Brit. Mus. 1931-444"; a rectangular printed label: "figured by Bernard/D'Abrera, 1986, in/*Sphingidae Mundi.*"

In the original description, Druce (1889) stated that this new species would be illustrated in a forthcoming part of the *Biologia Centrali-Americana.* However, the specimen he later chose to illustrate in that work (1896: 3, pl. 66, fig. 7) belongs to another species, *A. dariensis.* Druce's misidentification of his own species has contributed considerably to the confusion in this group. In particular, Rothschild and Jordan (1903) followed Druce's later, incorrect treatment, and subsequent authors have done the same.

When Druce discussed *donysa* in the *Biologia* (1896: 309–310), he cited specimens from Mexico: Cuesta de Misantla, Jalapa, and Orizaba; Guatemala: Guatemala City; and Panama: Chiriquí. About the specimen from Orizaba he writes: "... [it] is very much darker than any of the others before me, and on the underside it is reddish brown instead of yellow. It may belong to another species." This specimen is in the BMNH and is *donysa.* Thus, Druce had conjectured that two taxa were involved but failed to recognize that he had already described the "other species."

A few years ago, one of us (JMC), while visiting the BMNH, noted the incorrect placement of two taxa under *donysa* and made notes to that effect on the drawer's glass top. These notes apparently caused D'Abrera (1987: 52) to treat *dariensis* as a separate species from *donysa,* without recognizing that this was a new status for *dariensis,* previously considered to be a subspecies of *donysa.* Bridges (1993) follows this treatment. However, D'Abrera apparently does not believe his own action because he writes about *dariensis:* "This taxon is probably a junior synonym of *A. donysa* Druce."

The female of *donysa* is illustrated and described here for the first time (Fig. 2). We have seen only one example. It is very similar to the male, only slightly larger. The median line on the forewing upper side is straighter than in the male, reaching the inner margin nearer the tornus. The forewing upper side is darker than in the male. The dark pattern on the hindwing upper side is much reduced with respect to that in the male. This is consistent with the sexual dimorphism present in the other species of the complex.

Adhemarius dariensis (Rothschild and Jordan), **revised status**
(Figs. 3, 4, 11, 12)

Ambulyx donysa: Druce 1896, 2: 309–310 (in part); 3: pl. 66, fig. 7.

Amplypterus donysa: Rothschild and Jordan 1903: 185.

Amplypterus donysa dariensis Rothschild and Jordan 1916: 253, 254.

Amplypterus donysa: Hodges 1985: 323–328.

Adhemarius donysa dariensis: Carcasson and Heppner, 1996: 51.

Adhemarius dariensis (Figs. 3, 4) is much more widespread than *donysa.* Its known range, which includes that of *donysa,* is from San Luis Potosí to Chiapas in Mexico and south through Central America to Panama (Chiriquí). The two species are sympatric although *dariensis* generally appears to occur at lower elevations than does *donysa.* Specimens from Veracruz and farther north tend to have more elongate forewings, with a narrower apex, than do specimens from Chiapas and farther south and east. These and other differences led Rothschild and Jordan (1916) to separate the Costa Rican and Panamanian population from the Mexican population at their disposal, the latter of which they believed was referable to *donysa.* Having examined a considerable number of specimens belonging to the entire geographic range and dissected specimens at the extreme ends of the pattern variation, we have not found clear characters to subdivide this taxon.

In their description of *dariensis,* Rothschild and Jordan mention they have four males, three from Costa Rica and one from Chiriquí, and indicate the type to be from Sitio, Costa Rica. D'Abrera (1987: 52) again inadvertently designated a lectotype

Figs. 1–6. Habitus of *Adhemarius* species. 1–2, *A. donysa*. 1, Male, Mexico, Hidalgo, Highway 130, 4 mi W Hidalgo/Puebla state line, La Cabaña, ca 2100 m, 4 July 1987; left forewing length (LFWL) = 53 mm. 2, Female, Mexico, Oaxaca, Sierra Juarez, Gulf Slope, ca 1800 m, 19 August 1991, at MV light; LFWL = 55 mm. 3–4, *A. dariensis*. 3, Male, Mexico, Jalapa; LFWL = 51 mm. 4, Female, Mexico, Jalapa; LFWL = 58 mm. 5–6, *A. blanchardorum*. 5, Male, USA, Texas, Brewster County, Chisos Mts., Panther Pass, 1830 m, 4

Figs. 7–8. Habitus of *Adhemarius globifer.* 7, Male, Mexico, Mineras de Zacualpan [near Mexico City], August 1910, R. Müller; LFWL = 56 mm. 8, Female, Mexico, D. F., Zacualpan, leg. R. Müller [coll. CMNH]; LFWL = 59 mm.

when he cited a syntype as the "holotype." The lectotype of *dariensis* bears the following labels: 1) a round printed label with a purple circular margin: "Lecto-/type"; 2) a rectangular printed label: "Sitio/CR"; 3) a rectangular printed label: "June"; 4) a rectangular handwritten label: "*A. donysa/dariensis*/Type. R & J./Nov. Zool. 1916"; 5) a rectangular printed label: "Rothschild/Bequest/B.M.1939-1". This specimen is illustrated in D'Abrera (1986: [53]) as *A. dariensis.* We recognize two paralectotypes: the other male in the BMNH from Sitio, Costa Rica, which bears the following labels: 1) a round printed label with a turquoise circular margin: "Para-/lecto-/type"; 2) a rectangular printed label: "Sitio; CR"; 3) a rectangular printed label: "June"; 4) a rectangular handwritten label: "*A. donysa*"; 5) a rectangular printed label: "Rothschild; Bequest; B.M.1939-1" and the male in the BMNH from Chiriquí, Vulkan (Trötsch) also with a Rothschild Bequest label. We cannot identify the fourth syntype with certainty. There are two males from Costa Rica in the BMNH collection that were collected before 1916, one from Juan Vinas, 2500′ (= 762 m) (W. Schaus) 1913-50, and one from Cachi, 30-xi-1910 (Lankester), either of which could have been the third Costa Rican male referred to in the original description.

Adhemarius globifer (Dyar), **revised status**

(Figs. 7, 8, 13, 14)

Amplypterus globifer Dyar 1912: 45.
Adhemarius donysa: D'Abrera 1987: 52.
Adhemarius donysa: Bridges 1993: VIII.1.

Adhemarius globifer (Figs. 7, 8) appears to occur in Central Mexico (D.F.: Zacualpán, type locality), Morelos, Tamaulipas, Nuevo León, Chihuahua, and Sonora. Apparently a highland desert species, it does not seem to be sympatric with any of the other three species in the group. Few specimens are known, and our knowledge of its distribution is incomplete. Recent observations in Sonora indicate that the species oc-

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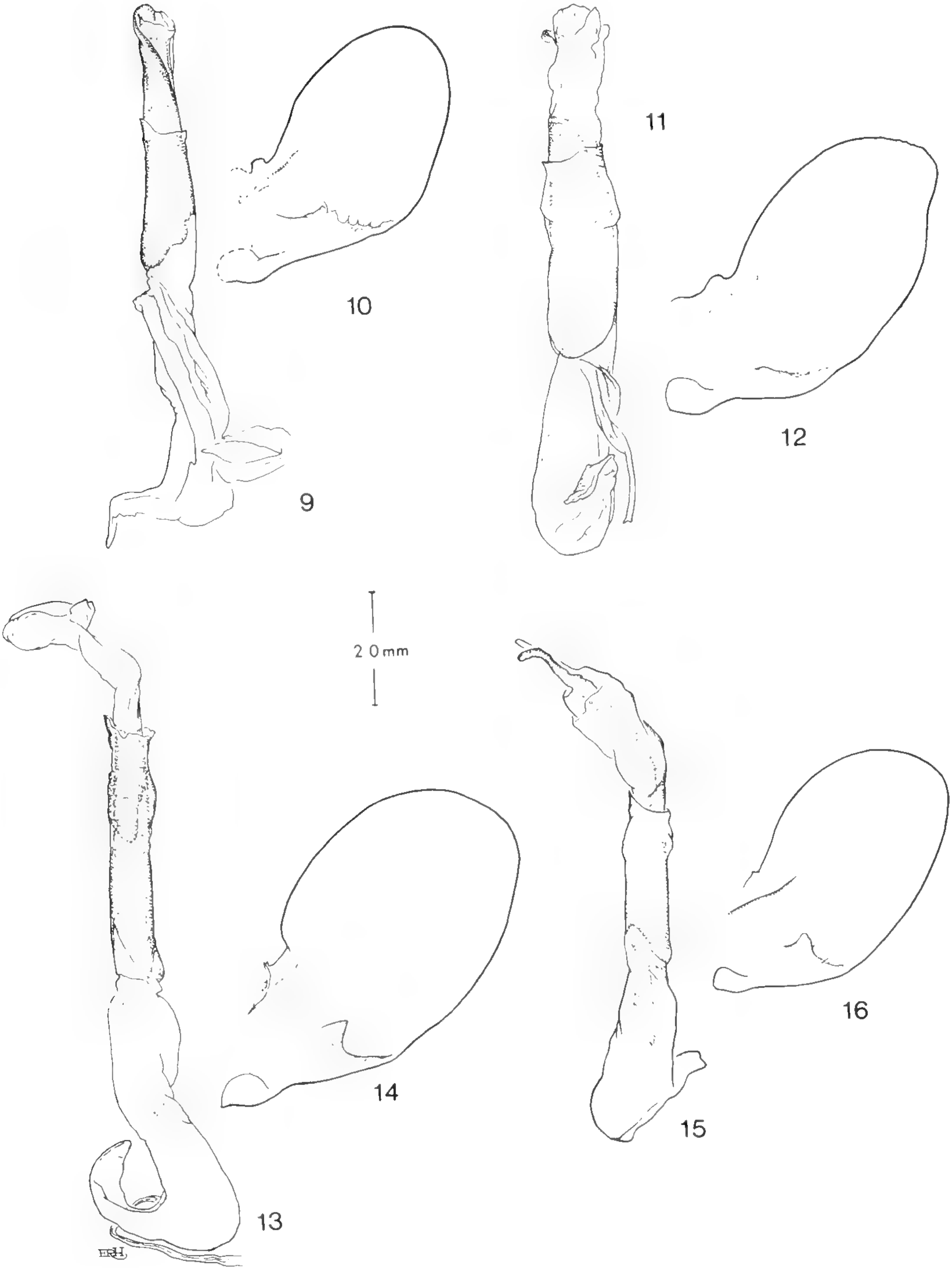
←

June 1973, R. W. Hodges; LFWL = 47 mm. 6, Female, USA, Texas, Big Bend National Park, Green Gulch, 6 May 1972, A. and M. E. Blanchard; LFWL = 53 mm.



Figs. 9–16. Male genitalia of *Adhemarius* species. 9–10, *A. blanchardorum*, USNM genitalia slide 12181. 9, Aedeagus. 10, Right valva. 11–12, *A. dariensis*, USNM genitalia slide 12183. 11, Aedeagus. 12, Right valva. 13–14, *A. globifer*, USNM genitalia slide 12185. 13, Aedeagus. 14, Right valva. 15–16, *A. donysa*, SAB genitalia slide 385. 15, Aedeagus. 16, Right valva.

curs in the oak zone at elevations between 1500 m and 2100 m.

The female was described by Clark (1923: 50). Contrary to the statement made by D'Abrera (1987: 52), the female of *globifer* differs substantially from those of both *donysa* and *dariensis,* in fact, more so than males do (cf. Figs. 3, 7 and the section on distinguishing characters), which confirms the validity of this taxon, rather than ". . . throwing further doubt on it." Furthermore, *globifer* is a paler species than either *donysa* or *dariensis,* not darker.

Adhemarius blanchardorum (Hodges) (Figs. 5, 6, 9, 10)

Amplypterus donysa: Blanchard 1973: 103.
Amplypterus blanchardorum Hodges 1985: 323.
Adhemarius blanchardorum: Carcasson and Heppner 1996: 53.

Adhemarius blanchardorum (Figs. 5, 6) appears to be restricted to the Chisos Mountains in Texas, from which very few specimens are known.

DISTINGUISHING CHARACTERS

Males of *Adhemarius donysa* can be separated from the other three species by the following characters: 1) broader wings, in particular forewing apex much less produced; and 2) median line of the forewing upper side much less oblique. A further feature separating *donysa* from *dariensis* is the medial line on the hindwing underside: straight in *donysa,* rather than curved basad when reaching the costal margin as it is in *dariensis. Adhemarius donysa* shares with *dariensis* the following characters, which separate both of them from *globifer* and *blanchardorum:* 1) discocellular vein well outlined on both sides of the forewing; and 2) antemarginal black pattern on the hindwing upper side well marked and extending distad along the veins, almost reaching the posterior margin. *Adhemarius globifer* and *blanchardorum* can be separated by the shape of the dark submarginal area of the forewing upper side. In *globifer* that area is globally convex with maximal width at M_2 and not sharply delimited basally, merging smoothly into the wing pattern. In *blanchardorum* that area is sharply delimited basally, generally narrower than in *globifer,* indented distally at M_2 and at M_3, i.e. convex between the veins, and its maximal width occurs between M_1 and M_2. In addition the ground color of the forewings is greener than the distinctly yellowish green of *globifer.*

The costal margin of the valva of *globifer* is straight at the base followed by a sharp angle, then broadly rounded to the apex (Fig. 14); the costal margin of *blanchardorum, dariensis,* and *donysa* lacks the straight segment at the base and is not as broadly rounded to the apex. The saccular fold is very poorly developed in *dariensis* (Fig. 12), well developed in the others. In *globifer* it is smooth margined and lacks setae except at the posterior part (Fig. 14), whereas in *donysa* it has a well-developed extension at ¼–⅕ its length, is nearly smooth, and has a few, short setae (Fig. 16). That of *blanchardorum* has an irregular margin with a few, short setae (Fig. 10). The apex of the aedeagus has a slender, curved extension in *blanchardorum, donysa,* and *globifer* that is lacking in *dariensis.*

Females of *donysa* can be separated from the other three species by the same external characters that separate the males. The female of *dariensis* can be separated from those of *globifer* and *blanchardorum* by the well-marked antemarginal black pattern on the hindwing upper side, extending distad along the veins. Also, the outer margin of the forewing in females of *globifer* and *blanchardorum* is crenulated near the tornus, which is not the case in *donysa* or *dariensis.* The female of *blanchardorum* differs externally from that of *globifer* in the shape of the submarginal dark area of the forewing upper side in the same way as the male does and by the color as indicated above.

The female genitalia of *blanchardorum*

and *dariensis* have been illustrated (Hodges 1985: figs. 13–16). Those of *donysa* and *globifer* have not.

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FIRST REPORT OF THE GENUS *SIPHLAENIGMA* PENNIKET AND THE FAMILY SIPHLAENIGMATIDAE (EPHEMEROPTERA) FROM AUSTRALIA

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Abstract.—***Siphlaenigma edmundsi,* new species,** is described from larvae from New South Wales, Australia. The species is distinguished from *S. janae* by its relatively small size, elongate and subconical maxillary palp segment 3, apicomedially broadly rounded labial palp segment 2 and subconical segment 3, poorly tracheated gills, and simple abdominal coloration. This is the first report of Siphlaenigmatidae outside of New Zealand. Based on the new distribution, *Siphlaenigma* may be at least 80 million years old and has evolved very little during that period.

Key Words: *Siphlaenigma,* Siphlaenigmatidae, Australia

Penniket (1962) proposed the mayfly family Siphlaenigmatidae for the New Zealand species *Siphlaenigma janae* Penniket. His basis for Siphlaenigmatidae was that, although larvae of *S. janae* were generally similar to those of Siphlonuridae s.l. and Baetidae, its adults did not fit the concepts of either family. Edmunds et al. (1963), Demoulin (1968), and Edmunds (1972, 1973) agreed with Penniket's (1962) placement of *S. janae* in a separate family. Riek (1973), McCafferty and Edmunds (1979), and Landa and Soldán (1985), however, considered *S. janae* to represent a subfamily within Baetidae. Later, McCafferty (1991) assigned family status to *Siphlaenigma* Penniket following strict cladistic criteria.

Diagnosis of larvae of Siphlaenigmatidae remained somewhat problematic because no consistent characters had been found to distinguish it from all Baetidae. Recently, however, Wang and McCafferty (1996) discovered two diagnostic characters in the larval stage that clearly distinguish Baetidae from Siphlaenigmatidae and other families. In baetids, the initial lateral branches of the epicranial suture are located anterior to (below) the lateral ocelli (Wang and McCafferty 1996: Figs. 1–6), and the femoral apices have a ventrally oriented dorsal lobe (Wang and McCafferty 1996: Figs. 13–16). In siphlaenigmatids, however, the initial lateral branches of the epicranial suture are near the posterior edge of the lateral ocelli (Wang and McCafferty 1996: Fig. 7), and the femoral apices lack the ventrally oriented lobe (Fig. 7). The adults of Siphlaenigmatidae differ from adults of Baetidae in having four-segmented mid- and hindtarsi (Penniket 1962: Figs. 7, 8), basally united IMA and MA_2 veins in the forewing (Penniket 1962: Fig. 1), hindwing with multiple longitudinal veins (Penniket 1962: Fig. 1), reduced but sclerotized penes (Penniket 1962: Fig. 3), and genital forceps with a long segment 1 and short, subequal segments 2 and 3 (Penniket 1962: Fig. 4). The absence of turbinate eyes in male adults of Siphlaenigmatidae also distinguishes it from almost all Baetidae; however, the South American baetid genus *Aturbina* Lugo-Ortiz and McCafferty was found atypically to have lost the turbinate eyes (Lugo-Ortiz and McCafferty 1996: Fig. 12).

Since Penniket's (1962) work, Siphlaenigmatidae has been considered monotypic and endemic to New Zealand. While studying specimens from Australia recently donated to us by George F. Edmunds, we discovered that he collected *Siphlaenigma* larvae in New South Wales over 30 years ago. The material had been initially sorted out with Australian Baetidae and thus has remained unrecognized until now. This is an important discovery particularly in terms of biogeography because most other pisciform mayflies known from Australia show classical Amphinotic patterns with closely related genera in New Zealand, Australia, and Chile/Patagonia.

Baetids are very poorly known in Australia, with many species as well as genera having remained unstudied and undescribed. Much of the materials from Australia that we have seen are simply identified as Baetidae sp., as was, for example, the *Siphlaenigma* we report here. Given the fact that Siphlaenigmatidae larvae superficially resemble Baetidae (see discussion above) and that they also are behaviorally similar when seen and taken in the field (G. F. Edmunds, pers. comm.), it was not surprising to us when we found *Siphlaenigma* in Australian collections or that the taxon has been historically unrecognized by entomologists. This discovery is no more surprising, for example, than our recent discovery from Australia of the baetid genus *Cloeodes* Traver (Lugo-Ortiz and McCafferty 1998) and other baetid genera known from other parts of the world that have historically gone unrecognized in Australia. Finally, any doubt that the *Siphlaenigma* we report actually come from Australia, can be quelled by the facts that (1) the new species of *Siphlaenigma* is very distinct from the well-known New Zealand species, and (2) Edmunds (pers. comm.) filled out his locale labels in the field. We expect that re-examination of materials of Australian "Baetidae" in other collections, in light of this report and new studies on Australian Baetidae, will lead to the discovery of additional specimens of *Siphlaenigma.*

The materials described and compared below are housed in the Purdue Entomological Research Collection, except where noted.

Siphlaenigma edmundsi Lugo-Ortiz and McCafferty, new species

(Figs. 1–10)

Larva.—Body length: 5.9–6.2 mm; caudal filaments length: 2.1–2.5 mm. *Head:* Coloration pale yellow-brown, with no distinct pattern. Labrum (Fig. 1) with submedial pair of long, fine, simple setae and anterior submarginal row of two to three long, fine, simple setae. Hypopharynx as in Fig. 2. Left mandible (Fig. 3) with outer set of incisors with four denticles, inner set with three denticles; prostheca medially with long, fine, simple setae. Right mandible (Fig. 4) with outer set of incisors with four denticles, inner set with three denticles; prostheca medially with long, fine, simple setae. Maxilla (Fig. 5) with single row of six to eight relatively long, fine, simple setae near medial hump; palp extending beyond galealacinia; palps three segmented; palp segment 1 approximately 0.80× length of segments 2 and 3 combined; segment 3 relatively long and subconical. Labium (Fig. 6) with glossa subequal in length to paraglossa; glossa bare; paraglossa with abundant short, fine, simple setae laterally and medially; palp three segmented; palp segment 1 as long as segments 2 and 3 combined, with scattered relatively robust, apically pointed, simple setae laterally; palp segment 2 with abundant long, fine, simple setae laterally and medially, and long, relatively robust, apically pointed simple setae distomedially; palp segment 3 subconical and relatively long. *Thorax:* Coloration pale yellow-brown, with no distinct pattern. Legs (Fig. 7) pale yellow-brown; femora with row of relatively short, fine, apically pointed, simple setae dorsally and ventrally, and short, fine, apically pointed, simple setae scattered over surface; tibiae with row of relatively short, fine, apically pointed, simple setae dorsally and ventrally, and short, fine, apically pointed, simple setae scattered over surface; tarsi with row of relatively short, fine, apically pointed, simple setae dorsally and ventrally, and short, fine, apically pointed, simple setae scattered over surface; tarsal claws (Fig. 8) with two rows of 14–16 minute, apically pointed, slender denticles. *Abdomen:* Coloration pale yellow-brown, with no distinct pattern; terga 1 and 10 uniformly pale yellow-brown; terga 2–9 uniformly pale yellow-brown, with submedial anterior medium brown subtriangular markings. Tergal surfaces (Fig. 9) creased. Sterna pale yellow-brown. Gills 1–7 (Fig. 10) narrow, poorly tracheated, approximately 1.25× length of corresponding segments. Paraprocts without marginal spines. Caudal filaments pale yellow-brown to cream, with relatively broad medium brown band near middle.

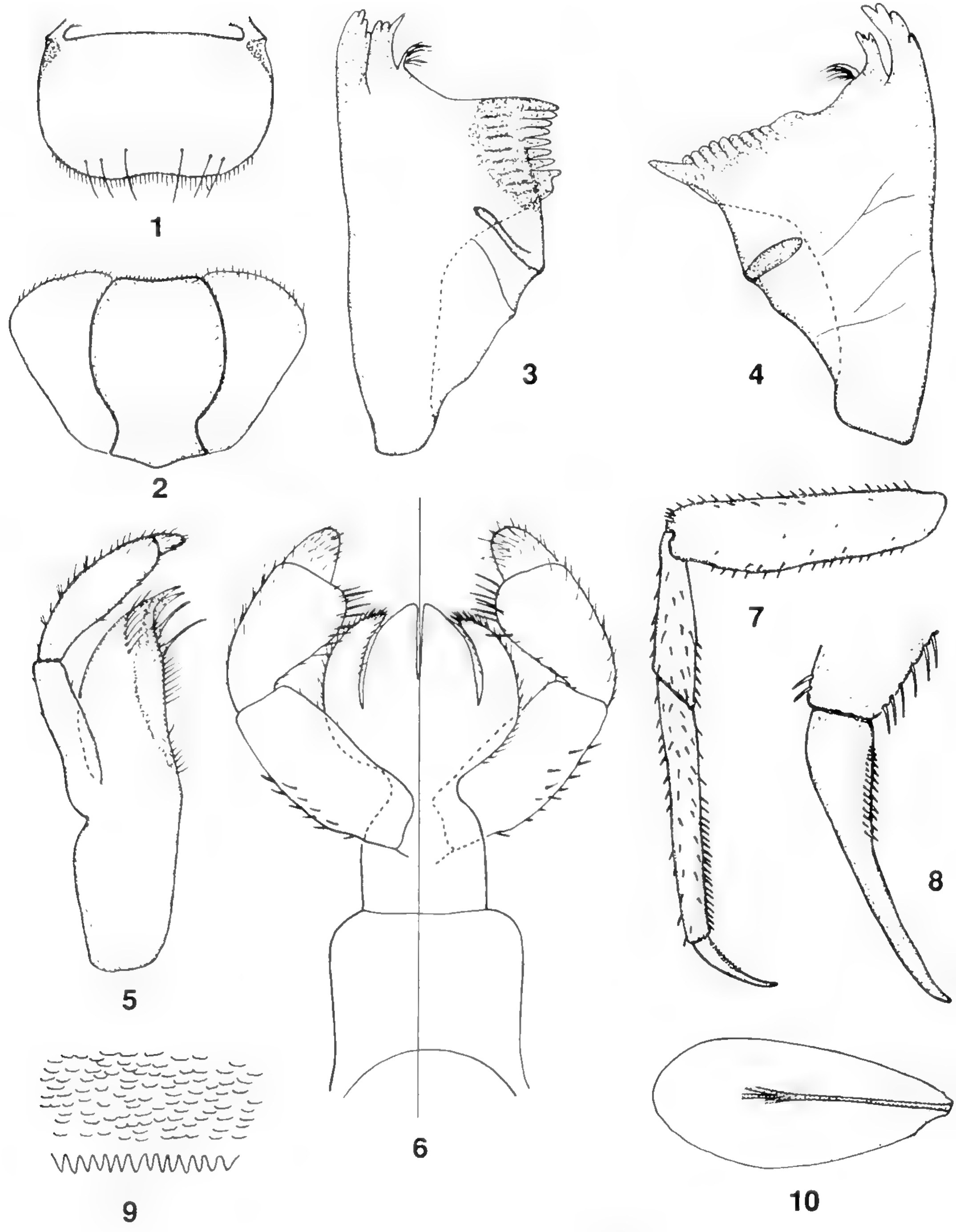
Adult.—Unknown.

Material examined.—Holotype: Larva, AUSTRALIA, New South Wales Prov., tributary of Mongarlowe R., nr. Monga, Clyde Mtn., I-25-1966, G. F. Edmunds, Jr. Paratypes: Five larvae, same data as holotype [mouthparts, forelegs, tergum 4, gill 4, and paraproct of one larva mounted on slide (medium: Euparal)] (one larva deposited in the Australian National Collection, Canberra). Additional material: 19 larvae, same data as holotype.

Etymology.—We are honored in naming this species after the collector, George F. Edmunds, Jr.

Discussion.—*Siphlaenigma edmundsi* differs from *S. janae* in its smaller size and in having segment 3 of the maxillary palps relatively elongate and subconical (Fig. 5), labial palps with an apicomedially broadly rounded segment 2 and a subconical segment 3 (Fig. 6), poorly tracheated gills (Fig. 10), and abdominal terga with a simple color pattern. Although the two species are distinctive, they are fundamentally similar and do not warrant distinction as separate genera. The fact that the two species are congeneric is significant because no other mayfly genus is known to occur in Australia and New Zealand. [The leptophlebiid genus *Atalophlebioides* Phillips has been reported from Australia and New Zealand, but Hubbard and Campbell (1996) have indicated that Australian species currently assigned to it most probably represent a different taxon.]

The discovery of *Siphlaenigma* in Australia strongly suggests that the taxon was present in Transantarctica prior to the separation of New Zealand approximately 80 million years ago. As a consequence, any notion that Siphlaenigmatidae evolved in New Zealand after the two landmasses were isolated is now insupportable, and new perspectives with respect to the historical biogeography of the family can now be taken. For example, it is possible that Siphlaenigmatidae was relatively widespread in western Gondwana during most of the Cretaceous and that it was decimated during the massive extinctions completed by the end of that period approximately 65 million years ago (McCafferty 1990, 1991, Wilson 1992). The two species of Siphlaenigmatidae that are known today, as such, would represent phylogenetic relicts. This would be consistent with the phylogenetic and paleontological observations by McCafferty (1990, 1991) and McCafferty and Wang (1997) showing that mayfly lineages in the Southern Hemisphere suffered major extinctions by the end of the Cretaceous. McCafferty and Wang (1997) showed that Southern Hemisphere phylogenetic relicts, viz., Ameletopsidae, Coloburiscidae, Oniscigastridae, Nesameletidae, Rallidentidae, and Teloganodidae, have small genera with one or few species each. The same may be said for clades within the Atalophlebiinae (Leptophlebiidae) (Towns and Peters 1978, 1996). Furthermore, Siphlaenigmatidae eventually may be found in southern temperate South America. Such Transantarctic



Figs. 1–10. *Siphlaenigma edmundsi.* 1, Labrum (dorsal). 2, Hypopharynx. 3, Left mandible. 4, Right mandible. 5, Right maxilla. 6, Labium (left-ventral; right-dorsal). 7, Right foreleg. 8, Tarsal claw. 9, Detail of tergum 4. 10, Gill 4.

affinities have been shown for several groups of aquatic insects, including Plecoptera (Illies 1965), Chironomidae (Brundin 1966), Trichoptera (Ross 1967), and Ephemeroptera (Edmunds 1975). Unlike other Amphinotic groups of mayflies, however, the same genus of Siphlaenigmatidae is found in different major isolated areas. This indicates that Siphlaenigmatidae, at least in terms of the larval stage, has evolved very little during the past 80 million years.

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TWO NEW SPECIES OF *SMITHISTRUMA* BROWN (HYMENOPTERA: FORMICIDAE) FROM FLORIDA

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Abstract.—Two new species of dacetonine ants are described from Florida. ***Smithistruma inopina*** known from three dealate queens, is aberrant for the genus in its triangular mandibles with small teeth, its lack of any specialized, broadened hairs, lack of spongiform appendages on the petiole, postpetiole, and gaster, lack of reticulate sculpture (except on the head), and lack of antennal scrobes. This species is provisionally assigned to *Smithistruma* because all the characters listed above occur in variable states within the genus and the basic structure of this ant (except for the mandibles) is similar to various species of *Smithistruma*. There is weak circumstantial evidence that this species is a social parasite. ***Smithistruma archboldi,*** known from numerous workers and queens, is distinguished by having both a wedge-shaped head and a conspicuous gap between the apical series of mandibular teeth and the clypeal border. This species seems to occur in the transition zone between xeric uplands and riparian or lakeside forest.

Key Words: Formicidae, Dacetonini, *Smithistruma*

The genus *Smithistruma* Brown, which includes 104 described species, is widely distributed in all geographic regions except for Australia (Bolton 1995). The southeastern United States, with 25 described species (including the two described below), is one of the world centers of distribution of the genus. Since members of the genus are small (usually about 2 mm in length), cryptic in habits, and slow moving, it is not surprising that new species are still being described from the southeast.

North American members of the genus *Smithistruma* can be distinguished from other myrmicine ants by the following combination of characters: antenna with six segments; mandibles in a frontal view of the head approximately triangular and not strongly bowed. In all species except for one of those described below, the head, especially the clypeus, is equipped with conspicuous modified hairs that are usually clavate or spoon-shaped, or elongate and apically curved. Outside of North America the boundaries of the genus *Smithistruma* have become increasingly blurred by the discovery of species apparently intermediate between *Smithistruma* and several other genera of dacetonines (Brown 1973, Bolton 1983). At this point there is no generally accepted solution to this problem, and until there is a convincing revision of the genera of the short-jawed dacetonines, we will continue to use the name *Smithistruma*. Since the type species of *Smithistruma* is from southeastern North America, the use of the name for species native to this region is not likely to lead to much confusion.

Smithistruma inopina Deyrup and Cover, new species

(Fig. 1)

Diagnosis.—Clypeus, antennal scapes, dorsum of mesosoma, gaster with coarse hairs rising from conspicuous punctures; no broadened or flattened hairs on head, body, or appendages; spongiform appendages absent; antennal scrobes absent.

Description of holotype female.—Measurements in mm: Total length (calculated as in Brown 1953): 2.40; head length: .62; head width: .36; length of mesosoma: .56.

Mandible in frontal view narrowly triangular, basal tooth an isoceles triangle, teeth of apical series small, longest about half as long as length of basal tooth, first and third longest, subequal, second and fifth subequal, about half length of first and third, fourth and sixth to eighth small, subequal; clypeus shining, with a small median submarginal tubercle and sparse conspicuous tapering hairs arising from punctures; remainder of head finely punctate, with moderately dense tapering hairs; long, flagelliform hairs absent on head; antennal scrobes absent; antennal scapes with sparse tapering hairs arising from punctures, hairs along inner edge proclinate on proximal third of scape, reclinate on distal two thirds of scape; head in frontal view wedge-shaped, as in *Smithistruma clypeata* (Roger) (Fig. 3).

Dealate, wing stumps present, flight structures well developed; pronotal angle rounded, sides of mesosoma not concave anteriorly; pronotum, mesonotum, metanotum, propodeal declivity smooth, shining, with sparse, curved, tapering hairs; sides of alitrunk smooth, shining; propodeal spines short, not subtended by a lamina; coxae smooth, shining, anterior surfaces with sparse tapering hairs; femora and tibiae with sparse proclinate tapering hairs.

Petiole, postpetiole, and base of gaster without spongiform appendages; gaster without grooves on first tergite; dorsum of petiole, postpetiole, and gaster smooth, shining, with sparse, tapering, curved hairs rising from punctures.

Color yellowish brown.

Types.—Dealate ♀, holotype and 2 paratypes. Holotype: FLORIDA: Putnam Co., Ocala National Forest, Rodman Resevoir, on blazed trail near parking lot, at base of pine, wet flatwoods habitat, 10 Dec. 1994, M. Deyrup. Paratypes: FLORIDA: Marion Co., 9 miles SSW of Ocala, in Ocala Waterway Development, sand pine scrub habitat, 16 Oct. 1990, M. Deyrup, 1; Alachua Co., Alachua County Fairgrounds, at base of pine, flatwoods habitat near parking lot, 23 Feb. 1986, C. Johnson, 1.

Holotype and one paratype in the Museum of Comparative Zoology, Harvard University, Cambridge, Massachusetts; one paratype presently in the arthropod collection of the Archbold Biological Station, Lake Placid, Florida.

Etymology.—*Inopina* (Latin), "unexpected," referring to the novel suite of character states displayed by the species.

Position in taxonomic guides.—*Smithistruma inopina* cannot be identified to genus in Cover's key (in Hölldobler and Wilson 1990) and dead ends at couplet 3 in Brown's key to Nearctic *Smithistruma* (1953). Both of these keys are designed for workers only, although Brown's key works well for all other queen *Smithistruma.*

Discussion.—*Smithistruma inopina* is described from three females, with no workers or males available. These specimens are the result of a survey, involving thousands of Berlese funnel samples, of the ants of Florida. Since the collecting phase of this project is almost complete, there is little chance that more specimens will be found soon. The next phase of the project, the preparation of a manual of the ants of Florida, requires names for as many species as possible, even if they are known from only a few specimens.

All three specimens were extracted by Berlese funnel from thick pine litter. The holotype was at the base of a *Pinus elliottii* Engelmann in wet, open flatwoods with

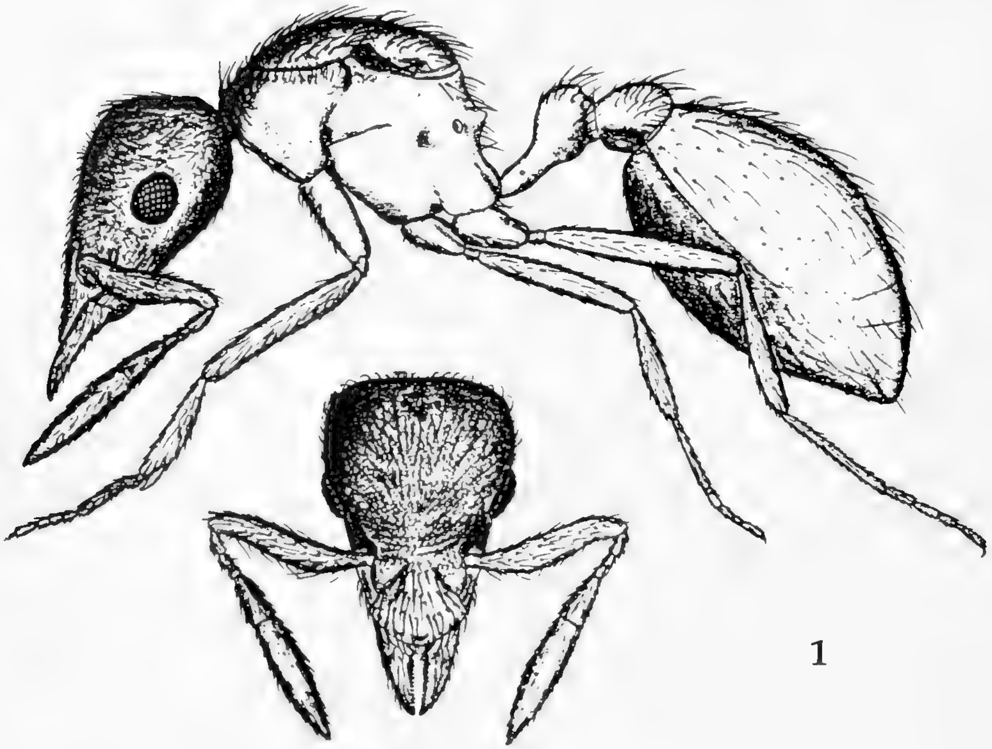

Fig. 1. *Smithistruma inopina*, dealate female.

Myrica cerifera L. and *Quercus nigra* L. along a trail by the Rodman Dam parking lot. The same sample of about two liters of unsifted litter included a large colony of *Smithistruma clypeata* (Roger) with a queen, a colony of *Paratrechina faisonensis* (Forel) with alates, numerous workers of *Pheidole dentigula* Smith, and a few workers of *Hypoponera opacior* (Forel). The Marion County paratype was from a xeric site with thick litter under dense *Pinus clausa* Chapman ex Engelmann and dense scrub oaks, *Quercus myrtifolia* Wildeman and *Quercus geminata* Small. The same two-liter unsifted sample included workers of *Smithistruma talpa* (Weber), *Solenopsis carolinensis* Forel, and *Paratrechina wojciki* Trager. The Alachua County paratype was from litter taken at the base of a pine, probably *Pinus elliottii*. The same sample included a large colony of *Smithistruma dietrichi* (Smith).

There is some circumstantial evidence that *S. inopina* might be a workerless parasite. 1. The species appears to be very rare; parasitic ants are frequently rare (Hölldobler and Wilson 1990), known from only one or a few collections. There are, however, other dacetonines that are rarely collected in Florida, for example *Smithistruma cloydi* Pfitzer, *S. abdita* (Wesson and Wesson), and *S. angulata* (Smith). 2. Only females are known. This is consistent with the social parasite hypothesis, but not supportive, since several other rare Florida *Smithistruma*, for example *S. angulata* and *S. pilinasis* (Forel), are also represented by solitary dealate females more often than one might expect. We assume that this means that the colonies of these species are not only rare, but also in microhabitats that are difficult to sample, so the species is most widely dispersed in the form of queens prospecting for a nest site, rather than as foraging workers. 3. All three females were taken in relatively small samples that also included other species of *Smithistruma*. If *S. inopina* is parasitic, its hosts are most likely to be, according to "Emery's rule," close relatives (Hölldobler and Wilson 1990), i.e. other *Smithistruma*. 4. Species of *Smithistruma*, as well as other dacetonines, are characterized by modifications, often elaborate, of the mandibles, pilosity, cuticular sculpture, grooves and depressions of the head and body, and spongiform appendages. Queens share most or all of the morphological elaborations of conspecific workers. The function of these character states is not understood in any specific way, but it seems likely that they are associated with defense and prey capture. The absence of all typical dacetonine elaborations in *S. inopina* suggests that this species makes its living in some novel way. One of the features of many parasitic ants is the loss of cuticular sculpture (Hölldobler and Wilson 1990). A sparse pilosity of curved, tapering, suberect hairs is typical of the parasitic genera *Stronglyognathus* Mayr, *Protomognathus* Wheeler, and *Harpagoxenus* Forel; in the cases of the latter two genera, this pilosity contrasts with the short, scale-like hairs of the hosts. *Smithistruma margaritae* (Forel) approaches *S. inopina* in its lack of antennal scrobes, the position of the eyes far from the ventral margins of the head, the greatly reduced spongiform appendages, and the lack of grooves at the base of the first gastral tergite. This could be a convergence based on some degree of dependence on other species, especially for defense. In Trinidad one author (MD) and Lloyd Davis observed workers of *S. margaritae* mingled in a foraging column of *Wasmannia auropunctata* (Roger) moving along a piece of plastic irrigation pipe on an open hillside each morning for three consecutive days. Returning to the site two years later, Lloyd Davis (personal communication) found this mixed foraging column still occurring. We do not suggest that *S. margaritae* is parasitic, only that it may have an unusual relationship with other ants.

We are assigning *inopina* to *Smithistruma*, rather than proposing a new genus, in spite of its lack of a number of superficial characters typical of *Smithistruma*. This decision is based on two considerations. The first is that the characters involved, such as enlarged mandibular teeth, expanded and flagelliform hairs, cuticular sculpture, and spongiform appendages, although present in other *Smithistruma*, vary remarkably from species to species, showing that they are labile in an evolutionary sense. The absence of these features can, with only a slight lurch in logic, be interpreted as another expression of this variability. The second consideration is that the general structure of the head, except for the shape of the mandibles, is very similar to that of other *Smithistruma* of the southeastern U.S., and not similar to any other genus of dacetine ants.

Smithistruma archboldi Deyrup and Cover, new species

(Fig. 2)

Diagnosis.—Head, in frontal view strongly wedge-shaped, the result of convergent ocular lamellae and a narrow clypeus; shape of head therefore resembling that of a number of other species such as *S. clypeata* (Fig. 3), *S. ohioensis* (Kennedy and Schramm) and *S. laevinasis* (Smith), but unlike these and other species with a wedge-shaped head, *S. archboldi* has a conspicuous gap between the apical series of teeth and the clypeal border.

Description of holotype worker.—Measurements in mm: Total length (calculated as in Brown 1953): 1.91; head length: .51; head width: .33; length of mesosoma: .54.

Mandible in frontal view with a broadly based triangular lamina, tapering gradually apically, terminating at about midlength; a conspicuous gap between most proximal teeth of apical series and clypeal border; 8 teeth in apical series, second longest, first and fourth subequal, third about half length and much more slender than second, teeth 5–8 slightly shorter than third; clypeus finely reticulate, not shining, about as long as

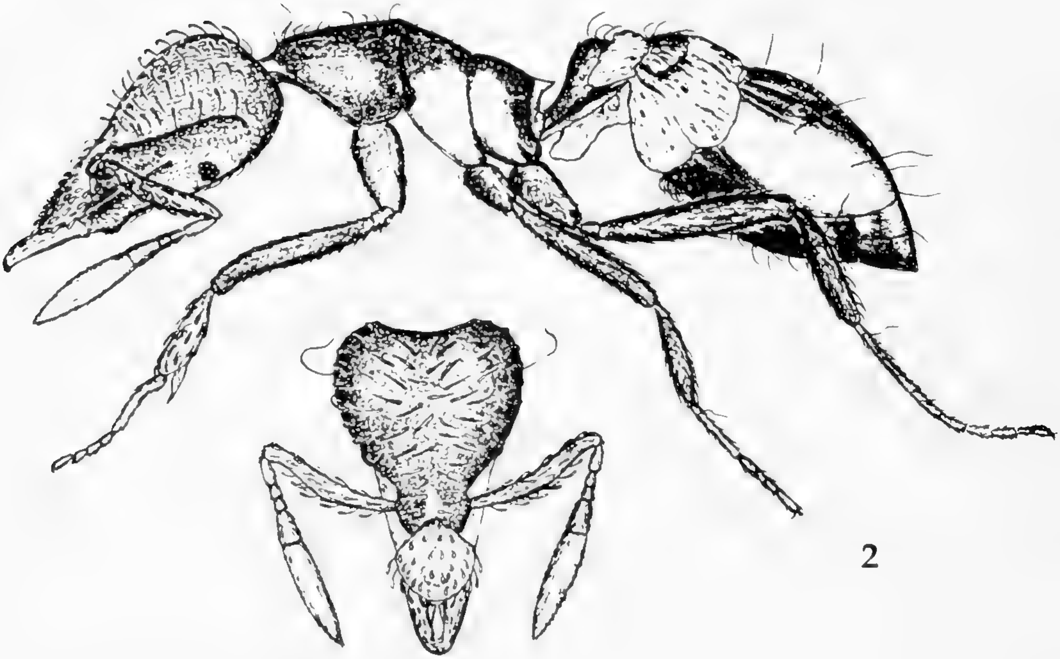

Fig. 2. *Smithistruma archboldi*, worker.

wide, with a submarginal median tubercle, anterior border evenly rounded, with 12 elongate, spatulate, marginal hairs curved toward midline, disc with small, sparse, curved, spatulate hairs; head in frontal view wedge-shaped, with converging ocular lamellae, as in the *clypeata* group of Brown (1953); head strongly reticulate, except for small frontal triangle; enlarged hairs on front of head elongate, curved, slightly broadened; a flagelliform hair on each side of vertex; antennal scapes curved at basal third but not angulate, inner borders of scapes with a row of elongate spatulate hairs, all proclinate.

Body and legs as in Fig. 2. We find no consistent differences in the body and legs between *S. archboldi* and *S. talpa* (Weber) (Fig. 4). For a description of *S. talpa* and the *talpa* group, see Brown 1953.

Color light ferrugineous.

Description of female.—Measurements in mm: total length (calculated as in Brown 1953): 2.53; head length: .59; head width: .42; length of mesosoma: .67.

Usual queen modifications present: ocelli present, compound eyes large, mesosoma modified for flight. Otherwise resembling the holotype worker, including the diagnostic characters of a wedge-shaped head in frontal view, conspicuous gap between the apical series of mandibular teeth and clypeal border, and type and disposition of hairs on clypeus.

Types.—Holotype worker, 210 worker and 8 dealate ♀ paratypes. Holotype, 1 dealate ♀, 19 worker paratypes: FLORIDA: Lake Co., Ocala National Forest, Road 445 at Alexander Springs Creek, mesic oak and pine forest, west side of creek on south side of road, 3 Sept. 1995, M. Deyrup. Paratypes: 11 workers, same site as holotype, 2 Apr. 1992, M. Deyrup and B. Ferster; 42 workers, 1 dealate ♀: FLORIDA: Putnam Co., three miles east of Melrose, Ordway Preserve, near Lake Rowen, Berlese sample, 24 Feb. 1995, Lloyd R. Davis; 28 workers: Putnam Co., three miles east of Melrose, Ordway Preserve, Berlese sample OK021195-B, 11 Feb. 1995, Lloyd Davis;

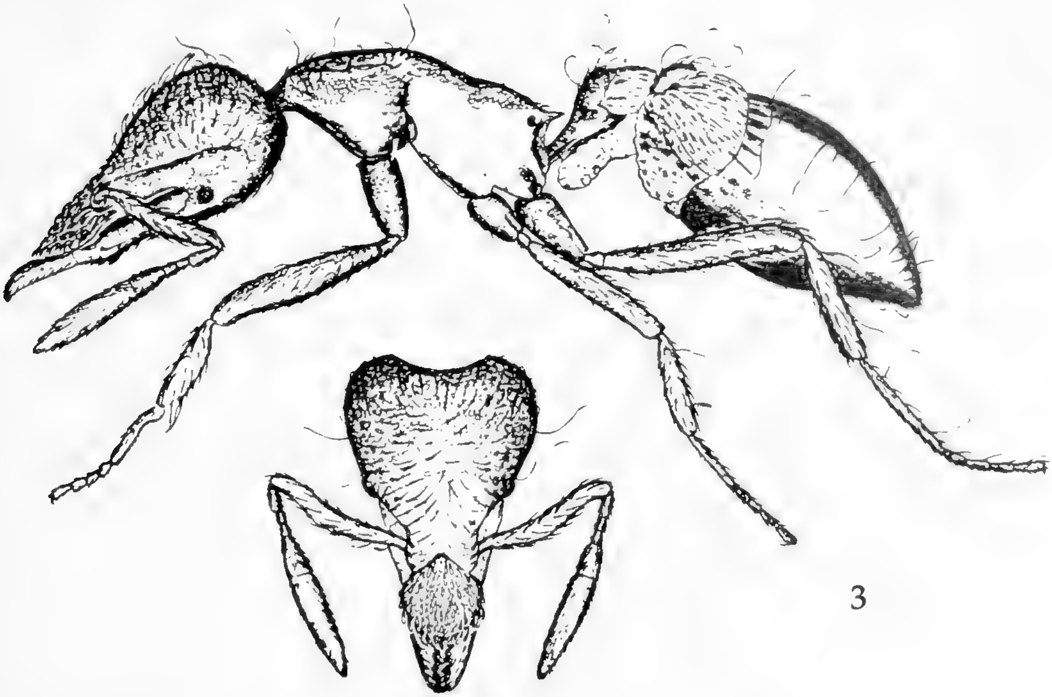

Fig. 3. *Smithistruma clypeata,* worker.

23 workers, 1 dealate ♀: Volusia Co., Spruce Creek Nature Conservancey Preserve, 22 Oct. 1994, M. Deyrup, B. Ferster, Z. Prusak; 7 workers, 1 dealate ♀: Bradford Co., Starke, 30 Apr. 1993, Lloyd R. Davis; 51 workers, 1 dealate ♀: Bradford Co., Hampton, 30 Apr. 1993, Lloyd R. Davis; 1 dealate ♀: Volusia Co., Deland, oak litter from vacant lot, 25 Dec. 1985, M. Deyrup; 1 dealate ♀: Putnam Co., Rodman Resevoir, scrub just west of dam, 3 Apr. 1988, Clifford Johnson; 1 dealate ♀, 11 workers: Alachua Co., Gainseville, mesic hammock by hospital, 24 Jul. 1986, Clifford Johnson; 1 dealate ♀, 7 workers: Bradford Co., Keystone Heights, 2 miles west, north side of Little Santa Fe Lake, 23 Feb. 1995, Lloyd Davis; 1 worker: Jefferson Co., Capps, 1 mile east, U.S. 19–27, in leaf litter, 24 July 1965, Walter Suter; 10 workers: GEORGIA: Charlton Co., St. George, 6 miles south, leaf litter from magnolia, pine and cypress swamp, 18 Aug. 1965, Walter Suter.

Holotype, 32 workers, 3 dealate ♀: Museum of Comparative Zoology, Harvard University, Cambridge, Massachusetts; 18 workers: National Museum of Natural History, Smithsonian Institution, Washington, D.C.; 20 workers, 1 dealate ♀: Los Angeles county Museum; 21 workers, 1 dealate ♀: The Natural History Museum, London; 18 workers: Florida State Collection of Arthropods, Gainesville, Florida; 9 workers: Canadian National Collection, Ottawa, Ontario; 6 workers: Field Museum, Chicago, Illinois; 7 workers: collection of Mark DuBois, Washington, Illinois; 7 workers: collection of William MacKay, El Paso, Texas; 7 workers: collection of Philip Ward, University of California, Davis, California; remaining paratypes in the arthropod collection of Archbold Biological Station, Lake Placid, Florida.

Etymology.—This species is named for Richard Archbold, who founded the Archbold Biological Station, which has support-

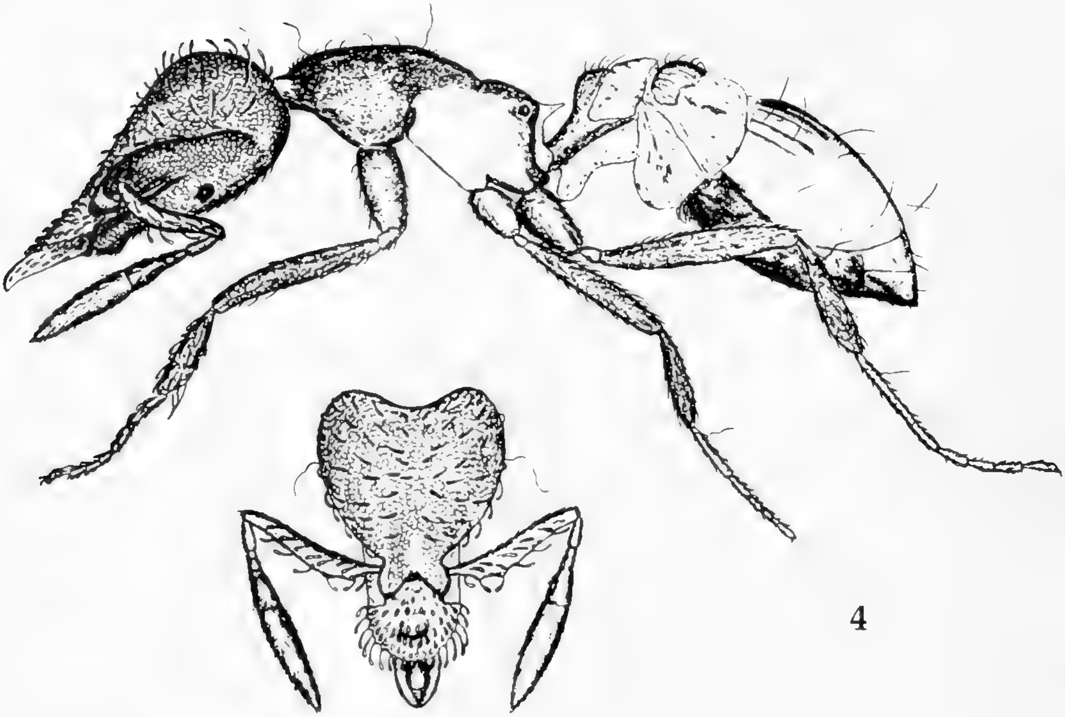

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Fig. 4. *Smithistruma talpa*, worker

ed a survey of Florida ants for the past decade.

Position in taxonomic guides.—In the most recent key to the Nearctic species of *Smithistruma* (Brown 1953), *S. archboldi* encounters an impasse at couplet 10. This is because previously described species with a wedge-shaped head (e.g. *S. clypeata,* Fig. 3) do not have a conspicuous gap between the clypeal border and the apical series of mandibular teeth (the "mandibular diastema") while species that have a conspicuous diastema also have the sides of the head more or less parallel beyond the occipital lobes (e.g. *S. talpa,* Fig. 4). This means that *S. archboldi* does not fit into any currently defined species group of *Smithistruma*; this is of little significance, since these groups are "connected or seemingly connected in all directions by intergradient forms, so that most of the limits . . . are to be considered artificial conveniences of a temporary sort" (Brown 1953).

Discussion.—Most of the collections of *S. archboldi* are from riparian or lakeside habitats with mixed conifer and broadleaf trees. A preference for relatively narrow ecotonal bands of habitat might explain why this species was not collected and described long ago. It is also possible that the species is restricted to uplands of the southeastern coastal plain, where sandy soils reduce the incidence and duration of flooding along the shores of streams and lakes.

It is reasonable these days to consider the conservation status of newly described species if, as in the case of the two described above, there is reason to believe that the species are rare, localized, or have narrow habitat requirements. *Smithistruma inopina* is known from the northern border of Ocala National Forest (the holotype locality) and from another site not far from the western side of the forest. Since the Ocala National Forest is a huge tract (380,000 acres), much of which is maintained in relatively natural habitats, the chances are good that there are protected populations of *S. inopina* that should be able to persist within the forest. The holotype locality of *S. archboldi* is also within the Ocala National Forest, and many of the paratypes are from the Ordway Preserve, administered by the University of Florida, or the Spruce Creek Preserve, administered by the Nature Conservancy. The latter site serves as a reminder that habitat destruction is not the only threat to many species of arthropods. At Spruce Creek there are populations of the exotic dacetonines, *Strumigenys eggersi* Emery and *S. rogeri* Emery, two species that appear to have replaced most of the native dacetonines at several of our survey sites in central Florida.

Southeastern *Smithistruma* are centered around the southern Appalachians, with some species having ranges extending up to southern New England, or down into Florida, or west to eastern Texas. Because of the consistency of this pattern, we suspect that the two species described here will be found to have ranges considerably north of the localities listed above. Aside from the 25 species of *Smithistruma* known from the southeastern U.S., there are a few species found in relict mesic areas of the southwest (Ward 1988). Several species have been described from Japan (Bolton 1995) and there are apparently a number of undescribed Japanese species that have been listed on the World Wide Web. Brown (1953) suggested that U.S. *Smithistruma* are most closely related to the Asian species. All this distributional evidence suggests that all the native Northern Hemisphere representatives of *Smithistruma* are faunal vestiges of the spectacularly diverse warm-temperate arcto-tertiary forests that were widespread in the Miocene (Raven and Axelrod 1978). *Smithistruma* is the only speciose group of ants that shows this pattern.

ACKNOWLEDGMENTS

We gratefully acknowlege Lloyd Davis, Clifford Johnson and Walter Suter, who have contributed hundreds of specimens to the Florida ant survey. We thank the managers of the Ordway Preserve, the Ocala National Forest, and Spruce Creek Preserve for maintaining the habitats that harbor the species described above.

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THE *ENCARSIA CUBENSIS* SPECIES-GROUP (HYMENOPTERA: APHELINIDAE)

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Abstract.—Taxonomic, host, and geographic range information for the six species comprising the *Encarsia cubensis* species-group is provided. Three new species, ***E. aleurothrixi, E. hansoni,*** and ***E. hamoni,*** are described from Brazil, Costa Rica, and Florida (USA), respectively. A lectotype is designated for *E. nigricephala* Dozier.

Resumen.—Se informa sobre la taxonomía, los hospederos y la distribución geográfica de seis especies que pertenecen al grupo de la especie *Encarsia cubensis.* Se describe tres nuevas especies, ***E. aleurothrixi, E. hansoni*** y ***E. hamoni*** recolectadas en Brasil, Costa Rica y Florida (EEUU), respectivamente. Se designa el lectotipo para *E. nigricephala* Dozier.

Key Words: *Encarsia,* whiteflies, parasitoids, biological control, taxonomy, Nearctic, Neotropical, *Bemisia, Aleurothrixus.*

As here defined, the *Encarsia cubensis* species-group consists of six species, all of which parasitize whiteflies in the New World, except for one species (*E. nigricephala* Dozier) which apparently was accidently introduced beyond its natural range into Réunion (Mascarene Islands, Indian Ocean). Various economically important whitefly species are attacked by members of this group. *Encarsia nigricephala* is one of the most common parasitoids of the *Bemisia tabaci* species-complex (Aleyrodidae) throughout the New World. *Encarsia quaintancei* Howard is a major parasitoid of the banded-winged whitefly, *Trialeurodes abutiloneus* (Haldeman), and also attacks the *Bemisia tabaci* species-complex.

Gahan (1931) first recognized these species as comprising a distinct group in the genus *Encarsia* and characterized it as species having only four tarsomeres on the middle tarsus and the presence of an area around the stigmal vein devoid of setae. DeBach and Rose (1981) erected the *Encarsia cubensis* species-group. *Encarsia cubensis* and *E. quaintancei* had previously been included in the '*formosa*-group' (= *luteola*-group) by Viggiani and Mazzone (1979). Polaszek et al. (1992) provided taxonomic, host and distribution information for *E. nigricephala* and *E. quaintancei.* Schauff et al. (1996) updated host and distribution records for these two species, and provided information on *E. cubensis.*

The *Encarsia cubensis* species-group can be defined using a combination of characters, none of which alone, however, distinguishes this group from other species-groups of *Encarsia.* For example, species belonging to the *parvella-* and *citrina-*

Table 1. Characteristics of the *Encarsia cubensis* species group compared with those of similar *Encarsia* species groups.

Species Group	Tarsal Formula	Fore Wing Asetose Area	Fore Wing Disc Width	Gastral Tergite	Host	Male Antenna
cubensis	5-4-5	yes	normal–broad	smooth	whitefly	F2 modified
luteola	5-4-5	no	normal–broad	smooth	whitefly	normal
singularis	5-4-5	no	narrow	sculptured	diaspine scale	F1 modified
citrina	5-5-5	yes	narrow–normal	sculptured	diaspine scale	normal
parvella/ pergandiella	5-5-5	yes	narrow–broad	smooth	whitefly	normal

groups also possess the asetose area around the stigmal vein of the fore wing. The 4-segmented mid tarsus is also found in the *luteola-* and *singularis* groups, as well in some unplaced species (e.g. *E. africana* (Hill) and *E. mohyuddini* Shafee and Rizvi). Reduction in the number of segments of the mid tarsus appears to have occurred independently in different lineages within *Encarsia*. Certainly within the Aphelinidae and the Chalcidoidea as a whole, reduction in number of tarsal segments by fusion of the two distal segments is common.

An ovoid sensory/glandular structure is present on F2 antennal segment of the males of the three species in this group whose males are known, and is present on both the F1 and F2 segment in the male of *E. hansoni*. Potentially, this structure is a unique synapomorphy for the *cubensis* species group; however, males of the *singularis*-group, a small group of armored scale parasitoids from the Oriental region, have a similar structure on the F1 antennal segment. Pedata et al. (1995) first demonstrated that these structures, often referred to as 'sensorial complexes' (Viggiani and Mazzone 1982, Polaszek et al. 1992), are at least partially glandular. Viggiani (1996) demonstrated that in *E. nigricephala* (and presumably in *E. quaintancei* and *E. hamoni*) the structure is entirely glandular. The form of these structures agrees at least partially with the 'release and spread' function attributed to similar antennal glands by Isidoro et al. (1996).

Within *Encarsia*, members of the *E. cubensis*-group show greatest affinity with members of the *parvella*-group, with which they share the asetose area of the fore wing, and from within which they may be derived. Characteristics of the *E. cubensis*-group are compared with those of related *Encarsia* species groups (Table 1).

The following six species are placed in the *E. cubensis* group: *E. aleurothrixi* Evans and Polaszek, n. sp., *E. cubensis* Gahan, *E. hamoni* Evans and Polaszek, n.sp., *E. hansoni* Evans and Polaszek, n. sp., *E. nigricephala* Dozier and *E. quaintancei* Howard.

Morphological terminology follows that of Hayat (1989). The scutellar setae are designated Sc1 (anterior pair) and Sc2 (posterior pair) as used in Evans et al. (1995). The length of the fore wing disc (Fig. 18, fd) is measured from the midpoint of an imaginary line drawn between the apex of the stigmal vein and the distal end of the frenal fold of the fore wing, to the fore wing apex. The width of the fore wing (Fig. 18, fww) refers to the maximum width of the fore wing; the length of the marginal fringe, refers to the length of the longest seta of the marginal fringe. Habitus drawings for each species show the gaster divided medially, with the dorsum on the left side and the venter on the right side. The tibia and tarsus of the middle leg for the female of each species is drawn on its left side. An asterisk is placed before new host and/or distribution records.

Holotypes of all members of the *E. cubensis* species group are deposited in the National Museum of Natural History, Smithsonian Institution (USNM) in Washington, D.C., U.S.A. Paratypes of *E. aleurothrixi* are deposited in The Natural History Museum, London, U.K. (BMNH), Florida State Collection of Arthropods, Gainesville, Florida, U.S.A (FSCA) and in the G. A. Evans, personal collection (GAE). Additional specimens of *E. cubensis* and *E. nigricephala* are deposited in the Centre de Cooperation Internationale en Recherche Agronomique pour le Developpement, Montpellier, France (CIRAD).

ENCARSIA CUBENSIS SPECIES-GROUP

Diagnosis.—Tarsal formula 5-4-5; fore wing moderate to broad in width with large asetose area beneath the stigmal vein, longest seta of marginal fringe not longer than maximum width of fore wing, distance between placoid sensilla on scutellum more than 2.5× the diameter of one sensillum, base of gastral tergite I smooth.

Additional characteristics observed in species of this group include: antennal club 3-segmented, F1 antennal segment usually short, quadrate or nearly so and shorter than pedicel, ovipositor short to moderate in length, subequal to length of tibia II and not exceptionally extruded, mesoscutum with 2 to 3 pairs of setae, males with antennal segments F5 and F6 fused, F2 (rarely F1) with an ovoid sensory/glandular structure covered by a plate (Figs. 11, 15).

KEY TO *ENCARSIA CUBENSIS* SPECIES-GROUP

1\. Mesoscutum with 2 pairs of setae, gaster completely yellow, or dark brown with central portion of tergites I and II yellow, (Figs. 4, 6, 8, 10 2

– Mesoscutum with 3 pairs of setae, gaster completely dark brown. (Figs. 2, 14) 5

2\. Gaster completely yellow, fore wing almond-shaped, pointed at apex (Figs. 19, 21); males known 3

– Gaster dark brown with central portion of tergites I and II yellow, fore wing round at apex (Figs. 18, 20); males unknown 4

3\. Scutellum dark brown, F1 oblong and quadrate, F6 elongate, 3.2× as long as wide (Fig. 7), 2 pairs of setae between cerci of tergite VI. (Fig. 8). Male with ovoid glandular structure on F1 and F2, F3 slightly longer than F2 . . . . *hansoni*

– Scutellum yellow, F1 cylindrical, 1.5–1.7× as long as wide, F6 not exceptionally elongate, 2.4× as long as wide (Fig. 9), 1 pair of setae between cerci of tergite VI. (Fig. 10). Male (Fig. 12) with ovoid glandular structure on F2, F3 shorter than F2 segment (Fig. 11) . . . . *nigricephala*

4\. Valvula III elongate (Fig. 4), 0.6× as long as ovipositor, F2 longer than F3 (Fig. 3) . . . . . *cubensis*

– Valvula III 0.4× as long as ovipositor (Fig. 6), F2 shorter than F3 (Fig. 5) . . . . *hamoni*

5\. Axillae and posterior half of mesoscutum yellow, second pair of mesoscutal setae proximal to anterior pair of setae (Fig. 2), valvula III with spatulate apical setae, F1 quadrate, 0.5× as long as F2 (Fig. 1); male unknown. . . . . *aleurothrixi*

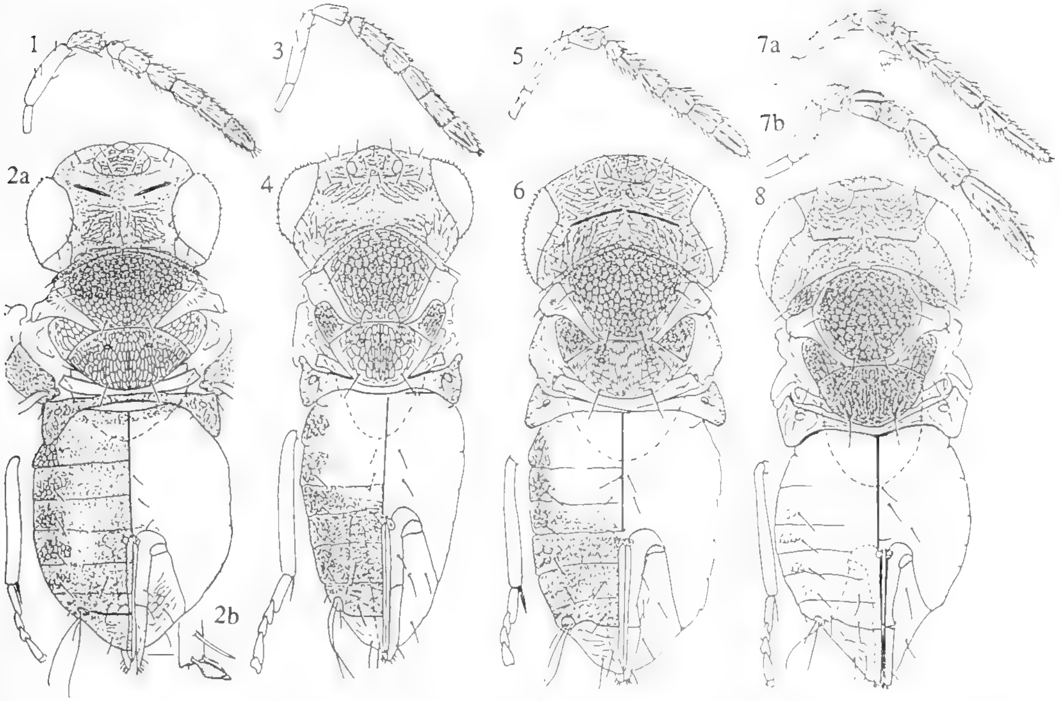
– Axillae and entire mesoscutum (except margins) dark brown, second pair of mesoscutal setae located approximately halfway between anterior and posterior pairs of setae (Fig. 14), valvula III with apical setae slender, F1 cylindrical, 0.75× as long as F2 (Fig. 13). Male with F3 longer than F2 (Fig. 16) and tibia III brownish . . . . *quaintancei*

Encarsia aleurothrixi Evans and Polaszek, new species

(Figs. 1, 2a, 2b, 17)

Diagnosis.—The female of *E. aleurothrixi* can be distinguished from other *Encarsia cubensis* group species by the unusual spatulate setae located on the apex of valvula III (may be difficult to discern unless viewed with phase-contrast microscopy), and by the anterolateral position of the second pair of mesoscutal setae. This species is most similar to *E. quaintancei* in coloration and number of mesoscutal setae, but can be distinguished from the latter species which has the second pair of mesoscutal setae located approximately halfway between the anterior and posterior pair of setae, the F1 antennal segment more elongate, the axillae dark brown, and slender apical setae on valvula III.

Description.—Female holotype. Coloration (Fig. 2): Head dark brown, eyes red, antenna pale, anterior half of mesoscutum, metanotum and gaster, dark brown; rest of



Figs. 1–8. 1–2 *Encarsia aleurothrixi* 1, Antenna, female. 2a, Habitus, female. 2b, Valvula III, apex. 3–4, *E. cubensis*. 3, Antenna, female. 4, Habitus, female. 5–6, *E. hamoni*. 5, Antenna, female. 6, Habitus, female. 7–8, *E. hansoni*. 7a, Antenna, female. 7b, Antenna, male. 8, Habitus, female.

mesosoma and legs, yellow; coxa III and valvula III infuscate; wings hyaline. Morphology: Antennal (Fig. 1) radicle (R), scape (S), pedicel (P), 3 funicle segments (F1–F3) and 3 club segments (F4–F6) with the following ratios of length to width: R: 3.6, S:4.5, P:1.4, F1:1.0, F2:1.7, F3:1.7, F4: 1.5, F5:1.5 and F6:1.8; relative lengths of segments R–F6 to length of F1: R:1.8, S: 4.5, P:1.8, F1:1.0, F2:1.9, F3:2.1, F4:2.1, F5:2.1, and F6:2.4; F1–F6 with the following number of linear sensilla: F1:0, F2:2, F3:2, F4:2, F5:3, F6:3. Mesoscutum with narrow, hexagonal sculpture, and 3 pairs of slender setae arranged as in Fig. 1; each side lobe with 2 setae; each axilla with 1 short seta, scutellar seta Sc1 0.7× as long as Sc2; distance between scutellar sensilla 5× the width of one sensillum; endophragma short, reaching halfway to posterior base of gastral tergite I; tibial spur of middle leg 0.7× corresponding basitarsus. Fore wing (Fig. 17) broad, disc 0.9× as long as wide, marginal fringe 0.3× width of wing; discal setae uniformily distributed except wide bare area along the distal margin of the fore wing and area surrounding stigmal vein; 6–7 costal, 2–3 basal group, and 2 submarginal vein setae; marginal vein with 5–6 long and stout setae along its anterior margin, 2 large setae at its base, and 7–8 short setae along its interior. Gastral tergites I–V dorsum with reticulate lateral margins, tergites V and VI with stipules, centrally; tergites I–VII with 0, 1, 1, 1, 2, 2, 2 pairs of setae, respectively. Venter with 2 pairs of setae at sternite II, III and IV, respectively; ovipositor arising at anterior base of tergite IV, as long as tibia of middle leg; valvula III slender, 0.5× ovipositor, with 2–3 pairs of distally-expanded, apical setae.

Male.—Unknown.

Distribution.—Brazil.

Hosts.—*Aleurothrixus aepim* (Goldi), *Aleurothrixus floccosus* (Maskell).

Material examined.—Brazil, Aguas de São Paolo, 24.i.1988, ex. *Aleurothrixus aepim* on *Manihot esculentum,* F.D. Bennett, (Holotype ♀ and 2 ♀ paratypes, USNM; 5 ♀ paratypes, BMNH; 8 ♀ paratypes, FSCA; 8 ♀ paratypes, GAE); Brazil, Piracicaba, 27.v.1991, ex. *Aleurothrixus floccosus* on *Citrus* sp., F. D. Bennett, (12 ♀ paratypes, GAE).

Etymology.—The species name is derived from its host, *Aleurothrixus.*

Encarsia cubensis Gahan
(Figs. 3, 4, 18)

Encarsia cubensis Gahan 1931:121.
Trichoporus cubensis: Dozier 1933:92.

Types.—Three syntype females reared from *Aleurothrixus howardii* (= *A. floccosus*), Santiago de las Vegas, Cuba, received from S. C. Bruner, in USNM [examined].

Diagnosis.—The female of *E. cubensis* can be distinguished from other *E. cubensis* group species (except *E. hamoni*) by having 2 pairs of mesoscutal setae and dark brown gaster with central portion of tergites I and II, yellow. *E. cubensis* is most similar to *E. hamoni* in coloration and number of mesoscutal setae and can be distinguished from that species by having the F2 longer than F3 antennal segment, the F1 antennal segment very short, 0.5× as long as F2, and valvula III 0.6× as long as the ovipositor.

Description.—Female syntype. Coloration (Fig. 4): Head, pronotum, mesoscutum (except lateral margins), axillae (except small, basal triangular area), lateral margins of metanotum and gasterl tergites I and II, and tergites III–VI, dark brown; lateral margins of mesoscutum, side lobes, scutellum, central area of tergites I and II, tergite VII and legs, yellowish; F6 antennal segment infuscate; wings hyaline. Morphology: Antennal segments (Fig. 3) with the following length to width ratios: R:3.0, S:5.0, P:1.8, F1:1.0, F2:1.8, F3:1.6, F4:1.8, F5:1.8, and F6:2.3; relative lengths of segments R–F6 to length of F1: R:1.7, S:4.7, P:2.0, F1:1.0, F2:2.0, F3:1.8, F4:2.0, F5:2.2 and F6:2.5; linear sensilla present on flagellar segments F2–F6. Mesoscutum with broad, hexagonal sculpture and 2 pairs of short setae; each axilla with 1 short seta, scutellar seta Sc1 0.6× as long as Sc2; distance between scutellar sensilla 5.2× width of one sensillum; endophragma short, not reaching tergite II; tibial spur of middle leg 0.8× length of corresponding basitarsus. Fore wing (Fig. 18) broad, disc 1.1× as long as wide, marginal fringe 0.4× width of fore wing; discal setae uniformily distributed except a wide asetose band along the distal margin of the fore wing and asetose area surrounding stigmal vein; 6–7 costal, 2 basal group, and 2 submarginal vein setae; marginal vein with 5–6 setae along its anterior margin, 2 setae at its base, and 7–8 short setae along its interior. Gastral tergites I–V dorsum with imbricate lateral margins, stipules present on tergites V–VI, centrally; tergites I–VII with 0, 1, 1, 1, 2, 2, 2 pairs of setae, respectively. Venter with a pair of setae at sternites I and II; ovipositor arising at level of tergite III, as long as tibia of middle leg; valvula III, 0.6× as long as ovipositor.

Male.—Unknown.

Hosts.—*Aleurothrixus floccosus* (Maskell), **Aleurotrachelus trachoides* (Back).

Distribution.—Brazil; Cuba; *Dominican Republic; *Guadeloupe; Haiti; Puerto Rico; USA: Florida.

Specimens examined.—In addition to syntypes, Dominican Republic, Charco Azul, 16.i.1995, ex. *?Aleurothrixus* sp. on *Manihot esculentum,* C. A. Serra (1 ♀, GAE); Guadeloupe: Vernon, 21.vi.1990, ex. **Aleurotrachelus trachoides,* J. Etienne, (1 ♀, CIRAD); Dom. Dudos, 1.ii.1990, J. Etienne (1 ♀, CIRAD); Puerto Rico: Avecibo, 19.x.1990, *Aleurothrixus floccosus* on *Tabebuia glomerata,* F. D. Bennett (2 ♀, GAE); USA: Florida, Miami, 22.iii.1992, ex. whitefly on *Cocos nucifera,* F. D. Bennett (1 ♀, GAE).

Encarsia hamoni Evans and Polaszek, new species

(Figs. 5, 6, 20)

Diagnosis.—The female of *E. hamoni* can be distinguished from the other *Encarsia cubensis* group species (except *E. cubensis*) by its dark brown gaster with yellow central area of tergites I and II, 2 pairs of mesoscutal setae, and rounded apex of the fore wing. *E. hamoni* is most similar to *E. cubensis* and can be distinguished from the latter species by having valvula III shorter, 0.4× as long as the ovipositor; F2 shorter than F3; and axillae completely dark brown.

Description.—Female holotype. Coloration (Fig. 6): Head, pronotum, mesoscutum (except lateral margins), axillae, lateral margins of metanotum and gastral tergites I and II, and tergites III–VI, dark brown; lateral margins of mesoscutum, side lobes, scutellum, central area of tergites I and II, tergite VII and legs, yellow; wings hyaline. Morphology: Antennal segments (Fig. 5) with the following ratios of length to width: R:1.9, S:4.5, P:1.9, F1:1.0, F2:1.6, F3:1.9, F4:1.5, F5:1.5 and F6:1.8; relative lengths of segments R–F6 to length of F1: R:1.9, S:4.5, P:1.9, F1:1.0, F2:1.6, F3:1.9, F4:1.9, F5:2.0, and F6:2.4; F1–F6 with the following number of linear sensilla: F1:0, F2:2, F3:2, F4:2, F5:3, F6:3. Mesoscutum with broad, hexagonal sculpture and 2 pairs of slender setae; each side lobe with 2 setae; each axilla with 1 seta, scutellar setae Sc1 0.7× as long as Sc2; distance between scutellar sensilla 5× the width of one sensillum; endophragma short, reaching almost to posterior base of gastral tergite I; tibial spur of middle leg 0.7× corresponding basitarsus. Fore wing (Fig. 20) broad, disc 0.9× as long as wide, marginal fringe 0.3× width of wing; discal setae uniformily distributed except wide bare area along the distal margin of the fore wing and the area surrounding stigmal vein; 6–7 costal, 1 basal group, and 2 submarginal vein setae; marginal vein with 5–6 long and stout setae along its anterior margin, 2 large setae at its base, and 7–8 short setae along its interior. Gastral tergites I–V dorsum with reticulate lateral margins, tergites V and VI with stipules, centrally; tergites I–VII with 0, 1, 1, 1, 2, 2, 2 pairs of setae, respectively. Venter with 2 pairs of setae at sternite II, III and IV, respectively; ovipositor arising at anterior margin of tergite IV, as long as tibia of middle leg; valvula III slender, 0.4× ovipositor.

Male.—Unknown.

Distribution.—U.S.A.: Florida, Georgia; Mexico.

Hosts.—*Tetraleurodes ursorum* (Cockerell); *Bemisia tabaci* species-complex.

Material examined.—U.S.A: Florida, Davie, 24.ii.1994, ex. *Tetraleurodes ursorum* on *Annona glabra,* A. B. Hamon, (Holotype ♀ and 3 ♀ paratypes, USNM; 2 ♀ paratypes, BMNH; 1 ♀ paratype, GAE). Additional specimens: USA: Georgia, Tifton, x.1992, *Bemisia tabaci* species-complex on *Gossypium hirsutum,* J. Chamberlain, (1 ♀, GAE); Mexico: Sinaloa, Guasave, 12.x.1990, B. Alvarado, (2 ♀, GAE).

Etymology.—This species is named in honor of Avas Hamon for his many years of assistance in the identification of whitefly and scale insect hosts.

Encarsia hansoni Evans and Polaszek, new species

(Figs. 7a, 7b, 8, 19)

Diagnosis.—The female of *E. hansoni* can be distinguished from the other *E. cubensis* group species by having the scutellum completely dark brown; the F1 antennal segment short and oblong; and the F6 antennal segment very elongate, 3.4× as long as wide.

Description.—Female holotype. Coloration (Fig. 8): Head dark brown, eyes red, antennae pale; mesoscutum (except for lateral margins), axillae and scutellum, dark brown; metanotum, gaster, and legs, yellowish; wings hyaline. Morphology: Antennal segments (Fig. 7a) with the following ratios of length to width: R:4.0, S:5.0, P: 1.3, F1:0.8 (ventral margin) and 1.0 (dorsal margin), F2:1.8, F3:1.9, F4:1.8, F5:2.0 and

F6:3.4; relative lengths of segments R–F6 to length of F1(ventral margin): R:2.0, S: 5.6, P:2.6, F1:1.0, F2:2.0, F3:2.1, F4:2.3, F5:2.5, and F6:3.9; F1–F6 with the following number of linear sensilla: F1:0, F2:1, F3:2, F4:3, F5:3, F6:3. Mesoscutum with broad, hexagonal sculpture and 2 pairs of slender setae; each side lobe with 2 setae; each axilla with 1 seta, scutellar setae Sc1 0.9× as long as Sc2; distance between scutellar sensilla 5× the width of one sensillum; endophragma short, reaching anterior base of tergite II; tibial spur of middle leg 0.9× as long as corresponding basitarsus. Fore wing (Fig. 19) almond-shaped, disc 1.4× as long as wide, marginal fringe 0.5× width of wing; discal setae uniformily distributed except for wide asetose band along the distal margin and large, asetose area surrounding stigmal vein; 5 costal, 2 basal group, and 2 submarginal vein setae; marginal vein with 5 setae along its anterior margin, 2 large setae at its base, and 7–8 short setae along its interior. Gastral tergites II–V dorsum with imbricate lateral margins, tergite VI smooth, tergite VII rugose; tergites I–VII with 0, 1, 1, 1, 2, 3, 2 pairs of setae, respectively. Venter with a pair of setae at sternite I, II and III, respectively; ovipositor arising at level of tergite III, 1.1× as long as tibia of middle leg; valvula III slender, 0.4× length of ovipositor.

Male.—(Specimen collected in a pan trap near the location of the holotype female and assumed to be the male of *E. hansoni.*) Coloration: Body dark brown, lateral margins of mesoscutum, side lobes, base of axillae, and scutellum, yellow; gaster tergite VII light brown; legs and antenna, pale; wings hyaline. Antennal segments (Fig. 7b) with the following length to width ratios: R:2.5, S:3.7, P:1.1, F1:1.0, F2:1.1, F3:1.2, F4:1.6, F5 + F6 (fused):3.6; ratio of each segment to length of F1: R:1.0, S:2.1, P:1.0, F1:1.0, F2:0.9, F3:1.1, F4:1.4, F5 + F6 (fused):3.4; F2 with 2 ovoid sensory/glandular structures covered by plate having 2 holes; F1 with 1 ovoid sensory/glandular structure; proximal half of F3 surface with rugose area; mesosomal sculpturing and setation and fore wing similar to those of female.

Distribution.—Costa Rica.

Host.—Unknown.

Material examined.—Costa Rica, La Selva, 17.vii.1995, C. Godoy and P. Hanson, (Holotype ♀, USNM); Costa Rica, 3 km south of Puerto Viejo, La Selva, i.1993, pan trap, P. Hanson, 1 ♂, USNM).

Etymology.—This species in named in honor of Paul Hanson, University of Costa Rica.

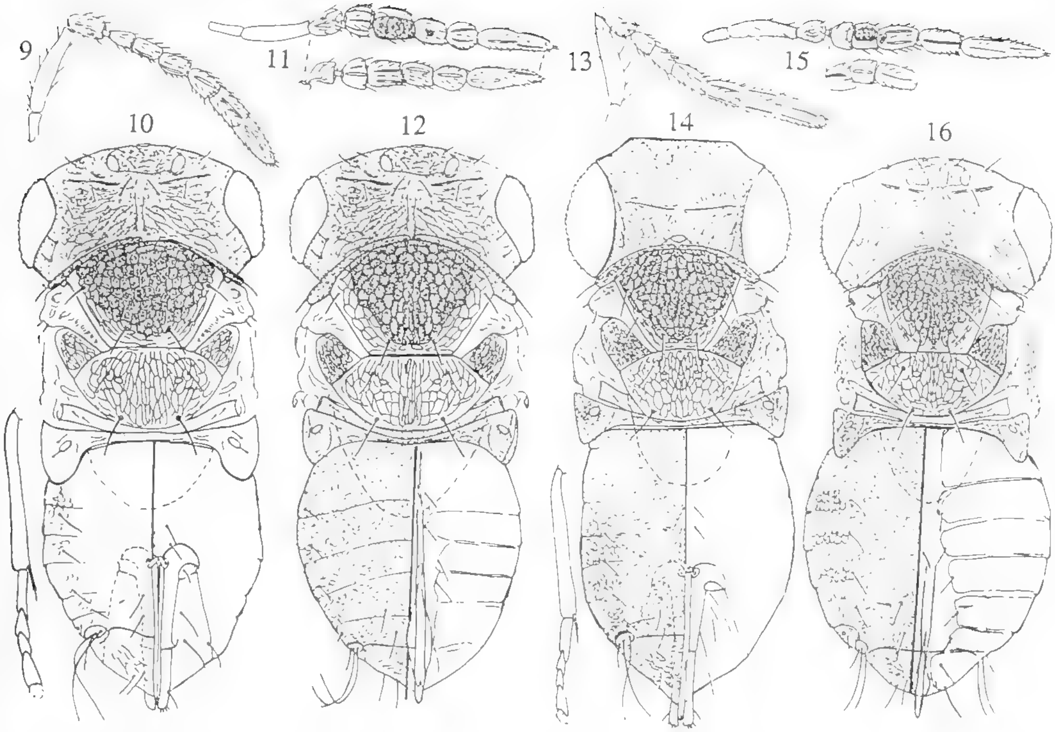
Encarsia nigricephala Dozier
(Figs. 9, 10, 11, 12, 21)

Encarsia nigricephala Dozier, 1937: 129.

Type.—Lectotype female and two paralectotype females (here designated) reared from *Bemisia* sp. on *Euphorbia hypericifolia,* Feb. 26, 1936, Mayaguez, Puerto Rico, in USNM. [examined]

Diagnosis.—The female of *E. nigricephala* can be distinguished from other *E. cubensis* group species by its dark brown head and anterior third to two thirds of mesoscutum, contrasting with the pale color of the remainder of the body. Males of *E. nigricephala* can be distinguished from *E. quaintancei* males by having 2 pairs of setae on the mesoscutum, the F2 longer than F3 antennal segment, and the hind tibia yellow. Males of *E. nigricephala* lack the ovoid sensory/glandular structure on the F1 antennal segment which is present in males of *E. hansoni.*

Description.—Female holotype. *Coloration*: (Fig. 10) Body yellowish with head, pronotum, and anterior third to two thirds of mesoscutum, dark brown; antenna and legs pale, F6 slightly infuscate; wings hyaline. Morphology: Antennal segments (Fig 9) with the following ratios of length to width: R:3.4, S:5.6, P:1.5, F1:2.0, F2:2.4, F3:2.0, F4:1.8, F5:1.7 and F6:2.3; relative lengths of segments R–F6 to length of F1: R:1.1, S:2.8, P:1.1, F1:1.0, F2:1.2, F3:1.1, F4:1.1, F5:1.2, and F6:1.5; linear sensilla present on F2–F6. Mesoscutum with me-



Figs. 9–16. 9–12, *Encarsia nigricephala*. 9, Antenna, female. 10, Habitus, feamle. 11, Antenna, male (dorsal/ventral). 12, Habitus, male. 13–16, *E. quaintancei*. 13, Antenna, female. 14, Habitus, female. 15, Antenna, male. 16, Habitus, male.

dium to broad hexagonal sculpture and 2 pairs of slender setae; each side lobe with 2 setae; each axilla with 1 seta, scutellar with Sc1 0.6× as long as Sc2; distance between scutellar sensilla about 6× the width of one sensillum; endophragma short, reaching base of tergite II; tibial spur of middle leg 0.6–0.8× as long as corresponding basitarsus. Fore wing (Fig. 21) almond-shaped, disc 1.3× as long as wide, marginal fringe 0.5× width of wing; discal setae uniformily distributed except wide asetose band along the distal margin and large, asetose area surrounding stigmal vein; 4–5 costal, 1 basal group, and 2 submarginal vein setae; marginal vein with 5–6 setae along its anterior margin, 2 setae at its base, and 6–7 short setae along its interior. Gastral tergites I–VI dorsum with imbricate lateral margins, tergite VII rugose; tergites I–VII with 0, 1, 1, 1, 2, 2, 2 pairs of setae, respectively. Venter with a pair of setae at sternite II and III, respectively; ovipositor arising at level of tergite III, 0.9× as long as tibia of middle leg; valvula III slender, 0.4–0.5× length of ovipositor.

Male.—(Description based upon specimen reared from the *Bemisia tabaci* species-complex, Puerto Rico, Mayaguez, 31.v.90, on *Lantana camara,* F.D. Bennett.) Coloration: Body dark brown, lateral margins of mesoscutum, side lobes, base of axillae, and scutellum, yellowish; legs and antenna, pale; wings hyaline. Antennal segments (Fig. 11) with the following length to width ratios: R: 3.0, S:4.1, P:1.3, F1:0.9, F2:1.6, F3:1.2, F4:1.3, F5 + F6 (fused):3.1; ratio of each segment to length of F1: R: 1.4, S:2.8, P:1.2, F1:1.0, F2:1.8, F3:1.2, F4: 1.3, F5 + F6 (fused):3.2; F2 longer than F3 and with 2 large, ovoid sensory/glandular structures covered by plate having 2 holes.

Ventral margins of funicle segments F2 and F3 longer than dorsal margins; mesosomal sculpturing and setation and fore wing similar to those of female.

Morphological variation.—We have examined hundreds of specimens of this species from a wide variety of hosts throughout the New World and have found very little morphological variation. The size of the dark brown area on the mesoscutum varies occasionally. Normally, this area covers approximately the anterior half of the mesoscutum; however, several specimens reared from *Bemisia argentifolia* in Guadeloupe and Colombia have the mesoscutum nearly entirely dark brown. The posterior margin of the scutellum is dark brown in a few specimens reared from *B. tabaci* species-complex in Georgia.

One male specimen, reared from an aleyrodid species on *Sonchus* sp. in Piracicaba, Brazil by F.D. Bennett, differs from *E. nigricephala* by having the F2 wider than long, subequal in length to the F3 antennal segment, and the last segment of the mid tarsus, dark brown. This specimen may represent a variation of *E. nigricephala* or possibly a distinct species.

Hosts.—**Aleurodicus dispersus* Russell, **Aleurotrachelus atratus* Hempel, *Bemisia argentifolia* Perring and Bellows, *B. tabaci* (Genn.), **Crenidorsum* sp., **Dialeurodes kirkaldyi* (Kotinsky), **Tetraleurodes acaciae* (Quaintance), *Trialeurodes abutiloneus* (Haldeman), *T. floridensis* (Quaintance), *T. vaporiorarum* (Westwood).

Distribution.—Barbados; Brazil; Colombia; *Ecuador; Grenada; Guadeloupe; *Guatemala; Honduras; Jamaica; Mexico; Puerto Rico; USA: Florida, Georgia, *Maryland, *Mississippi, Texas; Venezuela.

Specimens examined representing new host or distribution records.—Ecuador: Queredo, *Bemisia tabaci* species-complex on *Chamaesyce hirta,* 14.vi.1994, P. Stansly; Guatemala: (sent to Gainesville, Florida quarantine), 21.x.1991, ex. *Bemisia tabaci* species-complex; U.S.A., Florida, Indian River Beach, 10.iv.1987, ex. *Crenidorsum* sp., on *Coccoloba uvifera,* D. Mooney; U.S.A., Maryland, Colesville, 8.xi.1993, ex. *Bemisia argentifolia* on *Lycopersicon esculentum,* G. A. Evans; U.S.A., Mississippi, 1996, *Bemisia* tabaci species-complex on *Gossypium hirsutum,* M. Smith; U.S.A., Florida, Homestead, 5.ii.1991, *Aleurodicus dispersus* on ornamental tree, F. D. Bennett; U.S.A., Miami, 22.iii.1990, *Aleurotrachelus atratus* on *Cocos nucifera,* F. D. Bennett; U.S.A., Florida, Homestead, *Dialeurodes kirkaldyi* on ornamental tree, F. D. Bennett; Puerto Rico: Rio Piedras, 18.xi.1989, *Tetraleurodes acaciae* on *Jatropa gossypifolia,* F. D. Bennett. All of the above specimens deposited in GAE collection. Reunion: 1 ♀, Piton Saint Leu,21.v.1990, ex. *Trialeurodes vaporariorum,* B. Reynaud (CIRAD).

Encarsia quaintancei Howard
(Figs. 13, 14, 15, 16, 22)

Encarsia quaintancei Howard 1907: 79.

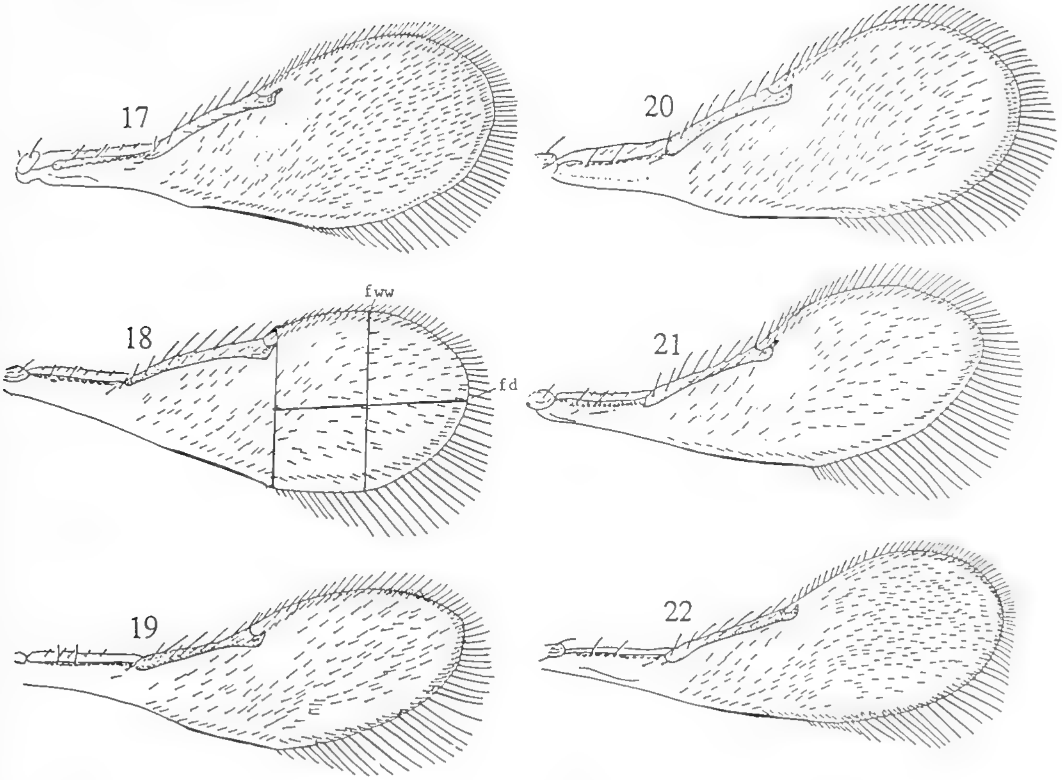
Prospaltella perspicuipennis Girault 1910: 234.

Encarsia perspicuipennis: Viggiani 1986: 71, n. comb., lectotype designated.

Prospaltella perspicuipennis: Polaszek et al. 1992: 387, synonymy.

Type.—Holotype female reared from *Aleyrodes* sp. on *Polygonum* sp., Washington, D.C., Bladensburg Road, 29.viii.1900, Theo. Pergande, in USNM [examined]. We consider the identification of the whitefly host of the holotype specimen as *Aleyrodes* sp. to be is erroneous and probably represents either *Trialeurodes abutilonea* or *T. vaporariorum* listed by Mound and Halsey (1978) as the whitefly species found on this host plant in the United States.

Diagnosis.—The female of *E. quaintancei* can be distinguished from other *E. cubensis* group species by having the scutellum bright yellow, contrasting with its dark brown head, mesoscutum and gaster, the F1 antennal segment cylindrical, and three pairs of mesoscutal setae. Males of this species can be distinguished from *E. nigrice-*



Figs. 17–22. Fore wings of *Encarsia* females. 17, *E. aleurothrixi*. 18, *E. cubensis*. 19, *E. hansoni*. 20, *E. hamoni*. 21, *E. nigricephala*. 22, *E. quaintancei*.

phala and *E. hansoni* males by having three pairs of mesoscutal setae, the F2 shorter than the F3 antennal segment, and the hind tibia brownish.

Description.—Holotype female. Coloration (Fig. 14): head, pronotum, axillae, metanotum and gaster, dark brown, scutellum bright lemon yellow, legs and antenna yellowish, F6 slightly infuscate; wings hyaline. Morphology: Antennal segments with the following ratios of length to width: R: 3.0, S:6.0, P:1.9, F1:1.3, F2:1.6, F3:2.2, F4: 1.9, F5:1.7 and F6:2.4; relative lengths of segments R–F6 to length of F1: R:1.5, S: 4.2, P:1.7, F1:1.0, F2:1.3, F3:1.8, F4:1.7, F5:1.7, and F6:2.3; F1–F6; linear sensilla present on F3–F6. Mesoscutum with narrow to medium hexagonal sculpture and 3 pairs of slender setae; each side lobe with 3 setae; each axilla with 1 short seta, scutellar setae Sc1 0.7× as long as Sc2; distance between scutellar sensilla 3× the width of one sensillum; endophragma short, not reaching posterior margin of tergite I; tibial spur of middle leg 0.75× as long as corresponding basitarsus. Fore wing (Fig. 22) apex rounded, disc 1.3× as long as wide, marginal fringe 0.34× width of wing; discal setae uniformily distributed except wide asetose band along the distal margin and large and large asetose area surrounding stigmal vein; 5–6 costal, 2–3 basal group, and 2 submarginal vein setae; marginal vein with 5 setae along its anterior margin, 2 setae at its base, and 6–7 short setae along its interior. Gastral tergites I–VI dorsum with imbricate lateral margins, tergite VII rugose; tergites I–VII with 0, 1, 1, 1, 2, 2, 2 pairs of setae, respectively. Venter with a pair of setae at sternite II and III, respectively; ovipositor arising at level of tergite IV, as long as tibia of mid leg; valvula III slender, 0.5× length of ovipositor.

Male.—(Description based upon specimen reared from *Bemisia tabaci* species-complex on *Emilia fosbergi,* USA, Florida, Ft. Pierce, 28.x.1990, F. D. Bennett). Coloration: Body (Fig. 16) dark brown, lateral and posterior margins of mesoscutum, side lobes, and scutellum, yellowish; antenna and legs pale, coxa III and femur III, brownish; wings hyaline. Antennal segments (Fig. 15) with the following length to width ratios: R:2.5, S:3.8, P:1.1, F1:0.9, F2:1.0, F3:1.8, F4:1.8, F5 + F6 (fused):3.7; ratio of each segment to length of F1: R: 1.2, S:3.2, P:1.4, F1:1.0, F2:1.2, F3:1.9, F4: 1.9, F5 + F6 (fused):3.8. F2 shorter than F3 and with 2 large, ovoid sensory/glandular structures covered by plate having 2 holes, F3 surface with striate, trapezoidal area; mesosomal sculpturing and setation and fore wing similar to those of female.

Hosts.—*Aleurothrixus floccosus; Bemisia argentifolia; B. tabaci; Trialeurodes abutiloneus; T. packardi* (Morill); **T. vaporariorum; Trialeurodes* sp.

Distribution.—*Brazil; El Salvador; Guadeloupe; Jamaica; Mexico; Puerto Rico; USA: District of Colombia, Florida, Illinois, Louisiana, Maryland, Mississippi; Venezuela.

Specimens examined representing new host or distribution records.—Brazil, Brasilia, iv.1992, *Trialeurodes vaporariorum,* R. Oliveira (1 ♀, 2 ♂, GAE).

Biology.—Dysart (1966) reported that this species completed its life cycle on *Trialeurodes abutiloneus* in 10 to 25 days, overwintered in the whitefly pupae and darkened the puparia of its whitefly host. However, Dysart's figure of the male antenna shows the F5 and F6 separated and the F2 segment without the ovoid sensory/glandular structure; this specimen was not *E. quaintancei* and probably represents the male of a species belonging to the *Encarsia luteola* species group.

WHITEFLY-PARASITOID HOST LIST

Aleurodicus dispersus Russell.—*E. nigricephala.*

Aleurothrixus aepim (Goldi).—*E. aleurothrixi.*

Aleurothrixus floccosus (Maskell), woolly whitefly.—*E. aleurothrixi, E. cubensis, E. quaintancei.*

Aleurotrachelus atratus Hempel.—*E. nigricephala.*

Aleurotrachelus trachoides (Back).—*E. cubensis.*

Bemisia argentifolia Perring and Bellows, silverleaf whitefly.—*E. nigricephala, E. quaintancei.*

Bemisia tabaci (Gennadius), sweetpotato whitefly.—*E. nigricephala, E. quaintancei.*

Bemisia tabaci species-complex.—*E. hamoni.*

Crenidorsum sp.—E. nigricephala.

Dialeurodes kirkaldyi (Kotinsky), Kirkaldy whitefly.—*E. nigricephala, E. quaintancei.*

Tetraleurodes acaciae (Quaintance).—*E. nigricephala.*

Tetraleurodes ursorum (Cockerell).—*E. hamoni.*

Trialeurodes abutiloneus (Haldeman), bandedwinged whitefly.—*E. nigricephala, E. quaintancei.*

Trialeurodes floridensis (Quaintance), avocado whitefly.—*E. nigricephala.*

Trialeurodes packardi (Morill), strawberry whitefly.—*E. quaintancei.*

Trialeurodes vaporiorarum (Westwood), greenhouse whitefly.—*E. nigricephala, E. quaintancei.*

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DESCRIPTIONS OF THE PUPAE OF SIX SPECIES OF *ARMIGERES* THEOBALD, SUBGENUS *LEICESTERIA* THEOBALD (DIPTERA: CULICIDAE) FROM NEPAL

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Abstract.—Descriptions and illustrations of previously unknown pupae of *Armigeres* (*Leicesteria*) *annulitarsis* (Leicester), *Ar.* (*L.*) *dentatus* Barraud, *Ar.* (*L.*) *dolichocephalus* (Leicester), *Ar.* (*L.*) *inchoatus* Barraud, and the partially described *Ar.* (*L.*) *digitatus* (Edwards) and *Ar.* (*L.*) *magnus* (Theobald) are presented. A key for their identification and the recently discovered *Ar.* (*L.*) *omissus* (Edwards) is included.

Key Words: mosquitoes, Culicidae, *Armigeres, Leicesteria,* pupae, Nepal

Thirteen species in the genus *Armigeres* Theobald are known from Nepal (Darsie and Pradhan 1990, Darsie et al. 1991, 1992). Six are placed in the subgenus *Armigeres* Theobald and seven in the subgenus *Leicesteria* Theobald. The pupae of two species adequately described in the subgenus *Armigeres* are *Ar. kesseli* Ramalingam (1987) and *Ar. theobaldi* Barraud (Toma et al. 1994). I am describing here the pupae of six species in the subgenus *Leicesteria,* four species whose pupae were unknown, *Armigeres annulitarsis* (Leicester), *Ar. dentatus* Barraud, *Ar. dolichocephalus* (Leicester), and *Ar. inchoatus* Barraud, and two species partially described by Delfinado (1966) and Baisas (1974), *Ar. digitatus* (Edwards) and *Ar. magnus* (Theobald). Recently a seventh species in this subgenus was discovered in our Nepal collection, *Armigeres* (*Leicesteria*) *omissus* (Edwards). Its pupa will be described later; however, it is added to the key.

Methods and Materials

Mosquito specimens used in this study were from several sources. The specimens from Nepal were collected during three field trips, results of which were reported by Darsie et al. (1991, 1992, 1993, 1994, 1996). Collection methods followed very closely those of Belkin et al. (1965). The majority of the collections were immatures from larval habitats, brought to the field laboratory. A proportion were reared individually to adult and the remainder mass reared, removing adults daily. The Nepal mosquito collection is stored at the Florida Medical Entomology Laboratory, Vero Beach, FL. The second source of material is from the U.S. Armed Forces Institute for Medical Sciences, Bangkok, Thailand. Representative collections made by its staff and employed in this study are deposited in the Walter Reed Biosystematics Unit, National Museum of Natural History, Smithsonian Institution, as were the specimens from the Institute for Medical Research, Malaysia. Nepal collection data is listed by district in upper case, locality, date, number and sex of the specimens, accompanying larval (Le) and/or pupal (Pe) exuviae, collection site, and in brackets, the collection number. Species confirmation was based on identifica-

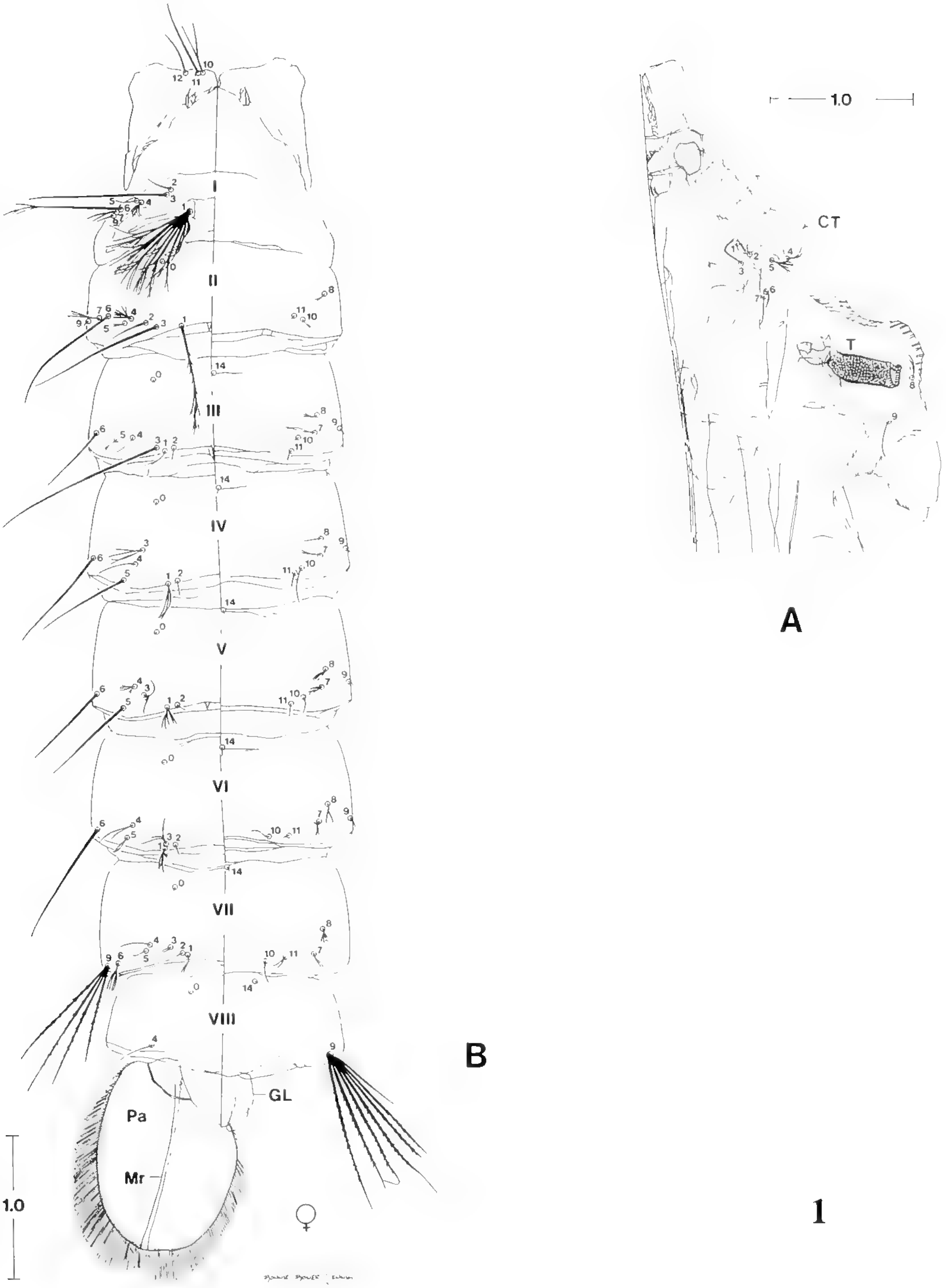

Fig. 1. Pupa of *Armigeres annulitarsis*. A, Cephalothorax. B, Metanotum and abdomen. Abbreviations: BU = paddle buttress; CT = cephalothorax; GL = genital lobe; Mr = paddle midrib; Pa = paddle; T = respiratory trumpet.

Table 1. Pupal chaetotaxy of *Armigeres annulitarsis.*

Seta	Cephalo-thorax	Abdominal Segments							
		I	II	III	IV	V	VI	VII	VIII
0	—	—	1	1	1	1	1	1	1
1	1	5–9(8,9)	1–10(2,3)	2	2–4(4)	3–6(3)	2–5(4)	2–3(2)	—
2	1–3(2)[1]	—	1	1	1	1	1	1	1
3	1	1	1	1	4–6(5)	2–3(2)	2–4(3)	2–4(2)	—
4	1–3(2)	4–8(?)	7–10(8)	1–2(2)	1–2(2)	5–7(6)	1–3(2)	1–2(1)	1–3(2)
5	3–8(4)	1	1–3(2)	1–2(2)	1	1	1–3(1,2)	1–2(1)	—
6	1	1–4(1)	1	1	1	1	1–3(1)	2–4(2)	—
7	1–2(2)	2–4(2)	2–5(3)	2–5(2)	1–4(2)	4–7(6)	2–5(3)	2–3(2)	—
8	2–3(2)	—	2–3(3)	2–5(3)	1–3(2)	1–3(2)	1–3(2)	4–10(5)	—
9	1	1	1	1	1	1	1	3–7(4)	5–7(7)
10	2–4(2)	—	1–2(1)	1	1	1	1	1–3(2)	—
11	1	—	1	1	1	1	1	1–2(1)	—
12	1	—	—	—	—	—	—	—	—
14	—	—	—	1	1	1	1	1	1

[1] Range followed in parentheses by the mode.

tion of associated adults and/or larvae. In the descriptions "b" means branches.

DESCRIPTIONS

Armigeres (*Leicesteria*) *annulitarsis* (Leicester)

(Fig. 1)

Position and size of setae as figured, range and modal number of branches in Table 1. *Cephalothorax:* Seta 3-CT much stouter that 1-CT and 2.0 longer; 6-CT rather stout, pale tan, 7-CT about 1.6 longer than 6-CT, single or double; trumpet length 0.43–0.5 mm long, index 2.3–2.5, pinna with small tragus. *Abdomen:* 1-II pedunculate, sparsely aciculate, usually with 2-3b in outer 0.45–0.61; 3-II stout, very long, 5.5 longer than 2-II; 1-III and 1-IV short, double or with 3, 4b; 1-V-VII at least 1.5 longer than 2-V-VII; 3-III subequal to length of following tergum; 3-IV with 4 to 6b; 6-II-V stout, at least 0.7 length of following tergum, single; 6-VI subequal in thickness to 5-V, usually single; 9-VII stout, aciculate, with 3-7b; 9-VIII stout, aciculate, with 5-7b. *Paddle:* length 1.30–1.39, index 1.26–1.4, fringe on outer margin extending to near base, fringe length 0.19 mm.

The description is based on the following specimens: Nepal, KASKI, Arghan, near Pokhara on the Prithvi Highway, VII-30-92, 3 ♀ Pe, 1 ♂ Pe, ex bamboo node [331]. Other specimens without accompanying immatures from Nepal are SUNSARI, Dharan, 6 ♀, ex light trap; JHAPA, Kanchanburi, VII-30-91, 1 ♀, reared from pupa, ex bamboo stump [101]; OKALDUNGA, Rumjatar, IX-23-91, 1 ♀, reared from pupa, ex bamboo stump [225].

Armigeres (*Leicesteria*) *dentatus* Barraud

(Fig. 2)

Positions and size of setae as figured; range and modal number of branches in Table 2. *Cephalothorax:* Seta 3-CT and 1-CT thin, very long, 1-CT about 1.4 length of 3-CT; 7-CT more than 2.4 length of 6-CT, usually double; trumpet length 0.47–0.57 mm, index 2.4–3.1. *Abdomen:* 1-II with 14-21b from near base; 3-II extremely long, 17.0 longer than 2-II; 1-III with 8-16b; 1-IV with 8-14b; 1-V-VII at least 1.7 length of 2-V-VII; 3-III 1.4 length of following tergum; 6-II-V with thin branches, 0.2–0.4 length of following tergum, single or with 2-5b; 6-VI stouter than 5-V, usually double;

Fig. 2. Pupa of *Armigeres dentatus*. A, Cephalothorax. B, Metanotum and abdomen. For explanation of abbreviations see Fig. 1.

Table 2. Pupal chaetotaxy of *Armigeres dentatus.*

Seta	Cephalothorax	Abdominal Segments							
		I	II	III	IV	V	VI	VII	VIII
0	—	—	1	1	1	1	1	1	1
1	1–2(1)[1]	14–19(17)	14–21(?)	8–16(11)	8–14(10)	5–8(7)	3–8(4)	1–5(2)	—
2	1–2(2)	1	1	1	1	1	1–2(1)	1	—
3	1–2(1)	1	1–2(1)	1–2(2)	3–8(4)	1–2(1)	1–2(1)	1–2(2)	1–3(1)
4	2–7(2)	2–5(5)	3–7(?)	1–2(2)	1–2(2)	2–5(4)	2–4(3)	1–4(3)	—
5	3–5(3)	1–2(1)	1–2(2)	3–8(4)	1–2(1)	1–2(1)	1–2(2)	1–3(1)	—
6	1	2–6(3)	2–5(3)	3–6(4)	1–4(4)	2–4(3)	1–3(2)	2–5(4)	—
7	1–3(2)	1–3(2)	2–4(2)	2–5(2)	1–3(2)	3–5(4)	2–3(2)	2–3(2)	—
8	2–5(4)	—	1–4(3)	2–6(3)	3–5(4)	3–5(4)	1–4(3)	3–6(3)	—
9	1–2(1)	1	1	1	1	1	1	4–8(5)	6–11(6)
10	4–7(6)	—	1–3(1)	1–4(2)	2–3(2)	1–3(2)	1–2(1)	1–2(2)	—
11	1(1)	—	1–2(1)	1	1–2(1)	1	1–2(1)	1–3(1)	—
12	1–3(2)	—	—	—	2–3(2)	1–3(1)	3–4(4)	—	—
14	1	—	—	—	1	1	1	1	1

[1] Ranges followed in parentheses by modes.

9-VII with 4-8b; 9-VIII with 6-11b. *Paddle:* length 1.34–1.44 mm, index 2.4–3.1, fringe on outer margin in apical 0.65, fringe length 0.10 mm.

The description is based on the following specimens: Thailand, Chiang Mai Province, Doi Pa Car, IV-9-64, 3 ♀ Le Pe, 2 ♂ Le Pe, ex bamboo stump. Collections of adults of this species in Nepal were made in SUNSARI, Dharan, IX-84, 2 ♀, IX-85, 2 ♀, ex light trap; JHAPA, Kanchanbari, VIII-2-91, 4 ♀, resting in forest.

Armigeres (Leicesteria) *dolichocephalus* (Leicester)

(Fig. 3)

Position and size of setae as figured; range and modal number of branches in Table 3. *Cephalothorax:* Seta 1,3-CT with thin branches, single, rarely double; 7-CT about 2.0 length of 6-CT, double or triple, 6-CT dark colored; trumpet length 0.58–0.65 mm, index 1.9–2.3. *Abdomen:* 1-II slightly pedunculate, branched in outer 0.88, with 24-36b; 3-II stout, about 3.0 longer than 2-II; 1-III with 4-11b; 1-IV with 3-13b; 1-V subequal to 2-V, 1-VI-VII 1.4 longer than 2-VI-VII; 6-II-V 0.07–0.15 length of following tergum; 6-VI stouter than 5-V, usually double; 9-VII with 2-6b; 9-VIII with 2-5b. *Paddle:* with conspicuous lobe apically on outer half, strongly emarginate, length 1.64–1.73 mm, index 1.6–1.76, fringe on apical 0.5 of outer margin, fringe length 0.10 mm.

The description was based on the following specimens: Malaysia, Institute for Medical Research, 1 ♀ Le Pe (No. 0875/13), 1 ♂ Le Pe (No. 0875/9), no locality given; Selangor, Ulu Langat, F.R., 1970?, 1 ♂ Le Pe (No. 3552-10). The species is represented in Nepal by adults as follows: SUNSARI, Dharan, IX-X-84, 2 ♀, ex light trap; KASKI, Pokhara, VII-28-92, 1 ♀, ex resting on bamboo; Arghan on Prithvi Highway, VII-31-92, 2 ♀. These records represent the first collection of this species in the Indian subcontinent.

Armigeres (Leicesteria) inchoatus Barraud

(Fig. 4)

Positions and size of setae as figured; range and modal number of branches in Table 4. *Cephalothorax:* Seta 1-CT about 1.6 length of 3-CT, both with thin branches; 7-CT at least 2.5 length of 6-CT, usually double; trumpet length 0.43–0.52 mm, index 1.7–2.3. *Abdomen:* Seta 1-II stout, pedun-

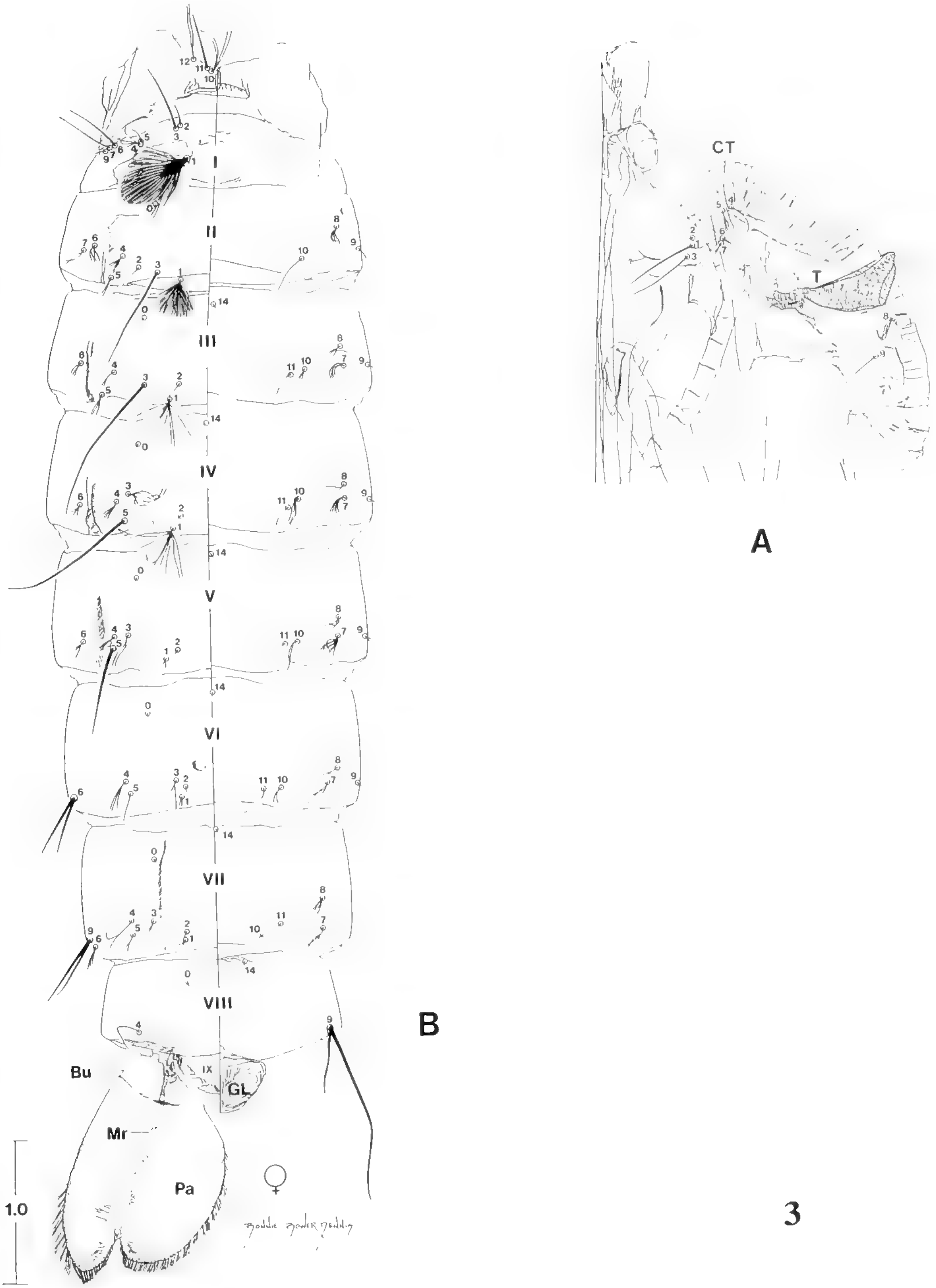

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Fig. 3. Pupa of *Armigeres dolichocephalus*. A, Cephalothorax. B, Metanotum and abdomen. For explanation of abbreviations see Fig. 1.

Table 3. Pupal chaetotaxy of *Armigeres dolichocephalus.*

Seta	Cephalo-thorax	Abdominal Segments I	II	III	IV	V	VI	VII	VIII
0	—	—	1	1	1	1	1	1	1
1	1	15–20(15)	24–36(27)	4–11(4)	3–13(?)	1–5(1)	2–5(2)	1–3(2)	—
2	2–4(2)[1]	1	1	1	1	1	1	1	—
3	1–2(1)	1	1	1–3(1)	4–7(5)	2–4(3)	2	2–3(3)	—
4	3	4–6(6)	4–7(4)	1–3(2)	2–4(3)	3–5(5)	2–5(2)	2–3(2)	1–2(1)
5	4–6(?)	1–2(1)	2–3(2)	3–5(3)	1	1	1	1–2(1)	—
6	1	1–3(?)	2–6(4)	2–5(3)	3–5(?)	1–4(1)	1–2(2)	3–4(3)	—
7	2–3(2)	1–2(2)	2–4(3)	3–6(3)	3–5(3)	3–8(?)	1–3(?)	1–3(3)	—
8	2–4(3)	—	—	2–4(?)	2–4(2)	2–5(3)	2–6(2)	3–6(4)	—
9	1	1	1	1	1–2(1)	1–2(1)	1	1–6(2)	2–6(3)
10	4–5(4)	—	1–3(1)	2–3(2)	1–4(2)	1–2(2)	1–3(1)	1–2(1)	—
11	1	—	1–4(1)	1	1	1	1	1–2(1)	—
12	1–2(1)	—	—	—	—	—	—	—	—
14	—	—	—	1	1	1	1	1	1

[1] Range followed in parentheses by mode.

culate, brush-like, with 6-16b on outer 0.10–0.25; 3-II about 12.0 longer than 2-II; 1-III with 4-6b, 1-IV with 2-6b; 1-V-VII at least 2.0 length of 2-V-VII; 3-III subequal to length of following tergum; 6-II-V with thin branches, 0.18–0.28 length of following tergum, single or double; 6-VI about as stout as 5-V, single; 9-VII stout, with 2-5b; 9-VIII stout, with 4-8b. *Paddle:* length 1.29–1.65 mm, index 1.48–2.0, fringe on apical 0.6 of outer margin, fringe length 0.05 mm.

The description is based on the following specimens: Nepal, KASKI, Pokhara, Male Patan, VII-28-92, 1 ♀ Le Pe, 3 ♀ Pe, ex bamboo stump [304]; Pokhara, Lamachaur, VII-28-92, 1 ♀ Le Pe, ex treehole [310]; 1 ♀ Le Pe, 5 ♀ P, 2 ♂ Le Pe, 3 ♂ Pe, ex bamboo stump [314]; Tholomani, VIII-25-92, 1 ♀ Pe, 1 ♂ Pe, ex bamboo stump [496].

Armigeres (*Leicesteria*) *digitatus* (Edwards)

(Fig. 5)

Positions and size as figured; range and modal number of branches in Table 5. *Cephalothorax:* Seta 1-CT and 3-CT, subequal in length, with thin branches, mostly single or double, rarely triple; 7-CT 1.6 length of dark colored 6-CT, single or double; trumpet length 0.57–0.63 mm, index 2.3–2.9. *Abdomen:* 1-II with 28-41b from near base; 3-II about 3.8 longer than 2-II; 1-III with 3-6b; 1-IV with 3-7b; 1-V-VII 2.0 or greater length of 2-V-VII; 6-II,III with thin branches, 0.27–0.45 length of following tergum, mostly single to triple; 6-IV,V with thin branches, 0.11–0.17 length of following tergum, usually double or triple; 6-VI stouter that 5-V, single or double; 9-VII with 2-4b; 9-VIII with 5-7b. *Paddle:* length 1.03–1.17 mm; index 1.34–1.48, fringe on outer margin to near base, fringe length 0.13 mm.

The description is based on the following specimens from the U.S. Army SEATO Laboratory, Bangkok, Thailand: Kanchanaburi Province, Ban Tha Thong Mon, IX-12-73, 1 ♀ Le Pe, 1 ♂ Le Pe, ex bamboo stump; Nakhonsawa Province, Khao Luang Nua, XI-7-68, 3 ♂ Le Pe, ex bamboo stump. Two adults without associated immatures were collected in Nepal: JHAPA, Kanchanbari, VIII-2-91, 1 ♂, resting outdoors [111]; Sunwari, VIII-5-91, 1 ♀, reared from pupa, ex bamboo stump [115].

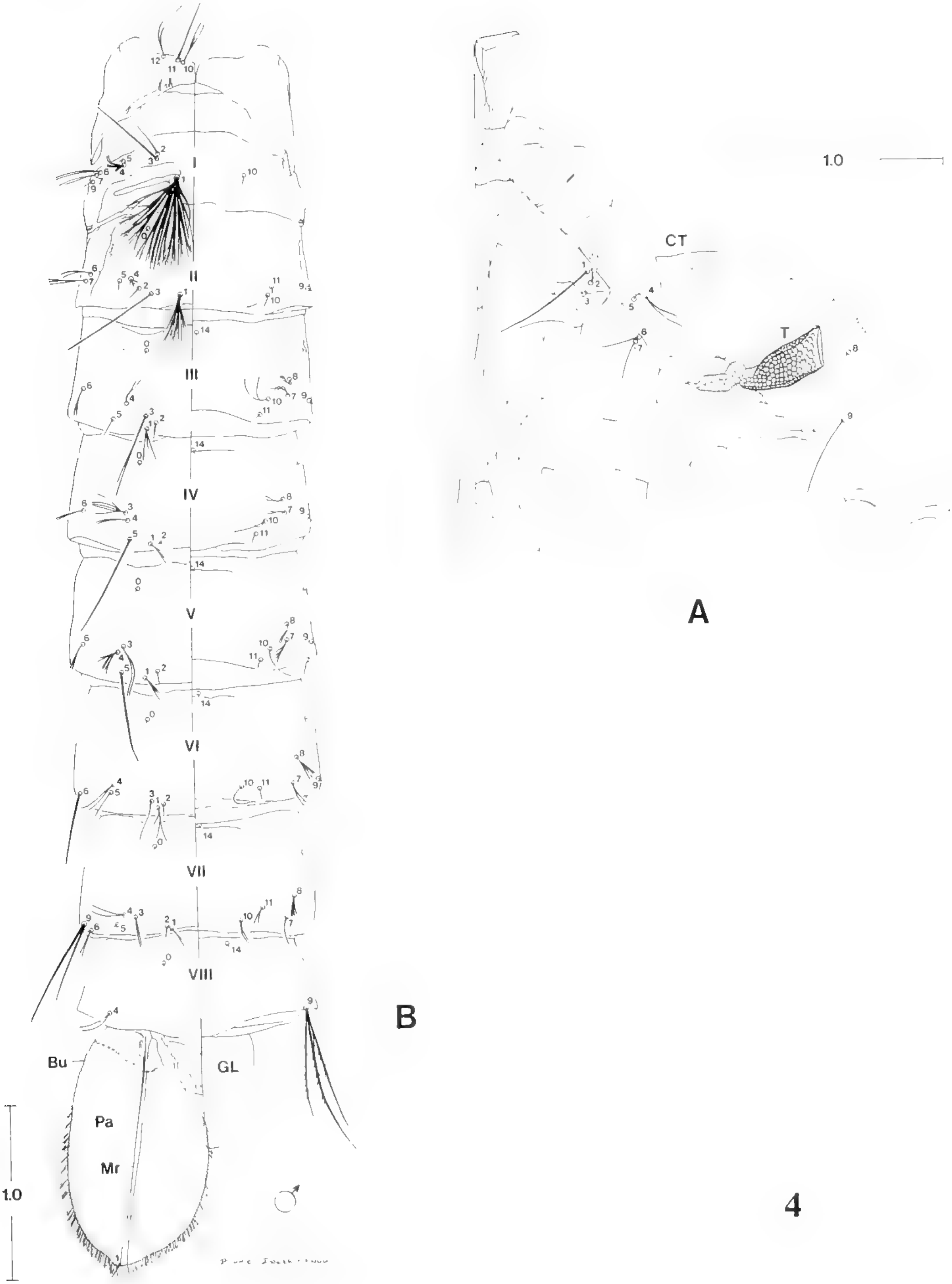

Fig. 4. Pupa of *Armigeres inchoatus*. A, Cephalothorax. B, Metanotum and abdomen. For explanation of abbreviations see Fig. 1.

Table 4. Pupal chaetotaxy of *Armigeres inchoatus.*

Seta	Cephalo-thorax	Abdominal Segments							
		I	II	III	IV	V	VI	VII	VIII
0	—	—	1	1	1	1	1	1	1
1	1–2(1)[1]	6–12(10)	8–19(?)	3–6(5)	2–6(4)	2–4(2)	2–5(2)	2–3(2)	—
2	1–3(2)	1	1	1	1	1	1	1	—
3	1–3(2)	1	1	1–2(1)	3–10(5)	3–6(3)	1–3(2)	1–2(2)	—
4	2–4(2)	4–7(5)	2–7(5)	1–3(2)	1–2(2)	2–6(5)	2–4(2)	2	1–3(2)
5	2–5(2)	1	1	1–3(1)	1–2(1)	1	1–2(1)	1–2(1)	—
6	1	2	1–2(2)	1–2(1)	1–2(2)	1–2(1)	1	1–5(2)	—
7	1–2(2)	2	2–5(2)	1–4(2)	1–3(2)	3–7(3)	1–3(3)	1–3(2)	—
8	1–3(2)	—	—	1–6(3)	2–5(2)	1–3(2)	2–3(2)	3–9(4)	—
9	1–2(1)	1	1	1	1	1	1	2–5(4)	3–8(5)
10	3–6(4)	1	1–3(2)	2–3(2)	1–4(2)	1–2(1)	1–2(1)	1–4(2)	—
11	1	—	1	1	1	1	1–2(1)	1–2(1)	—
12	1–2(1)	—	—	—	—	—	—	—	—
14	—	—	—	1	1	1	1	1	1

[1] Range followed in parentheses by the mode.

Armigeres (*Leicesteria*) *magnus* (Theobald)

(Fig. 6)

Positions and size of setae as figured; range and modal number of branches in Table 6. *Cephalothorax:* Setae 3-CT much stouter than 1-CT, subequal in length; 6-CT stout, light tan, 0.5 length of 7-CT; trumpet length 0.33–0.6 mm, index 0.2–0.3. *Abdomen:* 1-II long, pedunculate, with many long aciculae, single or 2- to 5-branched in distal 0.4–0.7; 3-II 4.0 length of 2-II, very stout; 1-III and 1-IV short, with 2-5 b; 1-V-VII 1.25–1.5 longer than 2-V-VII; 3-IV with 2-4b; 6-II-III stout, single, 0.8 as long as following segment; 6-IV, V rather stout, single, 0.5–0.6 as long as following segment; 6-VI stouter than 5-V, with 1-3b; 9-VII with 3-5b; 9-VIII with 4-8b. *Paddle:* length 1.19–1.45 mm; index 1.40–1.85, fringe on outer margin extending to near base, fringe length 0.17 mm.

The description is based on the following specimens: Nepal, OKALDUNGA, Rumjatar, Tallo Gaon, IX-21-91, 1 ♀ Le Pe, ex bamboo stump [225]; KASKI, Pokhara, Arghaun, VII-30-92, 1 ♀ Le Pe, ex bamboo stump [331]; Pokhara, Prithvi Highway, VII-31-92, 2 ♀ Le Pe, 1 ♂ Le Pe, ex bamboo stump [341].

KEY TO THE PUPAE OF THE GENUS ARMIGERES, SUBGENUS LEICESTERIA, FROM NEPAL

1. Paddle fringe extending to near base on outer margin (Figs. 1, 5, 6) 2
– Paddle fringe on apical 0.75 or less on outer margin (Figs. 2–4) 5
2(1). Seta 6-II-V short, thin, usually with 2 branches or more (Fig. 5) 3
– Seta 6-II-V long, stout, single (Figs. 1, 6) 4
3(2). Seta 1-II with 28 or more branches (Fig. 5) . . . . *digitatus*
– Seta 1-II with 17 or fewer branches . . *omissus*
4(2). Seta 3-IV usually 5- or 6-branched; seta 1-II sparsely aciculate (Fig. 1) . . . . *annulitarsis*
– Seta 3-IV usually with 4 or fewer branches; seta 1-II densely aciculate (Fig. 6) . . . *magnus*
5(1). Paddle with large external lobe; seta 1-II with 24 or more branches; seta 3-II 3.0 longer than 2-II (Fig. 3) . . . . . . *dolichocephalus*
– Paddle without large external lobe; seta 1-II with 21 or fewer branches; seta 3-II at least 12.0 longer than 2-II (Figs. 2, 4) 6
6(5). Seta 3-CT with thin branches, thinner than 1-CT; seta 6-VI single; setae 1-III-IV with 6 or fewer branches (Fig. 4) . . . . . *inchoatus*
– Setae 1-CT and 3-CT rather stout, subequal in size; seta 6-VI with 2 or more branches; setae 1-III-IV with 8 or more branches (Fig. 2) . . . . *dentatus*

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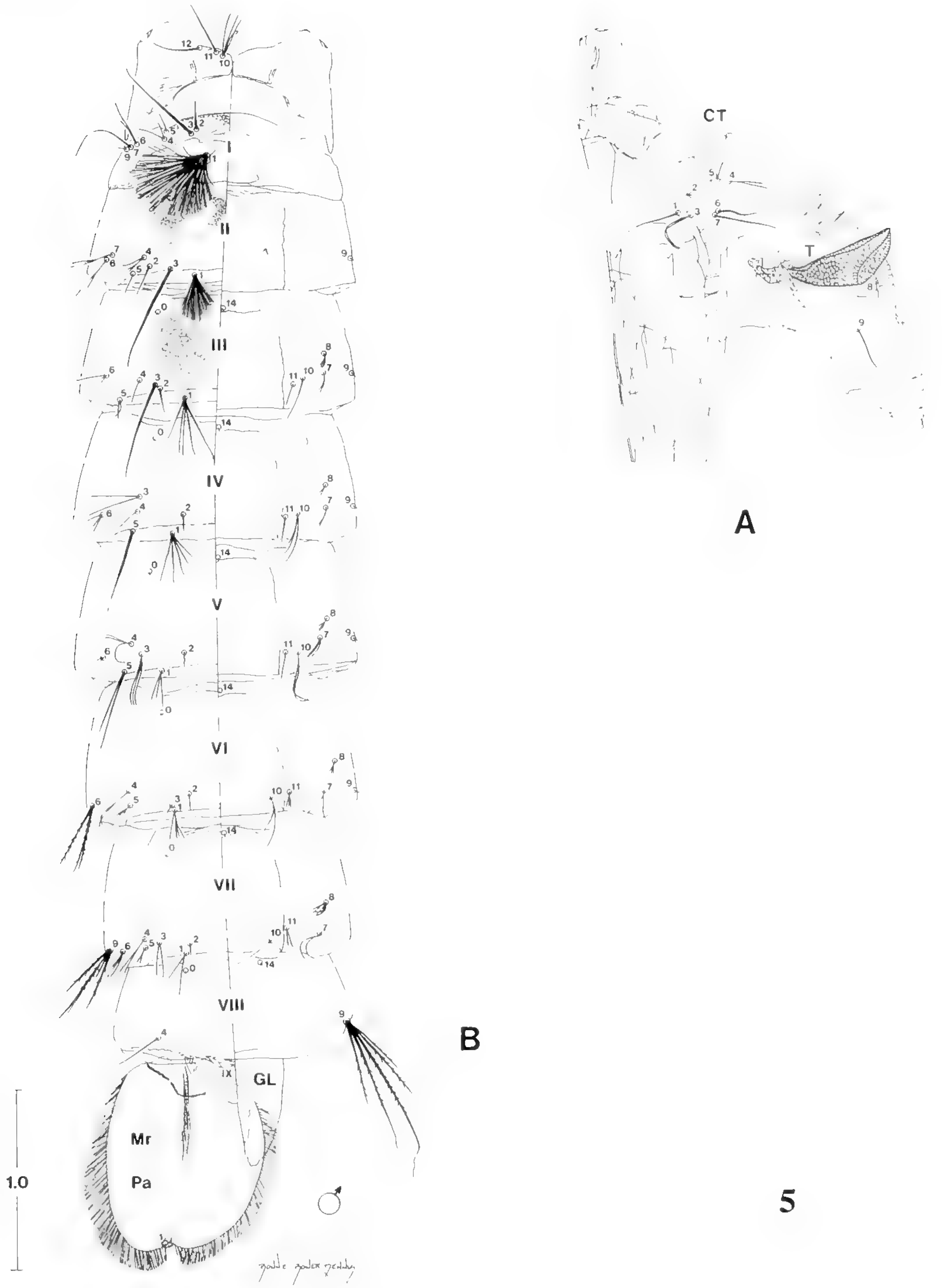

Fig. 5. Pupa of *Armigeres digitatus.* A, Cephalothorax. B, Metanotum and abdomen. For explanation of abbreviations see Fig. 1.

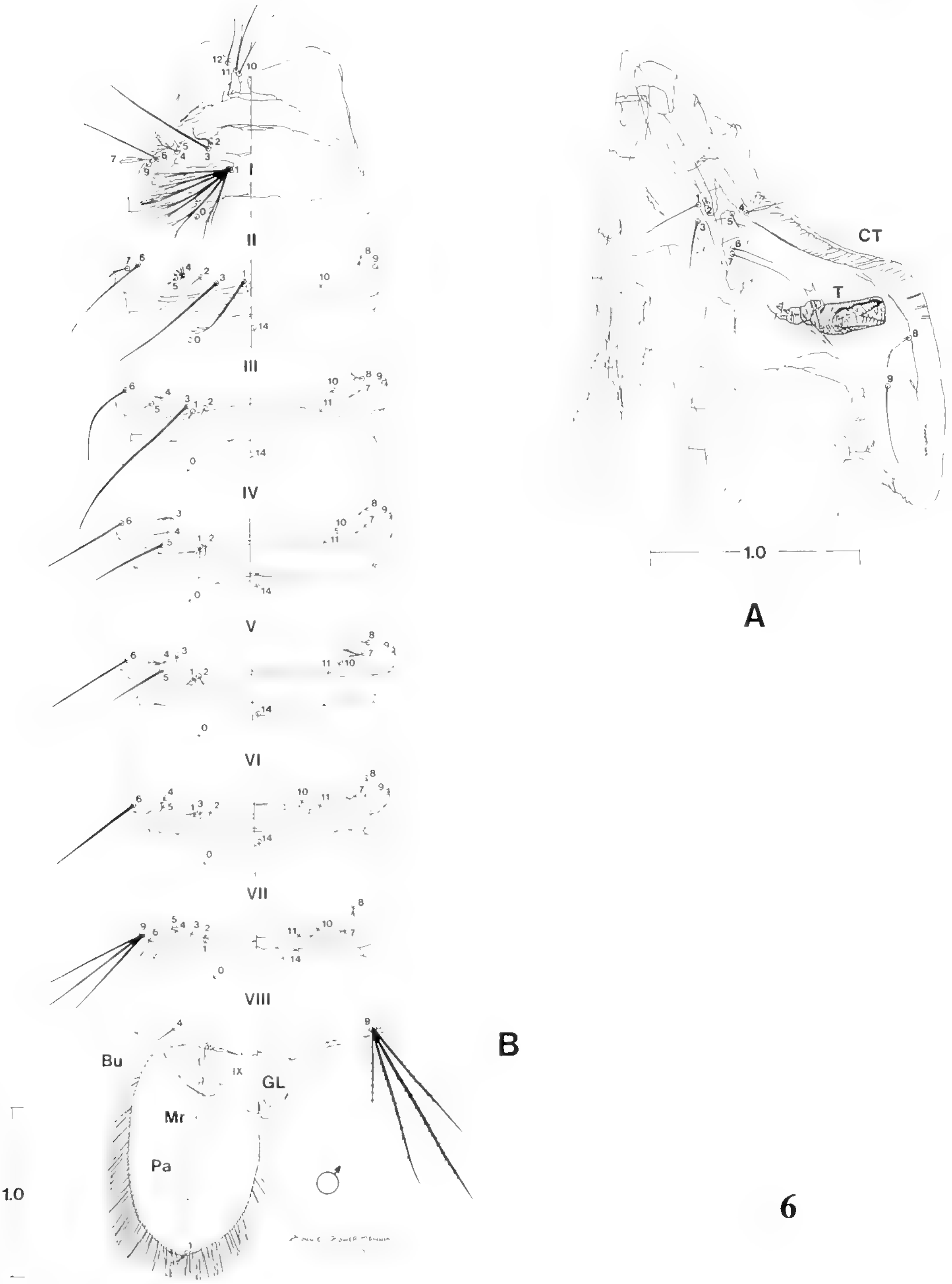

Fig. 6. Pupa of *Armigeres magnus*. A, Cephalothorax. B, Metanotum and abdomen. For explanation of abbreviations see Fig. 1.

Table 5. Pupal chaetotaxy of *Armigeres digitatus*.

Seta	Cephalo-thorax	Abdominal Segments I	II	III	IV	V	VI	VII	VIII
0	—	—	1	1	1	1	1	1	1
1	1–2(1)[1]	11–21(?)	28–41(?)	3–6(5)	3–7(5)	2–4(3)	1–4(2)	1–3(2)	—
2	2–3(2)	1(1)	1–2(1)	1	1–2(1)	1–2(1)	1(1)	1	—
3	2–3(2)	1–2(1)	1	1–2(1)	2–5(5)	2–3(3)	2–4(3)	2–3(2)	—
4	2–5(2)	2–3(2)	2–5(4)	1–3(2)	1–2(1)	3–5(4)	2–3(2)	1–2(2)	1–2(2)
5	2–4(3)	1	1–2(2)	2–5(2)	1–2(1)	1–5(1)	2–8(4)	2–3(2)	—
6	1–2(1)	1–3(2)	1–3(2)	2–4(3)	2–5(2)	2–3(2)	1–2(1)	2–4(3)	—
7	1–2(1)	1–2(2)	2	2–3(3)	1–3(2)	2–5(3)	2–4(3)	2–3(3)	—
8	2–4(3)	—	2–5(2)	2–4(3)	2–4(3)	2–5(3)	2–4(2)	3–7(6)	—
9	1	1	1	1	1	1	1	2–4(4)	5–7(6)
10	3–5(4)	—	2–3(2)	1–4(2)	2–3(2)	1–2(2)	1–2(2)	1–2(2)	—
11	1	—	—	1–2(1)	1	1	1–3(1)	1–3(2)	—
12	1–2(2)	—	—	—	—		—	—	—
14	—	—	—	1	1	1	1	1	1

[1] Range followed in parentheses by mode.

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Table 6. Pupal chaetotaxy of *Armigeres magnus*.

Seta	Cephalo-thorax	Abdominal Segments I	II	III	IV	V	VI	VII	VIII
0	—	—	1	1	1	1	1	1	1
1	1–3(1)[1]	5–10(6)	1–5(1)	2–4(2)	2–5(2)	2–4(4)	2–6(4)	1–5(2)	—
2	2–3(2)	1	1	1	1	1	1	1	—
3	1–2(1)	1	1	1	2–4(4)	2–6(3)	1–4(2)	1–6(2)	—
4	2–6(2)	5–6(6)	7–11(7)	1–2(1)	1–2(1)	2–6(2)	1–6(2)	1–3(1)	1–3(1)
5	2–6(5)	1–3(1)	1–2(1)	1–2(2)	1	1	1–3(1)	1–2(1)	—
6	1	1	1	1	1	1	1–3(1)	2–4(2)	—
7	1–2(1)	1–4(2)	2–5(3)	2–5(2)	2–4(2)	3–6(5)	1–6(3)	1–5(2)	—
8	2–3(2)	—	2–8(4)	3–4(3)	1–3(1)	1–3(1)	1–2(1)	2–8(4)	—
9	1–2(1)	1	1	1	1	1	1	3–5(3)	4–8(4,5)
10	2–4(2)	1	1–4(1)	1–3(1)	1–3(1)	1–2(1)	1–3(2)	1–3(2)	—
11	1–2(1)	—	1–2(1)	1–2(1)	1–2(1)	1–2(1)	1–2(1)	1–2(1)	—
12	1–3(1)	—	—		—	—		—	—
14	—	—	—	1	1	1	1	1–2(1)	1

[1] Range followed in parentheses by mode.

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A REVIEW OF THE BAT FLEA GENUS *HORMOPSYLLA* (SIPHONAPTERA: ISCHNOPSYLLIDAE)

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Abstract.—*Hormopsylla trux* Jordan, 1950 is reported for the first time in Venezuela. *Hormopsylla cryptica* Tipton and Machado-Allison, 1972 is a **new junior synonym** of *H. fosteri* (Rothschild, 1903). A key is provided to distinguish the four recognized species of the bat flea genus *Hormopsylla.*

Key Words: Siphonaptera, bat fleas, *Hormopsylla,* Ischnopsyllidae

A monograph of Ischnopsyllidae by Hopkins and Rothschild (1956) provides distributional records and host/parasite data for three species of *Hormopsylla*: *H. fosteri* (Rothschild 1903), *H. trux* Jordan, 1950, and *H. egena* Jordan, 1950. Since that publication, two new species have been described, *H. cryptica* Tipton and Machado-Allison, 1972, and *H. kyriophila* Tipton and Mendez, 1966, and additional records were reported for *H. kyriophila* by Smit (1971) and for *H. trux* by Whitaker and Easterla (1975) and Ayala-Barajas et al. (1988). Recently specimens of *H. fosteri* and *H. trux* were collected by R. Guerrero in Venezuela, the latter constituting a new record which warrants reporting. In this paper, we consolidate existing information, add new distributional records, annotate host/parasite data, and provide a key to the four recognized species of *Hormopsylla.*

HOST SYNONYMS

The following chiropteran species preceding various junior synonyms are currently accepted taxa according to Wilson and Reeder (1993). Junior synonyms are used throughout the text as cited in literature, or as extracted from slide labels. *Desmodus rotundus* (Geoffroy 1810) = *Desmodus rufus* Wied-Neuwied, 1826; *Eumops bonariensis* (Peters 1874) = *Molossus bonariensis* Dobson, 1876; *Molossus molossus* (Pallus 1766) = *Molossus coibensis* Allen, 1904, and *Molossus major* Hershkovitz, 1949; *Nyctinomops laticaudatus* (Geoffroy 1805) = *Nyctinomops gracilis* (sic!) Dobson, 1876, *Nyctinomus laticaudatus* (sic!) Miller, 1902, *Tadarida gracilis* (author unknown), *Tadarida laticaudata* Shamel, 1931, *Tadarida laticaudata yucatanica* Jones and Alvarez, 1962, and *Tadarida yucatanica* (Miller 1902); *Nyctinomops macrotis* (Gray 1840) = *Tadarida macrotis* Miller, 1924, and *Tadarida mollosa* Hershkovitz, 1949.

RESULTS AND DISCUSSION

Species of *Hormopsylla* are restricted to the Neotropical Region with one species reaching the southern Nearctic Region. They prefer bats of the Family Molossidae, although they have been collected from Vespertilionidae [*Eptesicus brasiliensis*

(Desmarest 1819)] and Phyllostomidae [(*D. rotundus* and *Phyllostomus hastatus* (Pallas 1767)]. In general, specimens of *Hormopsylla* are rare in collections, but more attention to collecting from molossid bats throughout their range (particularly from species of *Eumops* Miller, 1906, *Molossus* Geoffroy, 1805, and *Nyctinomops* Miller, 1902) would undoubtedly extend the distribution of all species of *Hormopsylla.*

Hormopsylla egena Jordan
(Fig. 3)

Hormopsylla egena Jordan 1950: 608, Fig. 5.

Material examined.—PERU: 4 ♀, ex: "bats in rat burrow in roof," Trujillo City, XII-1947, D.A. Macchiavello.

Remarks.—*Hormopsylla egena* is known only from seven females.

Hormopsylla fosteri Rothschild
(Figs. 2, 5, 7)

Hormopsylla fosteri Rothschild 1903: 324, Pl. X, Figs. 23–26.

Hormopsylla cryptica Tipton and Machado-Allison 1972: 87, Figs. 72–74. **New synonomy**.

Material examined.—ARGENTINA: 1 ♀, Tucumán, J. Morgensen; 9 ♂, 9 ♀, ex: *Eumops perotis* (Schinz 1821), embalse Rio Tercero, Cordoba Prov., Dep. Calamuchita, elev. ca. 400 m, 19-IX-1981, S.I. Tiranti (also 10 ♂, 20 ♀, alcohol); 4 ♂, 15 ♀, also in alcohol, *ibid.*, except 19 VIII–1981; BRAZIL: 2 ♀, ex: *D. rotundus,* São Paulo, P. Sawaya; PARAGUAY: ♂ lectotype, ♀ lectoallotype, ♀ paralectotype, ex: *M. bonariensis,* Ascension (sic!), 6-VIII-1900, S. Foster; VENEZUELA: (*Hormopsylla cryptica*), ♂ holotype (USNM No. 72537), ex: *E. brasiliensis,* 84 km sse Esmeralda, near Boca Mavaca, T.F. Amazonas, elev. 185 m, 13-II-1966, Tuttle Team; 1 ♂, 2 ♀, ex: *M. molossus,* Cumbre Cerro Guanay, Edo. Amazonas, elev. 1100 m, 14-II-1995, R. Guerrero; 1 ♂ 1 ♀, *ibid.*, but elev. 1200 m; 2 ♀, ex: *N. laticaudatus,* Tepuy, Guyana Highlands, Edo. Amazonas, elev. 1200 m, R. Guerrero, 13-II-1995.

Remarks.—The first record of *H. fosteri* in Venezuela was described from three males by Tipton and Machado-Allison (1972) as *H. cryptica.* Each was collected from a different host species (*E. brasiliensis, M. molossus,* and *N. laticaudatus*) at low elevations (150–185 meters). In our study, the holotype of *H. cryptica* (USNM No. 72537) could not be distinguished from the lectotype of *H. fosteri.* The characters used by Tipton and Machado-Allison (1972) (shape of the apex of St-VIII, the body of the clasper, the crochets, and median dorsal lobes) to separate these two species do not distinguish them. The shape of these structures is affected by orientation during mounting. The delicate membranous nature of the dorsal median lobe as seen in a dissected male of *H. fosteri* is particularily prone to distortion. Examination of many males demonstrated variation common to both species. Therefore, we propose that *H. cryptica* is a junior synonym of *H. fosteri.* Other records have since been added (see Material Examined: Venezuela above). Previously, *H. fosteri* was reported from *E. bonariensis* and *N. laticaudatus* in Paraguay by Rothschild (1903); from *D. rotundus* and *P. hastatus* in Brazil by Guimarães (1940) and Cunha (1914), respectively; and in Argentina (host unknown) by Hopkins and Rothschild (1956). An additional large series in the collection of Dr. Nixon Wilson is previously unreported (see Material Examined: Argentina, collected by S.I. Tiranti).

Rothschild (1903) did not designate a holotype, although his original description was based on one male and three females. The original description indicates the male was collected from *M. bonariensis,* but was later designated by Hopkins and Rothschild (1956: 214) as the "holotype" collected from *Nyctinomus laticaudatus.* The label of the actual designated lectotype in The Natural History Museum, London, indicates the host as *Molossus bonariensis.*

Hormopsylla kyriophila Tipton and Mendez
(Figs. 1, 6, 8)

Hormopsylla kyriophila Tipton and Mendez 1966: 303, Pl. 60–61.

Material examined.—PANAMA: ♂ holotype, Coll. No. 7583, USNM No. 104641, ex: *Tadarida yucatanica,* (under roof tile on) belfry of Church, Pacora (about 25 miles northeast of Panama City, elev. sea level), 21-VI-1961, (C.M.) Keenan and (V.J.) Tipton; ♀ allotype, *ibid.*, but Coll. No. 7284, 20-VI-1961. Information added from text of original description is indicated in parentheses.

Remarks.—*Hormopsylla kyriophila* was described from Panama from *T. yucatanica* and *M. molossus.* Smit (1971) also reported this flea in Cuba from *Tadarida laticaudata yucatanica* and in Veracruz State, Mexico from *N. laticaudatus.* Although the elevation for the specimens in Cuba are unknown, the other two collections have been at elevations below 100 meters.

Hormopsylla trux Jordan
(Fig. 4)

Hormopsylla trux Jordan 1950: 608, Fig. 5

Material examined.—U.S.A., TEXAS: 1 ♂, 1 ♀, ex: *E. perotis,* Big Bend National Park, Brewster Co., 23-VI-1967, D.A. Easterla; 1 ♂, *ibid.*, but 1-VII-1967; VENEZUELA: 1 ♂, 1 ♀, ex: *N. macrotis,* Talud del Cerro Marahuaca, Edo. Amazonas, elev. 1300 m, 21-II-1985, R. Guerrero.

Remarks.—The Venezuela record above is new for that country. This is not surprising, since Venezuela is situated geographically between other known records. Jordan (1950) described *H. trux* from a pair collected from "bats" near sea level in Trujillo City, Peru, and Ayala-Barajas et al. (1988) reported two females from *N. macrotis* at Indio Verdes, Mexico. The most northern record is reported by Whitaker and Easterla (1975) from Big Bend National Park, Brewster County, Texas. They recovered 23 specimens from a single *E. perotis* (among 19 examined) and 2 specimens from *N. macrotis* (among 64 examined). Such large numbers of fleas from a single bat among so many negative bats of the same species, locality, and collection period, would suggest limited exposure to adult fleas. *Eumops perotis,* a very large bat, requires substantial roosting heights (greater than 10 feet) to routinely begin flight (Barbour and Davis 1969). It is highly unlikely that host seeking adult *H. trux* could traverse vertical inclines to such great heights. Consequently, contact with adult fleas might only be possible during the bats infrequent contact with guano. This might provide an explanation of why a single adult became infested with a large numbers of fleas, while others had none at all. If this infestation mechanism is valid, one would expect to collect large numbers of adult *H. trux* from guano deposits during June and July in Texas environs. The altitudinal distribution of *Hormopsylla trux* appears to occur between sea level and 2200 meters wherever *E. perotis* occurs. *Nyctinomops macrotis* may serve in distributing *H. trux* across its range wherever *E. perotis* is located, since *E. perotis* is not considered a migratory species (Nowak and Paradiso 1983).

KEY TO THE KNOWN SPECIES OF *HORMOPSYLLA*

1\. Subdorsal incrassation of frons (between frons and cibarium) present 2

– Subdorsal incrassation of frons absent 5

2\. Male 3

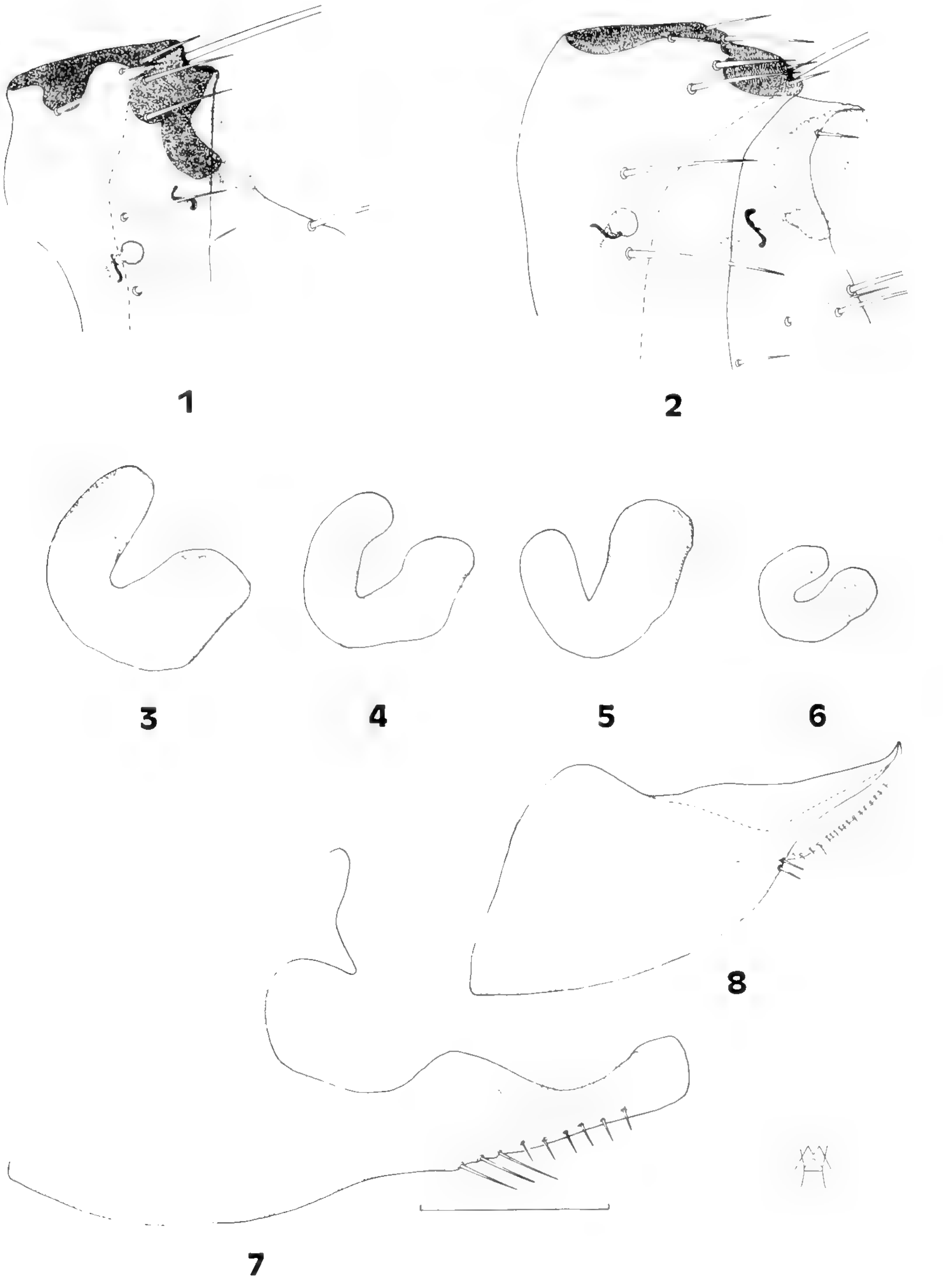
– Female 4

3\. Apex of eighth sternite blunt, with many coarse striae on the mesal surface running perpendicular to the long axis (Fig. 7) . . . . *fosteri*

– Apex of eighth sternite acute, without coarse striae on the mesal surface (Fig. 8) . . . . . . *kyriophila*

4\. Dorsal incrassation of tergite 7 much thicker than width of head of spermatheca (Figs. 1, 6); eighth tergite with a heavily sclerotized incrassation enveloping the last abdominal spiracle (Fig. 1); metanotal comb with 8–10 teeth . . . . *kyriophila*

– Dorsal incrassation much thinner than width of head of spermatheca (Figs. 2, 5); eighth tergite with at most, a faint sclerotization enveloping



Figs. 1–8. *Hormopsylla* spp. 1–2, Female, dorsal incrassations of abdominal tergites VII and VIII. 1, *H. kyriophila*. 2, *H. fosteri*. 3–6, Spermathecae. 3, *H. egena*. 4, *H. trux*. 5, *H. fosteri*. 6, *H. kyriophila*. 7–8, Eighth sternum. 7, *H. fosteri*. 8, *H. kyriophila*. Scale = 100 μ.

spiracle (Fig. 2); metanotal comb with 10–12 teeth . . . . *fosteri*

5. Vertical depth (thickness) of dorsal occipital incrassations less than the width of base of second genal tooth; metanotal comb with 20–22 teeth . . . . (male unknown) *egena*
– Vertical depth equal to, or distinctly greater than the width of the base of the second genal tooth; metanotal comb with 10–14 teeth . . . *trux*

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REEVALUATION OF UNRECOGNIZED NEARCTIC *BIBIO* GEOFFROY NAMES (DIPTERA: BIBIONIDAE)

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Abstract.—Five names of *Bibio* (Diptera: Bibionidae) were considered unrecognizable in the last catalog of Diptera of America North of Mexico. These names are reevaluated. **New synonyms** are: *B. fraternus* Loew and *B. baltimoricus* Macquart = *B. articulatus* Say; *B. castanipes* Jaennicke = *B. albipennis* Say; and *B. curtipes* James = *B. tristis* Williston. Lectotypes are designated for *B. baltimoricus* and *B. castanipes. Bibio pallipes* Say and *B. thoracicus* Say are considered *nomen dubia.*

Key Words: *Bibio,* Bibionidae, Nearctic

Hardy's (1965) catalog of Bibionidae of America North of Mexico included five names of *Bibio* Geoffroy which were considered unrecognizable due to inadequate original descriptions and/or lost or unavailable type material (Hardy 1945). A reevaluation of the original descriptions and available type material has resulted in a change of status for three. *Bibio tristis* Williston, although recognized by Hardy (1945, 1965), has never been properly placed, and the status of this species is discussed. *Bibio pallipes* Say and *B. thoracicus* Say are discussed and are considered *nomen dubia.*

MATERIAL AND METHODS

Terminology follows McAlpine (1981). Acronyms of collections where material has been deposited follows Arnett et al. (1993). The following made material available for study: American Museum of Natural History, New York, NY (AMNH); Nigel Wyatt, The Natural History Museum, London (BMNH); Boris C. Kondratieff, C. P. Gillette Museum, Colorado State University, Fort Collins (CSUC); Michael S. Kelly and Leslie C. Costa, Museum of Comparative Zoology, Harvard University, Cambridge, MA (MCZC); Forschungsinstitut und Naturmuseum Senckenberg, Germany (SMFD); Carl A. Olson, University of Arizona, Tucson (UAIC).

To insure positive identifications of primary types, label data for designated lectotypes is presented following O'Hara (1982): Labels are cited in full starting from the top down, with data from each label enclosed in quotation marks. Original spelling and punctuation are preserved, label lines are indicated by a slash mark (/), except when slashes are used on original labels to separate date information, and square brackets signify information not included on the specimen label.

Lectotypes are designated in accordance with Recommendation 73F of the International Code of Zoological Nomenclature (International Commission on Zoological Nomenclature 1985).

RESULTS

Bibio albipennis Say

Bibio albipennis Say 1823: 77. Syntype(s) destroyed, USA: Pennsylvania.

Bibio castanipes Jaennicke 1867: 317. Lectotype female (here designated) (SMFD), labeled: "Jilinois Am: b^a./D^r. Reufs." "LECTOTYPE/Bibio castanipes/Jaennicke/designated by/S. Fitzgerald 1997 [red label]". **New synonym.**

Bibio albipennis Say is one of the most commonly collected species in the United States. *Bibio castanipes* Jaennicke was unrecognized by Hardy (1945) due to the inadequate original description. Examination of the lectotype female (here designated), indicates this species is conspecific with *B. albipennis.* Only two species of Nearctic *Bibio, B. albipennis* and *B. curtipes* James (1936: 5; see discussion of *B. tristis* below), have the r-m cross vein one-fourth to one-third the length of the basal portion of Rs vein (Fitzgerald 1996). The females of *B. albipennis* and *B. curtipes* are distinguished by color of the legs. The lectotype female of *B. castanipes* is old and the coloration is greatly faded. However, the original description of *B. castanipes* stated that the legs were chestnut brown, which corresponds to the black to dark brown legs of *B. albipennis,* not the orange yellow legs of *B. curtipes.* The apical palpal segment of the female of *B. albipennis* is more elongate than that of *B. curtipes,* which is very minute, sometimes appearing vestigial or absent. The lectotype of *B. castanipes* has the apical palpal segment elongate like *B. albipennis.*

Bibio articulatus Say

Bibio articulatus Say 1823: 77. Syntype female(s) destroyed, USA: Pennsylvania.

Bibio baltimoricus Macquart 1855: 37. Lectotype female (here designated) (BMNH), labeled: "[circle with blue outline] Syn-/type" "SYNTYPE/Bibio/baltimoricus/ Macquart/det. J.E. Chainey, 1992" "[hand written] Baltimoricus/♂. Macq[uart]. n[ew]. sp[ecies]/Baltimore. (D. [illegible].)" "USA:/Baltimore/ex Bigot coll./BM 1960-539" "LECTOTYPE/*Bibio baltimoricus*/Macquart/designated by/S. Fitzgerald 1997". **New synonym.**

Bibio fraternus Loew 1864: 54. Syntype male(s) and female(s) (MCZC), USA: District of Columbia, Osten Sacken. **New synonym.**

Hardy (1945) stated that *B. articulatus* Say may be conspecific with *B. abbreviatus* Loew (1864: 54) or *B. fraternus* Loew, but left the status of the name in question due to the inadequacy of the original description and the lack of types. Although the types of *B. articulatus* are probably destroyed, the identity of the species can be determined from the original description. Both McAtee (1922) and Hardy (1945) indicated that the original description is inadequate because it does not refer to the length of the tarsal segments. The length of the hind basitarsus is important in distinguishing the male of *B. fraternus* from *B. abbreviatus* (Fitzgerald 1997). However, the original description of *B. articulatus* is of a female which can be distinguished by a set of characters exclusive of the length of the hind basitarsus. Only one species of Nearctic *Bibio, B. fraternus,* has the anterior spur of the fore tibia subequal to the posterior spine and the dorsum of the thorax orange yellow in the female.

Hardy (1945) stated that *B. baltimoricus* Macquart may be conspecific with *B. abbreviatus* or *B. fraternus,* but the original description is inadequate to fix its identity. Examination of the lectotype female and two paralectotype males (these types all here designated) of *B. baltimoricus* confirms that they are conspecific with *B. articulatus.* The male paralectotypes are in poor condition, but examination of their terminalia indicates that they are conspecific with *B. articulatus. Bibio articulatus* was discussed (diagnosed, with *B. abbreviatus*) and the male terminalia illustrated by Fitzgerald (1997).

Bibio tristis Williston

Bibio tristis Williston 1893: 113. Type(s) (apparently lost), USA: Western Kansas.

Bibio curtipes James 1936: 6. Holotype female (AMNH), USA: Colorado, Boulder; examined. **New synonym.**

Although recognized by Hardy (1945, 1965), *B. tristis* has not been properly placed in the literature. All specimens which I have examined identified as *B. tristis* (mostly by Hardy) represent *B. palliatus* McAtee (1922: 16) or *B. similis* James (1936: 5). Hardy (1945) stated that *B. tristis* is most similar to *B. xanthopus* Wiedemann (1828: 80), but can be distinguished by the black thoracic pile. Holt assigned specimens from the Graham Mountains, Arizona, to this species (McAtee 1922). Specimens examined (UAIC, CSUC) from Mt. Graham, Arizona, which match Hardy's (1945) concept of *B. tristis,* represent *B. xanthopus.* Although the type(s) of *B. tristis* are apparently lost (Hardy 1945), the identity of the species can be established from the original description. Williston (1893: 113, Fig. e) provided an illustration of a female of *B. tristis* including details of the wing venation. In this illustration the r-m crossvein is one-third the length of the basal portion of Rs vein. Only two Nearctic species exhibit this venational character, *B. albipennis* and *B. curtipes* (Fitzgerald 1996). Females of these two species are distinguished by leg color. The original description states that the legs are "red or yellowish-red" indicating that this species is a senior synonym of *B. curtipes.* Notes on the intraspecific color variation and an illustration of the male terminalia of *B. tristis* were provided by Fitzgerald (1996).

Bibio tristis has been recorded from Colorado, western Kansas, and Utah (Fitzgerald 1996). Since records of *B. tristis* from Washington (Hardy 1945) and Arizona (McAtee 1922) are likely based upon misidentifications, they are not included.

BIBIO SPECIES CONSIDERED *NOMEN DUBIA*

McAtee (1922) and Hardy (1945) stated that *B. pallipes* Say (1823: 76) may be conspecific with *B. fraternus* or *B. abbreviatus,* but both believed the original description to be inadequate. Neither the original description nor Wiedemann's (1828: 81) reference to the presumed type of *B. pallipes* refer to the length of the hind basitarsus. Since the type(s) of *B. pallipes* are apparently destroyed or lost this name remains unrecognized.

The type(s) of *B. thoracica* Say (1824: 368), described from "East Florida", is apparently destroyed. Wiedemann (1828: 78), presumably referring to a type specimen, stated that "this species had been smashed during mailing so that I was not able to see anything of it except the thorax." Wiedemann (1828) also stated that he "cannot decide whether this species might belong here [Bibio] or to Plecia," but the mention of "spines of the anterior tibia piceus, the exterior one much larger" by Say (1824) clearly places this species as *Bibio.* Hardy (1958) cited *B. thoracicus* as a probable synonym of *B. rufithorax* Wiedemann (1828: 78), even though the female of *B. rufithorax* has the legs entirely black to dark brown, as opposed to Say (1824) who described the legs of *B. thoracicus* as "thighs rufous." Say (1824), describing the female legs as bicolored and the dorsum of the thorax as orange, can only be referring to two species of Nearctic *Bibio, B. alienus* McAtee (1923: 62) or one of the color forms of *B. carolinus* Hardy (1945: 457). *Bibio alienus* is not known to occur in Florida. Although *B. carolinus* does occur in eastern Florida (CSUC), females that have the legs bicolored rather than entirely black to dark brown have only been examined from south of the United States. The name *thoracicus* applies to either *B. carolinus* or *B. alienus,* but until the color variation of *B. carolinus* in Florida, and the distribution of *B. alienus,* are better known, the status of the name *B. thoracicus* must remain unsettled.

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NEW EULOPHIDAE (HYMENOPTERA) REARED FROM CITRUS LEAFMINER, *PHYLLOCNISTIS CITRELLA* STAINTON (LEPIDOPTERA: GRACILLARIIDAE)

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Abstract.—Two new species of Eulophidae, ***Pediobius puertoricensis*** and ***Chrysocharodes lasallei*** (Hymenoptera: Eulophidae: Entedoninae) reared from the citrus leafminer, *Phyllocnistis citrella* Stainton (Lepidoptera: Gracillariidae) from Puerto Rico and Colombia, respectively, are described and illustrated.

Key Words: Biological control, taxonomy, Chalcidoidea, Eulophidae, citrus leafminer

The citrus leafminer, *Phyllocnistis citrella* (Stainton) (CLM), occurs naturally with citrus in much of Asia and in recent years has spread throughout most of the citrus growing regions of the world (Heppner 1993, Schauff et al. in press), most recently invading the Neotropics. In most of these regions, CLM has become a significant pest of cultivated citrus and has become the focus of a great deal of research. As part of the effort to establish effective biological control of this pest, researchers have been rearing numerous parasitoids, many of which have not been reliably identified to species. Most of these species appear to be parasitoids of native leafminers in areas adjacent to citrus groves which are moving onto CLM. These fortuitous parasitoids are having a major impact on the leafminer in several countries (Cano 1996, Cano et al. 1996, Castaño et al. 1996, Castro et al. 1996, Cave 1996, de la Llana 1996, Perales and Garza 1996, Perales et al. 1996, Peña et al. 1996, LaSalle and Peña in press). In order to supply scientific names to researchers working on CLM control, I am describing these two species which I have determined to be new to science.

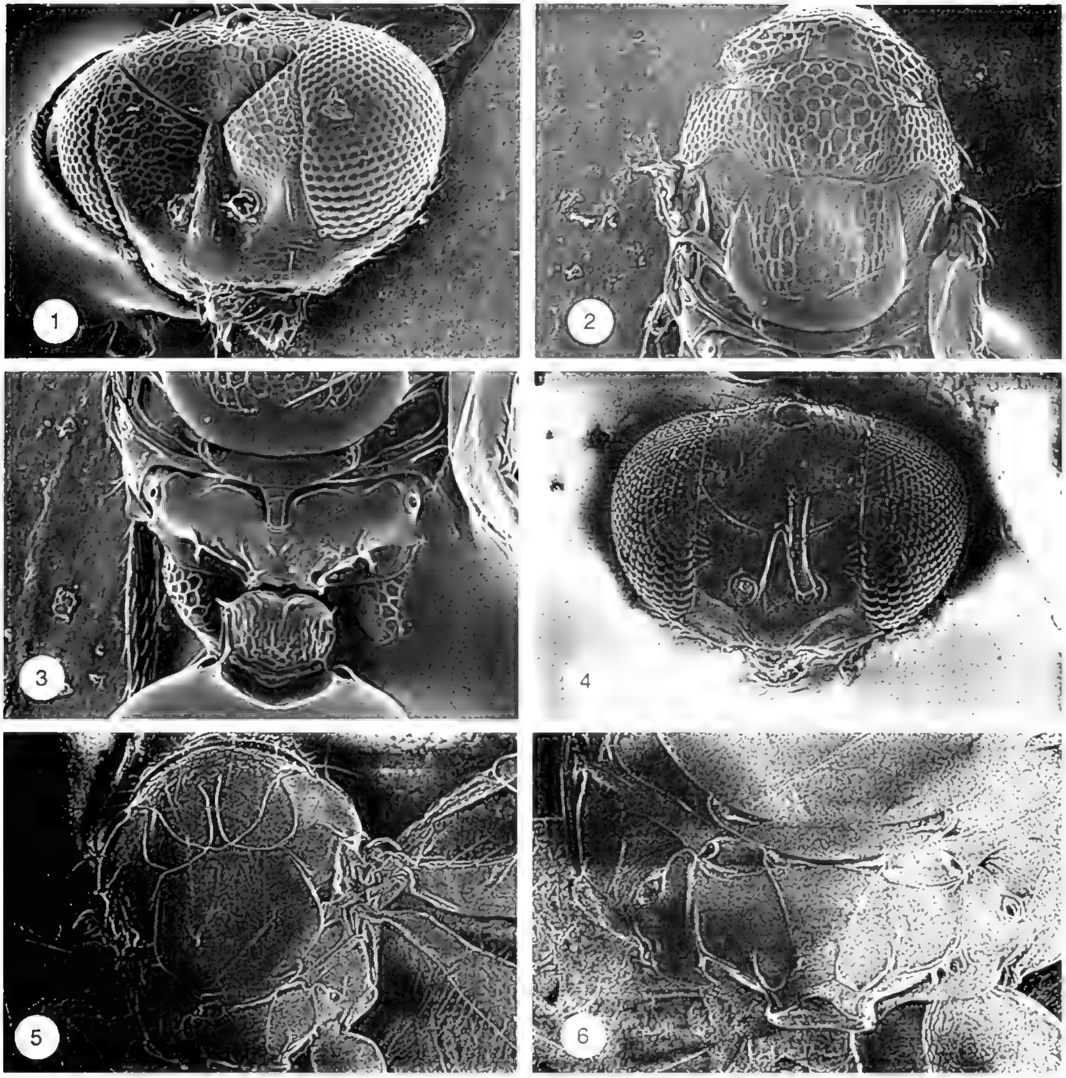
The genera of chalcidoid parasites attacking citrus leafminer were reviewed by Schauff et al. (in press). Both of these new species fit within genera already reported as attacking CLM. Both are from the family Eulophidae, subfamily Entedoninae as defined by Schauff (1991).

Abbreviations for museums are: (USNM) National Museum of Natural History, Smithsonian Institution, Washington, D.C. (BMNH) The Natural History Museum, London; (CNC) Canadian National Collection, Ottawa.

Pediobius puertoricensis Schauff, new species
(Figs. 4–6, 8, 10)

Diagnosis.—Head and thorax shiny metallic green; mesocutum anteriorly punctate to reticulate, posterior ⅔ shiny metallic, with large notaular foveae and broad median sulcus (Fig. 5); scutellum, axillae, and propodeum all smooth, shiny; median propodeal carinae well separated anteriorly and diverging posteriorly (Fig. 6).

This species is easily separated from other *Pediobius* by the structure of the mesos-



Figs. 1–6. Scanning Electron Micrographs 1–3, *Chrysocharodes lasallei*. 1, Head. 2, Dorsal thorax. 3, Propodeum and petiole. 4–6, *Pediobius puertoricensis* (uncoated material). 4, Head. 5, Dorsal thorax. 6, Propodeum

cutum. I know of no other species with a broad longitudinal median sulcus adjacent to the large notaular foveae, although there are hints of the beginning of such a sulcus in species such as *P. ropalidiae* (Risbec) (Kerrich 1973). In addition, most species have at least some sculpture on the scutellum. While these characters are unusual for *Pediobius*, they are found in other genera of Entedoninae and I do not feel that this species warrants separate generic status. The longitudinal sulcus medially on the mesoscutum is certainly the most obvious difference and I do not doubt that some authors would accord this species generic status based on this character alone. However, erecting such a genus might render *Pediobius* paraphyletic and I do not feel that to be a wise course at this time. Further study of Neotropical eulophids may indicate that a separate genus is warranted.

Pediobius is generally defined by the presence of paired submedian carinae on the propodeum (Schauff 1991) and while the structure of these carinae in *puertoricensis* is somewhat different than in most species, I feel that it falls within acceptable limits for the genus as currently defined.

There are few keys to *Pediobius* species, but in the most recent (Peck 1985), this species would key to either *P. temerus* (Walker) or *P. foveolatus* (Crawford). The characters of the mesoscutum and smooth scutellum would separate it immediately from these two.

Description.—Female. Body length 1.2 mm. Color metallic green to black except: scape, legs beyond coxae yellow; antennal funicle brown. *Head:* Antenna with 3-segmented funicle (Fig. 8). Vertex smooth with numerous scattered silvery setae, occiput carinate medially with an elongated pair of setae laterally; face (Fig. 4) smooth, frontofacial groove broadly U-shaped, intersected medially by raised interantennal prominence formed by scrobal grooves, with a single row of setae along eye margin, area below toruli with about 5 pairs of setae; eyes large, setose, eye height: malar space 40:15. *Mesosoma:* Pronotum collarlike, punctately sculptured anteriorly, smooth posteriorly; sculptured part with scattered silvery setae, with 3 pairs of elongated setae spread over posterior margin of sculptured area. Mesoscutum irregularly reticulate anteriorly, mostly smooth and shiny posteriorly and laterally, with deep, wide median groove in posterior ⅔ (Fig. 5) and with wide and shallow notaular foveae extending to margin of scutellum. Scutellum smooth and shiny; axillae smooth and slightly advanced forward of scutellum. Metanotum narrow, shiny, with a pair of small setae laterally. Propodeum (Fig. 6) mostly smooth, with a raised median area with diverging margins, step-like plicae, small rounded spiracle removed about 2× its diameter from 2 spiracular setae, and posteriorly with paired submedian carinae. Petiole as wide as long, dorsally rugose with irregular longitudinal carinae. *Metasoma:* Ovate, slightly longer than wide, first tergum about 2× as long as tergum 2, with a pair of large oval membranous openings adjacent to petiolar foramen. *Forewing:* As in Fig. 10.

Male. Body length 0.8–1.2 mm. Similar to female except for following: scape black, expanded apically; metasoma with white spot on dorsum anteromedially.

Types.—Holotype ♀ (USNM), "Puerto Rico, Limani Research Center, 30 April, 1996. Coll. M. Pomerinke. Host citrus leafminer". Paratypes: 1 ♂ with same data as holotype. 2 ♂: Puerto Rico, Utuado, Highway 140, Carlos Valez. 30 April, 1996. M. Pomerinke. Host citrus leafminer. 1 ♂, 1 ♀, Puerto Rico, Adjuntas, A.E.S. Limani, Citrus (Cleopatra cv.) rootstock, Feb. 6, 1996. Coll. E. Hernández. 1 ♂ and 1 ♀ paratype deposited in BMNH.

Etymology.—The species epithet is from the locality of the type series.

Chrysocharodes lasallei Schauff, new species

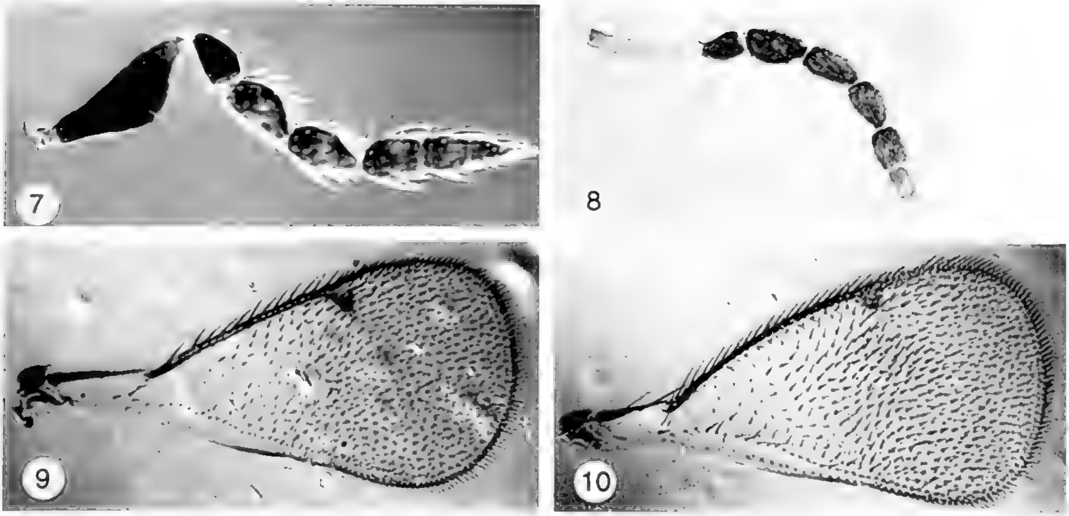
(Figs. 1–3, 7, 9)

Chrysocharodes sp. (Schauff et al., in press).

Diagnosis.—Scutellum as long as wide or wider than long, with open meshed reticulation covering most of dorsal surface, only becoming longitudinally reticulate/striate at lateral margin (Fig. 2); propodeum with median inverted U-shaped furrow extending about ½ length of propodeum and abutting indistinct median carina (Fig. 3); femora and apices of tibiae dark.

This species is differentiated from *C. petiolata,* the only other described species in the genus (Bouček, 1977) (lectotype, BMNH, examined), by the following: scutellum of *petiolata* with only about 2 rows of open reticulation medially, then becoming longitudinally striate laterally; propodeum with median U-shaped furrow extending about ⅔ length and abutting very short median carina; femur and tibia pale yellow (only middle legs present on lectotype, but all legs are probably yellow).

Chrysocharodes is a poorly known New World genus with no formal definition of



Figs. 7–10. Micrographs. 7, *Chrysocharodes lasallei,* female antenna. 8, *Pediobius puertoricensis,* antenna. 9, *C. lasallei,* forewing. 10, *P. puertoricensis,* forewing.

what unique features define the group. The pattern of carinae on the propodeum are different than in allied genera and would seem to be shared and apomorphic. The sculpturing of the mesoscutum and scutellum (wide, open messed reticulation) is certainly different from most allied species, but this is more a matter of degree and represents more continuous variation and is not definitely apomorphic.

Description.—Female. Body length 1.2–1.5 mm. Color black with metallic bluish reflections except for the following: scape becoming slightly lighter at apex, anterior ⅓ to ¼ of all tibiae black to dark brown, posterior ⅔ to ¾ yellow; tarsi yellow except dark brown at apex. *Head:* Antenna (Fig. 7) with scape expanded medially, funicle 2-segmented, club 3-segmented. Face below toruli irregularly striate to reticulate, laterad and above scrobal and frontal-facial grooves reticulate (Fig. 1). Mandible with 2 acute teeth, third tooth reduced to a small bump above second tooth. Vertex reticulate, except smooth laterad and posterior to occiput slightly carinate medially. Gena reticulate, malar suture indistinct, apparently absent in some specimens. Frontal-facial suture broadly V-shaped, intersected medially by raised interantennal prominence formed by scrobal grooves. *Mesosoma:* Pronotum (Fig. 2) reticulate anteriorly and laterally, becoming smooth postero-medially. Mesoscutum reticulate, notauli visible anteriorly, with sunken notaular alveoli posteriorly. Axillae reticulate, projecting slightly forward of anterior edge of scutellum. Scutellum reticulate, becoming smooth along posterior margin. Metanotum smooth. Propodeum smooth with a partial median carina abutting median u-shaped carina anteriorly (Fig. 3), laterally with small irregular carinae projecting forward from posterior margin. Petiole slightly wider than long, anterior edge carinate, dorsally rugose with incomplete longitudinal carinae. *Metasoma:* Ovate, slightly longer than wide, first tergum approximately 2× as long as second, smooth, shiny, metallic; remaining terga black, reticulate anteriorly, becoming smooth posteriorly. *Forewing:* Hyaline, less than 2× as long as wide; length of postmarginal vein subequal to stigmal vein (Fig. 9).

Male. Body length 0.9–1.3 mm. Similar to female except for following. Color. Legs slightly lighter brown, tibiae and tarsi occasionally very light yellow, almost white.

Metasoma black to brown. Scape with thin sensillar ridge on ventral surface. Metasoma about 1.5 times as long as broad, first tergite 2–3× as long as second, smooth, nonmetallic.

Types.—Holotype ♀ (USNM) with data "Colombia, Valle, LaUnion, 27-IV-96, M. Cobo, A. Trochez. *Citrus* spp., ex. *Phyllocnistis citrella.* Paratypes. 9 ♀, 10 ♂ with same data as holotype. 4 ♀ and 4 ♂ with same data except collected 12-V-96. Paratypes deposited in USNM, BMNH, and CNC.

Etymology.—Named in honor of my colleague Dr. John LaSalle who has done a great deal of work on the taxonomy of the parasites of the citrus leafminer.

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TWO NEW SPECIES OF WATER STRIDERS (HETEROPTERA: GERRIDAE) FROM THE PHILIPPINES

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Abstract.—Two new species of Gerridae are described from the Philippines: ***Ptilomera palawanensis*** from Palawan and ***Metrocoris zetteli*** from Mindanao. The descriptions are accompanied by a distribution map and figures of key characters.

Key Words: Gerridae, aquatic insects, Philippines, Palawan, Mindanao

Ongoing research into the systematics of Southeast Asian water striders continues to uncover new species from this region. To facilitate a forthcoming review of Philippine Gerridae by Dr. Herbert Zettel of the Vienna Museum, two new gerrid species from that archipelago, belonging to the genera *Ptilomera* Amyot and Serville and *Metrocoris* Mayr, are described below.

The last revision of *Metrocoris* in the Philippines was that of Polhemus (1990), who recognized three species: *M. tenuicornis* Esaki (Palawan), *M. luzonicus* Polhemus (Luzon), and *M. philippinensis* den Boer (Mindanao and Cebu). Based on recent collections by Herbert Zettel, additional material of *M. tenuicornis* is now at hand from Busuanga and Mindoro, and additional specimens of *M. philippinensis* have been taken on Negros and Panay, although the latter show slight variations in comparison to topotypic *M. philippinensis* from Mt. Apo on Mindanao.

The last comprehensive revision of *Ptilomera* was that of Hungerford and Matsuda (1965). Following their work, an additional species, *P. hungerfordi,* was described from the Philippines by Andersen (1967). Interestingly enough, the three known Philippine species of *Ptilomera,* including the new taxon described below, are all confined to the island of Palawan.

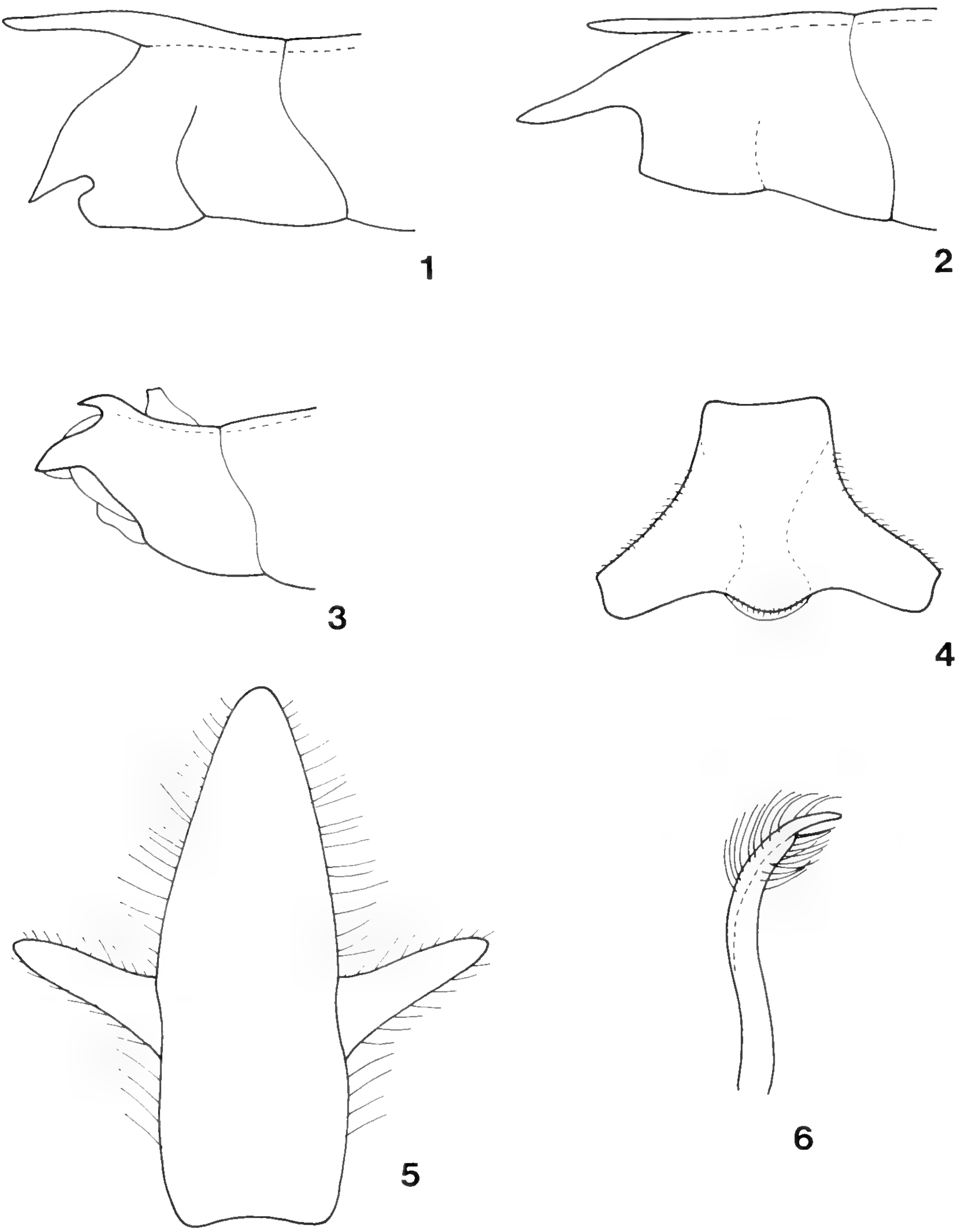
All measurements in the following descriptions are in millimeters; ranges are given for overall lengths and widths, while exact measurements refer to the dimensions of the holotypes. Collection depository acronyms are given in the acknowledgments. CL numbers in the material examined sections indicate a collection locality coding system used to cross reference specimens and ecological data.

Ptilomera palawanensis Polhemus, new species

(Figs. 1, 4–6, 9)

Diagnosis.—Recognized among Philippine *Ptilomera* species by the structures of the male genitalia (Figs. 4–6) and the armature of the terminal female abdomen (Fig. 1).

Description, wingless male.—Dorsal coloration dark brown (dark green in living specimens) with black markings on anterior portion of head, lateral portions of thorax, abdominal tergites, and foreleg; stripe of silvery hairs running longitudinally along each side of thorax, with smaller silvery patches on head and abdomen dorsally. Overall length 17.00–17.50 mm (mean =



Figs. 1–6. 1–3, Right lateral views of female terminal abdominal segments. 1, *Ptilomera palawanensis.* 2, *P. hungerfordi.* 3, *P. werneri.* 4–6, *P. palawanensis,* structural details of male genitalia. 4, Proctiger. 5, Pygophore. 6, Left paramere, dorsal view.

17.25, n = 2); maximum width (across mesoacetabulae) 3.90–4.10 mm (mean = 4.00, n = 2).

Head: dark brown, tip of clypeus and anterior portion of frons black, vertex with V-shaped dark spot centrally, patches of silvery setae present on either side of frons near bases of antennae; width across eyes 2.17; antenna black, lengths of segments I–IV = 8.54; 1.96; 2.24; 1.68; eyes brown, maximum width 0.55, length along inner margin 1.00, anterior width of interocular space 0.75, less than the length of an eye; rostrum yellowish brown, segment IV and midline of segment III glabrous black, basal 3 segments covered with very short recumbent pale setae, two long sensory setae present on posterior margin of segment III, overall length of rostrum 2.03, barely attaining posterior margin of prosternum.

Thorax: with pro-, meso- and metanota dark brown, broadly marked with black on anterolateral portion of pronotum behind eyes, laterally on meso- and metanota, and on pro-, meso- and metacetabula; side of thorax with longitudinal band of silvery hairs, beginning on mesopleuron and extending along metapleuron to metacetabula; silvery hair patches also present on pro- and mesoacetabulae, on pronotum behind eyes, and anterolaterally on anterior portions of meso- and metanota; pronotum gently raised medially at anterior margin, gently sulcate medially on posterior half; mesonotum evenly convex; metanotum with longitudinal medial suture.

Legs: brown, becoming blackish distally, forefemur with two parallel longitudinal black stripes centrally on dorsal face; ventral faces of forefemur and tibia, tip of foretibia, and entire foretarsus black; swimming fringe on posterior face of middle femur thick and well developed, occurring along entire length of segment; leg measurements as follows: foreleg, femur = 9.25, tibia = 8.25, tarsal I = 4.90, tarsal II = 1.90; middle leg, femur = 25.00, tibia = 16.00, tarsal I = 9.00, tarsal II = 0.75; hind leg, femur = 35.00, tibia = 18.00, tarsal I + II (fused) = 0.35.

Abdomen: with tergites black, shining centrally, bearing sparse covering of short silvery setae on lateral portions of tergites II–VII; connexiva black, approximately half as wide as abdominal tergites, reflexed upward to near vertical orientation, covered with fine black setae; first genital segment black, mottled with brown, clothed with short recumbent black setae; lateral portions of abdomen with scattered patches of silvery setae; proctiger (= suranal plate) with median lobe distinctly produced, rounded, lateral wings relatively long and narrow (Fig. 4); pygophore slender with tip narrowed, bearing numerous long black setae, apical portion roughly conical, lateral projections clearly exceeding wings of suranal plate (Fig. 5); parameres stout basally, broadly curving, tips pointed (Fig. 6).

Ventral surface: pale yellowish white, thickly covered with short recumbent pale setae; numerous tiny black spinules present at tip of pygophore; length of metasternum less than combined lengths of abdominal ventrites I and II; first genital segment longer than abdominal ventrite VII; with low rounded longitudinal carina medially.

Wingless female.—Similar to male in general structure and coloration but slightly smaller, length 16.00–17.00 mm (mean = 16.25, n = 10); width of head across eyes 1.96 mm; width of thorax across mesoacetabulae 3.60–4.00 mm (mean = 3.41, n = 10). Ventrolateral lobe of abdomen weakly produced, apex pointed; dorsolateral lobe curving downward, acute apically; connexival spines of moderate length, relatively stout, orientation nearly horizontal; medial ventral lobe of moderate size, mostly hidden by converging ventral margins of ventolateral lobes (Fig. 1); leg measurements as follows: foreleg, femur = 8.00, tibia = 7.00, tarsal I = 4.50, tarsal II = 1.80; middle leg, femur = 23.00, tibia = 15.00, tarsal I = 8.50, tarsal II = 0.80; hind leg, femur = 27.00, tibia = 15.00, tarsal I + II (fused) = 0.35.

Winged form.—Unknown.

Discussion.—The male parameres of *P. palawanensis* are similar to those of *P. hungerfordi* from Palawan, but the tip of the pygophore is more slender and the wings of the proctiger are narrower (Figs. 4–6). The female abdominal morphology is quite distinct from *P. hungerfordi,* with the ventrolateral lobe more produced, the dorsolateral lobe shorter and angled downward, and the connexival spines longer and stouter (compare Figs. 1 and 2). In *P. hungerfordi* there is a broad concavity between the ventrolateral and dorsolateral lobes, whereas in *P. palawanensis* these structures are separated by a relatively narrow slot (Figs. 1, 2). In addition, live specimens of *P. hungerfordi* are dark brown, whereas living specimens of *P. palawanensis* are dark green, changing to brown only after death.

None of the Philippine *Ptilomera* species shows close affinites to species on Borneo, despite evidence that north Borneo and Palawan have been linked historically by arc terranes along the eastern margin of the South China Sea (Polhemus 1996, Fig. 9). The Bornean *Ptilomera* species have males with sharply bent parameres, and females with the ventrolateral lobe of the terminal abdomen greatly reduced; neither of these character states are seen in the two Palawan species discussed above, or in *P. werneri* Hungerford and Matsuda, the third *Ptilomera* species known from Palawan. This latter is an odd, apparently primitive species (Hungerford and Matsuda 1958) that is different morphologically from any other congener in the region (Fig. 3), and its presence indicates that Palawan has had a long and complex faunal history independent from that of the remainder of the Philippines.

Ecological notes.—*Ptilomera palawanensis* was taken from swift, rocky streams in areas of disturbed primary rain forest. It frequently occurred in sympatry with *P. werneri* but was never taken in association with *P. hungerfordi,* even though the latter occurred on streams nearby, suggesting that *P. palawanensis* and *P. hungerfordi* may be competitively exclusive on any given stream.

Etymology.—The name "*palawanensis*" refers to the island of Palawan to which this species is endemic.

Material examined.—Holotype, wingless ♂: PHILIPPINES, Palawan, **Palawan Prov**., Estrella Falls at Estrella, 17 km. SW of Narra, 26 July 1985, CL 2010, J. T. and D. A. Polhemus (USNM). Paratypes: PHILIPPINES, Palawan, **Palawan Prov**.: 1 wingless ♂, 14 wingless ♀, same data as holotype (JTPC); 5 wingless ♂, 12 wingless ♀, Taritien Riv. above Trident Mine, Lapu Lapu, 7 km. NW of Narra, 27 July 1985, CL 2011, J. T. and D. A. Polhemus (JTPC); 5 wingless ♂, 5 wingless ♀, Balsahan Riv., Iwahig Penal Colony, 20 km. SW of Puerto Princesa, 27 July 1985, CL 2014, J. T. and D. A. Polhemus (JTPC); 1 wingless ♀, Estrella Falls, 5 km. N. of Narra, 5 April 1994, H. Zettel (NHMW); 1 wingless ♂, 1 wingless ♀, Montible River, 20 km. WSW of Puerto Princesa, 26 March 1994, H. Zettel (NHMW); 1 wingless ♀, Balsahan River at Iwahig, 9 km. W. of Puerto Princesa, 7 April 1994, H. Zettel (NHMW).

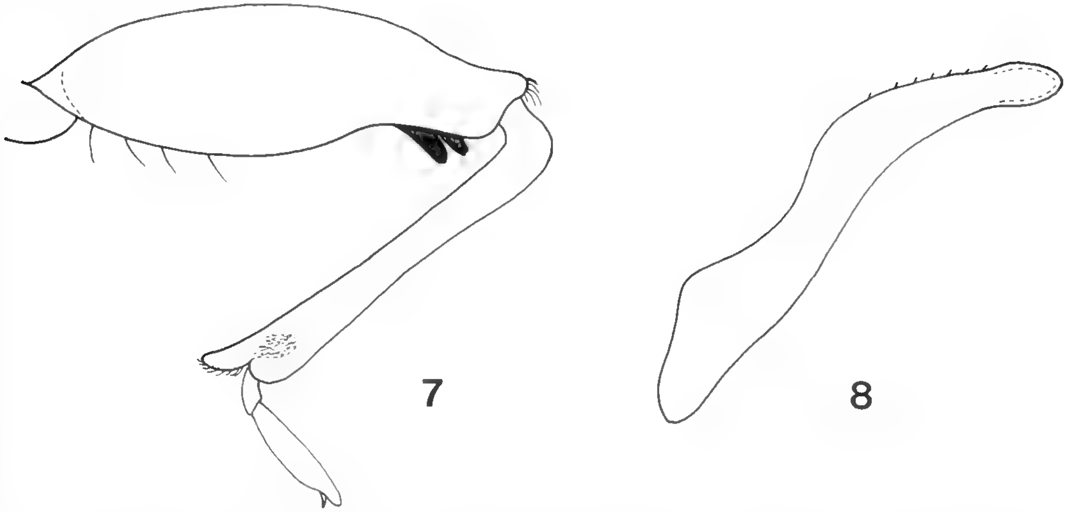
Metrocoris zetteli Polhemus, new species

(Figs. 7–9)

Diagnosis.—A relatively large and robust *Metrocoris* species, easily recognizable by the structure of the male fore femur (Fig. 7) and the shape of the male paramere (Fig. 8).

Description, wingless male.—Dorsal coloration orange brown, overlain with black markings on head, thorax and abdomen. Overall length 6.00–6.20 mm (mean = 6.10, n = 2); maximum width (across metacetabulae) 3.30–3.40 mm (mean = 3.35, n = 2).

Head: orange brown, antennal sockets, tylus, and areas adjacent to inner margins of eyes black, a moderate sized but relatively indistinct dark patch also present centrally on interoculus, width/length = 1.80/0.90; antennae dark brown, segments I–III bearing thick fringes of erect, curling, pale



Figs. 7–8. *Metrocoris zetteli*, structural details. 7, Male foreleg, dorsal view. 8, Male right paramere, lateral view.

setae along ventral margins, lengths of segments I–IV = 3.60, 1.20, 1.25, 0.85; eyes reddish brown, maximum width 0.50, length along inner margin 0.60, width of interocular space 0.65, subequal to the length of an eye; rostrum yellowish brown, segment IV black, reaching onto mesosternum, overall length of rostrum 1.75.

Thorax: with pronotum orange brown, anterior margin with broad, black transverse band, this band extending posteriorly in trilobate fashion laterally and along midline, lateral markings not reaching posterior margin, central marking narrowly joining small, subtriangular black mark extending anterad from posterior margin; pronotal dorsum not swollen or bulbous, width 0.95, length along midline 0.57. Mesonotum orange brown, with partially developed lateral stripes, these stripes curving backward but not attaining transverse dark band along anterior margin of mesonotum; intermediate longitudinal stripes moderately broad, just touching anterior margin of meso/metanotal transverse dark band, this latter band curving anteriorly then laterally, becoming confluent with posterior transverse dark band of metanotum; medial dark stripe of mesonotum narrow, continuing onto metanotum and abdominal tergites I and II; overall thoracic color pattern similar to that illustrated for *M. sunda* in Polhemus (1990, Fig. 1).

Legs: with forefemur yellowish brown, becoming diffusely infuscated on distal ⅔, distinctly inflated, length/width ratio 3.6/1.0, dorsal surface lacking short black spinules, ventral surface smooth and without small teeth or other modified setae, concave on distal ⅓, this concavity flanked by two large, subequal sized teeth near tip of femur (Fig. 7); foretibia strongly curved basally, inner margin beyond curve lacking small black asperities, terminating in moderate-sized spur; middle and hind legs uniformly medium brown, slender and without unusual modifications; leg measurements as follows: foreleg, femur = 3.60, tibia = 3.00, tarsal I = 0.25, tarsal II = 2.10; middle leg, femur = 9.00, tibia = 6.50, tarsal I = missing, tarsal II = missing; hind leg, femur = 7.00, tibia = 5.00, tarsal I = 0.50, tarsal II = 0.30.

Abdomen: with tergites orange brown, marked with black; tergites I and II with dark medial stripe, tergites I–VII with dark bands along anterior margins, these bands becoming broader laterally, tergites I and II further margined with black laterally and posteriorly, leaving orange brown markings enclosed with black, tergite VIII entirely

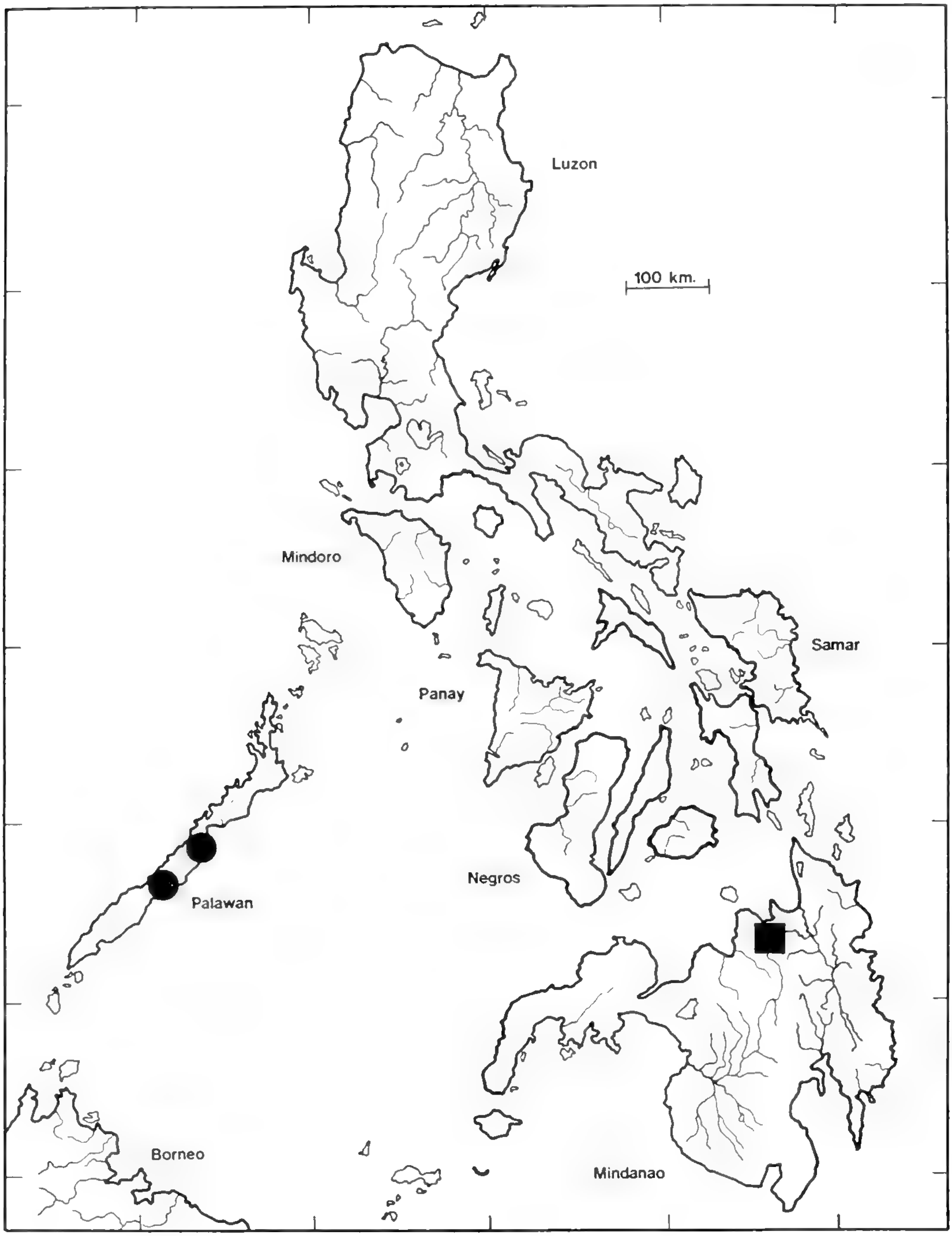


Fig. 9. Distribution of gerrid species in the Philippines. Square = *Metrocoris zetteli*. Circles = *Ptilomera palawanensis*.

dark brown dorsally; male paramere slender, weakly sinuate, tip slightly expanded (Fig. 8).

Ventral surface: orange brown, metasternal scent orifice moderately raised, ventral abdomen lacking depressions or tumescences.

Wingless female.—Similar to wingless male in general structure and coloration, but smaller in overall size; overall length 5.00–5.20 mm (mean = 5.12, n = 4); maximum width (across metacetabulae) 3.10–3.40 mm (mean = 3.23, n = 4); lengths of antennal segments I–IV = 2.10, 0.80, 1.00, 0.85; fore femur relatively slender, not swollen and armed as in male, leg measurements as follows: fore leg, femur = 2.45, tibia = 2.65, tarsal I = 0.12, tarsal II = 0.75; middle leg, femur = 6.50, tibia = 4.90, tarsal I = 2.00, tarsal II = 0.25; hind leg, femur = 5.80, tibia = 3.90, tarsal I = 0.40, tarsal II = 0.30.

Winged male.—Similar to wingless male in most structural characters, with following exceptions: overall length (including wings) 7.50 mm, maximum width (across pronotal humeri) 2.80 mm., pronotum expanded, anterior lobe yellowish brown with trilobate black markings similar to those of wingless male, posterior lobe orange brown, with broad transverse brown band extending across entire pronotum ahead of humeral angles, narrow, dark band extending posteriorly from this transverse band along longitudinal midline to apex of pronotum, flanked to either side by two (1 + 1) longitudinally ovate orange brown patches flanked laterally by diffuse brown patches extending posteriorly from transverse humeral band; fore femur not as swollen as in wingless male, apical teeth less developed.

Discussion.—*Metrocoris zetteli* may be recognized immediately among Philippine *Metrocoris* species by the male forefemur, which is highly swollen and has a distinctive armature consisting of a broad concavity ventrally on the distal ⅓, flanked apically by two large, subequal sized teeth (Fig. 7). These foreleg structures are similar in some degree to those seen in *M. strangulator* Breddin from the Greater Sunda Islands, but the latter species also has a large secondary tooth on the forefemur near the middle of the ventral face (Polhemus 1990, fig. 10), which is lacking in *M. zetteli*. The shape of the male paramere in *M. zetteli* is diagnostic as well (Fig. 8).

Etymology.—The name "*zetteli*" honors Dr. Herbert Zettel of the Vienna Museum, who has done much to advance our knowledge of Philippine water bugs.

Material examined.—Holotype, wingless ♂: PHILIPPINES, Mindanao, **Misamis Oriental Prov**., Mt. Kibungol, 20 km. SE of Gingoog, 700–800 m., 9–18 April 1960, H. M. Torrevillas (BPBM). Paratypes: PHILIPPINES, Mindanao, **Misamis Oriental Prov**.: 3 winged ♂, 4 wingless ♂, 10 wingless ♀, same data as holotype (BPBM, NHMW, USNM).

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THE ABNORMAL PRESENCE OF TWO OVARIES IN A *CANTHON CYANELLUS CYANELLUS* LECONTE FEMALE (COLEOPTERA: SCARABAEIDAE: SCARABAEINAE)

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Abstract.—The presence of one left ovary with one ovariole and a sole oviduct are anatomical features characteristic of female dung beetles of the subfamily Scarabaeinae. Abnormalities in reproductive system anatomy are quite rare in this subfamily; however, a mature *Canthon cyanellus cyanellus* female was discovered to have two ovaries with one ovariole each and two lateral oviducts. Both ovaries and oviducts were functional. This is the third abnormal female observed since 1930.

Resumen.—La presencia solamente del ovario izquierdo con una ovariola y un oviducto único, son características anatómicas propias de las hembras de los escarabajos estercoleros de la subfamilia Scarabaeinae. Las anormalidades en la anatomía del aparato reproductor en las hembras de esta subfamilia son muy poco frecuentes. Una hembra madura de *Canthon cyanellus cyanellus* presentó dos ovarios con una ovariola cada uno y dos oviductos laterales. Tanto los ovarios como los oviductos eran funcionales. Esta es la tercera de la hembras anormales observadas de 1930 a la fecha.

Key Words: *Canthon cyanellus cyanellus,* Scarabaeinae, ovaries, ovarioles, oviducts

The presence of a single left ovary, ovariole and oviduct is one of the most characteristic aspects of female dung beetle anatomy. This extreme reduction to one ovary and ovariole has been linked with a very low fertility rate and the elaborate and complex nesting behavior exhibited by this group (Halffter and Matthews 1966, Halffter and Edmonds 1982).

The first observations of the presence of a sole ovary and ovariole were done on various undetermined species of Coprini by Roussel (1860). Later, this characteristic was also observed in *Scarabaeus sacer* L., *Scarabeus semipunctatus* F., *Scarabeus variolosus* F., *Scarabeus laticollis* L., *Canthon rutilans* Cast., *Sisyphus schafferi* (L.), *Dichotomius anaglypticus* (Mannerhelm) (sub *Pinotus*), *Copris hispanus* (L.) (Heymons 1929, 1930), *Onthophagus fracticornis* (Preyssler), *Onthophagus nuchicornis* (L.), and *Copris lunaris* (L.) (Willimzik 1930). Observations of a greater number of species have shown that this anatomical characteristic is unique to all females of the subfamily (Robertson 1961, Halffter and Matthews 1966, Ritcher and Baker 1974, Halffter and Edmonds 1982).

Up until now, only two exceptional cases have been described. Heymons (1930) studied an adult *Scarabaeus sacer* L. female with a left ovary containing two ovarioles; Pluot (1979) reported an immature *Onthophagus lecontei* Harold adult female with

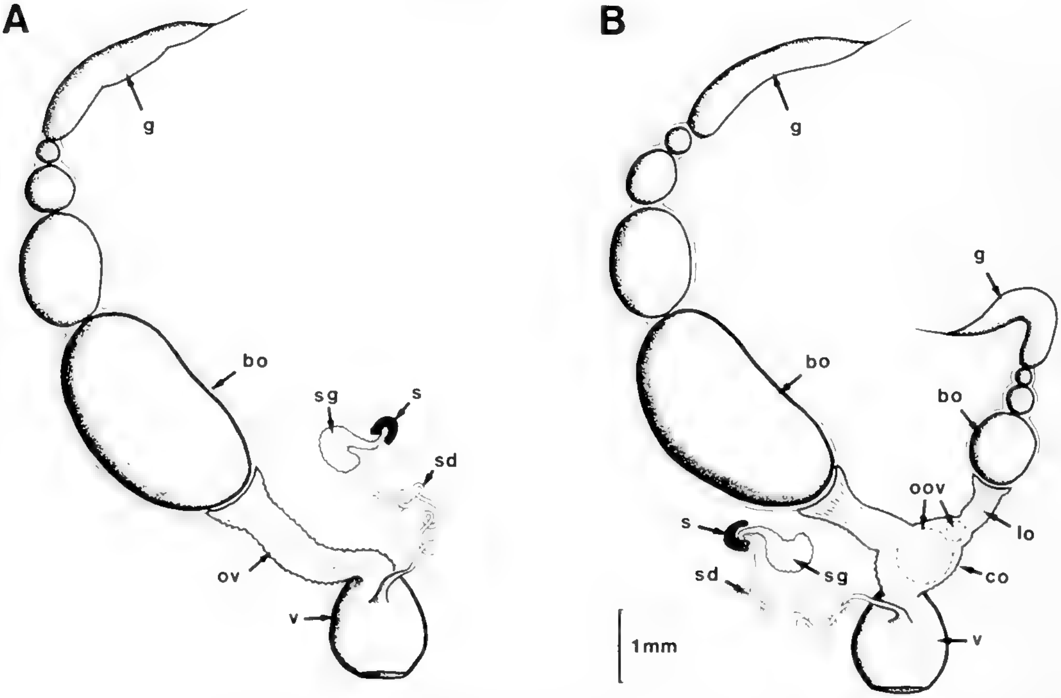

Fig. 1. Schematic drawings of the female reproductive system of *Canthon cyanellus cyanellus* made using a camera lucida. A, Normal. B, Abnormal. Abbreviations: bo = basal oocyte; co = common oviduct; g = germarium; lo = lateral oviduct; oov = oocytes in oviduct; ov = oviduct; s = spermatheca; sd = spermathecal duct. sg = spermathecal gland; v = vagina.

the same anomalies. This study presents a description of the reproductive system of a mature *Canthon cyanellus cyanellus* LeConte female, a necrophagous dung roller beetle from the tropical zone of Veracruz (Mexico), that had two ovaries with one ovariole each and two lateral oviducts.

MATERIAL AND METHODS

The subject of this study came from the brood of *Canthon cyanellus cyanellus* obtained from samples collected in June of 1996 in Los Tuxtlas, Veracruz, Mexico. The brood was kept in controlled environmental conditions (temperature of 27° C, relative humidity of 70%, 14 hour photoperiod, and continual feeding on beef).

The female studied was in a terrarium with a male from the time of emergence. They remained together under the abovementioned environmental conditions, and she was dissected two and a half months after emergence. The reproductive system was obtained in Ringer saline solution and drawn using the camera lucida. Afterwards, the specimen was fixed in AFATD liquid (alcohol-formol-trichloracetic acid-dimethyl sulfoxide) and was imbedded in Histosec® paraffin. The 8 μm histological cuts were dyed with PAS-Hematoxiline (Gabe 1968).

RESULTS

The reproductive system of the Scarabaeinae female is normally comprised of a left ovary with a single ovariole and oviduct, vagina and spermatheca with its spermathecal gland and duct (Fig. 1A). In the abnormal *Canthon cyanellus cyanellus* female that we describe herein, two ovaries with an ovariole each were present, along with two lateral oviducts, a common oviduct, vagina and spermatheca with its gland and duct (Fig. 1B).

The two ovaries had a well-developed, active germarium similar in size. Both germaria contained active prefollicular cells, trophocytes, and interstitial cells (Fig. 2A, B) and previtellogenic oocytes in the basal region (Fig. 2C, D). Both ovaries had a normal pedicel (Fig. 2E).

The vitellarium of the left ovary contained 4 oocytes. The basal oocyte, a little over 3.5 mm in length, was mature, with a well-formed chorion; it was ready to be ovulated. The three oocytes that followed were of various sizes and were undergoing vitellogenesis. The right ovary had 3 oocytes in vitellogenesis; the basal oocyte measured only 1 mm (Fig. 1B). The follicular epithelium was normal.

The two lateral oviducts appeared to be normal, and both connected to the common oviduct (Fig. 1B). The histological structure of the two lateral oviducts was similar: the wall, quite pleated lengthwise, had an epithelium—of mesodermic origin—covered by a muscular layer (Fig. 2F). The common oviduct, also pleated lengthwise, had an epithelium—of ectodermic origin—with a thin intima cuticular.

At the base of the right lateral oviduct, near the place where the common oviduct begins, an oocyte approximately 0.25 mm in diameter was present; in this same cavity were the remains of the vitellus. The oocyte was immature and was completely surrounded by a thick layer of follicular cells that had begun to degenerate (Fig. 2G). Furthermore, in the anterior region of the common oviduct a second oocyte was found that measured approximately 0.70 mm in length, and a large amount of vitellus was spread throughout the cavity. This oocyte was also immature and was partially surrounded by follicular cells that were degenerating visibly (Fig. 2H). The vagina, spermatheca and spermathecal gland were similar to those of all females of this species.

As to the behavior of this female, by the time of dissection she had made a nest with four nest balls (equal to four eggs laid). She was beginning to make the second nest, which contained two nest balls, and she was making the third ball to lay another egg.

These observations, both anatomical and behavioral, show that the two ovaries and oviducts were functional. We cannot, however, insure that the eggs laid came from both ovaries. The fact that we found immature oocytes in the right oviduct indicates that vitellogenesis took place in the right ovary just as in the left, although this process may not have occurred simultaneously in both ovaries. It is possible, on the other hand, that the left ovary's signal to ovulate also activated the right ovary, causing the still immature oocytes to enter the oviduct, where they remained and began to degenerate.

DISCUSSION

The *Canthon cyanellus cyanellus* female studied is an exceptional case. Over the past 13 years, we have maintained broods of this species for different research projects; therefore, we have records for the dissection of about 1000 females of known age and behavior, as well as information for females collected from the field. Furthermore, we have dissected between 10 and 15 females from each of 30 other species from different Scarabaeinae tribes. Until now, however, we had not found a single female with a reproductive system different from that of the standard female of this subfamily.

The *Canthon cyanellus cyanellus* female studied had not only two ovaries with one ovariole each but two lateral oviducts as well. Both the gonads and ducts were functional, and the female had oviposited several times. In the *Scarabeus sacer* female that Heymons studied in 1930, the second rudimentary ovariole of the left ovary had atrophied and its cells were degenerating. In 1979, Pluot observed that a *Onthophagus lecontei* female had a left ovary with two ovarioles of different sizes. The smaller ovariole was not functional and contained no oocytes and prefollicular cells; there was

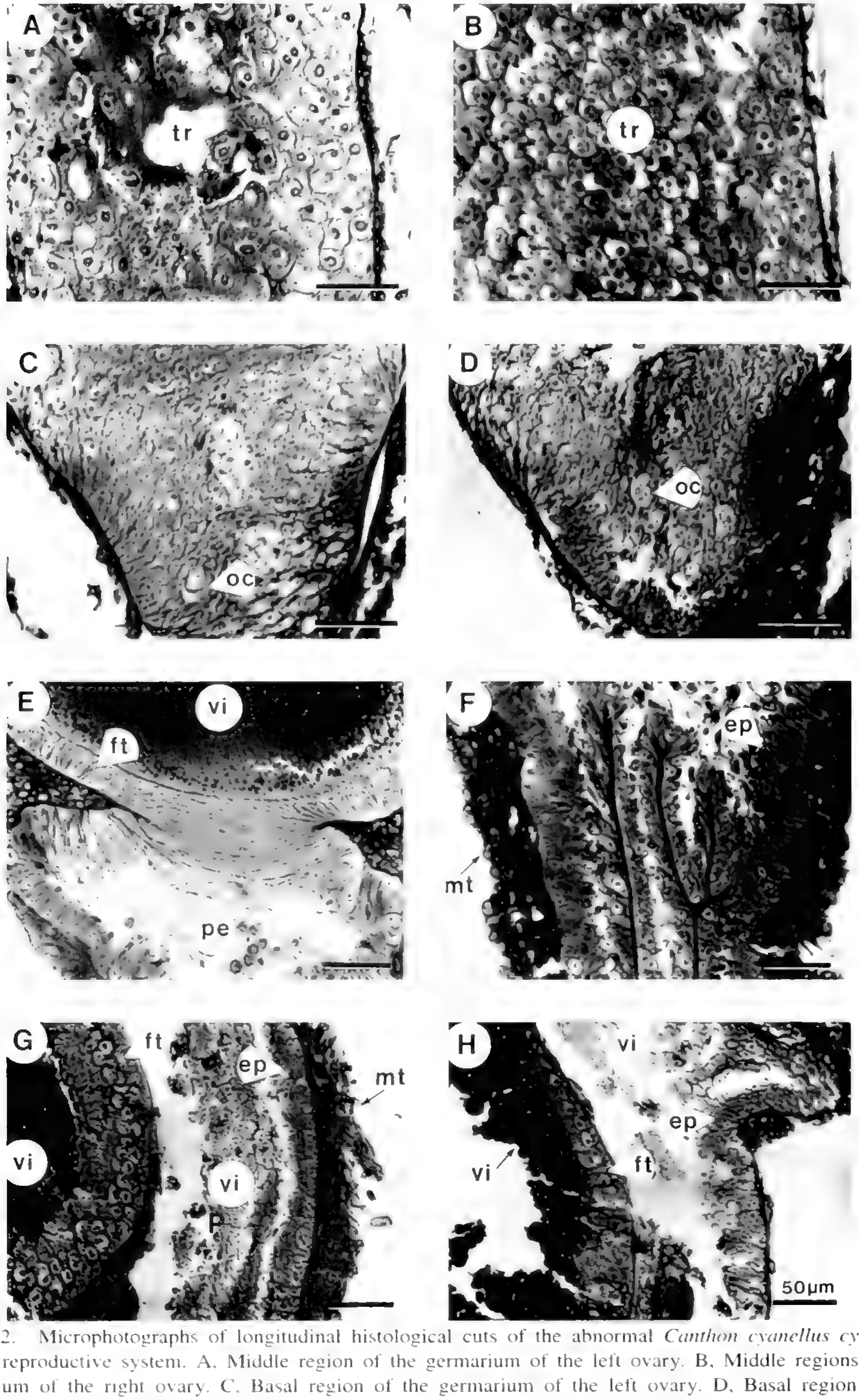

Fig. 2. Microphotographs of longitudinal histological cuts of the abnormal *Canthon cyanellus cyanellus* female reproductive system. A, Middle region of the germarium of the left ovary. B, Middle regions of the germarium of the right ovary. C, Basal region of the germarium of the left ovary. D, Basal region of the germarium of the right ovary. E, Basal oocyte of the right ovary and its pedicel. F, Anterior region of the right lateral oviduct. G, Posterior region of the right lateral oviduct. H, Anterior region of the common oviduct. Abbreviations: ep = epithelium of the oviduct; ft = follicular tissue; mt = muscular tissue; oc = oocyte surrounded by prefollicular tissue; pe = pedicel; tr = trophocytes; vi = vitellus.

no communication between the pedicel and germarium.

During ovarian organogenesis, at the end of larval development, the left ovarian rudiment of *Canthon indigaceus chevrolati* Harold and *Onthophagus* sp. had 6 ovarioles, 5 of which had atrophied. The right ovarian rudiment only contained 5 to 6 cellular masses which constituted the remains of the ovarioles. At the end of pupal development, the right ovarian rudiment, right lateral oviduct and 5 ovarioles of the left ovarian rudiment had degenerated (Pluot 1979).

According to Ritcher and Baker (1974), the basic number of Scarabaeoidea ovarioles seems to be 6 for each of the two ovaries (6-6). This characteristic appears without exception in Ochodaeinae, Geotrupinae, Acanthocerinae, and Melolonthinae and is also common in some species of Dynastinae, Rutelinae, Cetoniinae, Troginae, and Aphodiinae. In Scarabaeinae only 1-0 exists.

Taking into account the phylogenetic relationships between the different groups of Scarabaeoidea (Zunino 1983, D'Hotman and Scholtz 1990, Browne 1993) and the anatomic studies from the ovary of this group (Robertson 1961, Ritcher and Baker 1974), it can suppose that the reduction process at the ovariole nivel has an ancient origin since a phylogenetic point of view, and it can be attributed to subfamily common ancestor.

This reduction process could be unchained as of 6-6 (two ovaries with six ovarioles each one) to reach 1-0 (one ovary with only one ovariole) including not only the right ovary atrophy but the right lateral oviduct atrophy as well. It is also supported by an ontogenetic point of view. Observations done on *Canthon indigaceus chevrolati* and *Onthophagus* sp. regarding the atrophy of an ovary and five ovarioles from the other ovary during postembryonic development (Pluot 1979) provide such evidence, as does the fact that during early embryonic development in *Canthon, cyanellus cyanellus,* there are two similar ovarian rudiments with a 6-6 number of ovarioles (Martínez, unpublished data). The existence of adult females from other species in which the remains of ovarioles from the left ovary are observed (Heymons 1930, Pluot 1979) provides further evidence, as do the two ovaries with an ovariole and two lateral oviducts in the case of the *Canthon cyanellus cyanellus* female.

Further research during organogenesis is needed in order to determine what factors have induced this process of extreme reduction in female gonads, a process which has been related to complex reproductive behavior. It is also important to determine the reasons why in certain cases the reduction is not complete in adult females.

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EVANIIDAE (HYMENOPTERA) IN THE MID-ATLANTIC STATES: SEASONAL OCCURRENCE AND IDENTIFICATION

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Abstract.—Six species of Evaniidae are found in the mid-Atlantic states. *Evania appendigaster* (L.) and *Prosevania fuscipes* (Illiger) are introduced species and are found only in urban situations. *Evaniella semaeoda* Bradley, *Hyptia harpyoides* Bradley, *H. thoracica* (Blanchard), and *H. reticulata* (Say) are native and are widely distributed and common in field collections. The peak flight time for all four native species is similar, from late June to the end of July, but they are present in low population levels into September. A key, supplemented with scanning electron photographs, is given for identification of the species.

Key Words: Evaniidae, ensign wasps, key, seasonal occurrence, Delaware, Maryland, Virginia, West Virginia

Six species of Evaniidae, known as ensign wasps, occur in the mid-Atlantic states, here defined as Delaware, District of Columbia, Maryland, West Virginia, and Virginia. All are egg parasitoids of cockroaches. During 15 years of Malaise trapping in this area, I have collected about 7000 specimens and, based on this trapping, can determine the seasonality and distribution of the species. I also provide a key and SEM photographs for species identification.

Two biological groups are apparent. One includes two introduced species, *Evania appendigaster* (L.) and *Prosevania fuscipes* (Illiger), both of which are found only in buildings in urban areas. I have never taken these species in field collections. The other four species, *Evaniella semaeoda* Bradley, *Hyptia harpyoides* Bradley, *Hyptia thoracica* (Blanchard), and *Hyptia reticulata* (Say), are native, widely distributed, and most are common in field collections in Malaise traps throughout the area.

All native species have a similar flight period. The first individuals appear at the end of May or beginning of June. The peak flight time is from the end of June to the end of July. Thereafter a rapid decline in populations occurs, and only a few specimens are found in August, September, and the early part of October. The flight pattern indicates a single generation annually for each species in the mid-Atlantic states.

Identification of some species, especially those of *Hyptia,* are based on sculpture of the head and thorax. There have not been adequate illustrations accompanying previous keys to show these differences. Consequently, I present scanning electron photographs of the head and thorax sculpturation to aid in identification. The size of the eyes and sculpturation of parts of the thorax are additional characters used for the first time in a key to separate *Hyptia* species.

Deyrup and Atkinson (1993) studied the evaniid composition and seasonality at the Archbold Biological Station, Highlands, Co., Florida. They found *Evaniella semaeoda, Hyptia floridana* Ashmead, *H. reticulata,* and *H. thoracica. Hyptia floridana* was not found in this study, and *H. harpyoides* Bradley, very common in the mid-Atlantic region, was not found in their study. The other three species are common to both areas and their flight times are compared.

Most of the biological work has been done with the two introduced species which parasitize household cockroaches. Thoms and Robinson (1986, 1987) discussed the feasibility of one species, *Prosevania fuscipes* (as *P. punctata* (Brullé)), as a natural control agent for cockroaches in Virginia, and Edmunds (1953) discussed the same species as a factor in control of cockroaches in Ohio. However, very little is known of the native species, some of which parasitize *Parcoblatta* wood roaches common in the eastern forests. Some work on the eastern species was presented by Edmunds (1952a, b, 1953, 1954). Although the four native species differ morphologically, they all have a similar flight period and occur in the same habitats. Presumably, there are ecological, biological, and/or behavioral traits that also support species differentiation.

MATERIAL AND METHODS

Collection sites, years of trapping, and numbers of traps used at those sites are as follows: MARYLAND: Prince George's Co., Beltsville Agricultural Research Center (1991–1993, 3–4 traps each year); Garrett Co., Finzel Swamp, 1 km S Finzel (1992–1993, 1–2 traps each year); Allegany Co., Green Ridge State Park, 6 miles E Flintstone (1991–1992, 4 traps each year). VIRGINIA: Louisa Co., 4 miles S Cuckoo (1985–1989, 4–12 traps each year); Fairfax Co., near Annandale (backyard trap) (1981–1996, 1 trap each year); Essex Co., 1 mile S Dunnsville (1991–1996, 15–25 traps each year); Clarke Co., University of Virginia Blandy Experimental Farm and State Arboretum of Virginia, 2 miles S Boyce (1990–1995, 5–11 traps each year). WEST VIRGINIA: Tucker Co., Fernow Experimental Forest, south of Parsons (1991–1993, 20 traps each year); Hardy Co., 3 miles NE Mathias (1994–1996, 2–3 traps each year).

I used Townes-style Malaise traps for collecting (Townes 1972). Most collections were in 95% ethyl alcohol; potassium cyanide was used only in those traps at Green Ridge State Park, Maryland. Traps were run continuously through the collecting season, from the first part of March to mid-November in the more southerly and lower elevations sites (Essex Co., Fairfax Co.), and from mid-March to the first part of October at the other sites. I serviced the traps every ten days to two or three weeks depending on the weather and time of season. The total number of traps varied each year and at each site, usually from 20 to 30, but the same number and location of traps was kept constant for each site during each season.

In the records sections, county records are given for the mid-Atlantic states. For my collection sites, inclusive dates of collection and numbers of specimens are given in parentheses. The total number of species examined are those from my collection sites and are the basis for the graphs (Figs. 21–24). Specimens are deposited in the National Museum of Natural History, Smithsonian Institution, Washington, D.C.

Both sexes can be identified with the following key. For synonymy and references to original descriptions see Townes (1949) and Carlson (1979). State records in the distribution section are from these two sources plus more recent records of specimens I have examined.

KEY TO SPECIES

1. Forewing with one closed cell (Fig. 1) 2
– Forewing with 7 or 8 closed cells (Fig. 2) . . 4
2. Punctures on frons close, interspaces ridgelike

and less than half diameter of punctures (Fig. 12); lower lateral portion of propodeum striate, mesopleuron without distinct punctures (Fig. 18); head in front view with lower interocular distance about equal to eye height (Fig. 6) . . . . *Hyptia harpyoides*

– Punctures on frons farther apart, shining flat interspaces usually equal to or more than puncture diameters (Figs. 13, 14); lower lateral propodeum with large punctures and mesopleuron with 1 or 2 large medial or postero-medial punctures (Figs. 19, 20); head in front view with lower interocular distance about equal to or less than eye height (Figs. 7, 8) 3

3. Mesopleuron with one or two large central punctures (Fig. 20); head in front view with lower interocular distance subequal to eye height (Fig. 8); lower swelling of mesopleuron with numerous punctures (Fig. 20) . . . . *Hyptia thoracica*

– Mesopleuron with large puncture in median posterior corner (Fig. 19); head in front view with lower interocular distance shorter than eye height (Fig. 7); lower swelling of mesopleuron with only a few large punctures (Fig. 19) . . . . *Hyptia reticulata*

4. Head smooth, shining, without sculpture (Figs. 3, 9); lateral surface of thorax and propodeum with widely scattered punctures (Fig. 15) . . . . *Evania appendigaster*

– Head sculptured (Figs. 4, 5, 10, 11); lateral surface of thorax and propodeum with numerous closely set punctures (Figs. 16, 17) 5

5. Front of head and frons with longitudinal carinae (Figs. 4, 10); with carina below antennal sockets which extends posteriorly on each side (Fig. 4); eye in lateral view diagonal (Fig. 16) . . . . *Prosevania fuscipes*

– Front of head and frons punctate (Figs. 5, 11); without carina around antennal sockets (Fig. 5); eye in lateral view subparallel with posterior margin of head (Fig. 17) . . . . *Evaniella semaeoda*

SPECIES DISCUSSIONS

Evania appendigaster (Linnaeus)
(Figs. 3, 9, 15)

Distribution.—Arizona, District of Columbia, Florida, Georgia, Louisiana, Massachusetts, Missouri, New Mexico, New York, Pennsylvania, South Carolina, Tennessee, Texas.

Records.—District of Columbia.

Hosts.—Reared from egg capsules of *Blatta orientalis* L. and *Periplaneta* spp. (Townes 1949). Recorded from household cockroaches *Blatta orientalis, Periplaneta americana* (L.), and *Periplaneta australasiae* (F.) (Stange 1978).

Discussion.—This species is found only in urban areas. I have never collected it in the field. A District of Columbia record of June 5, 1879, is the earliest known Nearctic record of this introduced species. It is probably of Oriental origin (Townes 1949) but occurs in most tropical and subtropical regions of the world. It is most common in Arizona and the Gulf Coast and Atlantic states. I have seen only several other specimens, all from the District of Columbia, collected July 30, 1911, and March 3, 1945. See Huber (1920) and Stange (1978) for biological information. This is the least common of the two introduced species.

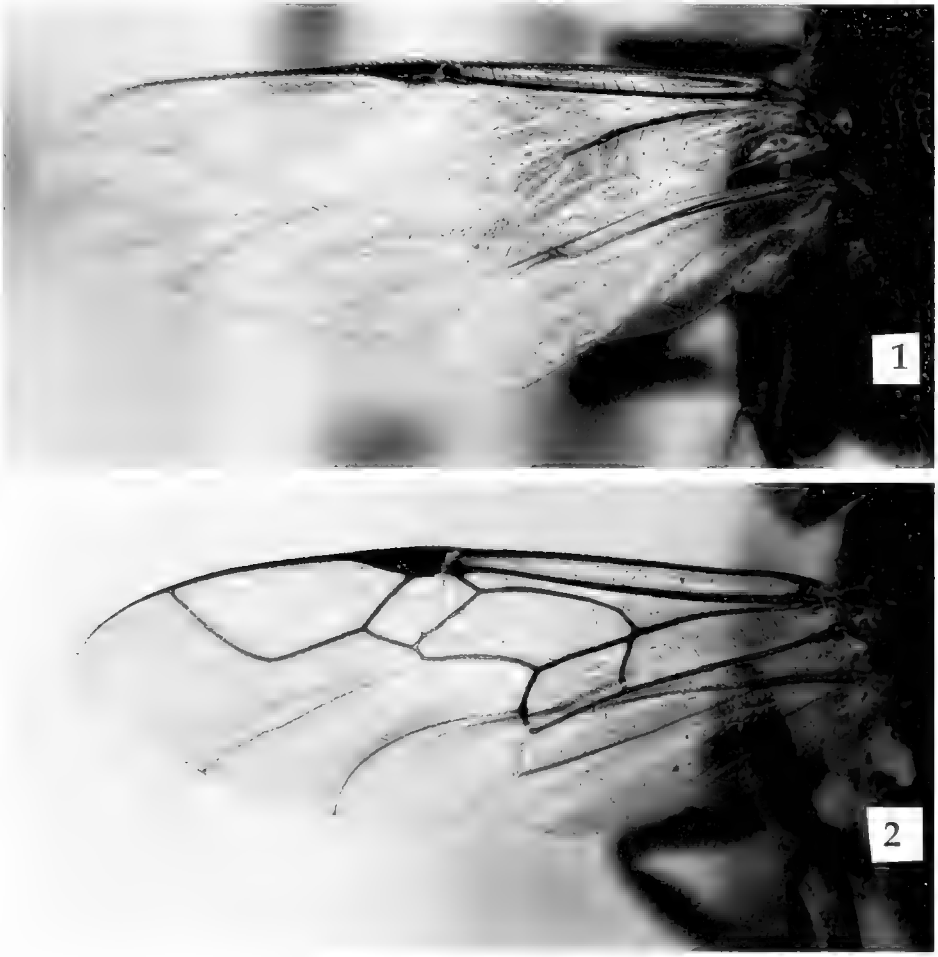
Prosevania fuscipes (Illiger)
(Figs. 4, 10, 16)

Distribution.—Delaware, District of Columbia, Georgia, Massachusetts, Missouri, New Jersey, New York, North Carolina, Ohio, Pennsylvania, Virginia.

Records.—Delaware: New Castle Co. District of Columbia. Maryland: Montgomery Co.; Prince George's Co.; Washington Co. Virginia: Arlington Co.; Fairfax Co.; Henrico Co.; City of Norfolk; Roanoke Co.

Hosts.—*Blatta orientalis* L., *Periplaneta americana* (L.), recorded by Carlson (1979).

Discussion.—This introduced species of Mediterranean origin (Townes 1949) occurs only in urban areas of the east coast. I have never collected it in the field. The first record of capture in the Nearctic Region is August 29, 1898 from Washington, D.C. It has been collected from June to October, but most collection dates are in July and August and most records are on windows and/or in buildings. This is much more common than the other introduced species, *Evania appendigaster.* Biological data are presented by Edmunds (1952a, b, 1953, 1954) and Thoms and Robinson (1986, 1987) who discussed this species as a potential biolog-



Figs. 1–2. Wings. 1, *Hyptia harpyoides*. 2, *Evaniella semaeoda*.

ical agent for household cockroaches in Virginia.

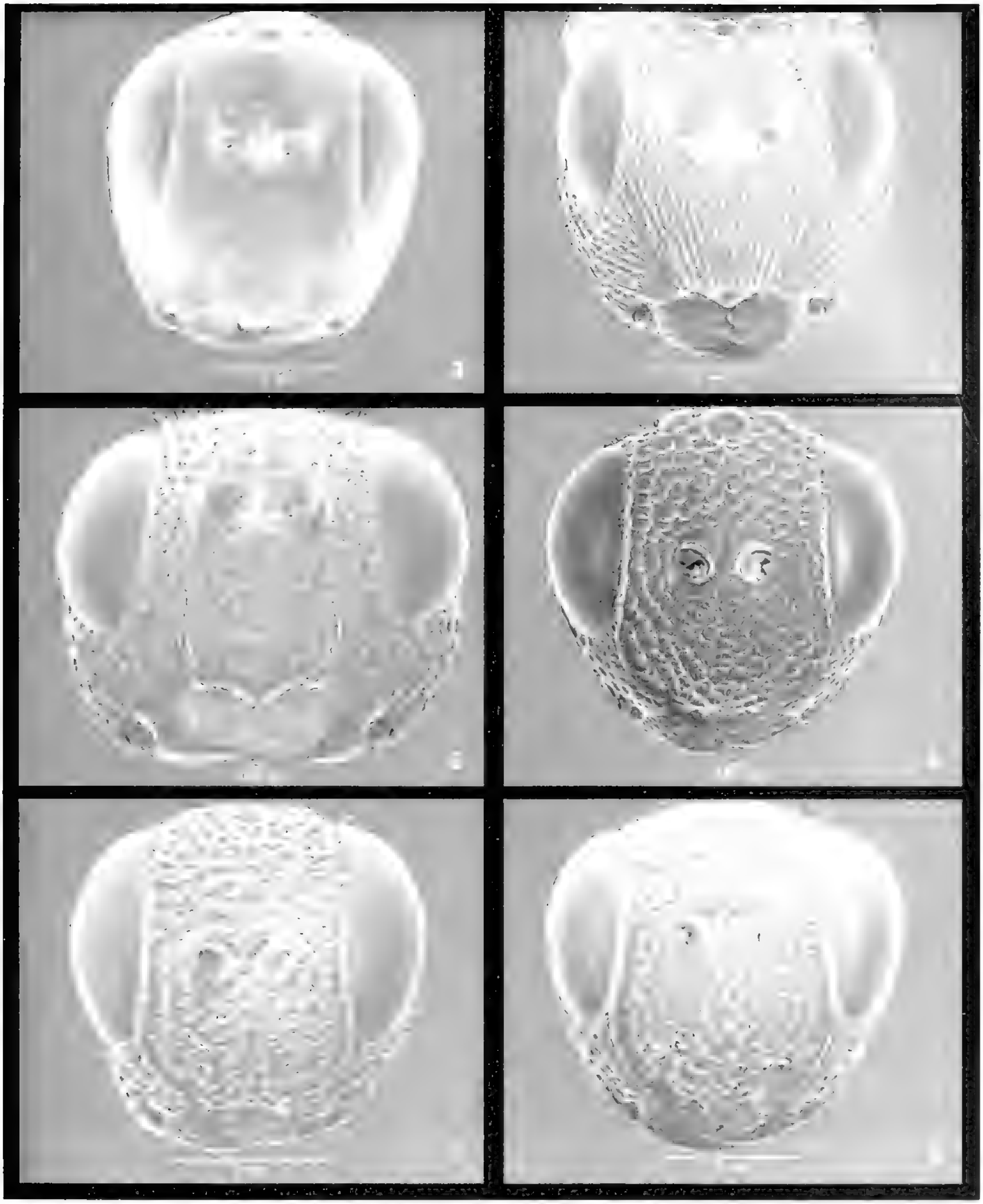
Evaniella semaeoda Bradley
(Figs. 2, 5, 11, 17, 21)

Distribution.—District of Columbia, Florida, Georgia, Kansas, Louisiana, Maryland, Massachusetts, Michigan, Missouri, New Jersey, New York, North Carolina (Brimley 1938), Pennsylvania, Rhode Island, Virginia, West Virginia.

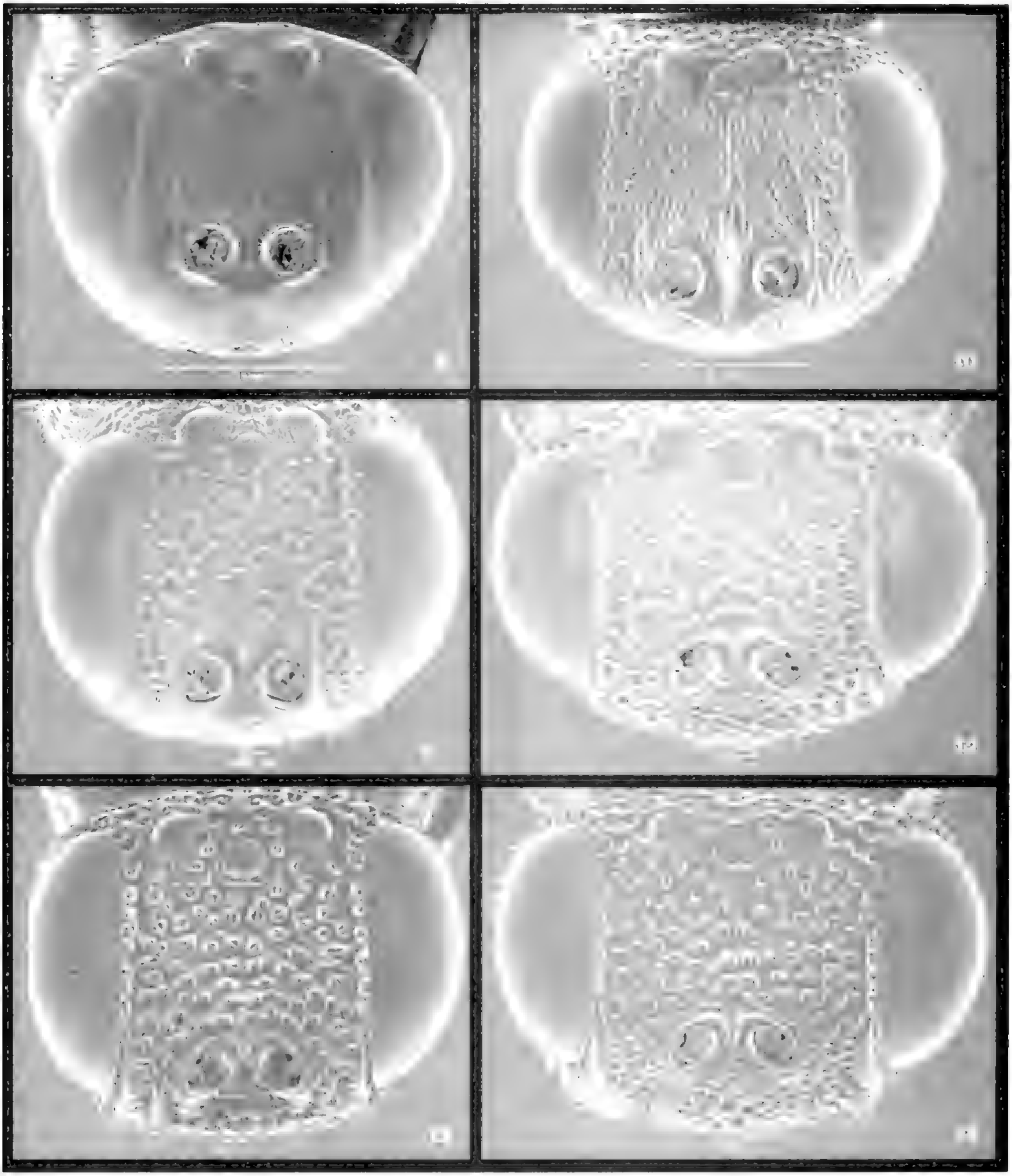
Records.—District of Columbia. Maryland: Allegany Co., 29–31.V (2); Montgomery Co.; Prince George's Co., 4.VI–29.IX (203). Virginia: Accomack Co.; Clarke Co., 12.VI–27.VIII (132); Essex Co., 25.V–28.IX (1853); Fairfax Co., 23.VI–8.IX (38); Louisa Co., 16.V–7.X (345). West Virginia: Tucker Co., 20–29.VI (1). Total specimens: 2562.

Hosts.—Unknown.

Discussion.—This was the second most common species collected, especially from traps set inside woods and forests and at woods edges. It was rare at the higher elevation sites in West Virginia and western Maryland; only one specimen was taken in Tucker Co., West Virginia, where 20 traps were used in each of three years. Adults were collected at flowers "*Xolisma ligustrina*." The seasonal occurrence is shown in Fig. 21.



Figs. 3–8. Front view of head. 3, *Evania appendigaster*. 4, *Prosevania punctata*. 5, *Evaniella semaeoda*. 6, *Hyptia harpyoides*. 7, *H. reticulata*. 8, *H. thoracica*.

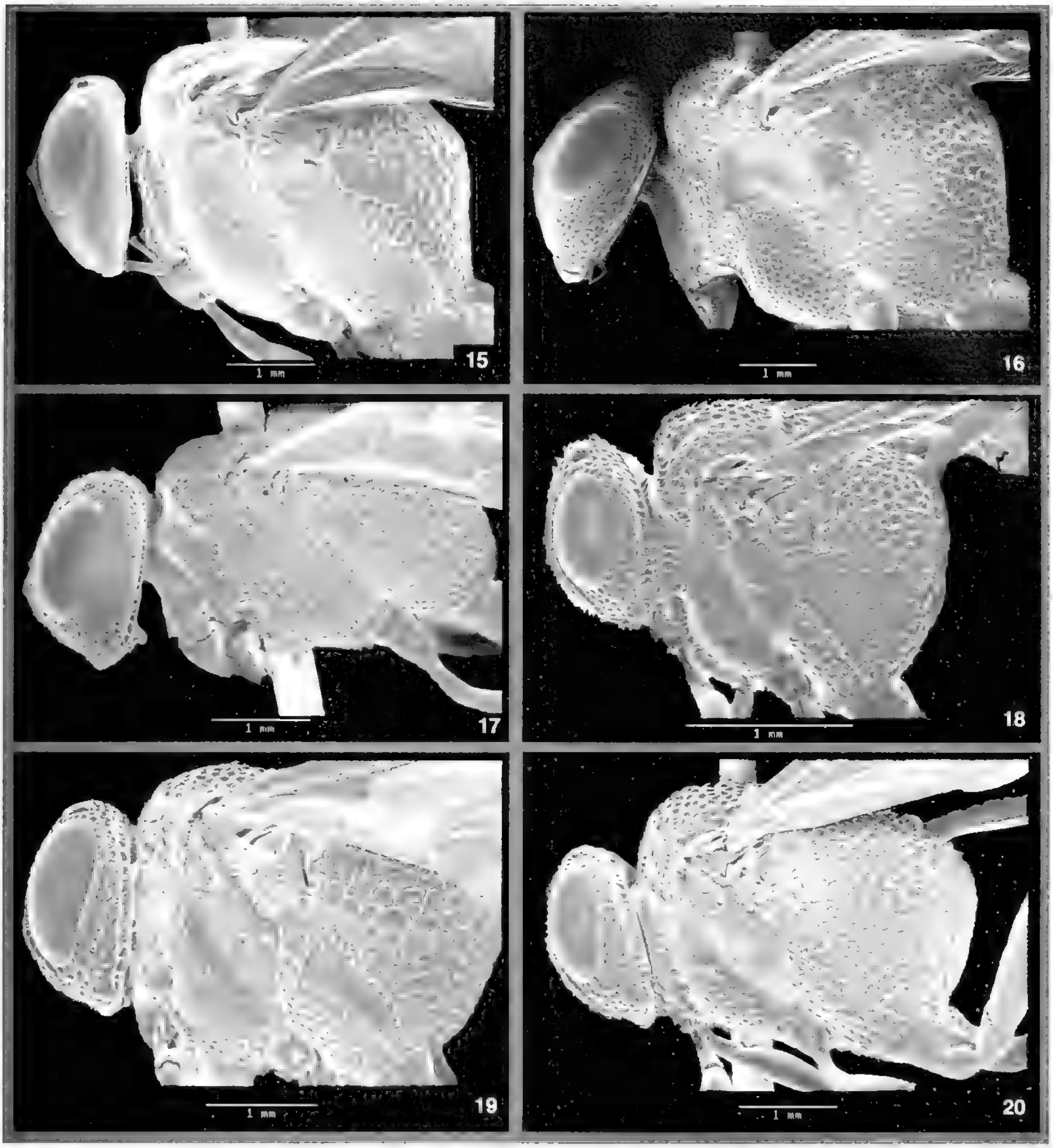


Figs. 9–14. Head, view of frons. 9, *Evania appendigaster*. 10, *Prosevania punctata*. 11, *Evaniella semaeoda*. 12, *Hyptia harpyoides*. 13, *H. reticulata*. 14, *H. thoracica*.

Deyrup and Atkinson (1993) recorded this species from April to November in southern Florida, with peak periods from May to October, most in August to October. It was the least common species at the site.

Hyptia harpyoides Bradley
(Figs. 1, 6, 12, 18, 22)

Distribution.—Connecticut, District of Columbia, Georgia, Illinois, Kansas, Maryland, Massachusetts, Michigan, Minnesota, Missis-

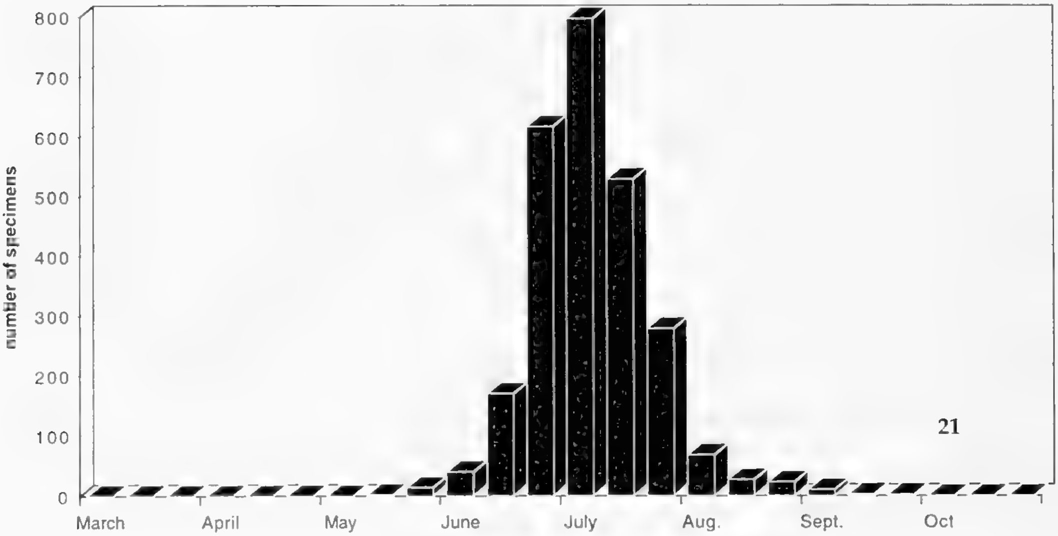


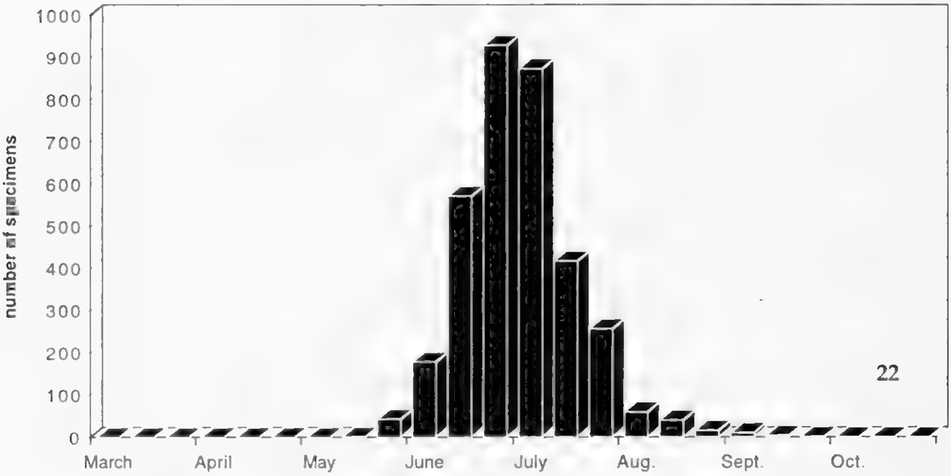
Figs. 15–20. Lateral view of head and thorax. 15, *Evania appendigaster*. 16, *Prosevania punctata*. 17, *Evaniella semaeoda*. 18, *Hyptia harpyoides*. 19, *H. reticulata*. 20, *H. thoracica*.

sippi, New Hampshire, New Jersey, New York, North Carolina, Ohio, Ontario, Pennsylvania, Rhode Island, South Carolina, Tennessee, Texas, Virginia, West Virginia.

Records.—District of Columbia. Maryland: Allegany Co., 10–20.VI (1); Garrett Co., 10–19.VII (1); Montgomery Co.; Prince George's Co., 16.V–29.IX (400); Worcester Co. Virginia: City of Chesapeake; Clarke Co., 22.V–27.VIII (469); Essex Co., 14.V–16.IX (2066); Fairfax Co., 31.V–26.VIII (92); Louisa Co., 23.V–18.IX (397); Loudon Co., Roanoke Co. West Virginia: Hardy Co., 2–23.VI–12–25.IX (112). Total specimens: 3332.

Hosts.—*Parcoblatta uhleriana* (Saussure), *P. virginica* (Brunn.) recorded by Carlson (1979).





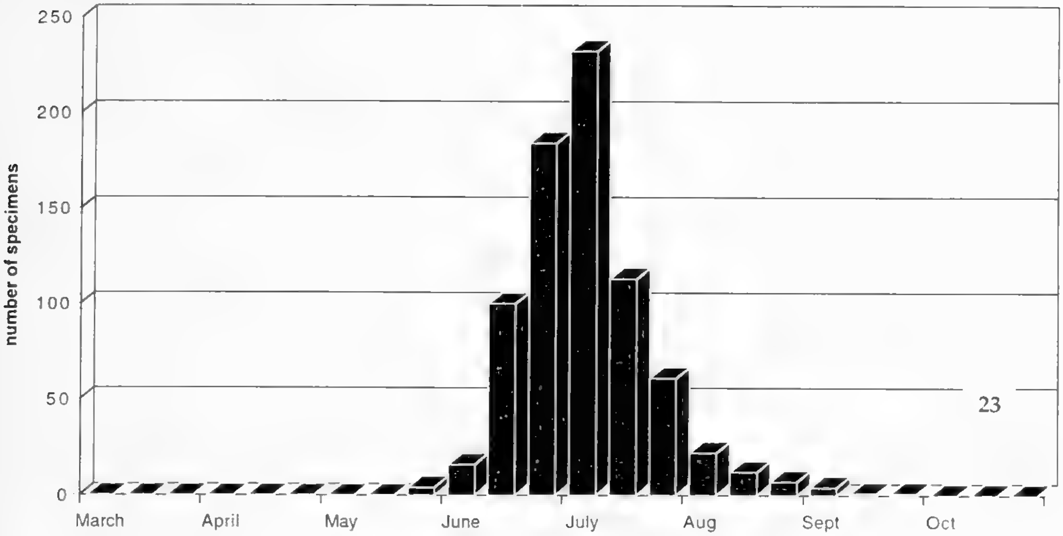
Figs. 21–22. Seasonal flight records. 21, *Evaniella semaeoda*. 22, *Hyptia harpyoides*.

Discussion.—*Hyptia harpyoides* is common in northeastern United States, and only one of two evaniids that occur in Canada. It has a more northern distribution than other species in the Nearctic Region. It was common in traps in woods and the most common species of Evaniidae collected. As with *Evaniella semaeoda*, it is more common at lower elevations and rather rare at higher elevations in West Virginia and western Maryland. The seasonal occurrence is shown in Fig. 22.

Adults have been collected "at honeydew."

Hyptia thoracica (Blanchard)
(Figs. 8, 14, 20, 23)

Distribution.—Connecticut, District of Columbia, Florida, Georgia, Indiana, Kansas, Maryland, Massachusetts, Michigan, Missouri, New Jersey, New York, North Carolina, Ohio, Ontario, Pennsylvania, Quebec, Rhode Island, South Carolina, Texas, Virginia, Wisconsin.



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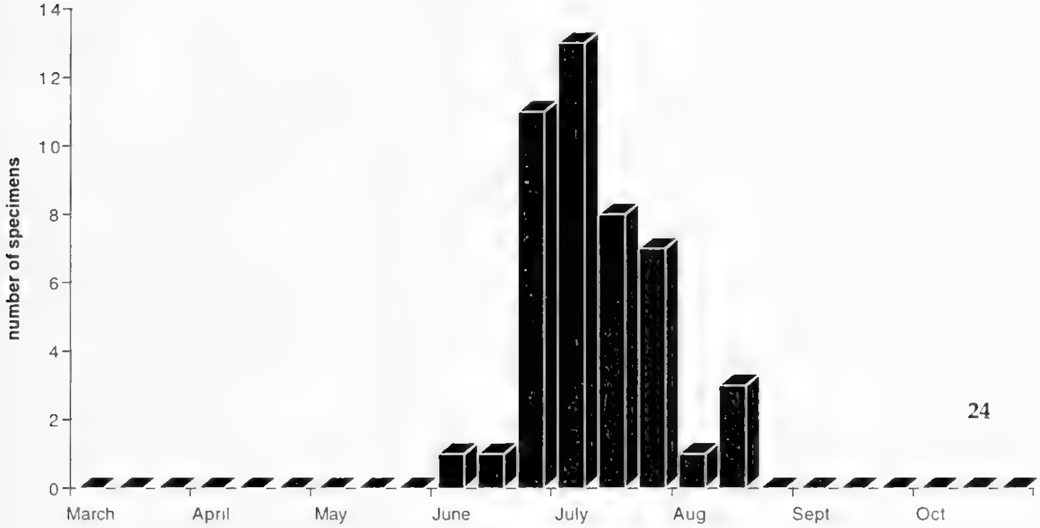

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Figs. 23–24. Seasonal flight records. 23, *Hyptia thoracica*. 24, *H. reticulata*.

Records.—District of Columbia. Maryland: Prince George's Co., 24.V–14.VIII (50). Virginia: Arlington Co., Clarke Co., 8.VI–7.VIII (56); Essex Co., 25.V–28.IX (620); Fairfax Co., 24.VI–11.VIII (4); Louisa Co., 8.VI–22.VIII (26). Total specimens: 750.

Hosts.—Two specimens in the National Museum of Natural History, Smithsonian Institution, were reared as follows: ex ootheca *Parcoblatta pennsylvanica* (Kirkwood, Missouri); and emerged ex ootheca *Parcoblatta* sp. (Vienna, Virginia).

Discussion.—This species was more common at the Essex Co. site than at the others. It was absent from the sites in West Virginia and western Maryland. Adults have been collected at honeydew, on "*Solanum carolinense*" (Solanaceae) and on trunk of diseased pine. The seasonal occurrence is shown in Fig. 23.

Deyrup and Atkinson (1993) recorded this species from March to December in southern Florida, with peak flights from July to October. It was the most common species at the site. Goulet (1994) recorded it from Quebec which is the most northern record.

Hyptia reticulata (Say)
(Figs. 7, 13, 19, 24)

Distribution.—Florida, Georgia, Louisiana, Maryland, Massachusetts, Mexico, Michigan, New York, North Carolina, Pennsylvania, Texas, Virginia.

Records.—Maryland: Allegany Co., 1–9.VI–9–18.VIII (4); Montgomery Co.; Prince George's Co., 14–24.VI (1). Virginia: Fairfax Co.; Louisa Co., 16.VI–23.VIII (41); City of Virginia Beach. Total specimens: 46.

Hosts.—Unknown.

Discussion.—This species is less common than the other species of *Hyptia*. It was most common at the Louisa Co. site. Adults have been collected at "tulip tree honeydew." The seasonal occurrence is shown in Fig. 24.

Deyrup and Atkinson (1993) recorded this species from April to October in southern Florida, with peak flight in June and July. It was the second most common species at the site.

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FAMILY PLACEMENT OF SPECIES PREVIOUSLY INCLUDED IN THE SCALE INSECT GENUS *SPHAEROCOCCUS* MASKELL (HEMIPTERA: COCCOIDEA)

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Abstract.—The genus *Sphaerococcus* Maskell has been the "dumping ground" for many rotund scale insects that did not seem to fit elsewhere. Although the genus is a member of the Pseudococcidae as defined by its type species, the family placement of many species is questionable or unknown. The purpose of this paper is to provide evidence for the correct family placement of each species described in *Sphaerococcus*. Twelve taxa are assigned to families in which they have never been placed previously and there are five new combinations and one new synonymy.

Key Words: scale insects, Coccoidea, Pseudococcidae, Lecanodiaspididae, Asterolecaniidae, Eriococcidae, Aclerdidae, Beesoniidae, Kermesidae, Phoenicococcidae

The genus *Sphaerococcus* Maskell is part of the family Pseudococcidae and should contain only two species, i.e. *S. casuarinae* Maskell (the type species) and *S. durus* De Lotto (Ben-Dov 1994). Since the genus was described by Maskell (1892) it has been the "dumping ground" for large rotund scale insects that did not seem to fit any place else.

There are 38 species or varieties that were originally described in the genus; the correct family placement of many of these, until now, has been unknown (Beardsley 1984). Species previously described in *Sphaerococcus* are currently considered to belong to eight different families and often are omitted from catalogs because their family placement is questionable or unknown. The purpose of this paper is to provide information on the family placement of all species originally described in *Sphaerococcus*. We have summarized the current placement of all 38 taxa, but have not reexamined type material of species that seem to be properly placed. This research is being undertaken so that *Sphaerococcus* species can be properly cataloged in the current initiative called "ScaleNet" (by Ben-Dov and Miller) to database the scale insects of the world (for more information see Miller and Gimpel (1996), Ben-Dov et al. (1997) or check the web site http://www.sel.barc.usda.gov/scalenet.htm). Much more research is needed to redescribe all *Sphaerococcus* taxa, to place them in appropriate genera, to designate lectotypes, and to perform other important taxonomic procedures, all of which is beyond the scope of this publication.

Depository abbreviations are as follows: Australian National Insect Collection, CSIRO, Canberra (ANIC); Agricultural Scientific Collections Trust at New South Wales Agriculture, Orange, Australia (ASCT)(formerly Biological and Chemical Research Institute, Rydalmere, Australia: BCRI); California Academy of Sciences, San Francisco (CASC); The Natural History Museum, London (BMNH); South Australian Museum, Adelaide, Australia (SAM); New Zealand Arthropod Collection, Auckland (NZAC); National Museum of Natural History, Beltsville, MD (USNM); University of California, Davis (UCD); University of Tennessee, Entomology Collection, Knoxville (UT); Virginia Polytechnic Institute and State University, Entomology Collection, Blacksburg (VPI).

Type data are provided for species when this information has not been provided in detail previously. Slide-label data are not provided for syntypes of Maskell's species because his labels included only the name of the species, the sex and instar, the year, and his initials. For example, one of the slides prepared and labeled by Maskell has the following information on the left label: "Sphaerococcus/ leptospermi/ late larva/ 1893 W.M.M."; there is no right label and no further attached information. Material borrowed from NZAC is part of the series mounted by Maskell and is identified by an orange and white sealant that surrounds the cover slip.

HISTORICAL BACKGROUND

Between 1906 and 1909 the entire Maskell Collection was borrowed from the New Zealand Department of Agriculture by the United States Department of Agriculture so that the species and genera described by Maskell could be redescribed and properly placed in the scale insect classification system (Morrison and Morrison 1922). Specimens were photographed, dry material was mounted, original unstained slide-mounted specimens were examined, and many species were redescribed (Morrison and Morrison 1922, 1923, 1927). A book of photographs is present in the Coccoidea library at Beltsville. This is the U.S. Department of Agriculture's scale-insect reference library which is associated with the USNM collection. Morrison made notes on the material and these notes are included in each of the following species treatments when available. Many of the specimens currently deposited in the USNM were acquired during this process. Morrison was very careful to compare the specimens prepared from dry material with the original slides made by Maskell to be certain that they were specimens of the same taxon. Each slide is enclosed in a paper jacket and is identified by a Maskell collection number. These numbers correspond to a ledger that was kept by Maskell. Unfortunately, he did not include ledger numbers on his slides although they were associated with the dry material. The Maskell Collection was returned to New Zealand in 1922. A few Maskell types were acquired by the USNM as parts of the collections of Brain and Cockerell. Specimens in the BMNH were apparently sent to Green by Maskell. Because of the incompleteness of label data maintained by Maskell, it is not always possible to recognize the type series and it is necessary to presume that "his specimens are original material unless the data labels indicate otherwise" (Deitz and Tocker 1980). Another complicating factor in identifying type material is that Maskell occasionally added additional collections of a species to the same lot of dry material as the type series (Deitz and Tocker 1980).

Scale insect specimens (including syntypes) from the collection of W. W. Froggatt are housed primarily in ANIC and ASCT in Australia, but some additional material was donated to or exchanged with collections outside of Australia and resides in BMNH and USNM. Froggatt's accession notebooks (see Gullan 1984) contain a number of lists of scale insect specimens sent to other workers. A substantial part of Froggatt's coccoid collection was purchased by the Commonwealth Scientific & Industrial Research Organisation (CSIRO, then called CSIR) in two parts: the first in 1928 and then additional specimens in 1937 after Froggatt's death (Upton, in press). Much of the original material upon which Froggatt based his descriptive catalog (Froggatt 1921) remained in the collection at the Entomological Branch of the New South Wales (NSW) Department of Agriculture in Sydney, which subsequently became the Biological & Chemical Research Institute (BCRI) of NSW Agriculture but recently was relocated to Orange, Australia. Thus, Froggatt's syntypes are distributed among several institutions, although all of his slide mounts (which are in poor condition and mostly require remounting) are housed in ANIC. Froggatt recorded details of his coccoid accessions in two notebooks (Gullan 1984), which are housed in ASCT.

The whereabouts of much of C. Fuller's coccoid collection is unknown, although some syntypic material resides in USNM and SAM, probably as the result of exchange with or donation to these collections.

SPECIES

Sphaerococcus acaciae Maskell, 1893:237

Current placement.—Asterolecaniidae—*Callococcus acaciae* (Maskell) (combination by Morrison and Morrison 1927).

Selected references.—Froggatt (1921: 7)(redescription); Morrison and Morrison (1927:11)(redescription, Asterolecaniinae), Koteja (1974:83)(as *Callococcus* group), and Deitz and Tocker (1980:25)(information about types, depositories, and taxonomic history).

Type material.—Syntypes in BMNH include 1 adult female on a slide; NZAC 5 slides and 2 pill boxes of dry material (DRM examined 3 of Maskell's original slides as follows: 1 adult female and several embryos; 1 first-instar nymph; and 3 first-instar nymphs—they are conspecific with the USNM material); USNM has 4 syntype slides as follows: 2 first-instar nymphs; 12 first-instar nymphs; 1 second-instar male, 1 first-instar nymph; 2 first-instar nymphs; (Maskell Collection No. 282). The Maskell ledger entry is "282. Sphaerococcus acaciae Maskell Australia/insects in sitû/N. Z. Trans. Vol. XXV, p. 237." There are no notes by Morrison, but there is a photograph with the label "Sphaerococcus acaciae Mask./Adult and Immature Females/ Maskell Coll. No. 282" in the U.S. Department of Agriculture Coccoidea library at Beltsville, Maryland.

Type data.—Australia, New South Wales, Queanbeyan, on *Acacia* sp., A. S. Olliff.

Discussion.—Based on examination of syntype material, DRM concurs with the placement of this taxon in the Asterolecaniidae (Morrison and Morrison 1927) primarily because the first-instar nymph has 8-shaped tubular ducts and the adult female has 8-shaped pores and tubular ducts with characteristic asterolecaniid internal longitudinal lines. The first-instar nymphs are dimorphic as in *Callococcus leptospermi* Maskell (Coles et al. 1988) and *C. pulchellus* (Maskell), but the adult female of *C. acaciae* is quite different and may not be congeneric.

Sphaerococcus africanus Brain, 1915:95

Current placement.—Pseudococcidae—*Lenania africanus* (Brain) (combination by Ben-Dov et al. 1997).

Selected references.—De Lotto (1969: 23)(redescription, likely referred to *Lenania*), Ben-Dov et al. (1997:203)(as *Lenania africanus*).

Type material.—Syntypes in USNM include: 1 slide containing 3 adult females with the left label "1850/on field bush/ Somerset West/T. F. D./26.11.06/africanus Brain/Sphaerococcus;" right label "13/ 32./C. K. B."; 3 other slides containing 51 first-instar nymphs, 4 adult females, and 1 adult female; all slides are labeled similarly, with left label "*Sphaerococcus/africanus* Brain/on *Cliffortia ruscifolia* L./Stellenbosch, CP./17.XII.'14./paratype.;" right label "B. 32./C. K. B."

Type data.—In addition there is another lot of material from South Africa, Stellenbosch, On *Elytropappus rhinocerotis* Less., November 10, 1914, C. P. van der Merwe. We do not know where this material is located.

Discussion.—This species was described in detail by De Lotto (1969) and was cataloged by Ben-Dov (1994); for additional information refer to these publications.

Sphaerococcus bambusae Maskell, 1893:237–238

Current placement.—Pseudococcidae—*Chaetococcus bambusae* (Maskell); type species of *Chaetococcus* (combination by Maskell 1898).

Selected references and discussion.—This species was described in detail by Williams (1985) and was cataloged by Ben-Dov (1994); for additional information refer to these publications.

Sphaerococcus cantentulatus Froggatt, 1921:8

Current placement.—Lecanodiaspididae—*Celaticoccus cantentulatus* (Froggatt) (combination by Lambdin and Kosztarab 1976).

Selected references.—Lambdin and Kosztarab (1976:56)(Description of genus and redescription of species; placed in Lecanodiaspididae).

Type material.—The lectotype and several paralectotypes were designated by Lambdin and Kosztarab (1976) and are in BMNH, and paralectotypes also were deposited in USNM and two other American institutions. These specimens are from the type locality of Condobolin (as evidenced by label data), and were sent by W. W. Froggatt to R. Newstead in England in February 1903 as recorded on page 110 of Froggatt's first accession notebook by the entry: "40 Sphaerococcus cantentulatus n. sp. Green, M.S. Condobolin." According to DJW it appears that this material was sent directly to Green by Newstead since the slides are labeled in Green's handwriting. Thus, this material was sent to Newstead [and Green] 18 years prior to Froggatt's description of the species. In addition to the above specimens there are paralectotypes in ASCT and ANIC that were not borrowed, examined or listed by Lambdin and Kosztarab (1976). ASCT holds 2 slide-mounted adult females (mounted by P. J. Gullan, 1997, ex dry material) and 2 dry-mounts each bearing a number of galls, with the label data: "(Acac. pendula)/Bramble Station near/Condobolin N.S.W./17.10.00" and "342." One of these mounts is that photographed for figure 3 of the original description in Froggatt (1921). ANIC holds 3 dry-mounts which PJG also has identified as paralectotypes; all are labeled in Froggatt's handwriting as *Sphaerococcus cantentulatus.* One mount has the data label: "(Acac. pendula)/Bramble Station near/Condobolin, N.S.W./17–10–00," another has: "N.S.Wales/Condobolin/W.W.F./Acacia stem/galls/15/x/1902" and the third mount has no data label.

Discussion.—PJG has mounted and examined females from Froggatt's original collection and notes that the illustration of the adult female in the Lambdin and Kosztarab (1976) paper is inaccurate in the position of the spiracles. They drew the spiracles as ventral, but they lie on the margin of the dorsal area that bears the 8-shaped pores. This position is best seen on a specimen that has the dorsum and venter separated. The collection date listed by Lambdin and Kosztarab is October 19, 1900; the correct date is October 17, 1900.

Sphaerococcus casuarinae Maskell, 1892:39–41

Current placement.—Pseudococcidae—*Sphaerococcus casuarinae* Maskell (1892); type species of *Sphaerococcus.*

Selected references and discussion.—

This species was described in detail by Williams (1985) and was cataloged by Ben-Dov (1994); for additional information refer to these publications.

Sphaerococcus cupressi Ehrhorn, 1911:277

Current placement.—Pseudococcidae—*Ehrhornia cupressi* (Ehrhorn); type species of *Ehrhornia* (current combination by Ferris 1918).

Selected references and discussion.—This species was described in detail by Ferris (1918, 1953) and was cataloged by Ben-Dov (1994); for additional information refer to these publications.

Sphaerococcus diaspidiformis Green, 1916:64

Current placement.—Asterolecaniidae—*Mycococcus diaspidiformis* (Green) (current combination by Ferris 1952).

Selected references.—Ferris (1952)(as Asterolecaniidae in *Mycococcus* based on Green's 1916 description)

Type material.—Syntypes in BMNH include 4 slides labeled as type or cotype with the following specimen label data: "Sphaerococcus/diaspidiformis/Green/on leaf stalk of Palm/Stapleton, N.T./Australia/G.F.H. 640,J.B.E.93." These slides include the following: 12 adult females; 11 adult females; 2 adult females; 10 adult females. There also are 2 lots of dry type material in the BMNH; the most complete label is as follows: "Sphaerococ. diaspidiformis/(type material)/Livistonia humilis/on leaf stalk of Palm sp./Stapleton, N.T. Australia/coll. G. F. Hill, No. 640/JBE 93." A single syntype slide in USNM contains a complete adult female and parts of others, also several embryos; it is labeled as follows: "*Sphaerococcus/diaspidiformis* Green/On leaf stalk of *Palm* sp./Stapleton, N.T. Australia/G. F. Hill, Coll. (E. E. Green)./Let. June 5, 1916 #14681/From Part of Type Material." There also is a box of dry material that contains 30 or 40 specimens on the host and has the same associated data as that mentioned above.

Discussion.—This species is clearly not congeneric with *Mycococcus copernicae* Ferris, which is the type of the genus, since it (*M. diaspidiformis*) does not have 8-shaped pores in the first-instar nymph. Family placement of this species is enigmatic but we tentatively agree with Ferris' (1952) asterolecaniid assignment because it has: Small ducts on the head that appear to be homologous with the "dorsal tubes" mentioned by Russell (1941), a heart-shaped labium that is indistinctly 2-segmented which is present in some asterolecaniids (Koteja 1974), simple quinquelocular pores, anal ring with an anal tube similar to *Polea* (see Lambdin 1977), and an unsegmented antenna.

Sphaerococcus draperi Newstead 1906:70

Current placement.—Phoenicococcidae—it is considered to be a junior synonym of *Phoenicococcus marlatti* Cockerell (see Newstead (1911) and Borchsenius (1966)).

Type material.—Syntypes in BMNH labeled as follows: "Phoenicoccus/marlatti, Ckll/=-Sphaerococcus/draperi, New./Newsteads'/Co-types./Egypt/B.M. 1945, 131." In addition there is a lot of dry material that is part of the type series labeled as follows: "*Sphaerococcus.* n.sp. (Newstead)/on Palm Leaf/Egypt. 4.iii.1906/W. Draper."

Discussion.—DJW has studied the syntypes of this species and concurs that it is identical with *P. marlatti.*

Sphaerococcus durus De Lotto, 1969:23

Current placement.—Pseudococcidae—*Sphaerococcus durus* De Lotto.

Selected references and discussion.—This species was described in detail by De Lotto (1969) and cataloged by Ben-Dov (1994); for additional information refer to these publications.

Sphaerococcus elevans Maskell, 1895:68

Current placement.—Eriococcidae—*Floracoccus elevans* (Maskell); type species of *Floracoccus* (combination by Beardsley 1974).

Selected references and discussion.—This species was described in detail by Beardsley (1974); for additional information refer to this publication. There is a photograph with the label "Sphaerococcus elevans Mask./Female 'Galls' on Bark/Maskell Coll. No.435" in the U.S. Department of Agriculture Coccoidea library at Beltsville, Maryland.

Sphaerococcus ethelae Fuller, 1899:449

Current placement.—Pseudococcidae—*Peridiococcus ethelae* (Fuller) (combination by Williams 1985).

Selected references and discussion.—This species was described in detail by Williams (1985) and was cataloged by Ben-Dov (1994); for additional information refer to these publications.

Sphaerococcus ferrugineus Froggatt, 1898:378

Current placement.—Beesoniidae (?)—"*Sphaerococcus*" *ferrugineus* Froggatt, **new family assignment.**

Selected references.—Froggatt (1921: 10)(description of gall and external appearance of female).

Type material.—There are 2 dry-mounts (total of 3 galls on 2 stem pieces) in Froggatt's collection in ANIC and both are labeled in his handwriting. PJG considers them to be syntypes. One mount with 2 galls (one mature, other small) is labeled: "Sphaerococcus/ferrugineus/Frg/New South Wales" and the other with a single mature gall is labeled: "Sphaerococcus/ferrugineus/Fro/N. S. Wales." Neither of these mounts is that photographed for figure 4 of Froggatt (1921) and thus there may be further unlocated syntypes.

Discussion.—PJG has examined specimens of this species and indicates that the correct family placement of this species is questionable based on the information available. The species has very distinctive galls that resemble those formed by the Beesoniidae. Mature females (non-type) have shallowly invaginated quinquelocular pores (like Beesoniidae and some Eriococcidae) and large bases to the clypeolabral shield (like Beesoniidae). Young adult females and first-instar nymphs are needed before the family placement can be confirmed.

Sphaerococcus froggatti Maskell, 1894:94

Current placement.—Eriococcidae—"*Sphaerococcus*" *froggatti* Maskell, **new family assignment**.

Selected references.—Cockerell (1896: 329)(checklist, included in Idiococcinae), Froggatt (1907:380) and Froggatt (1921: 10)(redescription of adult female and gall in Idiococcinae), Deitz and Tocker (1980: 20)(family status uncertain, literature citations, and list of types), Beardsley (1984: 88)(mentioned as unplaced in a family).

Type material.—Syntypes in the NZAC include 2 slides and 2 pill boxes of dry material (DRM examined both of Maskell's original slides as follows: 1 adult female; 6 first-instar nymphs and several embryos—they are conspecific with the USNM material); USNM has 3 slides containing: 1 adult female; 2 first-instar nymphs; and 5 first-instar nymphs, (Maskell Collection No. 378). A box of dry material containing several unopened galls has a label inside "Sphaerococcus froggatti, Mask./on Melaleuca linariifolia/No. 25. W. W. Froggatt, N.S.W." and also is considered to be part of the syntype series. The Maskell Collection ledger entry is: "378. Sphaerococcus Froggatti., Maskell Australia/insects in galls in sitû/ Maskell—N. Z. Trans. Vol. XXVI, 1893 p. 94" Notes by Morrison are as follows: "*Sphaerococcus froggatti* Mask. Box 20. The M.C. includes two slides of this species, one of 'larvae, 1893,' the other of 'adult female, 1893,' both in rather good condition. There are a considerable number of galls of this species, presumably, in 4 clusters on terminal twigs of host under #378." There is a photograph with the label

"Sphaerococcus froggatti Mask./Female Galls on Twigs/Maskell Coll. No. 378" in the U.S. Department of Agriculture Coccoidea library at Beltsville, Maryland. There are 2 slides in the BMNH labeled "Sphaerococcus/froggatti, Mask./Australia, Sydney/On Mela. linarifolia/Ex. coll. Froggatt/R. N. BM 1945, 121." These slides include the following: 4 adult females; 6 first-instar nymphs. These apparently are not part of the type series but were collected by Froggatt near the type locality. There also are two pill boxes of dry material from this same collection; the outside of the boxes are labeled in Maskell's handwriting "Sphaerococcus/sp. nov." and "Sphaerococcus/Froggatti/Mask."

Type data.—Australia, Flemington, near Sydney, on *Melaleuca linariifolia,* Froggatt.

Discussion.—DRM has examined type material of this species and concludes that it belongs in the Eriococcidae for the following reasons: the first-instar nymph possesses microtubular ducts, enlarged lateral setae, and a 3-segmented labium. The adult female is very similar to the adult female of *Sphaerococcus socialis.*

Sphaerococcus graminis Maskell, 1897:244

Current placement.—Pseudococcidae—*Antonina graminis* (Maskell) (combination by Fernald 1903).

Selected references and discussion.—This species was described in detail by Yang and Kosztarab (1967), and Williams (1985), and was cataloged by Ben-Dov (1994); for additional information refer to these publications.

Sphaerococcus inflatipes Maskell, 1893:238–240

Current placement.—Eriococcidae—*Sphaerococcopsis inflatipes* (Maskell) (combination by Cockerell 1899).

Selected references.—Hoy (1963: 193)(included in catalog of Eriococcidae), Beardsley (1972, 1974a)(lectotype designation and redescription in revision of *Sphaerococcopsis*).

Type material.—Lectotype adult female in ANIC; 3 paralectotype slides and 1 pill box of dry material in NZAC, and 3 paralectotype slides in USNM containing: 2 adult females; 5 adult females; and 3 second-instar female exuviae (Maskell Collection No. 299). The Maskell Collection ledger entry is "299. Sphaerococcus inflatipes (type) Maskell Australia/insects in sitû/N. Z. Trans. Vol. XXV, p. 238, 1892." There are no notes by Morrison but there is a photograph with the label "Sphaerococcopsis inflatipes (Mask.)/Female Tests on Bark/Maskell Coll. No. 299" in the U.S. Department of Agriculture Coccoidea library at Beltsville, Maryland.

Type data.—Australia, Victoria, Myrniong, on *Eucalyptus* sp., French.

Discussion.—Based on the description of Morrison and Morrison (1922:31) the first-instar nymph possesses conical setae typical of the Eriococcidae and has leg setae arranged similarly to other first-instar eriococcids. The adult male (with a complete dorsal-ventral penial sheath), chromosome system (with heterochromatic chromosomes), and chromosome number (with either 16 or 18 pairs of chromosomes) is typical of the eriococcids (Beardsley personal communication 1997). Examination of an adult female by DRM revealed the presence of translucent pores on the hind pair of legs on the tibia and tarsus and invaginated tubular ducts that are characteristic of some species of Eriococcidae. All of the above support the hypothesis that *S. inflatipes* is an eriococcid. However, abundant leg setae on the adult female and a 1- or possibly 2-segmented labium are atypical of the family. At one time, Beardsley suggested that *Sphaerococcopsis* and *Lachnodius* should be included in a separate family (Beardsley 1972), but he has since decided that the genera are correctly placed in the Eriococcidae (Beardsley personal communication 1997). We concur with this decision.

Sphaerococcus inflatipes var. *simplicior* Maskell, 1896:403

Current placement.—Eriococcidae—*Sphaerococcopsis simplicior* (Maskell) (combination by Morrison and Morrison 1922).

Selected references.—Morrison and Morrison (1922:31)(considered variety to be a separate species); (Hoy 1963: 193)(treated taxon as a variety of *S. inflatipes,* catalog); Beardsley (1974a:334)(redescribed species).

Type material.—Lectotype adult female is in ANIC; 1 paralectotype slide and 1 pill box of dry material in NZAC; 3 paralectotype slides in USNM containing: 1 adult female and many embryos; 3 first-instar nymphs; 1 first-instar nymph (Maskell Collection No. 455). The Maskell Collection ledger entry is "455. Sphaerococcus inflatipes var. simplicior Maskell Australia/insects in sitû/Maskell-N. Z. Trans. 1895 p." There are no notes by Morrison, but there is a photograph with the label "Sphaerococcopsis inflatipes/simplicior (Mask.)/Female Tests on Bark/Maskell Coll. No. 455" in the U.S. Department of Agriculture Coccoidea library at Beltsville, Maryland.

Discussion.—The first-instar nymphs of this species were examined by DRM and possess longitudinal lines of enlarged setae including those around the body margin, have leg setae typical of eriococcids, and have a few dorsal microtubular ducts. The adult female has translucent pores on the hind femur and tibia. All of these features support the hypothesis that *S. simplicior* should be placed in the Eriococcidae.

Sphaerococcus leaii Fuller, 1897:1346

Current placement.—Eriococcidae—*Casuarinaloma leaii* (Fuller); type species of *Casuarinaloma* (combination by Froggatt 1933).

Selected references.—Fuller (1899: 448)(detailed redescription including first-instar nymph); Froggatt (1921)(brief description of gall and adult female); Froggatt (1933)(placed species in new genus *Casuarinaloma*); Hoy (1963)(catalog).

Type material.—Syntypes in USNM as follows: Slide 1 with left label "On Casuarina/Swan R. (banks)/W.A./ 97/Larvae leaii"; right label "Sphaerococcus/Leai, Fuller/Larvae)/(types)/402"; the paper envelope containing the slide states "leaii Fuller W. Australia Brain Coll./On Casuarina sp. Fuller type/Brain #402/Casuarinaloma/(Sphaerococcus) 39 2882"; it contains 6 uncleared first-instar nymphs. Slide 2 with left label "Sphaer. pulchellus/leaii/ 402"; right label "Sphaerococcus/Leaii, Fuller/(types)/[On Casuarina sp./Swan R. Perth W. Aust.]"; the paper envelope is identical with the one above; the slide contains 5 unstained adult females and many embryos.

Discussion.—The first-instar nymphs of this species have enlarged setae arranged in longitudinal lines including the body margin and have protruding anal lobes with associated enlarged setae. The adult female has enlarged setae and the hind femora apparently have translucent pores. The presence of these characters supports the hypothesis that this species belongs in the Eriococcidae. Because of the poor condition of the material examined it was not possible to ascertain the number of labial segments or the occurrence of microtubular ducts.

Sphaerococcus leptospermi Maskell, 1894a:92–94

Current placement.—Asterolecaniidae—*Callococcus leptospermi* (Maskell).

Selected references and discussion.—This species was described in detail by Coles et al. (1988); for additional information refer to this publication. Also see Morrison and Morrison (1927:13)(redescription of adult female); Koteja (1974:83)(description of labium, included in *Callococcus* group). There is a photograph with the label "Sphaerococcus leptospermi Mask./Female Galls on Twigs/Maskell Coll. No. 301" in the U.S. Department of Agriculture Coccoidea library at Beltsville, Maryland.

Sphaerococcus leptospermi: Ferris, 1919:249

Current placement.—Lecanodiaspididae—*Gallinococcus leptospermi* (Morrison and Morrison), **new combination**; type species of *Gallinococcus.*

Selected references.—See discussion.

Type material.—The holotypes of *Amorphococcus leptospermi* Morrison and Morrison (1927) and *Gallinococcus ferrisi* Lambdin and Kosztarab (1973) are the same specimen, and labeled as follows: Left label in red "Amorphococcus/leptospermi/n.sp./*Holotype*/HM." in black ink "8480/Sphaerococcus/leptospermi Mask/on/Leptospermum/N. S. W./W. W. Froggatt"; in pencil "40358/B." Right label is not original and states in pencil "Leptospermi/associated with Lecaniodiaspis/H. M. March 11,/1952"; in ink "*Gallinococcus/ferrisi* n. sp./Det. Lambdin & Krb." In addition there are 3 paratype slides with 3 complete adult females and 4 paratype slides containing fragments of adult females; all in USNM.

Discussion.—Based on material sent to him by Froggatt, Ferris (1919) described and illustrated what he thought was *S. leptospermi* (Maskell); he treated it as a new combination "Amorphococcus leptospermi (Maskell)." The specimens that he described were not *S. leptospermi* but were of a species previously undescribed. Based on the International Code of Zoological Nomenclature (1985) Article 49, this misidentification cannot be used as a valid description of the new taxon even though it was not included in *Sphaerococcus.* The misidentification was first discovered by Morrison and Morrison (1927:3, 14) who described the species as "*Amorphococcus leptospermi* new species." Since the name used by Ferris has no validity under the Rules of Zoological Nomenclature, the name and description presented by Morrison and Morrison are the first to validate the species. Lindinger (1943:206) incorrectly considered *A. leptospermi* Morrison and Morrison to be a junior, primary homonym of *A. leptospermi* Ferris and proposed *Amorphococcus fallax* Lindinger as a replacement name. This name, therefore, is a junior, objective synonym of *A. leptospermi* Morrison and Morrison. Lambdin and Kosztarab (1973) restudied the species and also described it as a new species within a new genus (*Gallinococcus ferrisi*) and placed it in the family Lecanodiaspididae. The correct name of this taxon is *Gallinococcus leptospermi* (Morrison and Morrison); *G. ferrisi* Lambdin and Kosztarab is a junior, objective synonym (**new synonymy**). For the sake of clarification the following synonymy is presented:

Amorphococcus leptospermi Maskell: Ferris, 1919:249 (misidentification).

Amorphococcus leptospermi Morrison and Morrison, 1927:3, 14.

Amorphococcus fallax Lindinger, 1943:206 (invalid replacement name).

Gallinococcus ferrisi Lambdin and Kosztarab, 1973:85 (invalid replacement name).

Gallinococcus leptospermi (Morrison and Morrison) (**new combination**)

Sphaerococcus melaleucae Maskell, 1894a:94

Current placement.—Asterolecaniidae—"Sphaerococcus" melaleucae (Maskell), **new family assignment.**

Selected references.—Fuller (1897: 10)(treated species as variety of S. acaciae); Froggatt (1921:12)(described female and test); Deitz and Tocker (1980:20)(family status uncertain, literature citations, and list of types).

Type material.—Syntypes in NZAC include 1 slide and 2 pill boxes (DRM examined Maskell's original slide which includes 1 adult female—it is conspecific with the USNM material); USNM includes 3 slides: complete second instar or adult female; fragment of same; a slide with an unprepared test (Maskell Collection No. 377). The Maskell Collection ledger entry is "377. Sphaerococcus melaleucae Maskell

Australia/insects in galls in sitû/Maskell-N. Z. Trans. Vol. XXVI, 1893 p. 94." Notes by Morrison are as follows: "*Sphaerococcus melaleucae* Mask. Box 20. The M.C. includes a single good slide of this species of 'adult female, 1893,' which from a superficial examination appears to have some relationship with *S.* (*K.*) *obscurata* Mask. If possible try some more tests for larvae. In the M.C. are 7 more or less mature tests of this species on twigs of the host under #377." There is a photograph with the label "Sphaerococcus acaciae/melaleucae Ckll./Female Tests on Twigs/Maskell Coll. No. 377" in the U.S. Department of Agriculture Coccoidea library at Beltsville, Maryland.

Type data.—Australia, New South Wales, Penhurst, on *Melaleuca linariifolia,* W. W. Froggatt.

Discussion.—Examination of type material deposited in the NZAC and USNM by DRM reveals that this species possesses distinct 8-shaped pores and has a 3-segmented labium. Although most asterolecaniids have only a 1 or 2-segmented labium DRM proposes placing it in the Asterolecaniidae since the 8-shaped pores are typical of other members of this family and the labial structure seems to vary somewhat among families.

Sphaerococcus morrisoni Fuller, 1897:1346

Current placement.—Eriococcidae—"Sphaerococcus" morrisoni Fuller, **new family assignment**.

Selected references.—Fuller (1899: 450)(description of gall, adult female, and first instar); Froggatt (1921:12)(description of gall).

Type material.—Syntype material in USNM includes 3 slides as follows: 10 immature specimens; 4 adult females and numerous embryos; and 5 adult females. This material was acquired as part of the Brain Collection and is labeled "*Sphaerococcus/morrisoni* Fuller/Type/ [on *Melaleuca* sp./Penyarrah, W. Aust.]/Brain #407]." The USNM also has an empty gall from the Cockerell Collection that is labeled "Sphaerococcus morrisoni Full./TYPE Melaleuca/Ckll. Coll./Australia (Fuller)." The BMNH has dry material including 2 opened galls and 2 complete galls with the following label: "ex coll./W. W. Froggatt/Fuller/Sphaerococcus morrisoni."

Discussion.—Based on examination of syntype specimens by DRM, this species is placed in the Eriococcidae. Characters that support this hypothesis are the presence in one morph of first-instar nymph of simple microtubular ducts, enlarged setae arranged in longitudinal lines on the dorsum, trochanter sensoria arranged transversely; in what may be a second instar male the presence of invaginated tubular ducts; in the adult female the presence of quinquelocular pores. However, there are 2 morphs of first-instar nymphs (probably female and male) and the labium is 2-segmented; these characters normally do not occur in the Eriococcidae.

Sphaerococcus morrisoni var. *elongata* Fuller, 1899:451

Current placement.—Eriococcidae—"*Sphaerococcus*" *morrisoni* var. *elongatus* Fuller, **new family assignment**.

References.—Fuller (1897:1346)(mentions variety as "*Sphaerococcus morrisoni* var." from Western Australia: Swan River); Fuller (1899:451)(describes gall).

Type material.—We have been unable to locate specimens of this taxon. There are 2 unopened galls in the USNM that closely match the illustration of Fuller (1899, Fig. 23), but no label information is provided other than it is "Sphaerococcus morrisoni var. elongata" and is from "W. Austral." It is part of the Cockerell Collection. There is a photograph with the label "Sphaerococcus rugosus/elongatus Mask./Female Galls on Twigs/Maskell Coll. No. 537" in the U.S. Department of Agriculture Coccoidea library at Beltsville, Maryland.

Discussion.—Since we have been unable to locate authentic type material of this species it is difficult to assign it to a family.

However, we assume that the variety is closely related to *S. morrisoni* and therefore tentatively place it in the Eriococcidae until specimens are discovered.

Sphaerococcus newmanni Froggatt, 1921:14

Current placement.—Asterolecaniidae—*Callococcus newmanni* (Froggatt), **new combination and family assignment.**

Selected references.—Froggatt (1921: 14)(description of adult female, test, and first-instar nymph).

Type material.—PJG has mounted 3 adult female syntypes and many first-instar nymphs (5 slides) from dry material and has remounted a syntype adult female from an original Froggatt slide. In addition, 12 dry female syntypes remain as part of 2 dry-mounts. All of this material is labeled in Froggatt's handwriting and is in ASCT. The dry-mounts have data labels: "Newman 1911/Perth WA/16" and "520" and the slide has 2 original Froggatt labels: "Sphaerococcus/newmani/n sp/W. Australia/Froggatt" and "Sphaerococcus/newmani/Froggatt." In addition, ANIC has 2 dry-mounts containing 11 adult females that are labeled in Froggatt's handwriting, but the data are inadequate and thus it is unclear whether these specimens are part of Froggatt's syntypic series.

Type data.—Australia, Western Australia, Busseltown, L. J. Newman, on twigs of *Melaleuca* sp. Entry 520 in Froggatt's first accession notebook records no additional data.

Discussion.—PJG has studied the above mentioned material and is convinced that this species is a member of the genus *Callococcus*. It closely matches the appearance of *C. pulchellus* (the type species of the genus) but differs slightly in the structure of the mid-dorsal sclerotized band of ducts.

Sphaerococcus obscuratus Maskell, 1896:403

Current placement.—Eriococcidae—*Kuwanina obscurata* (Maskell) (combination by Ferris 1919).

Selected references.—Ferris (1919:252) (redescription of adult female and first-instar nymph, related to *Kuwanina parva* (Maskell)); Froggatt (1921:14)(redescription of blisters and adult female); Kosztarab (1968:12)(family placement uncertain); Deitz and Tocker (1980:20)(information about types, depositories, and taxonomic history).

Type material.—Syntypes in NZAC including 5 slides and 2 pill boxes of dry material (DRM examined 3 of Maskell's original slides as follows: 1 adult female; 1 adult female; and 2 first-instar nymphs (one of which is an *Acanthococcus*)—they are conspecific with the USNM material); USNM including material of 2 species, one that appears to belong to *Acanthococcus* and one that is identical to the material redescribed by Ferris (1919). Based on the original description of Maskell (1896) it is evident that this name did not pertain to an *Acanthococcus* since he indicated that it had reduced legs, occurred within the skin of the second instar, and occurred under the bark of the host. Material in the USNM includes 5 slides as follows: a dry mounted test; 2 adult females, some fragments, and some embryos; 3 first-instar nymphs; 1 adult female; and 1 first-instar nymph. There are 2 slides of the *Acanthococcus* species containing 1 adult female and 1 first-instar nymph (Maskell Collection No. 486). The Maskell Collection ledger entry is "486. Sphaerococcus melaleucae Maskell Australia/insects in sitû/Maskell—N. Z. Trans. 1895 p." Notes by Morrison are as follows: "*Sphaerococcus obscuratus* Mask. [*Kuwana obscuratus* (M.) Ferris]. Box 20. The M.C. includes 5 slides of this species, two of 'adult female, 1895,' one of '2*nd* stage female, 1895,' one of 'late larva, 1895' one of 'early larvae, 1895.' Besides there is a slide of 'mite parasitic on Sph. obscuratus, 1895.' The larval slides are poor, but indicate a distinctly Eriococcine relationship, or else two things are mixed together. The 2*nd* ♀ is very poor, the adults rather good. Relationships not certain.

There are a number of pustules of this species on the bark of the host under #486 and 2 possibly ♂ sacs." There is a photograph with the label "Sphaerococcus obscuratus Mask./Female 'Galls' on Twigs/Maskell Coll. No. 486" in the U.S. Department of Agriculture Coccoidea library at Beltsville, Maryland.

Type data.—According to Maskell (1896) Australia, New South Wales, Hornsby, near Sydney, on *Acacia longiflora* and *Eucalyptus obtusiflora,* W. W. Froggatt. According to Froggatt (1921) on *Acacia linarifolia* and *A. obtusiflora.*

Discussion.—DRM has examined material of this species and believes that it belongs in the Eriococcidae since it has conical setae in the first-instar nymph and adult female, a 3-segmented labium, and has microtubular ducts in the adult female. It does not appear to be congeneric with *Kuwanina parva* but is left in this genus until a more detailed analysis can be undertaken.

Sphaerococcus parvus Maskell, 1897:244

Current placement.—Eriococcidae—*Kuwanina parva* (Maskell); type species of *Kuwanina* (combination by Cockerell in Fernald 1903).

Selected references.—Morrison and Morrison (1922:58)(redescribed, placement uncertain); Kosztarab (1968:12)(Cryptococcidae); Hoy (1963:165)(catalog, placed in Eriococcidae); Deitz and Tocker (1980:20)(information about types, depositories, and taxonomic history).

Type material.—Syntypes in CASC including 2 boxes of dry material; NZAC has 2 syntype slides and 1 pill box of dry material (DRM examined both of Maskell's original slides as follows: 1 adult female and 3 embryos; 10 uncleared first-instar nymphs—they are conspecific with the USNM material); UCD has 1 syntype slide; USNM has 4 syntype slides containing: 1 adult female; 4 adult females; 3 first-instar nymphs; and 2 first-instar nymphs (Maskell Collection No. 560). The Maskell Collection ledger entry is "560. Sphaerococcus Japan/insects in sitû/From Koebele 1897/ on cherry" Notes by Morrison are as follows: "*Sphaerococcus parvus* Mask. [*Kuwanina* Ckll). Box 20. The M.C. includes two slides of this species, one of 'adult female, 1897' and one of 'larvae, 1897.' It was previously believed that there was no material of this species, but evidently that listed as 'Sphaerococcus' under '#560' is this species. This consists of a portion on which are several ♀s enclosed in wooly sacs."

Type data.—Japan, on cherry, Koebele.

Discussion.—This species is considered to be a member of the Eriococcidae (Hoy 1963) or the Cryptococcidae (Kosztarab 1968).

Sphaerococcus pirogallis Maskell, 1894a:95

Current placement.—Asterolecaniidae—*Eremococcus pirogallis* (Maskell); type species of *Eremococcus.*

References.—Froggatt (1907:380)(described gall and infestation around Sydney); Froggatt (1921:15) (description of gall and adult female); Ferris (1919:249)(described *Eremococcus* and redescribed *S. pirogallis*); Morrison and Morrison (1922:38)(redescription of adult female, second-instar female, and first-instar nymph); Deitz and Tocker (1980:20)((information about types, depositories, and taxonomic history).

Type material.—Syntypes included in NZAC include 6 slides and 2 pill boxes of dry material (DRM examined 2 of Maskell's original slides containing 1 adult female; 1 first-instar nymph—they are conspecific with the USNM material); USNM has 6 syntype slides containing: 4 adult females; second-instar female fragment; 1 first-instar nymph, 2 second-instar females, and 2 adult females; 1 first-instar nymph, 2 second instars, and 1 adult female; 1 adult female; dry mounted slide with 2 galls (Maskell Collection Number 364). There is a single box of material that is part of the Cockerell Collection that is marked as "type" that was received by Cockerell from

Maskell. The Maskell Collection ledger entry is "364. Sphaerococcus pirogallis Maskell Australia/galls, female, in sitû: gall cut open: female insects dorsal/and ventral view/Maskell—N. Z. Trans. XXVI 1893 p.95" There are no notes by Morrison, but there is a photograph with the label "Sphaerococcusis pirogallis Mask./Female Galls/Maskell Coll. No.364" in the U.S. Department of Agriculture Coccoidea library at Beltsville, Maryland. BMNH has 1 slide containing 3 adult females that might be part of the type series; it is labeled "Australia/W. W. Froggatt./1895/Let." BMNH also has 3 lots of dry material that may be part of the type series; label data from the most complete is as follows: "*Sphaerococ- pirogallis* Mask/on Leptospermum flavescens/Sydney—NSW—Australia/ ex coll. W. W. Froggatt."

Type data.—Australia, New South Wales, several localities around Sydney, on *Leptospermum flavescens,* W. W. Froggatt.

Discussion.—This species is widely accepted as an asterolecaniid (Morrison and Morrison 1922; Deitz and Tocker 1980).

Sphaerococcus populi Maskell, 1898:248

This species is now placed in the Aphididae genus *Doraphis* according to Eastop and Hille Ris Lambers (1976) and was illustrated by Ferris (1936:15) who considered it to be part of *Nipponaphis.* There is a photograph with the label "Sphaerococcus populi Mask./(Aphiidae [sic], n.g. near Cerataphis)/Maskell Coll. No.486" in the U.S. Department of Agriculture Coccoidea library at Beltsville, Maryland.

Sphaerococcus pulchellus Maskell, 1897a:324

Current placement.—Asterolecaniidae—*Callococcus pulchellus* (Maskell); type species of *Callococcus* (combination by Ferris 1918).

Selected references.—Ferris (1918: 329)(described *Callococcus* and redescribed *C. pulchellus*); Froggatt (1921: 17)(redescription, illustration of test); Morrison and Morrison (1922:32)(redescription of adult female and first-instar nymph); Deitz and Tocker (1980:25)(information about types, depositories, and taxonomic history).

Type material.—Syntypes in NZAC include 2 slides and 2 pill boxes of dry material (DRM examined 1 of Maskell's original slides with adult female—it is conspecific with the USNM material); USNM has 1 syntype slide containing 2 adult females and 5 first-instar nymphs (Maskell Collection Number 504) (Deitz and Tocker 1980 mention dry material in USNM but it apparently is not part of the type series). The Maskell Collection ledger entry is "504. Sphaerococcus pulchellus Maskell W. Australia/insects in sitû/from Lea 1896." Notes by Morrison are as follows: "*Sphaerococcus pulchellus* Mask. (*Callococcus* Ferris). Box 20. The M.C. includes three slides of this species, two of 'adult female, 1896' and one of 'late 2*nd* stage♀, 1896.' One supplementary slide of ♀♀, immature ♀♀ and larvae has already been prepared. The material consists of 13 more or less mature ♀ tests on 2 twigs under #504." There is a photograph with the label "Sphaerococcus pulchellus Mask./Female Tests on Twigs/ Maskell Coll. No. 504" in the U.S. Department of Agriculture Coccoidea library at Beltsville, Maryland.

Type data.—Australia, Western Australia, possibly from the Darling Ranges, common all over south-west Australia, in the vicinity of swampy ground, host unknown, A. M. Lea. According to Froggatt (1921) it occurs on an unknown species of *Melaleuca* and *Hypocalymma angustifolium.*

Discussion.—This species is widely accepted as an asterolecaniid (Ferris 1918; Deitz and Tocker 1980).

Sphaerococcus pustulans Green, 1905:7

Current placement.—Eriococcidae—*"Sphaerococcus" pustulans* Green, **new family assignment**.

Selected references.—The only description of this species is the original treatment by Green (1905:7).

Type material.—The BMNH has 1 adult female on a slide labeled as follows: "Sphaerococcus/pustulans/BM Green/from *Eucalyptus/gonicalyx.*/Myrmiong [sic]. Vict. Australia/coll. J. Lidgett. No 52." The slide contains 5 adult females. In addition there is a lot of dry material with the same information. USNM has 1 syntype slide containing an adult female and part of a second-instar nymph and a box containing a twig with several undisturbed pustules. The slide is labeled as follows: "*Sphaerococcus/pustulans* Green/*On* Bark of *Eucalyptus/gonicalyx.*/Myrmiong [sic], Victoria, Austr./J. Lidgett, Coll. (E. E. Green)/ #14642." The correct spelling of the locality is Myrniong.

Discussion.—Based on examination of specimens deposited in the BMNH and USNM by DJW and DRM, this species should be placed in the Eriococcidae. Characters that support this hypothesis are the presence of microtubular ducts and invaginated macrotubular ducts on the second-instar nymph, translucent pores on the hind coxa, and quinquelocular pores on the adult female. Other characters that are consistent with this family assignment on the adult females and second-instar nymph are trochanter sensoria arranged transverely and a denticle on the claw. It has a 1- or 2-segmented labium which is unusual for an eriococcid.

Sphaerococcus rugosus Maskell, 1897a:322

Current placement.—Asterolecaniidae—*Eremococcus rugosus* (Maskell), **new combination and family assignment.**

Selected references.—Froggatt (1921: 17)(description of female and gall); Deitz and Tocker (1980:20)(information about types, depositories, and taxonomic history).

Type material.—Syntypes in NZAC include 2 slides and 2 pill boxes of dry material (DRM examined 1 of Maskell's original slides with 1 poorly cleared first-instar nymph—it is conspecific with the USNM material); USNM has 5 syntype slides as follows: dry mounted slide with 1 gall; 27 first-instar nymphs; 11 first-instar nymphs; 14 first-instar nymphs; adult female (Maskell Collection Number 536). The Maskell Collection ledger entry is "536. Sphaerococcus rugosus (type) Maskell West Australia/insects in sitû/from Lea 1896." Notes by Morrison are as follows: "*Sphaerococcus rugosus* Mask. Box 20. The M.C. includes 2 slides of this species, one of 'adult female, 1896,' one of 'larva, 1896.' The female is very poor but perhaps a few things can be made out. The larva is a little better and is evidently very closely related to and probably congeneric with larva of *Eremococcus pirogallis* (Maskell). The collection also included under #536. The material consists of 8 galls on 1 twig of the host under #536." There is a photograph with the label "Sphaerococcus rugosus Mask./Female Galls on Twig/Maskell Coll. No. 536" in the U.S. Department of Agriculture Coccoidea library at Beltsville, Maryland.

Type data.—Australia, Western Australia, Mount Barker, on *Leptospermum* sp., A. M. Lea.

Discussion.—Based on examination of syntype slides by DRM in consultation with PJG it is believed that this species belongs in *Eremococcus* or to a closely related genus. Apparently, Morrison agreed (see note above). The first-instar nymphs of the type species of *Eremococcus,* (i.e. *E. pirogallis*) and *E. rugosus* share the following characteristics: posterior abdominal segments with curved, slightly enlarged marginal setae; dorsum with 1 or 2 pairs of large tubular ducts; dorsum with sclerotized segmental areas; antennae 3-segmented; labium 2-segmented; legs with distinctive wrinkled pattern on femur. The 8-shaped pores are more tubular in nature than in *E. pirogallis,* but the setae, anal-ring area, and very large clypeolabral shield are very similar to *E. pirogallis. Eremococcus rugosus* does not have the distinctive antennae mentioned by Ferris (1919) and Morrison and Morrison (1922) and has only one pair of large tubular ducts on the dorsum of the crawler; *E. pirogallis* has two pair (Morrison and Morrison 1922).

Sphaerococcus rugosus var. *elongatus* Maskell, 1897a:322

New placement.—Asterolecaniidae—*Eremococcus rugosus* var. *elongatus* (Maskell), **new combination and family assignment.**

Selected references.—Froggatt (1921: 17)(description of female and gall); Deitz and Tocker (1980:20)(information about types, depositories, and taxonomic history).

Type material.—Syntypes in NZAC include 2 slides and 2 pill boxes of dry material (DRM examined both of Maskell's original slides as follows: 1 adult female; 1 first-instar nymph—they are conspecific with the USNM material); USNM has 4 syntype slides as follows: dry mounted slide with 1 gall; 13 first-instar nymphs; 11 first-instar nymphs; 2 adult females and several embryos (Maskell Collection No. 537). The Maskell Collection ledger entry is "536. Sphaerococcus rugosus var. elongatus Maskell West Australia/insects in sitû/ from Lea 1896." Notes by Morrison are as follows: "*Sphaerococcus rugosus var elongatus* Mask. Box 20. The M.C. includes 2 slides of this species, one of 'adult female, 1896' very poor and one of 'larva, 1896,' not much better. The larva very close to that of *rugosus*. The material consists of 8 mature galls and a number of immature galls, some apparently ♂'s on the leaves of the host. under #537."

Type data.—Australia, Western Australia, possibly Albany, on undetermined tree with small leaves and clusters of small flowers, A. M. Lea.

Discussion.—Based on examination of syntype slides by DRM no obvious differences were detected between this taxon and *Eremococcus rugosus,* but a more detailed examination is required to determine if *E. rugosus rugosus* and *E. rugosus elongatus* are distinct taxa.

Sphaerococcus socialis Maskell, 1897a:325

New placement.—Eriococcidae–"*Sphaerococcus*" *socialis* Maskell, **new family assignment.**

Selected references.—Froggatt (1907: 380)(description of gall); Froggatt (1921: 18)(mentioned); Deitz and Tocker (1980: 21)(information about types, depositories, and taxonomic history).

Type material.—Syntypes in NZAC include 5 slides and 2 pill boxes of dry material (DRM has examined all 5 of these slides containing: 1 uncleared adult male; 1 uncleared male; 1 adult female; 1 adult female; and 1 first-instar nymph—they are conspecific with USNM material); USNM has 2 syntype slides as follows: 2 adult females; 2 adult females (Maskell Collection Number 510). The Maskell Collection ledger entry is "510. Sphaerococcus socialis Maskell West Australia/insects in galls in sitû/from Lea 1896/Geraldton, W. Australia." Notes by Morrison are as follows: "*Sphaerococcus socialis* Mask. Box 20. The M.C. includes five slides of this species, two of 'adult female, 1896,' one of 'larva, 1896,' one of 'adult male, 1896,' and one of 'larva, 1896.' No one of these can be considered good. The material consists of 17 more or less mature galls, on small branch of host and 1 on pin under #510." There is a photograph with the label "Sphaerococcus socialis Mask./Female Galls on Twig/Maskell Coll. No. 510" in the U.S. Department of Agriculture Coccoidea library at Beltsville, Maryland.

Type data.—According to Maskell (1897a): Australia, Western Australia, Geraldton, on myrtaceous plant (either *Melaleuca* or *Calothamnus*), A. M. Lea. According to Froggatt (1921) it occurs on *Melaleuca* sp.

Discussion.—According to DRM, the adult male of this species is very similar to the male of the 2 unidentified species of *Opisthoscelis* described by Theron (1968) by having the terminal 4 or 5 abdominal segments very elongate and attenuated. The adult females also are similar by having: the anterior end of the clypeolabral shield developed into 2 large lobe-like extensions; a 1-segmented labium; and many simple quinquelocular pores. "*Sphaerococcus*" *socialis* adult females do not have the unusually elongate legs of *Opisthoscelis* species and are not congeneric. All *Opisthoscelis* species induce galls on *Eucalyptus* unlike *S. socialis* which occurs on *Melaleuca* or *Calothamnus*. The similarities of the adult males and females of *S. socialis* and *Opisthoscelis* species suggest a strong possibility of a close relationship.

Sphaerococcus stypheliae Maskell, 1895:67

Current placement.—Pseudococcidae—*Peridiococcus stypheliae* (Maskell); type species of *Peridiococcus*.

Selected references and discussion.—This species was described in detail by Williams (1985); for additional information refer to that publication.

Sphaerococcus sylvestris Cockerell and King, 1898:326

Current placement.—Kermesidae—*Kermes sylvestris* (Cockerell and King).

Selected references and discussion.—This species was described in detail by Bullington and Kosztarab (1985); for additional information refer to that publication. There is a photograph with the label "Sphaerococcus stypheliae Mask./Female Tests on Twigs/Maskell Coll. No. 407" in the U.S. Department of Agriculture Coccoidea library at Beltsville, Maryland.

Sphaerococcus tepperi Fuller, 1897:1346

New placement.—Eriococcidae—"*Sphaerococcus*" *tepperi* (Fuller), **new family assignment.**

Selected references.—Fuller (1899: 449)(description of gall and adult female); Froggatt (1921:18)(description of gall and female).

Type material.—The only type material known to the authors is a single slide in the USNM that is part of the Brain Collection and has left label "on/Melaleuca/Swan R. W.A./1897"; right label "Sphaerococcus/tepperi/elegans/Fuller/(typus)/ 403." The slide contains 7 adult females, 1 or 2 embryos, and 1 shed skin. Because the original description closely matches the specimens on this slide, e.g. front two pairs of legs absent and hind pair atrophied, and because the cursory specimen data given by Fuller (1897, 1899) agree with the data on this slide, we believe that this slide is a syntype. In addition, there are two boxes of dry material in the USNM that were acquired as part of the Cockerell Collection, but they have no associated collection data other than a label that says "type" and gives the name "Sphaerococcus tepperi Fuller MS." The galls in the boxes are identical in appearance to the illustration given by Fuller (1899, figure 16).

Discussion.—Based on examination of the USNM syntypes, DRM believes that this species should be placed in the Eriococcidae. Evidence supporting this hypothesis is the presence of translucent pores on the hind legs and conical setae in the anal area. Unfortunately, the species does not have pores or ducts in the adult female and the only available embryo is in such poor condition that no diagnostic family characters can be seen. *Sphaerococcus tepperi* is superficially similar to species in the genera *Opisthoscelis* and *Capulinia* by having the legs limited to the hind pair only. In *Opisthoscelis* these legs are unusually large, but in *Capulinia* they vary from small to large and are represented by small nubs in *C. sallei* Signoret.

Sphaerococcus (Pseudolecanium) tokionis Cockerell, 1896:49–50

Current placement.—Aclerdidae—*Aclerda tokionis* (Cockerell).

Selected references and discussion.—This species was described in detail by McConnell (1953); for additional information refer to that publication.

Sphaerococcus tormentosus Fuller, 1899:450

Current placement.—Eriococcidae—"*Sphaerococcus*" *tormentosus* Fuller.

Selected references.—Afifi and Kosztarab (1967:29)(redescription of adult male, Eriococcidae); Coles et al. (1988:23)(male described as *S. tomentosus* Fuller ? by Afifi and Kosztarab (1967) is *Callococcus leptospermi*).

Type material.—Syntypes in BMNH include a slide labeled "Sphaerococcus/tomentosus/Full./on Melaleuca sp./W. Australia/ex. coll. C. Fuller/Euparol." This slide contains 1 adult female. In addition there is an envelope containing dry material from this same collection. Syntypes in the USNM include 1 slide from the Brain Collection with left label "*Sphaerococcus/tomentosus* Fuller/Type/[On *Melaleuca* sp-/Swan R. W. Australia/Brain #405]"; the slide contains 1 adult male and 6 first-instar nymphs all poorly cleared. Because the original description closely matches the specimens on this slide, e.g. first-instar nymphs with transverse rows of conical setae, and because it is labeled as type, we believe that the specimens on this slide are syntypes. The BMNH also has 2 slides labeled "Sphaerococcus/tomentosus/Full./from Leptospermum/ Australia/(Canberra, N.S.W.)/coll. Froggatt 1632." These slides apparently are not part of the type series and contain the following: 1 adult male; 4 adult females.

Discussion.—Based on examination of first-instar nymphs and the adult male, DRM believes that this species is a member of the Eriococcidae. Afifi and Kosztarab (1967) included descriptions of two different males. The one that they considered to be "*Sphaerococcus tomentosus* Fuller?" is apparently *Callococcus leptospermi* (Coles *et al.* 1988), the other is believed to be the adult male of *S. tormentosus* and possesses many eriococcid characteristics (Afifi and Kosztarab 1967). Examination of the first-instar nymphs reveals that they possess the following eriococcid characteristics: Longitudinal lines of conical setae, 3-segmented labium, and protruding anal lobes. This species has often been misspelled the species epithet as *tomentosus.*

Sphaerococcus turbinata Froggatt, 1921:19

New placement.—Asterolecaniidae—*Eremococcus turbinatus* (Froggatt), **new combination and family assignment.**

Selected references.—The only descriptive treatment of this species is by Froggatt (1921:19) and he only treated the galls; the female was so badly damaged by parasites that he did not provide a description.

Type materia.—PJG has determined that ANIC has syntypic material of this species consisting of a number of loose galls (not attached to stems and in a unit tray) plus 2 dry-mounts each with 4 mature galls attached to a piece of stem. The galls in the unit tray are accompanied by the label: "Sphaerococcus/turbinata/1518 n.sp. Frgg/ Lea Launceston Tas," whereas the 2 dry-mounts are labeled: "Launceston/(A.M. Lea)/1518." Entry 1518 in Froggatt's second accession notebook is: "Sphaerococcus turbinata Fr., p. 19 Cat pIII, A.M. Lea, Melaleuca sp. Tasmania." These data exactly match those given in Froggatt (1921), even to the extent that the damage to the gall matches that discussed in the original description. PJG mounted the remains of 1 adult female in a dry gall from the unit tray in the above collection in 1997.

Discussion.—According to PJG, this species is definitely a member of *Eremococcus* because the remains of the syntype female share the following features with *E. pirogallis* (the type species of the genus): central area of dorsum nodulose and more heavily sclerotized than rest of derm, anal ring small and simple, legs absent, clypeolabral shield large and sclerotized, and 8-shaped pores abundant marginally. Gullan also suggests that the type host of this species may be incorrectly identified as *Melaleuca* and probably is a species of *Leptos-*

permum, based on examination of the foliage associated with the syntype galls and also her recent host records for this species.

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OFFADENS, A NEW GENUS OF SMALL MINNOW MAYFLIES (EPHEMEROPTERA: BAETIDAE) FROM AUSTRALIA

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Abstract.—***Offadens,* new genus** (Ephemeroptera: Baetidae), is described and includes the Australian ***O. sobrinus,* new species,** and *O. soror* (Ulmer), new combination. The genus is unique among baetid larvae because of the presence of a small tooth between the incisors and prostheca of the right mandible. *Offadens sobrinus* is described from larvae from New South Wales, and is distinguished from *O. soror* by the deeply cleft incisors of the right mandible and longer and narrower segment 2 of the labial palps with a narrow distomedial process. The morphology of the maxillary palps of *O. soror* is discussed.

Key Words: Ephemeroptera, Baetidae, *Offadens,* new genus, new species, new combination, Australia

Small minnow mayflies (Ephemeroptera: Baetidae) are poorly known in Australia. Thirteen species in the genera *Baetis* Leach (4 spp.), *Bungona* Harker (1 sp.), *Centroptilum* Eaton (2 spp.), *Cloeon* Leach (5 spp.), and *Pseudocloeon* Klapálek (1 sp.) have been known historically, and Lugo-Ortiz and McCafferty (1998) recently described two new species of *Cloeodes* Traver from the eastern part of the continent. The taxonomic status of those Australian species assigned to *Baetis, Centroptilum,* and *Pseudocloeon* is uncertain because of outmoded generic concepts. This dearth of faunistic data on Australian Baetidae stands in marked contrast to the knowledge of most other mayfly families reported from the continent, presumably because baetids are generally small and therefore difficult to collect and study.

We herein describe a new genus of Baetidae from Australia. We describe a new species based on larvae collected from the southeastern part of the continent and assign to the new genus one of the species originally described in *Baetis.* Except where otherwise noted, the specimens studied are housed in the Purdue Entomological Research Collection, West Lafayette, Indiana.

Offadens Lugo-Ortiz and McCafferty, new genus

Larva.—*Head:* Labrum (Fig. 1; Suter 1986: Fig. 21j, k) with anterior margin almost straight and with deep anteromedial notch. Hypopharynx (Fig. 2; Suter 1986: 21r) with lingua with distomedial convexity. Left mandible (Fig. 3; Suter 1986: 21n, o) with incisors fused; prostheca robust, apically denticulate. Right mandible with incisors fused (Suter 1986: 21p, q) or deeply cleft (Fig. 4); prostheca slender, medially with minute, fine, simple setae; small tooth between prostheca and mola and at base of mola. Maxillary palp (Fig. 5) two segmented, extending beyond galealacinia. Labium (Fig. 6; Suter 1986: 21m) with glossa subequal in length to paraglossa; palp three segmented; segment 2 with distomedial projection. *Thorax:* Legs (Fig. 7; Suter 1986: 21f) with femora lacking villopore; tarsal claws (Fig. 8; Suter 1986: 21g) elongate. *Abdomen:* Terga (Fig. 9) with abundant small scale bases and regularly spaced marginal spines posteriorly. Gills (Fig. 10; Suter 1986: 21i, i′) platelike, held dorsolaterally, with minute marginal serrations and fine, simple setae. Paraproct (Fig. 11; Suter 1986: 21h) with marginal spines. Cercus with abundant short, fine, simple setae medially; terminal filament with abundant short, fine, simple setae laterally.

Adult.—Forewing (Suter 1986: Fig. 21a) with paired marginal intercalaries. Hindwing (Suter 1986: Fig. 21b) with small, acute costal projection in basal one third; three longitudinal veins present, middle vein forked. Male genital forcep (Suter 1986: Fig. 21d) three segmented; segment 2 strongly bowed inwardly; segment 3 elongate, ellipsoidal.

Etymology.—The generic name is a combination of the Latin words *offa* (morsel) and *dens* (tooth). It is in reference to the small tooth between the incisors and mola of the right mandible of the larva. The name is masculine.

Type species.—*Offadens sobrinus* Lugo-Ortiz and McCafferty, new species.

Species included.—*Offadens sobrinus* Lugo-Ortiz and McCafferty, new species; *O. soror* (Ulmer), new combination.

Distribution.—Australia: New South Wales, South Australia, Tasmania, Western Australia.

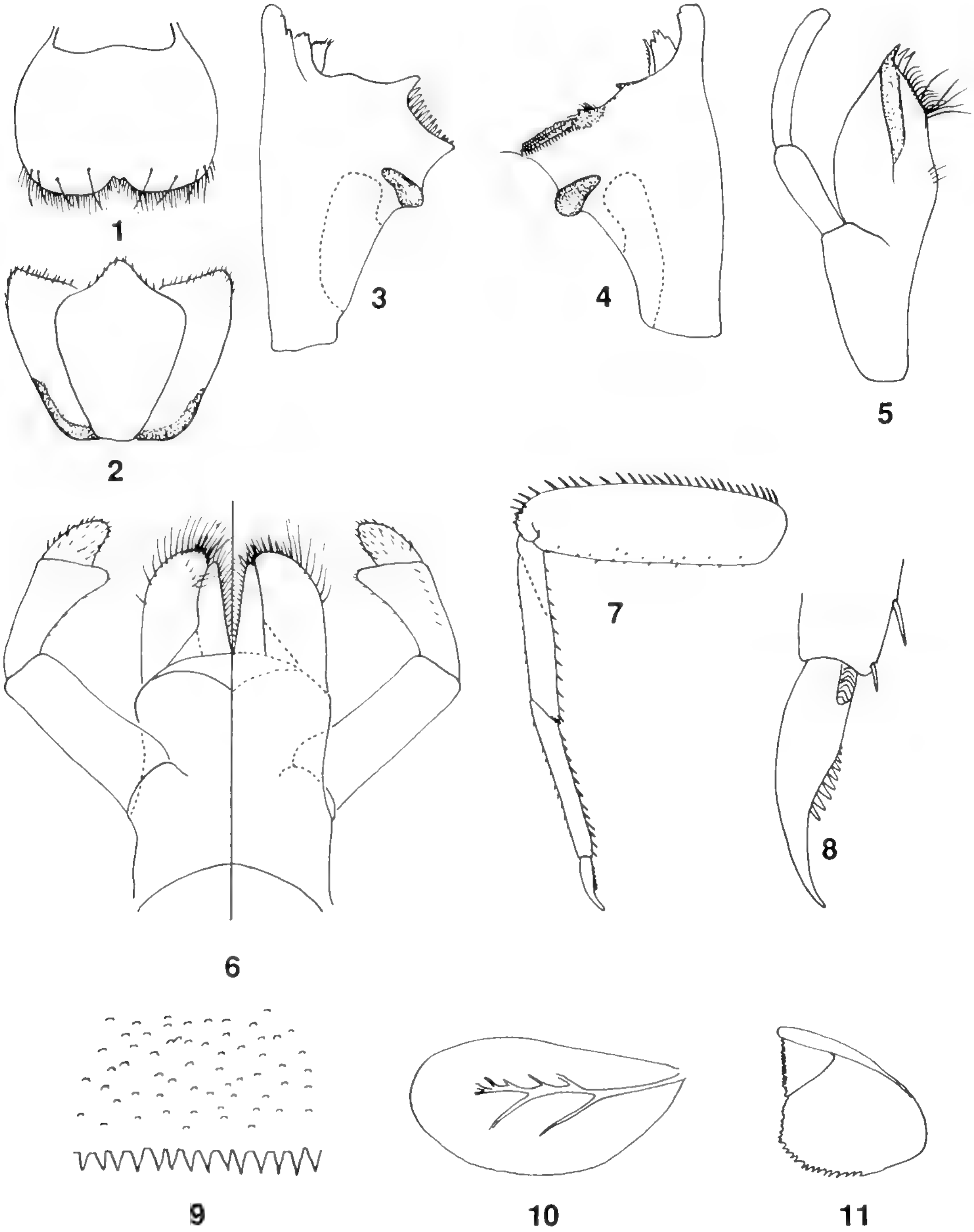
Discussion.—*Offadens* is similar to *Baetis* in several respects, but is not a member of the *Baetis* complex of genera (see, e.g. Waltz et al. 1994, Lugo-Ortiz and McCafferty 1997). The presence of a small tooth between the prostheca and mola of the right mandible (Fig. 4; Suter 1986: Fig. 21p) and the lack of the femoral villopore (Waltz and McCafferty 1987: Figs. 1, 4, 5, 12, 17) clearly distinguish larvae of *Offadens* from those of *Baetis* and its cognate genera. Adults of *Offadens* cannot be adequately distinguished at this time from those of other baetid genera with double marginal intercalaries in the forewings.

Apart from the fact that *Offadens* cannot be considered to belong to the *Baetis* complex of genera because it lacks the villopore, its phylogenetic relationships cannot be determined at this time. It is possible that *Offadens* is endemic to Australia as we have not seen other baetids with a similar right mandibular tooth. Cognate taxa may come to light as the baetid fauna of Australia and Southeast Asia are more thoroughly examined and documented.

Offadens sobrinus Lugo-Ortiz and McCafferty, new species

(Figs. 1–11)

Larva.—Body length: 4.5–5.5 mm. Caudal filament length: 2.3–2.8 mm. *Head:* Coloration pale yellow-brown, with no distinct pattern. Antenna approximately 2.5× length of head capsule. Labrum (Fig. 1) with submarginal row of four to six long, fine, simple setae. Hypopharynx as in Fig. 2. Left mandible (Fig. 3) with outer set of incisors with one large and two small denticles; inner set with four small denticles. Right mandible (Fig. 4) with outer incisors with large, thumblike denticle and inner incisors with four denticles. Maxillary palp (Fig. 5) two segmented; segment 1 approximately 0.68× length of segment 2. Labium (Fig. 6) with palp segment 1 as long as segments 2 and 3 combined; segment 2 approximately 2.5× length of segment 3, with narrow distomedial process and four to six short, fine, simple setae dorsally; segment 3 subconical, with abundant short, fine, simple setae scattered over surface. *Thorax:* Coloration pale yellow-brown, with no distinct pattern. Hindwing pads present. Legs (Fig. 7) with femora with row of long, robust, simple setae dorsally and short, stout, simple setae scattered ventrally; tibiae with row of robust, simple setae ventrally, slightly increasing in length distally, and minute, fine, simple setae dorsally; tarsal claws (Fig. 8) slightly elongate, with 8–10 denticles. *Abdomen:* Coloration pale yellow-brown, with no distinct pattern. Terga (Fig. 9) with abundant scale bases and regularly spaced posterior marginal spines; spines ap-



Figs. 1–11. *Offadens sobrinus.* 1, Labrum (dorsal). 2, Hypopharynx. 3, Left mandible. 4, Right mandible. 5, Left maxilla. 6, Labium (left-ventral; right-dorsal). 7, Right foreleg. 8, Tarsal claw. 9, Tergum 4 (detail). 10, Gill 4. 11, Paraproct.

proximately 1.5× longer than basal width. Gills (Fig. 10) on abdominal segments 1–7, platelike, with translucent tracheation. Paraproct (Fig. 11) with 16–18 marginal spines. Cercus pale yellow-brown; terminal filament approximately 0.78× as long as cercus.

Adult.—Unknown.

Material examined.—Holotype: Larva, AUSTRALIA, New South Wales Prov., Chandler R., 26 mi E of Armidale, II-19-1966, G. F. Edmunds, Jr. Paratypes: 16 larvae, same data as holotype [mouthparts, forelegs, tergum 4, gill 4, and paraproct of one larva mounted on slide (medium: Euparal)] (two larvae deposited in the Australian National Collection, Canberra). Additional material: 71 larvae, same data as holotype; 28 larvae, AUSTRALIA, New South Wales Prov., Commissioner's Waters, 4 mi E of Armidale, II-19-1966, G. F. Edmunds, Jr.

Etymology.—The specific epithet is the Latin word for cousin.

Discussion.—*Offadens sobrinus* is distinguished from *O. soror* (see below) by the deeply cleft incisors of the right mandible (Fig. 4) and the longer and narrower segment 2 of the labial palps with a narrow distomedial process (Fig. 6).

Offadens soror (Ulmer), **n. comb.**

Baetis soror Ulmer 1908:44 (male, female adults); Suter 1986:354 (larva).

Material examined.—AUSTRALIA, New South Wales Prov.: 5 larvae, Bobundara Cr., 3 mi N of Maffra, I-22-1966, G. F. Edmunds, Jr.; 2 larvae, Commissioner's Waters, 4 mi E of Armidale, II-19-1966, G. F. Edmunds, Jr.; 1 larva, Cabbage Tree Cr., at highway, Clyde Mtn., II-28-1966, G. F. Edmunds, Jr. [mouthparts, forelegs, and tergum 4 on slide (medium: Euparal)]; 1 larva, Mt. Kosciusko, creek, 1700 m, 4.5°C, IX-23-1966, J. Illies; 1 exuviae, 2 female subimagos, Commissioner's Waters, 9 mi E of Armidale, on Gare Rd, rapids, X-7-1974, M. N. and R. M. Winokur; Tasmania: 1 larva, Clarence R., below Clarence Lagoon, II-1-1966, G. F. Edmunds, Jr.

Discussion.—*Offadens soror* is distinguished from *O. sobrinus* (see above) by the fused incisors of the right mandible (Suter 1986: Fig. 21p, q) and the shorter segment 2 of the labial palps with a small distomedial process (Suter 1986: Fig. 21m).

Suter (1986: Fig. 21l) indicated that the maxillary palps of *O. soror* were three segmented. Our examination of specimens of *O. soror* revealed only two segments. We expect that Suter's (1986) depiction of a third segment is due to a mounting artifact, as in some specimens the tip of segment 2 of the maxillary palps tends to constrict somewhat when mounted. On the other hand, if correctly depicted, Suter's specimens possibly represent a variant of the species.

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ERETMOCERUS HALDEMAN (HYMENOPTERA: APHELINIDAE) IMPORTED AND RELEASED IN THE UNITED STATES FOR CONTROL OF *BEMISIA* (*TABACI* COMPLEX) (HOMOPTERA: ALEYRODIDAE)

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Abstract.—A key to the species of *Eretmocerus* imported by USDA-APHIS and released in the United States for the control of *Bemisia* (*tabaci* complex) is provided. ***Eretmocerus emiratus* n. sp., *E. hayati* n. sp.,** and ***E. melanoscutus* n. sp.** are described. A lectotype for *E. mundus* Mercet is designated and a redescription provided. Material labelled from Padappai, India, contained mixed forms. No formal name is assigned to this material.

Key Words: *Eretmocerus,* Aphelinidae, *Bemisia,* Aleyrodidae, biological control

Species of *Eretmocerus* Haldeman (Hymenoptera: Chalcidoidea: Aphelinidae) are being utilized in biological control programs directed against *Bemisia* (*tabaci* complex) (Homoptera: Aleyrodidae) around the world (Rose et al. 1996, Rose and Zolnerowich 1997). Rose and Zolnerowich (1997) provided a key and discussion of species of *Eretmocerus* present within the U.S. This paper, which is part of a larger study of *Eretmocerus* species of the world, provides a key and descriptions of species that attack *Bemisia* (*tabaci* complex) that were imported and released into the U.S. by the U.S. Department of Agriculture, Animal Plant Health Inspection Service Biological Control Laboratory in Mission, Texas. Although a number of foreign collections were made, and numerous laboratory cultures of exotic populations were maintained by the USDA, this paper treats only those species that were actually released into the field. Each culture initiated was assigned a unique quarantine accession number, which is reported below with the appropriate species.

Because of confusion regarding the use of the names *Bemisia tabaci* (Gennadius) A-strain, *B. tabaci* B-strain, and *B. argentifolii* Bellows and Perring on specimen labels and in the literature (Brown et al. 1995, Rosell et al. 1997), we refer to hosts from this group as *Bemisia* (*tabaci* complex). Species in the *Bemisia* (*tabaci* complex) are major agricultural pests with a wide range of plant hosts (Mound and Halsey 1978, Brown and Bird 1992). Direct and indirect damage to food, cash, and ornamental crops have been well documented (Byrne et al. 1990, Brown and Bird 1992, Perring et al. 1993).

There are currently 13 described species of *Eretmocerus* from the New World and 30 species from the Old World. Because most species of *Eretmocerus* have been reared from agricultural pests, little is known of the actual range of these species. Likewise, little is known about species found outside of agricultural settings.

All the species of *Eretmocerus* treated in this paper have only four setae on the mesoscutum and are parasites of *Bemisia* (*tabaci* complex). In contrast, nine of the 12 species present in the U.S. have six setae present on the mesoscutum (Rose and Zolnerowich 1997) and can be readily distinguished from the species discussed here. The species already present in the U.S. with only four setae on the mesoscutum are *Eretmocerus debachi* Rose and Rosen, *E. furuhashii* Rose and Zolnerowich, and *E. rosei* Evans and Bennett. *Eretmocerus debachi* and *E. furuhashii* are parasites of the bayberry whitefly, *Parabemisia myricae* (Kuwana) and can be identified using the key provided by Rose and Zolnerowich (1997). *Eretmocerus rosei* attacks *Dialeurodes kirkaldyi* (Kotinsky) and is distinct in having the anterior pair of setae on the scutellum greatly reduced (Evans and Bennett 1996).

In addition, the pedicel of the males discussed in this paper are much darker than those found in the native species discussed in Rose and Zolnerowich (1997). This difference holds true for live, critical point-dried, and slide-mounted specimens. This very dark pedicel is a useful way to distinguish exotic males from native males in the field.

The male portion of the key is based on fuscous patterns of specimens cleared in chloral phenol and glacial acetic acid and mounted in Hoyer's. Care should be used in using the key to identify males that are mounted otherwise.

METHODS

High quality microslide mounts are necessary to correctly examine and identify species of *Eretmocerus*. Because clearing and mounting specimens in balsam removes all or most of their color, most specimens used in this study were cleared in chloral phenol and glacial acetic acid and mounted in Hoyer's medium as described by Rosen and DeBach (1979), and the cover slips were sealed with two coats of red GLPT, a nonconducting insulating varnish used in electronics (GC Electronics, Rockford, Illinois). When possible, type material was critical point-dried and mounted on cards or slide-mounted in balsam. Descriptions of color or pigment are given for both critical point-dried and Hoyer's-mounted specimens where appropriate. Terms and measurements follow those of Rose and Zolnerowich (1997).

Label data for holotypes are presented exactly as recorded on the specimen labels, with the data for each individual label enclosed by quotation marks and each line of the label separated by a slash. Label data for material other than holotypes are standardized. Each culture maintained by USDA-APHIS received a unique quarantine accession number, and those numbers are reported along with the label data.

The following acronyms represent institutions or individuals who are repositories for type material or are otherwise mentioned in the text: BMNH, The Natural History Museum, London, United Kingdom; MJR, personal collection of M. J. Rose; MM, Museo de Madrid, Spain; TAMU, Texas A&M University, College Station; UCR, University of California, Riverside; USNM, National Museum of Natural History, Smithsonian Institution, Washington, D.C.

KEY TO SPECIES OF *ERETMOCERUS* IMPORTED INTO THE UNITED STATES FOR CONTROL OF *BEMISIA*

1. Female, antenna with 2 funicular segments (as in Fig. 3) 2
– Male, antenna without funicular segments 5*
2(1). Scutellum completely fuscous; mesoscutum distinctly fuscous in at least the anterior half . . . . *E. melanoscutus*, n. sp.
– Scutellum not fuscous; mesoscutum not fuscous, or if fuscous areas present they are restricted to the anterior ⅓ 3
3(2). First funicular segment short and triangular, its dorsal surface ⅓, occasionally slightly

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*Note that fuscous patterns used to identify males are taken from specimens cleared in chloral phenol and glacial acetic acid and mounted in Hoyer's.

more than ⅓, the length of its ventral surface (Fig. 1) . . . . *E. emiratus*, n. sp.
– First funicular segment longer, its dorsal surface at least ½ the length of its ventral surface (Figs. 3, 5, 7) 3
4(3). Ventral surface of first funicular segment slightly shorter than ventral surface of second funicular segment (Fig. 3); mesoscutum usually without fuscous areas in anterior ⅓ . . . . *E. hayati*, n. sp.
– Ventral surface of first funicular segment equal in length to ventral surface of second funicular segment (Fig. 7); mesoscutum usually with fuscous areas in anterior ⅓ . . . . *E. mundus*
5(1). Scutellum fuscous but distinctly lighter in color along lateral margins (Fig. 12), mesoscutum fuscous and usually lighter along lateral margins; forefemur with proximal ¼ clear and distal ¾ fuscous, mid- and hind femora with proximal ⅓–½ clear and remainder fuscous . . . . *E. hayati*, n. sp.
– Mesoscutum and scutellum evenly fuscous across their widths (Fig. 13); all femora uniformly pale amber to fuscous 6
6(5). Metanotum completely fuscous, occasionally lighter in lateral ⅓ (Fig. 13); femora and tibiae dark fuscous, all tarsi uniformly dark . . . . *E. melanoscutus*, n. sp.
– Metanotum not completely fuscous (Figs. 11, 14); femora and tibiae not dark fuscous, tarsi not uniformly dark 6
7(6). Metanotum fuscous to slightly fuscous medially (Fig. 11) . . . . *E. emiratus*, n. sp.
– Metanotum clear, or lateral ⅓ slightly fuscous with medial portion clear (Fig. 14) . . . . *E. mundus*

Eretmocerus emiratus **Zolnerowich and Rose, new species**

(Figs. 1–2, 11)

Diagnosis.—Females of *E. emiratus* can be distinguished by the extremely short and triangular first funicular segment (Fig. 1). Females are most similar to *E. melanoscutus*, which has a distinctly longer first funicular segment (Fig. 5) and a fuscous scutellum.

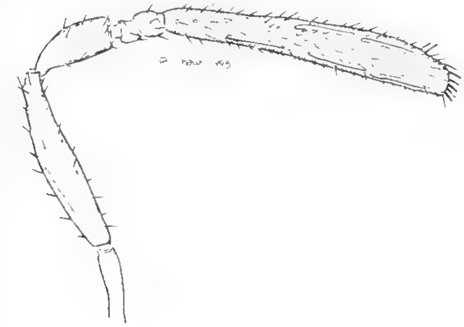
Males of *E. emiratus* can be recognized by the metanotum that is fuscous medially and clear laterally (Fig. 11) when mounted in Hoyer's. The most similar species, *E. melanoscutus*, differs in having the entire metanotum fuscous (Fig. 13).

Female.—Length of critical point-dried specimens 0.5–0.6 mm. Critical point-dried specimens with head pale yellow, vertex yellow to yellow orange. Eyes grey green, ocelli red. Antenna pale testaceous. Septa forming reticulate sculpture of mesoscutum fuscous, length of fuscous area varying from restricted to anterior margin to covering anterior ⅓ of mesoscutum, cells between septa, remainder of dorsal mesosoma, and dorsal gaster yellow orange; pronotum, mesopleuron, and remainder of gaster pale yellow. Each leg with coxa, femur, and tibia pale testaceous, tarsi slightly darker, last tarsal segment darkest.

Specimens mounted in Hoyer's with head amber. Eyes red. Radicle pale amber, scape pale amber, or fuscous at distal end, pedicel fuscous, funicular segments slightly fuscous, club fuscous with multiporous plate sensilla darker. Mesoscutum usually fuscous along anterior margin, occasionally clear; parapsis and axillae clear. Scutellum usually fuscous along anterior and posterior margins, occasionally clear. Metasoma clear. Tegula fuscous. Foretarsus darker than tibia, last tarsal segment of mid- and hind legs fuscous. Forewing with costal cell and venation slightly fuscous and frenal fold fuscous. Hind wing venation fuscous.

Face and occiput with transverse substrigulate sculpture, interscrobal area vertically substrigulate. Antenna (Fig. 1) with radicle 3.0–5.1× as long as wide; scape 4.0–6.5× as long as wide, 2.2–3.1× length of radicle, 2.0–2.7× length of pedicel, 0.64–0.76× length of club; pedicel 2.0–2.62× as long as wide, 1.0–1.4× length of radicle; 0.36–0.48× length of scape, 0.26–0.31× length of club. First funicular segment 0.58–0.81× as wide as long; second funicular segment 0.76–1.17× as long as wide. Club 5.3–6.6× as long as wide, 1.3–1.6× length of scape, 3.2–3.9× length of pedicel.

Mesoscutum with 4 setae and reticulate sculpture that becomes elongate laterally, and with substrigulate sculpture posteromedially. Parapsis with 2 setae and substrigulate sculpture; axilla with 1 seta and substrigulate sculpture. Scutellum with elon-



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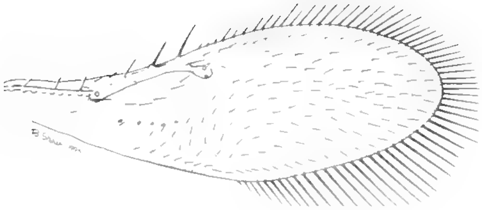

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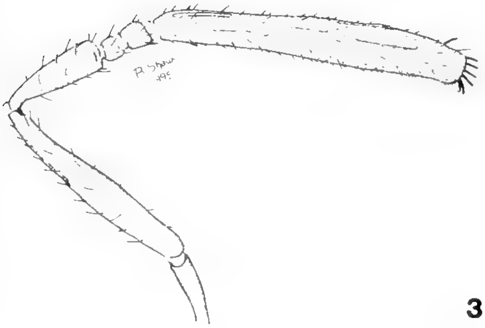

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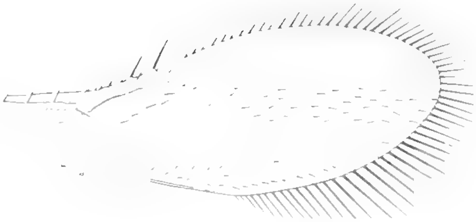

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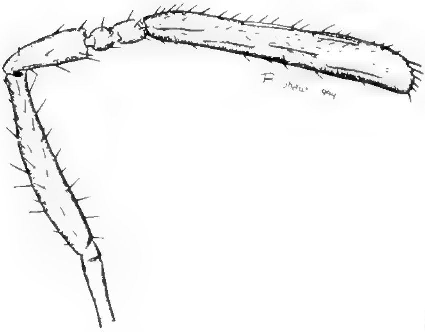

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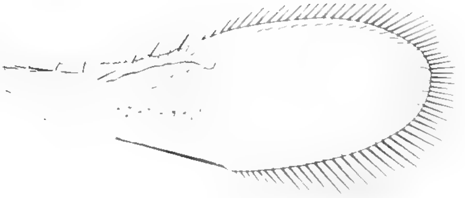

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Figs. 1–6. 1–2, *Eretmocerus emiratus*. 1, Female antenna. 2, Female forewing. 3–4, *E. hayati*. 3, Female antenna. 4, Female forewing. 5–6, *E. melanoscutus*. 5, Female antenna. 6, Female forewing.

gate reticulate sculpture that becomes substrigulate medially and with 4 setae and 2 placoid sensilla. Propodeum with substrigulate sculpture. Endophragma extending to gastral tergite II.

Forewing (Fig. 2) 2.9–3.4× as long as wide at width I, 2.6–3.1× as long as maximum width of disc. Longest anterior alary fringe 0.25–0.35× width of disc, longest posterior alary fringe 0.50–0.66× width of disc. Base of wing usually with 1 seta which may occasionally be absent, distal portion of costal cell usually with 2 setae. Marginal vein with 3 long setae, 6–9 setae between marginal vein and linea calva. Linea calva with a line of 5–7 tubercles on ventral surface of wing near posterior end of linea calva; a group of 13–18 setae including those forming distal edge of linea calva point toward anterior margin of wing, remaining 75–110 setae in disc point to distal apex of wing.

Hind wing 7.5–8.3× as long as wide.

Gastral tergite I with substrigulate sculpture anteriorly and anterolaterally; lateral margins of tergites coriacious with stippling; gastral tergites I–VI usually with paired setae as follows: 1, 1, 1, 1, 2, 1 but can be 1, 1, 1, 1, 1–2, 1. Syntergum with 4 setae.

Ovipositor slightly exserted, 0.88–1.18× length of club, 1.2–1.5× length of scape, 1.0–1.2× length of midtibia.

Male.—Length of specimens mounted in Hoyer's 0.55–0.65 mm. Specimens mounted in Hoyer's (Fig. 11) with head amber to orange. Eyes dark red. Radicle and scape pale amber, scape occasionally fuscous at distal end, pedicel dark fuscous, club slightly fuscous, multiporous plate sensilla dark fuscous. Pronotum fuscous. Mesoscutum fuscous, occasionally darker in the anterior half or along the anterior margin, septa forming sculpture darker than cells; parapsis and axillae clear. Scutellum fuscous, darkest along anterior and posterior margins, septa forming sculpture darker than cells. Metanotum slightly fuscous medially. Propodeum fuscous between spiracles, with a clear area anteromedially. Gastral tergites I, III–VI, and syntergum slightly fuscous, gastral tergite II slightly fuscous medially. Aedeagus slightly fuscous. Each leg slightly fuscous from femur to end of last tarsal segment, tarsi darker than tibiae, last tarsal segment darkest. Tegula fuscous. Forewing with base, costal cell, venation, and frenal fold amber fuscous. Hind wing with base of vein slightly fuscous.

Host.—Reared from *Bemisia* (*tabaci* complex) on okra, *Abelmoschus esculentus* (Malvaceae).

Discussion.—This species has been released in Arizona, California, and Texas. In the Middle East, *Eretmocerus emiratus* is similar to *E. roseni* Gerling. Both species have the first funicular segment reduced, but *E. roseni* has the club 4–4.5× as long as wide and is a parasite of *Acaudaleyrodes citri* (Priesner and Hosni) (Gerling 1972).

Etymology.—Named for the United Arab Emirates, the country where it was originally collected.

Holotype.—♀ mounted in balsam on a slide labelled, "original material:/United Arab Emirates/Ras al Khaimah/xi.11.1995/ Porter & Romadan/ex: Bemisia/on: okra" "USA: Texas/Hidalgo Co./Mission Biological/Control Laboratory/M95104/Lab culture." Deposited in USNM.

Paratypes.—Same data as holotype (1 ♀ mounted in balsam, 7 ♀ and 17 ♂ mounted in Hoyer's, 9 ♀ card-mounted). Paratypes deposited with BMNH, MJR, TAMU, USNM.

Eretmocerus hayati Zolnerowich and Rose, new species

(Figs. 3–4, 12)

Diagnosis.—Females of *E. hayati* can be distinguished by the length of the ventral surface of the first funicular segment, which is slightly shorter than the ventral surface of the second funicular segment (Fig. 3). Females of *E. hayati* are most similar to those of *E. mundus,* which differ in having the ventral surfaces of the funicular segments equal in length (Fig. 7).

Males of *E. hayati* can be distinguished by the clear areas in the lateral portions of the scutellum, and usually the mesoscutum, of specimens mounted in Hoyer's (Fig. 12). Males are most similar to those of *E. mundus,* which differ in having the mesoscutum and scutellum evenly colored across their widths (Fig. 14).

Female.—Length of critical point-dried specimens 0.48–0.60 mm. Critical point-dried specimens with head pale yellow, vertex orange yellow. Eyes grey green, ocelli red. Antenna with scape testaceous, darker at the extreme apex; flagellum darker than scape. Mesoscutum usually orange yellow, occasionally with septa forming reticulate sculpture in anterior ⅓ fuscous with cells between septa orange yellow; remainder of dorsal mesosoma and gaster yellow orange.

Lateral areas of mesosoma yellow, gaster yellow or yellow orange laterally. Legs with coxae, femora, and tibiae testaceous, tarsi testaceous or slightly darker than tibiae, last tarsal segment darkest.

Specimens mounted in Hoyer's with head amber. Eyes red. Radicle pale amber to slightly fuscous, scape pale amber to slightly fuscous, darker along apex of ventral edge, pedicel amber to slightly fuscous, funicular segments amber or slightly fuscous, club fuscous to slightly fuscous with multiporous plate sensilla darker. Mesoscutum, axillae, parapsis, scutellum, metanotum, propodeum, and metasoma clear, or anterior margin of mesoscutum slightly fuscous. Forefemur and tibia slightly fuscous, foretarsus fuscous and darker than tibia. Mid- and hind femora and tibiae slightly fuscous, mid- and hind tarsi 1–3 clear to slightly fuscous, last tarsal segment fuscous and darker than preceding segments. Tegula slightly fuscous. Forewing faintly fuscous from base to distal end of stigmal vein and frenal fold, costal cell slightly fuscous, venation and frenal fold fuscous. Hind wing venation slightly fuscous.

Face and occiput with transverse substrigulate sculpture, interscrobal area vertically substrigulate. Antenna (Fig. 3) with radicle 2.9–5.5× as long as wide; scape 4.4–6.8× as long as wide, 2.2–3.2× length of radicle, 1.9–2.4× length of pedicel, 0.60–0.75× length of club; pedicel 2.3–3.5× as long as wide, 1.0–1.5× length of radicle, 0.4–0.5× length of scape, 0.29–0.35× length of club. First funicular segment 0.76–1.2× as wide as long; second funicular segment 0.78–1.34× as long as wide. Club 5.6–7.0× as long as wide, 1.3–1.6× length of scape, 2.7–3.4× length of pedicel.

Mesoscutum with 4 setae, anterior half with reticulate sculpture, laterally and posteriorly with elongate reticulate to substrigulate sculpture. Parapsis with 2 setae and substrigulate sculpture; axilla with 1 seta and substrigulate sculpture. Scutellum with elongate reticulate to substrigulate sculpture and with 4 setae and 2 placoid sensilla. Propodeum with substrigulate sculpture. Endophragma extending to posterior half of gastral tergite II or anterior half of gastral tergite III.

Forewing (Fig. 4) 3–3.7× as long as wide at width I, 2.7–3.4× as long as maximum width of disc. Longest anterior alary fringe 0.25–0.45× width of disc, longest posterior alary fringe 0.53–0.78× width of disc. Base of wing usually with 1 seta which may occasionally be absent, distal portion of costal cell usually with 2–3 setae. Marginal vein with 3 long setae, 5–9 setae between marginal vein and linea calva. Linea calva with 5–6 tubercles on ventral surface of wing near posterior end of linea calva; a group of 13–22 setae including those forming distal edge of linea calva point toward anterior margin of wing, remaining 95–120 setae in disc point to distal apex of wing.

Hind wing 7.8–10.5× as long as wide.

Gastral tergite I with substrigulate sculpture anteriorly, laterally with reticulate to substrigulate sculpture; lateral margins of tergites faintly coriaceous with stippling; gastral tergites I–VI with paired setae as follows: 1, 1, 1, 1, 1–2, 1. Syntergum with 4 setae.

Ovipositor exserted, 0.79–1.0× length of club, 1.0–1.5× length of scape, 0.76–1.1× length of midtibia.

Male.—Length of critical point-dried specimens 0.43–0.58 mm. Critical point-dried specimens with head pale yellow, vertex orange yellow. Eyes grey green, ocelli red. Scape pale yellow to testaceous in proximal ⅔, becoming more fuscous in distal ⅓, pedicel dark fuscous, club testaceous. Pronotum dorsally and laterally fuscous, remainder pale yellow. Mesoscutum varying from fuscous in the anterior ⅓ with remainder orange yellow to entirely dark brown, or with septa forming sculpture fuscous and cells between septa orange. Axillae and parapsis orange. Scutellum entirely fuscous, or with septa forming sculpture fuscous and cells between septa orange. Metanotum orange, or orange medially and fuscous laterally. Propodeum orange medially, lateral ⅓ fuscous. Gastral tergites orange dorsally, medially fuscous orange. Mesosoma and gaster pale yellow laterally. Legs with coxae testaceous, forefemur with proximal ¼ testaceous and remainder slightly fuscous, mid- and hind femora with proximal ½ testaceous and remainder slightly fuscous, tibiae slightly fuscous, tarsi fuscous.

Specimens mounted in Hoyer's (Fig. 12) with head pale amber. Eyes red. Radicle slightly fuscous, scape slightly fuscous, becoming darker at the apex, margins of apex dark, pedicel dark fuscous, club slightly fuscous, multiporous plate sensilla darker than club. Pronotum fuscous to slightly fuscous. Mesoscutum fuscous, darker in anterior half and along the anterior margin, septa forming sculpture darker than cells, usually lighter along lateral margins; parapsis and axillae clear. Scutellum fuscous, darkest along anterior and posterior margins, septa forming sculpture darker than cells, lighter along lateral margins. Metanotum slightly fuscous, or only slightly fuscous in lateral ⅕–⅓. Propodeum fuscous between spiracles, with a clear area medially. Gastral tergites I–IV slightly fuscous medially. Aedeagus slightly fuscous. Foreleg with distal ¾ of femur fuscous, tibia and tarsi slightly darker than femur, with last tarsal segment darkest. Mid- and hind legs with distal ⅓–½ of femora slightly fuscous, tibiae fuscous and darker than femora, tarsi fuscous and occasionally darker than tibiae, with last tarsal segment darkest. Tegula fuscous. Forewing slightly infuscate from base to distal end of stigmal vein and frenal fold, costal cell, venation, and frenal fold fuscous. Hind wing with venation fuscous.

Host.—Reared from *Bemisia* (*tabaci* complex) on *Solanum melongena,* eggplant (Solanaceae).

Discussion.—This species has been released in Arizona, California, and Texas.

Eretmocerus hayati is similar to *E. longipilus* Khan and Shafee, an Indian species which has similar antennae. *Eretmocerus longipilus* differs in having an extremely elongate posterior alary fringe that is nearly as long as the width of the forewing, and the shape of the forewing is different (Khan and Shafee 1980).

Etymology.—Named in honor of Dr. M. Hayat of the Aligarh Muslim University, India.

Holotype.—♀ mounted in balsam on a slide labelled, "original material/INDIA: Thirumala/20.xii.1992/Kirk & Lacey/ex: Bemisia tabaci/on: Solanum melongena" "USA: Texas/Hidalgo Co./Mission Biological/Control Laboratory/M93005 Lab culture." Deposited in USNM.

Paratypes.—Same data as holotype (4 ♀, 4 ♂ mounted in balsam, 7 ♀ card-mounted); Pakistan: Punjab, Multan, 11.iv.1995, Kirk & Akey, *Bemisia* on eggplant (*Solanum melongena*), M95012 (29 ♀, 28 ♂ slide-mounted, 20 ♀, 13 ♂ card-mounted). Paratypes deposited with BMNH, MJR, UCR, TAMU, USNM.

Other specimens examined.—USA: Texas, Hidalgo Co., Mission Biological Control Laboratory, M93005 Lab culture. INDIA: Thirumala, 20.xii.1992, *Bemisia tabaci* on *Solanum melongena* (28 ♀, 5 ♂); M93005, 23.xii.1992 (5 ♀, 1 ♂); M93005, 15.xii.1993 (15 ♀, 2 ♂); M93005, 3.x.1994 (7 ♀, 25 ♂). PAKISTAN: Punjab, Multan, 18.iv.1995, Kirk & Akey, M95012 (10 ♀, 7 ♂), Punjab, Multan, 11.xi.1995, Kirk & Lacey, M95105 (17 ♀, 10 ♂).

Eretmocerus melanoscutus Zolnerowich and Rose, new species

(Figs. 5–6, 13)

Diagnosis.—Females of *E. melanoscutus* can be distinguished by the fuscous mesoscutum and scutellum, and the first funicular segment that is shorter than the second (Fig. 5). *Eretmocerus mundus* is most similar but does not have a fuscous scutellum and the ventral surface of the first funicular segment is equal in length to the ventral surface of the second funicular segment (Fig. 7).

Males of *E. melanoscutus* are distinguished by the completely fuscous metanotum of specimens mounted in Hoyer's (Fig. 13). It is most similar to *E. emiratus*, which has the lateral portions of the metanotum not fuscous (Fig. 11).

Female.—Length of specimens mounted in Hoyer's 0.57–0.73 mm. Specimens mounted in Hoyer's with head amber. Eyes red. Radicle, scape, and pedicel slightly fuscous, funicular segments clear, much paler than pedicel and club, club fuscous with multiporous plate sensilla darker. Anterior half of mesoscutum fuscous, darkest along anterior margin, septa forming sculpture darker than cells between septa; parapsis and axillae clear. Scutellum fuscous, darkest along anterior and posterior margins, septa forming sculpture darker than cells between septa. Propodeum with lateral margins slightly fuscous. Tegula fuscous. Foretarsus darker than remainder of foreleg, last tarsal segment of mid- and hind legs slightly fuscous. Forewing infuscate from base to distal end of stigmal vein and frenal fold, remainder hyaline, venation and frenal fold fuscous. Hind wing venation fuscous.

Face and occiput with transverse substrigulate sculpture, interscrobal area vertically substrigulate. Antenna (Fig. 5) with radicle 2.8–4.3× as long as wide; scape 4.5–6.7× as long as wide, 2.2–3.2× length of radicle, 2.0–2.6× length of pedicel, 0.6–0.7× length of club; pedicel 1.9–2.8× as long as wide, 0.9–1.3× length of radicle, 0.37–0.50× length of scape, 0.24–0.35× length of club. First funicular segment 0.7–1.0× as wide as long; second funicular segment 0.85–1.20× as long as wide. Club 5.1–6.8× as long as wide, 1.4–1.6× length of scape, 2.9–4.2× length of pedicel.

Mesoscutum with 4 setae, anterior half with reticulate sculpture, remainder with elongate reticulate sculpture. Parapsis with 2 setae and substrigulate sculpture; axilla with 1 seta and substrigulate sculpture. Scutellum with elongate reticulate sculpture and with 4 setae and 2 placoid sensilla. Propodeum with substrigulate sculpture. Endophragma extending to posterior half of gastral tergite II.

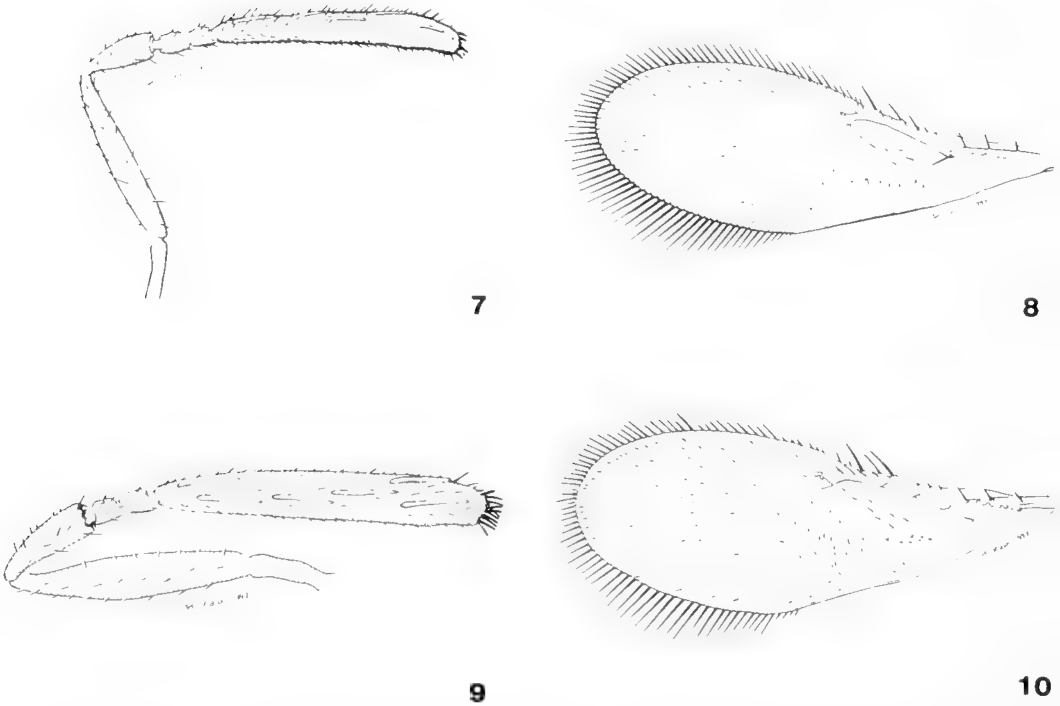
Forewing (Fig. 6) 3.1–3.7× as long as wide at width I, 2.7–3.2× as long as maximum width of disc. Longest anterior alary fringe 0.21–0.43× width of disc, longest posterior alary fringe 0.43–0.72× width of disc. Base of wing usually with 1 seta which may occasionally be absent, distal portion of costal cell usually with 1–5 setae. Marginal vein with 3 long setae, 4–10 setae between marginal vein and linea calva. Linea calva with a line of 5–9 tubercles on ventral surface of wing near posterior end of linea calva; a group of 14–27 setae including those forming distal edge of linea calva point toward anterior margin of wing, remaining 68–123 setae in disc point to distal apex of wing.

Hind wing 7.7–9.2× as long as wide.

Gastral tergite I with substrigulate sculpture medially that becomes reticulate to substrigulate anterolaterally; lateral margins of tergites faintly coriaceous with stippling; gastral tergites I–VI usually with paired setae as follows: 1, 1, 1, 1, 2, 1, but can be 1, 1, 1, 2, 2, 1. Syntergum with 4 setae.

Ovipositor slightly exserted, 0.87–1.0× length of club, 1.24–1.6× length of scape, 1.16–1.35× length of midtibia.

Male.—Length of specimens mounted in Hoyer's 0.53–0.62 mm. Specimens mounted in Hoyer's (Fig. 13) with head amber. Eyes red. Radicle and scape fuscous, lighter than pedicel, pedicel dark fuscous, club fuscous, multiporous plate sensilla darker. Pronotum fuscous. Mesoscutum fuscous, darker along anterior margin, septa forming sculpture darker than cells; parapsis and axillae clear. Scutellum fuscous, darkest along anterior and posterior margins. Metanotum fuscous, occasionally lighter in lateral ⅓. Propodeum fuscous, lighter lateral to spiracles and with a clear area medially. Gastral tergites slightly fuscous. Aedeagus slightly fuscous. Coxae and trochanters slightly fuscous, remainder of legs uniformly fuscous and much darker than coxae and trochanters. Tegula fuscous. Forewing slightly infuscate from base to distal end of stigmal vein and frenal fold, coastal cell, venation,



Figs. 7–10. *Eretmocerus mundus*. 7, Female antenna. 8, Female forewing. 9, Lectotype female, antenna. 10, Lectotype female, forewing.

and frenal fold fuscous. Hind wing with base and venation slightly fuscous.

Host.—Reared from *Bemisia* (*tabaci* complex) on *Chromolaena odorata* (Asteraceae), *Cucurbita moschata* (Cucurbitaceae), and *Xanthium* (Asteraceae).

Discussion.—This species has been released in Arizona, California, and Texas.

Etymology.—A combination of *melano* and *scutum*, denoting the unique fuscous scutellum found in females.

Holotype.—♀ mounted in Hoyer's on a slide labelled, "Loc THAILAND:/Chiang Mai/Date III.17.1994/Host Bemisia/tabaci/Det/19/On Chromalaena [sic]/odorata" "Name Eretmocerus/♀/Sp 1/Det/19/Coll Lacey & Kirk/No. M94036/Corr." Deposited in USNM.

Paratypes.—THAILAND: same data as holotype (6 ♀, 11 ♂). Paratypes deposited with BMNH, MJR, TAMU, USNM.

Other specimens examined.—THAILAND: Chiang Dao, III.15.1994, *Bemisia tabaci* on *Xanthium*, M94033 (3 ♀, 2 ♂); Chiang Mai, XII.8.1994, J. Goolsby, *Bemisia tabaci* on *Chromalaena odorata*, M94036 lab culture (17 ♀); Nonthabur, Sai Noi, Klong Hai Roi, III.9.1994, Lacey & Kirk, *Bemisia tabaci* on *Cucurbita moschata*, M94023 lab culture (8 ♀, 7 ♂); Pang Hang, III.15.1994, Lacey & Kirk, *Bemisia tabaci* on *Xanthium*, M94032 (2 ♀); Pisenaroh, III.12.1994, Lacey & Kirk, *Bemisia tabaci* on *Cucurbita moschata*, M94027 (3 ♀, 1 ♂).

Eretmocerus mundus Mercet
(Figs. 7–10, 14)

Eretmocerus mundus Mercet, 1931: 200. [MM, type examined].

Type material.—Lectotype here designated, ♀ mounted in Hoyer's on a slide labelled, "Name Eretmocerus/mundus Merc./Remount ♀ tipo/Rose 1997" "Loc Beas de Segura/(Jaen) La Mesa/Date 19" "Eretmocerus/mundus Mercet, 1931/LECTOTYPE/det. G. Zolnerowich." Remounted from a slide labelled, "MUSEO DE MADRID/LAB. DE ENTOMOL./Eretmocerus/mundus Merc./♀ tipo/Beas de Segura/(Jaen) La Mesa."

Diagnosis.—Females of *E. mundus* can be distinguished by the ventral surface of the first funicular segment being equal in length to the ventral surface of the second funicular segment (Fig. 7). Females of *E. mundus* are most similar to those of *E. hayati,* which differ in having the ventral surface of the first funicular segment shorter than the ventral surface of the second funicular segment (Fig. 3).

Males of *E. mundus* are distinguished by the metanotum which is not fuscous, or only slightly fuscous laterally (Fig. 14). Males are most similar to those of *E. hayati,* which differ in having clear lateral areas on the scutellum and usually on the mesoscutum, and a slightly fuscous metanotum (Fig. 12).

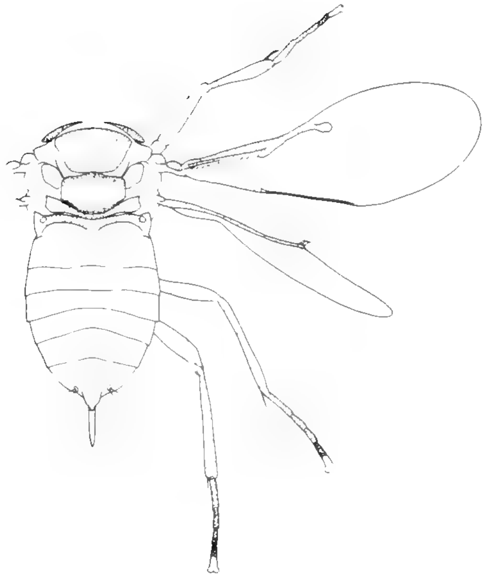
Female.—Length of critical point-dried specimens 0.46–0.61 mm. Critical point-dried specimens with head yellow, vertex orange yellow. Eyes grey green, ocelli red. Antenna testaceous, scape usually darker at extreme apex. Septa forming reticulate sculpture of mesoscutum fuscous, length of fuscous area varying from restricted to anterior margin to covering anterior ⅓ of mesoscutum, cells between septa, remainder of dorsal mesosoma, and dorsal gaster orange yellow; lateral areas of mesosoma and gaster pale yellow. Legs with coxae, femora, and tibiae testacous, tarsi slightly darker than tibiae, last tarsal segment darkest.

Specimens mounted in Hoyer's with head amber. Eyes red. Radicle pale amber to slightly fuscous, scape and pedicel slightly fuscous, scape distinctly fuscous at extreme apex, funicular segments clear to slightly fuscous and less dark than pedicel or club, club fuscous with multiporous plate sensilla darker than club. Mesoscutum clear, or anterior margin slightly fuscous. Parapsis, axillae, scutellum, metanotum, and propodeum clear. Tegula slightly fuscous. Metasoma clear. Legs uniformly amber, with last tarsal segment of each leg slightly fuscous. Forewing slightly infuscate from base to distal end of stigmal vein and frenal fold, costal cell adjacent to submarginal vein slightly fuscous, submarginal vein fuscous, marginal and stigmal veins slightly fuscous, frenal fold fuscous. Hind wing venation slightly fuscous.

Face and occiput with transverse substrigulate sculpture, interscrobal area vertically substrigulate. Antenna (Fig. 7) with radicle 2.6–4.7× as long as wide; scape 5.2–6.8× as long as wide, 2.3–3.7× length of radicle, 2.0–2.5× length of pedicel, 0.62–0.76× length of club; pedicel 2.2–3.0× as long as wide, 1.0–1.6× length of radicle, 0.40–0.48× length of scape, 0.26–0.35× length of club. First funicular segment 0.84–1.3× as wide as long; second funicular segment 0.93–1.4× as long as wide. Club 5.7–7.4× as long as wide, 1.3–1.6× length of scape, 2.85–3.85× length of pedicel.

Mesoscutum with 4 setae, anterior half with reticulate sculpture, laterally and posteriorly with elongate reticulate to substrigulate sculpture. Parapsis with 2 setae and substrigulate sculpture; axilla with 1 seta and substrigulate sculpture. Scutellum with elongate reticulate to substrigulate sculpture and with 4 setae and 2 placoid sensilla. Propodeum with substrigulate sculpture. Endophragma extending to posterior half of gastral tergite II or anterior half of gastral tergite III.

Forewing (Fig. 8) 3.0–3.5× as long as wide at width I, 2.6–3.2× as long as maximum width of disc. Longest anterior alary fringe 0.2–0.4× width of disc, longest posterior alary fringe 0.43–0.70× width of disc. Base of wing usually with 1 seta which may occasionally be absent, distal portion of costal cell usually with 2–3, rarely 4, setae. Marginal vein with 3, rarely 4 long setae, 5–7 setae, occasionally 8–10, between marginal vein and linea calva. Linea calva with 5–9 tubercles on ventral surface of wing near posterior end of linea cal-



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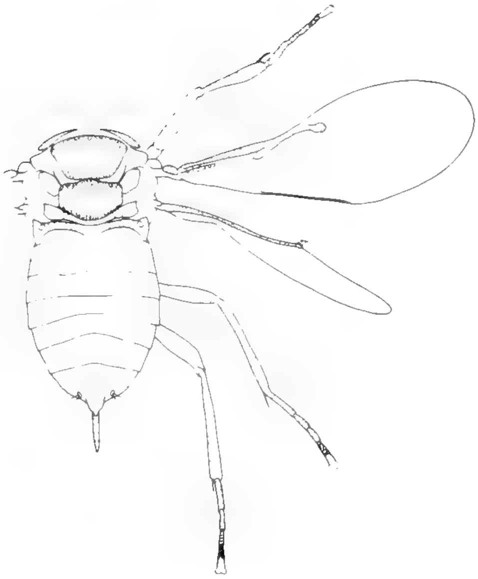

14

Figs. 11–14. Male habitus as mounted in Hoyer's. 11, *Eretmocerus emiratus.* 12, *E. hayati.* 13, *E. melanoscutus.* 14, *E. mundus.*

va; a group of 11–24 setae including those forming distal edge of linea calva point toward anterior margin of wing, remaining 80–122 setae in disc point to distal apex of wing.

Hind wing 6.3–8.9× as long as wide.

Gastral tergite I with substrigulate sculpture anteriorly, laterally with reticulate to substrigulate sculpture; lateral margins of tergites faintly coriaceous with stippling; gastral tergites I–VI usually with paired setae as follows: 1, 1, 1, 1, 1–2, 1. Syntergum with 4 setae.

Ovipositor slightly exserted, 0.8–1.0× length of club, 1.14–1.5× length of scape, 0.95–1.3× length of midtibia.

Male.—Length of critical point-dried specimens 0.45–0.59 mm. Critical point-dried specimens with head pale yellow, vertex orange. Eyes grey green, ocelli red. Scape yellow testaceous in proximal ⅔, becoming darker in distal ⅓, pedicel dark fuscous, club testaceous. Pronotum dorsally and laterally fuscous, remainder pale yellow. Mesoscutum and scutellum varying from entirely dark brown to slightly fuscous, or with septa forming sculpture dark brown and cells between septa orange. Axillae and parapsis orange, metanotum orange medially and fuscous orange in lateral ¼–⅓, propodeum fuscous orange between spiracles and pale yellow lateral to spiracles. Gastral tergites fuscous orange. Mesosoma yellow laterally, gaster orange yellow laterally. Each leg with coxa, femur, and tibia testaceous, tarsi slightly darker than tibia, last tarsal segment darkest.

Specimens mounted in Hoyer's (Fig. 14) with head amber. Eyes red. Radicle clear, scape clear, slightly fuscous at extreme apex, pedicel dark fuscous, club fuscous, multiporous plate sensilla darker. Pronotum slightly fuscous. Mesoscutum fuscous to slightly fuscous, darker along anterior margin, septa forming sculpture darker than cells; parapsis and axillae clear. Scutellum fuscous to slightly fuscous, darkest along anterior and posterior margins, septa forming sculpture darker than cells. Metanotum clear or lateral ⅓ fuscous with medial portion clear. Propodeum clear, or slightly fuscous between spiracles and clear medially. Gastral tergites slightly fuscous. Aedeagus fuscous. Femora, tibiae, and tarsi pale amber or slightly fuscous, tarsi slightly darker than tibiae, last tarsal segment darkest. Tegula fuscous. Forewing with base, costal cell, venation, and frenal fold fuscous. Hind wing with venation fuscous.

Host.—Reared from *Bemisia* (*tabaci* complex) on *Abelmoschus* and *Gossypium* (Malvaceae), *Brassica* (Cruciferae), *Cucumis* (Cucurbitaceae), *Ipomoea* (Convolvulaceae), *Lantana* (Verbenaceae), and *Sonchus* (Asteraceae).

Discussion.—This species has been released in Arizona, California, Florida, South Carolina, and Texas.

Mercet (1931) described *E. mundus* from an unknown whitefly on eggplant, *Solanum melongena* (Solanaceae). The original material consisted of two females collected September 1, 1931, at Beas de Segura, Jaen Province, Spain. Mercet's description of the male was derived from specimens collected at the R. Osservatorio di Fitopatologia per le Puglie in Italy.

The two females Mercet deposited in the Museo de Madrid were missing for a number of years. Searches for Mercet's specimens at the Museo de Madrid by E. M. Perez, the museum curator, and M. J. Verdu and M. Fabrigat Marti failed to produce any specimens of *Eretmocerus* deposited by Mercet. Extensive personal communications and a request for information on the missing specimens published in *Chalcid Forum* also failed to produce the missing specimens. A type slide with one female was found by J. L. Nieves-Aldrey in 1997, who sent it to G. Evans. The type was then remounted by M. Rose. The antenna and forewing shown in Figs. 9–10 are drawn from the lectotype.

Mercet's original description contained a unique character found on the mesoscutum, ". . . almost glabrous, with only one pair of fine long setae . . ." Mercet made an error, as the mesoscutum of the lectotype has a total of four setae, but the position of the anterior pair of setae in the original mount made them extremely difficult to see.

Silvestri (1934) created a nomen nudum when he used the name *Eretmocerus masii* for 18 female and 21 male specimens reared from *Bemisia tabaci* collected in Italy without providing a description. Viggiani (1965) synonymized *Eretmocerus masii* with *Eretmocerus mundus,* and provided a redescription of *E. mundus* based on Silvestri's specimens of *E. masii.* Silvestri's specimens of *E. masii* were not available for study.

Specimens examined.—ISRAEL: Ein Gev, 9.x.1994, *Bemisia* on *Ipomoea,* M94118, Kirk and Lacey (3 ♀, 1 ♂); Ein Sedi (Dead Sea), 10.x.1994, *Bemisia* on *Lantana,* M94116, Kirk and Lacey (1 ♀, 1 ♂); Gat, 8.x.1994, *Bemisia tabaci* on *Brassica oleracea* (kohlrabi), M94103, Kirk and Lacey (8 ♀, 12 ♂); Gat, 8.x.1994, *Bemisia* on *Sonchus,* M94105, Kirk and Lacey (5 ♀, 4 ♂); Gat, 8.x.1994, *Bemisia tabaci* on *Abelmoschus esculentus,* M94110, Kirk and Lacey (1 ♀, 1 ♂); Golan, Ma'aleh Samla, 8.x.1994, *Bemisia tabaci* on *Cucumis melo* (cantaloupe), M94120, Kirk and Lacey (5 ♀, 7 ♂); Negev Desert, 11.x.1994, *Bemisia* on *Cucumis melo, Cucumis sativus,* M94124, Kirk and Lacey (3 ♀, 1 ♂); Spain: Mazarron, Casas Nuevas, 23.xi.1994, *Bemisia* on *Ipomoea,* M94128, Kirk and Lacey (1 ♀, 6 ♂); Valencia, Alicante, Mazarron, 1.xi.1993, *Bemisia tabaci* on *Lantana* or eggplant, WF 582B, WF 582C, Lacey and Kirk (16 ♀, 11 ♂); Murcia, 2.xii.1991, *Bemisia tabaci* on cotton, Kirk, Chen, and Sobhain (7 ♀); USA: Texas: Hidalgo Co., Mission Biological Control Laboratory, M92014 lab culture, original material: SPAIN: Murcia, i.1992, ex. *Bemisia tabaci,* M92014, Kirk, Chen, and Sobhain (43 ♀, 28 ♂); Hidalgo Co., Mission Biological Control Laboratory, M93004 lab culture, original material: Spain: Murcia, ex. *Bemisia tabaci,* M93004, Kirk and Lacey (22 ♀, 21 ♂).

M92019, PADAPPAI, INDIA

This culture of *Eretmocerus* labelled as originating from Padappai, India, contained two distinct species and a rare intermediate form. It is not clear exactly what species, or if more than one species, were released in the field. Records of release sites are not available. Most of the specimens examined from this culture material were assignable to *Eretmocerus mundus,* which is redescribed in this paper and has the ventral surface of the first funicular segment as long as the ventral surface of the second funicular segment (Fig. 7). Other specimens from this culture were placed as *Eretmocerus hayati,* which is described in this paper and has the ventral surface of first funicular segment slightly shorter than ventral surface of second funicular segment (Fig. 3). Rare females have the length of the first funicular segment intermediate between *E. mundus* and *E. hayati.*

Lack of original material and the presence of three distinct forms in this culture preclude additional comments.

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A REVIEW OF THE GENUS *LIODEMA* HORN (COLEOPTERA: TENEBRIONIDAE) WITH DESCRIPTION OF A NEW SPECIES FROM COSTA RICA AND PANAMA

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Abstract.—The five species of the New World genus *Liodema* are reviewed. A new species, ***L. explanatum*** is described from Costa Rica and Panama. The following synonymy is recorded: *L. quadrinotatum* (Laporte and Brullé), *L. kirschi* Bates, *L. obydense* Bates, **n. syn.,** *L. fulvum* Bates, *L. horni* Bates, **n. syn.,** *L. proximum* (Chevrolat), *L. tergocinctum* (Chevrolat), and *L. inscriptum* (Chevrolat), are all synonyms of *L. maculatum* (Fabricius); *L. cruciatum* (Chevrolat), *L. hamatiferum* (Chevrolat), **n. syn.,** *L. ramulosum* (Chevrolat), **n. syn.,** *L. zimmermani* Champion, **n. syn.,** and *L. flavo-variegatum* Champion, **n. syn.,** are all synonyms of *L. serricorne* Bates. *Liodema irradians* (Chevrolat) is transferred to *Platydema* **n. comb.** and *L. tenuicorne* (Chevrolat) is transferred to Crypticini (Tenebrionidae), **n. comb.**

Key Words: Darkling beetles, Tenebrionidae, *Liodema*

The genus *Liodema* was described by Horn (1870:385) to receive *Platydema laeve* Haldeman (1848:101) from North Carolina, which is the type by monotypy. Members of *Liodema* closely resemble species of the large genus *Platydema* Laporte and Brullé but differ in having the mesosternum prolonged cephalad as a prominent, blunt lobe which conceals the prosternal process.

The only other genus with such a peculiar modification of the mesosternum is *Stenoscapha* (Bates 1873:237) with two described species from Brazil and Mexico. In *Stenoscapha* the tibiae are all armed with conspicuous apical spurs (they are very short in *Liodema*).

According to Gebien (1940:417), *Liodema* contains twelve species, all of which are New World in distribution. I have been assembling specimens for several decades in anticipation of a generic revision. Having seen most of the existing types and having studied specimens from major collections around the world, I feel compelled to report my understanding of the genus to date.

I believe there is much more variation in size and color pattern than previous workers supposed. It is interesting that Bates (1873) described six species, five of which were each described from a single specimen. The study of intraspecific variation was difficult because so few series of specimens from a single locality and date were available. Also, the genitalia did not prove helpful in separating species.

SPECIES EXCLUDED FROM *LIODEMA*

Scaphidema irradians Chevrolat 1877a:178 (type locality: Cayenne.)

I have been unable to determine who transferred this species to *Liodema*. It is so placed in Gebien's catalogs and in that of Blackwelder (1945:529). I examined the type in MNHN in 1980 and again in 1987. The type is a unique from Cayenne and belongs to the genus *Platydema,* **new comb.**

Platydema tenuicorne: Chevrolat 1877b: 182. (type locality: Caracas, Venezuela.)
Liodema tenuicorne: Chevrolat 1878a:243 (generic transfer).

I studied the unique type of this species in MNHN in 1980 and determined it to be a crypticine, and indicated in my notes its similarity to *Gonwanocrypticus obsoletus* (Say). It is badly mounted so that the mesosternum is not clearly visible. It is definitely not a *Liodema,* but I am not certain of its generic placement.

KEY TO SPECIES OF *LIODEMA*

1. Elytra uniformly dark brown or piceous . . . . *L. laeve* (Haldeman)
– Elytra with reddish or yellowish and black markings. 2
2. Elytra and pronotum with lateral margins distinctly explanate; pronotum uniformly dark (Fig. 1) . . . . *L. explanatum,* new species
– Elytra and pronotum with lateral margins narrow, scarcely visible from above; pronotal coloration variable 3
3. Elytra with black markings, mostly lateral, usually not attaining suture *L. connexum* Bates
– Elytra with dark markings usually extending along suture 4
4. Elytra mostly black with a basal and apical crescent-shaped reddish or yellowish mark; pronotum usually uniformly black . . . . *L. maculatum* (Fabricius)
– Elytra mostly yellowish or reddish with an oblique, irregular median black band, a subapical one, and a basal band with 3 or 4 finger like extensions; pronotum usually with black central markings on a light background . . . . *L. serricorne* Bates

Liodema laeve (Haldeman)

Platydema laevis Haldeman 1848:101 (type locality: North Carolina, in MCZC, type No. 8372).
Liodema laeve: Horn 1870:385; Champion 1886:205; Triplehorn 1965:436.

This species is unicolorous dark brown or piceous, totally lacking reddish or yellowish bands or spots which characterize the others. Measurements: Length 3.7–4.4 mm; width: 2.4–2.5 mm.

Distribution.—This is the only species occurring in the United States (Florida, Georgia, Mississippi, North Carolina, and Texas). It also occurs in Costa Rica (Turrialba, Puntarenas; Santa Cecilia, Guanacaste), Mexico (Querétaro, Tamaulipas, Veracruz), and Panama (Chiriquí Province). A total of 37 specimens was studied; it remains relatively rare in collections and the largest series studied consists of three specimens.

Liodema explanatum Triplehorn, new species
(Fig. 1)

Description.—Holotype, sex undetermined: Elongate-oval, moderately convex, dark brown with reddish-brown elytral maculations, slightly shining. Head flat, reddish brown, becoming darker posteriorly, clypeus large, well-defined, anterior margin truncate, finely and obsoletely punctate, frons flat, punctate as clypeus, eye reniform, dorsal lobe narrow and much smaller than ventral lobe, eyes separated ventrally by almost three times the diameter of one eye; antenna uniformly light reddish brown. Pronotum twice as broad as long, somewhat trapezoidal, basal margin about twice width of apical margin, apical margin truncate, angles obtusely rounded, basal margin strongly bisinuate, angles acute, lateral margins almost straight, rapidly converging from base to apex, distinctly explanate in basal half, surface punctation as on head. Elytron with lateral margin slightly arcuate, narrowly but conspicuously and uniformly explanate from base to apex, finely punctate-striate, punctures shallowly impressed and not in grooves, two large, light reddish-brown blotches on each elytron, one in basal third not quite reaching base, suture nor lateral margins, one in apical third, smaller and transverse, attaining lateral margin but not suture. Ventral surface shiny, minutely and obsoletely punctate, legs, antenna, mouthparts, and epipleuron concolorous

Fig. 1. *Liodema explanatum.* Actual length, 5.0 mm.

with ventral surface. (Length: 5.1 mm; width: 3.0 mm.)

Variation.—I am unable to distinguish between the sexes without dissection. The coloration is rather uniform, but sometimes the basal reddish blotch does attain the basal margin. Measurements (46 specimens): Length: 4.3–5.4 mm.; width: 2.8–3.3 mm.

Discussion.—This species is easily distinguished from all other *Liodema* by the explanate lateral margins of the elytra and basal half of the pronotal margins. It is also the least convex species of the genus. The elytral color pattern is similar to that of *L. maculatum,* but the basal reddish blotch is much larger.

Types.—Holotype, sex undetermined: Costa Rica, Puntarenas, Monteverde area, 6–14 June 1973, 1400–1700 m, Erwin and Hevel Central American Expedition, 1973. Paratypes: same data, 14; Costa Rica, Puntarenas, Monteverde, V-26-VI-3, 1984, E. Riley, D. Rider, D. LeDoux, 9; Costa Rica, Coronado, 1400–1500 m, 22-IV-28, 15-VIII-31, Neverman, 3; Costa Rica, Neverman Collection; Costa Rica, Guanacaste, Estac. Cacao, sw side Volcano Cacao, 1000–1400 m, IX-XII, 1989, URGC, R. Blanco + C. Chavez, 20; same data except VI-1990, no collectors listed, 5; Costa Rica, Puntarenas, Fca. Cafrosa, Est. Las Mellizas. P. N. Amistad, 1300 m, XI-1989, M. Ramierez + M. Mora, 1; Costa Rica, Cartago Prov., Pejibaye, 22-III-1987, W. E. Steiner, 1; Panama, Cocle Prov., El Valle, 829 m, 26/27-V-1983, W. E. Steiner, 14; Panama, Chiriquí Prov., 2 km N. Sta. Clara, Hartmann's Finca, 1300 m, 8°51′N, 82°36′W, 24/25-V-1977, H. + A. Howden, 1. Holotype and paratypes in USNM; paratypes in CNCI, LSUC, OSUC, and INBC.

Liodema connexum Bates

Liodema connexum Bates 1873:236 (type locality: Colombia; type in BMNH).

Platydema nigro-fasciatum Chevrolat 1878a:215 (type locality: Mexico; type in MNHN).

Liodema nigro-fasciatum: Chevrolat 1878a: 243 (generic transfer); Champion 1886: 207 (as synonym of *L. connexum*).

In this species, the elytra are predominately (sometimes entirely) reddish with a basal humeral black blotch connected narrowly along the margin with an irregular median band which does not attain the suture. Measurements: Length: 2.8–5.2 mm.; width: 2.5–3.1 mm.

I do not agree with Champion in regarding *L. cruciatum* (Chevrolat) as a variety of *L. connexum.* I believe it to be a synonym of *L. serricorne* and have so treated it under that name.

Distribution.—I have seen only 33 specimens I consider to be this species. Since it is so rare in collections, I have recorded the data as follows: Costa Rica (Puntarenas, Monteverde; Hamburg Farm, Reventazon, Ebene Limon); Colombia (Pichindé); Ecuador (Santo Domingo); Panama (Chiriquí Province, Panama Province; Boca del Toro); Peru (Sinchona; Tarma Province; 15 km SE Moyabamba).

Liodema maculatum (Fabricius)

Mycetophagus maculatus Fabricius 1801: 556 (type locality: Essequibo, Guyana; not seen).

Platydema quadrinotatum Laporte and Brullé 1831:380 (type locality: Colombia, not seen); Chevrolat 1878a:243 (transferred to *Liodema*); Champion 1886:205 (listed as a probable synonym of *L. kirschii.*)

Liodema kirschii Bates 1873:235 (type locality: Bogota, Colombia; type in BMNH); Champion 1886:205, pl. 9, fig. 13; Gebien 1940:417 (as synonym of *L. maculatum*)

Liodema obydense Bates 1873:235 (type locality: Obydos, Brazil; type in BMNH) Champion 1886:206. **New synonymy.**

Liodema fulvum Bates 1873:236 (type locality: Cumana, Venezuela; type in BMNH); Champion 1886:205 (as synonym of *L. kirschii*).

Liodema horni Bates 1873:236 (type locality: Santarem, Brazil; type in BMNH). **New synonymy.**

Scaphidema proximum Chevrolat 1877a: 178 (type locality: Mexico; type in MNHN).

Scaphisoma (sic) *proximum:* Bates, Chevrolat, 1878a:243 (synonym of *Liodema obidense* (sic)).

Scaphidema tergocinctum Chevrolat 1877a: 178 (type locality: Guatemala; type in MNHN).

Scaphisoma (sic) *tergocinctum:* Chevrolat 1878a:243 (synonym of *Liodema kirschii* Bates).

Liodema inscriptum Chevrolat 1878a:222 (type locality: Cordoba, Mexico; type not seen); Champion 1886:205 (as synonym of *L. kirschii*).

Liodema maculatum: Gebien 1906:219.

This species is quite variable in both size and coloration. The dorsum is typically dull black with two reddish maculae on each elytron, one a crescent-shaped band curving caudad from the base at the scutellum to the humeri (but not reaching the lateral margin), the other an apical large reddish blotch extending to the sides, apex, and sometimes the suture, with an oblique black spot at its center.

Often, the apical red blotch appears to be a crescent-shaped band curving cephalad, just the opposite of the basal band. The greatest variation is in the amount of red forming the bands.

Measurements (100+ specimens).—Length: 3.3–6.5 mm; width: 2.0–3.6 mm.

Distribution.—Specimens (more than 350) were examined from the following countries: Argentina, Belize, Bolivia, Brazil, Colombia, Costa Rica, Ecuador, El Salvador, Guatemala, Guyana, Honduras, Mexico, Nicaragua, Panama, Paraguay, Peru, Trinidad, Uruguay, Venezuela.

The species ranges from Mexico (states of Tamaulipas, San Luis Potosi, and Nayarit) south to Argentina (Rio Paraná). It is the only species of *Liodema* which may be considered at all common and the only one in which large series (25–35 specimens) are available for study.

Liodema serricorne Bates

Liodema serricorne Bates 1873:236 (type locality: Cayenne; type in BMNH); Champion 1886:207, pl. 9, fig. 17.

Platydema cruciatum Chevrolat 1877b:182 (type locality: Bogota, Colombia; type in MNHN).

Scaphidema cruciatum: Chevrolat 1877c: 187 (synonymy).

Liodema, cruciatum: Chevrolat 1878a:243; Champion 1886:207, pl. 9, fig. 16 (as variety of *L. connexum*).

Platydema hamatiferum Chevrolat 1878b:C (type locality: Petropolis, Brazil; type in MNHN). **New synonymy.**

Platydema ramulosum Chevrolat 1878b:C (type locality: Petropolis, Brazil; type in MNHN). **New synonymy.**

Liodema zimmermani Champion 1886:206, pl. 9, fig. 14 (type locality: Pantaleon, Guatemala; type in BMNH). **New synonymy.**

Liodema flavo-variegatum Champion 1886: 208, pl. 9, fig. 18 (type locality: Bugaba, Panama; type in BMNH). **New synonymy.**

Typically, the color pattern of this variable species consists of three or four dark streaks extending caudally from the base of the elytra, an oblique transverse band extending from the lateral margin, uniting at the suture, and extending forward to the base and caudally where it sometimes joins a thinner transverse band which does not extend to the lateral margin; the pronotum is usually yellowish brown with a dark central blotch and two outward-facing crescent-shaped dark markings.

There are many variations of this color pattern, mostly in the relative extent of the dark markings on both pronotum and elytra. In extreme cases the elytra are very dark and the pattern approaches that of *L. maculatum*; the pronotum may be almost completely dark. No geographic difference in color patterns is evident.

A series of 49 specimens from Bolivia (Beni, 40 km E. San Borja, Estacion Biologica Beni, Palm Camp at Rio Curiraba, 9–15 Sept., 1987, W. E. Steiner, on bark of cut trees at night; inundation forest) is remarkable in the uniformity of the color pattern and the size of the individuals. The finger like lobes of dark coloration are not as distinctly separated as in the typical form, the entire apex of the elytra is uniformly reddish, and the pronotum is mostly dark with light margins. It is very similar to Champion's illustration of *L. cruciatum* (see above synonymy). I have seen this same color pattern in other specimens from various places.

Measurements (87 specimens).—Length: 2.9–5.4 mm.; width 1.7–3.0 mm.

Distribution.—Specimens (112) were examined from the following countries: Argentina, Belize, Bolivia, Brazil, Colombia, Costa Rica, Dominican Republic, El Salvador, French Guiana, Guatemala, Guyana, Honduras, Mexico, Nicaragua, Panama, Peru, Suriname, Trinidad, Venezuela. This species ranges from Tampico, Tamaulipas, Mexico to Argentina (Desecho Chico).

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The illustration of *Liodema explanatum* was prepared by Jason Fairchild.

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A REVISION OF THE CYPRESS-FEEDING MOTHS OF THE GENUS *CUTINA* WALKER (LEPIDOPTERA: NOCTUIDAE)

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Abstract.—The genus *Cutina* consists of 4 species that are associated with cypress (*Taxodium* spp.) swamps throughout the southeastern United States. Two species are described as new: ***C. aluticolor, n.sp.***, and ***C. arcuata, n.sp.*** Redescriptions of *C. albopunctella* Walker and *C. distincta* (Grote) are provided. *C. albopunctella* has been reared on bald cypress, *Taxodium distichum* (L.) L.C. Rich. A phylogenetic analysis of *Cutina* indicates that *C. albopunctella* is considered basal with *C. distincta* the sister species to the *C. aluticolor* + *C. arcuata* clade, with *C. aluticolor* and *C. arcuata* sister species.

Key Words: *Cutina,* Noctuidae, phylogeny, cypress, *Taxodium*

The North American genus *Cutina*, subfamily Catocalinae (Poole 1989), was only known from two species *C. albopunctella* Walker and *C. distincta* (Grote). In this revision, we describe two additional species, illustrate all species, and present a phylogeny of the genus.

Cutina albopunctella was reared by one of us (DCF) on bald cypress (*Taxodium distichum* (L.) L.C. Rich) from eggs obtained from a live caught female. All species of *Cutina* are associated with wet habitats such as swamps, ponds, lake margins, floodplains, and river banks that contain cypress and tupelo (*Nyssa* spp.). The distribution of cypress and tupelo (Duncan and Duncan 1988) is virtually the same as *Cutina* in the southeastern United States (Figs. 41–44). *Cutina* is probably multi-brooded, at least in the southern portion of its range, with a seasonal flight period from mid-February to mid-September.

MATERIAL AND METHODS

Abbreviations for collections used in this study are: AMNH (American Museum of Natural History, New York, New York); BM (Bryant Mather, Jackson, Mississippi); BMNH (The Natural History Museum, London); ERH (Eric H. Metzler, Columbus, Ohio); FSCA (Florida State Collection of Arthropods, Gainesville, Florida); JBS (J. Bolling Sullivan, North Carolina); JRH (J.R. Heitzman, Missouri); MSU (R.L. Brown, Mississippi State University); ULK (University of Louisville, Louisville, Kentucky); USNM (National Museum of Natural History, Smithsonian Institution, Washington, D.C.); VAB (V.A. Brou, Louisiana); and VSA (V.S.A. Albu, Ohio). A total of 1032 specimens were examined during the course of this study. All data in material examined sections refer to what is printed on specimen labels. All specimens examined during this study were labeled with a bar code having a unique number (USNM ENT 00000000) and entered in a database that will be maintained in the Department of Entomology, Smithsonian Institution, Washington, D.C.

Cutina Walker

Cutina Walker 1866:1734.—Barnes and McDunnough 1917:82.—Kimball 1965: 127.—Nye 1975:146.—Franclemont and Todd 1983:127.—Poole 1989:301. Type species: *Cutina albopunctella* Walker, 1866, by monotypy.

Description.—*Head* (Fig. 2): Eyes well developed. Ocelli present. Labial palpus upright; scales on middle segment expanded ventrally; apical segment exposed. Haustellum well developed. *Thorax:* Protibia with an apical spine; epiphysis less than 0.5 times length of tibia. Mesotibia with 3–9 spines (Figs. 3–4); one pair of uneven apical spurs. Metatibia with two pair of uneven apical spurs. *Forewing* (Fig. 1): Small moths with length 7.2–14.0 mm. Ground color gray to brown. Accessory cell present. $R_3 + R_4$ stalked just beyond middle; R_5 to termen; M_2 and M_3 connate. Outer margin with black spots. *Hindwing* (Fig. 1): Length 7.0–11.2 mm. Female with 3 frenular bristles. R_5 and M_1 connate; M_3 and CuA_1 stalked just beyond M_2. Ground gray to brown. *Male genitalia* (Figs. 29–36): Gnathos present. Valve narrow to sickle-shaped. Aedoeagus curved. Vesica complex. *Female genitalia* (Figs. 37–40): Eighth sternite with a pair of large elongate lobes; 2 dark scale patches dorsal to these lobes. Ductus bursae short. Corpus bursae covered with minute spicules. Appendix bursae present.

Distribution.—*Cutina* occurs from southeastern Maryland to southern Florida, along the Gulf Coast from southwestern Florida to eastern Texas and western Louisiana, throughout Mississippi to southeastern Oklahoma, Missouri and extreme southwestern Indiana and western Kentucky.

Discussion.—Species of *Cutina* are small moths with forewing ground color gray to brown and hindwing ground color buff to light brown. The pattern can be longitudinally streaked or with median and postmedian lines distinct. Lobes of the 8th sternite in the females are covered with scales and can be seen without dissection. Upon dissection these lobes are kidney-shaped and have an associated scale patch dorsad to them.

One of us (DCF) earlier assumed that more than four species might be represented in the highly variable material available for examination. The peninsular Florida forms of *C. albopunctella* and *C. arcuata* appeared especially likely to be distinct. However, no clear evidence was found to support this.

All species of *Cutina* can be readily distinguished by comparing specimens to the illustrations of adults in Figs. 5–28.

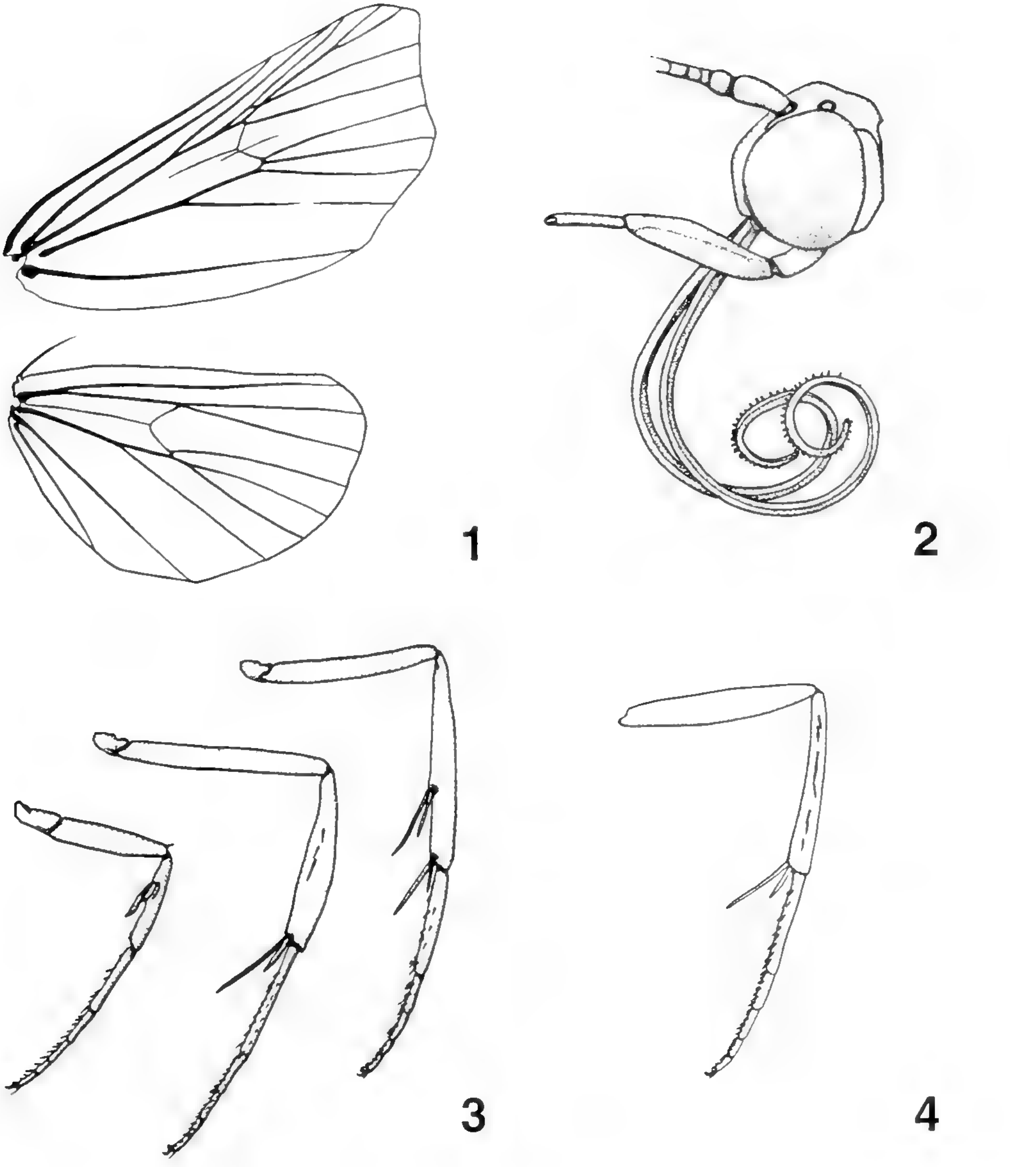
Cutina albopunctella Walker
(Figs. 4, 5–12, 29–30, 37, 41)

Cutina albopunctella Walker 1866:1735.—Hampson 1913:157.—Barnes and McDunnough 1917:82.—Barnes and Benjamin 1925:198.—Kimball 1965:127.—Franclemont and Todd 1983:127.—Poole 1989:301.

Erastria strigulataria Smith 1900:173.—Dyar 1902:209.—Barnes and McDunnough 1917:82, (junior synonym).—Kimball 1965:127.—Todd 1982: 201.—Franclemont and Todd 1983:127.—Poole 1989:301.

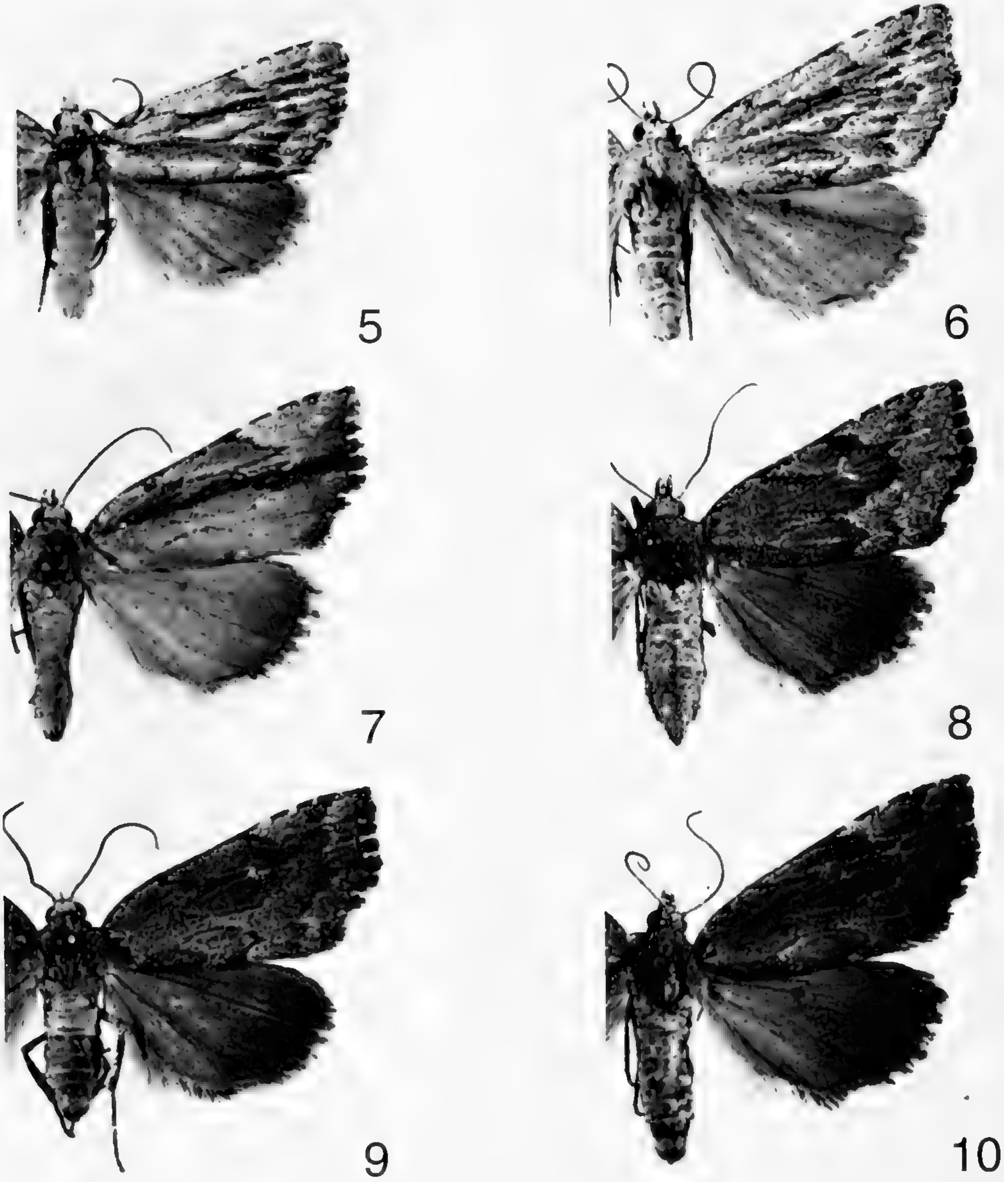
Diagnosis.—Forewing ground color light brown with longitudinal white streaks from base to termen (peninsular Florida), or ground color brown dusted with white scales (non-peninsular Florida). Mesotibia with 6–9 small spines. Uncus diamond shaped. Sinus vaginalis rectangular-shaped caudally and lobes of 8th sternite trapezoidal.

Description.—*Head:* Vertex white, mixed with light gray. Labial palpus light gray bordered by white ventrally. Antennal scape white mixed with light gray; scales on flagellum white to light brown apically. *Thorax:* Patagium white, mixed with light gray. Metanotum white, mixed with light gray; scale tuft absent. Tegula white, mixed with light gray. Venter white. Legs light brown



Figs. 1–4. *Cutina aluticolor.* 1, Wing venation. 2, Head, lateral. 3, Legs. 4, *C. albopunctella* middle leg.

and white with white apical tibial band; 6–9 spines on mesotibia. Tarsi light brown with white apical band. *Forewing* (Figs. 5–12): Male length 11.2–14 mm. Female length 11.8–13.8 mm. Ground color light brown with longitudinal white streaks from base to termen. Basal line absent. Antemedial line absent. Postmedial line absent. Subterminal line white (obscure in some specimens). Longitudinal streaks of white scales overlying ground color. Ovate patch along posterior margin, outlined with dark scales. *Hindwing:* Male length 8.4–11.2 mm. Female length 9.4–10.6 mm. Ground color buff. *Abdomen:* Dorsum light brown; venter light brown. *Male genitalia* (Figs. 29–30): Uncus with subapical diamond-shaped expansion. Tegumen with pair of lateral projections at basal third. Valve widest at base, margins straight; costal projec-



Figs. 5–10. *Cutina albopunctella,* adults, 3× natural size. 5, ♂, Florida, Highlands Co., USNM ENT 00059264, (AMNH). 6, ♂, Florida, Collier Co., USNM ENT 00059255, (USNM). 7, ♂, South Carolina, Charleston Co., USNM ENT 00059471, (USNM). 8, ♀, South Carolina, Charleston Co., USNM ENT 00059475, (USNM). 9, ♂, South Carolina, Charleston Co., USNM ENT 00059494, (USNM). 10, ♂, South Carolina, Charleston Co., USNM ENT 00059489, (USNM).

tion at basal third; ampulla a swollen knob; harpe a swollen knob, smaller than ampulla; cucullus apex rounded. Apex of aedoeagus pointed, with dorsal margin projecting beyond ventral margin into vesica. Vesica with distal diverticula enlarged, bulbous.

Female genitalia (Fig. 37): Sinus vaginalis well sclerotized laterally and ventrally, rectangular-shaped caudad. Lobes of 8th sternite trapezoidal; lateral margin straight. Signa longer on anterior half of corpus bursae than on posterior half.

Type material.—Holotype, BMNH. *Cutina albopunctella* Walker was described from one male from the "United States" in the BMNH (from E. Doubleday). The type locality was not given, but Doubleday collected at "St. John's Bluff, East Florida" in March and April 1838. This was on the south side of the St. John's River at or near the present site of Fort Caroline National Memorial, Jacksonville (Ferguson 1963). The holotype, based on a color photograph, is clearly of the smaller peninsular Florida form with longitudinally white-striated forewings, although other specimens examined indicate that the Jacksonville area is at the interface or blend zone between this southern form with exaggerated striation and the larger, more grayish form occurring northward.

Erastria strigulataria J. B. Smith was described from "Florida (Mrs. Slosson), 1 female only." All that remains of the holotype in the AMNH are four wings mounted on a card. The frenulum on the left hindwing shows that the specimen was a male, not a female as indicated in the original description (Todd 1982: 201). Annie Trumbull Slosson spent winters at various places in southern Florida (Miami, Punta Gorda, Charlotte Harbor), and there is no way to determine the specific type locality (Dougherty 1990). The holotype again represents the peninsular Florida form of *C. albopunctella.*

Type locality.—United States.

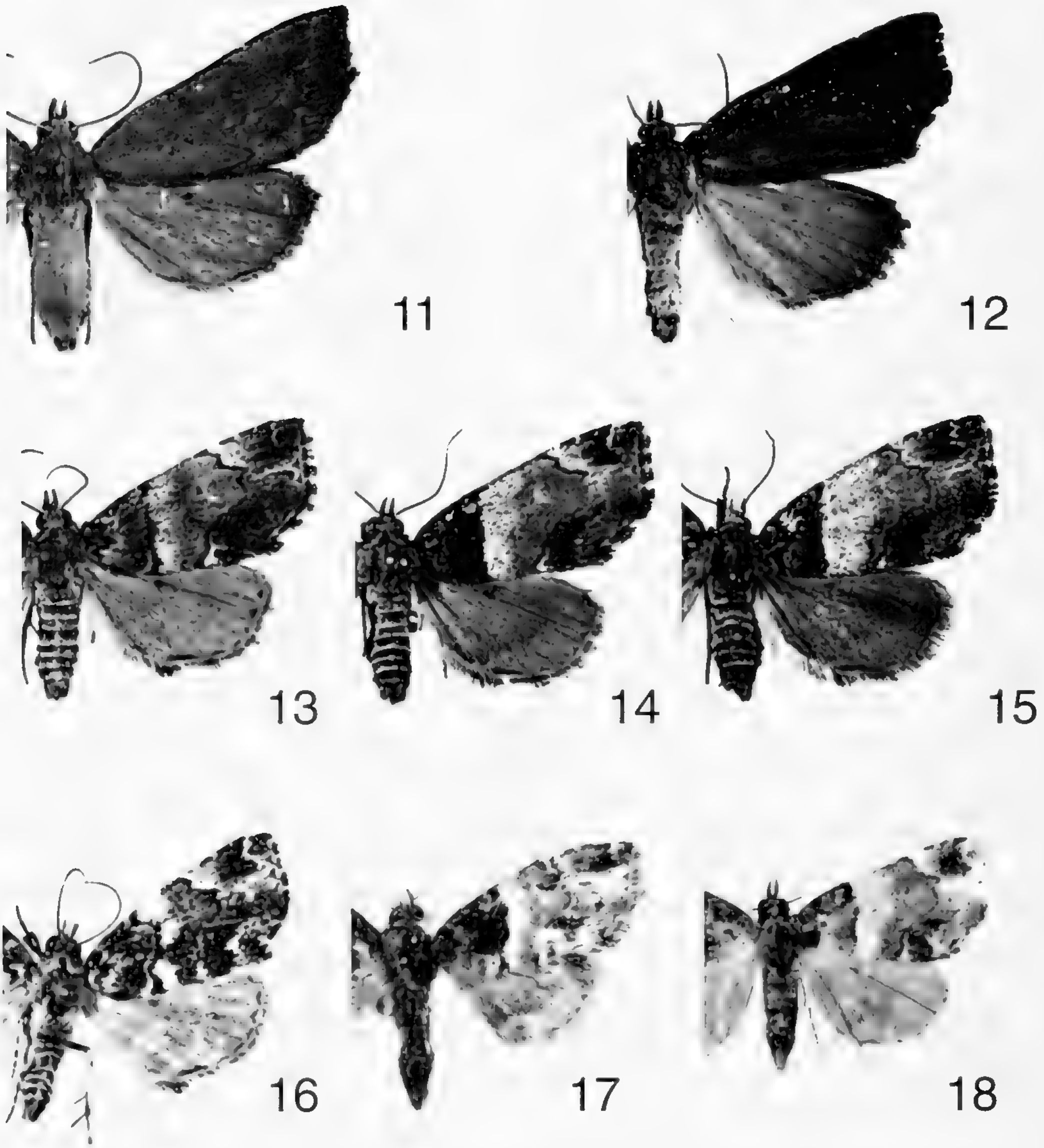
Host.—Bald Cypress, *Taxodium distichum* (L.) L.C. Rich. Larvae from eggs laid by a female taken in the Okefenokee Swamp, Georgia, were reared to maturity on this host by DCF.

Immature stages.—Mature larva 32 mm in length. Abdominal prolegs on A5, A6, and A10 fully developed. A pair of small, rudimentary bumps marking position of prolegs on A4. Bright green with well defined white subdorsal and spiracular stripes. A thinner pair of addorsals and faintest trace of a pale subventral and yellowish midventral stripe. Head green with extensions of whitish subdorsals. Legs green, space between addorsals darker green, marking position of dorsal vessel.

Flight period.—Records for end of February, end of March through end of September.

Distribution (Fig. 41).—From southern Florida north to coastal Georgia, South Carolina, North Carolina, and eastern Maryland; southern Alabama, Louisiana and Mississippi north to eastern Mississippi, southeastern Missouri, southern Indiana, and west to western Louisiana and eastern Texas.

Material examined.—183 ♂ and 157 ♀. ALABAMA: Baldwin Co., Bon Secour N.W.R., 11–16 May 1994 , R.L. Brown & D. Pollock, 2 ♂, 2 ♀ (MSU);1 mi S Claiborne Dam, 29 May 1995, R.L. Brown, 1 ♂, 30 May 1995, R.L. Brown & J. MacGown,1 ♂ (MSU) Monroe Co., Haines Island Park, 30 May 1995, J. MacGown & R.L. Brown, 1 ♂ (MSU). FLORIDA: [no specific locality], E.T. Owen Coll., 1 ♂, (USNM); Collier Co., Big Cypress Swamp Natl. Pres., Turner Rd., 1.5 mi N of US Hwy 41, 18 March 1997, 1 ♂, 2 ♀, 5 mi S of Hwy 41, 20 March 1997, 2 ♂, 1 ♀, M.G. Pogue (USNM); Fakahatchee Strand, Big Cypress Swamp, 24 February 1985, D.C. Ferguson, ♂ genitalia slide USNM 56789 [green label], 11 ♂ (USNM); Fakahatchee Strand, Jane's Scenic Dr., near Copeland, 28 Mar. 1986, H.D. Baggett, 2 ♀ (USNM); Fakahatchee Strand Preserve, 3.4 mi NW Copeland, 17 March 1997, M.G. Pogue, 1 ♂, 1 ♀ (USNM); Collier-Seminole State Park, 18 June 1987, T.L. Schiefer, 1 ♀ (MSU); Naples, 1 June 1995, 2 ♀ (JG). Duval Co., Jacksonville, Jax. Police Acad., 5 June 1980, H.D. Baggett, 1 ♀ (USNM). Flagler Co., Crescent Lake, Shell Bluff Landing, 12 May 1990, H.D. Baggett, 1 ♂, genitalia slide USNM 44535 [green label] (USNM). Hernando Co., Weeki Wachee Springs, 5 June 1960, J.F. May, 1 ♂, genitalia slide USNM 56790 [green label] (USNM). Highlands Co., Archbold Biol. Sta., 12–19 June 1955, A.K. Wyatt, 1 ♂

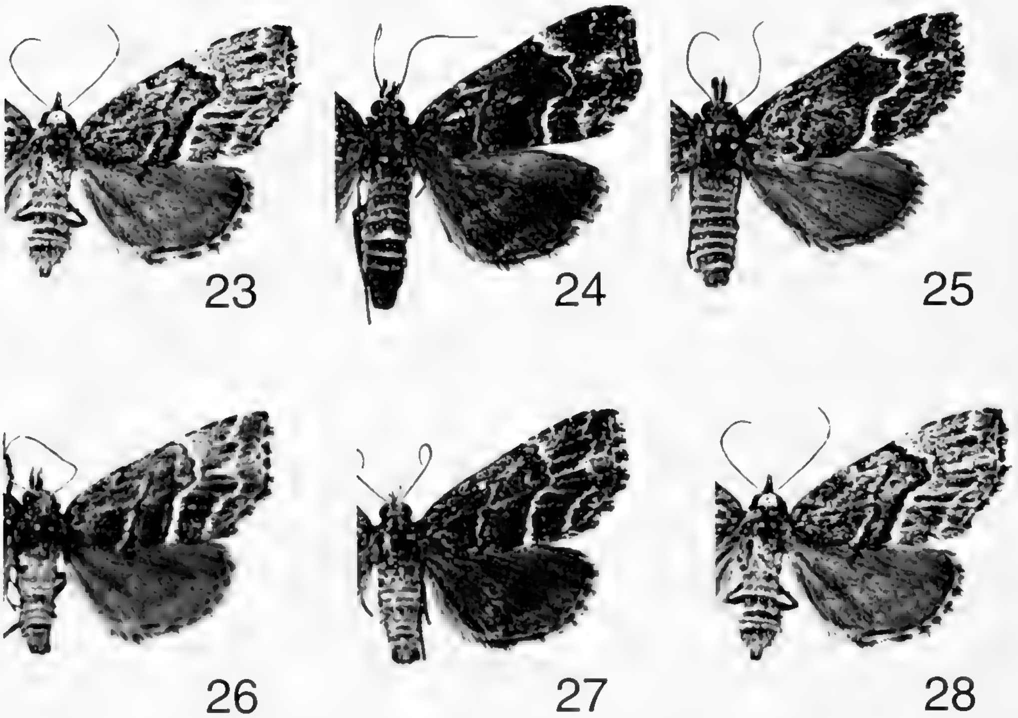


Figs. 11–18. Adults, 3× natural size. 11, *Cutina albopunctella*, ♂, South Carolina, Charleston Co., USNM ENT 00059639, (USNM). 12, *C. albopunctella*, ♂, Missouri, Wayne Co., USNM ENT 00059615, (USNM). 13, *C. distincta*, ♀, Florida, Collier Co., USNM ENT 00059920, (USNM). 14, *C. distincta*, ♂, South Carolina, Charleston Co., USNM ENT 00059958, (USNM). 15, *C. distincta*, ♀, South Carolina, Charleston Co., USNM ENT 00059973, (USNM). 16, *C. distincta*, ♂, Louisiana, St. John the Baptist Parish, USNM ENT 00060016, (VAB). 17, *C. distincta*, ♀, holotype, [No locality], Col. B. Neumögen, (USNM). 18, *C. inquieticolor* Dyar (synonym of *C. distincta*), ♀, Lectotype, Type No. 25422, Florida, Hillsborough Co., (USNM).

(USNM). Hillsborough Co., Stemper, 16 Sep. 1911, Barnes Coll., 1 ♀ (USNM); Tampa, 22 Apr. 1982, 9 June 1981, H.D. Baggett, 2 ♀ (FSCA). Lee Co., Ft. Myers, 5 May 1978, C.V. Covell, 2 ♂, 2 ♀, 2 ♀ genitalia slides USNM 56791, 57212 [green labels], Apr. 16–23, 4 ♂, May 1–7, Barnes Coll., 2 ♂ (USNM). Liberty Co., Torreya

Figs. 19–22. *Cutina aluticolor*, adults, 3× natural size. 19, ♂, Holotype USNM 105501, Florida, Putnam Co., USNM ENT 00059550, (USNM). 20, Florida, Putnam Co., USNM ENT 00059541, 21, Florida, Putnam Co., USNM ENT 00059639, 22, Florida, Putnam Co., USNM ENT 00059555.

State Park, 21 May 1982, H.D. Baggett, 1 ♂ (FSCA). Marion Co., Ocala National Forest, 3 June 1995, J. Glaser, 1 ♀ (JG). Monroe Co., Everglade, Apr. 8–15, Barnes Coll., 1 ♂ (USNM). Pinellas Co., St. Petersburg, May, 2 ♀, September,1 ♂, Barnes Coll., (USNM), [no date], O. Bucholz, 1 ♂ (AMNH). Polk Co., Lakeland, 11 Aug. 1941, J.R. Malloch, 1 ♂ (USNM). St. Johns Co., Hastings, J.R. Smith, 1 ♂ (USNM). Sumter Co., Withlacoochie State Forest, 31 May 1995, 1 ♀ (JG). GEORGIA: Charlton Co., Boardwalk trail, Okefenokee Swamp, nr. Folkston, 26 Mar. 1990, 11 ♂, 9 ♀, 2 ♂ genitalia slides USNM 44538, 44536 [green labels], 28 Mar. 1990, D.C. Ferguson, 20 ♂, 35 ♀ (USNM); Boardwalk trail, Chesser Is., Okefenokee National Wildlife Refuge, 16 Apr. 1991, 1 ♂, 8 ♀, 18 Apr. 1991, 1 ♀, 19 Apr. 1991, D.C. Ferguson, 1 ♂, 1 ♀ (USNM); Chesser Is. Homestead, Okefenokee National Wildlife Refuge, 16 Apr. 1991, 1 ♀, 19 Apr. 1991, 1 ♂, 3 ♀, D.C. Ferguson (USNM); Trader's Hill, Folkston, 17 Apr. 1991, D.C. Ferguson, 1 ♂ (USNM). Clinch Co., 7 mi NE Fargo, 7 May 1981, D.C. Ferguson, 1 ♂ (USNM); Ware Co., Okefenokee Swamp, 12 May 1988, J.F.G. Clarke, 1 ♀ (USNM). INDIANA: Posey Co., Gray Estates, 30 June 1995, Enz & Covell, 3 ♂ (ULK). LOUISIANA: Bossier Par., Barksdale A.F.B., 17 Apr. 1996, 1 ♂, 1 ♀, 25 Apr. 1996, 1 ♂, 3 June 1996, 1 ♂, 18 June 1996, 1 ♂, 11 July 1996, 2 ♂, 14 Aug. 1996, 1 ♀, D.M. Pollock, 20 May 1996, R.L. Brown, 1 ♂ (MSU). Calcasieu Par., S.H. Jones State Park, 19–23 May 1993, R.L. Brown & D. Pollock, 9 ♂, 2 ♀ (MSU). Plaquemines Par., Callender Field, 28 Aug. 1971, 1 ♀ (EHM). St. Charles Par., Bonnet Carre Spillway, 5 May 1972, 1 ♀ (EHM). St. John the Baptist Par., Edgard, 27 May 1977, 1 ♂, 7 June 1981, 1 ♀, 20 June 1977, 1 ♂, V.A. Brou (VAB). St. Tammany Par., 4.2 mi NE Abita Springs, sec. 24, T6S, R12E, 4 Apr. 1984, V.A. Brou, 1



Figs. 23–28. *Cutina arcuata*, adults, 3× natural size. 23. ♂, Holotype USNM 105502, South Carolina, Charleston Co., USNM ENT 00059837, (USNM). 24, ♀, South Carolina, Charleston Co., USNM ENT 00059827, (USNM). 25, ♂, South Carolina, Charleston Co., USNM ENT 00059835, (USNM). 26, ♂, Florida, Collier Co., USNM ENT 00059792, (USNM). 27, ♂, Florida, Collier Co., USNM ENT 00059793, (USNM). 28, ♂, Florida, Putnam Co., USNM ENT 00059744, (USNM).

♀ (VAB). Webster Par., Lake Bistineau St. Pk., 11 May 1980, 2 ♂, 27 May 1979, 1 ♂, [no collector] (VAB), 20 May 1996, R.L. Brown, 2 ♀ (MSU). MARYLAND: Worcester Co., Pocomoke St. For., 30 July 1990, 1 ♂, 16 July 1993, 1 ♀, J. Glaser, (JG); Nassawango Preserve, 24 July 1989, J. Glaser, 3 ♀ (JG); Shad Landing, 20 May 1985, 1 ♂, 30 July 1990, 2 ♀ (JG); Pocomoke State Forest, 16 July 1993, J. Glaser, 1 ♀ (JG); 7 mi N. of Pocomoke, Blades Rd., 16 June 1997, 1 ♂, 2 ♀ (JG). MISSISSIPPI: George Co., Mixon Lakes, 8–9 Apr. 1994, R.L. Brown & D. Pollock, 1 ♂, 2 ♀(MSU). Hancock Co., M.T.F., 20 Mar. 1992, 1 ♀, 24 Mar. 1992, 1 ♂, 15 Apr. 1992, 1 ♀, 20 Apr. 1992, 2 ♂, 3 May 1992, 1 ♀, 14 May 1992, 1 ♀, 15 May 1992, 1 ♂, 2 June 1992, 1 ♀, 5 July 1992, 1 ♂, 7 July 1992, 1 ♂, 2 ♀, 9 July 1992, 1 ♀, 15 July 1992, 1 ♀, 18 July 1992, 1 ♂, 25 July 1992, 1 ♀, 9 Aug. 1992, 4 ♂, 1 ♀, ♀ genitalia slide USNM 44539 [green label], 13 Sep. 1991, 1 ♀, R. Kergosien (BM). Harrison Co., Lizana, 9 June 1992, 1 ♀, 27 July 1991, 1 ♀, R. Kergosien (BM); Long Beach, 4 Aug. 1991, R. Kergosien, 1 ♂ (BM). Jackson Co., Blk. Cr., nr. George-Jacoline, 1 Aug. 1991, Rick Kergosien collr., 1 ♂, 3 ♀ (BM); O. Sprgs., 3 June 1979, R. Kergosien, 1 ♀ (BM), I-10 at Escatawpa River, 13 Apr. 1991, R.L. Brown, 2 ♂, 1 ♀(MSU). Noxubee Co., Noxubee Wild. Ref., 26 Apr. 1987, R.L. Brown, 1 ♂ (USNM), 16 Aug. 1984, S. Cho, 1 ♂, 14 Apr. 1993, D.M. Pollock, 1 ♂, 1 ♀ (MSU). Oktibbeha Co., T18W, R14E, Sec. 23, 10 May 1988, R.L. & B.B. Brown, 1 ♂ (USNM), 30 June 1988, R.L. & B.B. Brown, 1 ♀ (MSU). Pearl River Co., 3 mi east Bogalusa, 17 Aug. 1991, R. Kergosien, 1 ♂, 2 ♀ (BM). Tishomingo Co., Tish. St. Pk., 11 Apr. 1986, R.L. Brown, 1 ♀ (USNM). MISSOURI: Stoddard Co., Otter Slough Wildlife Area, 25 Aug. 1983, J.R. Heitzman, Cypress-Tupelo Swamp with associated southeastern forest, 3 ♂ (JRH). Wayne Co., Markham Sprgs. Nat. For. Cmpg., 7 June 1984, 1 ♀, 21 July 1984, 6 ♂, 5 ♀, ♂ genitalia slide USNM 44538, ♀ genitalia slide USNM 56802 [green labels], J.R. Heitzman, Cane, Cypress, Tupelo, pine, & deciduous forest (JRH). NORTH CAROLINA: Craven Co., Croatan For. Rd. 167, 21 July 1993, J. Bolling Sullivan, 1 ♀ (USNM); North Harlowe, 20 Mar. 1990, 1 ♂ (USNM), 23 Mar. 1990, 1 ♂ (JBS), 1 Apr. 1990, 1 ♂ (JBS), 2 Apr. 1990, 1 ♂ (USNM), 14 Apr. 1990, 1 ♂ (JBS), 17 Apr. 1991, 1 ♂ (JBS), 21 Apr. 1990, 2 ♂, 1 ♀, 8 May 1990, 1 ♂, 30 June 1990, 2 ♂, 1 ♀ (USNM), 4 July 1990, 1 ♀ (JBS), 7 July 1990, 1 ♂, 19 July 1990, 1 ♂, 24 July 1978, 1 ♀, 29 July 1990, 1 ♂, 17 Aug. 1990, 1 ♂ (USNM), 1 ♀ (JBS), J. Bolling Sullivan. New Hanover Co., Car. Beach State Park, E. of Dow Rd., 1–10 Aug. 1994, J. Bolling Sullivan, Richard Broadwell, & Brad Smith, UV trap, coastal fringe sandhill, 1 ♂ (USNM). SOUTH CAROLINA: Charleston Co., McClellanville, 5 May 1969, 1 ♀, 7 May 1969, 1 ♂, R.B. Dominick, Charles R. Edwards, light (USNM); Wedge Plantation, McClellanville, 8 Apr. 1977, 1 ♂, 21 Apr. 1974, 3 ♂, 24 Apr. 1974, 1 ♀, 1 May 1972, 1 ♂, 2 June 1978, 1 ♀, genitalia slide USNM 56576 [green label], 5 June 1978, 1 ♂, 2 ♀, 3 Aug. 1968, 5 ♂, 5 ♀, ♂ genitalia slide USNM 57210, ♀ genitalia slide USNM 57211 [green labels], 5 Aug. 1968, 2 ♂, 7 Aug. 1968, 2 ♀, 13 Aug. 1968, 1 ♂, 19 Aug. 1971, 2 ♂, 26 Aug. 1981, 1 ♂, 2 ♀, D.C. Ferguson (USNM); Wedge Plantation, South Santee River, 28 Mar. 1967, 2 ♂, 1 ♀, 29 Mar. 1967, 1 ♂, 1 ♀, 31 Mar. 1967, 1 ♂, 1 ♀, 6 Aug. 1968, 3 ♂, 1 ♀, D.C. Ferguson (USNM),17 July 1967, 1 ♀, 27 July 1967, 1 ♂, 28 July 1967, 1 ♂, 30 July 1967, 1 ♂, James W. Porter (USNM), 4 Aug. 1967, 1 ♂, genitalia USNM 56582, James W. Porter (USNM). TEXAS: Harris Co., [no specific locality], June 16–23, Barnes Coll., 1 ♂ (USNM). Harrison Co., Cado Lake St. P., 18 Aug. 1985, 1 ♂, 1 ♀, 29 Aug. 1985, 1 ♀, E.C. Knudson; Jasper Co., Bouton Lake, 9 Apr. 1986, 1 ♂ (USNM).

Discussion.—This species is quite variable throughout its range. The type of *C. albopunctella* agrees with the peninsular Florida specimens (Figs. 5–6). Genitalically there is no significant difference between that population and remaining populations over this species range, although Florida specimens usually have a whitish-striated forewing that gives them a distinctive appearance. In the forewing pattern of the Georgia and South Carolina specimens there is a large medial patch of ground color that is outlined with black scales extending from middle of costa to posterior margin of discal cell, with apices truncate to pointed, and a ground color ovate patch outlined in black scales along posterior margin. Some specimens have a wide black horizontal streak from base of forewing to middle of outer margin (Fig. 7). This pattern becomes less distinct in North Carolina. Specimens from Mississippi, Missouri, Texas, and Maryland are practically devoid of pattern, only a remnant postmedial line is present on some specimens. Louisiana specimens can show either a pattern or it can be lacking.

Cutina albopunctella is easily distinguished from the other species by its large size, whitish-striated forewing (peninsular Florida), or its brown forewing dusted with white scales (non-peninsular Florida). *Cutina distincta* differs in the basal fourth of forewing being mixed with black with an adjacent white band. There are 6–9 small spines on the mesotibia (Fig. 4) versus fewer than 4 (Fig. 3) on the other species. The uncus in the male genitalia is diamond shaped. In the female genitalia the sinus vaginalis is rectangular-shaped caudally and the lobes of the 8th sternite are trapezoidal.

Cutina distincta (Grote)
(Figs. 13–18, 31–32, 38, 42)

Eustrotia distincta Grote 1882:184.—Dyar 1902:209.

Erastria distincta Smith 1893:311.

Cutina distincta:—Barnes and Benjamin 1925:198.—Kimball 1965:127.—Franclemont and Todd 1983:127.—Poole 1989:301.

Taseopteryx inquietcolor Dyar 1922:169.—Barnes and Benjamin 1925:198, (junior synonym).—Kimball 1965:127.—Franclemont and Todd 1983:127.—Poole 1989:301.

Diagnosis.—Metanotum black. Tarsi brown with white apical band. Forewing with basal fourth mixed with black scales and an adjacent white band, antemedial line black, postmedial line black. Valve equal width to angulate margins at ⅔ length. Sinus vaginalis lightly sclerotized, half-circle shaped caudad with caudal margin straight or only slightly concave.

Description.—*Head:* Vertex light brown. Labial palpus light brown speckled with black and white. Antennal scape light brown; scales on flagellum brown, white lateral scale every other segment. *Thorax:* Patagium light brown. Metanotum black; scale tuft present. Tegula a variable mixture of white, brown, and black scales. Venter white. Legs brown and white with white apical tibial band; 4 or fewer spines on mesotibia. Tarsi brown with white apical band. *Forewing* (Figs. 13–18): Male length 9.6–11.8 mm. Female length 10–11.6 mm. Ground color light brown. Basal fourth mixed with black scales and an adjacent white band. Basal line black, indistinct. Antemedial line black. Postmedial line black. Ovate patch absent. Postmedial band mixed with black scales, present as costal subapical and tornal patches. *Hindwing:* Male length 7.6–9.4 mm. Female length 8–9 mm. Ground color light brown. *Abdomen:* Abdomen dorsum a varying mixture of light brown to black scales with a white posterior margin; venter brown. *Male genitalia* (Figs. 31–32): Uncus slender, constant width throughout length. Tegumen without lateral projections. Valve equal width to angulate margins at ⅔ length; ampulla as wide as base of valve, apex produced; harpe wider at base, angled toward costa at mid-length, narrower than ampulla; costal projection at basal third of valve absent; ampulla as wide as base of valve, apex produced; harpe widest at base, angled toward costa at mid-length, narrower than ampulla; cucullus apex pointed. Apex of aedoeagus pointed, with dorsal margin projecting beyond ventral margin into vesica. Vesica with distal diverticula elongate, constricted medially. *Female genitalia* (Fig. 38): Sinus vaginalis lightly sclerotized, half-circle shaped caudad with caudal margin straight or only slightly concave. Lobes of 8th sternite kidney-shaped; lateral margin gently curved forming a wide obtuse angle. Signa long on entire corpus bursae.

Type material.—Holotype ♀, USNM. *Eustrotia distincta* Grote was described from a single specimen (Fig. 17) collected by B. Neumögen, with no specific locality or other data given. It is a heavily marked specimen with narrowed bands, similar to many we have seen from Florida and the Gulf States.

Taseopteryx inquieticolor Dyar was described from two female syntypes in the USNM from "Stemper, Hillsborough County, Florida, September 7 and October 2, 1911 (F Marloff)." We hereby designate as lectotype the better specimen, taken 2 October 1911 (Fig. 18), and it is so labeled. Both syntypes are normal specimens of *C. distincta.*

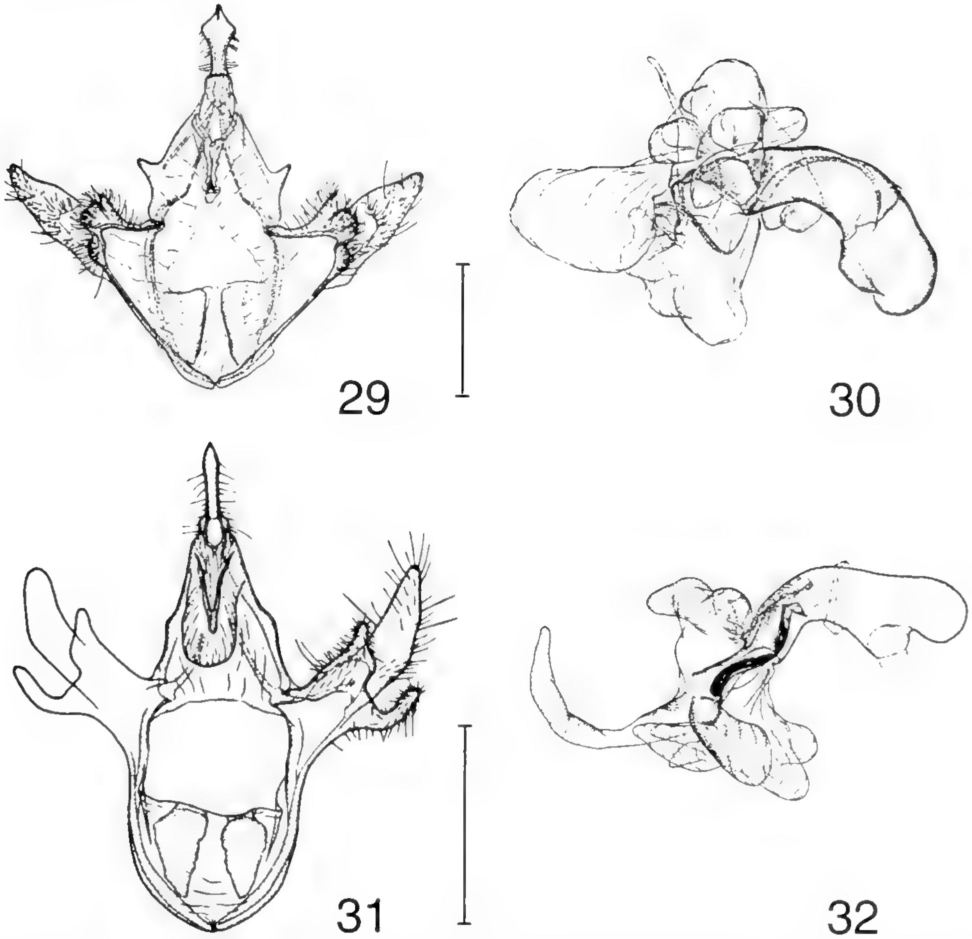
Type locality.—No locality given.

Host.—Cypress (*Taxodium* sp.). A single specimen was reared by R.L. Brown (MSU).

Immature stages.—Unknown.

Flight period.—Records from the end of February and March through September.

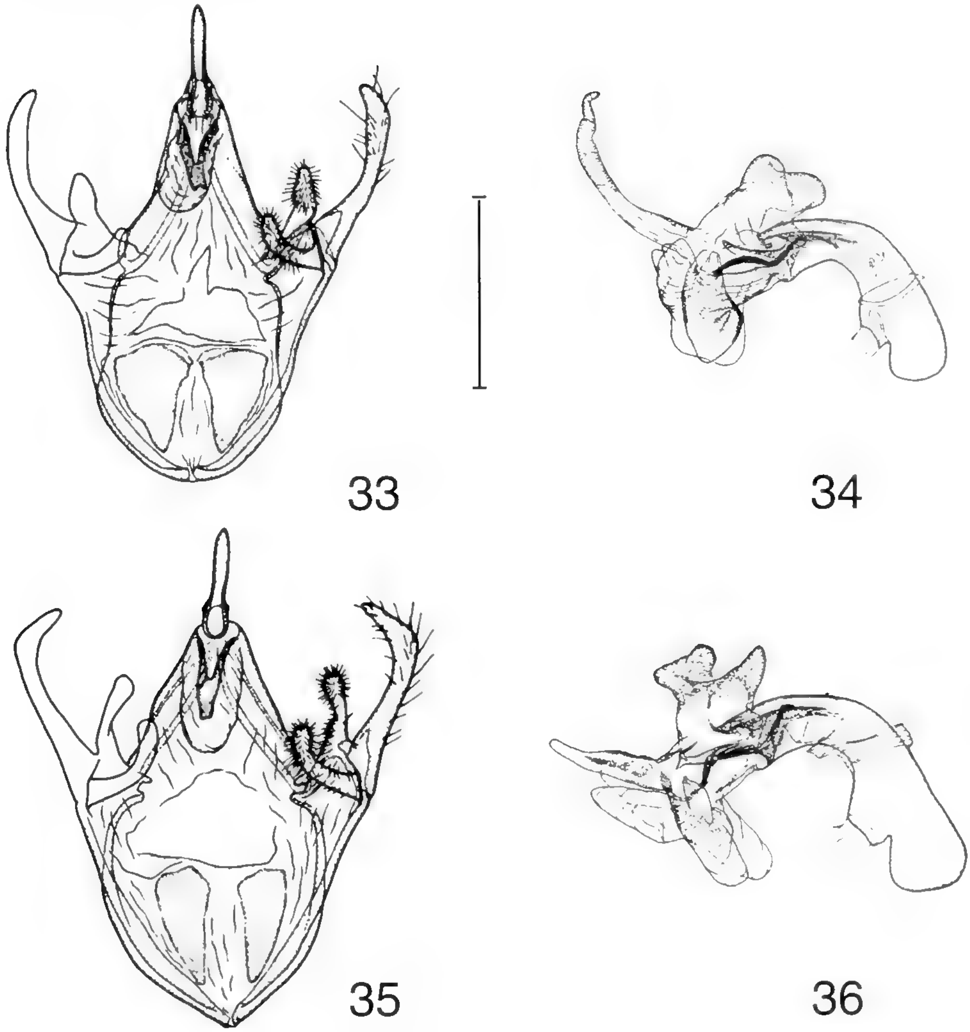
Distribution (Fig. 42).—From southwestern and northeastern Florida north along the Atlantic coast to eastern Maryland.



Figs. 29–32. Male genitalia. 29, *Cutina albopunctella*, genitalia. 30, *C. albopunctella*, aedoeagus. 31, *C. distincta*, genitalia. 32, *C. distincta*, aedoeagus. (All scale lines 1.0 mm.)

Southern Mississippi, Louisiana, southeastern Oklahoma, and eastern Texas north to west central Mississippi, western Kentucky, and northwestern Louisiana.

Material examined.—100 ♂ and 71 ♀. ALABAMA: Baldwin Co., Bon Secour N.W.R., 11–16 May 1994, R.L. Brown & D. Pollock, 1 ♀ (MSU). Monroe Co., Haines Island Park, 28 May 1995, R.L. Brown, 1 ♀ (MSU); Issac Creek Campground, 26–31 May 1995, R.L. Brown, 1 ♂ (MSU). FLORIDA: Charlotte Co., Punta Gorda, 15 May 1953, H. Ramstadt, 1 ♀ (USNM). Collier Co., Collier-Seminole State Park, 2 May 1987, H.D. Baggett, 1 ♂ (USNM); Fakahatchee Strand, Big Cypress Swamp, 24 Feb. 1985, D.C. Ferguson, 4 ♂, 1 ♀, Fakahatchee Strand Preserve, 3.4 mi NW Copeland, 17 March 1997, M.G. Pogue, 1 ♂ (USNM). Hillsborough Co., Tampa, 14 June 1981, 1 ♀, H.D. Baggett (FSCA); Tampa, USF Golf Crse., 25 Apr. 1982, 1 ♀, H.D. Baggett, bait trail (FSCA). Levy Co., Manatee Sprgs. St. Pk., 5 Apr. 1968, C.V. Covell, Jr., 1 ♂ (ULK). Liberty Co., Torreya State Park, 4 July 1986, H.D. Baggett, 1 ♂ (FSCA). Palm Beach Co., Loxahatchee, Flying Cow Ranch, 21 Apr. 1962, 1 ♂, 1 ♀ (USNM). Putnam Co., Palatka, 6 May 1990, H.D. Baggett, 1 ♀ (USNM); Univ. of Florida Preserve, Welaka, 21 Mar. 1987, 4 ♂, 22 Mar. 1987, 7 ♂, 24 Mar. 1987, 1 ♀, 25 Mar. 1987, 3 ♂, 1 ♀, 26 Mar. 1987, 5 ♂, D.C. Ferguson (USNM); Weems Property, Red Water Lake, 29 July 1967, H.V. Weems, Jr. 1 ♀ (USNM). St. Johns Co., Hastings, 1 ♀ (USNM). Volusia Co., De Land, 1–15 Mar. 1953, H. Ramstadt, 1 ♀ (USNM). GEORGIA: Charlton Co., Boardwalk trail, Okefenokee Swamp, nr. Folkston, 26 Mar. 1990, 2 ♂, 1 ♀, 28 Mar. 1990, 2 ♂, D.C. Ferguson (USNM); Boardwalk trail, Chesser Is., Okefenokee Natl. Wildlife Refuge, 18 Apr. 1991, D.C. Ferguson, 1 ♂ (USNM); Okefenokee Swamp, nr. Stephen Foster State Pk., 5 May 1981, D.C. Ferguson, 1 ♀ (USNM). KENTUCKY: Fulton Co., Rt. 94, 2.5 mi E Cayce, 8 Sep. 1984, C.V. Covell, Jr., 1 ♀ (ULK). LOUISIANA: Bossier Par., Bodcau W.M.A., 20 May 1996, D. Adamski, blacklight in calcareous forest, William H. Cross Expedition, 1 ♀ (USNM); Barksdale A.F.B., 10 Apr. 1996, 1 ♂, 11 Apr. 1996, D. Pollock, 2 ♂, (MSU). Calcasieu Par., near Lake Charles, 3 Sep. 1961, J.R. Heitzman, light in swamp, 1 ♂ (USNM); S.H. Jones State Park, 19–23 May 1993, R.L. Brown & D. Pollock, 2 ♂, (MSU). St. Charles Par., Bonnet Carre Spillway, 24 July 1971, 1 ♀, E.H. Metzler (EHM). St. John the Baptist Par., Edgard, 10 Apr. 1984, 1 ♀, 16 May 1981, 1 ♀, 20 May 1982, 1 ♂, 23 May 1982, 1 ♂, 24 May 1981, 1 ♀, 25 May 1976, 1 ♂, 26 Sep. 1980, 1 ♂, V.A. Brou, UV light trap, (VAB). St. Tammany Par., 4.2 mi NE Abita Springs, sec. 24, T6S, R12E, 26 Mar. 1984, 1 ♀, 1 May 1983, 1 ♂, 13 May 1984, 1 ♀, 30 July 1983, 1 ♀, 30 Aug. 1983, 1 ♀, V.A. Brou (VAB). MARYLAND: Wicomico Co., Vienna, 10 Sep. 1988, J. Glaser, 1 ♀ (JG). Worcester Co., Pocomoke St. For., 30 July 1990, 1 ♂, 2 ♀, 16 July 1993, 1 ♂, 1 ♀, J. Glaser (JG); Shad Landing, 24 July 1989, 1 ♂, 30 July 1990, 1 ♀, J. Glaser (JG); Nassawango Preserve, 24 July 1989, J. Glaser, 1 ♂ (JG); 7 mi N. Pocomoke, Blades Rd., 16 June 1997, 1 ♂ (JG). MISSISSIPPI: Bolivar Co., 4.2 mi WSW Scott, 23 June 1993, D.M. Pollock, 3 ♂ (MSU). Franklin Co., 2 mi W Quentin, 19 Aug. 1982, R.L. Brown, 1 ♀ (MSU). George Co., Mixon Lakes, 12 Apr. 1996, R.L. Brown, 1 ♀ (MSU); Pascagoula Rvr. W.M.A., 9 Apr. 1994, R.L. Brown & D. Pollock, 2 ♀ (MSU). Hancock Co., M.T.F., 24 Apr. 1992, 1 ♀, 3 May 1992, 1 ♂, 15 May 1992, 1 ♂, 19 May 1992, 1 ♂, 26 May 1977, 1 ♀, 21 June 1992, 1 ♀, 25 June 1992, 1 ♂, 13 Sep. 1992, 1 ♂, R. Kergosien (BM); St. Louis Bay, 30 July 1979, 1 ♂, 1 Aug. 1979, R. Kergosien, 1 ♀ (BM). Harrison Co., Lizana, 30 June 1991, R. Kergosien, 1 ♀ (BM); Long Beach, 21 May 1992, R. Kergosien, 1 ♂ (BM); Pass Christian, 1 June 1979, R. Kergosien, 1 ♀ (BM). Jackson Co., MS Sandhill Crane N.W.R., 7 Sep. 1994, J.A. MacGown, 1 ♀ (MSU). Noxubee Co., Noxubee Wild. Ref., 14 Apr. 1993, D.M. Pollock, 1 ♂ (MSU). Oktibbeha Co., 6 mi SW Starkville, 25 Apr. 1985, 1 ♂, 17 Aug. 1974, 1 ♀, R.L & B.B. Brown, (MSU); T18W R14E Sec. 23, 19 Apr. 1992, 1 ♀, 28 May 1991, 1 ♀, 6 June 1987, 2 ♀, 7 Aug. 1987, 1 ♂, 11 Aug. 1987, 1 ♀, R.L & B.B. Brown (MSU). Sharkey Co., Delta Nat. For., 18 Aug. 1993, D.M. Pollock, 1 ♀ (MSU). Stone Co., Red River Mgt. Area, 11 May 1981, R.L. Brown, 1 ♂ (MSU). Tishomingo Co., Tish. St. Pk., 11 Apr. 1986, 1 ♂, 11–12 Apr. 1986, 1 ♂, 15 Apr. 1988, R.L. Brown, 1 ♂ (MSU). Washington Co., Greenville, Aug. 1909, Geo. Dorner, 1 ♂ (USNM). OKLAHOMA: McCurtain Co., Broken Bow, 13 June 1939, Kaiser-Nailon, 1 ♂ (USNM); Eagletown, 12 June 1939, Kaiser-Nailon, 1 ♂, 1 ♀ (USNM). NORTH CAROLINA: Brunswick Co., Greenbank Bluff, 11 Sep. 1995, 1 ♂, 18 Sep. 1995, 1 ♀, J. Bolling Sullivan, coastal plain marl outcrop, 15 W UV trap (USNM); Leland, 26 June 1939, Otto Buchholz, 1 ♀ (AMNH); Jct. St. Hwy. 101 & 181, 27 June 1977, J. Bolling Sullivan, 1 ♀ (USNM); Walker Mill Pond, 29 Apr. 1990, J. Bolling Sullivan, 1 ♂ (USNM). Craven Co., North Harlowe, 23 May 1990, 1 ♂, 27 May 1990, 1 ♀, 7 June 1990, 1 ♀, 13 June 1990, 1 ♀, 26 June 1990, 1 ♂, 8 Aug. 1990, 1 ♂, 17 Aug. 1990, 1 ♂, 29 Aug. 1990, 2 ♂, 2 Sep.



Figs. 33–36. Male genitalia. 33, *Cutina aluticolor*, genitalia. 34, *C. aluticolor*, aedoeagus. 35, *C. arcuata*, genitalia. 36, *C. arcuata*, aedoeagus. (All scale lines 1.0 mm.)

1990, 1 ♂, J. Bolling Sullivan (USNM); Pinecliff, 23 June 1978, 1 ♀, 24 July 1978, 1 ♀, J. Bolling Sullivan, (USNM). SOUTH CAROLINA: Charleston Co., McClellanville, 19 Apr. 1971, 1 ♀, 1 June 1968, 1 ♂, 15 June 1972, 1 ♀, genitalia slide USNM 57206 [green label], 26 June 1971, 1 ♀, 29 July 1971, 1 ♀, R.B. Dominick, Charles R. Edwards, (USNM); Wedge Plantation, McClellanville, 21 Apr. 1974, 1 ♂, 25 Apr. 1980, 1 ♀, 6 June 1978, 1 ♀, D.C. Ferguson (USNM); Wedge Plantation, McClellanville, South Santee River, 27 Mar. 1967, 1 ♂, genitalia slide USNM 56586 [green label], 28 Mar. 1967, 1 ♂, 29 Mar. 1967, 6 ♂, 31 Mar. 1967, 1 ♂, genitalia slide USNM 56573 [green label], 12 July 1967, 1 ♂, 15 July 1967, 1 ♂, genitalia slide USNM 56585 [green label], 20 July 1967, 1 ♂, 27 July 1967, 1 ♀, 1 Aug. 1967, 1 ♂, 17 Aug. 1967, 1 ♂, 18 Aug. 1967, 1 ♀, D.C. Ferguson (USNM). TEXAS: Harrison Co., Caddo Lake St. P., 29 Aug. 1985, E.C. Knudson, 1 ♀ (USNM). Jasper Co., Martin Dies St. Pk., 29 June 1986, 1 ♀, 17 Aug. 1985, 1 ♀, E.C. Knudson (USNM).

Montgomery Co., Camp Strake, 7 Sep. 1977, 1 ♀, 14 Sep. 1977, 1 ♀, A. & M.E. Blanchard (USNM). Tyler Co., Town Bluff Dam B, 3 Mar. 1967, 1 ♂, genitalia slide A.B. 4565 [green label], 7 Aug. 1975, 1 ♂, A. & M.E. Blanchard (USNM). VIRGINIA: Chesapeake Co., Seashore St. Pk., 1–4 June 1975, D. & M. Davis, 3 ♂ (USNM); Seashore State Park, Cape Henry, 10 June 1974, Don & Mignon Davis, 1 ♀ (USNM). Nansemond Co., L. Drummond, Dismal Swamp, 8–9 June 1974, D. & M. Davis, 1 ♀, 6–7 July 1962, 1 ♂, D.R. Davis (USNM).

Discussion.—The dark brown basal band and apical and tornal patches distinguishes this species. Specimens from Texas tend to lose this basal band, but have a distinct black antemedial line.

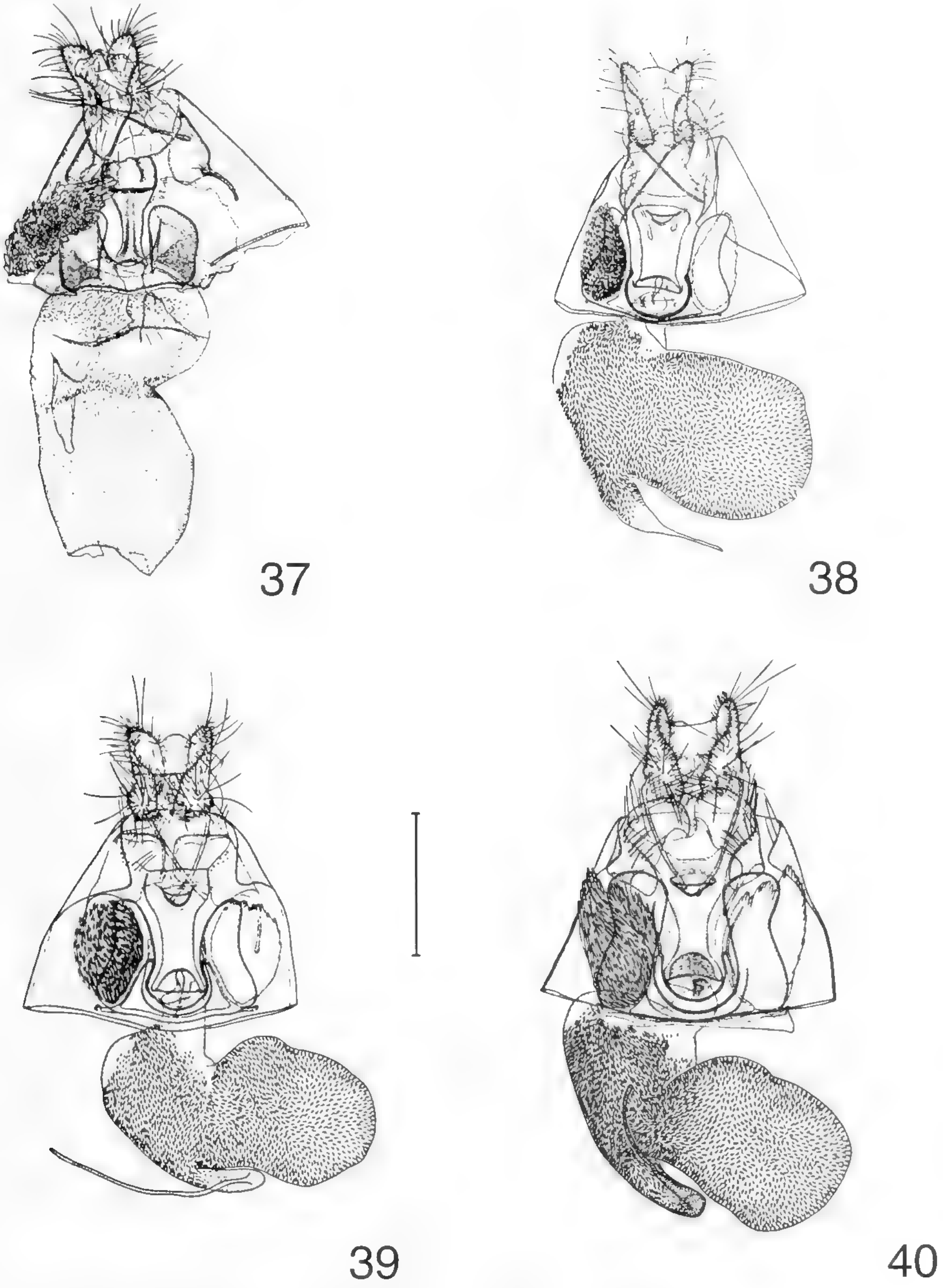
Cutina aluticolor Pogue and Ferguson, new species

(Figs. 1–3, 19–22, 33–34, 39, 43)

Diagnosis.—Forewing ground color light brown, basal line absent, postmedial band black, reduced to a tornal patch. Valve narrow, margins curved. Lobes of 8th sternite kidney-shaped; lateral margin gently curved, forming a wide obtuse angle.

Description.—*Head:* Vertex light brown. Labial palpus light brown speckled with black and white. Antennal scape light brown; scales on flagellum brown, white laterally. *Thorax:* Patagium light brown. Metanotum light brown; scale tuft absent. Tegula light brown. Venter white. Legs brown and white with white apical tibial band; 4 or fewer spines on mesotibia. Tarsi light brown with white apical band. *Forewing* (Figs. 19–22): Male length 9.8–11.2 mm. Female length 9–11.2 mm. Ground color light brown. Basal line absent. Antemedial line absent. Postmedial line black, with white scales highlighting apical fourth. Ovate patch absent. Postmedial band black, reduced to a tornal patch. *Hindwing:* Male length 7.8–8.8 mm. Female length 7–9 mm. Ground color light brown. *Abdomen:* Dorsum light brown; venter light brown. *Male genitalia* (Figs. 33–34): Uncus slender, constant width throughout length. Tegumen without lateral projections. Valve narrow, margins curved; costal projection at basal third of valve absent; ampulla equal width throughout length; harpe equal width throughout length, similar to ampulla; cucullus apex pointed. Apex of aedoeagus, truncate, with dorsal and ventral margins equal. Vesica with distal diverticula elongate, constricted medially. *Female genitalia* (Fig. 39): Sinus vaginalis lightly sclerotized, crescent-shaped caudad with caudal margin concave. Lobes of 8th sternite kidney-shaped; lateral margin gently curved, forming a wide obtuse angle. Signa long on entire corpus bursae.

Type material.—Holotype ♂ with following 4 labels: "Univ. of Florida Preserve, Welaka, Putnam Co., Fla. March 22, 1987/ D.C. Ferguson, Collector/USNM ENT 00059550 [bar code label]/HOLOTYPE USNM 105501, *Cutina aluticolor,* Pogue and Ferguson [Red label]." Deposited in the USNM. Paratypes: 148 ♂, 140 ♀. FLORIDA: Flagler Co., Crescent Lake, Shell Bluff Landing, 5 Apr. 1989, H.D. Baggett, 1 ♀ (USNM). Hillsborough Co., Tampa, 22 Apr. 1982, 1 ♀, 28 Apr. 1984, 1 ♀, 14 June 1981, 1 ♂, 1 ♀, H.D. Baggett (USNM); Tampa, USF Golf Crse., 4 May 1981, 1 ♀, 9 June 1981, 2 ♀, H.D. Baggett, bait trail (FSCA). Liberty Co., Torreya State Park, 21 May 1982, 1 ♀, 4 July 1986, 1 ♀, H.D. Baggett, (USNM). Putnam Co., 2 mi SW Satsuma, 18 June 1968, J.A. Concello, 1 ♂, 1 ♀, ♀ genitalia slide USNM 56577 [green label]; Palatka, 8 Feb. 1989, 1 ♂, 24 May 1990, 1 ♂, H.D. Baggett (USNM); Univ. of Florida Preserve, Welaka, 21 Mar. 1987, 9 ♂, 1 ♀, ♂ genitalia slide USNM 57207 [green label], 22 Mar. 1987, 7 ♂, 1 ♀, 23 Mar. 1987, 2 ♂, 25 Mar. 1987, 5 ♂, 7 ♀, ♂ genitalia slide USNM 57208, ♀ genitalia slide USNM 57209 [green labels], 26 Mar. 1987, 14 ♂, 2 ♀, 19 Sep. 1987, 1 ♀ (USNM). INDIANA: Posey Co., Gray Estates, 30 June 1995, Enz & Covell, 1 ♀ (ULK); Goose Pond Sl., 22



Figs. 37–40. Female genitalia. 37, *Cutina albopunctella*. 38, *C. distincta*. 39, *C. aluticolor*. 40, *C. arcuata*. (All scale lines 1.0 mm.)

Aug. 1995, 1 ♀, 30 June 1995, 4 ♂, Enz & Covell (ULK); Twin Swamps, 30 June 1995, 1 ♀, 22 Aug. 1995, 2 ♂, 2 ♀, Enz & Covell (ULK). LOUISIANA: Ascencion Par., Prairieville, 24 Mar. 1978, 1 ♀, 15 Apr, 1978, 1 ♀, Vernon A. Brou (VAB). Bossier Par., Barksdale A.F.B.,11 Apr. 1996, 1 ♂, 11 July 1996, 1 ♀, D.M. Pollock, (MSU). Calcasieu Par., S.H. Jones St. Pk., 19–23 May 1993, R.L. Brown & D.M. Pollock, 15 ♂, 31 ♀, J.A. McGown, 2 ♂, 1 ♀, 20–21 May 1993, R.L. Brown & D.M. Pollock, 1 ♀(MSU). St. Charles Par., Hahnville, 3 July 1978, V.A. Brou, 1 ♀ (VAB). St. John the Baptist Par., Edgard, 13 Mar. 1980, 1 ♀, 6 May 1983, 1 ♂, 20 May 1981, 1 ♂, 26 June 1982, 1 ♀, 15 Aug. 1983, 1 ♂, 18 Aug. 1983, 1 ♂, V.A. Brou, UV light trap (VAB). **MISSISSIPPI:** Bolivar Co., 4.2 mi WSW Scott, 23 June 1993, D.M. Pollock, 1 ♀ (MSU). George Co., Mixon Lakes, 8–9 Apr. 1994, 1 ♂, R.L. Brown & D. Pollock, 12 Apr. 1996, R.L. Brown, 2 ♀ (MSU). Hancock Co., M.T.F., 13 Mar. 1992, 2 ♂, 28 Mar. 1992, 2 ♂, 1 ♀, 25 May 1992, 1 ♂, 28 May 1977, 1 ♂, 21 June 1992, 1 ♂, 18 July 1992, 1 ♀, 9 Aug. 1991, 7 ♂, 13 ♀, 13 Sep. 1991, 1 ♂, R. Kergosien, (BM); 2 mi N Pearlington, T9S, R16W, Sec. 6, 23 July 1989, T.L. Schiefer, 1 ♀ (MSU). Pearl River Co., 3 mi east Bogalusa, 17 Aug. 1991, R. Kergosien, 2 ♂, 1 ♀ (BM). Noxubee Co., Noxubee N.W. Refuge, 14 Apr. 1993, D.M. Pollock, 2 ♂, 3 ♀ (MSU). Oktibbeha Co., 6 mi W. Starkville, 15 Apr. 1986, R.L & B.B. Brown, 1 ♂ (MSU). Tishomingo Co., Tish. St. Pk., 11 Apr. 1986, R.L. Brown, 1 ♂ (MSU). **MISSOURI:** Stoddard Co., Otter Slough Wildlife Area, 25 Aug. 1983, J.R. Heitzman, Cypress-Tupelo Swamp with associated southeastern forest, coll. at blacklight 1 ♂, 2 ♀ (JRH). Wayne Co., Markham Springs Nat. For. Cmpg., 7 June 1984, 2 ♂, 21 July 1984, 1 ♂, 2 ♀, J.R. Heitzman, Cane, Cypress, Tupelo, pine & deciduous forest, coll. at blacklight (JRH). **NORTH CAROLINA:** Brunswick Co., Greenbank Bluff, 11 Sep. 1995, J. Bolling Sullivan, CP marl outcrop, 1 ♂ (USNM). Carteret Co., Walker Mill Pond, 30 May 1990, J. Bolling Sullivan, 1 ♂ (USNM); Pinecliff, 26 July 1978, J. Bolling Sullivan, 3 ♀ (USNM). Craven Co., North Harlowe, 20 Mar. 1990, 2 ♂, 1 ♀, 28 Mar. 1990, 2 ♂, 31 Mar. 1990, 3 ♂, 21 Apr. 1990, 1 ♂, 21 Apr. 1991, 3 ♂, 1 ♀, 25 Apr. 1990, 1 ♂, 2 ♀, 28 Apr. 1990, 1 ♂, 1 ♀, 1 May 1990, 1 ♂, 9 May 1990, 1 ♀, 13 May 1990, 1 ♂, 26 May 1990, 1 ♀, 3 June 1990, 4 ♂, 1 ♀, 7 June 1990, 1 ♂, 8 June 1990, 2 ♀, 13 June 1990, 3 ♀, 15 June 1990, 2 ♂, 5 ♀, 21 June 1990, 1 ♂, 1 ♀, 23 June 1990, 2 ♀, 30 June 1990, 1 ♀, 14 July 1990, 2 ♀, 18 July 1990, 1 ♀, 21 July 1990, 4 ♀, 31 July 1990, 3 ♀, 10 Aug. 1990, 1 ♀, 14 Aug. 1990, 1 ♀, 15 Aug. 1990, 1 ♀, 17 Aug. 1990, 2 ♂, 18 Aug. 1990, 1 ♂, 21 Aug. 1990, 2 ♂, 2 ♀, 29 Aug. 1990, 2 ♀, 2 Sep. 1990, 2 ♂, J. Bolling Sullivan (USNM); Pinecliff, 23 June 1978, 1 ♀, 13 July 1978, 1 ♂, 12 Aug. 1978, 3 ♀, J. Bolling Sullivan (USNM). New Hanover Co., Smith Creek, Wilmington, 30 Apr. 1994, 1 ♂, 15 June 1990, 1 ♂, 17 June 1990, 1 ♂, 22 June 1990, 1 ♂, 18 July 1994, 2 ♂, 24 July 1990, 3 ♂, 17 Aug. 1990, 2 ♂, 28 Aug. 1990, 2 ♂, 2 ♀, J. Bolling Sullivan, Richard Broadwell, & Brad Smith (USNM). Pender Co., Holly Shelter Gamelands, 18 July 1995, J. Bolling Sullivan, 1 ♂ (USNM). **SOUTH CAROLINA:** Charleston Co., McClellanville, 13 July 1970, R.B. Dominick, Charles R. Edwards, 1 ♂ (USNM); Wedge Plantation, South Santee River, 27 Mar. 1967, 1 ♂, 29 Mar. 1967, 2 ♂, 2 ♂ genitalia slides USNM 56583, 56575 [green labels], 31 Mar. 1967, 1 ♂, D.C. Ferguson (USNM); **TEXAS:** Jasper Co., Martin Dies St. Pk., 29 June 1986, E.C. Knudson, 2 ♂ (USNM). **VIRGINIA:** Nansemond Co., L. Drummond, Dismal Swamp, 6–7 July 1962, O.S. Flint, Jr., 1 ♂ (USNM).

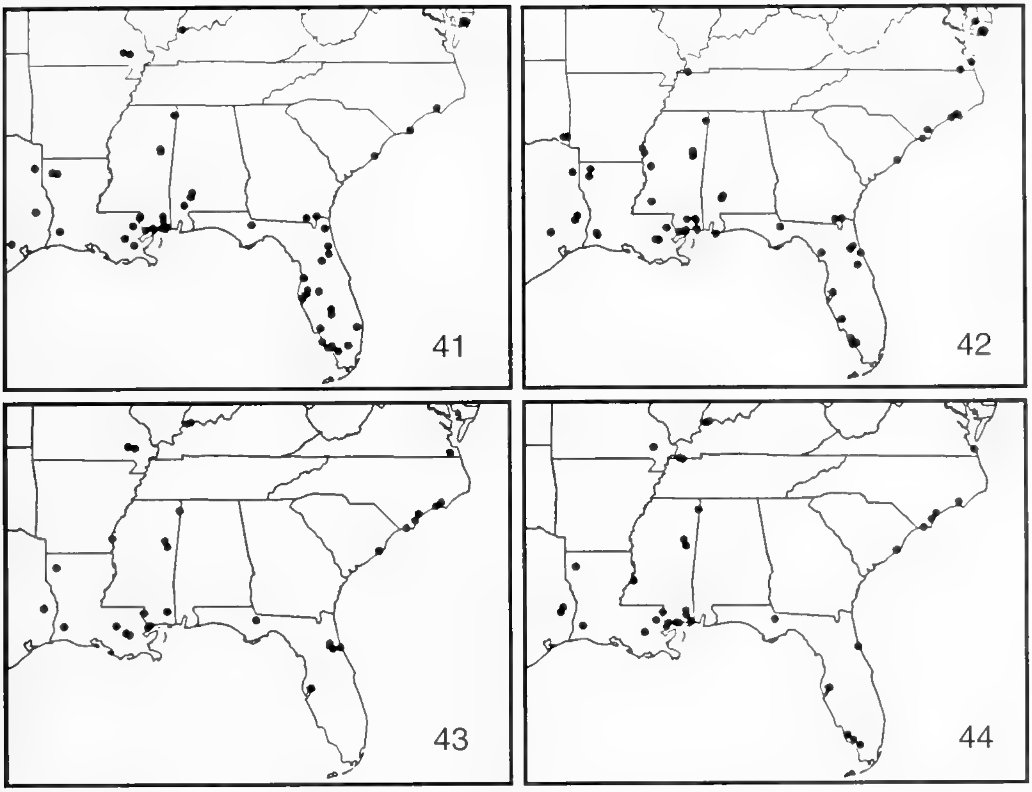
Host.—Unknown, probably Cypress (*Taxodium* sp.).

Immature stages.—Unknown.

Flight period.—Records from mid-February and March through September.

Distribution (Fig. 43).—From west central to northeastern Florida, South Carolina, and North Carolina. Mississippi, Louisiana, eastern Texas, north to southeastern Missouri and southwestern Indiana.

Discussion.—Specimens from Florida tend to have a lighter ground color, more distinct pattern, and a tornal patch. Speci-



Figs. 41–44. *Cutina* distribution. 41, *C. albopunctella*. 42, *C. distincta*. 43, *C. aluticolor*. 44, *C. arcuata*.

mens from outside Florida are darker, with a less distinct pattern and no tornal patch. The best character to distinguish *C. aluticolor* is the white highlighting at the apex of the postmedial line.

Etymology.—The specific name refers to the Latin terms *aluta* meaning leather and *color,* referring to the brown leather-colored forewing ground color.

Cutina arcuata Pogue and Ferguson, new species

(Figs. 23–28, 35–36, 40, 44)

Diagnosis.—Forewing ground color brown, basal line black, indistinct, antemedial line white and black. Postmedial line black and white, produced subapically, postmedial band irregular, mostly black mixed with brown and white. Valve narrow, margins abruptly angulate at ⅔ length. Lobes of 8th sternite kidney-shaped; lateral margin abruptly curved forming a narrow obtuse angle.

Description.—*Head:* Vertex a mixture of white and light brown. Labial palpus light brown speckled with black and white. Antennal scape white and brown; scales on flagellum brown, white laterally. *Thorax:* Patagium light brown. Metanotum brown with some white scales; scale tuft present. Tegula a variable mixture of white, brown, and black scales. Venter white. Legs brown and white with white apical tibial band; 4 or fewer spines on mesotibia. Tarsi light brown with white apical band. *Forewing* (Figs. 23–28): Male length 9.4–10.6 mm. Female length 9.6–10.6 mm. Ground color brown. Basal line black, indistinct. Antemedial line white and black. Postmedial line black and white, produced subapically. Ovate patch absent. Postmedial band irregular, mostly black mixed with brown and white. *Hindwing:* Male length 7.2–8.2 mm. Female length 7.6–8.2 mm. Ground color light brown. *Abdomen:* Dorsum a mixture of brown and black scales with a white posterior margin; venter brown. *Male genitalia* (Figs. 35–36): Uncus slender, constant width throughout length. Tegumen without lateral projections. Valve narrow, margins abruptly angulate at ⅔ length; costal projection at basal third of valve absent; ampulla equal width throughout length; harpe equal width throughout length, similar to ampulla; cucullus pointed. Apex of aedoeagus, truncate, with dorsal and ventral margins equal. Vesica with distal diverticula, tapered from base to apex. *Female genitalia* (Fig. 40): Sinus vaginalis lightly sclerotized, crescent-shaped caudad with caudal margin concave. Lobes of 8th sternite kidney-shaped; lateral margin abruptly curved forming a narrow obtuse angle. Signa long on entire corpus bursae.

Type material.—Holotype ♂ with following 3 labels: "Wedge Plantation, South Santee River, Charleston Co., S.C. March 28, 1967 Douglas C. Ferguson/USNM ENT 00059837 [bar code label]/HOLOTYPE USNM 105502, *Cutina arcuata,* Pogue and Ferguson [Red label]." Deposited in the USNM. Paratypes: 157 ♂ , 76 ♀. FLORIDA: Collier Co., Big Cypress Swamp Natl. Pres., 5 mi S of US Hwy 41, 20 March 1997, M.G. Pogue, 1 ♂, 2 ♀ (USNM); Fakahatchee Strand, Big Cypress Swamp, 24 Feb. 1985, D.C. Ferguson, 15 ♂, 2 ♂ genitalia slides USNM 56803, 57202 [green labels] (USNM); Fakahatchee Strand Preserve, 3.4 mi NW of Copeland, 17 March 1997, M.G. Pogue, 1 ♂, 1 ♀ (USNM). Lee Co., Six Mile Cypress Slough, 15 Mar. 1997, M.G. Pogue, 1 ♂, 3 ♀ (USNM). Hillsborough Co., Tampa, 22 Apr. 1982,1 ♀, 14 June 1981, 1 ♀, H.D. Baggett, (FSCA); Tampa, USF Golf Crse., 4 May 1981, 1 ♀, 9 June 1981, 1 ♀, bait trail, H.D. Baggett (FSCA). Liberty Co., Torreya State Park, 20 June 1987, T.L. Schiefer, 1 ♀ (MSU). Putnam Co., Univ. Of Florida Preserve, Welaka, 21 Mar. 1987, 2 ♂, 22 Mar. 1987, 2 ♂, 2 ♀, ♂ genitalia slide USNM 57204 [green label], 2 ♀, 25 Mar. 1987, 9 ♂, 6 ♀, 26 Mar. 1987, 13 ♂, D.C. Ferguson (USNM); University Reserve, Welaka, 7 Apr. 1972, 1 ♀, D.C. Ferguson (USNM); University Conservation Reserve, Welaka, 23 Mar. 1987, D.C. Ferguson, 5 ♂, 1 ♀ (USNM). INDIANA: Posey Co., Goose Pond Sl., 30 June 1995, 5 ♂, 2 ♀, 22 Aug. 1995, 5 ♂, 1 ♀, Enz & Covell (ULK); Twin Swamps, 22 Aug. 1995, 4 ♂, 2 ♀, 1 Oct. 1995, 1 ♂, Enz & Covell. KENTUCKY: Fulton Co., Reelfoot Wlfe. Area, 12 May 1984, C.V. Covell, Jr., 2 ♂ (USNM); Rt. 94, 2.5 mi E Cayce, 3 Aug. 1986, C.V. Covell, Jr., 1 ♀ (USNM). LOUISIANA: Bossier Par., Barksdale A.F.B., 17 Apr. 1996, 1 ♂, 24 Aug. 1994, 1 ♂, D.M. Pollock (MSU). Calcasieu Par., S.H. Jones St. Pk., 19–23 May 1993, R.L. Brown & D.M. Pollock, 18 ♂, 6 ♀ (MSU). St. John the Baptist Par., Edgard, 9 May 1979, 1 ♂, 9 June 1983, 1 ♀, 24 July 1977, 1 ♂, V.A. Brou (VAB). St. Charles Par., Bonnet Carre Spillway, 9 Aug. 1971, 3 ♀, E.H. Metzler (EHM). St. Tammany Par., 4.2 mi NE Abita Springs, sec. 24, T6S, R12E, 13 Apr. 1984, V.A. Brou, 1 ♂ (VAB). MISSISSIPPI: Bolivar Co., 4.2 mi WSW Scott, 12–13 May 1993, D.M. Pollock, 1 ♂ (MSU). Claiborne Co., 3.6 mi W Port Gibson, 12 July 1993, D.M. Pollock, 2 ♀ (MSU). George Co., Mixon Lakes, 12 Apr. 1996, R.L. Brown, 1 ♂ (MSU). Hancock Co., Diamondhead, 5 Apr. 1991, R. Kergosien, 1 ♀ (BM); M.T.F., 17 Mar. 1992, 1 ♂, 19 Mar. 1992, 1 ♂, 1 ♀, 28 Mar. 1992, 1 ♂, 7 Apr. 1992, 1 ♀, 15 Apr. 1992, 1 ♂, 15 May 1992, 1 ♂, 19 May 1992, 1 ♂, 29 June 1973, 1 ♂, 11 July 1992, 1 ♀, 18 July 1992, 1 ♀, 9 Aug. 1991, 3 ♂, 5 ♀, R. Kergosien (BM); 2 mi N Pearlington, T9S, R16W, Sec. 6, 23 July 1989, T.L. Schiefer, 2 ♂ (MSU). Harrison Co., Hansboro, 7 Apr. 1967, Bryant Mather, 1 ♂ (BM); I-10 exit 24, 6 Apr. 1992, R. Kergosien, 1 ♂ (BM); Lizana, 29 June 1991, R. Kergosien, 1 ♂ (BM). Jackson, Co., Blk. Cr., nr. George-Jacoline, 1 Aug. 1991, R. Kergosien, 1 ♂ (BM); I-10 at Escatawpa

River, 13 Apr. 1991, R.L. Brown, 1 ♂, 1 ♀ (MSU). Noxubee Co., Noxubee N.W. Refuge, 14 Apr. 1993, D.M. Pollock, 11 ♂(MSU). Oktibbeha Co., 6 mi SW Starkville, 21 July 1986, R.L. & B.B. Brown, 2 ♀ (MSU). Pearl River Co., 3 mi east Bogalusa, 17 Aug. 1991, R. Kergosien, 2 ♂ (BM). Tishomingo Co., Tish. St. Pk., 11 Apr. 1986, R.L. Brown, 1 ♀, 11–12 Apr. 1986, J.R. MacDonald, 1 ♂ (MSU). **MISSOURI:** Stoddard Co., Otter Slough Wildlife Area, 4 July 1982, 1 ♀, 25 Aug. 1983, 1 ♂, 1 ♀, J.R. Heitzman (JRH). **NORTH CAROLINA:** Brunswick Co., Greenbank Bluff, 16 Apr. 1995, 2 ♂, 28 Aug. 1995, 1 ♂, J. Bolling Sullivan, coastal plain marl outcrop (USNM). Craven Co., North Harlowe, 28 Mar. 1990, 1 ♂, 13 Apr. 1990, 1 ♂, 3 June 1990, 1 ♂, 21 Aug. 1990, 1 ♀, J. Bolling Sullivan (USNM); Pinecliff, 23 June 1978, J. Bolling Sullivan, 1 ♂ (USNM). New Hanover Co., Smith Creek, Wilmington, 15 June 1994, 1 ♂, 18 June 1994, 1 ♂, 17 July 1994, 2 ♂, 3 ♀, 31 July 1994, 1 ♂, J. Bolling Sullivan, Richard Broadwell, & Brad Smith (USNM). Pender Co., Holly Shelter gamelands, 23 May 1995, 1 ♂, cypress-gum swamp on Cape Fear,18 July 1995, 1 ♂, swamp hardwoods, J. Bolling Sullivan, 15 W UV trap (USNM). **SOUTH CAROLINA:** Charleston Co., Wedge Plantation, McClellanville, 21 Apr. 1974, 1 ♂, 1 ♀, ♂ genitalia slide USNM 56587 [green label], 1 ♀, 4 June 1978, 1 ♀, 5 June 1978, 1 ♀, D.C. Ferguson (USNM); Wedge Plantation, South Santee River, 27 Mar. 1967, 2 ♂, 28 Mar. 1967, 5 ♂, 29 Mar. 1967, 5 ♂, 2 ♀, 31 Mar. 1967, 2 ♂, 5 Aug. 1968, 1 ♀, D.C. Ferguson (USNM); Wedge Plantation, South Santee River, 12 July 1967, 1 ♀, 2 Aug. 1967, 1 ♀, 3 Aug. 1967, 1 ♀, 23 Aug. 1967, 1 ♂, James W. Porter (USNM). Dorchester Co., Saint George, 23 June 1996, V.S.A. Albu, 1 ♀ (VSA). **TEXAS:** Jasper Co., Martin Dies St. Pk., 29 June 1986, E.C. Knudson, 3 ♀ (USNM). Tyler Co., Town Bluff Dam B, 7 Aug. 1975, A. & M.E. Blanchard, ♂ genitalia slide A.B. 4566 (USNM). **VIRGINIA:** Chesapeake Co., Seashore St. Pk., 1–4 June 1975, D. & M. Davis, 4 ♂, 1 ♀ (USNM).

Host.—Unknown, probably cypress (*Taxodium* sp.). The series from the type locality was collected in a trap in a small, isolated stand of cypress on the University of Florida Conservation Reserve. None were taken at other sites in the Reserve where cypress was absent.

Immature stages.—Unknown.

Flight period.—Records from the end of February and March through August.

Distribution (Fig. 44).—From southwest and northeast Florida and eastern South Carolina, North Carolina, and southeastern Virginia. Mississippi, Louisiana, and eastern Texas, north to southeastern Missouri, and southwestern Kentucky and Indiana.

Discussion.—Specimens from peninsular Florida have gray scales in the postmedial area of the forewing resulting in a pale apical area and longitudinal streaks (Figs. 26–28). Also, this Florida form tends to have a narrower median space, i.e. the antemedian and postmedian lines are closer together than in specimens from elsewhere. The male genitalia is most similar to that of *Cutina aluticolor,* but valve has an abrupt angle at ⅔ its length.

Etymology.—The specific name refers to the produced postmedial line and is Latin.

PHYLOGENY

A phylogenetic analysis was undertaken to determine the relationships between the species of *Cutina. Cutina* is monophyletic based on the following synapomorphies: 1) 8th sternite of the female with kidney-shaped lobes and 2) associated scale patches dorsad to lobes.

Character coding.—Outgroup comparison was used to determine polarity of binary characters, the outgroup having the plesiomorphic character state. Multistate characters were polarized using Morphocline Analysis (Maslin 1952).

Methods.—Hennig86 (Farris 1988) analyzed the data and constructed trees using

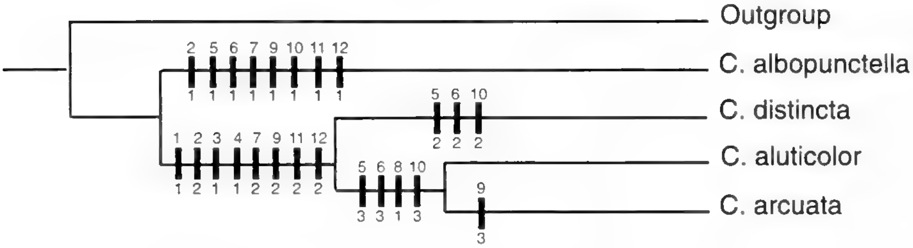


Fig. 45. Cladogram of the species of *Cutina*. Synapomorphies refer to solid black rectangles. Character numbers are on top and state numbers are on bottom of rectangles.

the most parsimonious Wagner trees method. The implicit enumeration command (ie*), plus branch swapping (bb*), was used to generate the trees. This command uses an exact algorithm and retains all trees produced resulting in the most parsimonious trees.

Outgroup.—*Focillidia* was used as the outgroup as it shares the same angulate outer margin of the forewing with *Cutina*. The uncus shape in *Focillidia* is similar to the diamond-shaped apex in *C. albopunctella*; as are the lateral projections on the tegumen, only smaller. *Focillidia* includes 3 species, *F. texana* Hampson, a southern species that occurs in Florida, Texas, and Arizona; *F. grenadensis* Hampson, an Antillean species; and *F. bipunctata* (Walker) a Central and South American species. *F. texana* and *bipunctata* were sampled for characters used in the phylogenetic analysis.

CHARACTERS

Characters of the male and female genitalia were used almost exclusively, as these show the best relationships between taxa. Twelve characters were used, 3 binary and 9 multistate; derived from 8 ♂, 3 ♀, and 1 leg character. The character matrix is shown in Table 1.

Leg.—*Character 1.* Number of spines on mesotibia: 0) 6–9 (Fig. 4), 1) 4 or fewer (Fig. 3).

Male genitalia.—*Character 2.* Uncus shape: 0) wide, diamond-shaped, 1) subapical diamond-shaped expansion (Fig. 29); 2) slender, constant width throughout length (Figs. 31, 33, 35). *Character 3.* Lateral projections on tegumen: 0) present; 1) absent; (Fig. 29). *Character 4.* Costal projection of valve: 0) present at basal third, 1) absent at basal third (Fig. 29). *Character 5.* Ampulla shape: 0) elongate, truncate projection; 1) a swollen knob (Fig. 29); 2) as wide as base of valve, apex produced (Fig. 31); 3) equal width throughout length (Fig. 33). *Character 6.* Harpe shape: 0) asymmetrical, right side with wide serrate apex, left side with a narrow rounded apex; 1) a swollen knob, smaller than ampulla (Fig. 29); 2) widest at base, angled toward costa at mid-length, narrower than ampulla (Fig. 31); 3) equal width throughout length, similar to ampulla (Fig. 33). *Character 7.* Cucullus apex shape: 0) asymmetrical, right side rounded with minute costal projection, left side rounded with elongate costal projection; 1) rounded (Fig. 29); 2) pointed (Fig. 31). *Character 8.* Apex of aedoeagus: 0) pointed, with dorsal margin projecting beyond ventral margin into vesica (Fig. 29); 1) truncate, with dorsal and ventral margins equal (Fig. 33). *Character 9.* Vesica shape: 0) single, bulbous; 1) distal diverticula enlarged, bulbous (Fig. 30); 2) distal diverticula elongate, constricted medially (Fig. 32); 3) distal diverticula, tapered from base to apex (Fig. 36).

Female genitalia.—*Character 10.* Sinus vaginalis shape: 0) a deeply invaginated groove; 1) well scelrotized laterally and ventrally, rectangular-shaped caudally (Fig. 37); 2) lightly sclerotized, half-circle

Table 1. Character matrix used in the phylogenetic analysis of *Cutina*.

Taxa	Characters											
	1	2	3	4	5	6	7	8	9	10	11	12
Outgroup	0	0	0	0	0	0	0	0	0	0	0	0
C. albopunctella	0	1	0	0	1	1	1	0	1	1	1	1
C. distincta	1	2	1	1	2	2	2	0	2	2	2	2
C. aluticolor	1	2	1	1	3	3	2	1	2	3	2	2
C. arcuata	1	2	1	1	3	3	2	1	3	3	2	2

shaped caudad (Fig. 38), 3) lightly sclerotized, crescent-shaped caudally (Fig. 39). *Character 11.* 8th sternite shape: 0) a half circle-shaped flap; 1) paired trapezoidal projections (Fig. 37); 2) paired kidney-shaped projections (Fig. 38). *Character 12.* Signa form: 0) spicules short and thick; 1) longer on anterior half of corpus bursae than posterior half (Fig. 37); 2) long on entire corpus bursae (Fig. 38).

RESULTS

All binary characters were coded as plesiomorphic in the outgroup. All multistate characters were coded using morphocline analysis. This resulted in a fully resolved tree with a length of 24, a C.I. of 100, and a R.I. of 100 (Fig. 45).

DISCUSSION

Cutina albopunctella is the basal taxon to all other species of *Cutina*. The similar shape of the uncus apex is most closely related to the overall uncus shape of the outgroup. The lateral projections on the tegumen are shared with the outgroup. Monophyly of the remaining species is established by eight character states (1, 2(2), 3, 4, 7(2), 9(2), 11(2), 12(2)). The clade of *C. aluticolor* + *C. arcuata* is defined by four character states (5(3), 6(3), 8, 10(3)). *C. arcuata* is defined by character 9(3).

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ON THE STRUCTURE AND FUNCTION OF THE FEMALE GENITALIA IN FLEA BEETLES (COLEOPTERA: CHRYSOMELIDAE: ALTICINAE)

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Abstract.—Structure, terminology and possible homology of female genitalia in flea beetles (Alticinae) are discussed. The relative position of the male and female genitalia was examined in a pair of *Aphthona formosana* Chen preserved in copulation. It is speculated that the vaginal palpi of the female genitalia and the median lobe of the male genitalia function together during copulation as an "internal courtship device" to regulate sperm transfer and egg fertilization.

Key Words: Female genitalia, homology, function, Alticinae

The earliest documented observations on beetle genitalic structures are by Foudras (1859, 1860). That predates the claim of Nichols (1986) for Thomson (1875) by nearly 15 years. In the introduction to his famous "Alticides" Foudras (1859) admitted the usefulness of the "aedeagus" for species differentiation and further (Foudras 1860) provided diagnostic characters for many European species. Baly (1879) and Weise (1886, 1889a, b) discussed the taxonomic importance of the median lobe in several genera of Cryptocephalinae, Chrysomelinae, Donaciinae and Clytrinae. Early in this century, male genitalia (median lobe of the aedeagus in particular) were employed for species differentiation in flea beetles by Heikertinger (1911, 1913, 1921, 1925) and the median lobe has been illustrated in many descriptions of Palearctic species published subsequently, especially for such large genera as *Altica* Geoffroy, *Aphthona* Chevrolat, and *Longitarsus* Latreille.

The first attempt to describe female genitalia (mostly the spermatheca) was by Spett and Lewitt (1925). Later Spett and Lewitt (1926) described the spermathecae of 63 species of Alticinae from 15 Palearctic genera. However, only since the 1960s has the spermatheca become a popular source of species level characters in flea beetles (Samuelson 1966, Berti and Rapilly 1973, 1977, Leonardi 1970, 1975). A comprehensive review of research on alticine spermathecae was published by Döberl (1986). The other structures of the female genitalia received much less attention (Suzuki 1982, 1983, 1988). To my knowledge Lyubishchev (1959, 1969) and Kevan (1962) were the first to use vaginal palpi for discrimination of species in the genus *Altica*. Several new characters in the shape, proportions and degree of sclerotization of the vaginal palpi (= styli in Konstantinov 1987, 1994) as well as intraspecific variability have been found more recently in this genus (Konstantinov 1987). Kangas and Rutanen (1993) confirmed these characters for Finnish species of *Altica*. Since these publications, illustrations of the vaginal palpi usually have accompanied redescriptions of *Altica* species (Doguet 1994, LeSage 1995). There was a single attempt to review the female genitalia of the Palearctic genera (Konstantinov 1994). Aside from *Altica* (Lyubishchev 1959, 1969, Kevan 1962, Konstantinov 1987, Kangas and Rutanen 1993, Doguet 1994, LeSage 1995), *Crepidodera* Chevrolat (Konstantinov 1996), *Aphthona* (Konstantinov and Vandenberg 1996), *Bellaltica* Reid (Reid 1988), *Pedilia* Clark (Duckett 1995) and *Homichloda* Weise (Cox 1997) almost nothing has been published about these structures in other flea beetle genera.

Despite a demonstrated usefulness of female genitalia for species identification and derivation of relationships of flea beetles, they are much less known than male genitalia. Homology, terminology and functions of their structures remain obscure.

METHODS

Techniques for dissecting and studying female genitalia are simple and have been well documented (Tanner 1927, Döberl 1986, Duckett 1995). In these and the present study, beetle abdomens were treated with hot 10 % KOH, then washed in water and dissected. The genitalia were transferred to a mixture of water and glycerin (which prevents collapse of the spermatheca and vaginal palpi). A second method involves everting the entire genital apparatus without dissecting the abdomen, however this method is not recommended as the process puts structures in artificial conditions changing their relative position, and preservation of the natural position of the structures is essential for their recognition, naming and comparison.

A male and female of *Aphthona formosana* Chen preserved *in copula* with the internal sack inflated were studied to determine the approximate position of the median lobe of the male and sclerotized structures of the female genitalia during the last phases of copulation and permit some speculation on the functions of some parts of the female genitalia.

STRUCTURE OF THE FEMALE GENITALIA IN FLEA BEETLES

The chitinized structures of the female genitalia (Fig. 1) are situated in the abdomen and covered by the strongly sclerotized 7th tergite and sternite. As in all other leaf beetles, the ventral side of the abdomen consists of 5 visible sternites. The first true sternite is reduced and the first visible sternite is composed of the second and third true sternites. The dorsal side of the abdomen consists of 7 visible tergites. The vagina is formed by invagination of the body surface and its opening (vulva) is situated between the 9th tergite and 8th sternite. The sclerotized structures of the female genitalia are derivatives of the 8th and 9th abdominal segments, but their homology and terminology is poorly known (Lindroth 1957, Teotia 1958, Konstantinov 1994). The 8th and 9th sclerites lie telescoped within the 7th segment. The 8th tergite is situated under the 7th, and the 9th tergite is situated under the 8th. They have preserved the plate shape, and are easily recognizable. The 8th and 9th tergites are connected with each other by membranes which join the distal margin of the upper sclerite with the proximal margin of the lower sclerite.

The sternites are highly modified. The 8th sternite is represented by a weakly sclerotized plate lying above the 7th sternite, usually with a well developed, strongly sclerotized, narrow projection called a tignum (Kevan 1962, Konstantinov 1994, Konstantinov and Vandenberg 1996), spiculum gastrale (Kasap and Crowson 1985, Crowson and Crowson 1996), spiculum (Reid 1988) or long apodeme (Teotia 1958). All these terms are synonyms and their usage does not create contradictory hypotheses of homology between the structures.

The paired vaginal palpi are elongate, partly sclerotized structures with several long setae on the apex and a cavity inside, contained within the vagina and attached to the inner wall of its dorsal surface. They extend posteriorly along the dorsal side of

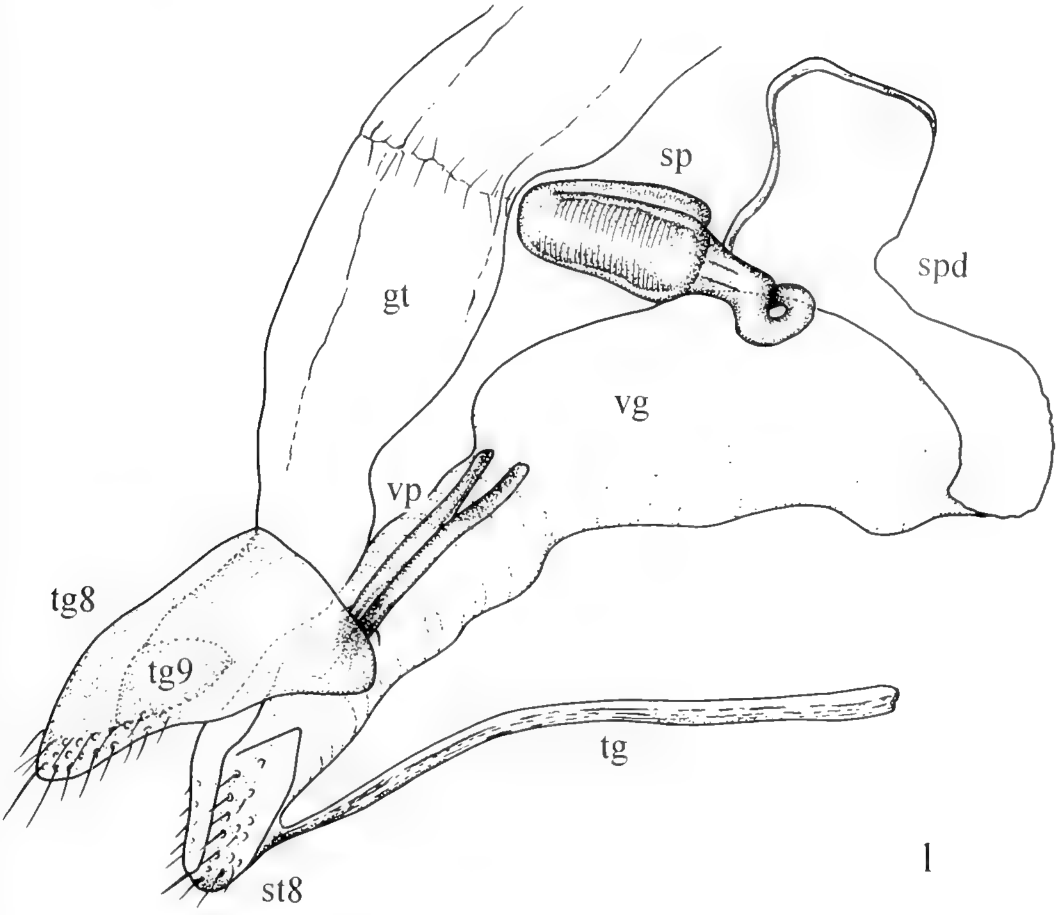


Fig. 1. Female genitalia of *Altica tamaricis* (lateral view). Abbreviations: gt = gut; sp = spermatheca; spd = spermathecal duct; st8 = 8th sternite; tg = tignum; tg8 = 8th tergite; tg9 = 9th tergite; vg = vagina; vp = vaginal palpi.

the vagina, terminating below the basal part of the 9th tergite. The apical part of the palpus is circularly sclerotized; basally the sclerotization continues on the dorsal side as a narrow stripe along the medial side. The ventral side of the palpus is usually membranous near the middle and forms a sclerotized plate basally. Unfortunately nothing is known about the origin of the vaginal palpi. It is unlikely that they represent a modified 9th sternite, as I proposed previously (Konstantinov 1994) because of the position of the vaginal palpi on the dorsal wall of the vagina.

Many terms have been applied to vaginal palpi: gonocoxa (Duckett 1995), hemisternite (Reid 1988), ovipositor (Crowson and Crowson 1996), styli (Konstantinov 1987, 1994), vaginal palps (Kasap and Crowson 1985, Konstantinov and Vandenberg 1996), and unjointed coxites (Teotia 1958). The term gonocoxa is used in various meanings, but more preferably as a coxite of gonopods (Tuxen 1956). Hemisternites are primarily defined as 2 sclerites of the 9th sternite (Tuxen 1956, Lindroth 1957) surrounding the gonopore. The term ovipositor does not imply any homology but determines the function of the structure. Styli are the distal part of the gonopods, movably attached to basal segment of the gonopods (coxites) or to abdominal sterna (Tuxen 1956), usually divided into 2 articulated joints (Lindroth 1957). Coxites are the basal parts of the appendages of the 9th (rarely 8th) genital segment carrying styli (Tuxen 1956). The application of these terms to the vaginal palpi would consider them as: 1) sclerites attached to the 9th sternite; 2) basal part of the appendages of the 9th genital segment (either tergite or sternite) carrying styli; 3) styli themselves, which are the apical part of the aforementioned appendage; 4) the whole appendage attached to the 9th tergite.

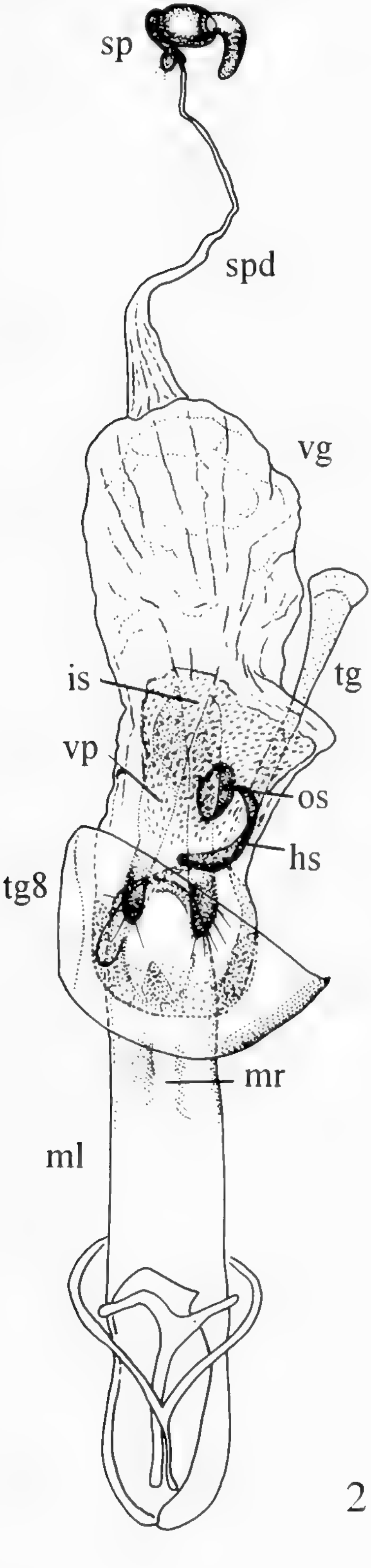
The structure of the female genitalia in Alticinae is extremely different from that in other families of beetles (Bils 1976, Burmeister 1976, 1980, Jablokoff-Khnzorian 1974, Mickoleit 1973). It is also different from that in other leaf beetle subfamilies. Donaciinae have well developed paraprocts with attached setose structures that can be interpreted as coxites (Askevold 1988). In Sagrinae the paraprocts contain coxites with attached styli (Mann and Crowson 1989). The female genitalia of Chrysomelinae (Konstantinov and Rusakov 1993) lack the 9th tergite and are extremely diverse: ranging from *Timarcha tenebricosa* F. with well developed paired structures situated inside the vagina, tignum and spermatheca to *Gonioctena viminalis* L. without 8th sternite, vaginal palpi and sclerotized spermatheca. No visible paraprocts and no structures associated with paraprocts have been found in Alticinae, and therefore no structures can be easily homologized with the gonocoxite and gonostylus. Therefore the names hemisternite, styli, coxites and gonocoxa cannot be applied to vaginal palpi in flea beetles until a connection between vaginal palpi and the 9th segment is found. There are 3 possibilities to homologize the vaginal palpi: 1) vaginal palpi are paraprocts (halves of the 9th tergite) which moved inside the vagina; 2) vaginal palpi are hemisternites (appendages of the 9th sternite) and by definition they should be at the gonopore; 3) vaginal palpi are inverted and sclerotized parts of the vaginal wall; in this case they do not represent any segment. Since it is improbable that a sternite or tergite can become integrated as part of the vagina, the most likely possibility is the latter. That alternative is the only one that does not imply either erroneous or unsupported ideas on the homological relationships between structures of the female genitalia. The name vaginal palpi describes the location of the palpi inside the vagina and because of that this name is more neutral.

FUNCTION OF THE VAGINAL PALPI

There are two main points of view on the function of the sclerotized structures of female genitalia in flea beetles. The first one considers them as adaptations for oviposition. According to this view the vaginal palpi serve a sensory function in the selection of a favorable ovipositional substrate and/or mechanical function in penetrating the substrate during oviposition. The second point of view considers the sclerotized structures of the female genitalia as organs participating in copulation.

Eberhard (1985) showed that single copulation does not necessarily entail fertilization in groups where females make genitalic contact with more than one male. His hypothesis of sexual selection by cryptic female choice suggests that "male genitalia function as an "internal courtship" device to increase the likehood that females will actually use a given male's sperm to fertilize her eggs rather than those of another male." Therefore the female is choosing males based on the structure of their genitalia.

This suggests that females should have a sense organ which would be in mechanical contact with the male genitalia and recieve stimuli provided by male genitalia during intromission. In the case of flea beetles there are only 2 structures that can function as this sensory organ: the vagina and the vaginal palpi. In most flea beetle genera the diameter of the vagina is much larger than the diameter of the median lobe of the aedeagus, it also has no indication of any sensory structures. The vaginal palpi are at-



tached to the dorsal wall of the vagina, slightly bent ventrally (in lateral view) so their apices are located slightly above the middle of the vagina. The wholly sclerotized apices with a cavity inside and several long setae, strong medial sclerotization and sclerotized ventral side with membranous medial part make this organ quite sensitive to mechanical influence. In this example of copulation (Figs. 2, 3), in which the internal sack of the median lobe is inflated, there is contact between the apices of the vaginal palpi and the apical part of the ventral side of the median lobe. This part of the median lobe is the most species specific in flea beetles. In *Altica* it has many longitudinal impressions and transverse ridges. In *Aphthona,* especially in the *hammarstroemi* group of species it has a moderately developed median ridge and two lateral impressions. In the *A. formosana* pair in copulation the median ridge of the median lobe of the male is situated between the apicies of the vaginal palpi of the female. The chitinized structures of the internal sac are represented by an oval structure and a long hook to the left of the oval structure. The membrane of the sac, especially apically, is covered with numerous short setae (Fig. 3). All these structures are situated just below the vaginal palpi where they might contribute to their stimulation.

Based on the structure, position and orientation of the vaginal palpi and the median lobe of the aedeagus I suggest that the vaginal palpi function as sense organs, the female component of a so called "internal courtship device" which receives stimuli produced by movement of the median lobe of the aedeagus that induce sperm transfer and egg fertilization.

←

Fig. 2. Male genitalia inside vagina (dorsal view) of *Aphthona formosana.* Abbreviations: hs = hook structure of the internal sack; is = internal sack of the aedeagus; ml = median lobe of the aedeagus; mr = median ridge of the median lobe; os = oval structure of the internal sack. Other abbreviations as in Fig. 1.

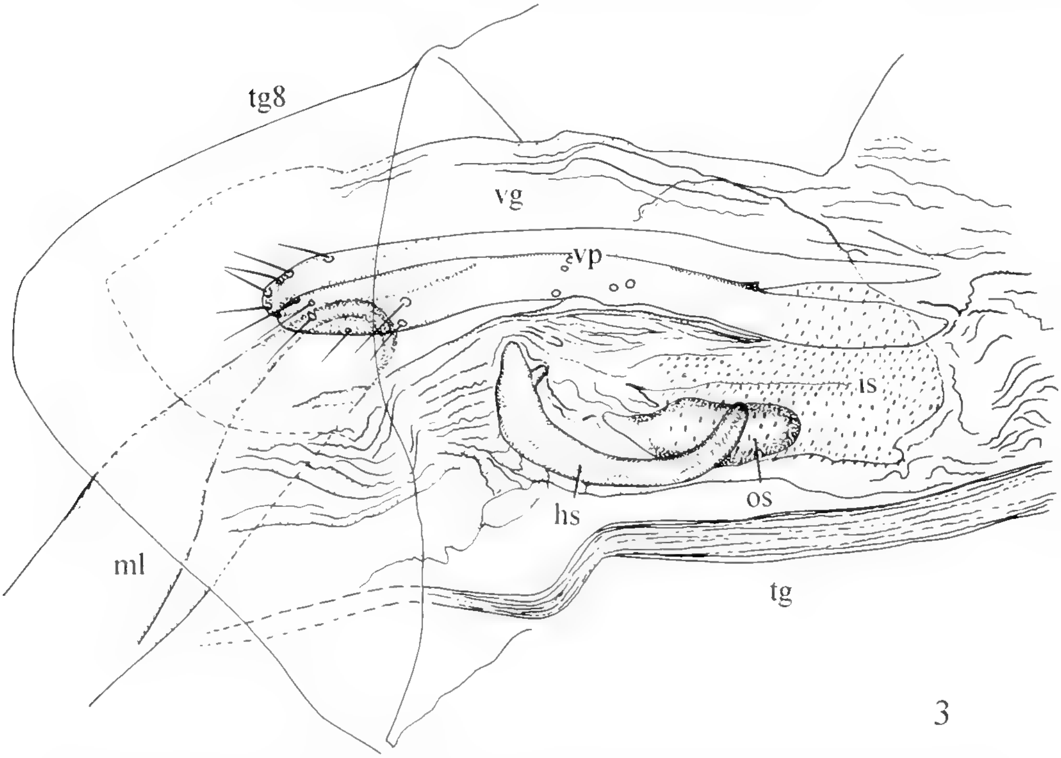


Fig. 3. Male genitalia inside vagina (lateral view) of *Aphthona formosana.* Abbreviations as in Fig. 1, 2.

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LIFE HISTORY AND DESCRIPTION OF IMMATURE STAGES OF *TRUPANEA PSEUDOVICINA* HERING (DIPTERA: TEPHRITIDAE) ON *POROPHYLLUM GRACILE* BENTHAM IN SOUTHERN CALIFORNIA

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Abstract.—*Trupanea pseudovicina* Hering is a monophagous, univoltine fruit fly (Diptera: Tephritidae) infesting flower heads of *Porophyllum gracile* Bentham (Asteraceae) in southern California, but may be oligophagous on still-unknown hosts in other southwestern United States. The egg, first-third instar larvae, and puparia are described and figured for the first time. The immature stages of *T. pseudovicina* are similar to those of five other California congeners described to date, with only the lateral spiracular complex of the third instars differing among these six species. The life cycle is of the aggregative type in southern California. The adults are long lived and comprise the over-summering and over-wintering stage that returns in spring to oviposit in the preblossom flower heads of *P. gracile*. An average of 2.5 (range: 1–7) eggs were oviposited, mostly singly or side-by-side in pairs, but also in packets of up to five, by one or more females in preblossom flower heads. First and early-second instars feed mostly on florets and ovules in preblossom heads. Late-second and third instars feed on soft achenes, not pitting the receptacles. Pupariation occurs in the open flower heads, within which an average of 30% of the florets/soft achenes were destroyed in heads containing puparia. Five species of chalcidoid Hymenoptera were reared from individual puparia and mature flower heads bearing *T. pseudovicina* puparia as solitary, larval-pupal endoparasitoids: *Colotrechnus* sp. (Eulophidae), *Eurytoma* n. sp. nr. *levivultus* Bugbee, *Eurytoma* sp. (1 ♀) (Eurytomidae), *Halticoptera* sp. (Pteromalidae), and *Pteromalus* sp. (Pteromalidae).

Key Words: Insecta, *Trupanea*, Asteraceae, nonfrugivorous Tephritidae, biology, taxonomy of immature stages, flower-head feeding, monophagy, host-plant range, parasitoids

Trupanea pseudovicina Hering (Diptera: Tephritidae) is a monophagous species in one of the larger and more widespread genera of nonfrugivorous fruit flies in North America and California (Foote and Blanc 1963, Foote et al. 1993). Being of little or no economic importance, most species of *Trupanea* remain little known (Foote 1960, Foote et al. 1993), except for seven species of *Trupanea* from southern California for which we have published detailed life histories (Cavender and Goeden 1982, Goeden 1987, 1988, Goeden and Teerink 1997c, Goeden et al. 1998, Headrick and Goeden 1991, Knio et al. 1996b), along with descriptions of the immature stages of five of these species (Cavender and Goeden 1982, Goeden and Teerink 1997c, Goeden et al. 1998, Headrick and Goeden 1991, Knio et al. 1996a). This paper describes the life history of an eighth species, *T. pseudovicina*, and its immature stages.

MATERIALS AND METHODS

This study was based in large part on dissections of subsamples of flower heads of *Porophyllum gracile* Bentham (Asteraceae) infested by *T. pseudovicina* from samples collected during 1991–1994 in the low-elevation Colorado (northern Sonoran) Desert and high-elevation, eastern Mojave Desert in southern California in the manner described by Goeden (1985, 1992). The principal study site in the Colorado Desert was in Valliceto Valley at the mouth of Smugglers Canyon, 440-m elevation, San Diego Co. One-liter samples of excised, immature and mature flower heads containing eggs, larvae, and puparia were transported in cold-chests in an air-conditioned vehicle to the laboratory and stored under refrigeration for subsequent dissection, photography, description, and measurement. Six eggs, 14 first-, 10 second-, and 10 third-instar larvae, and 6 puparia dissected from flower heads were preserved in 70% EtOH for scanning electron microscopy (SEM). Additional puparia were placed in separate, glass shell vials stoppered with absorbant cotton and held in humidity chambers at room temperature for adult and parasitoid emergence. Specimens for SEM were hydrated to distilled water in a decreasing series of acidulated EtOH. They were osmicated for 24 h, dehydrated through an increasing series of acidulated EtOH and two, 1-h immersions in Hexamethlydisilazane (HMDS), mounted on stubs, sputter-coated with a gold-palladium alloy, and studied with a JEOL JSM C-35 SEM in the Department of Nematology, University of California, Riverside.

Most adults reared from isolated puparia were individually caged in 850-ml, clear-plastic, screened-top cages with a cotton wick and basal water reservoir and provisioned with a strip of paper toweling impregnated with yeast hydrolyzate and sucrose. These cages were used for longevity studies in the insectary of the Department of Entomology, University of California, Riverside, at 25 ± 1°C, and 14/10 (L/D) photoperiod.

Plant names used in this paper follow Hickman (1993) and Bremer (1994); tephritid names and adult terminology follow Foote et al. (1993). Terminology and telegraphic format used to describe the immature stages follow Knio et al. (1996a), Goeden and Teerink (1997a, b, c), and Goeden et al. (1998) and our earlier works cited therein. Means ±SE are used throughout this paper. Voucher specimens of *T. pseudovicina* and its parasitoids reside in the research collections of RDG; preserved specimens of eggs, larvae and puparia are stored in a separate collection of immature Tephritidae maintained by JAT.

RESULTS AND DISCUSSION

TAXONOMY

Adult.—*Trupanea pseudovicina* was first described by Hering (1942) as *Trypanea texana*, which was preoccupied by *texana* Malloch. It was renamed *Trypanea pseudovicina* by Hering (1947). Foote (1960), Foote and Blanc (1963), and Foote et al. (1993) pictured the wing patterns of the female and male, which unlike some *Trupanea* spp., e.g. *T. bisetosa* (Coquillett), *T. imperfecta* (Coquillett), *T. jonesi* Curran, and *T. nigricornis* (Coquillett), are not sexually dimorphic.

Immature stages.—The immature stages of *T. pseudovicina* heretofore have neither been described nor illustrated.

Egg: Forty three eggs of *T. pseudovicina* dissected from heads of *Porophyllum gracile* were white, opaque, smooth; elongate-ellipsoidal, 0.61 ± 0.005 (range, 0.54–0.66) mm long, 0.16 ± 0.002 (range, 0.14–0.18) mm wide, smoothly rounded at tapered basal end (Fig. 1A), pedicel 0.02 mm long, with a single row of aeropyles (Fig. 1B).

The egg of *T. pseudovicina* is similar in shape to the eggs of other *Trupanea* species previously described, larger in width and

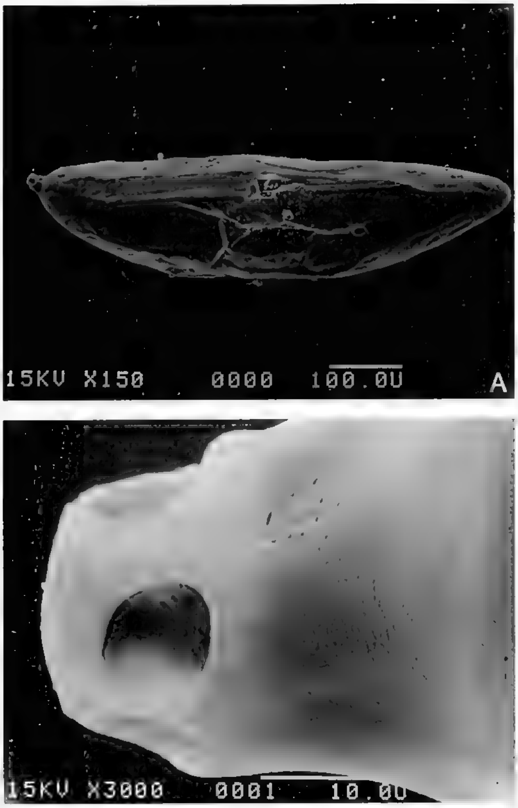

Fig. 1. Egg of *Trupanea pseudovicina:* (A) habitus, anterior to left; (B) pedicel.

length than *T. californica* Malloch, but shorter than *T. bisetosa, T. conjuncta* (Adams), *T. imperfecta, T. jonesi, T. nigricornis,* and *T. signata* Foote (Goeden 1987, 1988, Headrick and Goeden 1991, Knio et al. 1996a, Goeden and Teerink 1997c). As in *T. pseudovicina,* a single row of aeropyles circumscribes the pedicel of *T. nigricornis, T. signata,* and *T. jonesi* (Goeden and Teerink 1997c, Goeden et al. 1998); whereas, *T. bisetosa* has 1–2 rows of aeropyles (Knio et al. 1996a).

Third instar: White, elongate-cylindrical, tapering anteriorly, rounded posteriorly, minute acanthae circumscribe thoracic and abdominal intersegmental lines (Fig. 2A); gnathocephalon conical, with rugose pads dorsally and laterally (Fig. 2B), rugose pads laterad of mouth lumen serrated on ventral margin (Fig. 2B-1, C-1); dorsal sensory organ a single, dome-shaped papilla (Fig. 2B-2, C-2); subdorsal sensilla laterad of dorsal sensory organ (Fig. 2C-3); anterior sensory lobe (Fig. 2B-3) bears terminal sensory organ (Fig. 2C-4), pit sensory organ (Fig. 2C-5), lateral sensory organ (Fig. 2C-6) and supralateral sensory organ (Fig. 2C-7); stomal sense organ ventrolaterad of anterior sensory lobe (Fig. 2C-8, D-1); mouth hooks tridentate (Fig. 2D-2); median oral lobe laterally flattened, tapered anteriorly (Fig. 2D-3); labial lobe attached to median oral lobe, with two pore sensilla (Fig. 2D-4); ventrolateral sensillum laterad of labial lobe (Fig. 2D-5); prothorax circumscribed anteriorly by minute acanthae (Fig. 2E-1), rugose pads (Fig. 2E-2) and single row of verruciform sensilla, with additional sensilla dorsad (Fig. 2E-3); single stelex sensillum located dorsomedially on prothorax; anterior thoracic spiracles on posterior margin of prothorax bear four rounded papillae (Fig. 2E-4, F); metathoracic lateral spiracular complex consists of spiracle, stelex sensillum, and verruciform sensillum; abdominal lateral spiracular complexes consist of spiracle only; caudal segment circumscribed by minute acanthae (Fig. 2G-1), and stelex sensilla (Fig. 2G-2); posterior spiracular plates with three ovoid rimae, ca. 0.038 mm in length (Fig. 2G-3), and four interspiracular processes with 5–6 branches, longest measuring 0.016 mm (Fig. 2G-4); intermediate sensory complex ventrad of posterior spiracular plates, consists of stelex sensillum (Fig. 2H-1) and medusoid sensillum (Fig. 2H-2).

Trupanea pseudovicina differs from previously described *Trupanea* species in being more elongate-cylindrical than barrel-shaped (Headrick and Goeden 1991, Knio et al. 1996a, Goeden and Teerink 1997c, Goeden et al. 1998). The serrated rugose pads laterad of the mouth lumen are similar to those on *T. nigricornis, T. signata* and *T. jonesi* (Knio et al. 1996a, Goeden and Teerink 1997c, Goeden et al. 1998). The subdorsal sensilla are similar to those found on *T. bisetosa* and *T. jonesi* (Knio et al. 1996a,

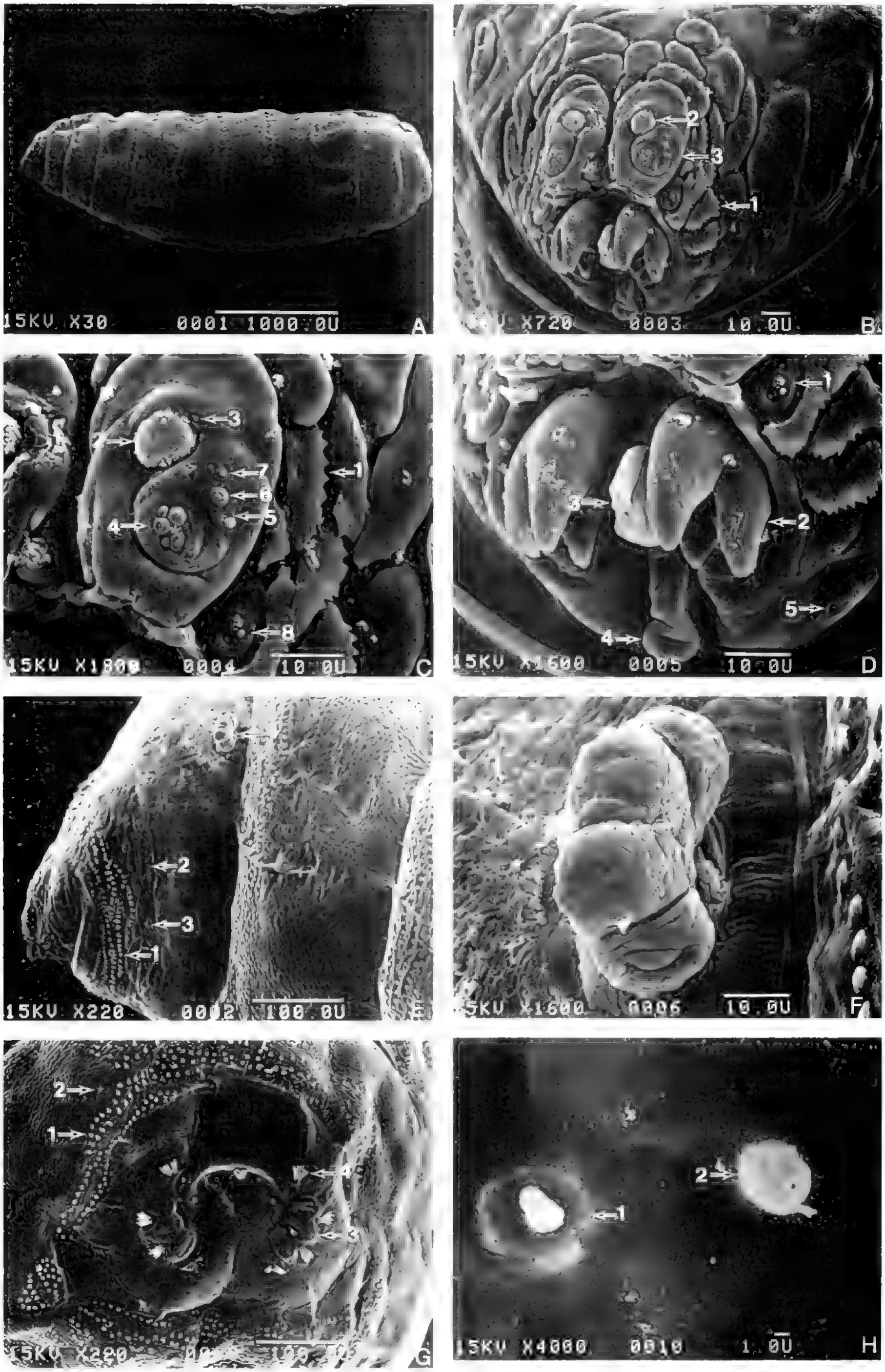

Fig. 2. Third instar of *Trupanea pseudovicina*. (A) habitus, anterior to left, (B) gnathocephalon, anterior view, 1—serrated rugose pads, 2—dorsal sensory organ, 3—anterior sensory lobe; (C) anterior sensory lobe, 1—serrated rugose pads, 2—dorsal sensory organ, 3—subdorsal sensilla, 4—terminal sensory organ, 5—pit sensory organ, 6—lateral sensory organ, 7—supralateral sensory organ, 8—stomal sense organ; (D) gnathocephalon, anterior view, 1—stomal sense organ, 2—mouth hook, 3—median oral lobe, 4—labial lobe, 5—ventro-

Goeden et al. 1998). The lateral spiracular complex in each *Trupanea* species previously examined has differed slightly in the number or type of sensilla present (Headrick and Goeden 1991, Knio et al. 1996a, Goeden and Teerink 1997c, Goeden et al. 1998). The metathoracic lateral spiracular complex in *T. pseudovicina* is similar to that in *T. jonesi,* but the abdominal lateral spiracular complex is different; *T. jonesi* bears one placoid sensillum (Goeden et al. 1998); whereas, *T. pseudovicina* has no sensilla.

Second instar: White, elongate-cylindrical, tapering slightly anteriorly, rounded posteriorly, minute acanthae circumscribe thoracic and abdominal intersegmental lines (Fig. 3A); gnathocephalon conical (Fig. 3B, D); rugose pads laterad of mouth lumen serrated on ventral margin (Fig. 3B-1, D-1); dorsal sensory organ a single, dome-shaped papilla (Fig. 3B-2, C-1); subdorsal sensilla laterad of dorsal sensory organ (Fig. 3C-2); anterior sensory lobe bears all four sensory organs (Fig. 3B-3); stomal sense organ ventrolaterad of anterior sensory lobe (Fig. 3C-3, D-2); mouth hooks bidentate (Fig. 3B-4, D-3); median oral lobe laterally flattened, tapered anteriorly (Fig. 3B-5, D-4); prothorax circumscribed anteriorly by minute acanthae (Fig. 3D-5) and verruciform sensilla (Fig. 3D-6); anterior thoracic spiracles bear four rounded papillae (Fig. 3E); metathoracic lateral spiracular complex consists of spiracle (Fig. 3F-1), stelex sensillum (Fig. 3F-2), and verruciform sensillum (Fig. 3F-3); abdominal lateral spiracular complexes consist of spiracle only (Fig. 3G); caudal segment bears posterior spiracular plates (Fig. 3H); posterior spiracular plates consist of three ovoid rimae, ca. 0.016 mm in length (Fig. 3H-1), and four interspiracular processes, each with 4–5 branches, longest measuring 0.013 mm (Fig. 3H-2); intermediate sensory complex consists of stelex sensillum and medusoid sensillum.

The second instar is very similar to the third instar in general habitus and sensory structures, but lacks the rugose pads that circumscribe the prothorax in the third instar. Also, the mouth hooks are bidentate in the second instar, and the posterior spiracular plates differ slightly in the size of the rimae and the number of branches in the interspiracular processes. *Trupanea jonesi* differs from *T. pseudovicina* in that the rugose pads near the mouth lumen are not serrated, and the prothorax is circumscribed by rugose pads (Goeden et al. 1998). *Trupanea bisetosa* and *T. nigricornis* second instars have tridentate mouth hooks and the ventral margin of the ventral lobe is papillate (Knio et al. 1996a).

First instar: White, elongate-cylindrical, rounded anteriorly and posteriorly, minute acanthae circumscribe meso-, metathoracic and abdominal intersegmental lines (Fig. 4A); gnathocephalon conical, lacking rugose pads (Fig. 4B); dorsal sensory organ a single, dome-shaped papilla (Fig. 4B-1); subdorsal sensillum laterad of dorsal sensory organ (Fig. 4B-2); anterior sensory lobe with four sensory organs (Fig. 4B-3); stomal sense organs reduced (Fig. 4B-4); mouth hooks bidentate (Fig. 4B-5); median oral lobe laterally flattened (Fig. 4B-6); prothorax with minute acanthae ventrally, thoracic segments circumscribed by single row of verruciform sensilla; anterior thoracic spiracles not present; lateral spiracular complex not seen; caudal segment smooth, lacking minute acanthae (Fig. 4C), circumscribed by stelex sensilla in a 2-dorsal, 4-ventral arrangement (Fig. 4C-1); posterior

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lateral sensillum; (E) prothorax, lateral view, 1—minute acanthae, 2—rugose pads, 3—verruciform sensillum, 4—anterior thoracic spiracle; (F) anterior thoracic spiracle; (G) caudal segment, 1—minute acanthae, 2—stelex sensillum, 3—rima, 4—interspiracular process; (H) intermediate sensory complex, 1—stelex sensillum, 2—medusoid sensillum.

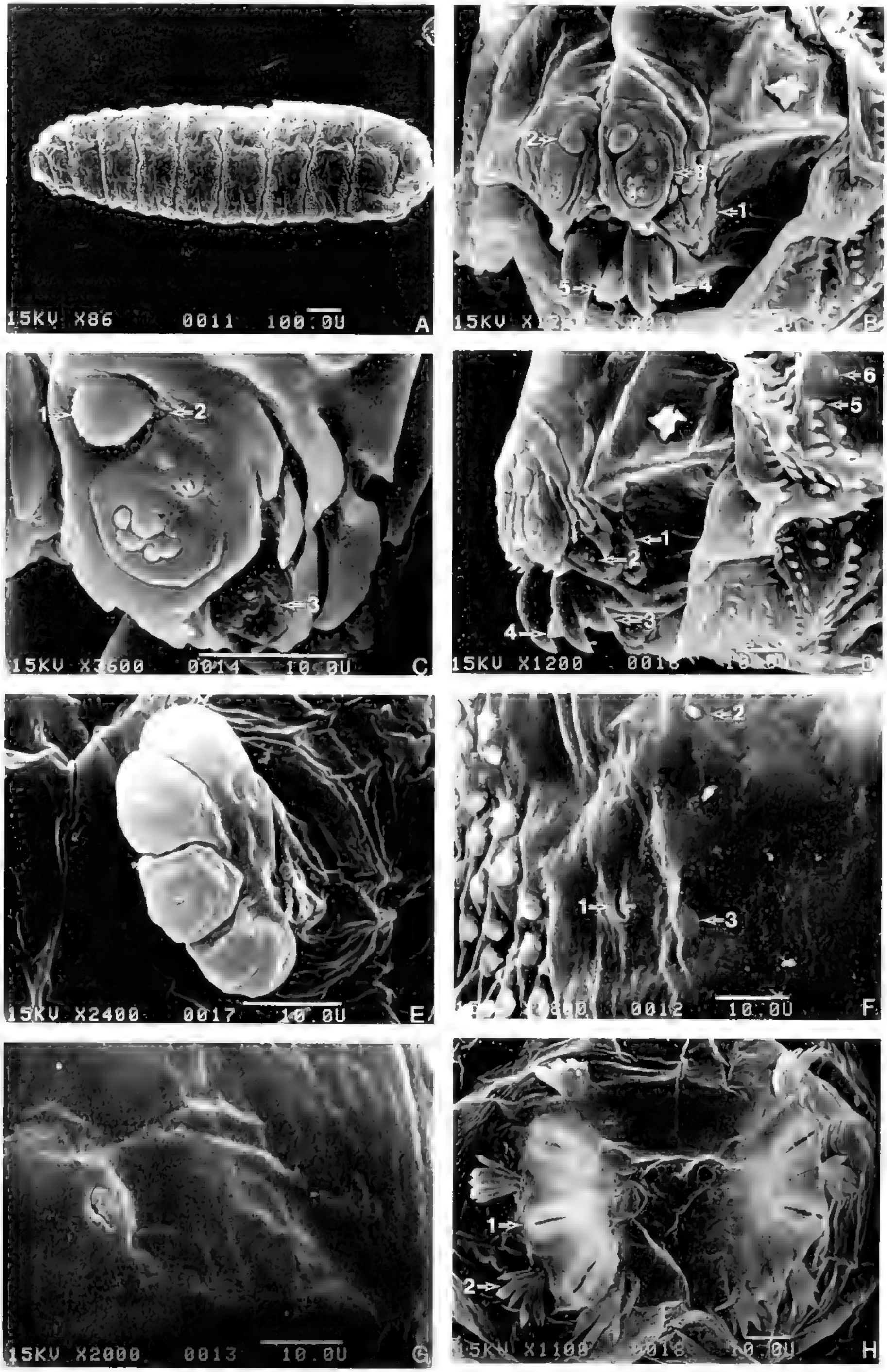

Fig. 3. Second instar of *Trupanea pseudovicina:* (A) habitus, anterior to left; (B) gnathocephalon, anterior view, 1—serrated rugose pads, 2—dorsal sensory organ, 3—anterior sensory lobe, 4—mouth hook, 5—median oral lobe, (C) anterior sensory lobe, 1—dorsal sensory organ, 2—subdorsal sensilla, 3—stomal sense organ; (D) gnathocephalon, lateral view, 1—serrated rugose pads, 2—stomal sense organ, 3—mouth hook, 4—median oral lobe, 5—minute acanthae, 6—verruciform sensillum; (E) anterior thoracic spiracle; (F) metathoracic lateral

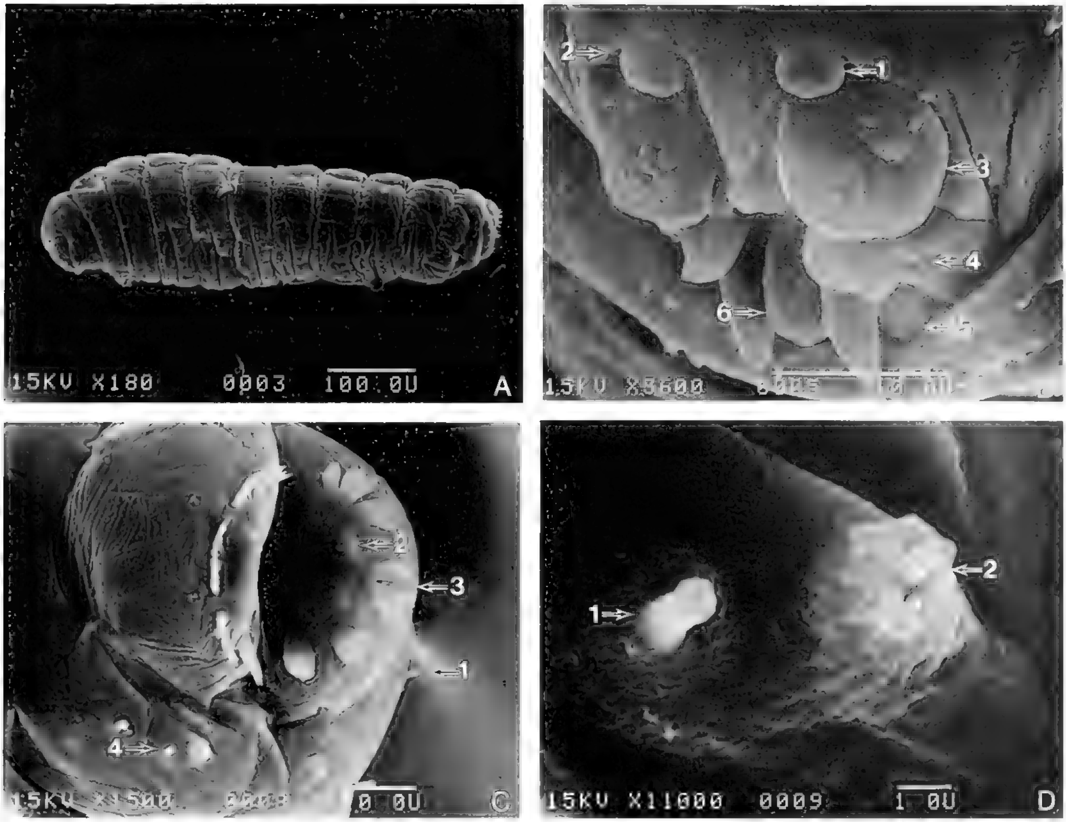

Fig. 4. First instar of *Trupanea pseudovicina:* (A) habitus, anterior to left; (B) gnathocephalon, anterior view, 1—dorsal sensory organ, 2—subdorsal sensillum, 3—anterior sensory lobe, 4—stomal sense organ, 5—mouth hook, 6—median oral lobe; (C) caudal segment, 1—stelex sensillum, 2—rima, 3—interspiracular process, 4—intermediate sensory complex; (D) intermediate sensory complex, 1—stelex sensillum, 2—medusoid sensillum

spiracular plates with two ovoid rimae, ca. 0.007 mm in length (Fig. 4C-2), and four interspiracular processes, each with 1–3 branches, longest measuring 0.006 mm (Fig. 4C-3); intermediate sensory complex (Fig. 4C-4), with stelex sensillum (Fig. 4D-1) and medusoid sensillum (Fig. 4D-2).

The first instar differs from the second instar in possessing fewer rows of acanthae circumscribing the intersegmental lines, and the prothorax is not circumscribed by acanthae. The gnathocephalon is smooth, lacking rugose pads, and the stomal sense organs are reduced and nearly indistinct. The posterior spiracular plates differ in bearing two rimae and the interspiracular processes have fewer branches than the second instar. The interspiracular processes differ slightly among the first instars of previously studied *Trupanea* species (Knio et al. 1996a, Goeden et al. 1998). *Trupanea pseudovicina* and *T. bisetosa* interspiracular processes are very similar, with 1–4 branches, either blade-like or broad with dentate margins; however, *T. nigricornis* has four, broad branches with dentate margins in each in-

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spiracular complex, 1—spiracle, 2—stelex sensillum, 3—verruciform sensillum; (G) seventh abdominal lateral spiracular complex, spiracle; (H) posterior spiracular plates, 1—rima, 2—interspiracular process

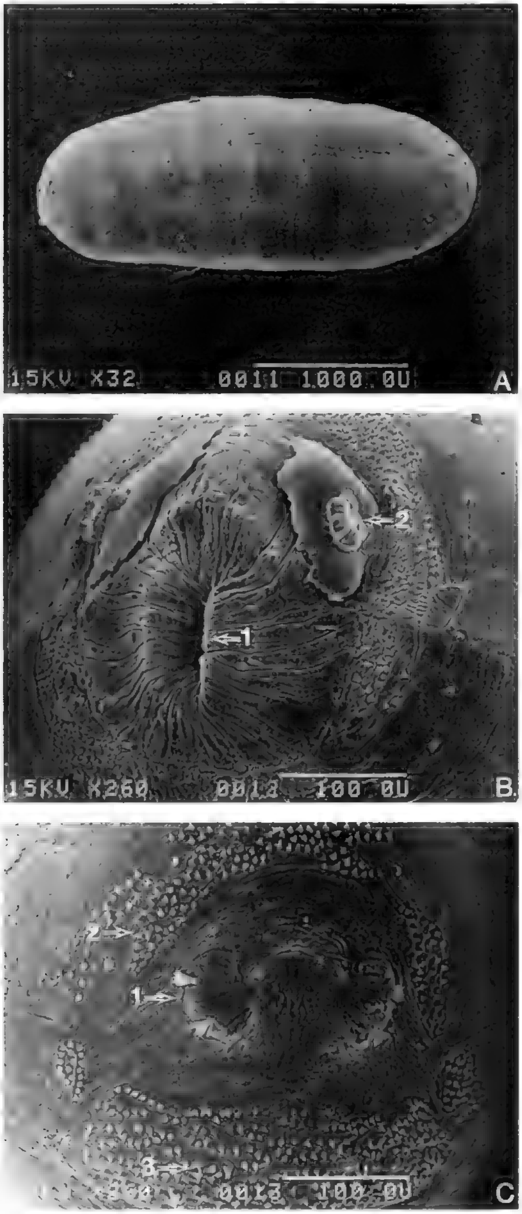

Fig. 5. Puparium of *Trupanea pseudovicina:* (A) habitus, anterior to left; (B) anterior end, 1—invagination scar, 2—anterior thoracic spiracle; (C) caudal segment, 1—posterior spiracular plates, 2—minute acanthae, 3—intermediate sensory complex.

terspiracular process, and *T. jonesi* has very reduced interspiracular processes (Knio et al. 1996a, Goeden et al. 1998).

Puparium: Black, elongate-ellipsoidal (Fig. 5A); anterior end bears invagination scar (Fig. 5B-1) and anterior thoracic spiracles (Fig. 5B-2); caudal segment bears posterior spiracular plates (Fig. 5C-1), band of minute acanthae (Fig. 5C-2) and the intermediate sensory complex (Fig. 5C-3). One hundred-seventy-six puparia averaged 2.75 ± 0.02 (range, 2.13–3.35) mm in length; 1.12 ± 0.01 (range, 0.70–1.38) mm in width.

DISTRIBUTION AND HOSTS

The distribution of *T. pseudovicina* mapped by Foote et al. (1993) included several locations each in Arizona, California, New Mexico, and Texas, and single locations in Colorado, Kansas, and Nevada.

Wasbauer (1972) reported *T. pseudovicina* from *Porophyllum gracile* and *Bebbia juncea* (Bentham) Greene. The former hostplant belongs to the subtribe Pectidinae in the tribe Helenieae of the Asteraceae (Hickman 1993, Bremer 1994), and is the only validated host of this tephritid in North America (Goeden 1985, 1989, 1992). On the other hand, *B. juncea* belongs to the subtribe Galinsoginae in a different tribe, Heliantheae (Hickman 1993, Bremer 1994), and *T. pseudovicina* was not recorded in the insect fauna of this desert shrub when surveyed by Goeden and Ricker (1989); consequently, this additional information now strongly indicates that the record for *B. juncea* in Wasbauer (1972) is erroneous, not representing the rare host earlier suggested in explanation by Goeden (1985) (Foote et al. 1993). Accordingly, *T. pseudovicina* may be either a true monophage (one hostplant species) in North America north of Mexico or a near-monophage (one hostplant genus) on *P. gracile* and has not yet been reported from *P. ruderale* (Jacquin) R. Johnson, *P. scoparium* Gray, or *P. greggii* Gray, the other congeners in the southwestern United States (Arizona, New Mexico, Texas) or on additional species of *Porophyllum* in the Sonoran Desert and other parts of Mexico (Shreve and Wiggens 1964, Johnson 1969, Hickman 1993). Alternatively, if identifications and records for *T. pseu-*

dovicina in Foote et al. (1993) are correct for Nebraska and Oklahoma, where *P. gracile* does not occur according to Johnson (1969), this instead is an oligophagous tephritid that reproduces in flower heads of a still-to-be-reported, additional host genus or genera. Like several other tephritid species that we have studied, e.g. *Trupanea conjuncta* (Goeden 1987), *Tomoplagia cressoni* Aczél (Goeden and Headrick 1991), *Zonosemata vittigera* (Coquillett) (Goeden and Ricker 1971), *Trupanea pseudovicina* represents a native southern California tephritid closely associated with a native host-plant, which along with its congeners, is primarily distributed in Mexico and southward, where they remain little known.

BIOLOGY

Egg.—In 28 closed, preblossom, immature flower heads, 85 eggs were inserted pedicel-last between the tips of the phyllaries, and most were deposited perpendicular to the receptacle (n = 83, 98%; Fig. 6A, B) and inserted among the florets (n = 57, 67%, Fig. 6A). Only a single egg each was found deposited at an angle to the long axis of the head or parallel to the receptacle. Twenty eight of the 85 eggs (33%) were deposited loosely above or upon the closed florets (Fig. 6B) in the space beneath the appressed distal parts of the phyllaries. Only three of the 85 eggs (4%) were inserted partially into a floret. The diameters of the receptacles of 23 flower heads containing eggs averaged 1.8 ± 0.1 (range, 1.1–2.6) mm, and 28 infested heads contained an average of 2.5 ± 0.3 (range, 1–7) eggs oviposited mostly singly (Fig. 6B) or side-by-side in pairs, but also in packets (Fig. 6A) of up to five, by one or more females.

Larva.—Upon eclosion, first instars tunneled into or fed externally on one or more unelongated floral tubes of the immature florets (Fig. 6C). An average of 2.7 ± 0.5 (range, 1–7) first instars was found feeding within 14 closed, preblossom flower heads. The receptacles of these heads averaged 1.8 ± 0.7 (range, 1.1–2.3) mm in diameter with an average of 27 ± 7 (range, 23–30) florets, of which an average of only 1.5 ± 0.4 (range, 0–6) floral tubes, or 6% (range, 0–21%), were damaged. No ovules or receptacles within these 14 infested flower heads were pitted by first instar feeding.

Second instars fed mainly in floral tubes and ovules of preblossom flower heads or soft achenes of open heads (Fig. 6D). Most second instars fed with their mouthparts directed towards the receptacles within individual floral tubes/ovules (Fig. 6D), but two, even three, early second instars occasionally were found within a single floret. A few second instars were found tunneling through several ovules/soft achenes parallel to, but well above the receptacles (Fig. 6D). Receptacles of 17 flower heads containing second instars were undamaged and averaged 2.3 ± 0.1 (range, 2.0–3.3) mm in diameter. These flower heads contained an average of 3.2 ± 0.3 (range, 1–5) second instars that had destroyed an average of 5.1 ± 1.0 (range, 1–15) ovules/soft achenes, or 17.3% (range, 3.8–50%) of an average total of 29 ± 0.7 (range, 24–34) ovules/soft achenes.

Most third instars confined their feeding to soft achenes and florets at the margins, and less commonly to the centers, of open or postblossom heads (Fig. 6E). Heavily infested preblossom flower heads never opened and were completely excavated (Fig. 6F). In 49 flower heads averaging 2.2 ± 0.4 (range, 1.5–2.7) mm in diameter and containing an average of 2.2 ± 0.2 (range, 1–8) third instars, an average of 7.8 ± 1.0 (range 1–26) soft achenes/florets were damaged, or 29% (range, 5–100%). Most third instars fed with their long axes oriented perpendicular to and mouthparts directed towards the receptacles (Fig. 6E), within the lower parts of the floral tubes and upper parts of the soft achenes, well above the receptacles. No receptacles were pitted in the 49 flower heads that contained third instars, even in heavily infested, totally excavated heads (Fig. 6F). Upon completing

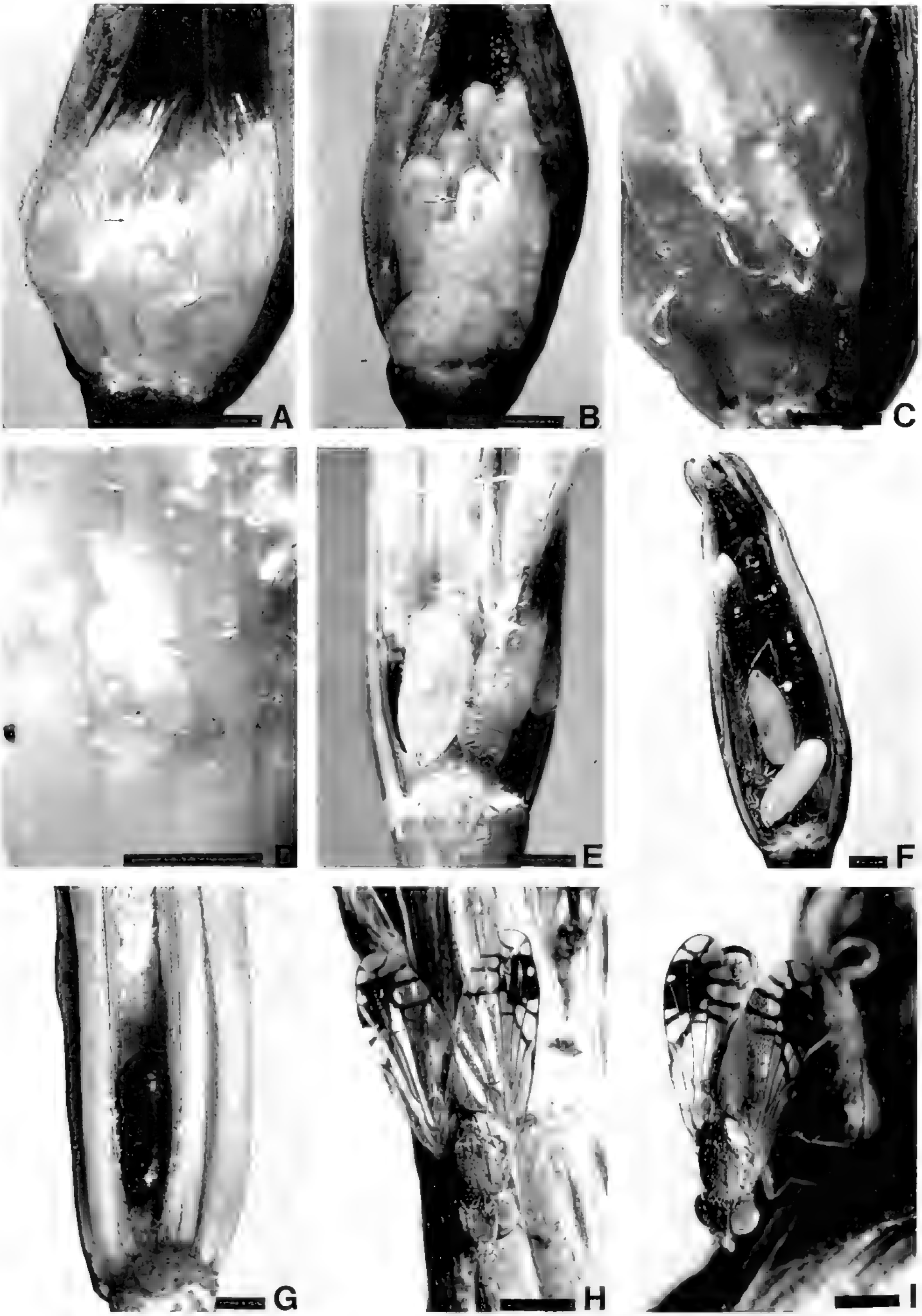

Fig. 6. Life stages of *Trupanea pseudovicina* in or on *Porophyllum gracile*: (A) three eggs (arrow) inserted among florets in closed, preblossom flower head; (B) egg (arrow) inserted atop florets in closed, preblossom flower head; (C) first instar tunneling in floret; (D) second instar feeding on soft achene at margin of open flower head; (E) third instar feeding on soft achene; (F) five puparia (top), prepuparium, and third instar (bottom) in completely excavated closed flower head; (G) single puparium between fully formed, undamaged achenes; (H) adult male on flower head; (I) adult female on flower head. Lines = 1 mm.

feeding, the larvae oriented with their anterior ends away from the receptacles, retracted their mouthparts, and pupariated (Fig. 6F).

Pupa.—Flower heads containing puparia (Fig. 6F, G) contained the greatest damage produced by the seed-feeding larvae of *T. pseudovicina* within flower heads sampled. The receptacles of 74 infested flower heads containing puparia averaged 2.2 ± 0.04 (range, 1.4–3.2) mm in diameter and bore an average total of 29.1 ± 0.6 (17–40) soft achenes/florets, of which an average of 6.4 ± 0.6 (range, 2–27) soft achenes/florets or 30% (range, 6–100%) were damaged. Again, no receptacles were pitted. These heads contained an average of 2.0 ± 0.1 (range, 1–6) puparia. Most puparia of *T. pseudovicina* were found alongside of the phyllaries at the margins of the flower heads, all had their anterior ends facing away from the receptacles, and their long axes were perpendicular to the receptacles (Fig. 6F, G).

Adult.—Adults emerged from mature flower heads, and were long-lived under insectary conditions, as 67 unmated males averaged 95 ± 4 (range, 22–224) days, and 86 virgin females averaged 112 ± 5 (range, 17–218) days. These flies are among the longest lived native species of nonfrugivorous Tephritidae from southern California in terms of average and maximum adult longevities that we have recorded. Such longevities are fully in accord with the aggregative type of life cycle ascribed below to this tephritid. The premating and mating behaviors of *T. pseudovicina* were not studied in the field, and as with most congeners that we have studied, adults would not mate in petri dish arenas so useful with many other nonfrugivorous tephritid species (Headrick and Goeden 1994).

Seasonal history.—The life cycle of *T. pseudovicina* in southern California follows an aggregative pattern in which the long-lived adults, in reproductive diapause, overwinter and aggregate to mate on preblossom host plants in the spring (March–April) (Headrick and Goeden 1994). They reproduce at first in the Colorado Desert, then in the Mojave Desert and on occasional host plants scattered in chaparral in the interior valleys (Munz 1974, Hickman 1993). A single generation is produced each year at each locale on *P. gracile,* and most of the life span of *T. pseudovicina* is spent as adults.

Natural enemies.—Five species of chalcidoid Hymenoptera were reared from individual puparia and mature flower heads bearing puparia of *T. pseudovicina* as solitary, larval-pupal endoparasitoids: *Colotrechnus* sp. (Eulophidae), *Eurytoma* n. sp. nr. *levivultus* Bugbee, *Eurytoma* sp. (1 ♀) (Eurytomidae), *Halticoptera* sp. (Pteromalidae), *Pteromalus* sp. (Pteromalidae).

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100(2), 1998, pp. 373–381

A NEW EXOTIC THREAT TO NORTH AMERICAN HARDWOOD FORESTS: AN ASIAN LONGHORNED BEETLE, *ANOPLOPHORA GLABRIPENNIS* (MOTSCHULSKY) (COLEOPTERA: CERAMBYCIDAE). I. LARVAL DESCRIPTION AND DIAGNOSIS

JOSEPH F. CAVEY, E. RICHARD HOEBEKE, STEVEN PASSOA, AND STEVEN W. LINGAFELTER

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Abstract.—*Anoplophora glabripennis* (Motschulsky), an Asian longhorned beetle native to eastern China, Korea, and Japan, was discovered in the New York City area attacking various hardwood trees in August 1996. This represents the first known infestation of any member of the lamiine genus *Anoplophora* in North America. To better enable identification of the immature stages of this important exotic forest pest, the mature larva is thoroughly described and illustrated with the use of photomicrographs. In addition, the larva of *A. glabripennis* is compared with North American larvae of the hardwood-feeding genera *Xylotrechus, Neoclytus, Saperda,* and *Glycobius* and of the conifer-feeding, morphologically similar genus *Monochamus.*

Key Words: Cerambycidae, longhorned beetle, *Anoplophora,* exotic pest

Borers of the beetle family Cerambycidae comprise one of the economically most important groups of insect pests of hardwood trees in the world (Craighead 1923, Drooz 1985, Solomon 1995). Cerambycid larvae are borers in dead wood, and their principal ecological role involves the reduction of dead and dying trees, broken branches, and slash (Haack and Slansky 1987, Bíly and Mehl 1989). However, some species attack living or slightly weakened and stressed trees, and many are capable of causing serious injury or even death of their host (Linsley 1959).

Members of the lamiine genus *Anoplophora* Hope infest living, and apparently healthy, hardwood trees. The 30+ species (and subspecies) of the genus are endemic to the Oriental and eastern Palearctic regions (Breuning 1943–45). *Anoplophora chinensis* (Förster) is considered one of the most destructive longhorned beetles in the world and is a serious pest in China (Duffy 1968). Associated with a wide range of ornamental host plants, this species infests fruit trees throughout lowland orchards in China and can become extremely abundant (Wang et al. 1996). Gressitt (1942) noted that *A. chinensis* infested an estimated 90% of all *Citrus* trees on the Lingnan University (now Zhong Shan) campus in China, and that this pest kills many young *Citrus* trees annually despite preventive measures. Another important pest, *A. malasiaca* (Thomson), the white-spotted longhorned beetle, is widely distributed throughout most of Japan, China, and Malaysia. Larvae of this species develop in the phloem and xylem of living trunks of citrus, apple (*Malus*), pear (*Pyrus*), and numerous other trees, and cause the deterioration or death of trees, resulting in serious economic damage (Adachi 1994). *Anoplophora glabripennis,* native to the eastern provinces of China, Korea, and Japan, is one of the most important pests in poplar (*Populus*) plantations of eastern China (Yan 1985). Primarily a trunk and large branch borer, this species also severely damages a variety of other Asian hardwood trees, including maple (*Acer*), willow (*Salix*), elm (*Ulmus*), and mulberry (*Morus*). Early instar larvae of *A. glabripennis* initially feed beneath the bark, destroying the cambial tissue, and late instar larvae seriously weaken trees by feeding in both sapwood and heartwood, where numerous larval tunnels often cause tree breakage and death.

Established populations of *A. glabripennis* were detected in the New York City area (mostly in the Greenpoint and Williamsburg sections of northern Brooklyn, and in a small area of southern Queens) in late August 1996, and again in a few small communities around Amityville, Long Island, in September 1996, infesting various hardwood trees, especially maples, along streets, and in parks and yards. Evidence strongly suggests that this immigrant cerambycid probably gained entry into North America through wood crating and palleting, or other large-dimensional wood blocking used in bracing and stacking cargo during transport from the Far East, and particularly China. Since the winter of 1996–1997, federal and state quarantine officials have attempted to eradicate this new exotic forest pest from the two infested New York sites. Regulators must remove and destroy all trees showing symptoms of attack, because other control methods are ineffective for this pest (Haack et al. 1997).

Because adult *A. glabripennis* will be found only in summer to autumn, conclusive recognition of the larval stage is crucial to eradication and control efforts in New York, especially to facilitate tree removal decisions and early detection of new infestations. The object of this paper is to provide a detailed description and a diagnosis of the larva of *A. glabripennis,* with photomicrographs of diagnostic features, to enable regulatory officials and taxonomists to identify this important pest species of hardwood trees. A forthcoming paper will provide a description and illustrations of the adult beetle, and a summary of its biology and seasonal history, its host trees, damage symptoms, and native geographic range.

MATERIALS AND METHODS

The description provided below is based, in part, on the published work of Xiao (1980) and on our own examination of numerous mature and early instar larvae of *A. glabripennis* extracted from infested Norway maple trees (*Acer platanoides* L.) in Brooklyn and Amityville, New York. The terminology used in the description is partially modified from Craighead (1923), Duffy (1953, 1968), Xiao (1980), and Torre-Bueno (1989).

Except for Fig. 1, the photographs in this paper were taken by Steven Passoa, in color, with 35 mm film or a SONY DXC-107A video camera and UP-1200 video printer, using either a Zeiss Photomic 2, Zeiss Tessovar, Nikon Optiphot 2, Nikon Multiphot, or Wild M5A Apochromat dissecting microscope. However, for the purposes of this paper, all figures, except Fig. 1a and 1b, were reproduced in black-and-white.

LARVAL DESCRIPTION

Mature larva.—Length to 50 mm; head capsule width to 5 mm. *Body* (Fig. 1a, 1b): Elongate, cylindrical, fleshy, pale yellow. *Head* (Fig. 2a, 3): Elongate-oblong, sides

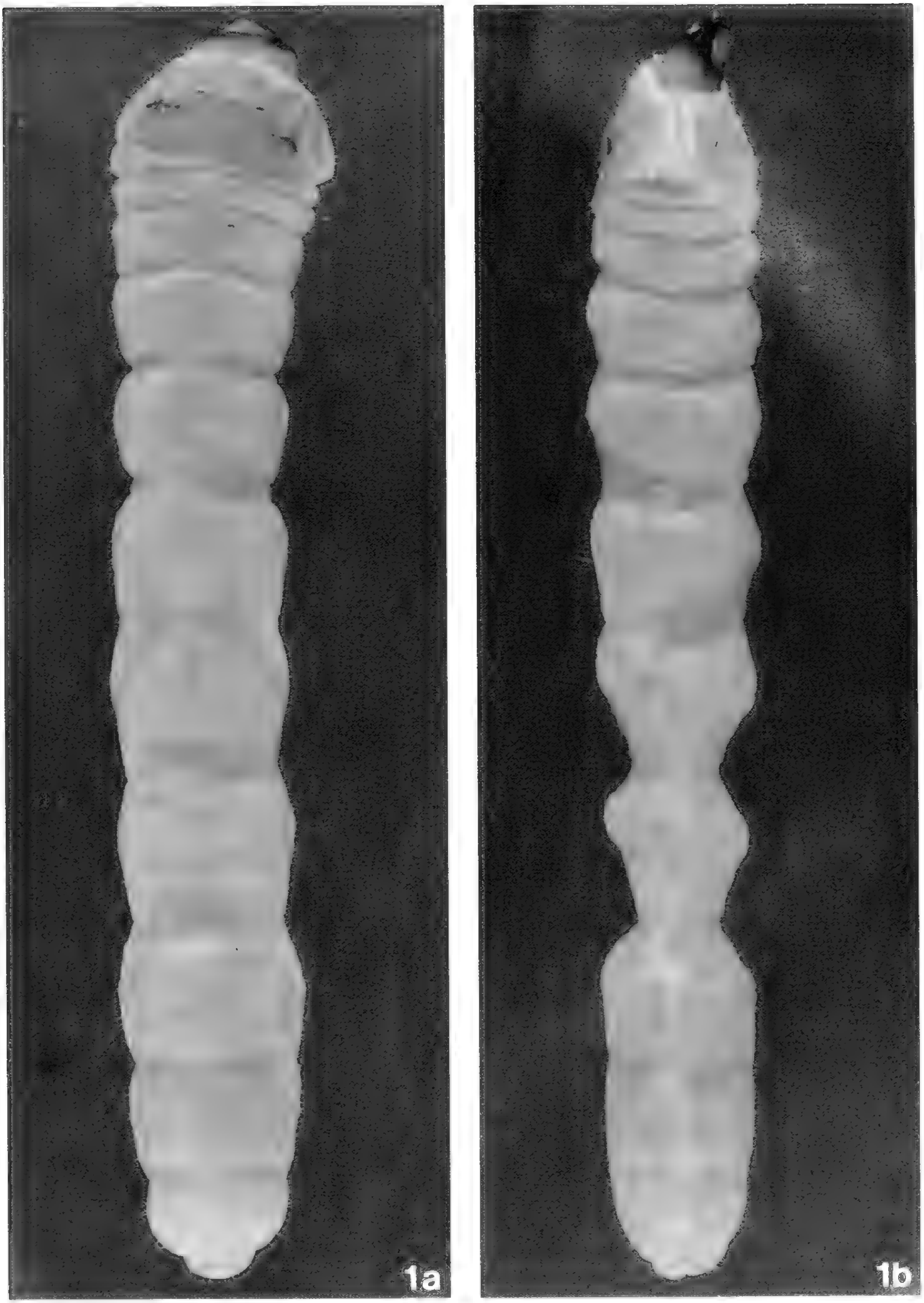
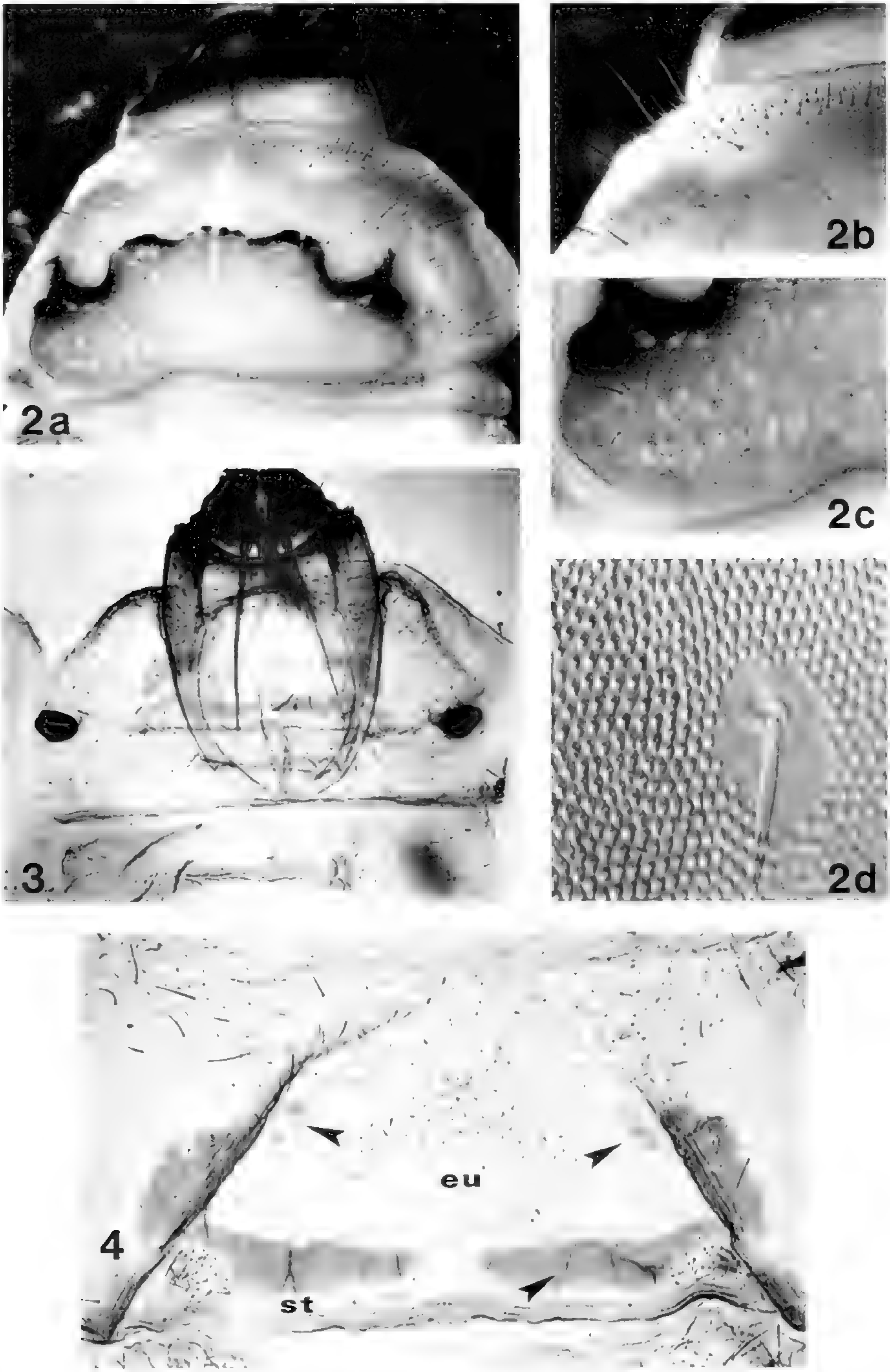
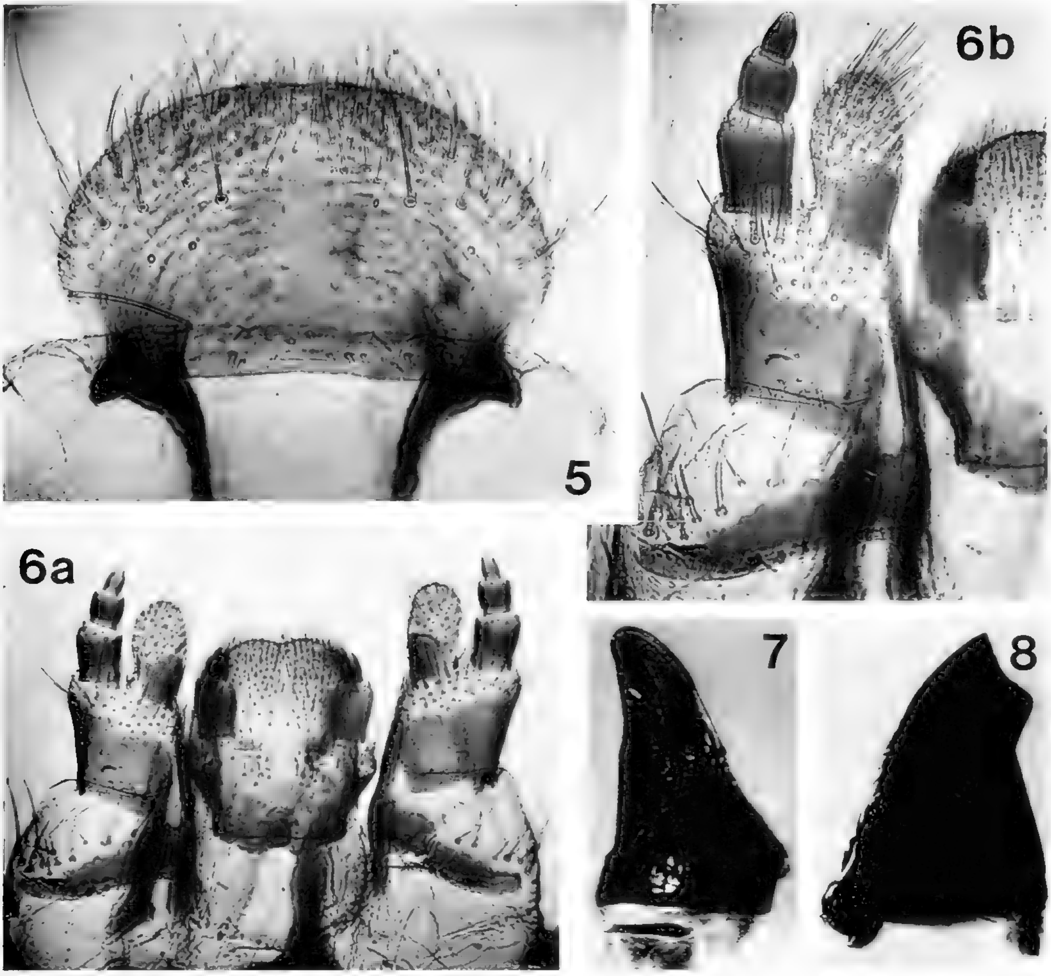


Fig. 1. Larval habitus of *Anoplophora glabripennis*. 1a, Dorsal habitus. 1b, Lateral habitus.

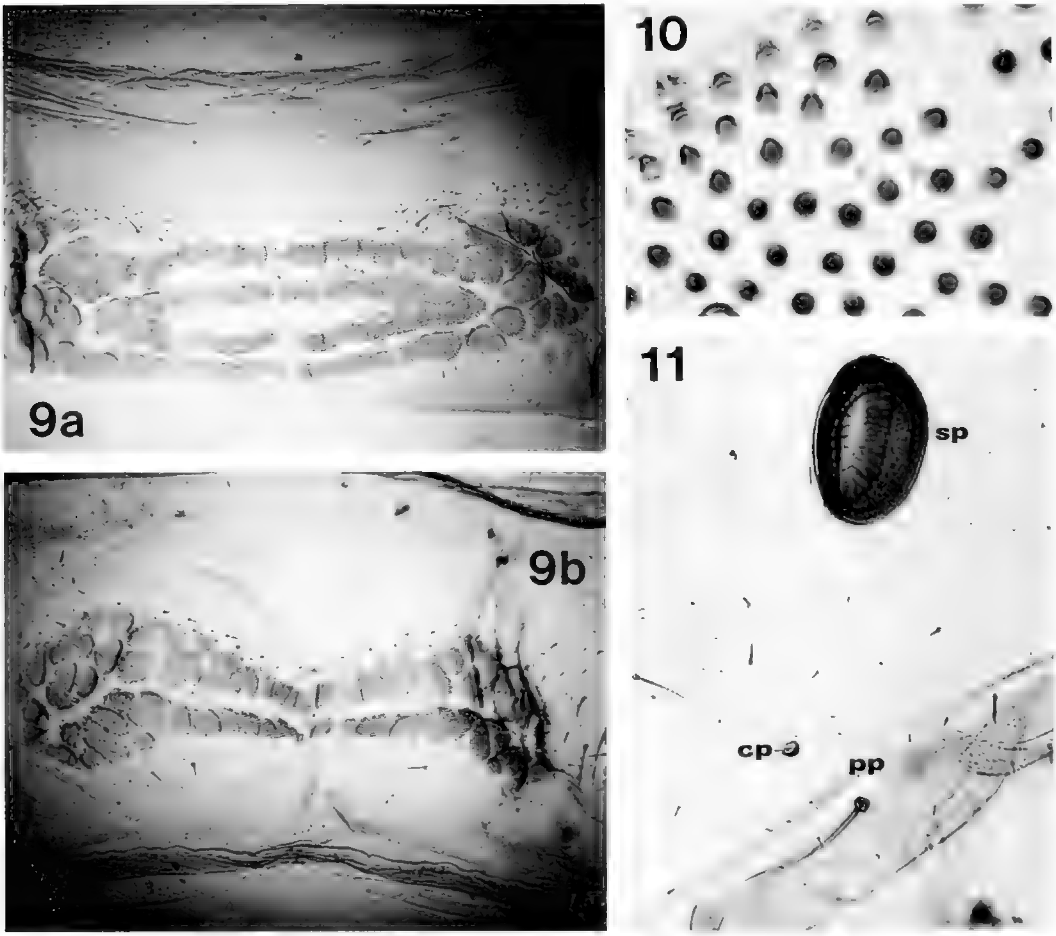


Figs. 2–4. Anatomical features of *Anoplophora glabripennis*. 2a, Dorsal view of head and thorax. 2b, Close-up of pronotal subapical setae. 2c, Close-up of pronotal spiculose region showing increasing density of spicules towards anterior margin of raised posterior sclerotization. 2d, Close-up of pronotal micro-spiculose region showing a non-spiculose pit or depression. 3, Venter of head and thorax. 4, Close-up of prosternum showing characteristic small, micro-spiculose patchs (arrows) of eusternum (eu) and transverse patches of sternellum (st).



Figs. 5–8. Anatomical features of *Anoplophora glabripennis*. 5, Labrum. 6a, Maxillae and labium. 6b, Close-up of maxilla. 7, Left mandible, lateral view of biting surface. 8, Left mandible, outer (anterior) face

parallel, two-thirds retracted into thorax, reddish brown; mouthparts prognathous. Antenna 3-segmented, short, with segments 2 and 3 sclerotized, length of segment 2 equal to its width, segment 2 bearing a hyaline process, or supplementary joint, ventrad of and subequal in length to segment 3. Frons with coarse, mostly round, setiferous punctures. Single ocellus proximal to and posteroventrad of antenna. Labrum (Fig. 5) yellowish, semicircular, dorsum with dense, long, erect setae. Clypeus yellowish, trapezoidal in shape. Maxilla as in Fig. 6a, 6b; maxillary palpus (Fig. 6b) brownish, 3-segmented. Labium as in Fig. 6a; labial palpus brownish, 2-segmented. Mandible (Figs. 7, 8) stout, heavily sclerotized, with oblique cutting edge behind pointed apex, and with 2 setae on basal one-third of outer face. *Thorax* (Figs. 1–4): Without legs. Pronotum (Fig. 2) with transverse band of rather dense, long, stiff setae along the anteapical margin (Fig. 2b). Anterior area (Fig. 2a, 2b), or apical one-third, of pronotum pale yellow, lightly sclerotized, densely covered with shallow pits or wrinkles, with sparse setae similar to those comprising ante-apical pronotal band, and with evident, smooth midline. Posterior area (Fig. 2a, 2c, 2d), or basal two-thirds,



Figs. 9–11. Anatomical features of *Anoplophora glabripennis*. 9a, Dorsal abdominal ampullae of segment IV. 9b, Ventral abdominal ampullae of segment IV. 10, Close-up of micro-spicules on abdominal ampullae. 11, Abdominal spiracle (sp), pleural plate (pp), and chitinous pit (cp).

of pronotum much darker yellow, distinctly raised, more heavily sclerotized; anterior margin of posterior area distinctly shaped, with margin (Fig. 2a, 2c) very narrowly dark brown to ferrugineous, slightly bisinuate at middle and strongly undulate laterad; remainder of raised posterior area micro-spiculose (Fig. 2c) and also bearing moderately dense, elongate, shallow, pale pits (Fig. 2d), and sparsely clothed with finer, shorter setae. Conspicuous, pigmented micro-spiculose patches on sternellum and presternum (Figs. 3, 4), and very small separate patches on eusternum (Fig. 4). Mesothorax short, with transverse, irregular band or row of coarse, long setae (no dorsal ampullae), and with ventral ampullae. Meso- and metathoracic ventral ampullae bordered by anterior row of short setae and lateral swollen areas set with setae of varied lengths. *Abdomen* (Figs. 1, 9–11): With 10 visible segments, segment 10 with nipple-like apophysis; segments 7–9 much wider and more flattened than segments 1–6. Segments 1–7 with distinct dorsal ampullae arranged in 4 transverse rows, converging at sides and appearing as 2 narrow, micro-spiculose rings (Fig. 9a). Ampullae also scattered at sides where transverse rows converge. Ampullae covered with reddish-brown spicules (Fig. 10). Ventral ampullae of segments 1–7 (Fig. 9b) form two rows converging at middle and diverging at sides; anterior row consists of two fused lines of ampullae and posterior row consists of single line of ampullae. Abdominal spiracles smaller than mesothoracic spiracle, with spiracular openings typically less than 1.8 times as long (dorsal/ventral axis) as greatest width (anterior/posterior axis), appearing broadly oval (Fig. 11). Pleural tubercle or plate (Fig. 11) somewhat broadly oval, lightly sclerotized, and with at least 2 well-defined, long, erect setae, but sometimes with additional shorter hairs; pleural plate with chitinous pit or pore at anterior and posterior extremities. Anus trilobate.

Specimens examined.—NEW YORK: Kings Co., Brooklyn (Greenpoint), 30-III-1997 (8); (Williamsburg), 14-X-1997 (5). Suffolk Co., Amityville, 30-VII-1997 (12).

Specimens preserved in 70% ethanol and deposited in the Cornell University Insect Collection, Ithaca, New York, and the National Museum of Natural History, Smithsonian Institution, Washington, DC.

DIAGNOSIS

The only North American cerambycid larvae likely to be mistaken for *Anoplophora glabripennis* are those belonging to the conifer-feeding lamiine genus *Monochamus* Megerle. Other hardwood-feeding cerambycid larvae in the United States, particularly species of *Xylotrechus* Chrevolat, *Saperda* Fabricius, *Neoclytus* Thomson, and the sugar maple borer, *Glycobius speciosus* (Say), are easily distinguished from those of *Anoplophora. Xylotrechus, Neoclytus,* and *Glycobius* belong to the subfamily Cerambycinae and are recognized by the usually visible thoracic legs (rudimentary in *Xylotrechus*), narrow and projecting clypeus and labrum, and prosternum with one or two longitudinal impressions medially. Larvae of the lamiine genus *Saperda* are recognized by the poorly delineated eusternum with a large spiculose patch on each side, very large asperites on posterior two-thirds of the pronotum, anterior margin of the posterior, sclerotized portion of the pronotum not well differentiated from the remainder (well differentiated in *Anoplophora*), and very large depression on the head above the antenna (small depression in *Anoplophora*).

The larvae of *A. glabripennis* can be distinguished from *Monochamus* spp. chiefly by characters of the pronotum, prosternum, and dorsal and ventral ampullae. Illustrations of *Monochamus* spp. can be found in Craighead (1923) and Hellrigl (1970). In *A. glabripennis,* the anterior area of the pronotum is well differentiated from the posterior area in being very lightly sclerotized, the surface integument slightly wrinkled and glabrous, and light yellow in color. In contrast, the posterior pronotal area is more heavily sclerotized, raised, and has a brown pigmented, densely spiculose surface. The anterior border of the posterior region is much more densely spiculose, appearing to have a dark brown or black delineation (as in Fig. 2a, 2c). This region also has small, scattered, non-spiculose punctures. In *Monochamus* spp., there is no obvious distinction between the anterior and posterior areas except for the posterior region being moderately micro-spiculose, but unpigmented. The coloration and sclerotization of both regions are similar. The larvae of *A. glabripennis* also have a distinctive prothoracic venter. There are conspicuous, pigmented micro-spiculose patches on the sternellum and presternum, and very small separate patches on the eusternum (Fig. 4). *Monochamus* larvae differ in having a large, inconspicuous (only visible after integument is dry), non-pigmented micro-spiculose patch at the posterior corners of the eusternum and continuing over the invagination to the posterior margin of the presternum and sternellum. The last major difference between *A. glabripennis* and *Monochamus* spp. involves the dorsal and ventral abdominal ampullae. In both taxa, these ampullae are covered with spicules (Fig. 10). These are conspicuous and colored reddish brown in *A. glabripennis,* but in *Monochamus* they are non-pigmented and visible only after the integument dries. In *A. glabripennis*, the dorsal abdominal ampullae are arranged in 4 transverse rows, converging at the sides and appearing as 2 narrow, micro-spiculose rings (Fig. 9a). These ampullae are also scattered at the sides where the transverse rows converge. In *Monochamus* spp., the dorsal ampullae are more scattered, usually neither in rows nor rings, and have a more warty (tuberculate) appearance. The ventral ampullae in *A. glabripennis* form 2 rows, converging at the middle and diverging at the sides (Fig. 9b). In *Monochamus* spp., the ventral ampullae, like the dorsal, are more scattered, creating a warty appearance. The abdominal spiracles also show some differences between *A. glabripennis* and *Monochamus* spp., although not as discrete. In *A. glabripennis,* the spiracular openings are typically less than 1.8 times as long (dorsal/ventral axis) as the greatest width (anterior/posterior axis), appearing broadly oval (Fig. 11). In *Monochamus* spp., the spiracular openings are more narrow, usually at least twice as long as the greatest width. This character does show some variability, however, and will not consistently separate the two taxa.

ACKNOWLEDGMENTS

We acknowledge the assistance of various members of the APHIS-appointed Asian longhorned beetle eradication project science advisory panel and project management team who continue to play a pivotal role in ongoing research, and in survey and eradication currently being conducted in New York: Victor C. Mastro (USDA, APHIS, PPQ, Otis ANGB, MA), Terry Goodman (USDA, APHIS, PPQ, Wallingford, CT), Kenneth R. Law (USDA, APHIS, PPQ, Newburgh, NY), and Robert A. Haack (USDA Forest Service, East Lansing, MI). We express our appreciation to Susan Dirks and Dennis Roberts (Horticultural Inspectors, New York State Department of Agriculture & Markets) for their assistance in collecting immature stages of *A. glabripennis* in Amityville, New York.

We especially would like to single out Terry Goodman for his administrative support of this publication and the photographic equipment needed to produce it. His help greatly improved this manuscript. We also thank APHIS, PPQ, Northeastern Region for funding this publication and Fototechniks (Cincinnati, OH) for providing us with Figures 1a and 1b.

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REPORTS OF OFFICERS

EDITOR

Volume 99 of the *Proceedings* totaled 784 pages. Seventy-three articles, 11 notes, 3 book reviews, 3 obituaries, and the minutes of Society meetings were published.

Memoir 18, "Contributions to Diptera," a volume in memory of W. W. Wirth edited by W. N. Mathis and W. L. Grogan was published in January. Memoir 19, "Monograph of the Berytidae, or Stilt Bugs (Heteroptera) of the Western Hemisphere" by T. J. Henry, was published in August. Miscellaneous Publication "A Handbook of the Families of Nearctic Chalcidoidea (Hymenoptera): Second Edition, Revised" by E. Eric Grissell and Michael E. Schauff, was published in April. Approval was received to go ahead with two additional Memoirs which will be published in 1998: "The genera of Elaphidiini Thomson 1864 (Coleoptera: Cerambycidae)" by Steven W. Lingafelter, and "New World *Blepharida* Chevrolat, 1836 (Coleoptera: Chrysomelidae)" by David G. Furth.

I extend my appreciation to Gary Miller for his continuing efforts to acquire informative book reviews, and to Tom Henry and Wayne Mathis, other members of the Publications Committee, for their continued advice and support. I thank Marie Blair and Cathy Anderson for their much needed assistance in handling correspondence, routing manuscripts, and preparation of manuscripts and plates for the printer. Without their help, my job would have been much more difficult.

I am also grateful to the many reviewers for the time-consuming efforts and constructive reviews. Their contributions are essential to help increase the quality of papers publish in the *Proceedings.*

Respectfully submitted,
David R. Smith, *Editor*

TREASURER

SUMMARY FINANCIAL STATEMENT FOR 1997

	General Fund	Special Publications Fund	Total Assets
Assets: November 1, 1996	$ 8,897.65	$107,599.85	$116,497.50
Total Receipts for 1997	78,290.36	15,415.08	93,705.44
Total Disbursements for 1997	72,351.71−	15,181.52−	87,533.23
Assets: October 31, 1997	14,836.30	107,833.41	122,669.71
Net Changes in Funds	$ 5,938.65	$ 233.56	$ 6,172.21

Audited by the Auditing Committee, December 2, 1997, consisting of Norman E. Woodley, John W. Brown, and Michael E. Schauff, Chairman. Presented to the membership at the meeting of December 5, 1997.

Respectfully submitted,
Michael G. Pogue, *Treasurer*

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SOCIETY MEETINGS

1022nd Regular Meeting—October 2, 1997

The 1022nd Regular Meeting of the Entomological Society of Washington (ESW) was called to order a 7:31 pm by President M. Alma Solis on October 2, 1997, in the Waldo Schmitt Room of the National Museum of Natural History, Washington, D.C. There were 14 members and 6 guests present. The minutes of both the May 1, 1997 meeting, and the June 3, 1997 Annual Banquet were read by Recording Secretary.

There were no officers' reports. Under committee reports, Membership Chair John Brown read the names of eleven new members. Michael W. Hastriter, studying flea systematics at Brigham Young University; Katherine C. Kelley, studying chemical ecology, phylogenetic systematics, character covariance, and predator-prey interactions at the University of Chicago; Marc A. Branham, studying behavior and systematics of Lampyridae, at Ohio State University; Dr. Miguel Archangelsky, Entomologist at the Museum of Biological Diversity, Ohio State University, Columbus, interested in systematics, biology, and ecology of Hydrophilidae, emphasizing immatures; Kelly B. Miller, studying systematics of Coleoptera (Dyticidae), at Colorado State University; Michael Gates, a graduate student studying insect systematics, morphology, and taxonomy at the University of California, Riverside; Dr. Andrew Jensen, a Postdoctoral fellow at the USDA, Systematic Entomology Lab (SEL), interested in aphid systematics and life histories; Dr. Gregory A. Evans, interested in the systematics of Aphelinidae (Hymenoptera), in the Dept. of Entomology, Div. of Plant Industry, Gainesville, Florida; Dr. Mathias Jaschhof, working on Mycetophiloidea (Diptera), and subfamily Lestermiinae (Diptera: Cecidomyiidae), at Zoologisches Institut und Museum, Greifswald, Germany; Dr. [MAJ(P)] Scott W. Gordon, Army Entomologist at the USUHS, Bethesda, Maryland, interested in medical entomology, molecular systematics, general collecting and insects in films; and Carlos R. Lugo-Ortiz, in the Dept. of Entomology, Purdue University, interested in systematics, biogeography, and stream ecology of Ephemeroptera. None of these new members were present.

Four visitors were introduced. Warren Steiner introduced Mathew Loeser, a student at the University of Utah. M. Alma Solis introduced George Gibbs, a micropterigid specialist from the University of Victoria, Michael Shaffer a Scientific Associate, retired Pyraloidea specialist at The Natural History Museum, London, and his wife, Monika Shaffer-Fehre, a Research Fellow at the Royal Botanical Gardens, Richmond, United Kingdom. Michael Shaffer has added two new families to the Smithsonian Institution collection during this current visit.

President Solis asked for presentation of any notes or exhibits. David Furth showed four recently published books and placed them on display at the back of the room. These included: *Amber, Window to the Past* by David A. Grimaldi, 1996. Published by Harry N. Abrams, Inc., in association with the American Museum of Natural History, 216 pp. (ISBN: 0-8109-1966-4); *Biologie des Coleopteres: Chrysomelides* by Pierre Jolivet, 1997. Published by Societe Nouvelle des Editions Bouber, 9 rue de Savoie 7500B (ISBN: 2085004-089-4) and (a 2-Vol. Set); *World Catalogue of Odonata*—Vol. I: *Zygoptera,* by Henrik Steinmann, Das Terreich, Berlin. Teilband 110. *xxvi* + 500 pp. (ISBN: 3-11-014933-8). (—a 2-Vol. Set); and *World Catalogue of Odonata*—Vol. II: *Anisoptera,* by Henrik Steinmann, Das Terreich, Berlin. Teilband 111. *xiv* + 636 pp. (ISBN: 3-11-014934-6).

Andy Brower, our evening's speaker, showed two books and placed them on display at the back of to room: *The Butterflies of Venezuela: Part 1; Nymphalidae (Limenitidinae, Apaturinae, Charaxinae)*. Andrew F. E. Neild, 1997. Meridian Publications, London. 144 pp. + Figs. (ISBN: 0-9527657-5); and *Heliconius and Related Genera*, by Helmuth and Ruth Holzinger. 1994. Science Nat., 2, Rue Andre Mellene, 60200 Venette, France. 144 pp. + Figs. (ISBN: 0-85724-68-6).

David Smith showed and placed on display the new Memoir: *Monograph of the Stilt Bugs, or Berytidae (Heteroptera) of the Western Hemisphere*, by Thomas J. Henry, 1997. Memoirs of the Entomological Society of Washington, No. 19. 1997. 279 pp. (ISBN: 2-85004-089-4).

Harold Harlan showed a colorful red tie with butterflies on it. He also showed a special 3-inch diameter cloth patch with a "Swallowtail" design that he and several other ESW members had designed, bought, and distributed to Scouts and others who visited the Insect Study Merit Badge Booth they ran at the 1997 Boy Scouts of America National Jamboree. Other ESW members participating included: Gary Miller, Melissa Miller, Mike Turell, and Ben Pagac. The patches were passed around and any ESW member could keep one.

David Furth, Program Chair, introduced our speaker for the evening, Andrew V. Z. Brower, who is nearing the end of a Postdoctoral Fellowship at the Smithsonian Institution. Andy earned a B.S. and M.S. from the Yale University, School of Forestry. Both of his parents had earned their Ph.D.s from Yale. He worked for one summer in the Milwaukee, Wisconsin, Public Museum; and another two summers at Harvard University. Then he earned a Ph.D. at Cornell University under Dr. Rick Harrison. His doctoral research included significant efforts in molecular biology. Andy had a 3½-year Post-doctoral Fellowship at the American Museum of Natural History in New York City; followed by his current Postdoctoral Fellowship here at the Smithsonian Institution. He will begin an appointment in the Department of Entomology, Oregon State University, November 15, 1997.

Dr. Brower's title was "Molecular Phylogenetics of Nymphalid Butterflies." He listed five areas in biology that can benefit from phylogenetic information from butterflies. These included: ecological genetics, comparative developmental biology, coevolution of insects and their food plants, biogeography, and conservation biology. He illustrated these points with examples from his work on *Heliconius* molecular systematics, as well as with studies from the literature. Andy gave a good overview of his molecular systematic work on nymphalid butterflies, introducing the main groups with a number of excellent slides of living specimens. He ended his talk with a summary of his phylogenetic hypothesis based on a 375-base-pair region of the "wingless" gene. This gene is located in the mitochondrial DNA. Although he was able to recover the monophyly of almost all of the traditionally recognized nymphalid subfamilies, relationships among these were not well resolved. He suggested that further careful study of both molecules and morphology were needed to provide more robust resolution of nymphalid relationships.

The meeting was adjourned at 8:45 pm. Refreshments were kindly provided by President M. Alma Solis.

Respectfully submitted,
Harold Harlan,
Recording Secretary

1023rd Regular Meeting—November 6, 1997

The 1023rd Regular Meeting of the Entomological Society of Washington (ESW) was called to order at 7:33 pm by President M. Alma Solis on November 6, 1997, in the Waldo Schmitt Room of the National Museum of Natural History, Washington, D.C. There were 20 members and 19 guests present. Minutes of the October 1997 meeting were read and approved with minor changes. President Solis announced that a

Life Member of the Society, Dr. Vitor Becker, in Brazil, had recently lost his job. Letters of solidarity and support would be welcome. Anyone who wants to write can contact her for Dr. Becker's address or other information.

There were no officers' reports. Under committee reports, on behalf of Chris Thompson, Chair of the Nominating Committee, David Furth read the list of nominees for next year's ESW Officers. Membership Chair, John Brown read the name of one new member, Dr. David C. Houghton, Dept. of Entomology, University of Minnesota, specializing in Trichoptera.

There was no new business. President Solis asked if anyone had notes, books, or specimens to exhibit. David Furth showed two new books: *The Butterflies of Costa Rica and Their Natural History*, Vol. II. *Riodinidae*, by Phillip DeVries, 1997; Princeton Univ. Press, Princeton, NJ. (ISBN: 0-691-02890-7 (hb); or ISBN: 0-691-02889-3 (pb).) and, *The Economic Importance of Insects*, by Dennis S. Hill, 1997; Chapman and Hall, New York, NY. (ISBN: 0-412-49800-6). Ralph Eckerlin showed one new book: *Biodiversidad, Taxonomia y Biogeografia de Arthropodos de Mexico*, Edited by: Jorge Llorente Bousquets, A. N. García Aldrete, and E. Gonzáles Soriano, 1996, published by Universidad Nacional Autonoma de Mexico, Cuidad Universitaria, MEXICO, D.F. (ISBN: 968-36-4857-6). Susan Broda introduced a guest, Ann Marie Juette, from USDA, APHIS.

David Furth introduced our speaker, Dr. Mark Moffett. Dr. Moffett earned his B.A. at Beloit College, Wisconsin. He met Dr. E. O. Wilson at Woods Hole, Massachusetts, and subsequently went on to earn his Ph.D. at Harvard, studying army ants under Dr. Wilson. Following that, he spent two years as a curator at Harvard's Museum of Comparative Zoology (where he is still based). During his Ph.D. research, he bought a camera to photograph his research subject, ants. This eventually led to his becoming a very well-known and widely-traveled nature photographer. He has done extensive work in the upper canopies of tropical rainforests, and has had many far-flung assignments for National Geographic. He wrote a book, *High Frontier: Exploring the Tropical Rainforest Canopy* (Harvard Univ. Press, 1994), that combines excellent photos with outstanding scientific observations.

Dr. Moffett's title was: "Those Little Murderers: A Smorgasbord of Ant Behavior." He showed a series of excellent slides, including many ant taxa. He described and showed morphological adaptations to each example ant species' habitat, food source(s) and habits; from simple seed-collecting or predaceous ants, to species that cultivate their fungus gardens, to a species that collects feathers and places them around their cone-shaped mound in such a way that they resemble a dead bird. On closer observation the latter may have been a mechanism for collecting water, via dew condensation on the feathers. The speaker further discussed the various levels of sociality, from solitary foragers to those with distinctly caste-specific functions, including five different systems of recruiting nest mates (workers) to a specific task. He related their observed morphologic adaptations to their field-observed behaviors. In general, tropical ant species seemed to be "niche specialists."

After Dr. Moffett's talk, eight more visitors were introduced. Dr. Moffett introduced Tristan, a local Washington, D.C. boy who is a "bug enthusiast." David Smith introduced Alexey Zinovjev, visiting from St. Petersburg, Russia, to work with him on sawflies; and Tami Carlow who is with the Systematic Entomology Lab, USDA. David Furth introduced Vilma Savini, from Marcaibo, Venezuela, studying flea beetles; and Gene Rosenberg from the Smithsonian Institution and the Botanical Society of Washington. Ted Schultz introduced Ulrich Mueller from the University of Maryland, who will be collaborating on fungus-feeding ants, and Rachelle Adams, visiting regarding a technical job. Kate Spencer, a freelance illustrator with the Zoology Dept., Smithsonian Institution, introduced herself.

The meeting was adjourned at 8:48 pm. Refreshments were provided by David Furth and Gabriela Chavarria.

Respectfully submitted,
Harold Harlan,
Recording Secretary

1024th Annual Meeting—December 4, 1997

The 1024th Annual Meeting of the Entomological Society of Washington (ESW) was called to order at 7:35 pm by President M. Alma Solis on December 4, 1997, in the Waldo Schmitt Room of the National Museum of Natural History, Washington, D.C. There were 16 members and 9 guests present. Minutes of the November 1997 meeting were read and approved.

President-Elect Warren Steiner reported on the annual ESW Banquet held on June 3, 1997, at the USUHS, Bethesda, Maryland. There were 83 tickets sold (4 to students) for a total of $2061.00. The Maryland Entomological Society donated $150.00 toward the banquet expenses. David Furth was the MC and Bernd Heinrich was the speaker. His title was "Adventures with Hot and Cold Dung-ball Rolling Beetles." Total cost was $2606.67, which included an honorarium for the speaker and complementary dinner for the speaker and the MC, leaving a deficit of $395.67 which was subsidized by the Society. John Brown, Membership Chair, announced that ESW has had 26 new membership applicants this year, far exceeding the past 5 or 6 years. He has developed a new membership application and he has already sent several of these out to prospective candidates. Corresponding Secretary Hollis Williams stated that she thought a new member's name was supposed to be read tonight. John Brown then proceeded to read the names of four new member candidates for their first reading: Dr. David Staley, of Federal Way, Washington, interested in Medical Entomology and General Taxonomy; Dr. Marcia S. Couri, of the Museo Nacional, Rio de Janeiro, Brazil (no interest stated); Dr. Alan C. Schroeder, with USAID in Arlington, Virginia, interested in International Entomology and Trans-Boundary Pests; and Dr. D. L. Deonier, of Lawrence, Kansas, interested in the systematics and biology of Ephydridae (Diptera). One new member, Alan C. Schroeder, was present and stated that he is currently an Associate Professor at the University of Maryland—Eastern Shore, and that his connection with USAID had been based on prior research funding for studies he had conducted on locust plagues in Africa, and on armyworms.

Dave Smith, Editor, reported on the publications activities over the past year. There were a lot of manuscripts processed between November 1, 1996 and October 31, 1997. About 120 manuscripts were received, not including the Memoirs and Miscellaneous Publication. Each manuscript requires an average of about seven items of correspondence from its receipt to the time it is published. It's easy to see why Dave is so thankful, and the ESW owes a debt of gratitude to Cathy and Marie. A question was asked: "Is there a limit to the number of pages authorized (to be published by ESW)?" Dave Smith replied that he did not know of any such limit, but that he has tried to keep the size of volumes fairly consistent, and this had worked well so far. President Solis said she knew of no such provision in the ESW Bylaws.

Mike Schauff, Chair of the Auditing Committee (which included himself, John Brown and Norm Woodley) reported that as of October 31, 1997, the General Fund had a balance of $14,836.30, an increase of $5938.65; and the Special Publication Fund had $107,000.00 (and "change"), a net increase of $233.56 from last year. This was in spite of all the Memoirs and special publication this year. Both funds totaled $122,669.71, an increase of about $6000.00 from the prior year. He said that, financially, ESW is in pretty good shape, and members were "starting to vie to be Treasurer . . . " He placed his report on a table in the front of the room for members present to review.

President M. Alma Solis said it had been an honor serving as President this year, and working with all these great and dedicated people. All of the ESW officers really have been doing a great job and she thanked them all. She also thanked all the regular and special committee chairs and members, all the people who have brought refreshments, and all the members who regularly attend meetings and generally support the ESW. She said the State of the Society is good overall. One big issue addressed this past year has been the back issues of ESW publications. There are significant volumes of them both at the Smithsonian Institution and stuffed into a storage room in Beltsville, Maryland, which we now have to vacate. A procedure has been established to deal with these, and a protocol has been developed to address future publications retention. It was decided earlier in the year that ESW must dispose of most of the stored publications due to storage costs. She thanked two key people involved in this effort, and presented a "Certificate of Recognition of Service Rendered to the Entomological Society of Washington" to each. Hollis Williams made sure that members who had Memoirs were notified of the proposed actions via letter. Hollis has been the ESW Corresponding Secretary for a number of years. She developed the Membership Directory, and has generally filled in for other ESW Officers and members where and whenever needed. Dave Furth has made numerous contacts with book sellers and individuals who wanted some of the excess (stored) publications, and was able to find useful disposition for a significant portion of them which would have otherwise just been discarded. In the future, it may be possible to scan publications into electronic form for archiving. This is being investigated. Alma Solis invited everyone to go out and help Gary Miller (and Executive Committee members) move those back issues. This is currently planned for either Monday or Tuesday of either the first or the second week of January 1998.

President Solis read the proposed slate of candidates for ESW Officers for next year: *President-Elect*—Michael Schauff; *Editor*—David Smith; *Treasurer*—Michael Pogue; *Recording Secretary*—Stuart McKamey; *Corresponding Secretary*—Hollis B. Williams; *Custodian*—Andrew Jensen; *Program Chair*—David Furth; and *Membership Chair*—John Brown (note: *President* and *Past-President* are filled by succession only). She asked for a motion to accept the slate of officers as read. It was so moved, seconded, and the motion carried.

President Solis stated that since Dr. Curtis Sabrosky, an Honorary Member and Honorary President of ESW, had passed away, there is now an opening for possible election of a current Honorary Member to Honorary President and for some other member to Honorary Member status. These matters could be addressed in the coming year. She then asked if anyone had notes, books, or specimens to exhibit. David Nickle showed and passed around a large mecopodine katydid from Australia in a plastic container. He called it sort of an "ancient dinosaur" of the katydids. Warren Steiner showed and passed around a partly humorous little book entitled "That Gunk on Your Car," which was sort of "field guide to North American insects (i.e. those bugs on your grill or windshield)." David Furth showed eight new books and placed them on display at the back of the room: *Elytron.* The Bulletin of the European Association of Coleopterology, Vol. X. Barcelona, Spain. 1996 (ISSN: 0214-13353); *Fauna Polski, Fauna Poloniae. Lech Borowiec, Mordellidae, Miastkowat* (*Insecta: Coleoptera*). 1996. Polska Akademia Nauk, Muzeum I Instytut Zoologii, "Tom 18," Warszawa. 191 pp. ISBN: 83-85192-54-9 (ISSNE: 0303-4909); *Leaf Beetles* (*Chrysomelidae*) *of Taiwan.* by Shinsaku Kimoto and Haruo Takizawa, Tokai University Press, July 1997, Tokyo, Japan. *vi* + 583 pp. (ISBN: 4-486-01401-4 C3645); *Orthoptera, Tetrigoidea & Tridactyloidea (Orthoptera: Caelifera)*. Species File 6, by Daniel Otte, 1997. Published by the Orthopterists Society and the Academy of Natural Sciences of Philadelphia, Philadelphia, Pennsylvania. May 1997. *iii* + 261 pp. (ISBN: 0-9640101-7-8 (Number 6)); *Orthoptera, Tetrigonioidea (Orthoptera: Caelifera)*. Species File 7, by Daniel Otte, 1997. Published by the Orthopterists Society and the Academy of Natural Sciences of Philadelphia, Philadelphia, Pennsylvania. May 1997 (ISBN: 0-9640101-8-6 (Number 7)); *The World of the Monarch Butterfly*. By Eric S. Grace, the Sierra Book Club, San Francisco, California. 1997. *viii* + 114 pp. + plates. www.sierraclub.org/books (ISBN: 0-87156-981-7); *Wings*. The Xerces Society, Portland, Oregon, Vol. 20 (No. 2), Fall 1997, "Essays on Invertebrate Conservation." (Latest is *Ants* by Tom Eisner); and *Digest of Cultural Entomology*. By Dexter Sear, P.O. Box 796, Kalaheo, Kauai, Hawaii 96741. Fourth Issue, November 1997, 323 pp. http://www.insects.org.

David Furth introduced our speaker for the evening, Dr. Adrian B. Forsyth, from the Entomology Department of the Smithsonian Institution. He has published extensively, including nine books, and is most interested in and works on biodiversity and its rapid assessment. He was recently Vice President of Conservation International.

Dr Forsyth's title was: "Amazonian Dung Beetles." He gave the history of the large, remote plateau in western Brazil, which is within the Ricardo Franco Mountain Range, and is drained by the Rio Verde. The margins of this plateau rise from the Amazon jungles as an almost sheer, 1000 foot rock wall. This area, and the British explorer, Col. Fawcette's descriptions of it, were what inspired Sir Arthur Conan Doyle's 1912 book *The Lost World*. When Dr. Forsyth's team first visited the plateau, they started with satellite maps and aerial surveys. They needed to choose a "signal organism," or group, that could be quickly and simply sampled in all situations, and that would give a good, representative measure of the biodiversity of each sampled area. This had to be comparable for a range of biological settings and sites. Butterflies were considered first, but it would be hard to collect good representative samples at different sites. They settled on dung beetles. These beetles are more easily collected using baited traps. They are not extremely diverse taxonomically, and trapping would be simple, with several good baits readily available wherever the investigators happened to be. It turned out that dung beetle reflected (and correlated well with) plant biomass well, and were highly differentiated, overall. They vary five orders of magnitude in body mass. A very few species make up most of the community. Those few "big ones" handle most of the biomass of dung in a particular area. The other species (70%+) contribute very little to the biomass or overall ecosystem function.

After the talk, President Solis asked for visitors to be introduced. Dr. Forsyth introduced Lynn Cherry, a Botanist. Warren Steiner introduced Gerardo Rios, UNAM, Mexico working with Terry Erwin.

M. Alma Solis called Warren Steiner to the podium and officially transferred to his care the gavel and a box of ESW paraphernalia specific to the office of President. Warren adjourned the meeting at 9:02 pm. Refreshments were provided by Ralph Eckerlin and Jil Swearingen.

Respectfully submitted,
Harold Harlan,
Recording Secretary

PUBLICATIONS FOR SALE BY THE ENTOMOLOGICAL SOCIETY OF WASHINGTON

Miscellaneous Publications

A Handbook of the Families of Nearctic Chalcidoidea (Hymenoptera), by E. Eric Grissell and Michael E. Schauff. 85 pp. 1990	$10.00
A Handbook of the Families of Nearctic Chalcidoidea (Hymenoptera): Second Edition, Revised, by E. Eric Grissell and Michael E. Schauff. 87 pp. 1997	15.00

Memoirs of the Entomological Society of Washington

Memoirs 2, 3, 7, 9, 10, 11, and 13 are no longer available.

No. 1.	The North American Bees of the Genus *Osmia*, by Grace Sandhouse. 167 pp. 1939	$15.00
No. 4.	A Manual of the Chiggers, by G. W. Wharton and H. S. Fuller. 185 pp. 1952	15.00
No. 5.	A Classification of the Siphonaptera of South America, by Phyllis T. Johnson. 298 pp. 1957	15.00
No. 6.	The Female Tabanidae of Japan, Korea and Manchuria, by Wallace P. Murdoch and Hirosi Takahasi. 230 pp. 1969	15.00
No. 8.	The North American Predaceous Midges of the Genus *Palpomyia* Meigen (Diptera: Ceratopogonidae), by W. L. Grogan, Jr. and W. W. Wirth. 125 pp. 1979	12.00
No. 12.	The Holarctic Genera of Mymaridae (Hymenoptera: Chalcidoidae), by Michael E. Schauff. 67 pp. 1984	5.00
No. 14.	Biology and Phylogeny of Curculionoidea, edited by R. S. Anderson and C. H. C. Lyal. 174 pp. 1995	25.00
No. 15.	A Revision of the Genus *Ceratopogon* Meigen (Diptera: Ceratopogonidae), by A. Borkent and W. L. Grogan, Jr. 198 pp. 1995	25.00
No. 16.	The Genera of Beridinae (Diptera: Stratiomyidae), by Norman E. Woodley. 231 pp. 1995	25.00
No. 17.	Contributions on Hymenoptera and Associated Insects, Dedicated to Karl V. Krombein, edited by B. B. Norden and A. S. Menke. 216 pp. 1996	25.00
No. 18.	Contributions on Diptera, Dedicated to Willis W. Wirth, edited by Wayne N. Mathis and William L. Grogan, Jr. 297 pp. 1997	25.00
No. 19.	Monograph of the Stilt Bugs, or Berytidae (Heteroptera), of the Western Hemisphere, by Thomas J. Henry. 149 pp. 1997	18.00
No. 20.	The Genera of Elaphidiini Thomson 1864 (Coleoptera: Cerambycidae), by Steven W. Lingafelter. 118 pp. 1998	12.00

Back issues of the Proceedings of the Entomological Society of Washington are available at $60.00 per volume to non-members and $25.00 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, MRC 168, Smithsonian Institution, Washington, D.C. 20560.

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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, MRC-168, Smithsonian Institution, Washington, D.C. 20560.

MEETINGS.—Regular meetings of the Society are held in the Natural History Building, Smithsonian Institution, on the first Thursday of each month from October to June, inclusive, at 7:30 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 $25.00 (U.S. currency).

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The Society does not exchange its publications for those of other societies.

PLEASE SEE PP. 599–600 OF THIS ISSUE FOR INFORMATION REGARDING PREPARATION OF MANUSCRIPTS.

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100(3), 1998, pp. 389–394

REDISCOVERY OF *POLYSTOECHOTES GAZULLAI* NAVÁS (NEUROPTERA: POLYSTOECHOTIDAE)

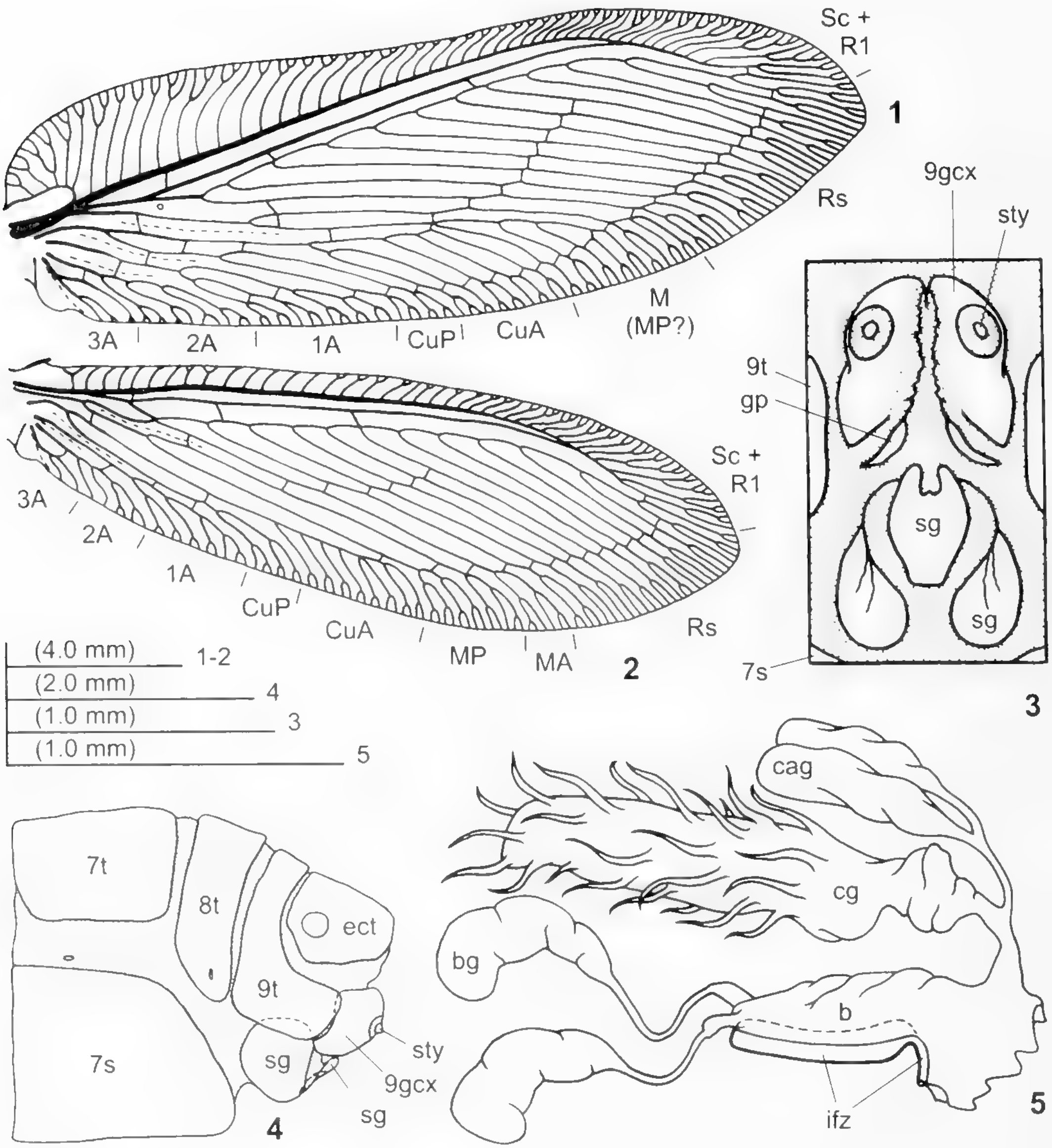
JOHN D. OSWALD

Department of Entomology, Texas A&M University, College Station, TX 77843-2475, U.S.A. (e-mail: j-oswald@tamu.edu).

Abstract.—*Polystoechotes gazullai* is redescribed and figured from a single female specimen collected near Vallenar, Chile, in 1989. This is the first new record of *P. gazullai* to be published since its original description in 1924. The whereabouts of the holotype of *P. gazullai* is unknown; consequently, the new specimen described here is also the only known extant specimen of this species. *Polystoechotes gazullai* appears to be correctly placed in the family Polystoechotidae, but its relationships with other polystoechotid species remain uncertain.

Key Words: Insecta, Polystoechotidae, giant lacewings, Chile

The small New World neuropteran family Polystoechotidae contains only four known extant species as follows (distributions in parentheses): *Fontecilla graphicus* Navás (Chile), *Platystoechotes lineatus* Carpenter (USA: California), *Polystoechotes punctatus* Fabricius (North America from southern Canada south to Panama), and *Polystoechotes gazullai* Navás (Chile). Polystoechotids are generally regarded as relatively "primitive" neuropterans related, somewhat tentatively, to ithonids and rapismatids. Although none of the species of the family Polystoechotidae are particularly well known, sufficient specimens of the first three species listed above have accumulated in collections to permit their adequate characterization. *Polystoechotes gazullai*, on the other hand, has remained enigmatic for many years. Originally described in 1924 by Longinos Navás from apparently a single specimen collected by the Jesuit father, Reverend Padre Gazulla, at Las Mercedes, Chile, no additional specimens of *P. gazullai* have subsequently been reported in the literature. The primary type of *P. gazullai*, formerly contained in Navás' personal collection, has apparently been lost or destroyed. Furthermore, Navás' original description of *gazullai* was unillustrated, rather brief and largely restricted to superficial venational and coloration characters. Consequently, the validity and identity of *P. gazullai* have long been questioned. A single new specimen attributable to *P. gazullai* was collected near Vallenar in north–central Chile by Robert Miller and Lionel Stange in 1989. This specimen, a female, provides the first opportunity to shed additional light on this species since its original description. The redescription provided below, based on this new specimen, provides the first available information on the terminalia of *P. gazullai* and the first illustrations of its wing venation. It is hoped that this redescription will bring *P. gazullai* to the attention of Chilean collectors and generate additional material, especially males, for additional study.



Figs. 1–5. *Polystoechotes gazullai,* female. 1, Forewing, dorsal (left forewing converted to right dorsal view). 2, Hind wing, dorsal (left hind wing converted to right dorsal view). 3, Abdominal apex detail, posteroventral. 4, Abdominal apex, lateral. 5, Internal genitalia, dorsolateral. Abbreviations: 1A, 2A, 3A, anal veins; 7s, seventh sternite; 7t, 8t, 9t, tergites; 9gcx, ninth gonocoxite; b, bursa; bg, bursal gland; cag, colleterial accessory gland; cg, colleterial gland; CuA, cubitus anterior; CuP, cubitus posterior; ect, ectoproct; gp, gonapophysis posterioris; ifz, insemination/fertilization canal; M, media; MP, media posterior; R1, first branch of radius; Rs, radial sector; Sc, subcosta; sg, subgenitale; sty, stylus.

Polystoechotes gazullai Navás (Figs. 1–6)

Polystoechotes gazullai Navás, 1924:14 (original description); Carpenter 1940: 268 (mentioned); Penny [1978]:49 (listed).

Diagnosis.—Readily distinguishable from *Fontecilla graphicus,* the only other polystoechotid known from the Americas south of Panama, by the following characters (corresponding characters in *F. graphicus* are given in parentheses): apex of forewing not falcate (falcate); mesothorax with a fuscous median stripe (mesothorax flavous medially); hind wing without prominent maculae (prominent maculations present, especially near margins); forewing with one nygma (two nygmata usually present, the distal nygma sometimes absent); hind wing lacking nygmata (one nygma usually present, sometimes absent).

Description.—*Head:* Partially retracted under pronotum; antenna filiform, ca. half as long as forewing; eyes hemispherical, small; ocelli absent; vertex covered with longer brown and shorter white recumbent macrotrichia.

Thorax: Pronotum short and broad; pro- and mesonotum covered with erect to suberect brownish macrotrichia and shorter recumbent white macrotrichia; mesonotum fuscous (medially and laterally) with a pair of parasagittal flavous stripes extending from prescutum to scutellum; legs densely setose; tibial spurs present, straight; tarsi 5-segmented; ungues simple, arched.

Forewing (Figs. 1, 6): *Length:* 19.5 mm; a single nygma present in radio-medial space slightly distal to fork R1-Rs, other nygmata lacking; jugal lobe prominent. *Venation:* trichosores (not shown in Figs. 1–2) prominent and distinct distally, fused into a marginal vein proximally; marginal end-twigging of longitudinal veins prominent; humeral vein pectinately branched, anterior humeral trace recurrent, enclosing an elongate humeral space; nearly all subcostal veinlets branched; pterostigmal region indistinct; subcosta distally touching R1, but not insensibly fused; subcosto-radial space with a single crossvein, located basally; radial space with two nearly complete gradate series, outer series continuing basally into medial, cubital and anal areas; anterior sectoral trace pectinate, with 12 branches proximal to the outer gradate series; R-Rs space with three crossveins. *Coloration:* Veins mostly fuscous, with irregular flavous segments; membrane hyaline with fuscous maculations, maculations especially prominent in pterostigmal region, adjacent to anterior radial and anterior cubital traces and along outer gradate series in medial and radial spaces; some maculae in basal portions of costo-subcostal, subcosto-radial and intraradial spaces vaguely aligned to form a pair of tenuous oblique bands. *Vestiture* (dorsal surface): veins bearing long erect to suberect fuscous setae and shorter, more recumbent, white setae; membrane with microtrichia absent except for extreme base of wing (e.g. humeral space, jugal space)

Hind wing (Figs. 2, 6): *Length:* 17.0 mm; nygmata entirely lacking; jugal lobe distinct. *Venation:* similar to forewing but costo-subcosal space narrower, humeral vein only slightly recurrent, not pectinately branched, most other proximal subcostal veinlets simple, distal veinlets of same space mostly forked; basal crossvein of subcosto-radial space weakly developed but present; anterior sectoral trace 10–12 branched; sigmoid vein (base of MA) present. *Coloration:* Veins hyaline to fuscous, but largely lacking prominent alternating segments of contrasting color; membrane largely hyaline, but with some brownish clouding, especially in pterostigmal region. *Vestiture* (dorsal surface): fuscous vein setae more recumbent, white vein setae largely lacking; microtrichia as in forewing.

Female terminalia: Tergite 7 (Fig. 4, 7t): Hemiannular, unmodified; *Sternite 7* (Fig. 4, 7s). Hemiannular, somewhat elongated ventrally, posterior margin shallowly emarginate medially. *Tergite 8* (Fig. 4, 8t): Hemiannular, dorsally about one-half as long as tergite 7, ventrolateral margins prolonged and enclosing spiracles of 8th somite, prolonged lobes narrowed and rounded. *Tergite 9* (Fig. 4, 9t): A narrow strap dorsally, expanded and subtending ectoprocts ventrally, not divided on dorsal midline. *Ectoprocts* (Fig. 4, ect): A single, broad, transverse plate, not divided or weakened on

Fig. 6. *Polystoechotes gazullai*, female, body and wings.

dorsal midline; cercal calli present, each with ca. 35 trichobothria, trichobothrial alveoli rosettiform. *9th gonocoxites* (Figs. 3–4, 9gcx): Present, reniform; stylus (sty) present as a short setose papilla. *Gonapophyses posteriores* (Fig. 3, gp): Present, a pair of crescentic, sclerotized, concave plates; *Subgenitale* (Figs. 3–4, sg): Present, large, tripartite, consisting of a small ovate median sclerite and a pair of larger lateral sclerites, lateral and median sclerites separated from each other by narrow membranous regions; median sclerite prominently emarginate distally and bearing a field of short setae on proximal half (not illustrated); lateral sclerites somewhat D-shaped in lateral view, asetose. *Bursa copulatrix* (Fig. 5, b): Walls membranous, colleterial gland (cg) and colleterial accessory glands (cag) present, attached to proximodorsal roof of bursa at a short common duct, colleterial gland bearing numerous slender processes, one pair of bursal glands (bg) present, each consisting of an inflated lobe joined by a slender duct to the bursa near the anterior end of the insemination/fertilization canal. *Insemination/fertilization canal* (Fig. 5, ifz): "Spermatheca" of the slit-entry type, thick-walled and darkly tanned, ventral surface shallowly concave; width gradually expanded posteriorly until abruptly narrowed at beginning of distal portion of fertilization canal, which is short and simply arched, not arranged as a series of arched loops.

Natural history and immature stages.—Unknown. The specimen redescribed here was collected at light in a desert region (L. Stange, personal communication).

Distribution.—Known only from Chile.

Primary type.—Holotype, sex unknown, not examined (holotype presumed, number of specimens examined by Navás unstated, description probably based on a single specimen). Formerly contained in the personal collection of L. Navás, now presumed lost or destroyed. Not listed in Monserrat (1985). Type data from original description [bracketed material added]: "Chile: Las Mercedes, R[everend]. P[adre]. Gazulla, Enero [=January] de 1924 (Col[ección].

m[ihi].).'' There are at least three localities and populated places in Chile named "Las Mercedes." These three range between 32°51′S and 34°44′S and are all in the vicinity of Santiago.

Material examined.—Chile: Antofagasta Prov.: 1♀, 16 km S. Vallenar, 10.ii.1989, 1000 m, R. Miller & L. Stange (Florida State Collection of Arthropods).

Etymology.—Unexplained, probably from the surname of Reverend Padre Gazulla, collector of the holotype.

Discussion.—The phylogenetic position of *P. gazullai* with respect to other polystoechotids is not entirely clear, and only a few general notes in this regard can be provided at the present time. A more detailed analysis will have to wait until a broader review of the family is available. Additionally, knowledge of the phylogenetic position of *P. gazullai* is negatively impacted by the fact that the male of this species is unknown.

Navás apparently placed *gazullai* in the genus *Polystoechotes* on the basis of the generally similar body form and on venational similarities. No combined generic diagnosis encompassing both species of *Polystoechotes* (*gazullai* and *punctatus*) has ever been published, and there is no evidence that any neuropterist other than Navás ever examined the holotype of *P. gazullai.* Comparisons between *P. punctatus* and *P. gazullai* made for this work suggest that the two species are not particularly closely related, although they share many apparently plesiomorphic traits.

The wing venation of both *Polystoechotes* species is similar, but this similarity is due largely to the possession of traits that are probably plesiomorphic at the level of this family (e.g. in the forewing: trichosores present distally; end-twigging of longitudinal veins well developed; Rs originating near wing base; Rs with numerous pectinate branches; cubital and anal areas well developed; nygmata present; and, in the hind wing: a sigmoid vein present). The shape of the forewing and the humeral space differ significantly between the two species. In *P. gazullai* (Fig. 1), the forewing humeral region is broad and the margins of the wing are nearly parallel sided basally. In *P. punctatus* (see Carpenter 1940:268, fig. 69), the forewing humeral region is narrow (only slightly wider than the width of the costo-subcostal space distally), and the hind margin of the wing is prominently rounded. One notable (derived?) similarity between the two species is the nearly total restriction of the end-twigging of forewing Rs branches to the immediate vicinity of, or beyond, the outer gradate series.

The female terminalia of both *Polystoechotes* species are also of generally similar form. But, this similarity is also probably based on plesiomorphic traits (e.g. eighth tergite ends enclosing spiracles of eighth somite; ninth tergite ends enlarged posteroventrally and subtending ectoprocts; ectoprocts in the form of a single, undivided, transverse plate; paired ninth gonocoxites present, and each bearing a distinct stylus; sclerotized portion of insemination/fertilization canal narrow and with only a short distal duct; colleterial, colleterial accessory and bursal glands all present). The subgenitale is strongly developed in both *P. gazullai* and *P. punctatus* (as in other polystoechotids), but is of substantially different form in the two species. In *P. gazullai,* the subgenitale is distinctly tripartite, consisting of a distally emarginate, suboval, median plate, which is flanked by a pair of large D-shaped (lateral view) lateral plates. All three plates are closely membranously associated ventrally (Fig. 3), and the morphology and arrangement of these sclerites is similar to the condition found in the other Chilean polystoechotid species, *Fontecilla graphicus.* In *P. punctatus,* the subgenitale is a single broad median sclerite that possesses a strongly-sclerotized, ascending, lateral lobe on each side. From the anterodorsal angles of these lobes arises a slender sclerotized bridge that arches across the dorsal surface of the bursa over the insemination/fertilization canal. This bridge is unique within the family Polystoechotidae, and nothing similar is present in *P. gazullai.* The modifications of the subgenitale found in polystoechotids appear to be associated with a specialized method of male/female coupling in this group.

The lack of convincing synapomorphic traits linking *P. gazullai* and *P. punctatus* is reason to question the sister-group relationship implied between these species by their congeneric taxonomic status. However, until a more general analysis of relationships within the Polystoechotidae (and between polystoechotids and the apparently related "primitive" taxa in the families Ithonidae and Rapismatidae) can be undertaken, I believe that it is premature to make any substantive change to the taxonomy of *P. gazullai.* Consequently, *gazullai* is provisionally retained here in the genus *Polystoechotes.*

ACKNOWLEDGMENTS

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REVISION OF NORTH AMERICAN *ALEIODES* WESMAEL (PART 3): THE *SERIATUS* (HERRICH-SCHAEFFER) SPECIES-GROUP (HYMENOPTERA: BRACONIDAE: ROGADINAE)

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Abstract.—The *Aleiodes seriatus* (Herrich-Schaeffer) species-group is defined to include the following previously described species: *A. seriatus* (Herrich-Schaeffer), *A. femoratus* Cresson, *A. bakeri* (Brues), *A. nigristemmaticum* (Enderlein) **n. comb.**, *A. nigribasis* (Enderlein) **n. comb.**, *A. scriptus* (Enderlein) **n. comb.**, *A. nigricosta* (Enderlein) **n. comb.**, *A. percurrens* (Lyle) **n. comb.** and *A. sanctivincentensis* (Shenefelt) **n. comb.** (replacement name for *Rhogas pectoralis* Ashmead). Five new species are also described: ***A. akidnus* n. sp.**, ***A. pardalotus* n. sp.**, ***A. preclarus* n. sp.**, ***A. virginiensis* n. sp.**, and ***A. wahli* n. sp.** The *Aleiodes seriatus* species-group is considered monophyletic and distinguished by a row of flattened, coalesced setae at the apex of the hind tibia on the inner side. An identification key, descriptions, distribution and biological information for the seven North American species are provided.

Key Words: Braconidae, *Aleiodes*, taxonomy, revision

The rogadine braconid genus *Aleiodes* Wesmael is worldwide in distribution, but is particularly species-rich in the Holarctic Region. *Aleiodes* is well diversified in North America, with at least 90 species in the United States and Canada (S. Shaw et al. 1997). This study is the third in a series of planned papers on *Aleiodes* species-groups, intended to provide a complete revision of the genus for North America (see S. Shaw et al. 1997, 1998). The *A. seriatus* (Herrich-Schaeffer) group is moderate sized with species occurring in the Palaearctic, Nearctic, Neotropical and Indo-Australian regions. This is a distinctive monophyletic group with all species having a row of flattened, coalesced setae (Figs. 10, 11) at the apex of the hind tibia on the inner side (see discussion below under Comments after the species-group diagnosis). Our definition of this species-group includes all species known to us worldwide. However, because our main intent is to provide a revision of the North American species, species treatments are limited to the Nearctic fauna.

Aleiodes species are koinobiont endoparasitoids of lepidopterous larvae, especially macrolepidoptera of the superfamilies Noctuoidea and Geometroidea, and to a lesser extent, Arctioidea, Sphingoidea, and Papilionoidea (S. Shaw et al. 1997). Very little is know about the biology of the *seriatus* species-group, but the few records indicate parasitism of hadenine and catocaline noctuids and arctiids. The method of parasitism, unique to the tribe Rogadini, is noteworthy: the *Aleiodes* larva completes its feeding and pupates within the shrunken and mummified remains of the host caterpillar. In all known cases, the form of the mummy caused by a particular *Aleiodes* species is characteristic for that host and parasitoid, so mummified remains are of considerable diagnostic value and should be retained with the parasitoid when reared. For a more complete discussion of *Aleiodes* biology, readers may refer to M. Shaw (1983, 1994), M. Shaw and Huddleston (1991), S. Shaw (1995, 1997), and S. Shaw et al. (1997).

METHODS

Species covered in this paper can be identified as members of the subfamily Rogadinae using the keys of S. Shaw (1995), M. Shaw and Huddleston (1991) or Wharton et al. (1997). Our definition of *Aleiodes* follows that of S. Shaw (1993), S. Shaw et al. (1997) and van Achterberg (1991). Specimens can be determined as *Aleiodes* using the keys of Shaw (1997). The species-groups of North American *Aleiodes* can be keyed using the key provided in S. Shaw et al. (1997).

Terminology follows that used for *Aleiodes* by S. Shaw (1997), S. Shaw (1993) and Marsh (1989). Microsculpture terminology follows that of Harris (1979). General terminology and in particular wing vein terminology agrees with the system adopted for the Manual of New World Genera of the Family Braconidae (Wharton et al. 1997) and agrees closely to that of Goulet and Huber (1993). A labeled diagram of wing veins was provided by S. Shaw et al. (1997).

Acronyms for collections where type material is deposited are as follows: AEI (American Entomological Institute, Gainesville, FL), ABS (Archbold Biological Station, Lake Placid, FL), ANSP (Academy of Natural Sciences, Philadelphia), FSCA (Florida State Collection of Arthropods, Gainesville, FL), NCDA (North Carolina Department of Agriculture, Raleigh, NC), PASW (Polish Academy of Sciences, Warsaw), RMSEL (Rocky Mountain Systematic Entomology Laboratory, University of Wyoming, Laramie, WY), USNM (National Museum of Natural History, Smithsonian Institution, Washington, DC), WVU (West Virginia University, Morgantown, WV).

ALEIODES SERIATUS SPECIES-GROUP

Included species.—*seriatus* (Herrich-Schaeffer) 1838, Europe; *femoratus* Cresson 1896, U.S.; *bakeri* (Brues) 1912, Brazil; *nigristemmaticum* (Enderlein) 1920, **n. comb.,** U.S., Mexico, Central and northern South America; *nigribasis* (Enderlein) 1920, **n. comb.,** Ecuador; *scriptus* (Enderlein) 1920, **n. comb.,** Brazil; *nigricosta* (Enderlein) 1920, **n. comb.,** Brazil; *percurrens* (Lyle) 1921, **n. comb.,** India; *sanctivincentensis* (Shenefelt) 1975, **n. comb.** (replacement name for *pectoralis* Ashmead 1894), St. Vincent; *akidnus,* n. sp.; *pardalotus,* n. sp.; *preclarus,* n. sp.; *virginiensis* n. sp.; and *wahli,* n. sp.

Diagnostic characters.—Eyes and ocelli usually large, the ocellocullar distance equal to diameter of lateral ocellus, sometimes much less (Figs. 1, 2, 5), one species with smaller ocelli with the ocellocular distance twice the ocellar diameter (Figs. 3, 4); hind wing vein RS usually straight (Fig. 8) or bent downward after the middle (Figs. 6, 7), occasionally slightly sinuate (Fig. 9); hind tibia with dense cluster of flattened setae at apex on inner side (Figs. 10, 11).

Comments.—This is a moderately sized mostly New World species-group associated with noctuids and arctiids. We have seen numerous undetermined specimens from Costa Rica indicating that this species-group is probably well represented in the Neotropical Region. The cluster of flattened setae at the apex of the hind tibia will distinguish the species from all other groups.

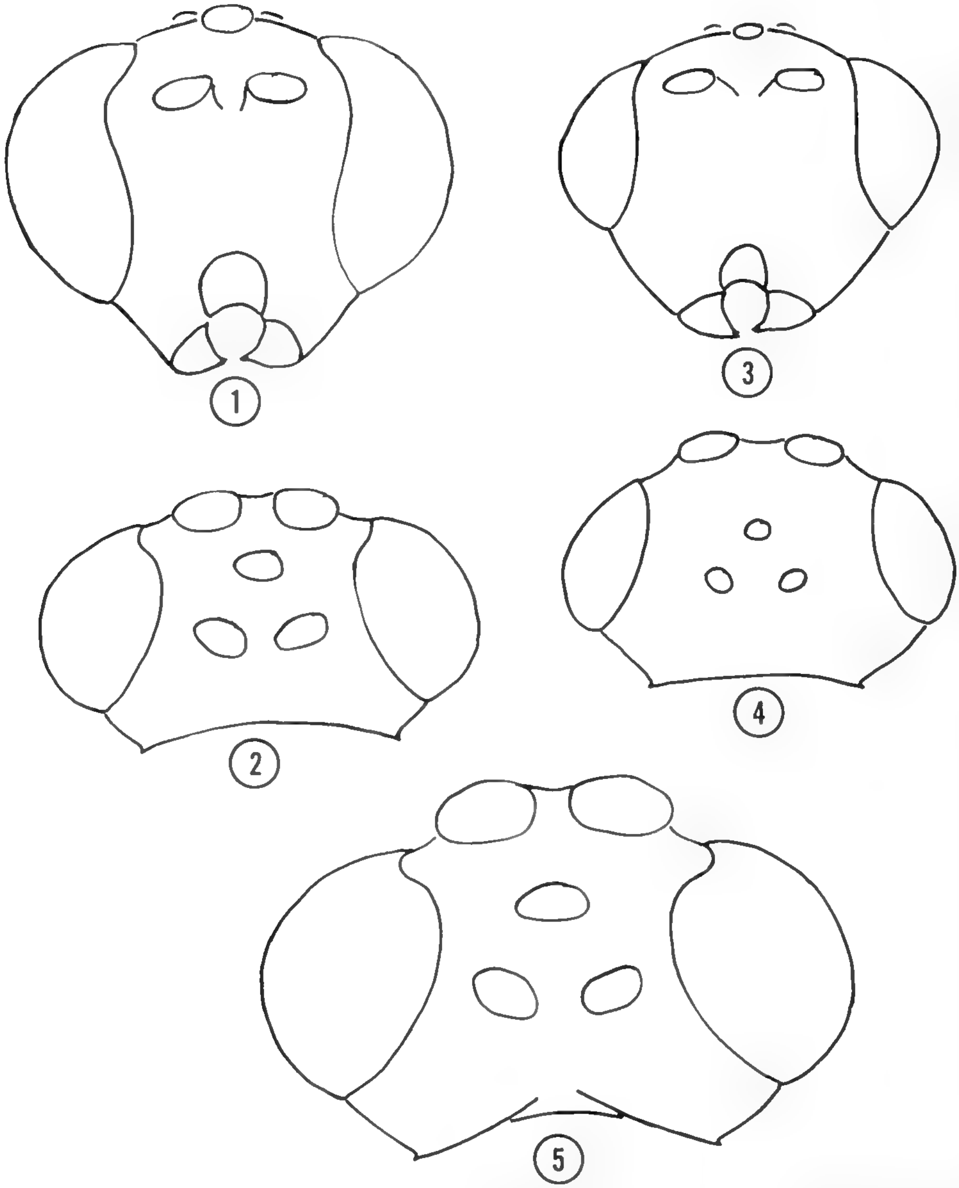
Recent research by Fortier (1997) indicates that the *seriatus*-group is monophyletic, as defined by the specialized row of flattened setae on the hind tibia. However, some confusion could result because this feature is convergently evolved in some other rogadine genera including *Rogas* Nees, *Cystomastax* Szepligeti, and *Macrostomion* Szepligeti (see Figs. 16, 17 of Shaw 1997), as well as in the homolobine genus *Exasticolus* (see Fig. 7 of Wharton 1997). Careful attention needs to be given to the details of tarsal claw form, propodeal and mesopleural sculptural, and forewing venation to avoid confusing members of the *Aleiodes seriatus*-group with other rogadines having a similar fringe of flat setae (Shaw 1997). Most notably, all species of *Rogas, Cystomastax,* and *Macrostomion* have the tarsal claw with a large, blunt basal lobe or tooth, while this feature is absent in the *Aleiodes seriatus*-group. It was suggested by van Achterberg (1979) that in *Exasticolus* this flattened "comb" of setae may "facilitate walking on the webs of the hosts" which are Lasiocampidae. However, it seems unlikely that this structure was evolved for that function for two reasons: first, the feature occurs in several genera that parasitize a variety of different lepidopteran hosts (including Limacodidae, Lycaenidae, Riodinidae, Arctiidae, and Noctuidae), most of which do not form extensive silk-shelters as in lasiocampids; and secondly, the feature is not sexually dimorphic, therefore occurs in males that are not involved in host-searching. Although it is true that all the species having this characteristic seem to be nocturnally-active parasitoids of exposed-feeding lepidopteran larvae, the comb of seta may have no host-related function at all. Perhaps it is an adaptation for cleaning the body, or perhaps it is merely the result of genetic drift and has no particular function. Clearly, behavioral observations of species in these genera are needed to resolve this issue.

KEY TO THE NORTH AMERICAN SPECIES OF THE *SERIATUS*-GROUP

1. Ocelli small, ocellocular distance 2 times or more diameter of lateral ocellus (Fig. 4); fore wing vein r equal to or longer than 3RSa (Fig. 9) . *akidnus,* new species
– Ocelli large, ocellocular distance at most equal to diameter of lateral ocellus, usually much less (as in Figs. 2, 5); fore wing vein r shorter than 3RSa (as in Figs. 6–8) 2
2(1). Metasoma yellow with black spots on basal ½ of first tergum and laterally on second and third terga *pardalotus,* new species
– Metasoma uniformly brown, orange or honey yellow 3
3(2). Hind wing vein RS straight, marginal cell gradually widening to wing apex (Fig. 8); fore wing stigma brown, at most yellow at extreme apex . . . . *femoratus* Cresson
– Hind wing vein RS parallel to wing margin on basal ⅓, suddenly curved downward, marginal cell suddenly widened at apex (Figs. 6, 7); fore wing stigma yellow or bicolored brown with yellow at base and apex 4
4(3). Fore wing stigma entirely yellow; occipital carina complete across vertex (Fig. 2) . . . . *nigristemmaticum* (Enderlein)
– Fore wing stigma bicolored brown with yellow at apex and base; occipital carina interrupted on vertex (Fig. 5) 5
5(4). Mesosoma and legs entirely honey yellow, tegula yellow . . . . . *virginiensis,* new species
– Mesosoma yellow with black or dark brown markings, hind femur brown on apical ¾, hind coxa brown apicoventrally, tegula brown 6
6(5). Antennal flagellum yellow . . . . *wahli,* new species
– Antennal flagellum black . . . . *preclarus,* new species

Aleiodes akidnus Marsh and Shaw, new species
(Figs. 3, 4, 9)

Female.—*Color:* honey yellow, legs somewhat lighter, ocellar triangle black, flagellum brown except basal flagellomeres yellow, wings hyaline, veins brown. *Size:* body length, 4.0 mm; fore wing length, 3.0 mm. *Head:* eyes and ocelli small; 43–45 antennomeres, all flagellomeres longer than wide; malar space long, length twice basal



Figs. 1–5. Heads of *Aleiodes* spp. 1, *A. nigristemmaticum,* anterior view. 2, *A. nigristemmaticum,* dorsal view. 3, *A. akidnus,* anterior view. 4, *A. akidnus,* dorsal view. 5, *A. virginiensis,* dorsal view.

width of mandible and ⅔ eye height (Fig. 3); temple wide, about ½ eye width; occipital carina complete, reaching hypostomal carina; hypoclypeal depression small and circular, diameter about equal to basal width of mandible and ⅓ face height; mandibles small, tips not touching when closed; clypeus swollen; ocelli small, ocellocular distance slightly more than twice diameter of lateral ocellus (Fig. 4); face, frons, temple and vertex entirely coriaceous, face with raised longitudinal ridge below antennae; maxillary palpus not swollen. *Mesosoma:* pronotum rugulose coriaceous, median length about equal to length of first flagellomere; mesonotum coriaceous; notauli very weak and indistinct, indicated only by weak rugulose lines, small rugulose area before scutellum where notauli would meet; scutellum coriaceous, bordered laterally by carina; mesopleuron coriaceous, weakly rugose on subalar area and medially, sternaulus absent; propodeum rugulose coriaceous dorsally, coriaceous laterally, median carina complete. *Wings:* (Fig. 9): fore wing with vein r equal to or slightly longer than vein 3RSa, second submarginal cell nearly square, vein RS+Mb slightly longer than vein r, vein 1cu-a beyond vein 1M by distance slightly more than length of vein 1cu-a; hind wing vein RS weakly sinuate, marginal cell narrowest in middle, vein r-m shorter than vein 1M, veins M+CU and 1M about equal in length, vein m-cu absent. *Legs:* tarsal claws not pectinate; hind tibia with row of dense coalesced flattened setae at apex on inner side. *Metasoma:* first tergum costate coriaceous, longer than apical width, median carina complete; second tergum costate coriaceous, median carina complete; third tergum costate coriaceous on basal ¾, coriaceous on apical ¼, median carina complete; remainder of terga finely coriaceous; ovipositor short, about ½ length hind basitarsus.

Male.—Unknown.

Holotype.—♀: FLORIDA, Monroe Co., Big Pine Key, Alligator Pond, July 2, 1978, L. Stange, black light trap. Deposited in FSCA.

Paratypes.—FLORIDA: 2 ♀, Leon Co., Tall Timbers Res. Sta., August 4–19, 1971, D. L. Harris; 1 female, Gainesville, October 31, 1965, Ladonia O'Berry. Deposited in USNM, RMSEL, FSCA.

Distribution.—Florida.

Biology.—Unknown.

Comments.—This species departs markedly from the other species in this group by its smaller eyes and ocelli and its wing venation. However, it is similar in habitus to other species with the flattened setae at the apex of the hind tibia, such as *sanctivincentensis* and a few undescribed species from Central America.

Etymology.—The specific name is from the Greek *akidnus* meaning "weak or feeble," in reference to the weak, indistinct notauli.

Aleiodes femoratus Cresson
(Fig. 8)

Aleiodes femoratus Cresson 1869: 382.

Diagnosis.—Body unicolored honey yellow, propleuron and mesopleuron dorsally and hind femur often marked with brown, wings lightly dusky, veins brown except C+Sc+R and 1R1 of fore wing which are yellow; body length 6.0–7.0 mm; 47–52 antennomeres; length of malar space equal to basal width of mandible; hypoclypeal depression small and circular, diameter less than basal width of mandible; face costulate-rugose, frons rugulose, vertex and temple coriaceous; propleuron rugose; mesonotum and scutellum coriaceous; sternaulus rugose; propodeum rugulose coriaceous, median carina present only basally; first, second and basal ⅔ of third metasomal terga costate, median carina complete on first and second terga and base of third; fore wing (Fig. 8) with vein 1cu-a beyond 1M by distance greater than length of 1cu-a, vein r nearly as long as 3RSa, second submarginal cell short; hind wing with marginal cell gradually widening, vein RS straight, vein r-m longer than 1M; hind tibia with dense cluster of coalesced flatted setae on inner side at apex, tarsal claws not pectinate.

Type material examined.—*Aleiodes femoratus* Cresson, holotype ♀, West Virginia [ANSP].

Distribution.—We have examined specimens from West Virginia, Virginia, Maryland, North Carolina, Florida and Illinois. Probably occurs throughout the eastern U.S.

Biology.—Unknown.

Comments.—This species can be distinguished from others in the *seriatus* group by the unicolored stigma in the fore wing, the gradually widening marginal cell and the straight vein RS in the hind wing.

Aleiodes nigristemmaticum (Enderlein), **new combination**
(Figs. 1, 2, 6, 10–12)

Rhogas nigristemmaticum Enderlein (1918)1920: 156.

Diagnosis.—Body unicolored yellow, scape and pedicel marked with light brown, flagellum brown on basal half to light brown at apex, ocellar triangle black, apical tarsomeres brown at apex, wings hyaline, veins light brown except C+Sc+R, stigma and 1R1 yellow; body length, 6.5–7.5 mm; 50–57 antennomeres; head coriaceous, eyes and ocelli large, covering most of head; malar space about equal to basal width of mandible and about ¼ eye height (Fig. 1), temple very narrow; hypoclypeal depression small and circular, diameter equal to malar space; ocellocular distance less than diameter of lateral ocellus (Fig. 2); occipital carina complete; mesonotum and scutellum coriaceous, notauli weakly indicated; mesopleuron coriaceous, sternaulus rugulose; propodeum rugulose-coriaceous, median carina complete; first, second and base of third metasomal terga costate, median carina complete to base of third tergum; fore wing (Fig. 6) with vein 1cu-a beyond 1M by distance greater than length of 1cu-a, vein r nearly as long as 3RSa; hind wing with vein RS parallel to wing margin on basal ⅓, suddenly curved downward so marginal cell is suddenly widened to apex, vein r-m longer than 1M; hind tibia with dense cluster of coalesced flattened setae on inner side at apex (Figs. 10, 11), tarsal claws not pectinate.

Type material examined.—*Rhogas nigristemmaticum* Enderlein, lectotype ♀ (here designated), Chiapas, Mexico [PASW]; paralectotype ♀, same data.

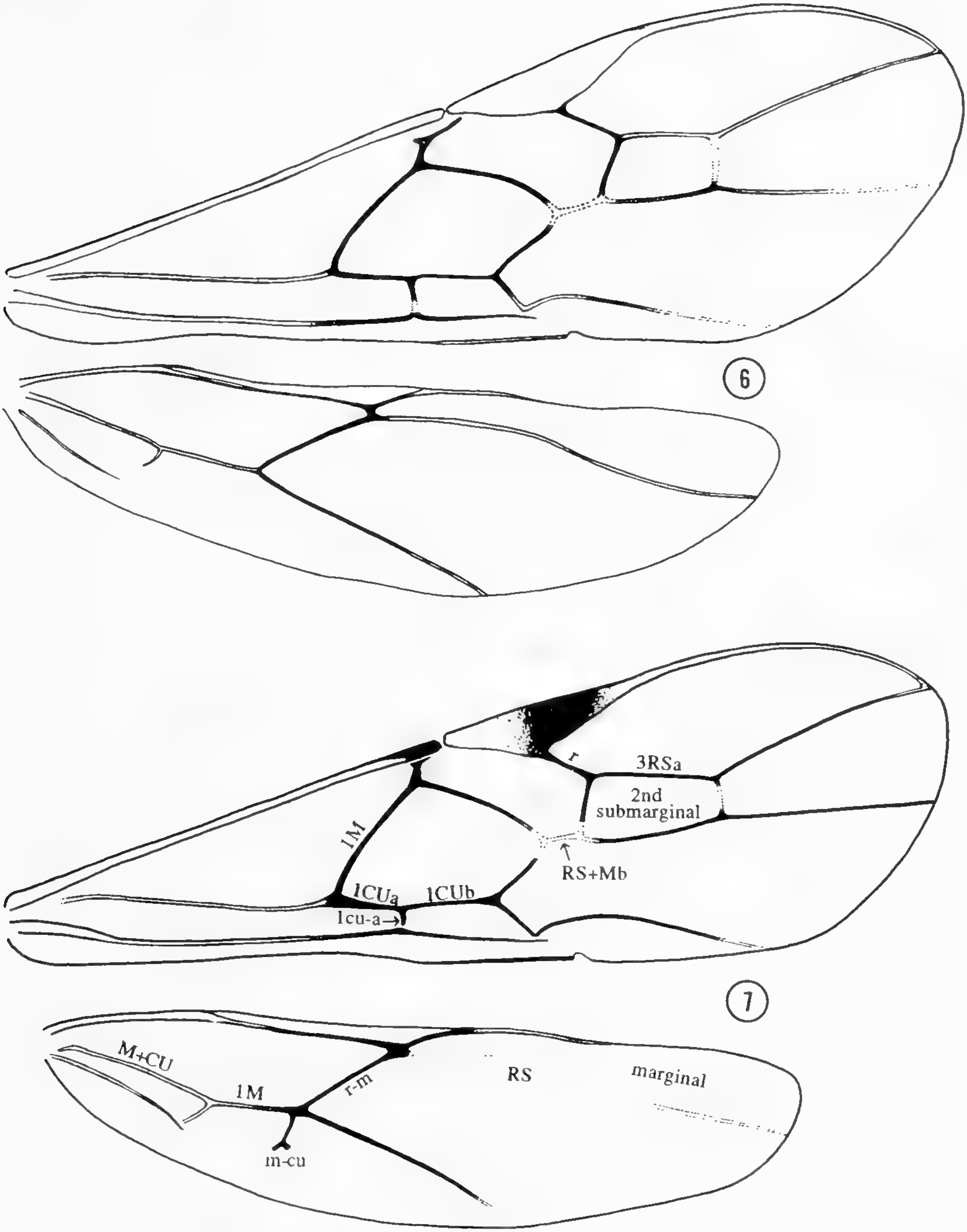
Distribution.—Florida, Mississippi, Mexico, Central America, northern South America, West Indies.

Biology.—Observations on the biology of *A. nigristemmaticum* were made at the La Selva Research Station, Heredia Province, Costa Rica, during August 1994 by Mr. Les Price. The study site was an early successional secondary regrowth forest area, known locally as "La Flaminia," with dominant plants being *Mimosa,* grasses and *Phyllanthus* vines that were the food plant of the *Mocis* sp. larvae (Noctuidae) parasitized by *Aleiodes.* The parasitized host larva situated itself vertically on the host plant, with the head facing downward. The parasitoid larva formed a "glue-hole" at the prothoracic venter of the parasitized host larva, attaching the host to the substrate. As mummification progressed, the host larva projected its posterior end outward and upward at a 45° angle, and the larval cuticle is sloughed off anteriorly to form a dark brown to blackish mummy. The resulting mummy is very cryptic and resembles a plant bud or sepal (Fig. 12) due to its shape and color, and also its position on the plant. This may serve to protect the developing parasitoid from visually searching predators, such as birds, frogs and lizards, but it apparently is still quite exposed to hyperparasitism. Of the 28 host mummies collected, only three adults of *A. nigristemmaticum* emerged while seven hyperparasitoids of the genus *Conura* Spinola (Chalcididae) emerged during the same period. We have seen specimens from Venezuela and Honduras reared from *Mocis latipes* (Gn.).

Comments.—This species is distinguished by its yellow stigma, complete occipital carina and suddenly widened marginal cell of the hind wing.

Aleiodes pardalotus Marsh and Shaw, new species

Female.—*Color:* ground color of body yellow; head with brown spot on face, brown spots on occiput behind eye, ocellar triangle black, scape brown on outer edge, pedicel brown, flagellum gradually turning light brown to apex; pronotum with black spot laterally behind head; median meso-



Figs. 6, 7. Wings of *Aleiodes* spp. 6, *A. nigristemmaticum*. 7, *A. virginiensis*.

notal lobe black on apical ½, lateral lobes black medially; scutellum black; mesopleuron with black spots on subalar area and venter; propodeum black basally; first metasomal tergum black on basal ½, second tergum with black spot laterally, third tergum with black spot laterally and medially at apex, fourth tergum black medially; apex of hind coxa with black spot laterally, hind femur black at apex, hind tibia brown at base, middle and hind apical tarsomeres black; wings hyaline, veins brown except stigma yellow at apex and base, fore wing vein C+SC+R yellow medially. *Size:* body length, 5.5 mm; wing length, 4.5 mm. *Head:* eyes and ocelli large, covering most of head; 50 antennomeres, all flagellomeres short, only slightly longer than wide; malar space short, equal to basal width of mandible and ⅕ eye height; temple narrow, ⅕ eye width; occipital carina reaching hypostomal carina, slightly interrupted on vertex behind ocelli; hypoclypeal depression small and circular, width equal to basal width of mandible and less than ½ face height; maxillary palpus not swollen; mandibles small, tips not touching when closed; clypeus not swollen; ocelli large, ocellocular distance about ⅓ diameter of lateral ocellus; face and frons weakly rugulose coriaceous, vertex and temple coriaceous. *Mesosoma:* pronotum strongly porcate; mesonotum and scutellum strongly coriaceous; notauli distinct but weakly impressed, meeting in large rugose area before scutellum; mesopleuron coriaceous with median and subalar area rugose, sternaulus absent; propodeum rugose coriaceous dorsally, coriaceous laterally, median carina complete. *Wings:* fore wing with vein r ½ length 3RSa, vein 1cu-a beyond 1M by distance slightly more than twice length of 1cu-a, vein 1CUa only slightly shorter than 1CUb; hind wing vein RS slightly sinuate, marginal cell narrowest in middle, vein r-m longer than 1M, vein M+CU slightly more than twice length of 1M, vein m-cu weak, represented by very short fuscous line. *Legs:* tarsal claws not pectinate; hind tibia with row of dense coalesced flattened setae at apex on inner side. *Metasoma:* first tergum longer than apical width,costate coriaceous, median carina complete; second tergum costate coriaceous, median carina complete; third tergum costate coriaceous on basal ¾, coriaceous on apical ¼, median carina complete on basal ¾; remainder of terga coriaceous; ovipositor about ⅓ length of hind basitarsus.

Male.—Unknown.

Holotype.—♀: FLORIDA, Archbold Biol. Sta., Lk. Placid, Highlands Co., January 25, 1985, M. Deyrup. Deposited in USNM.

Distribution.—Known only from the type locality in Florida.

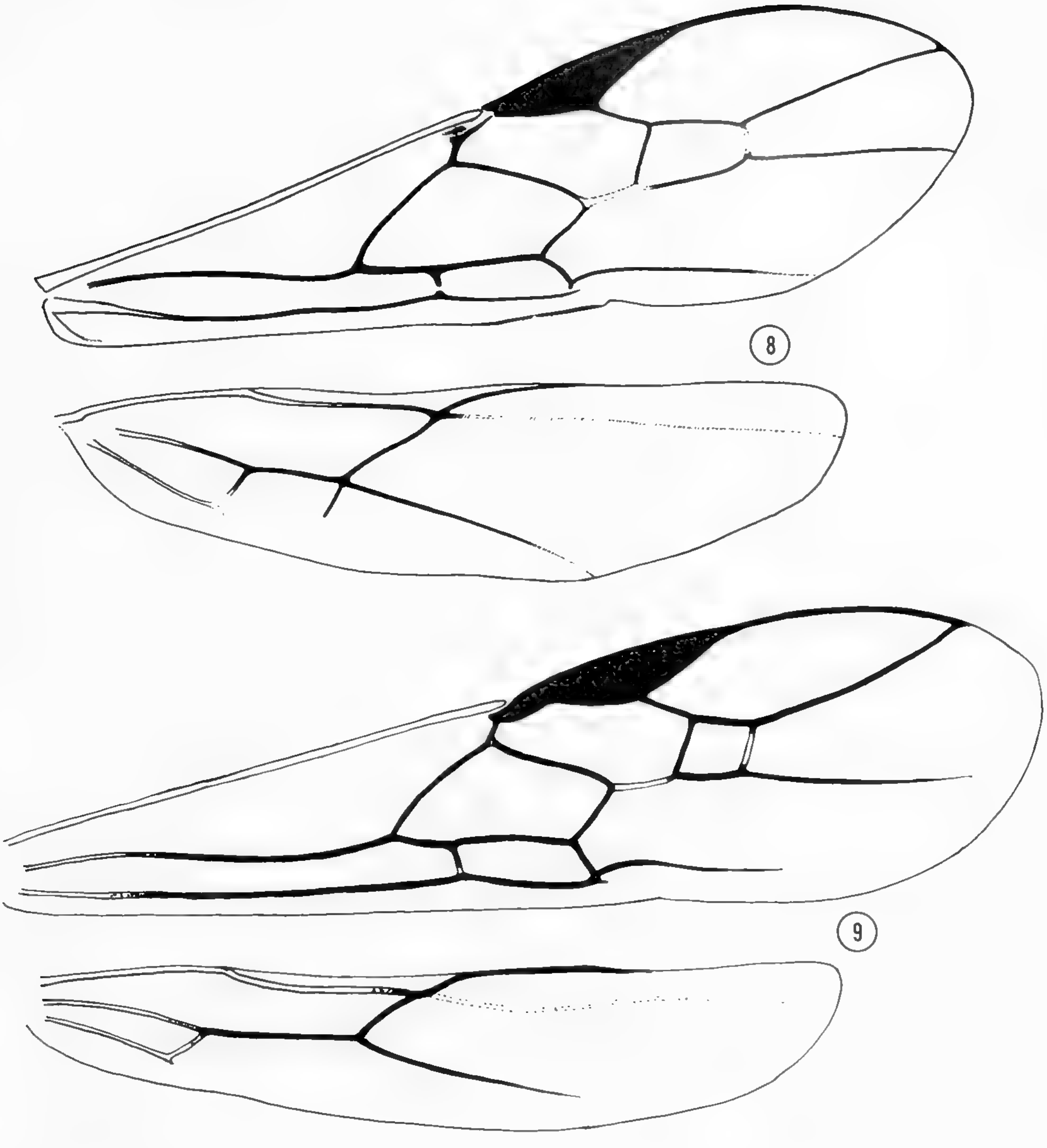
Biology.—Unknown.

Comments.—This species is very distinct from others in this group as well as all North American species in the genus by its distinctive spotted color pattern. We have seen similar color patterns in a few unidentified specimens from Central America and it is possible *pardalotus* is a northern extension of a Neotropical species.

Etymology.—The specific name is from the Greek *pardalotus* meaning "spotted like a leopard" in reference to its spotted color pattern.

Aleiodes preclarus Marsh and Shaw, new species

Female.—*Color:* antenna black, scape yellow ventrally, pedicel yellow at apex, first flagellomere yellow at base; head yellow, face medially, clypeus, ocellar triangle, occiput and lower part of temple black; propleuron black; pronotum yellow with black spot dorsally; mesonotum black, occasionally yellow medially; mesonotum black, yellow dorsally; propodeum yellow dorsally, black dorsal-laterally, yellow laterally; metasoma orange, first tergum black at basal lateral corners; fore leg yellow, middle leg yellow, middle femur black at apex, hind coxa yellow, black at apex, hind trochanters yellow, hind femur black, yellow at base, hind tibia black, yellow at base, hind tarsus yellow; wings hyaline, infuscated around veins, veins black, fore wing vein C+SC+R yellow in middle, veins M+Cu and 1–1A yellow, stigma black with weak yellow spots at extreme base and apex, hind wing veins C+SC+R, SC+R, M+Cu, 1M, 1A and cu-a yellow, tegula brown. *Size:* body length, 5.5–6.0 mm; fore wing length



Figs. 8, 9. Wings of *Aleiodes* spp. 8, *A. femoratus*. 9, *A. akidnus*.

5.5–6.0 mm. *Head:* eyes and ocelli large, covering most of head; 52–55 antennomeres, all flagellomeres longer than wide; malar space short, slightly shorter than basal width of mandible and about ⅕ eye height; temple narrow, about ¼ eye width; occipital carina briefly interrupted behind ocelli, meeting hypostomal carina; hypoclypeal depression small and circular, diameter equal to malar space; clypeus swollen; ocelli moderate in size, ocellocular distance about ¾ diameter of lateral ocellus; face coriaceous rugulose, frons procate coriaceous, vertex and temple coriaceous, occiput smooth and shining; maxillary palpus not swollen. *Mesosoma:* pronotum porcate; mesonotum and scutellum strongly coriaceous; notauli weak and finely scrobiculate, meeting in small rugose area before scutellum; mesopleuron coriaceous dorsally, strongly rugose ventrally along sternaulus and at subalar sulcus; propodeum rugose coriaceous dorsally, coriaceous laterally, median carina complete. *Wings:* fore wing with vein r ½ length of 3RSa, vein 1cu-a beyond 1M by distance equal to twice length of 1cu-a, vein 1CUa only slightly shorter than 1CUb; hind wing with vein RS parallel to wing margin for ½ its length, angled downward beyond, marginal cell widened to apex, vein 1r-m longer than 1M, vein M+CU twice as long as 1m, vein m-cu a distinct tubular vein and about ¾ as long as 1M. *Legs:* apex of hind tibia with dense cluster of flattened setae on inner side; tarsal claws not pectinate. *Metasoma:* first tergum costate coriaceous, longer than apical width, median carina complete; second tergum costate coriaceous, median carina complete; third tergum costate coriaceous on basal ⅔, coriaceous on apical ⅓, median carina on basal ⅔; remainder of terga finely coriaceous; ovipositor about ¼ length of hind basitarsus.

Male.—Essentially as in female; flagellum yellow, stigma more distinctly bicolored.

Holotype.—♀: WEST VIRGINIA, Pocahontas Co., Monongahela National Forest, June 5, 1995, plot 16–10, Petrice/Roth, ex *Hypoprepia fucosa* on white oak, em. June 19, 1995. Deposited in USNM.

Paratypes.—WEST VIRGINIA: 2 ♀, same data as holotype with dates of May 29, 1995 and July 1, 1996 and host tree of red oak. VIRGINIA: 1 ♂, George Washington National Forest, Dearfield Co., May 22, 1995, Petrice/Roth, ex. *Hypoprepia fucosa* on red maple. KENTUCKY: 1 ♀, Crail Hope, July 7, 1948, Carl Cook. Deposited in USNM, RMSEL, WVU.

Distribution.—Known only from the states of West Virginia, Virginia, and Kentucky.

Biology.—Reared from the lichen-feeding arctiid *Hypoprepia fucosa* Hbn. on white oak, red oak, and red maple.

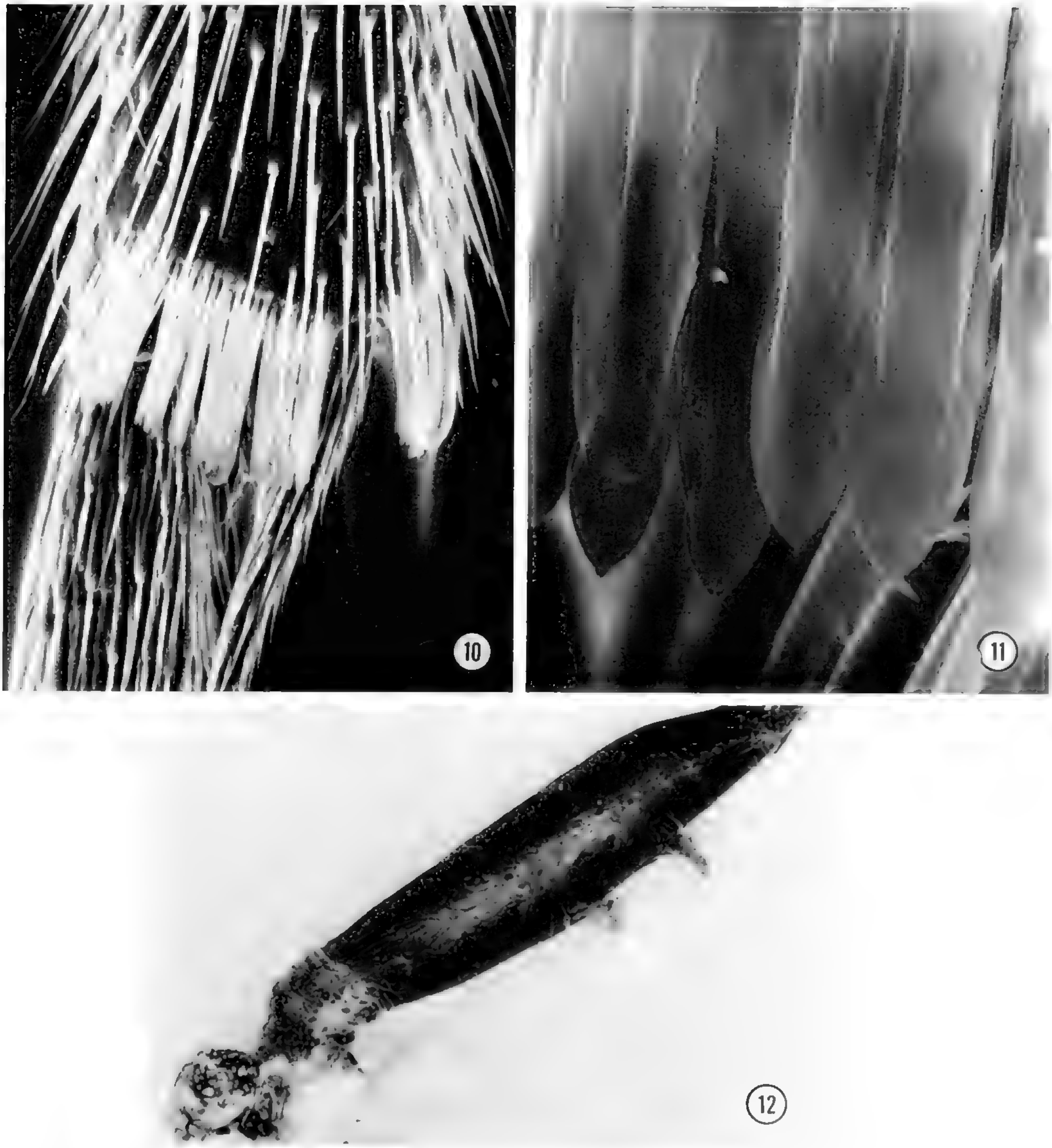
Comments.—This species is similar to *wahli* but can be distinguished by its black flagellum. The distinction between *preclarus, wahli* and *virginiensis* is mostly by color; perhaps after more material is collected it will be shown that this as all one species with a large range of color.

Etymology.—The specific name is from the Latin *preclarus* meaning very beautiful, splendid, in reference to the striking coloration of this species.

Aleiodes virginiensis Marsh and Shaw, new species

(Figs. 5, 7)

Female.—*Color:* entire body including antennae honey yellow, propodeum dorsally, metasomal terga 1–3 and hind femora somewhat darker; scape and pedicel with brown longitudinal stripe on posterior side, apex of flagellum occasionally darker; ocellar triangle black; wings slightly dusky, stigma bicolored brown with yellow at base and apex, fore wing veins C+Sc+R, M+Cu, 1–1A and 1-R1 yellow, remainder of veins brown, tegula yellow, hind wing veins 1-Sc+R, M+Cu, 1-M, 1–1A and cu-a yellow, remainder of veins brown. *Size:* body length, 7–8 mm; fore wing length, 6–7 mm. *Head:* eyes and ocelli large, covering much of head; 58–63 antennomeres, all flagellomeres longer than wide; malar space short, equal to basal width of mandible and about ¼ eye height; temple very narrow, at its narrowest nearly ⅕ eye width; occipital carina reaching hypostomal carina, interrupted on vertex below ocelli (Fig. 5); hypoclypeal depression small and circular, width equal to basal width of mandible and less than ½ face height; clypeus weakly swollen; ocelli large, ocellocular distance ½ diameter of lateral ocellus (Fig. 5); face and frons coriaceous and weakly rugulose, temple and vertex coriaceous; maxillary palpus not swollen; mandibles small, tips not crossing when closed. *Mesosoma:* pronotum porcate laterally; mesonotum and scutellum coriaceous, notauli weakly scrobiculate, meeting in triangular rugose area before scutellum; mesopleuron coriaceous, subalar sulcus rugose, sternaulus represent-



Figs. 10–12. *Aleiodes nigristemmaticum.* 10, 11, Apex of hind tibia showing dense cluster of flat setae. 12, Mummified host.

ed by wide shallow rugose area; propodeum rugose coriaceous dorsally, coriaceous laterally, median carina complete. *Wings* (Fig. 7): fore wing with vein r ½ length of 3RSa and ⅘ length of m-cu, vein 1cu-a beyond vein 1M by distance about twice length of 1cu-a, veins 1CUa and 1CUb nearly equal in length; hind wing with vein RS parallel to wing margin on basal ⅓ and suddenly curved downward, marginal cell broad at apex, vein r-m longer than 1M, vein M+CU about twice length of 1M, vein m-cu strong and at least ½ length of 1M. *Legs:* tarsal claws not pectinate, with few spines at extreme base; hind tibia with row of dense coalesced flattened setae at apex on inner side, inner spur less than ½ length of hind basitarsus; hind coxa coriaceous dorsally.

Metasoma: first tergum costate coriaceous, longer than apical width, median carina complete; second tergum costate coriaceous, median carina complete; third tergum costate coriaceous on basal ¾, coriaceous on apical ¼, median carina complete on basal ¾; remainder of terga coriaceous; ovipositor about ½ length of hind basitarsus.

Male.—Unknown.

Holotype.—♀: VIRGINIA, Essex Co., 1 mi SE Dunnsville, August 27–September 16, 1991, Malaise trap, D. R. Smith. Deposited in USNM.

Paratypes.—VIRGINIA, 2 ♀s, same data as holotype except dates of July 12–26, 1991 and July 27–August 16, 1991. Deposited in USNM, RMSEL.

Distribution.—Known only from the type locality in Virginia.

Biology.—Unknown.

Comments.—This species is similar to *preclarus* and *wahli* but is distinguished by its entirely yellow color (see comments under *preclarus*).

Etymology.—The specific name refers to the type locality of this species.

Aleiodes wahli Marsh and Shaw, new species

Female.—*Color:* head yellow, ocellar triangle, face medially and occiput brown; antenna yellow, scape and pedicel with brown longitudinal stripe posteriorly, basal flagellomeres occasionally brown at base; mesosoma yellow with brown markings on propleuron, pronotum dorsally, along notaulices and margins of mesonotum and scutellum, along subalar groove and sternaulus of mesopleuron, and on propodeum laterally and apically, propodeum light brown dorsally; metasomal terga light brown, sterna yellow, first metasomal tergum with black spots at basal corners, ovipositor sheaths yellow, black on apical half; legs yellow, hind coxa brown at apex, hind femur brown on apical ¾; wings dusky along most veins, tegula brown, fore wing veins C+Sc+R, 1R1, M+Cu and 1–1A yellow, remainder brown, stigma brown with small yellow spots at apex and usually at base, hind wing veins C+SC+R, SC+R, M+Cu, 1–1A and cu-a yellow, remainder brown. *Size:* body length, 5.5–6.0 mm; fore wing length, 5.5–6.0 mm. *Head:* eyes and ocelli large, covering much of head; 56–59 antennomeres, all flagellomeres longer than wide; malar space short, equal to basal width of mandible and about ¼ eye height; temple very narrow, at its narrowest nearly ⅕ eye width; occipital carina reaching hypostomal carina, slightly interrupted on vertex behind ocelli; hypoclypeal depression small and circular, width equal to basal width of mandible and less than ½ face height; clypeus weakly swollen; ocelli large, ocellocular distance ½ diameter of lateral ocellus; face and frons rugose coriaceous, temple and vertex coriaceous; maxillary palpus not swollen; mandibles small, tips not crossing when closed. *Mesosoma:* pronotum porcate laterally; mesonotum and scutellum coriaceous, notauli weakly scrobiculate; mesopleuron coriaceous, subalar sulcus rugose, sternaulus represented by wide rugose area; propodeum rugose coriaceous dorsally, coriaceous laterally, median carina complete. *Wings:* fore wing with vein r ½ length of 3RSa and ⅘ length of m-cu, vein 1cu-a beyond 1M by distance slightly more than twice length of 1cu-a, vein 1CUa noticeably shorter than 1CUb; hind wing with vein RS parallel to wing margin on basal ⅓ and curved downward, marginal cell broad at apex, vein r-m longer than 1M, vein M+CU about twice length of 1M, vein m-cu strong and about ½ length of 1M. *Legs:* tarsal claws not pectinate, with few spines at extreme base; hind tibia with row of dense coalesced flattened setae at apex on inner side, inner spur less than ½ length of basitarsus; hind coxa coriaceous dorsally. *Metasoma:* first tergum costate coriaceous, longer than apical width, median carina complete; second tergum costate coriaceous, median carina complete; third tergum costate coriaceous on basal ¾, coriaceous on apical ¼, median carina complete on basal ¾; remainder of terga coriaceous; ovipositor about ½ length of hind basitarsus.

Male.—Essentially as in female.

Holotype.—♀: FLORIDA, Highlands Co., Archbold Biol. Sta., November 27, 1987, D. Wahl. Deposited in AEI.

Paratypes.—FLORIDA: 10 ♀, 2 ♂, same data as holotype except, dates of December 6, 1984, November 29, 1985, October 9, 1987, November 27, 1987, December 4 and 18, 1987, January 2–11, 1988, and collector M. Deyrup; 1 ♀, Liberty Co., Torreya St. Pk., August 30, 1978; 1 ♀, Dade County, Fuch's Hammock, near Homestead, May 25, 1979, Terhune S. Dickel and H. V. Weems, Jr.; 1 ♂, Levy Co., September 9, 1955, H. V. Weems, Jr. NORTH CAROLINA: 1 ♀, Martin Co., near Williamston, October 6, 1978, Malaise trap. Deposited in AEI, FSCA, USNM, RMSEL, NCDA, ABS.

Distribution.—Known only from the type localities in Florida and North Carolina.

Biology.—Unknown.

Comments.—This species is nearly similar to *virginiensis* and *preclarus* but is distinguished by its yellow flagellum (see comments under *preclarus*).

Etymology.—This species is named for our colleague and friend, David Wahl, American Entomological Institute, Gainesville, Florida, who collected many specimens of the type series from Florida.

ACKNOWLEDGMENTS

We thank Les Price, formerly of the University of Wyoming (presently at the University of Arkansas) for the information on the biology of *nigristemmaticum,* and Linda Butler, West Virginia University, for information on the biology of *preclarus.* We are also thankful to Donald Azuma, for the loan of the holotype of *femoratus,* to E. Kierych, Polish Academy of Sciences, Warsaw, for the loan of the holotype of *nigristemmaticum,* and to the curators of all the collections listed in Methods for the loan of specimens for this study. This research was supported, in part, by grant DEB-930–6314 from the National Science Foundation to S. R. Shaw. Additional support was provided by supplemental REU grants in 1994, 1995 and 1996 (Research Experience for Undergraduates), some of which provided funding for the work in Costa Rica by Les Price.

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A REVISION OF THE GENUS *PARARCHYTAS* BRAUER AND BERGENSTAMM (DIPTERA: TACHINIDAE)

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Abstract.—The genus *Pararchytas* is revised. A new species is described, ***P. apache*** (type locality: New Mexico, Grant Co., Cherry Creek campground, 14 mi. N of Silver City, 7400 feet). A lectotype is designated for *Tachina decisa* Walker. A key to the three known species, diagnostic descriptions, distribution maps, and illustrations are provided.

Key Words: *Pararchytas,* Tachinidae, taxonomy, identification

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The genus *Pararchytas* was described by Brauer and Bergenstamm (1894) to include the single species *Tachina decisa* Walker. It remained monotypic until Brooks (1945) described a second species, *P. hammondi.* Guimarães (1971) subsequently synonymized *Jurinia punctata* Wulp with *P. decisus* (Walker).

In his paragraph comparing *P. hammondi* with *P. decisus,* Brooks (1945: 80) noted a single specimen (CNC) from Oak Creek Canyon, Arizona that was more robust and more strongly bristled that he said "undoubtedly represents a distinct species." I came to a similar conclusion independently after examining material of *Pararchytas* in the USNM collection. All three species are exceedingly similar morphologically, including the male genitalia.

This paper presents a review of the taxonomy of *Pararchytas,* including a key to the three known species. This study is based primarily on USNM and CNC material, with specimens from a few other collections included. Depository institutions are cited in the acknowledgments section, including abbreviations used elsewhere in the text. For the common *P. decisus,* locality information is summarized rather than presented as full specimen label data.

Although species of *Pararchytas* may be fairly common, almost nothing is known about the biology of the genus. Larval hosts have not been recorded, and I did not examine any reared specimens during this study. I have collected *P. decisus* visiting flowers, a habit they have in common with many other large Tachininae.

Pararchytas Brauer and Bergenstamm

Pararchytas Brauer and Bergenstamm 1894: 76. Type species, *Tachina decisa* Walker, by monotypy.

Diagnosis.—The bare prosternum, pilosity on the posterior margin of the hind coxa, multiple bristle-like setae on the posterior margin of abdominal tergite three, and well-developed palpi place *Pararchytas* in the tribe Dejeaniini. The combination of normal-sized yellow palpi, bare eyes, well-developed ocellar setae, discal bristles on abdominal tergites 3 and 4, lack of marginal bristles on tergite 1+2, uniformly brownish-black abdomen, and wing with basal region and crossvein r-m darkened, will distinguish *Pararchytas* from other genera of

Dejeaniini. The darkened crossvein r-m may be a synapomorphy for all species of *Pararchytas*. Wood's (1987) key may be used to identify material to the generic level.

The phylogenetic relationships within the Tachininae are virtually unknown, so it is not possible to discuss the relationships of *Pararchytas* to other taxa. It is most similar to an apparently undescribed taxon (I have seen two specimens in the USNM) from Mexico and Trinidad, which differs from *Pararchytas* in having strong median marginal setae on abdominal tergite 1+2.

KEY TO SPECIES OF *PARARCHYTAS*

1. Tomentum of parafrontals with yellowish cast; ground color of vertex yellow, not readily visible by contrasting with tomentum; apical scutellar bristles variable 2
– Tomentum of parafrontals whitish; ground color of vertex dark, contrasting with tomentum and visible beneath it; apical scutellar bristles often absent, represented only by vestigial sockets, occasionally one or both are present, full-sized . . . . . *hammondi* Brooks
2. Apical scutellar bristles reduced, hair-like and divergent to occasionally absent with only vestigial sockets present; third abdominal tergite with marginal setae between medians and laterals tending to be bristle-like, enlarged compared to setae of general vestiture . . . . *apache*, new species
– Apical scutellar setae of normal size, crossed at about their middle; third abdominal tergite with marginal setae between medians and laterals very little enlarged, similar to setae of general vestiture . . . . *decisus* (Walker)

Pararchytas decisus (Walker)
(Figs. 1, 2; Map 1)

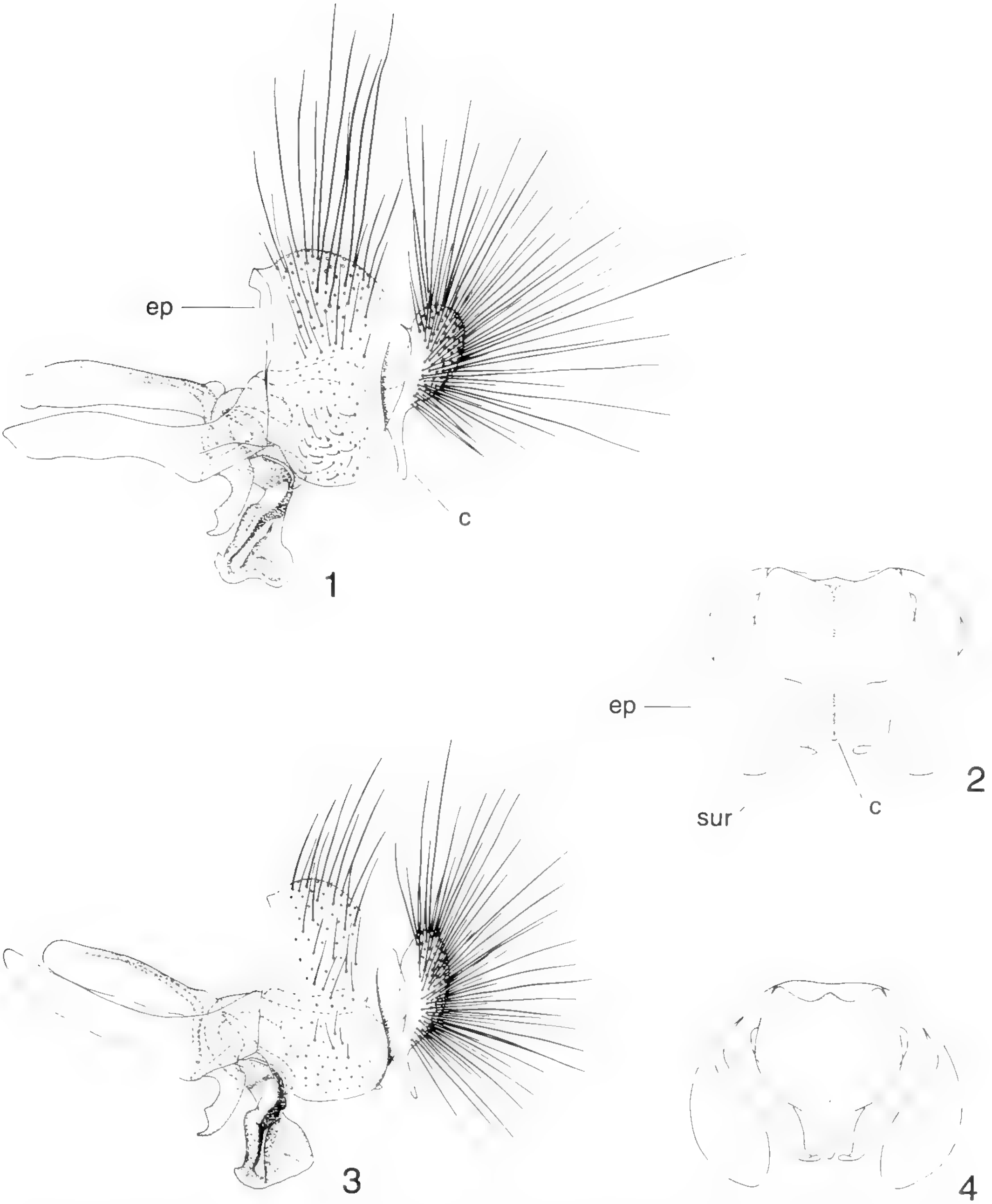
Tachina decisa Walker 1849: 715.
Jurinia puctata Wulp 1892: 191. Syn. by Guimarães, 1971: 59.

Type material.—There are 1 ♂ and 2 ♀ syntypes of *Tachina decisa* in BMNH. I am hereby designating the male as lectotype. It is labeled: "SYN-TYPE/*Locality ?* Pres: by Entomological Club. 44.12./Ent. Club. 44-12./Tachina decisa Walk [verso reads] One of Walkers series so named. EAW/SYN-TYPE ♂ Tachina decisa Walker R. W. Crosskey det 1972/LECTOTYPE ♂ Tachina decisa Walker, 1849: 715. Des. N. E. Woodley 1997." This specimen was cited by Walker (1849: 716) in series "c," with a locality of "North America." The two females are labeled as paralectotypes. One is clearly from Walker's series "b" from Nova Scotia.

The ♀ holotype of *Jurinia punctata* Wulp is also in BMNH. It is labeled: "Type [verso reads] Jurinia puctata V.d.W./♀/Omilteme, Guerrero, 8000 ft. July. H.H. Smith/ B.C.A. Dipt. II. Jurinia puctata v.d.W./Central America. Pres. By F. D. Godman. O. Salvin. 1903–172."

Diagnosis.—*Pararchytas decisus* can be readily distinguished from *P. hammondi* by the yellowish tomentum of its head. It can be separated from *P. apache* by the large, crossed apical setae of the scutellum, and the generally smaller, less stout discal and marginal setae of the third abdominal tergite. This is most noticeable in the setae laterad of the larger median marginals, which normally differ little from the general vestiture of the abdomen.

Description.—*Male:* Head yellowish to brownish in ground color, occiput darker, densely covered with whitish yellow tomentum virtually obscuring ground color, thinnest on vertex; setae and hairs of head black except for dense yellowish white setae on occiput, which encroach onto lower, posterior portion of genal dilation; frons at vertex 0.26 to 0.34 head width; first antennal flagellomere ovoid to slightly produced posteriorly; palpus 0.80 to 0.95 as long as eye height, strongly narrowed in basal half, gradually spatulate in apical half, laterally compressed; setulae present on outer side of palpus, longest on apical part of lower margin; prementum 0.93 to 1.16 as long as eye height; labella with short yellowish golden hairs. Thorax brownish black, postpronotal lobes, vague lateral areas of scutum, postalar calli, and scutellum more yellowish to reddish brown; tomentum of scutum light brownish, becoming more whitish and



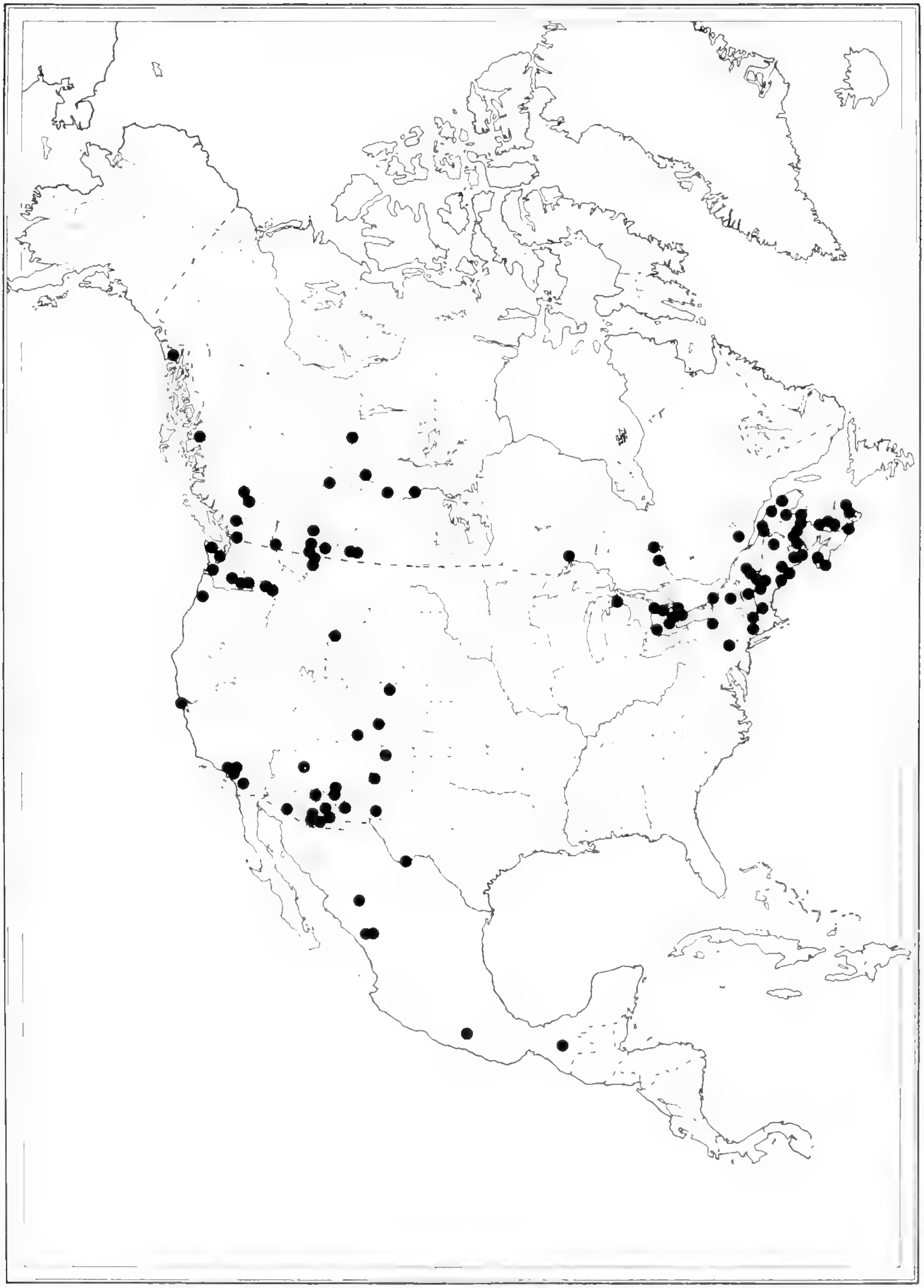
Figs. 1–4. Male terminalia of *Pararchytas. P. decisus:* 1, Left lateral view. 2, Posterior view, setae omitted. *P. hammondi:* 3, Left lateral view. 4, Posterior view, setae omitted. Abbreviations: *c,* cerci; *ep,* epandrium; *sur,* surstyli.

denser anteriorly, appearing weakly vittate presuturally; hairs and setae of thorax entirely black except for a few tiny pale hairs on anterior portion of postalar wall; scutellum with apical setae large, crossed at about midpoints; wings nearly hyaline, with base up to fork of radial sector and a small spot over crossvein r-m darkened, and small area at bend of M faintly darkened; tegula blackish, basicosta dark yellow; both calypters dark, sometimes with darker margins, sometimes entirely very dark; halter with stem yellowish, knob dark; legs brownish to brownish black, tibiae sometimes more yellowish, pulvilli pale yellowish, bases of tarsal claws brownish to yellowish. Abdomen brownish to brownish black, blackish centrally, forming an irregular median vitta from the declivous portion of syntergite 1+2, narrowing posteriorly, most prominent in specimens with paler abdomens, terminalia dark yellowish to brownish, cerci darker; inconspicuous tomentum present, most easily visible on fifth tergite, less so on fourth, and present around discal setae on third; hairs and major setae black; tergite three with one pair of median discal setae and one pair of median marginals, with a small number of enlarged bristle-like hairs, mostly between and posterior to the discals, sometimes one or two enlarged hairs lateral to the marginals, but even if the marginal hairs are slightly enlarged, they do not appear bristle-like; fourth tergite usually with a single pair of median discal setae and very strong marginals extending to lateral margin, with an irregular row of smaller bristle-like setae just posterior to the marginals, sometimes a few enlarged hairs around discals, but these not very prominent; apical half of tergite five evenly set with bristle-like setae, slightly decreasing in size posteriorly; sternites two-four with short, stout bristle-like setae on apical half. Terminalia (Figs. 1, 2) with epandrium short and deep, evenly rounded in lateral view, densely setose with longest setae on dorsum; surstyli triangular in lateral view, apices slightly recurved; cerci laterally rounded in posterior view, the apical third produced triangularly, entirely fused, dorsal part evenly set with long setae; fifth sternite with narrow v-shaped emargination posteriorly, the resultant lobes truncately rounded, strongly setose. Length, 9.1 to 13.4 mm.

Female: Very similar to male in most respects, differing as follows: Head with frons 0.32 to 0.36 width of head at vertex; with two strong proclinate orbital setae. Thorax with front legs with tarsomeres 2–4 slightly flattened and expanded laterally; tarsal claws and pulvilli shorter than in male. Abdomen with terminalia small, concolorous with rest of abdomen. Length, 8.9 to 13.5 mm.

Distribution (Map 1).—Transcontinental in the north, from the panhandle of Alaska to southern Quebec and Nova Scotia, south to Pennsylvania in the east, and mountainous areas in the west south into Mexico.

Locality records.—(380 ♂, 260 ♀). UNITED STATES: *Alaska:* Glacier Bay National Monument, Lituya Bay, west side of Cenotaph Island. CANADA: *Alberta:* Banff, Norquay Mountain Meadows; Bilby; Claresholm; Coaldale; Cypress Hills; Edmonton; Frank; Jumping Pond Creek, 20 mi. W Calgary; Mildred Lake, 57°03′N, 111°35′W; Waterton. *British Columbia:* Cultus Lake; Fitzgerald; Lillooet; Lillooet, Seton Lake; 100 Mile House; Robson; 25 km SW Terrace on Highway 25; Williams Lake. *New Brunswick:* Bathurst; Birch Cove, near Chamcook; Boiestown; Chamcook; Douglas; Fredericton; McGivney; Musquash; Renous; St. Andrews. *Nova Scotia:* Annapolis Royal; Cape Breton Island, Cheticamp; Frizzletown; Queen's County, White Point Beach; Smith's Cove; Tory Creek, Guysboro; Victoria County, Pony Island Point. *Ontario:* Belfountain; Belwood; Charlton; Elora; Elsinore; Erin; Fergus; Guelph; Keswick; Low Bush, Lake Abitibi; Lucan; Macdiarmid, Lake Nipigon; Meaford; St. Lawrence Island National Park, Adelaide Island; St. Lawrence Island National Park, Grenadier Island Centre; Toronto. *Prince Edward Island:* Brackley Beach; Portage; Wood Islands. *Quebec:* Cap Bon Ami; Cap Chat; Cross Point; Laurentide Park, Le Relais; Mont Joli; Mont Orford; North Hatley; Notre Dame du Portage; Parke Reserve; Saint Eleuthère; Saint Joseph de Kamouraska. *Saskatchewan:* Big River; Cypress Hills; Meadow Lake; Nipawin. UNITED STATES: *Arizona:*



Map 1. Distribution of *Pararchytas decisus.*

Apache Co.; Cochise Co.; Coconino Co.; Gila Co.; Graham Co.; Greenlee Co.; Pima Co.; Santa Cruz Co. *California:* Marin Co.; Los Angeles Co.; San Bernardino Co.; San Diego Co.; San Mateo Co. *Colorado:* Chaffee Co.; La Plata Co.; Larimer Co. *Connecticut:* Litchfield Co. *Maine:* Aroostook Co.; Hancock Co.; Kennebec Co.; Lincoln Co.; Oxford Co.; Penobscot Co. *Michigan:* Cheboygan Co. *Montana:* Flathead Co. *New Hampshire:* Cheshire Co.; Coos Co.; Grafton Co. *New Mexico:* Grant Co.; Mora Co.; Otero Co.; Torrance Co. *New York:* Erie Co.; Tompkins Co.; Warren Co. *Oregon:* Benton Co. *Pennsylvania:* Monroe Co. *Texas:* Brewster Co. *Vermont:* Washington Co. *Washington:* Benton Co.; Clallam Co.; Kitsap Co.; Lewis Co.; Yakima Co. *Wyoming:* Teton Co. MEXICO: *Chiapas:* San Cristobal, 7000 ft. *Chihuahua:* head of Rio Piedras Verdes, 7300 ft. *Durango:* 10 mi. W El Salto, 9000 ft.; Navios, 26 mi. E of El Salto, 8000 ft.; 30 mi. W. Durango, 8000 ft.; road from Durango City to La Flor, 65–70 km SSW Durango City, 2590 m.

Flight period.—Over the entire range of *P. decisus* collection dates range from 4 April to 1 December. This range of dates occurs in southern California alone, so the species is apparently active much of the year in the southern part of its range. In Canada, dates range from 7 June to 6 October, with the vast majority from July and August, indicating a primarily summer activity period in the northern part of the species' range.

Biology.—Like other Dejeaniini, this species is often collected at flowers. Specimens I have examined were collected from *Apocynum, Aster, Ceanothus, Eupatorium perfoliatum, Helenium hooperi, Lomatium, Meliotus, Solidago sempervirens, Solidago* spp., and *Zygadenus elegans.*

Remarks.—*Pararchytas decisus* is the most widespread species in the genus, and the most common in collections. I have noted some variation in the species. Specimens from the southwestern United States are slightly darker on average, the black medial markings on the abdomen thus being more indistinct. Also, males from the southwest often have a wider frons that is slightly more convex in appearance than that found in more eastern specimens.

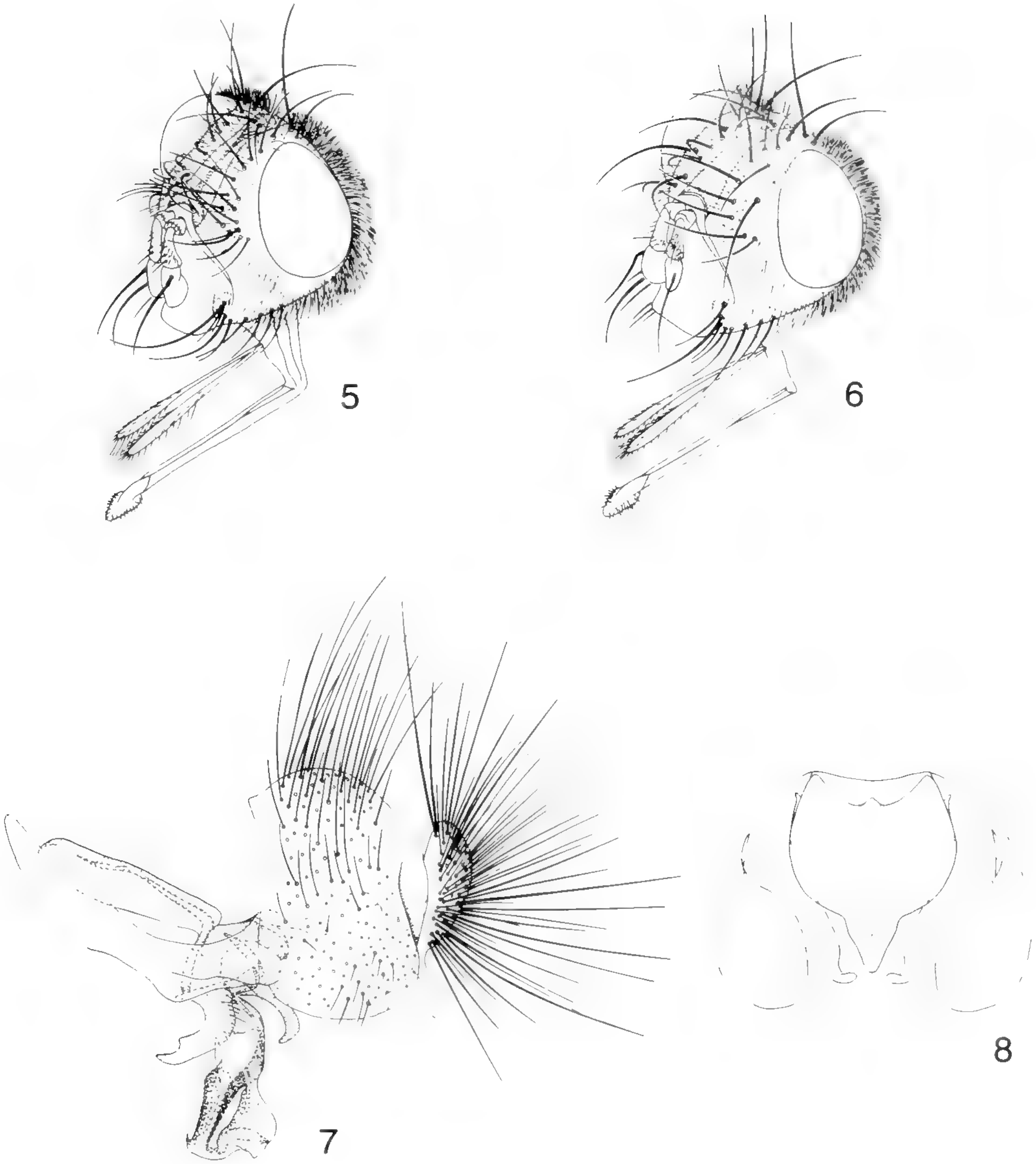
Pararchytas decisus is sympatric with *P. apache* in Arizona, New Mexico, and northern Mexico, sometimes being taken at the same locality. Unfortunately, the male genitalia of *Pararchytas* are extremely similar among species, being essentially useless for identification. However, the characters used in the key to separate *P. decisus* and *P. apache* are remarkably consistent even though they are based on chaetotaxy. This is especially true of the apical scutellar setae, which are large and crossed in *P. decisus* and very reduced or absent in *P. apache.* Of all the *P. decisus* I examined, only eight specimens had the right apical scutellar seta reduced or absent, only seven had the left seta reduced or absent, and only one (of 588 total specimens examined for this character) had both apical setae absent. All of the specimens of *P. apache* I examined have reduced or absent apicals.

I am uncertain of the identity of two male specimens from Mexico in USNM (Dist. Federal, La Cima, 26.ix.1991, A. L. Norrbom; and Veracruz, Perote, 14.ix.1989, E. Barrera, T. J. Henry, and I. M. Kerzhner). Both specimens have the general vestiture of the abdomen longer and finer than typical *P. decisus.* Also, the Veracruz specimen has the apical scutellar setae reduced and divergent as found in *P. apache.* The status of these specimens remains uncertain until much more material is available from Mexico.

Pararchytas apache Woodley, new species

(Figs. 5–8; Map 2)

Type material.—The holotype ♂ (CNC) is labeled: "USA NM Grant Co. Cherry Ck. campgrd. 14mi. N. Silver City 15–16.viii.1993 7400′ J.E. O'Hara/HOLOTYPE ♂ Pararchytas apache N.E.Woodley



Figs. 5–8. *Pararchytas apache.* 5, Left dorsolateral view of male head. 6, Left dorsolateral view of female head. 7, Male terminalia, left lateral view. 8, Male terminalia, posterior view, setae omitted.

1997." The specimen is in excellent, fresh condition.

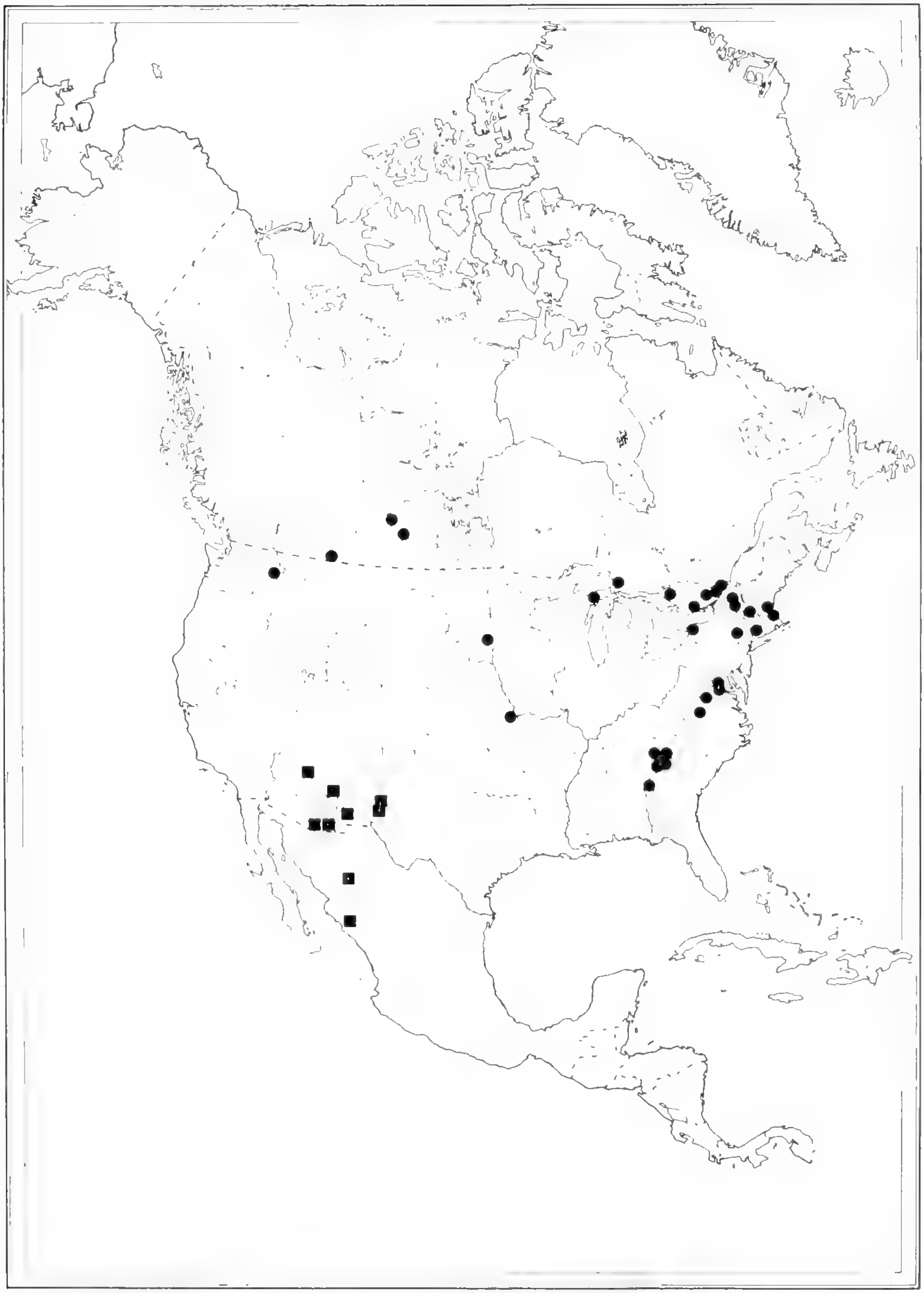
Diagnosis.—*Pararchytas apache* can be distinguished from *P. hammondi* by the yellowish tomentum of the head, which it shares with *P. decisus,* and its geographic range is quite distant from that of *P. hammondi.* It is most similar to *P. decisus,* from which it differs by having very reduced, divergent apical scutellar setae (sometimes absent) and setae lateral to the median marginals on abdominal tergite three often extending in a row to the laterals. In general, *P. apache* is more bristly in appearance and more uniformly dark in color than *P. decisus,* but this is difficult to appreciate without comparing series of specimens.

Description.—*Male:* Very similar to *P. decisus,* differing only in the following respects: Head (Fig. 5) with frons at vertex 0.28 to 0.32 head width; first antennal flagellomere ovoid to slightly produced posteriorly; palpus 0.93 to 1.10 as long as eye height; prementum 1.08 to 1.38 as long as eye height. Thorax with apical scutellar setae very reduced, hair-like to absent; legs with tibiae sometimes yellowish brown, but not as yellow as in some *P. decisus.* Abdomen brownish black, the central area only vaguely darker, not as readily discernible to the naked eye; tomentum less evident on fourth tergite, the lateral areas basally usually quite shiny, and tomentum around discal setae on third tergite vague to absent; tergite three with enlarged bristle-like hairs around discal setae usually stouter than in *P. decisus,* and setae lateral to median marginals usually noticeably enlarged and extending in a row to the lateral setae; fourth tergite usually with several enlarged seta-like hairs around discals that are stouter than in *P. decisus.* Terminalia (Figs. 7, 8) very similar to those of *P. decisus.* Length, 11.8 to 13.8 mm.

Female: Very similar to male in most respects, differing as follows: Head (Fig. 6) with frons 0.32 to 0.35 width of head at vertex; with two strong proclinate orbital setae; palpi 0.95–1.03 eye height; prementum 1.05 to 1.12 eye height. Thorax with front legs with tarsomeres 2–4 slightly flattened and expanded laterally; tarsal claws and pulvilli shorter than in male. Abdomen with terminalia small, concolorous with rest of abdomen. Length, 11.6 to 13.9 mm.

Distribution (Map 2).—Known from north-central Arizona and southwestern New Mexico south to Chihuahua and Sinaloa, Mexico.

Material examined.—(53 ♂ and 33 ♀). PARATYPES: UNITED STATES: *Arizona:* 1 ♂, Apache Co., Apache Sitgreaves Nat. Forest, Alpine Divide Campgr., 6 km N of Alpine, 2600m, 11–12.viii.1980, J.E. and W.M. O'Hara (CNC); 2 ♂, Cochise Co., Chiricahua Mtns., Onion Flat, 12.viii.1940, E. S. Ross (CAS); 1 ♀, Cochise Co., Chiricahua Mtns., Onion Saddle, 7600 ft., 14.ix.1965, C. W. Sabrosky (USNM); 1 ♀, Cochise Co., Chiricahua Mtns., Rustler Park, 21.viii.1970, R. E. Woodruff (USNM); 1 ♀, Coconino Co., Oak Creek Canyon, Todd's Lodge, 3.x.1948, G. H. and J. L. Sperry (USNM); 1♂, same data but 12.ix.1947 (USNM); 1 ♀, same data but 28.ix.1948; 1 ♀, same data but 26.ix.1948 (USNM); 1 ♂, Coconino Co., Oak Creek Canyon, 8.ix.1932, R. H. Beamer (CNC); 2 ♀ Coconino Co., Oak Creek Canyon, 6000 ft., viii, F. H. Snow (CNC); 1 ♂, Coconino Co., Oak Creek Canyon, 4800 ft., 10.viii.1962, F. Werner, J. Bequaert (CNC); 1 ♂, Santa Cruz Co., 0–2 mi. Mt. Wrightson trail, Santa Rita Mtns, 6.ix.1961, Bequaert and Noller (CNC); 2 ♀, Santa Cruz Co., trail to Mt. Wrightson, 6–8000 ft., 27.viii.1962, H. E. Milliron (CNC). *New Mexico:* ♀ Allotype, 3 ♂, Grant Co., Gila National Forest, Cherry Creek Campground, 21 km N Silver City, 2250 m, 3–4.viii.1980, J. E. and W. M. O'Hara (CNC); 8 ♂, same data but 14–16.viii.1983, J. E. O'Hara (CNC); 5 ♂, same data but 16–19.viii.1982, flowers of *Ceanothus* (CNC); 1 ♂, 1 ♀, same data but 29–31.vii.1982 (CNC); 6 ♂, Grant Co., Gila National Forest, Cherry Creek Campground, 14 mi. N Silver City, 7400 ft., 15–16.viii.1993, J. E. O'Hara (CNC); 4 ♀, same data but 16.ix.1994 (CNC); 1 ♂, 1 ♀, Grant Co., Pinos Altos Mtns., 28.viii.1951, E. L Kessel (CAS); 6 ♂, Lincoln Co., 1.5 mi. W of Alto, 7400 ft., 24–25.vii.1982, R. S. Anderson (CNC); 1 ♂, Lincoln Co., White Mtns., Rio Ruidoso, 6500 ft., 30.vii, C. H. T. Townsend (BMNH); 1 ♀, Otero Co., Cloudcroft, 8500–9500 ft., 6.ix.1963, H. V. Weems, Jr. (USNM); 2 ♂, 2 ♀, Otero Co., Sacramento Mtns., Lincoln National Forest, 3 km NE of Cloudcroft, 1–2.viii.1980, J. E. and W. M. O'Hara (CNC). MEXICO: *Chihuahua:* 1 ♂, Sierra Madre,



Map 2. Distribution of *Pararchytas hammondi* Brooks ● and *P. apache* ■.

about 7300 ft., 15.viii, C. H. T. Townsend (BMNH); 2 ♂, Sanchez (probably 27°27′N, 107°41′W), 2.ix.1909, C. H. T. Townsend (USNM); 3 ♂, 5 ♀ Mound Valley, 23.viii.1909, C. H. T. Townsend (BMNH, USNM); 4 ♂, 5 ♀, same data but 24.viii.1909 (BMNH, USNM); 1 ♂, 4 ♀, same data but flowers of *Rudbeckia,* 25.viii.1909 (USNM). *Sinaloa:* 2 ♂, 1–1.5 km SE of El Palmito, 1981 m, 11.ix.1979, D. E. and J. A. Breedlove (CAS).

Additional material.—4 ♂ Lincoln Co., 1.5 mi. W of Alto, 7400 ft., 24–25.vii.1982, R. S. Anderson (CNC). See remarks for status of these specimens.

Flight period.—*Pararchytas apache* has been collected from 24 July to 3 October. It seems to have a much more limited activity period than *P. decisus.*

Biology.—This species has been collected at flowers of *Ceanothus* and *Rudbeckia,* but nothing is known of its biology.

Etymology.—The species epithet, a noun in apposition, is based on the Apache Indian tribe that inhabited the area where this species occurs.

Remarks.—*Pararchytas apache* is probably sympatric throughout its range with *P. decisus.* There is some variation in the abdominal chaetotaxy, particularly in the development of the marginal row of setae lateral to the median marginals on abdominal tergite three. These are usually notably stronger than the surrounding general pilosity, but occasional specimens have them only weakly developed. The palpi and prementum are somewhat variable in length, and seem on average to be longer than those of *P. decisus,* but I have not made exhaustive measurements of the latter species to confirm this rigorously.

The series of specimens cited under additional material contains the only problematic specimens I have examined. Of the 8 ♂ in the series taken from this locality, four specimens are not considered paratypes because there is some uncertainty about their identity. Three have the apical scutellar setae larger than normal for *P. apache,* although they are not as large as typically found in *P. decisus,* and they are somewhat convergent although they do not cross.

Pararchytas hammondi Brooks
(Figs. 3, 4; Map 2)

Pararchytas hammondi Brooks 1945: 80.

Type material.—The holotype male of *Pararchytas hammondi* Brooks (CNC) is labeled: "Avonmore. Ont. 13. VII. 1939 G.H.Hammond/HoloTYPE ♂ Pararchytas hammondi Brks No. 5516". It is in excellent condition.

Diagnosis.—*Pararchytas hammondi* can be distinguished from other species of the genus by having whitish tomentum on the head, especially the parafrontals, not yellowish as found in the other species. Also, the vertex of the head is dark in ground color and visible through the thin tomentum. *Pararchytas hammondi* also differs from *P. decisus* in having reduced apical setae of the scutellum. *Pararchytas hammondi* does not occur near the range of *P. apache,* so is very unlikely to be confused with that species.

Description.—*Male:* Differs from *P. decisus* as follows: Head with parafrontal region brownish to blackish in ground color, covered with whitish tomentum virtually obscuring ground color, but thin on vertex, the cuticle visible, sometimes subshining; frons at vertex 0.26 to 0.28 head width; dense pale setae on occiput without a yellow cast; palpus 0.85 to 0.90 as long as eye height; prementum 0.98 to 1.10 as long as eye height. Thorax with tomentum of scutum whiter than in *P. decisus;* scutellum with apical setae usually absent, only vestigial sockets present, occasionally one or both present as full sized setae, if both present they are crossed at about midpoints; legs with femora usually more brownish than in *P. decisus.* Abdomen dark brownish, blackish centrally but usually not as distinctly so as in *P. decisus* that have this coloration. Terminalia (Figs. 3, 4) essentially as in *P. decisus.* Length, 9.5 to 12.9 mm.

Female: Very similar to male in most respects, differing as follows: Head with frons 0.29 to 0.33 width of head at vertex; with two strong proclinate orbital setae. Thorax with front legs with tarsomeres 2–4 slightly flattened and expanded laterally; tarsal claws and pulvilli shorter than in male. Abdomen with terminalia small, concolorous with rest of abdomen. Length, 10.3 to 12.5 mm.

Distribution (Map 2).—Transcontinental from New England across southern Canada to eastern Washington, south in the east to northern Georgia; South Dakota and Kansas.

Material examined.—(109 ♂, 25 ♀). CANADA: *Alberta:* 1 ♂, Writing-on-Stone Provincial Park, 23.viii.1982, D. McCorquodale (CNC). *Ontario:* Holotype ♂, Allotype ♀ (CNC), 22 ♂ Paratypes (CNC), 3 ♂ Paratypes (USNM), 32 ♂ (CNC), Avonmore, 13.vii.1939, G. H. Hammond; 12 ♂ Paratypes, 6 ♂, same data but 13.vi.1939 (CNC); 8 ♀ Paratypes (CNC), 1 ♀ Paratype (USNM), 4 ♂ (CNC), 1 ♀ (CNC), same data but 8.viii.1938; 1 ♀, Apple Hill, 9.viii.1938, G. H. Hammond (CNC); 1 ♂, Eldorado, 13.vii.1944, G. S. Walley (CNC); 1 ♂, Emsdale, 20.vii.1911, M. C. Van Duzee (CAS); 1 ♂, Innisville, 6.viii.1963, W. R. M. Mason (CNC); 2 ♂, Virgin's Bower, Icewater Creek watershed, 50 km N Sault Ste. Marie, 28.vi.1983, P. D. Kingsbury (DEBU). *Saskatchewan:* 1 ♀, Saskatoon, 3.ix.1911, T. N. Willing (CNC); 1 ♀, Earl Grey, 24.viii.1924, J. D. Ritchie (CNC); 1 ♀, same data but 16.viii.1925 (CNC); 1 ♂, same data but 4.vii.1926 (CNC). UNITED STATES: *Connecticut:* 1 ♀, Litchfield Co., Colebrook, 2.ix.1911 (USNM). *Georgia:* 1 ♀, Meriwether Co., Luthersville, 12.vii.1949, P. W. Fattig (USNM); 1 ♂, Rabun Co., Rabun Bald, 4714′, 6–12.vii.1952, H. R. Dodge (CNC); 1 ♂, same data but 24.ix.1952 (WSU); 1 ♂, Towns-Union Cos., Mt. Enotah, 4782′, 13.vii.1952, D. Sudia & H. R. Dodge, (CNC); 1 ♂, same data but 1.viii.1952, J. M. Seago (WSU); 1 ♂, same data but 11.ix.1952 (WSU). *Kansas:* 1 ♀, Leavenworth Co., 25.vi.1924, R. H. Beamer (CNC). *Maryland:* 1 ♀, Montgomery Co., Plummers Island, 22.vii.1906, W. L. McAtee (USNM); 1 ♀, same data but 9.viii.1906 (USNM). *Massachusetts:* 1 ♂, Essex Co., North Saugus, 13.vii.1911, F. H. Mosher (CNC). *Michigan:* 1 ♀, Alger Co., 1.ix.1946, R. R. Dreisbach (CNC). *New Hampshire:* 1 ♀, Rockingham Co., Canobie Lake, "frequent flowers of *Bidens frondosa,*" G. Dimmock (USNM). *New York:* 1 ♂, Erie Co., East Aurora, 29.vii.1917, M. C. Van Duzee (CAS); 2 ♂, Essex Co., Lake Placid, vii.1949, W. G. Downs (USNM); 1 ♀, Delaware Co., Cooks Falls, 19.ix.1929 (USNM); 1 ♂, Warren Co., North Creek, 15.vii.1918, W. T. M. Forbes (CNC). *North Carolina:* 1 ♀, Haywood Co., Mt. Pisgah, 20.vi.1955, "on *Hydrangea arborescens,*" H. V. Weems, Jr.(USNM); 1 ♂, Swain Co., 5 mi. N Nantahalah, 8.vi.1965, J. G. Chillcott (CNC). *South Dakota:* 1 ♂, no further data (USNM); 1 ♂, Brookings (WSU); 3 ♂, Brookings, J. M. Aldrich (USNM); 1 ♂, same data but 19.vi.1891 (USNM). *Tennessee:* 1 ♂, Sevier Co., Great Smoky Mountains National Park, Headquarters, 12.vi.1946, R. R. Dreisbach (CNC). *Vermont:* Bennington Co., Manchester to Peru, 15.vii.1935, Blanton and Borders (CAS). *Virginia:* 1 ♀, Arlington Co., near mouth of Four Mile Run, 17.ix.1916, W. L. McAtee (USNM); 1 ♂, Bedford Co., Peaks of Otter, 26.vii.1906, W. Palmer (USNM); 1 ♂, Shenandoah National Park, 1600 feet, 7.vii.1945, J. E. Graf (USNM). *Washington:* Spokane Co., Spokane, 24.vi.1930, J. M. Aldrich (USNM).

Flight period.—Specimens examined have collection dates ranging from 8 June to 24 September, with most collections in July and August.

Biology.—As with other species, *P. hammondi* has been collected from flowers. Specimens I have seen are from *Bidens frondosa* and *Hydrangea arborescens.*

Nothing is otherwise known about the biology of the species.

Remarks.—Brooks (1945) cited only the date "13.VII.1939" for all male paratypes. As can be seen from the material examined, a number of them are dated "13.VI.1939." This was probably either an oversight by Brooks, or a labeling error by the original collector.

Pararchytas hammondi is a very uniform species in appearance and dimensions. I have noted very little variation in color or other characters. There is some variation in the apical scutellar setae. Sixteen specimens have been noted that have one fully developed seta (11.9% of all specimens examined, 14 ♂ and 2 ♀), almost equally divided between left and right. Fifteen specimens (11.2% of all specimens examined, all males) have both apical setae fully developed. I have not observed any specimens that have reduced setae; they are either present or absent.

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DESCRIPTION OF THE PREIMAGINAL STAGES OF *PYRACTOMENA BOREALIS* (RANDALL, 1838) (COLEOPTERA: LAMPYRIDAE) AND NOTES ON ITS BIOLOGY

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Abstract.—The preimaginal stages of *Pyractomena borealis* (Randall 1838) are described and illustrated. Information on the biology is also included. A detailed description of the functional morphology of the holdfast organ of the larva is presented together with a schematic illustration, step by step, of the eversion process. Instructions on rearing techniques are also provided.

Key words: Lampyridae, firefly, *Pyractomena borealis,* larvae, pupae, biology, holdfast organ, rearing

Resumen.—Los estadios preimaginales de *Pyractomena borealis* (Randall 1838) son descriptos e ilustrados. Se incluye información sobre la biología de esta especie. También se presenta una descripción detallada de la morfología funcional del órgano "holdfast" de las larvas de esta especie, asi como una ilustración esquemática, paso a paso, del proceso de eversión. También se proveen instrucciones de cría para esta especie.

It is surprising that the biology of fireflies, a group of beetles that has received so much attention from a behavioral point of view, are still poorly known. Another aspect of this family of beetles that has also been largely neglected is the study of their immature stages. There are few descriptions of larvae from the New World and, with a few exceptions, most of those descriptions are very brief.

Of the 18 Nearctic genera of Lampyridae (Poole and Gentili 1996), only eight have described immature stages. Four of those genera are known from immatures described in Europe (*Lampyris* Geoffroy and *Phausis* LeConte) and Brazil (*Aspisoma* Laporte and *Bicellonycha* Motschulsky) (Vogel 1912, Haddon 1915, Bugnion 1929, Costa et al. 1988). It should also be mentioned that the larvae of several genera are difficult to tell apart, especially those of the tribe Photinini (LaBella and Lloyd 1991). There are two main obstacles preventing an easy association of adults with immatures. The first is the apparent difficulty in rearing lampyrids in the laboratory; the other is that females are usually difficult to collect. Rearing lampyrids is not as difficult as it may appear, and several genera such as *Pyractomena* Melsheimar, *Photinus* Laporte and *Photuris* Dejean have been reared successfully in the laboratory (Williams 1917, McLean et al. 1972, Buschman 1977). The second obstacle, that of finding females, can be overcome by collecting larvae in the field, and rearing them through to the adult stage. One final problem is that some species spend multiple years as larvae (Williams 1917, Hess 1920, Buschman 1977) and, in at least some cases, such as *Pyractomena lucifera* Melsheimar, the life cycles can be heterovoltine (Buschman 1977).

Green (1957) revised the Nearctic species of *Pyractomena* Melsheimar and also included larval and pupal descriptions of four of the 16 Nearctic species: *P. ecostata* (LeConte), *P. angulata* (Say), *P. borealis* (Randall), and *P. punctiventris* (LeConte). His descriptions are brief and make reference to general body shape and coloration. No details of features such as the head capsule or the mouthparts are included; furthermore, in the case of *P. borealis,* the description is based on three larval exuviae. Buschman (1977) studied the biology of some selected fireflies, among them *Pyractomena lucifera* and provides a detailed description of the life cycle of this species under both laboratory and natural conditions (Buschman 1977, 1984).

MATERIALS AND METHODS

Mature larvae of *Pyractomena borealis* were collected by MA on March 23, 1994 at Cedar Bog Natural Preserve (Ohio). They were kept in a small plastic container with a wet paper towel, and brought to the laboratory. A small terrarium was made with a rectangular plastic container (12 × 20 × 7 cm); part of the lid was cut out and replaced with a fine mesh to allow gas exchange and to avoid an excessive build up of humidity. Fine sand mixed with some soil (80% sand and 20% soil) was used as the substrate and, on top, small pieces of bark were added. The substrate was kept moist during the entire rearing process. Small aquatic snails were offered to these larvae, but those were refused and pupation took place soon after the larvae were collected. No special requirements were necessary for pupation. Several males and one female emerged from the pupal exuviae, and two days after copulation the female laid a cluster of eggs. Newly emerged larvae were offered snails which they accepted, and throughout the rearing process they were maintained on the same diet. In order to keep the container clean, the empty shells were removed every other day. The culture was subdivided as larvae reached the third instar to avoid an overcrowded environment (however, cannibalism was never observed).

Several larvae of each instar were fixed in boiling water, and stored in 75% alcohol. All the last (fifth) instar larvae were fixed by the end of July. Pupae were fixed in the same way, but right after fixation they were punctured in two or three places with a minuten pin, thus preventing the swelling of the pupae and allowing the maintenance of their natural shape.

To study the larval morphology, several specimens were cleared in lactic acid and dissected in order to obtain different parts of the body (head capsule, mouthparts, holdfast organ, etc.). These were arranged on slides using Hoyer's as the mounting medium. Drawings were done using a dissecting microscope (Wild M5) and a compound microscope (Wild M20), both with a camera lucida. The schematic illustration of the eversion process of the holdfast organ was done using MacDraw II, version 1.1.

Pyractomena borealis (Randall)

Description of fifth larval instar.—Body elongate, fusiform, slightly flattened dorsoventrally (Fig. 1). Cuticle shiny on sclerotized areas, granulose with short clubbed setae on clear granules, areas with dark granules lacking setae (Fig. 8). Color pattern variegated, ranging from light brown to dark brown. Length: 17.0 to 22.0 mm. Length of remaining instars: first = 3.5 to 4.5 mm; second = 7.0 to 8.5 mm; third = 9.0 to 11.0 mm; fourth = 13.0 to 16.0 mm.

Head capsule: Prognathous, small, subcylindrical, twice as long as wide (Fig. 2); retractile within the thorax. Head capsule not fused ventrally (Fig. 3). Labrum and

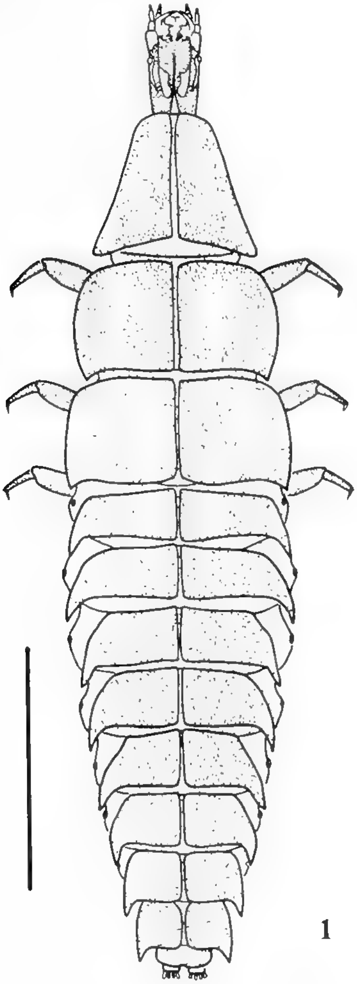


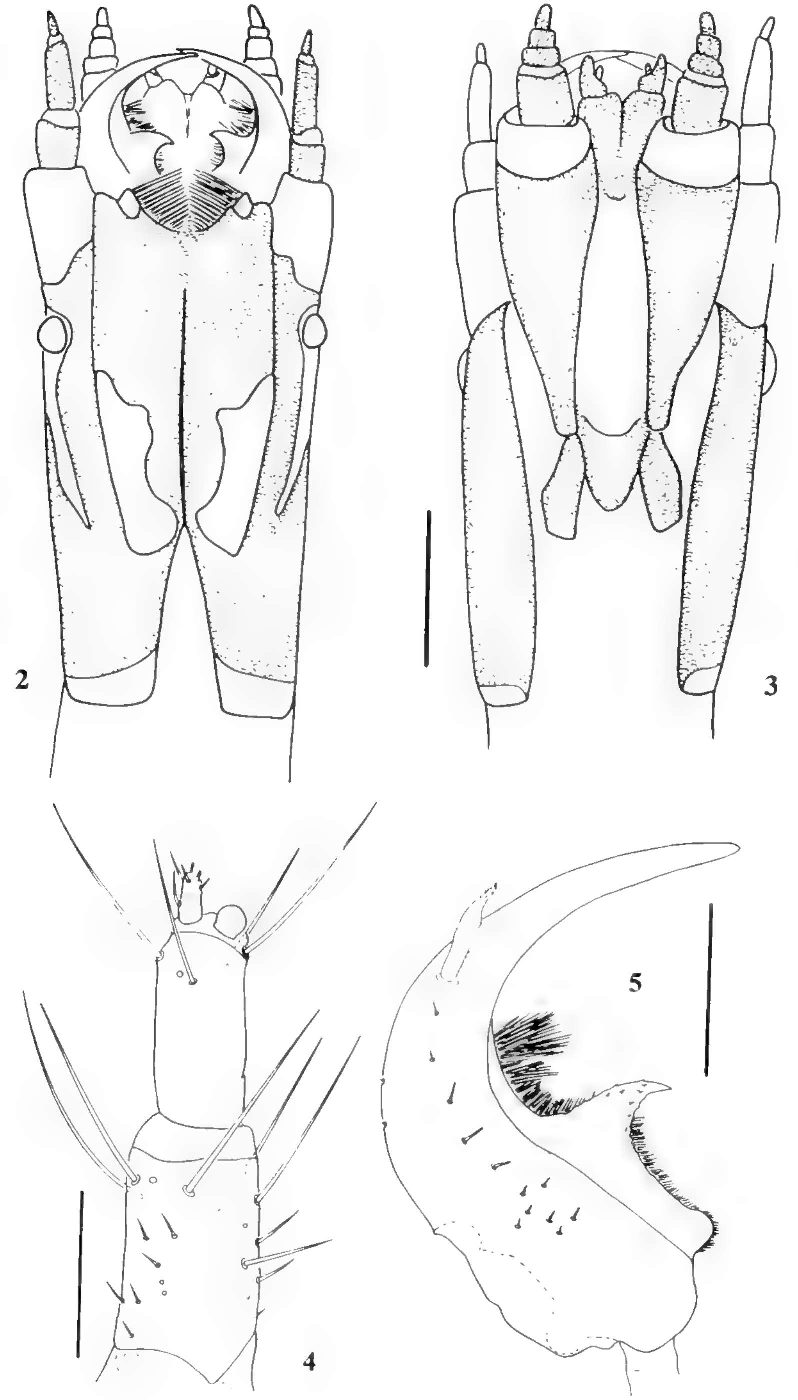
Fig. 1. *Pyractomena borealis*, fifth instar larva, habitus. Scale bar = 5.0 mm.

clypeus fused. Head with 3 internal ridges, 1 along middle of head, extending almost to distal edge; 2 lateral ones originating behind inner margins of antennae, extending back and disappearing at basal third of head capsule. Epicranial suture, in fifth-instar larvae, present as a fine line, V-shaped, extending forward from base of middle internal ridge to base of lateral internal ridges; non-functional (head capsule not split open between last larval instar and pupal stage). Occiput forming a V-shaped incision dorsally, from where median internal ridge originates. One pair of lateral stemmata, posterior to base of antennae. Epipharynx formed by two oval plates covered by transverse rows of microtrichiae, and an anterior brush of long, slender setae that project past labroclypeal margin.

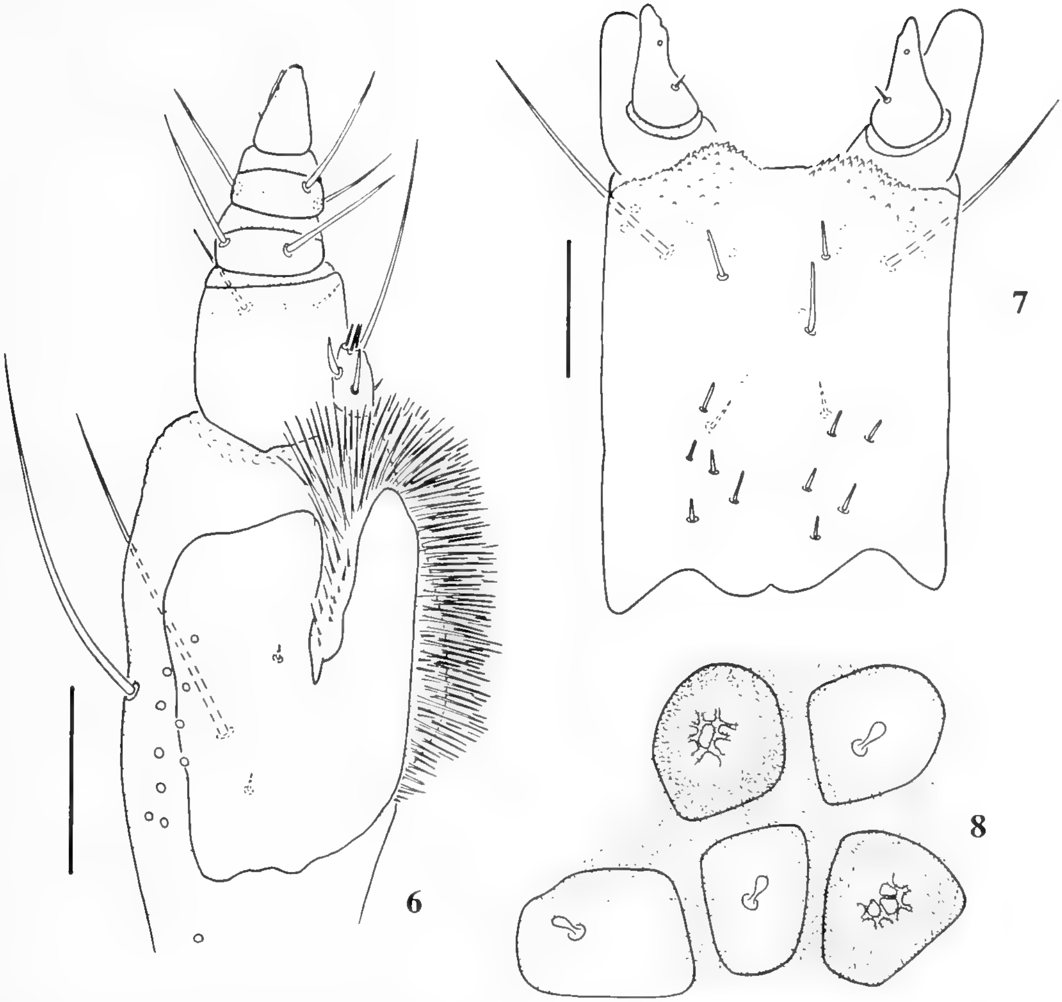
Antenna: Three-segmented, partially retractable within membranous base (Fig. 4); originating on latero-apical edges of Head capsule. Basal segment widest, attached to membranous base, carrying five long subapical setae distributed as follows: two dorsal, two ventral and one lateral; several other short setae also on dorsal and lateral surfaces. Second segment as long as first, narrower, with four long subapical setae, carrying a large globular sensorium, half length of third antennal segment (longer in first instar larva). Third segment much smaller, with several short setae and a pair of small cuticular projections.

Maxilla: Elongated, closely attached to labium, forming an homogeneous structure loosely connected to head capsule (Fig. 3). Cardo narrowly subquadrate, covered by dense pubescence. Stipes as an elongate triangle, broader on distal end, ventral surface more sclerotized than dorsal, which is incompletely sclerotized (Fig. 6); galea two-segmented, basal segment short, distal segment carrying several short setae and one long apical seta that reaches base of last palpal segment; lacinia reduced, appearing as a thick brush of cuticular spines, covering base of galea and inner margin of stipes (more reduced in first instar larva). Palpus four-segmented, basal segment largest, as long as other three combined, with two ventral setae; second and third segments short, wider than long, second segment with two long dorsal setae and third segment with one dorsal and two lateral long setae; distal segment subconical.

Mandible: Symmetrical, strongly falcate, with an inner channel opening subapically on outer edge (Fig. 5). Retinaculum present, forming a sharp inner tooth on basal third of mandible, with several sharp, short, triangular spines. Ventral surface of mandible with a dense brush of slender spines pro-



Figs. 2–5. *Pyractomena borealis*, head of fifth instar larva. 2, Dorsal view. 3, Ventral view. Scale bar = 0.5 mm. 4, 5, Fifth instar larva. 4, Left antenna, dorsal view. 5, Left mandible, dorsal view. Scale bars = 0.2 mm.



Figs. 6–8. *Pyractomena borealis*, fifth instar larva. 6, Left maxilla, dorsal view. 7, Prementum and labial palpi, dorsal view. 8, Detail of the cuticular granules. Scale bars: Fig. 6 = 0.2 mm, Fig. 7 = 0.1 mm.

jecting mediad; dorsal surface with several short setae. One clear, hyaline, long seta or sensory appendage close to outer margin of mandible, just before channel opening carrying several small distal spines.

Labium: Closely attached to maxilla; formed by a short and strongly sclerotized prementum, an elongated and poorly sclerotized mentum, and a small subtriangular submentum. Prementum, in ventral view, with a distal apical cleft (Fig. 3) and a pair of long and slender setae; in dorsal view with a group of small, apical cuticular spines and several short setae. Palpus two-segmented; basal segment longer and projecting further than second, second segment attached to basal half of first one (Fig. 7).

Thorax: Three-segmented. Prothorax subtriangular, wider at base, containing retracted head when larva in repose. Meso- and metathorax subrectangular. Thoracic tergites subdivided by a sagittal line. Color pattern variegated, ranging from light yellow to dark brown (Fig. 1). All three segments with pleural areas formed by an upper laterotergite, below it an epimeron and episternum separated by a deep pleural suture; mesothoracic laterotergite subdivided, anterior plate smaller, carrying mesothoracic spiracle. Prosternum large, subpentagonal; meso- and metasterna smaller, narrow, subdivided into an anterior basisternum and a posterior sternellum. A long and soft neck, with two pairs of long and narrow sclerites (one dorsal and one ventral), connects head with prothorax; head retracts completely within this neck. One pair of biforous spiracles present on mesopleura.

Legs: Five-segmented, coxae long and cylindrical; trochanters small, subtriangular in lateral view; femora long and cylindrical; tibiotarsi as long as femora, tapering towards distal end; pretarsi strong, simple, with a pair of stout setae at base. Femora and tibiotarsi with a double row of strong setae on inner margin.

Abdomen: Ten-segmented, segments one to eight similar in shape, becoming narrower towards end; each tergite subrectangular, divided by a sagittal line, with a lateral projection on each side pointing backwards (Fig. 1); ninth segment much smaller, subquadrate, lacking sagittal line and without lateral projections; segment ten as a narrow ring surrounding anal region, carrying holdfast organ. Pleural areas well developed, segments one to seven subdivided, upper plate large, suboval, carrying spiracles, lower plate small, narrowly subtriangular; pleura eight with only one suboval plate carrying a spiracle; pleural areas of segments nine and ten reduced. Abdominal sterna large, subquadrate, narrowing towards end of abdomen. Color pattern similar to that of thorax, variegated. Biforous spiracles present on pleurites one to eight.

Description of pupa.—Slightly curved, ventrally concave; young pupa light brown in color, mature pupa darker. Length: 19.0 to 23.0 mm.

Head: Completely covered by pronotum in dorsal view (Figs. 9, 10), light brown. Eyes large, on sides of head; antennae inserted in front of eyes, closer to center of frons; antenna and mouthparts dark brown.

Thorax: Pronotum large, subtriangular, covering head; light brown with two dark brown longitudinal bands in disk. Meso- and metanota shorter, subrectangular, carrying wingpads on sides and slightly darker than pronotum. First and second pair of legs fully visible in ventral view; third pair of legs partially covered by wingpads.

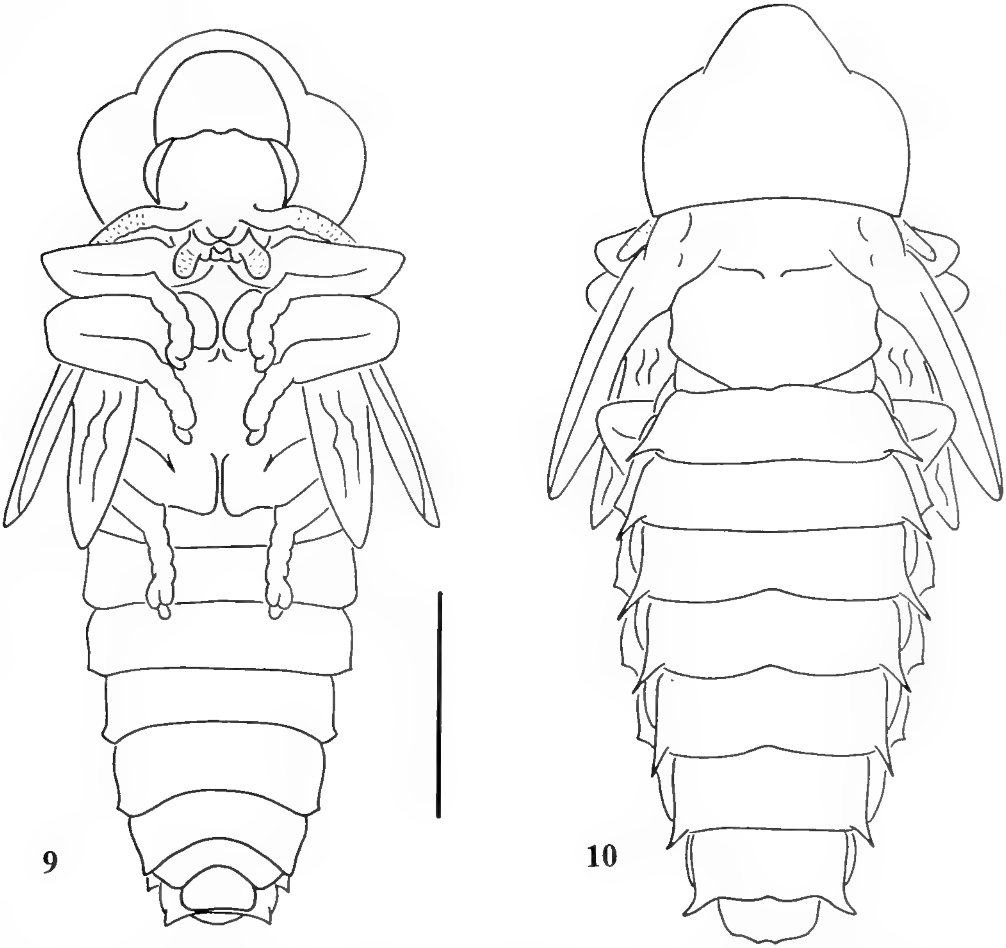
Abdomen: Segments wider than long, light brown. Tergites one to seven similar in shape but becoming narrower after tergite three; subrectangular, with acute projections on postero-lateral corners, and becoming smaller toward abdominal apex. Sternite one covered by legs and wingpads, segment two partially visible, remaining sternites fully visible. Segment eight small, partially visible in dorsal view, tergite with a short acute projection on each posterolateral corner.

Spiracles: Seven pairs of functional spiracles; first in pleuron of mesothorax, remaining six on abdominal segments two to seven.

BIOLOGY

The following description of the life cycle of *Pyractomena borealis* was obtained from specimens collected in the field and reared in the laboratory. In many cases, specimens reared in the laboratory may have different developmental times than those living in natural habitats due to changes in the light:dark cycle (Buschman 1977, personal observations). In any case, *P. borealis* seems to be an annual species and, in Ohio, adults are collected in the spring. Green (1957) collected pupal exuviae in May (Minnesota), and April (Maryland); these agree with our dates for Ohio. In the same paper Green lists the collection dates for adult specimens in several states, all ranging from March (southern states) to July and August (northern states and Canadian provinces).

Several mature larvae were collected, on the bark of trees at heights of 2 to 5 feet above the ground. They did not feed, suggesting that they either overwintered as mature fifth instar larvae or prepupae. The lar-



Figs. 9–10. *Pyractomena borealis*, pupa. 9, Ventral view. 10, Dorsal view. Scale bar = 5.0 mm.

vae were very active, and they pupated five to six days after being brought into the laboratory. Prepupae attached themselves to the bark using the holdfast organ, pupating exposed instead of digging a pupal chamber as do many other lampyrids, as has also been reported by other authors (Balduf 1935, Buschman 1977, 1984, LaBella and Lloyd 1991). The prepupae, and latter the pupae, hung vertically, with the head pointing downward and the venter facing the bark. The larval skin remained attached to the substrate, surrounding the terminal abdominal segments of the pupa. Adults emerged in 4 to 5 days. Males were first to emerge. The only female reared was approached by males soon after emergence, and her cuticle was not completely sclerotized during copulation. Eggs were laid three to four days after mating, in cracks of the bark or under pieces of bark. The only clutch of eggs obtained consisted of approximately 100 eggs.

First instar larvae emerged one month after the eggs were laid. Larvae of all instars fed on snails. Aquatic snails of the genera *Physa* Draparnaud and *Gyraulus* Agassiz were used in the laboratory. Early instars to the third, showed gregarious feeding habits. Small groups of three to six larvae were seen feeding together on the same prey. Since larvae have a protractable head and a

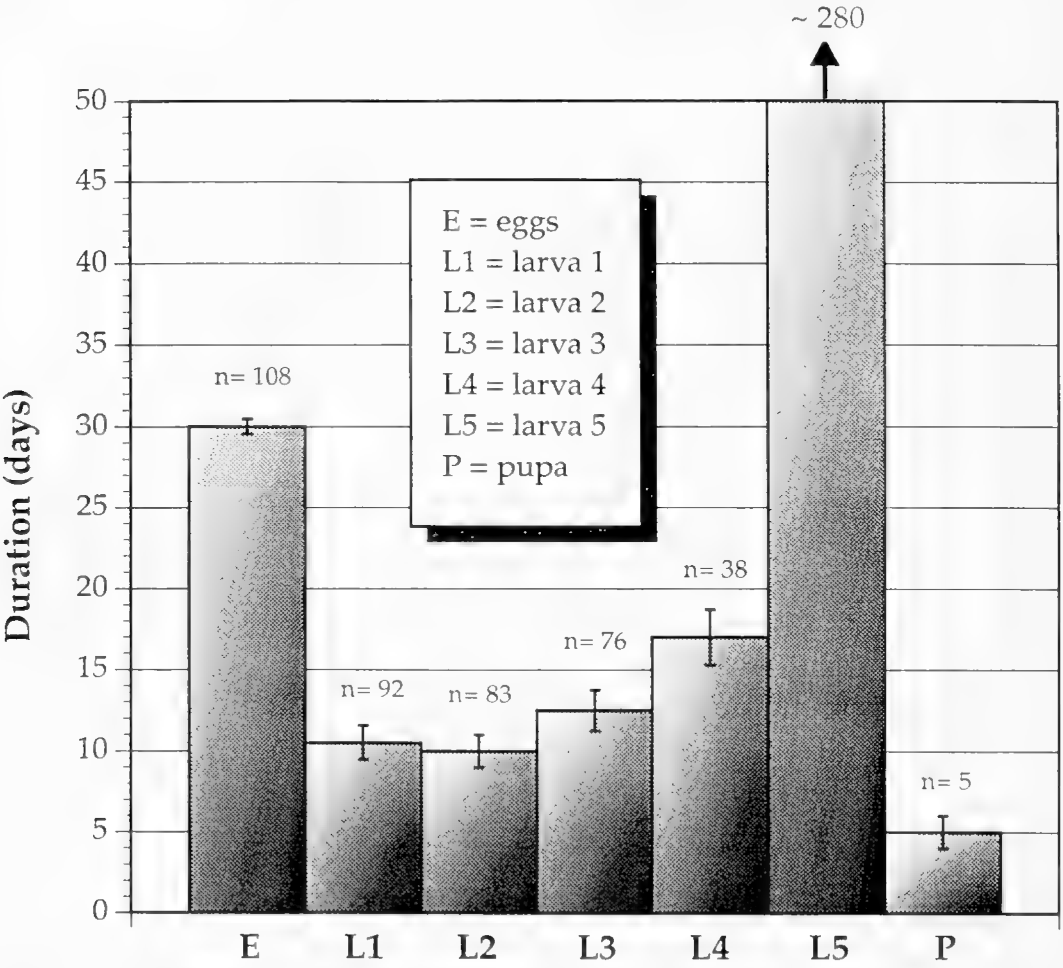
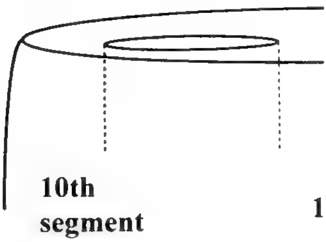


Fig. 11. Mean duration (in days) of the preimaginal stages of *Pyractomena borealis* (n = number of larvae). Duration of the fifth instar is approximate

long neck, up to twice the length of the head, they can extend it forward and eat the contents of retracted snails. They also injected extraoral digesting fluids through their mandibles. After feeding they used the anal holdfast organ to groom their heads, mouthparts, and neck. Before moulting to the next instar, larvae stopped feeding and hung themselves from the bark or walls of the container using the holdfast organ, similar to what they did between the prepupal and pupal stages. The holdfast organ was also used to aid locomotion while wandering around on the bark.

The duration of each stage was very constant between larvae and is summarized in Fig. 11. First and second instars moulted after 9 to 11 days. The duration of subsequent instars increased with age: third instar larvae 12 to 13 days, fourth instars 16 to 18 days, and, fifth instar larvae were fixed after about 40 or 50 days. The approximate duration of the fifth instar, based on the date when the larvae at Cedar Bog were collected, would be around 280 days. This species has five instars (under laboratory conditions), and the last instar seems to be the one that overwinters. We have no infor-



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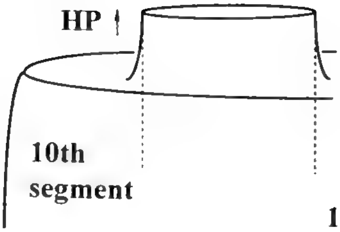

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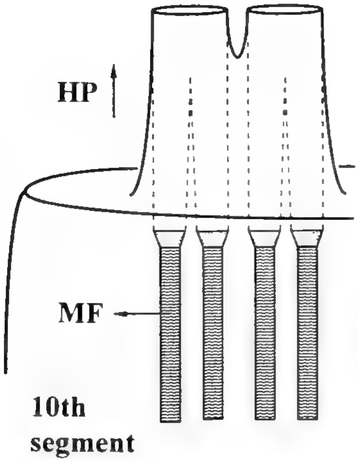

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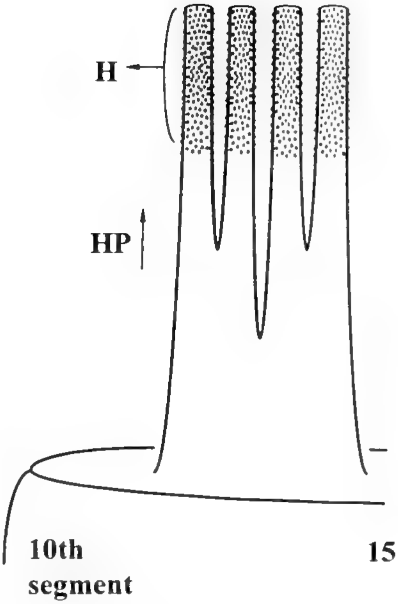

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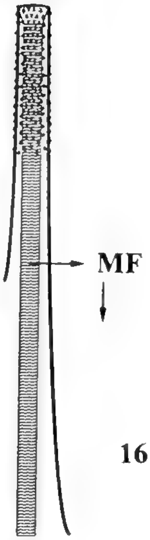

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Figs 12–16. Schematic representation of the evertion process of the holdfast organ; see text for a detailed description. 12, Holdfast organ retracted. 13, First step of the process due to haemolymph pressure (HP). 14, First branching of the holdfast organ, the internal muscle fibers (MF) are attached to the end of the finger-like appendages. 15, 16, Schematic representation of the evertion process of the holdfast organ; see text for a detailed description. 15, Holdfast organ completely everted due to haemolymph pressure (HP), the cuticular hooks (H) cover the distal two-thirds of each finger-like appendage 16, Detail of one finger-like appendage with internal muscle fiber (MF) responsible for retraction of appendage.

mation on where the larvae overwinter, but it may be among plant debris at the base of the trees.

FUNCTIONAL MORPHOLOGY OF THE HOLDFAST ORGAN

The holdfast organ (also called caudal appendage, caudal grasping organ, and tail organ) has been mentioned or described by several authors (Targioni Tozzetti 1866, Bugnion 1922, 1929, 1933, Blair 1927, Okada 1928, Balduf 1935, Peterson 1951, Costa et al. 1988, LaBella and Lloyd 1991, Tyler 1994), and it seems to be unique to lampyrid larvae (within the elateroid lineage), being absent in related families. Similar structures are present in some carabids and staphylinoids (Silphidae), but these seem to be convergencies. As mentioned above, the holdfast organ has different functions: aiding the larvae in locomotion; cleaning their heads and mouthparts after consuming prey; and attaching themselves to the substrate between moults and during the pupal stage.

This organ is composed of a series of eversible, digitiform structures that project from the membranous area of the last abdominal segment (10th), surrounding the anal region. There are five such structures on each side of the tenth segment. Figures 12–16 show a schematic representation of the eversion process of one such structure. The finger-like appendages first appear as a single tube when they begin to evert (Figs. 12, 13), via haemolymph pressure (HP). As evertion proceeds, these tubes fork once (Fig. 14), and then a second time (Fig. 15); this produces four terminal processes, each one covered on its terminal two thirds with microscopic hooks (H). These hooks point outwards and forwards, and attach easily to any substrate on which the larvae walk. They are also useful for removing mucus and other residues left on their head, mouthparts, and neck after feeding on snails. This last function is extremely important since the head is usually retracted within the prothorax, and any dirt or sticky residue would affect this retraction.

On the inside of each of these caudal filaments is one muscle fiber (MF) (Figs. 14,16), which is responsible for the retraction of each finger-like appendage. During retraction, the hooks point inwards and backwards, thus avoiding being caught on the membranous cuticle of these appendages.

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DESCRIPTION OF IMMATURE STAGES OF *TRUPANEA CONJUNCTA* (ADAMS) (DIPTERA: TEPHRITIDAE)

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Abstract.—The pre-imaginal stages of *Trupanea conjuncta* (Adams) are described. *Trupanea conjuncta* is a narrowly oligophagous, univoltine, nonfrugivorous tephritid in southern California. The third instar larva differs from previously studied Tephritidae, including six congeneric species, in that the integument is finely punctate posterior of the prothorax and the median oral lobe bears lateral projections. The metathoracic lateral spiracular complex consists of a single spiracle unaccompanied by any sensilla; the abdominal lateral spiracular complex consists of a spiracle and two verruciform sensilla. Thus, the lateral spiracular complex is the only morphological feature observed to differ among third instars of all seven species of *Trupanea* studied to date. The first and second instars of *T. conjuncta* differ from the third instar in that the integument is smooth, without punctuation.

Key Words: Insecta, *Trupanea*, Asteraceae, nonfrugivorous Tephritidae, taxonomy of immature stages, egg, larva, puparium

The life history of *Trupanea conjuncta* (Adams) (Diptera: Tephritidae) was described by Goeden (1987) before adoption of our current format incorporating descriptions of the immature stages. To correct this deficiency and allow full comparison of the 31 species of southern California nonfrugivorous fruit flies for which both life histories and descriptions of the immature stages now have been published, this paper describes the immature stages of *T. conjuncta*.

MATERIALS AND METHODS

One-liter samples of excised, immature and mature flower heads from the known hosts of *T. conjuncta, Trixis californica* Kellogg and *Perezia microcephala* (de Candolle) Gray (Asteraceae), potentially containing eggs, larvae, and puparia were transported in cold-chests in an air-conditioned vehicle to the laboratory and stored under refrigeration for subsequent dissection, photography, description, and measurement. Twenty-two eggs, 23 first-, 14 second-, and nine third-instar larvae, and nine puparia dissected from flower heads were preserved in 70% EtOH for scanning electron microscopy (SEM). Additional puparia were placed in separate, glass shell vials stoppered with absorbant cotton and held in humidity chambers at room temperature for adult and parasitoid emergence. Specimens for SEM were hydrated to distilled water in a decreasing series of acidulated EtOH. They were osmicated for 24h, dehydrated through an increasing series of acidulated EtOH and two, 1-h immersions in Hexamethlydisilazane (HMDS), mounted on stubs, sputter-coated with a gold-palladium alloy, and studied with a JEOL JSM C-35 SEM in the Department of Nematology, University of California, Riverside.

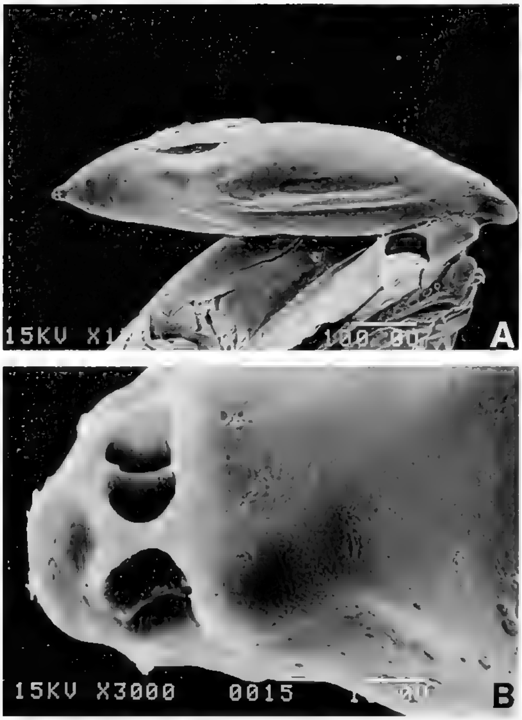

Fig. 1. Egg of *Trupanea conjuncta:* (A) habitus, pedicel to left; (B) egg pedicel.

Plant names used in this paper follow Munz (1974), as updated by Hickman (1993) and Bremer (1994); tephritid names follow Foote et al. (1993). Terminology and telegraphic format used to describe the immature stages follow Knio et al. (1996), Goeden and Teerink (1997a, b, 1998; Goeden et al. 1998), and our earlier works cited therein. Means ± SE are used throughout this paper. Voucher specimens of *T. conjuncta* eggs, larvae and puparia are stored in a collection of immature Tephritidae maintained by JAT.

RESULTS

Immature stages.—The eggs and puparium of *T. conjuncta* were described and photographs of these stages and larvae provided by Goeden (1987), but detailed descriptions, especially of larvae based on scanning electron microscopy heretofore have not been published.

Egg: The egg (Fig. 1A) of *T. conjuncta* has a short pedicel with a single row of aeropyles (Fig. 1B).

Third instar larva: White, barrel-shaped, tapering anteriorly, rounded posteriorly; minute acanthae circumscribe thoracic and abdominal intersegmental lines (Fig. 2A); segments TII-AVIII finely punctate (Fig. 2A, E); gnathocephalon smooth, conical (Fig. 2B), rugose pads dorsal and lateral to mouth lumen (Fig. 2B-1); dorsal sensory organ a single dome-shaped papilla (Fig. 2B-2, C-1); subdorsal sensilla laterad of dorsal sensory organ (Fig. 2B-3); anterior sensory lobe (Fig. 2B-4) bears terminal sensory organ (Fig. 2C-2), pit sensory organ (Fig. 2C-3), lateral sensory organ (Fig. 2C-4), and supralateral sensory organ (Fig. 2C-5); stomal sense organ ventrolaterad of anterior sensory lobe (Fig. 2C-6); mouth hooks tridentate (Fig. 2D-1); median oral lobe tapered anteriorly with lateral projection (Fig. 2D-2); labial lobe and median oral lobe attached, two pore sensilla in lateral lobe (Fig. 2D-3); six pit sensilla circumscribe gnathocephalon posterior to rugose pads; prothorax circumscribed anteriorly by minute acanthae (Fig. 2E-1), rugose pads (Fig. 2E-2) and two rows of verruciform sensilla (Fig. 2E-3); anterior thoracic spiracles on posterior margin of prothorax bear five ovoid papillae (Fig. 2E-4); metathoracic lateral spiracular complex consists of an open spiracle; abdominal lateral spiracular complex consists of a spiracle (Fig. 2F-1), and two verruciform sensilla (Fig. 2F-2); caudal segment circumscribed by minute acanthae (Fig. 2G-1), and stelex sensilla in a 2- dorsal, 4- ventral arrangement (Fig. 2G-2); posterior spiracular plate bears three ovoid rimae, ca. 0.04 mm in length (Fig. 2G-3), and four interspiracular processes each with 6-8 branches, longest measuring 0.015 mm (Fig. 2G-4); intermediate sensory complex ventrad of posterior spiracular plates consists of a medusoid sensillum (Fig. 2H-1), and a stelex sensillum (Fig. 2H-2).

Second instar larva: White, elongate-cylindrical, tapering slightly anteriorly, rounded posteriorly; minute acanthae circumscribe meso-, metathoracic and abdominal intersegmental lines (Fig. 3A); gnathocephalon conical (Fig. 3B), rugose pads dorsal and lateral to mouth lumen (Fig. 3B-1); dorsal sensory organ a single dome-shaped papilla (Fig. 3B-2, C-1); subdorsal sensillum laterad of dorsal sensory organ (Fig. 3C-2); anterior sensory organ bears all four sensory organs 3C-3); stomal sense organ ventrolaterad of anterior sensory lobe (Fig. 3B-3, C-4); mouth hooks bidentate (Fig. 3B-4); median oral lobe tapered anteriorly; prothorax with minute acanthae ventrally; anterior thoracic spiracle consists of 5 papillae (Fig. 3D); lateral spiracular complex not seen; caudal segment circumscribed by minute acanthae and stelex sensilla; posterior spiracular plate bears three ovoid rimae, 0.017 mm in length (Fig. 3E-1), and four interspiracular processes, each with 3-5 branches, longest measuring 0.012 mm (Fig. 3E-2), intermediate sensory complex consists of a medusoid sensillum (Fig. 3F-1) and stelex sensillum (Fig. 3F-2).

First instar larva: White, elongate-cylindrical, rounded anteriorly and posteriorly, minute acanthae circumscribe intersegmental lines (Fig. 4A); gnathocephalon smooth, lacking rugose pads (Fig. 4B); dorsal sensory organ a single dome-shaped papilla (Fig. 4B-1); anterior sensory lobe bears all four sensory organs (Fig. 4B-2); stomal sense organs indistinct; mouth hooks bidentate (Fig. 4B-3); median oral lobe laterally flattened; minute acanthae on ventral margin of prothorax (Fig. 4B-4); anterior thoracic spiracle not present; abdominal lateral spiracular complex consists of a spiracle and two verruciform sensilla; caudal segment circumscribed by stelex sensilla (Fig. 4C-1); posterior spiracular plate bears two ovoid rimae, ca. 0.006 mm in length (Fig. 4C-2), and four interspiracular processes, longest measuring 0.006 mm (Fig. 4C-3); intermediate sensory complex consists of a medusoid sensillum (Fig. 4C-4), and a stelex sensillum (Fig. 4C-5).

Puparium: Minute acanthae circumscribe intersegmental lines, integument finely punctate (Fig. 5A), anterior end bears the invagination scar (Fig. 5B-1) and anterior thoracic spiracle (Fig. 5B-2); caudal segment circumscribed by minute acanthae; posterior spiracular plate bears three ovoid rimae (Fig. 5C-1), and four interspiracular processes (Fig. 5C-2); intermediate sensory complex ventrad of posterior spiracular plates (Fig. 5C-3).

DISCUSSION

The egg (Fig. 1A) of *T. conjuncta* has an elongate-ellipsoidal shape and short pedicel with a single row of aeropyles (Fig. 1B) like all other congeners studied (Goeden 1987, 1988; Headrick and Goeden 1991; Goeden and Teerink 1997b, 1998; Goeden et al. 1998), except for *T. bisetosa* (Coquillett), which has two rows of aeropyles (Knio et al. 1996).

The third instar of *Trupanea conjuncta* is unique among *Trupanea* species previously studied in that the integument is finely punctate in the segments posterior of the prothorax 2A, E, F) (Headrick and Goeden 1991; Knio et al. 1996; Goeden and Teerink 1997b, 1998 Goeden et al. 1998). Several Tephritid species are shagreened, with evenly distributed, smooth dome-shaped verrucae covering the integument, for example, *Tomoplagia cressoni* Aczél, *Valentibulla californica* (Coquillett) and *Xenochaeta dichromata* Snow (Goeden and Headrick 1991, Goeden et al. 1995, Goeden and Teerink 1997a); however, a punctate integument was not seen in any tephritid previously studied by us (Headrick and Goeden 1990, 1991; Goeden et al. 1995, 1998; Goeden and Teerink 1997a, b, 1998; Headrick et al. 1997; Knio et al. 1996, and our earlier works cited therein).

The median oral lobe, by bearing a pair of lateral projections (Fig. 2D-2), also differs any tephritid previously studied by us (Headrick and Goeden 1990, 1991; Goeden et al. 1995 1998; Goeden and Teerink 1997a, b, 1998; Headrick et al. 1997; Knio et al. 1996, and our earlier works cited

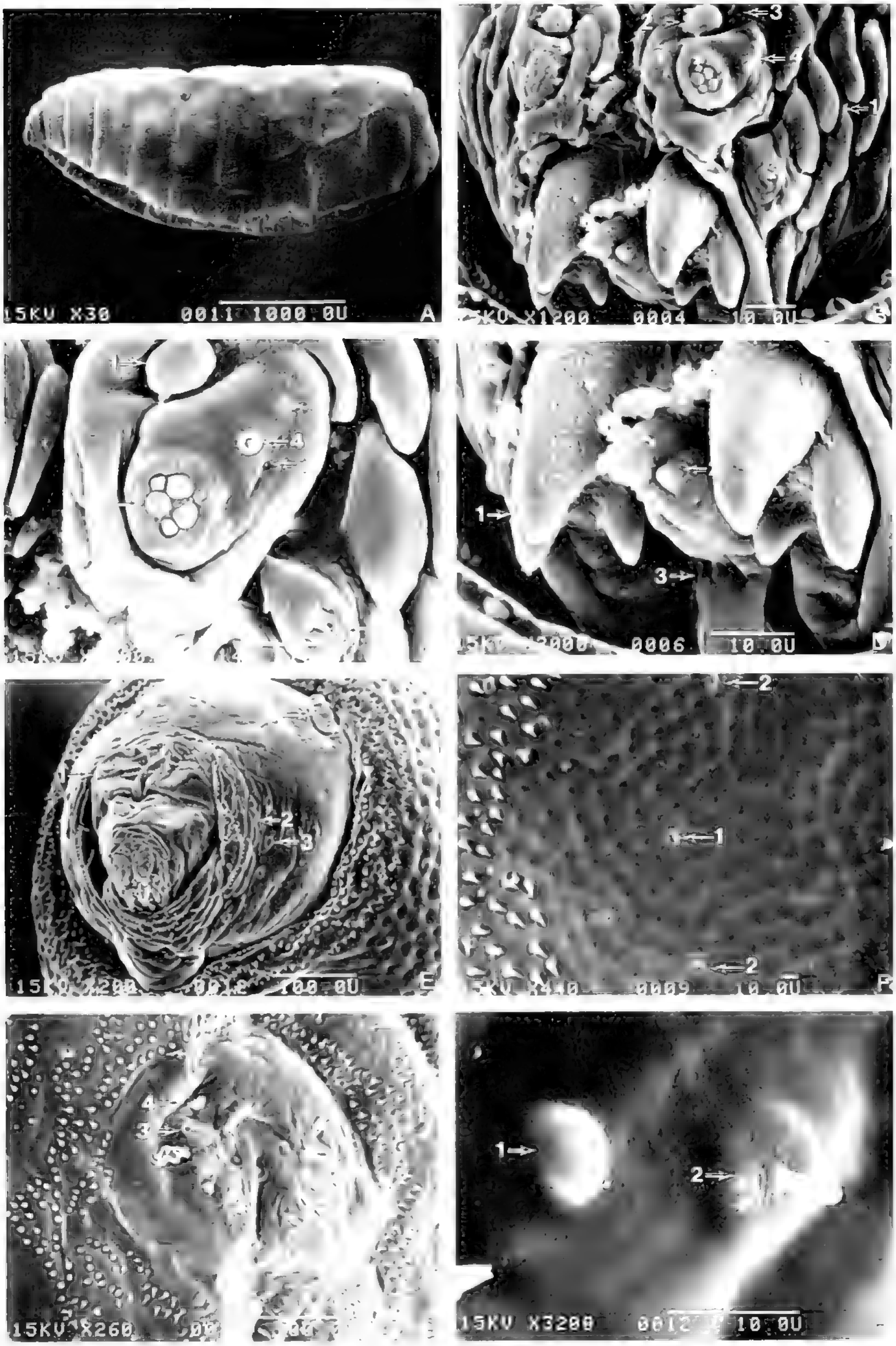

Fig. 2. Third instar of *Trupanea conjuncta*: (A) habitus, anterior end to left; (B) gnathocephalon, anterior view, 1—rugose pads, 2—dorsal sensory organ, 3—subdorsal sensilla, 4—anterior sensory lobe; (C) anterior sensory lobe, 1—dorsal sensory organ, 2—terminal sensory organ, 3—pit sensory organ, 4—lateral sensory organ, 5—supralateral sensory organ, 6—stomal sense organ; (D) gnathocephalon, ventral view, 1—mouth hooks, 2—median oral lobe, 3—labial lobe sensilla; (E) gnathocephalon, prothorax, mesothorax, lateral view,

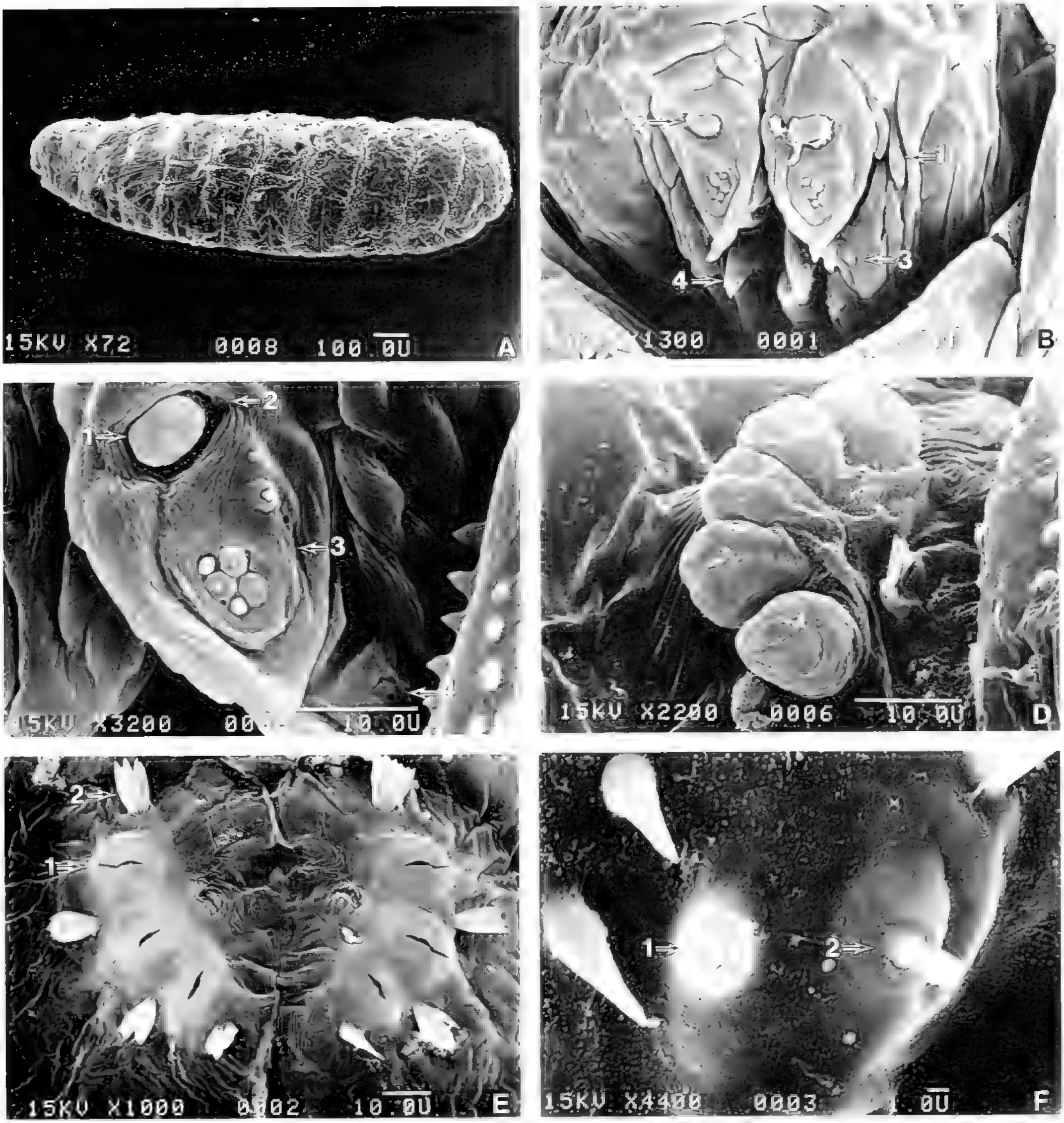

Fig. 3. Second instar of *Trupanea conjuncta:* (A) habitus, anterior end to left; (B) gnathocephalon, anterior view, 1—rugose pads, 2—dorsal sensory organ, 3—stomal sense organ, 4—mouth hook; (C) gnathocephalon, anterior view, 1—dorsal sensory organ, 2—subdorsal sensillum, 3—anterior sensory lobe, 4—stomal sense organ; (D) anterior thoracic spiracle; (E) caudal segment, 1—rima, 2—interspiracular process; (F) intermediate sensory complex, 1—medusoid sensillum, 2—stelex sensillum.

←

1—minute acanthae, 2—rugose pads, 3—verruciform sensilla, 4—anterior thoracic spiracle; (F) fourth abdominal segment, 1—spiracle, 2—verruciform sensilla; (G) caudal segment, 1—minute acanthae, 2—stelex sensillum, 3—rima, 4—interspiracular process; (H) intermediate sensory complex, 1—medusoid sensillum, 2—stelex sensillum.

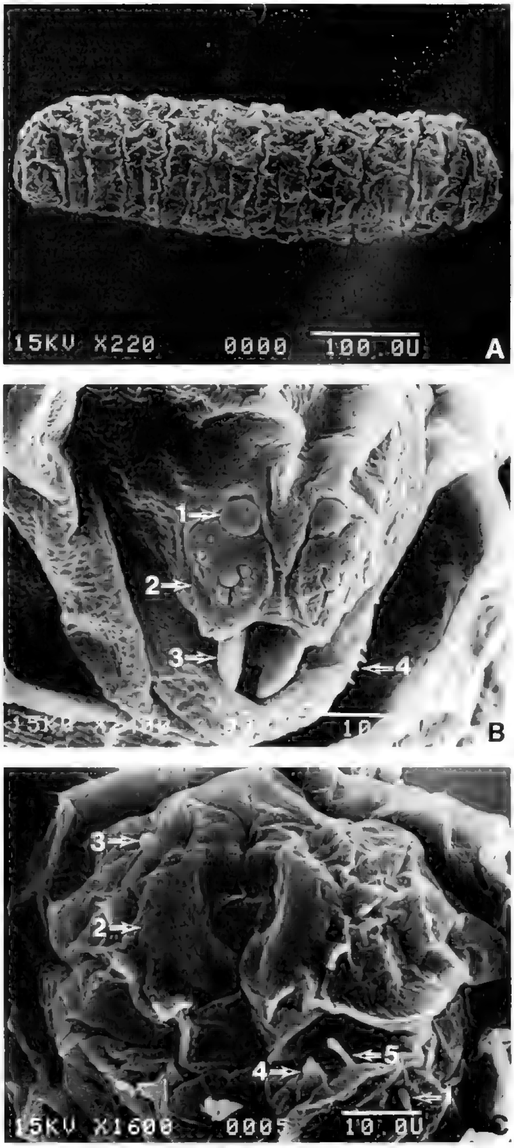

Fig. 4. First instar of *Trupanea conjuncta:* (A) habitus, anterior end to left; (B) gnathocephalon, anterior view, 1—dorsal sensory organ, 2—anterior sensory lobe, 3—mouth hook, 4—minute acanthae; (C) caudal segment, 1—stelex sensillum, 2—rima, 3—interspiracular process, 4—intermediate sensory complex, medusoid sensillum, 5—intermediate sensory complex, stelex sensillum.

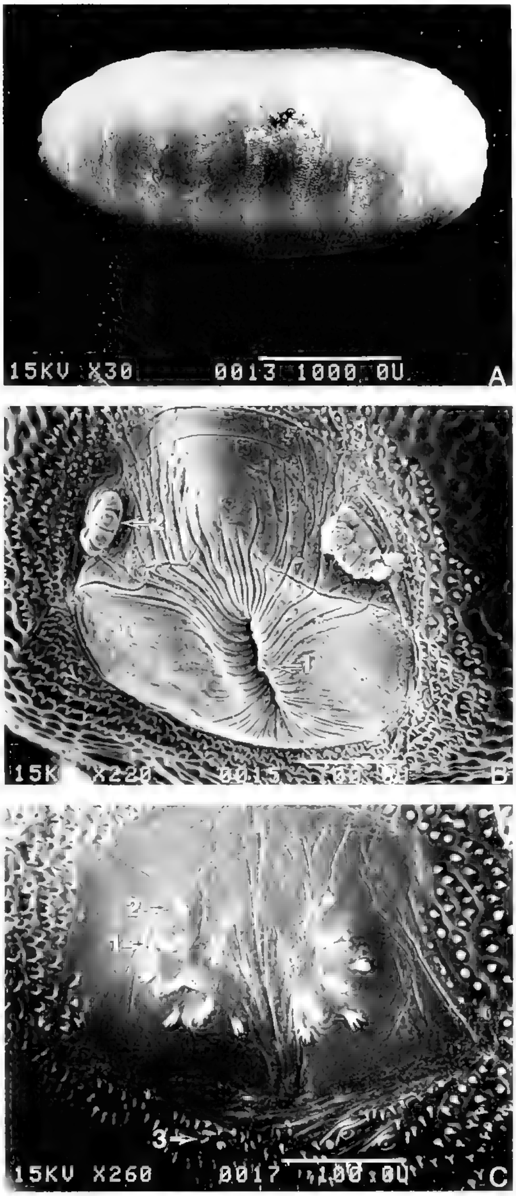

Fig. 5. Puparium of *Trupanea conjuncta:* (A) habitus, anterior end to left; (B) anterior end, 1—invagination scar, 2—anterior thoracic spiracle; (C) caudal end, 1—rima; 2—interspiracular process, 3—intermediate sensory complex.

therein). The median oral lobe in *Aciurina trixa* Curran and *Paracantha gentilis* Hering is lobed along the ventral margin, but not laterally as in *T. conjuncta* (Headrick and Goeden 1990 Headrick et al. 1997).

The lateral spiracular complex of *T. conjuncta* is unique among *Trupanea* species previously studied in lacking verruciform sensilla on the metathorax (Knio et al. 1996). The lateral spiracular complex is the only morphological feature observed to differ among third instars of all seven species of *Trupanea* studied to date (Headrick and Goeden 1991; Knio et al. 1996; Goeden and Teerink 1997b, 1998; Goeden et al. 1998). Otherwise, *T. conjuncta* is similar to the other *Trupanea* species in general habitus and sensory structures; however, there are other slight similarities and differences between this and certain other *Trupanea* species. For example, the rugose pads on the gnathocephalon of *T. conjuncta* are not serrated, like those of *T. bisetosa* (Knio et al. 1996). A subdorsal sensillum is present, as noted with *T. bisetosa*, *T. jonesi* Curran and *T. pseudovicina* Hering (Knio et al. 1996, Goeden and Teerink 1998, Goeden et al. 1998), but not seen with *T. nigricornis* (Coquillett) or *T. signata* Foote (Knio et al. 1996, Goeden and Teerink 1997b). The anterior thoracic spiracle with five papillae has more papillae than all previously studied species, with the exception of *T. signata*, which has 4-5 papillae (Headrick and Goeden 1991; Knio et al. 1996; Goeden and Teerink 1997 b, 1998; Goeden et al. 1998). The interspiracular processes with 6–8 branches are similar to those reported for *T. bisetosa* and *T. californica* Malloch (Headrick and Goeden 1991, Knio et al. 1996).

The second instar differs from the third instar in general habitus, being more elongate-cylindrical than barrel-shaped, and in that the integument is smooth, not finely punctate. In contrast, the second instars of *V. californica* and *X. dichromata* were also shagreened like the third instar (Goeden et al. 1995, Goeden and Teerink 1997a). The second instar also lacks the rugose pads and verruciform sensilla which circumscribe the prothorax, and the mouth hooks are bidentate.

The first instar differs from the second instar in lacking rugose pads on the gnathocephalon and the stomal sense organ is indistinct. The greatest difference occurs in the spiracular system; the first instar typically lacks anterior thoracic spiracles and the posterior spiracular plate bears only two rimae. The interspiracular processes are not greatly reduced as in *T. jonesi* (Goeden and Teerink 1998a).

The puparia of *T. conjuncta* are larger than those of *T. californica, T. imperfecta* (Coquillett), *T. jonesi, T. nigricornis,* and *T. pseudovicina* and smaller than those of *T. bisetosa* and *T. signata* (Goeden 1987, 1988; Headrick and Goeden 1991; Knio et al. 1996; Goeden and Teerink 1997b, 1998; Goeden et al. 1998).

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IMMATURE STAGES OF *HEZA INSIGNIS* STÅL (HETEROPTERA: REDUVIIDAE: HARPACTORINAE)

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Abstract.—The egg and five instars of the harpactorine *Heza insignis* Stål are described and illustrated. Descriptions include morphological and morphometrical characters of specimens reared in the laboratory.

Key Words: Heteroptera, Reduviidae, Harpactorinae, *Heza insignis*, eggs, nymphs

The genus *Heza* Amyot and Serville is comprised of 36 species (Maldonado Capriles 1990). Maldonado Capriles (1976) revised the genus and included a key to 28 or the 31 species known at that time. Maldonado Capriles (1983) added four new species, and, in the same year, Maldonado Capriles and Brailovsky (1983) described one more. *Heza insignis* Stål was described from Brazil, and adults were redescribed from specimens from Bolivia by Maldonado Capriles (1976).

The purpose of this paper is to describe the egg and nymphs of *Heza insignis* in an effort to complete the knowledge of the life cycle of this species.

MATERIALS AND METHODS

The material used in this study consists of eggs and specimens reared in the laboratory at the Instituto de Biología, UNICAMP (Universidad do Campinas), Campinas, São Paulo, Brazil. The material was preserved in 75% ethanol.

Terminology used for morphology follows that of Miller (1971) and Swadener and Yonke (1975).

The measurements are given in millimeters. Illustrations were made with a drawing tube on a Wild M-stereomicroscope.

Scanning electron micrographs of eggs and fifth instars were made from specimens mounted on stubs, sputter-coated with a gold palladium alloy, and studied with a JEOL T-100 SEM.

DESCRIPTION

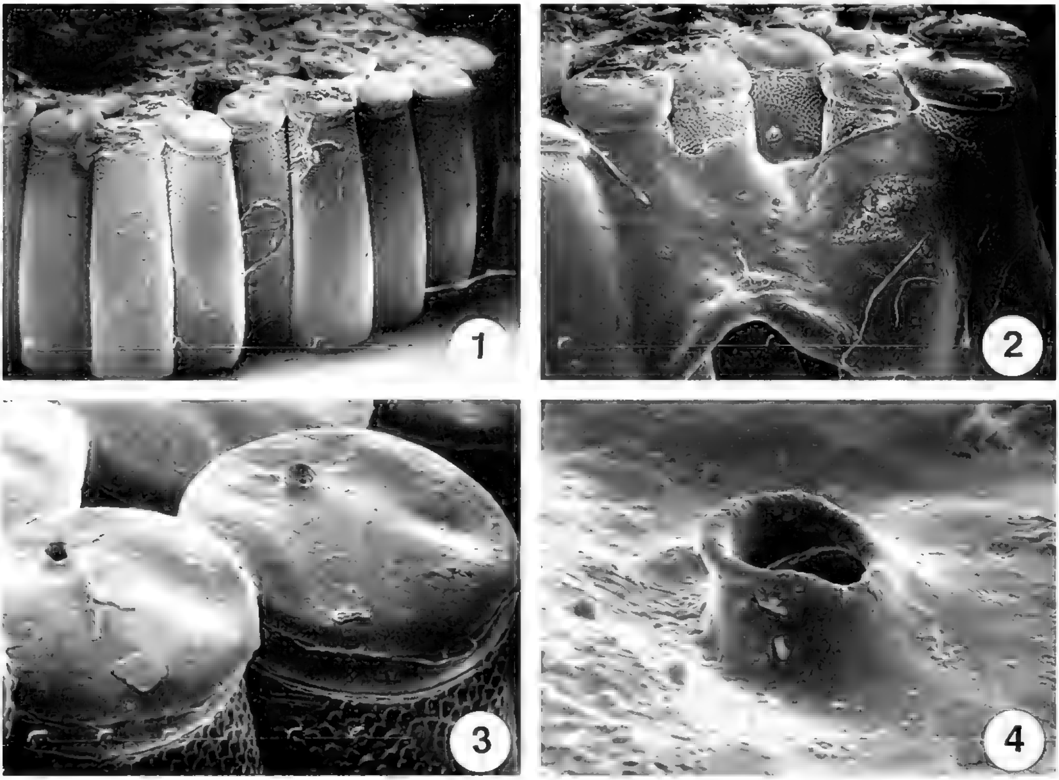
Heza insignis Stål

Egg. (Figs. 1–4).—Length 1.45–1.56 ($\bar{x}$ = 1.48), diameter of operculum 0.37–0.46 ($\bar{x}$ = 0.42). Ova of regular masses of dark brown eggs cemented by their margins (Fig. 2).

Cylindrical and elongated (Fig. 1), chorion (Fig. 3) provided with well developed perforations near apical extreme. Most of chorion and complete surface of operculum (Fig. 3) covered with a mucilaginous substance. Operculum with a lateral elevated pore (Fig. 4). Hexagonal ornamentation visible under substance covering operculum.

First instar (Fig. 5).—Total length 2,4–2,72 ($\bar{x}$ = 2.53). Body (Fig. 5) not elongate.

Length of head 0.56–0.60 ($\bar{x}$ = 0.58), width of head 0.28–0.29 ($\bar{x}$ = 0.44). Head pyriform, homogenous pale brown without granulations. Pilosity on clypeus, pale brown. Eye prominent, red and brown. Width of eye 0.04–0.05 ($\bar{x}$ = 0.045), interocular space 0.15–0.16 ($\bar{x}$ = 0,156). Ocelli



Figs. 1–4. *Heza insignis*, eggs. 1, General aspect in lateral view. 2, Substance surrounding the eggs. 3, Chorium and operculum. 4, Pore of the operculum.

absent. Postocular region surrounded by a fine pale brown stripe. Rostral segments paler than rest of head. Pilosity present. Rostral length 0.65–0.74 mm ($\bar{x}$ = 0.69), ratio of length of segments ca. 1:1.21:0.6. Antenna elongate, cylindrical, and filiform with pilosities, uniformly pale brown except two reduced bands in antennal segment 1. Antenna 2.82–3.40 long ($\bar{x}$ = 3.18), ratio of length of segments ca. 1:0.43:0.55:0.5. Antennal segment 4 annulated. Neck differentiated from rest of head.

Thorax dark brown. Pronotum 0.23–0.26. ($\bar{x}$ = 0.25), width of pronotum 0.21–0.23 ($\bar{x}$ = 0.216). Pilosity and granulations absents. Spines of the anterior lobe absent. Median sulci present.

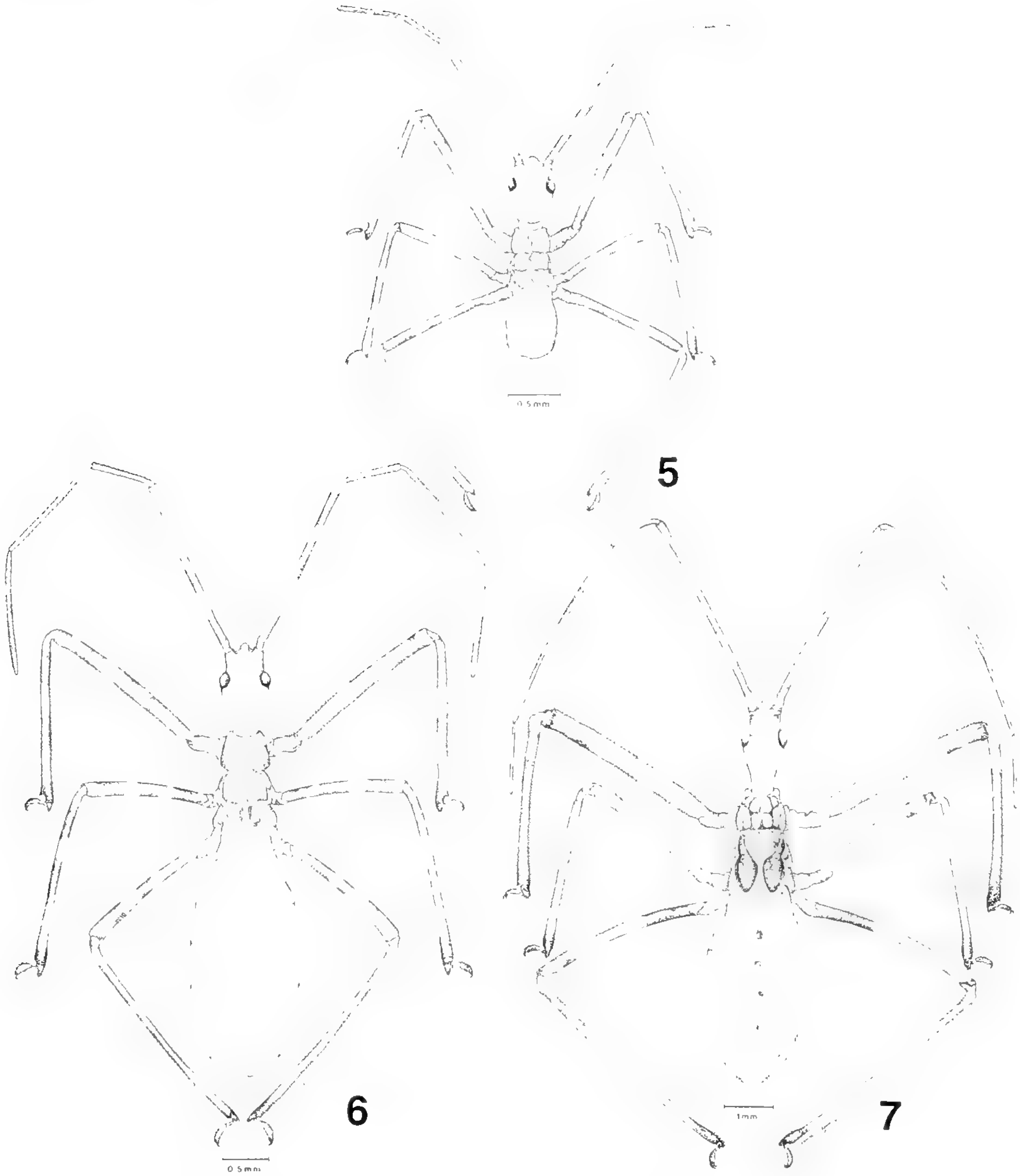
Legs pale brown, pilose. Two pale brown bands on femora and tibiae 1, 2 and 3. Tarsi dark brown.

Wing pads absent.

Abdominal length 0.43–0.46 ($\bar{x}$ = 0.44), abdominal width 0.23–0.26 ($\bar{x}$ = 0.24), abdomen pale brown. Abdomen rounded, light brown. Scent glands not visible.

Second instar (Fig. 6).—Total length 5.44–6.16 ($\bar{x}$ = 5.86). Form (Fig. 6) and color similar to previous instar.

Length of head 0.47–0.49 ($\bar{x}$ = 0.47), width of head 0.25–0.26 ($\bar{x}$ = 0.256). Head more elongate than in first instar. Eye conspicuous and red. Width of eye 0.05–0.07 ($\bar{x}$ = 0.06), interocular space 0.15–0.18 ($\bar{x}$ = 0.17). Ocelli absent. Postocular region as in first instar. Rostral segments dark brown distad, pale proximad. Rostrum 0.44–0.49 long. ($\bar{x}$ = 0.46), ratio of length of segments ca. 1:0.71:0.43. Antenna 2.45–2.5 long ($\bar{x}$ = 2.48), ratio of length of segment ca. 1.0.32:0.67:0.73. Color of antennal seg-



Figs. 5–7. *Heza insignis.* 5, First instar. 6, Second instar. 7, Third instar.

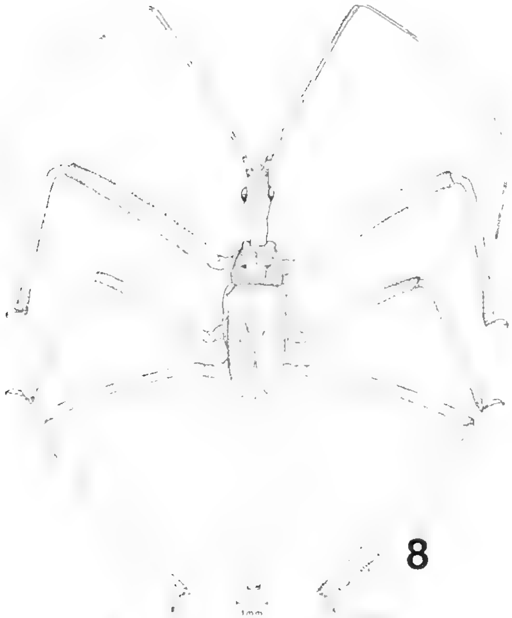
ments and ornamentation of segment 4 as in previous instar. Neck more differentiated from rest of head than in first instar.

Thorax dark brown. Pronotum 0.19–0.21 long ($\bar{x}$ = 0.2), width of pronotum 0.28–0.29 ($\bar{x}$ = 0.28). Median sulci present.

Wing pads 0.23–0.25 long ($\bar{x}$ = 0.24), color dark brown.

Abdominal length 1.12–1.2 ($\bar{x}$ = 1.17), abdominal width 0.56–0.60 ($\bar{x}$ = 0.57). Abdomen less rounded than in first instar. Scent glands present on posterior border of abdominal segments 3–5, color not different from the rest of the abdomen.

Third instar (Fig. 7).—Total length 8.06–8.96 ($\bar{x}$ = 8.44). Body (Fig. 7) elongate.



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Figs. 8–9. *Heza insignis*. 8, Fourth instar. 9, Fifth instar.

Length of head 1.66–1.79 ($\bar{x}$ = 1.74), width of head 0.83–0.89 ($\bar{x}$ = 0.87). Head pyriform, uniformly dark brown with pilosity and rugosities. Eye red, prominent and rounded. Width of eye 0.22–0.23 ($\bar{x}$ = 0.228), interocular space 0.37–0.40 ($\bar{x}$ = 0.38). Ocelli absent. Postocular region similar to second instar. Rostral segments pale brown with pilosities. Rostral length 2.4–2.64 ($\bar{x}$ = 2.5), ratio of length of segments ca. 1:0.81:0.27. Antenna 10.24–14.08 ($\bar{x}$ = 12.18), ratio of length of segments ca. 1: 0.25:0.71:0.48. Base of antennal segment 1 with dark spine. Segments 3–4 annulated. Neck well differentiated.

Thorax dark brown with pilosities and granulations. Pronotum 0.96–1.2 long ($\bar{x}$ = 1.09), width of pronotum 0.88–0.96 ($\bar{x}$ = 0.93). Anterior lobe with two spines and carina that extends laterally.

Legs uniformly pale brown, except some specimens showing two or three bands paler on femora and tibia 1 and 2. Pilosity as in second instar.

Wing pads dark brown. Length of wing pads 0.23–0.25 mm ($\bar{x}$ = 0.23 mm).

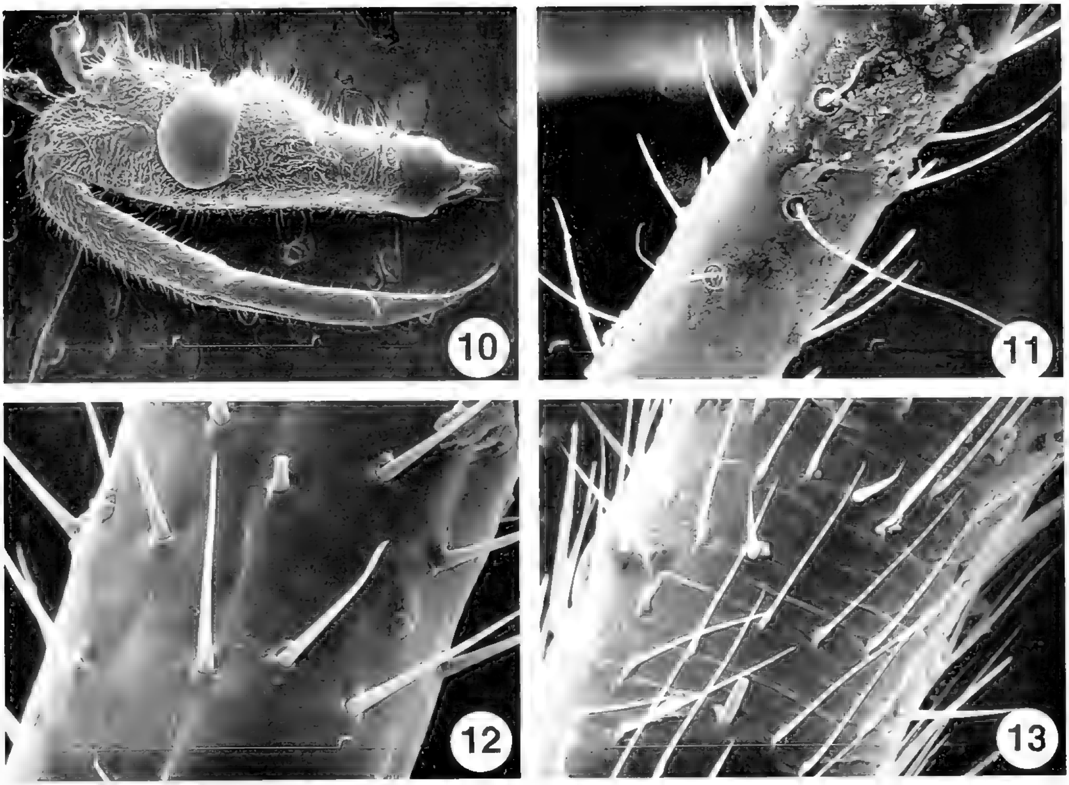
Abdominal length 3.71, abdominal width 1.4–1.53 ($\bar{x}$ = 1.46). Abdomen fusiform pale brown with granulosities. Scent glands well developed on abdominal segments 3–5, consisting in a light brown papila with dark brown bases. Segment 6 with a dark brown spot in same position as scent glands of anterior segments.

Fourth instar (Fig. 8).—Total length 10.11–11.90 ($\bar{x}$ = 11.21). Body (Fig. 8) similar to previous instar 1.15 ($\bar{x}$ = 1.10).

Length of head 2.04–2.17 ($\bar{x}$ = 1.82), width of head 1.02. Eye red and more conspicuous than in third instar. Width eye 0.12–0.16 ($\bar{x}$ = 0.14), interocular space 0.8 Ocelli absent. Postocular region less rounded than in previous instar. Rostral length 3.28–3.68 ($\bar{x}$ = 3.49), ratio of length of segments ca. 1:0.94:0.47. Antenna 17.76–19.04 long ($\bar{x}$ = 18.18), ratio of length of segments ca. 1:0.22:1.13:0.3.

Thorax dark brown with pilosity and granulations. Pronotum 1.6–1.84 long. ($\bar{x}$ = 1.7), with of pronotum 2.0–2.08 ($\bar{x}$ = 2.04). Median sulci present and lateral sulci conspicuous.

Legs similar to those of the previous instar, femur 1 densily pilose on internal margin; wing pads 4.0–4.4 long ($\bar{x}$ = 4.13).



Figs. 10–13. *Heza insignis*, fifth instar. 10, Head, lateral view. 11, Antennal segment 2 and a trichobothria. 12–13, Antennal segment 4.

Abdominal length 4.48– 5.63 ($\bar{x}$ = 5.2), abdominal width 1.4–2.04 ($\bar{x}$ = 1.82). Abdomen pale brown, elongate with granulations. Connexivum with dark spots. Scent glands on segment 3–5, segment 6 as in third instar.

Fifth instar (Figs. 9–13).—Total length 13.31–14.59 ($\bar{x}$ = 13.9). Body (Fig. 9) elongate, dark brown.

Length of head 1.92–2.17 ($\bar{x}$ = 2.08), width of head 1.15. Head (Fig. 10) pyriform, homogenous dark brown without granulations. Dark brown pilosity. Eye prominent, red and rounded. Outlined red ocelli present. Width of eye 0.07–0.05 ($\bar{x}$ = 0.06), interocular space 0.8–0.96 ($\bar{x}$ = 0.9). Ocelli conspicuous red. Postocular region not rounded with a fine stripe pale brown. Rostral segments paler than the rest of head, without rugosities or granulosities. Rostral length 3.6–3.84 ($\bar{x}$ = 3.7), ratio of length of segments ca 1:0.95:0.36. Antenna 15.23–20.24 long ($\bar{x}$ = 18.14), ratio of length of segments ca 1:0.52:0.97.0.3. Antenna elongate, cylindrical and filiform, pilosity dark brown. Segment 2 with a trichobothrium as in Fig. 11. Segments 3 and 4 (Figs. 12–13) as in previous instar. Base of antennal segment 1 with one conspicuous dark brown spine (Fig. 10).

Thorax dark brown with pilosities and granulosities. Pronotum 2.00–2.24 long. ($\bar{x}$ = 2.08), width of pronotum 2.16–2.40 ($\bar{x}$ = 2.32). Anterior lobe with two conspicuous dark brown spines and carina extending laterally. Median sulci and lateral sulci present.

Legs similar to those of present in fourth instar.

Wing pads 4.4–4.8 long ($\bar{x}$ = 4.64), color dark brown.

Abdominal length 6.65–7.55 ($\bar{x}$ = 7.29), abdominal width 3.2–4.48 ($\bar{x}$ = 3.84), abdomen laterally darker. Abdomen elongate dark brown, reduced pilosity, granulated not rugated. External margin of connexivum darker. Scent glands as in previous instar.

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THE DISTINCTION BETWEEN *DASINEURA* SPP. (DIPTERA: CECIDOMYIIDAE) FROM APPLE AND PEAR

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Abstract.—Two species of gall midges, *Dasineura pyri* (Bouché) and *Dasineura mali* (Kieffer), are responsible for a similar leaf roll on pear and apple, respectively. These two species are found to have distinct differences in their male genitalia, effectively distinguishing these taxa morphologically. This evidence supports biological evidence that the two species are distinct and allows for ease of discrimination for voucher purposes.

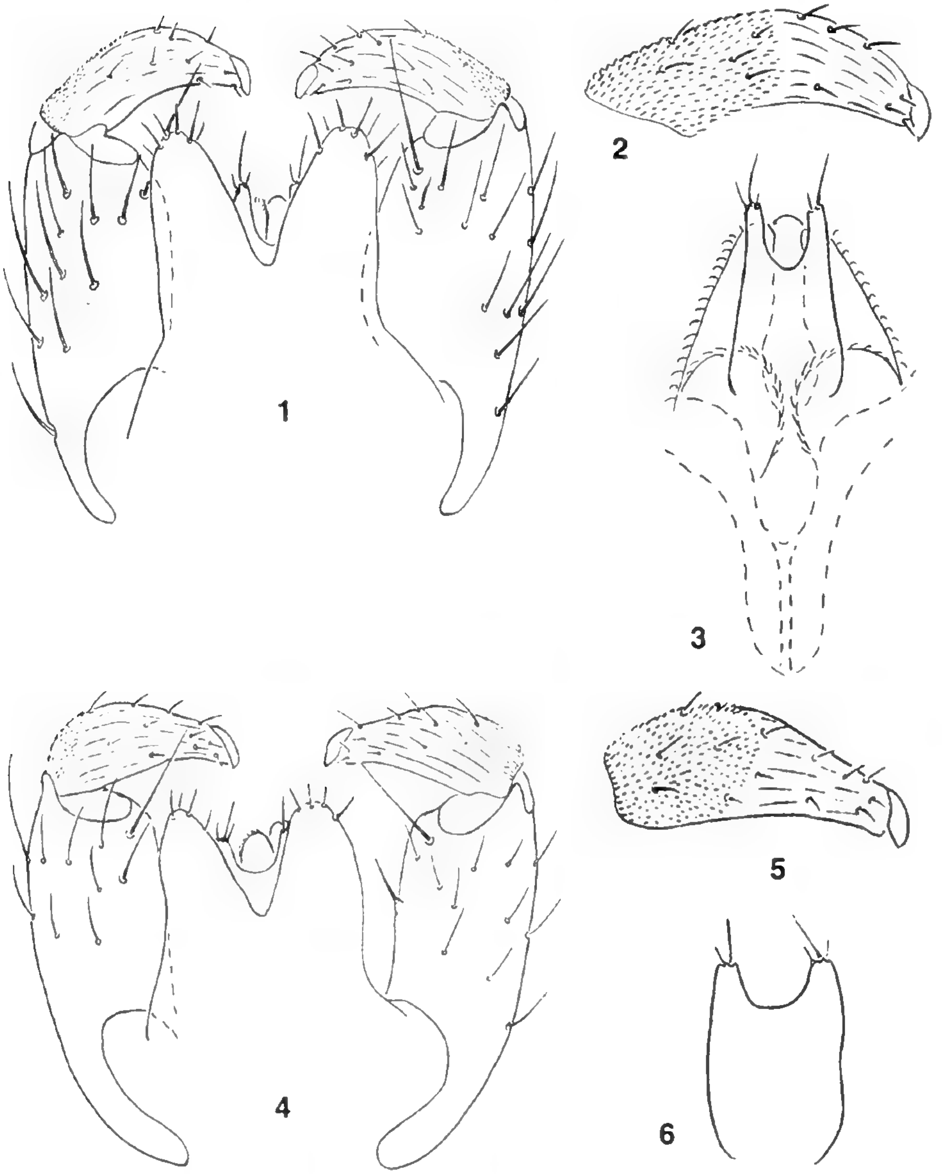
Key Words: New Zealand, male genitalia, identification

Dasineura pyri (Bouché) and *Dasineura mali* (Kieffer) were described from similar damage on pear and apple, respectively. Both species exhibit similar habits (Barnes 1948, Sylvén 1975). Females lay eggs on new leaves and the larvae hatch shortly after and begin feeding, causing the leaves to roll around them. Fully fed third instars usually drop to the soil to pupate, after which the rolled leaves die. Both species may have several generations per year.

Bouché (1847) originally described the larva, pupa, and both sexes of *D. pyri*. This species is known throughout Europe, where it is evidently native, and was accidentally introduced with stock into North America and New Zealand (Barnes 1948). Kieffer (1904) described the larva, male, and female of *D. mali* but did not point out any differences between his new species and *D. pyri*. *Dasineura mali* has been reported throughout Eurasia, and it has also been accidentally introduced with stock into North America and New Zealand (Barnes 1948).

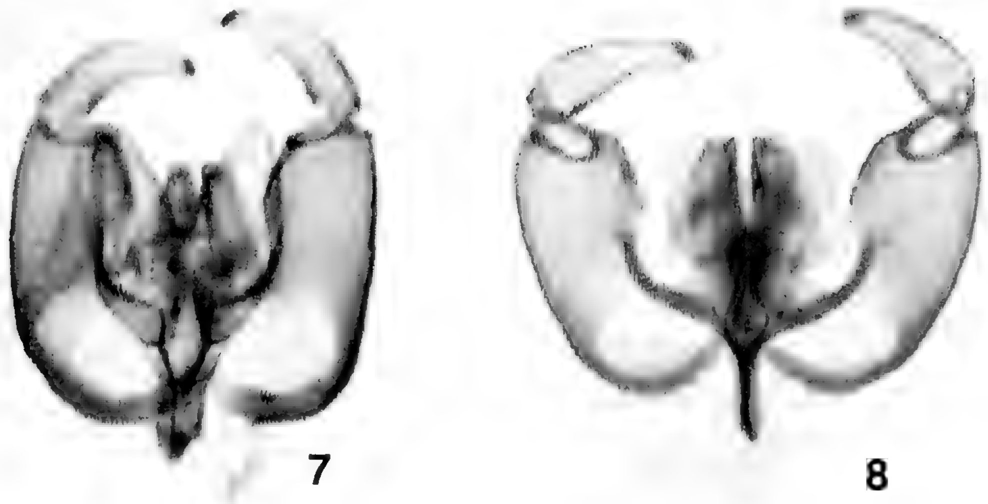
No practical method to separate these two species has ever been published, although several observations indicate they are distinct. Barnes (1948) tried unsuccessfully to breed each on the other's host. Harris et al. (1996) found that male gall midges from apple did not respond to female gall midges from pear in wind tunnel assays. Both species were included in many-species studies of Oligotrophini, the tribe to which these two species belong. Differences between small samples of *D. pyri* and *D. mali* were reported for: the length of certain larval setae as compared to larval length (Sylvén 1975); the length of the R5 vein in relation to wing length and length of the ovipositor relative to wing length (Sylvén and Carlbäcker 1981); and morphometrics of the antennae (Sylvén and Carlbäcker 1983).

In New Zealand leafcurling gall midges are pests in both apple and pear orchards. The development of management systems for these pests would be aided by knowing definitely whether only one pest or two separate pests need to be managed. A study was made to determine whether these species showed any differences that could be used to separate them with confidence.



Figs. 1–6. 1–3, Male genitalia of *Dasineura pyri* (from New Zealand). 1, Dorsal view. 2, Gonostylus (ventral). 3, Hypoproct and, behind, the aedeagus, parameres, and aedeagal apodeme. 4–6, Male genitalia of *D. mali* (from New Zealand). 4, Dorsal view. 5, Gonostylus (ventral). 6, Hypoproct (ventral).

Mature larvae were collected from typical damage on apple and pear trees in Hawkes Bay, New Zealand. Adults were reared from them and the pupal exuviae were also saved. All stages were temporarily preserved in 70% alcohol. Examples from the various stages were permanently mounted in Canada balsam on slides using the method outlined in Gagné (1989, 1994). The mounted specimens from the two hosts were viewed by one of us (RJG) without looking at the labels to see whether two different entities could be detected from differences in characters usually used for spe-



Figs. 7, 8. 7, Male genitalia of *Dasineura pyri* (from New Zealand). 8, Male genitalia of *D. mali* (from New Zealand).

cies discrimination. These characters included, e.g. the shape of the larval spatula, the shape of the pupal head, the number and shape of adult antennal flagellomeres, and the shape of the genitalia. Larvae, pupae, and females appeared to be similar, and larvae and females were not distinguishable with characters used in Sylvén (1975) and Sylvén and Carlbäcker (1981, 1983). Slide-mounted males, however, readily fell into two groups on the basis of the shape of their gonostyli (Figs. 1, 2, 4–8). The specimens in one of these groups all came from apple, those of the other group all from pear.

A further test was made comparing the males from New Zealand together with other males from apple and pear already in the USNM collection, again without looking at the labels. These other male specimens came from pear from Canada (New Brunswick; n = 5), UK (England; n = 8), and USA (Washington; n = 2) and from apple from Austria (n = 6), Canada (New Brunswick; n = 2), and USA (Massachusetts; n = 3). These specimens again fell into two groups corresponding to whether they came from pear or apple.

The gonostyli of *D. pyri* (Figs. 1, 2) are longer than those of *D. mali* (Figs. 4, 5) and evenly tapered. Those of *D. mali* are more bulbous at their bases. The hypoproct is slightly more deeply divided in *D. pyri* (Fig. 3) than in *D. mali* (Fig. 6) in the New Zealand specimens, but that difference is not evident in specimens from elsewhere, so is evidently subject to variation. *Dasineura pyri* and *D. mali* are thus distinguishable and are demonstrably distinct species.

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NOMENCLATURAL CHANGES IN THE PENTATOMOIDEA (HEMIPTERA-HETEROPTERA: CYDNIDAE, PENTATOMIDAE). II. SPECIES LEVEL CHANGES

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Abstract.—Numerous species level nomenclatural problems in the Pentatomoidea (Heteroptera) are discussed and corrected. These corrections have necessitated nine specific replacement names: ***Carbula linnavuorii*** for *C. litigatrix:* Linnavuori, 1975 (not Kirkaldy 1909); ***C. nigricornis schoutedeni*** for *C. n. obtusangula* Schouteden, 1916; ***Dalpada neoclavata*** for *Cimex clavatus* Fabricius, 1798; ***Diploxys cachani*** for *D. bimaculata* Cachan, 1952; ***Eysarcoris distanti*** for *Neocarbula capitatus* Distant, 1918; ***Menida parva*** for *Rhaphigaster parvulus* Signoret, 1858; ***Menida versicoloratus*** for *Pentatoma versicolor* Palisot de Beauvois, 1811; ***Pentatoma zhengi*** for *P. venosa* Zheng and Ling, 1983; and ***Runibea dallasi*** for *Pentatoma proxima* Dallas, 1851.

Key Words: nomenclature, systematics, Heteroptera, Pentatomoidea, Pentatomidae, Cydnidae

While preparing a catalog of the Pentatomidae of the World, I have found many nomenclatural problems. Interestingly, a reviewer of an earlier paper concerning nomenclatural changes in the Pentatomidae (Rider and Rolston 1995) commented that his biggest surprise was that there were not more problems to be corrected. Since the above paper, another paper on nomenclatural changes already has been published (Rider 1997); two others soon will appear in print (Rider 1998, Rider and Fischer 1998). In the present paper, I address a number of species level nomenclatural problems.

The problems dealt with in this paper are strictly of a nomenclatural nature. I do not intend to validate the taxonomy involved with the current problems. If current workers are correct taxonomically in their recent papers, then the names should be as proposed herein.

CYDNIDAE: CYDNINAE

Pangaeus serripes (Westwood 1837), **revised status**

Cimex aethiops Fabricius 1787: 296 (primary junior homonym of *Cimex aethiops* Goeze 1778, Scutelleridae)
Cydnus serripes Westwood 1837: 19; Stål 1876: 26.
Aethus margo Dallas 1851: 116.
Pangaeus aethiops: Stål 1868: 7.
Pangoeus [sic] *serripes:* Signoret 1882: 247, pl. 8 fig. 106.
Pangaeus serripes: Uhler 1886: 3; Lethierry and Severin 1893: 70.
Pangaeus (Pangaeus) aethiops: Froeschner 1960: 479, 504–507, figs. 14, 24, 46, 103, 127, 155, 177, 235.

Goeze's (1778) description of *Cimex aethiops* predates Fabricius' (1787) usage of the same name by nine years. *Cimex aethiops* Goeze currently is considered to be a junior synonym of the scutellerid *Eurygaster austriaca* (Schrank), a species occurring throughout much of Europe. The next available name for *C. aethiops* Fabricius is *Cydnus serripes* Westwood; therefore, the proper name for this tropical American cydnid is *Pangaeus serripes.*

PENTATOMIDAE: PENTATOMINAE

Agonoscelis versicoloratus (Turton 1802), **revised status**

Cimex versicolor Fabricius 1794: 120 (primary junior homonym of *Cimex versicolor* Gmelin 1790; *Menida*)
Cimex versicoloratus Turton 1802: 648 (new name for *Cimex versicolor* Fabricius 1794)
Cimex pubescens Thunberg 1822: 2.
Aelia infuscata Westwood 1837: 8, 32.
Cimex acinorum Germar 1838: 177–178.
Agonoscelis versicolor: Dallas 1851: 179; Stål 1865: 178; Lethierry and Severin 1893: 151.
Agonoscelis pubescens: Kirkaldy 1909: 98.

Gmelin's (1790) usage of the binomen *Cimex versicolor* precedes Fabricius' (1794) by four years. Turton (1802) recognized this case of homonymy and proposed the replacement name *C. versicoloratus.* No one used Turton's name, although Kirkaldy (1909) also realized that *C. versicolor* Fabricius was preoccupied; he used the next available name, *Agonoscelis pubescens* (Thunberg). Virtually no one has followed Kirkaldy in using *A. pubescens;* most workers are still using *A. versicolor* as the valid name. *Agonoscelis versicoloratus* is a relatively common species, occurring throughout much of Africa south of the Sahara desert. Gmelin's (1790) *C. versicolor* is a member of the pentatomid genus *Menida* (see also discussion below).

There currently are four subspecies of *Agonoscelis versicoloratus* that are affected by this name change. Along with the nominate form, their correct combinations are: *Agonoscelis versicoloratus fallaciosa* Linnavuori, *A. v. gambiensis* (Westwood), and *A. v. tibialis* Horváth. Horváth's name, *tibialis,* has, in the past, only been used as a varietal name, which actually may be its proper status.

Antestiopsis thunbergii (Gmelin 1790), **revised status**

Cimex variegatus Thunberg 1783: 48–49, pl. 2 fig. 62; Thunberg 1822: 3 (primary junior homonym of *Cimex variegatus* Poda 1761, Stenocephalidae)
Cimex thunbergii Gmelin 1790: 2158; Turton 1802: 652 (new name for *Cimex variegatus* Thunberg 1783)
Cimex olivaceus Thunberg 1822: 2–3. (primary junior homonym of *Cimex olivaceus* Fabricius 1777, Miridae)
Pentatoma orbitalis Westwood 1837: 8, 35.
Cimex facetus Germar 1838: 172.
Pentatoma lineaticollis Stål 1853: 220.
Strachia pentatomoides Walker 1867: 325.
Antestiopsis faceta: Leston 1952: 269.
Antestiopsis orbitalis: Leston 1953: 58.
Antestiopsis lineaticollis: Le Pelley 1959: 54, 185.
Antestiopsis orbitalis orbitalis: Greathead 1966: 520, 521–525, figs. 2, 8, 14–16, 34, pl. 19 figs. 1, 2.

This taxon was first described by Thunberg in 1783 as *Cimex variegatus.* This name, however, is a junior primary homonym of *Cimex variegatus* Poda, 1761, a species in the heteropteran family Stenocephalidae. Gmelin (1790), realizing that *Cimex variegatus* Thunberg was preoccupied, proposed *C. thunbergii* as a replacement name. Owing to the great variability in the dorsal coloration, this species has been redescribed a number of times by different authors. In his relatively recent revisionary work on the group, Greathead (1966) settled upon *Antestiopsis orbitalis* (Westwood) as the proper name for this taxon. Even so, other authors continue to use the other specific epithets (*A. faceta* [Germar], *A. lineaticollis* [Stål], *A. variegatus*), and Greathead used these other names for the various forms. *Cimex thunbergii* is clearly the oldest valid name for this species.

There currently are three subspecies of this taxon recognized. Besides the nominate form, there also is *Antestiopsis thunbergii bechuana* (Kirkaldy) and *A. t. ghesquierei* Carayon.

Antheminia eurynota remota (Horváth 1908)

Carpocoris remotus Horváth 1908: 296; McDonald 1966: 21–22, 50, figs. 148–154, 448.

Carpocoris (Antheminia) remotus: Kirkaldy 1909: 57; Van Duzee, 1917: 37.

Antheminia eurynota tamaninii Kerzhner 1972: 369, figs. 57–60.

Codophila (Antheminia) remota: Thomas 1974: 441.

Codophila remota: Froeschner 1988: 573.

Antheminia eurynota remota: Kerzhner 1993: 103–104.

Tamanini (1958, 1962) worked extensively on four closely related pentatomid genera: *Antheminia* Mulsant and Rey, *Carpocoris* Kolenati, *Codophila* Mulsant and Rey, and *Dolycoris* Mulsant and Rey. He concluded that *Antheminia* should be recognized as a subgenus of *Codophila*, a fact reported on by Thomas (1974). Thomas also diagnosed the two American species, *C. remota* (Horváth) and *C. sulcata* (Van Duzee), placing them both in *Codophila (Antheminia)*. Most Old World workers, however, still recognize both *Antheminia* and *Codophila* as valid genera, including even Tamanini in 1981. This generic realignment also results in the new combination *Antheminia sulcata* (Van Duzee).

Because many New World workers may have missed the synonymical note published by Kerzhner (1993), this information is repeated here. Kerzhner concluded that *remota* is conspecific with the Old World species *A. eurynota* Horváth; both taxa were described by Horváth (1908) with *A. eurynota* having page priority. Moreover, Kerzhner found that the American species resembled most closely (genitalia were identical) specimens earlier (Kerzhner 1972) described by himself as *Antheminia eurynota tamininii.* Kerzhner did not comment on *A. sulcata,* which needs to be reexamined as it is also closely related.

Carbula limpoponis (Stål 1853), **revised status**

Cimex marginellus Thunberg 1822: 4–5 (primary junior homonym of *Cimex marginellus* Fabricius 1781, Miridae)

Pentatoma limpoponis Stål 1853: 219; Walker 1867: 296.

Pentatoma (Carbula) marginella: Stål 1865: 143.

Pentatoma (Carbula) limpoponis: Stål 1865: 143–144.

Carbula limpoponis: Stål 1876: 83; Lethierry and Severin 1893: 143; Kirkaldy 1909: 88; Cachan 1952: 412, 415–416.

Carbula marginella: Stål 1876: 83; Lethierry and Severin 1893: 143; Kirkaldy 1909: 88; Linnavuori 1982: 93, 96–97.

Carbula pedalis Bergroth 1891: 203–204; Lethierry and Severin 1893: 143; Kirkaldy 1909: 88.

Carbula litigatrix Kirkaldy 1909: 88 (unnecessary new name for *Cimex marginellus* Thunberg, 1822)

This species has had a long and confusing taxonomic history. Thunberg (1822) first described this species as *Cimex marginellus,* a combination used previously by Fabricius (1781) for a new species of Miridae. This species was described twice in subsequent years, once by Stål (1853) as *Pentatoma limpoponis* and once by Bergroth (1891) as *Carbula pedalis.* Most workers considered these three names to represent three valid species until Linnavuori (1975) placed *C. limpoponis* and *C. pedalis* as junior synonyms of *C. marginellus.* Linnavuori, however, mistakenly recognized *C. litigatrix* as a separate species. *Carbula litigatrix* was proposed by Kirkaldy (1909) as a replacement name for *Cimex marginellus* Thunberg, 1822, recognizing that it was preoccupied by *C. marginellus* Fabricius, 1781. As such, *C. litigatrix* and *C. marginellus* must represent the same species, which leaves *C. litigatrix* sensu Linnavuori, 1975, without a name (see below). At any rate, *C. marginellus* Thunberg, 1822, is preoccupied; if *C. limpoponis* and *C. pedalis* are indeed synonyms of *C. marginellus* (per Linnavuori 1975), then both would have priority over Kirkaldy's replacement name (*C. litigatrix*).

The problem is compounded by the fact that Linnavuori (1982) described a new subspecies of this species as *C. marginella sindouana*. This subspecies should be tentatively represented by the new combination *C. limpoponis sindouana*. *Carbula* Stål is a large and important genus badly in need of a thorough revision. Only then will the true status of the above species be resolved.

Carbula linnavuorii Rider, new name

Carbula litigatrix: Linnavuori 1975:51, 62–63, figs. 37a–f.

Linnavuori (1975) recognized *Carbula litigatrix* as being distinct from *C. marginella* (Thunberg). *Carbula litigatrix* was, however, originally proposed as a replacement name for the preoccupied *Cimex marginella* Thunberg, 1822; the two names must stand for the same species (see above discussion). This leaves *Carbula litigatrix* sensu Linnavuori, 1975 without a name. I propose *Carbula linnavuorii* as a new name.

Carbula nigricornis schoutedeni Rider, new name

Carbula nigricornis var. *obtusangula* Schouteden 1916: 305 (primary junior homonym of *Carbula obtusangula* Reuter 1881, *Carbula*)

Schouteden (1916) described *C. obtusangula* as a new variety of *Carbula nigricornis* Schouteden, evidently unaware that Reuter (1881) had used *C. obtusangula* for a new species of *Carbula* from the Oriental region. Reuter's species still is considered to be a valid species and has been reported from China, Japan, and Okinawa. No subsequent workers have even mentioned Schouteden's variety, so it must still be treated as a valid subspecific name, thus requiring a new name; I propose *schoutedeni*.

Dalpada neoclavata Rider, new name

Cimex clavatus Fabricius 1798: 532 (primary junior homonym of *Cimex clavatus* Linnaeus 1767, Miridae; *Cimex clavatus* Thunberg 1783, Alydidae; and *Cimex clavatus* Reich 1795, Alydidae)

Dalpada clavata: Dallas 1851: 184; Stål 1876: 43; Lethierry and Severin 1893: 98; Kirkaldy 1909: 193.

The binomen *Cimex clavatus* already had been used for three other hemipterans when Fabricius (1798) used it in describing his new species of Pentatomidae. Linnaeus (1767) used this name for a new species of Miridae, and Thunberg (1783) and Reich (1795) both used it to describe two separate species of Alydidae. Distant (1893) considered both *D. bulbifera* Walker and *D. consobrina* Walker to be junior synonyms of *D. clavata* (Fabricius, 1798), but Ghauri (1982) resurrected both names, considering them both to represent valid species. This leaves *Cimex clavata* without any known junior synonyms; thus I propose *Dalpada neoclavata* as a replacement name. This species is known to occur in China, India, Myanmar, Sri Lanka, and Thailand.

Diploxys cachani Rider, new name

Diploxys bimaculata Cachan 1952: 382, 383–384, figs. 362–364, pl. 12 fig. 3 (secondary junior homonym of *Gonopsis bimaculata* Stål 1858, *Diploxys bipunctata*)

In 1858, Stål described *Gonopsis bimaculata,* a species that he himself (Stål 1865) later placed as a junior synonym of *Diploxys bipunctata* Amyot and Serville. Cachan (1952) subsequently described *Diploxys bimaculata* from Madagascar, thus creating a secondary junior homonym, which still exists. I propose *cachani* as a replacement name.

Eurus rotundatus Dallas, 1851, **revised status**

Cimex dilatatus Thunberg 1822:5 (primary junior homonym of *Cimex dilatatus* Turton 1802, Miridae)
Eurus rotundatus Dallas 1851: 190, pl. 7 figs. 2a, b.
Brachymenum circuliventre Mayr 1864: 909.
Eurus dilatatus: Stål 1865: 109–110; Kirkaldy 1909: 201; Linnavuori 1982: 57, figs. 71c–f, 72a.

Turton (1802) proposed *Cimex dilatatus* as a replacement name for the preoccupied name *Cimex pictus* Gmelin, a member of the heteropteran family Miridae. This usage precedes Thunberg's name by twenty years. The next available synonym is *Eurus rotundatus* Dallas. This species occurs in South Africa.

Eysarcoris distanti **Rider, new name**

Neocarbula capitata Distant 1918: 134–135, fig. 68 (secondary junior homonym of *Eusarcocoris capitatus* Distant 1902, *Eysarcoris*)
Stollia capitata: Kiritshenko 1961: 443.

Distant (1902) described the species *capitatus* in *Eusarcocoris*, an unjustified emended form of the genus *Eysarcoris* Hahn. This Indian species still is regarded as a valid species in the genus *Eysarcoris*. In 1918, Distant described another Indian species as *Neocarbula capitata*. This species has only been referred to one other time as *Stollia capitata* (Kiritshenko 1961). Both *Neocarbula* Distant and *Stollia* Ellenrieder now are regarded as junior synonyms of *Eysarcoris*. Transferral of Distant's 1918 species into *Eysarcoris* creates a secondary homonym, which I propose to correct with the new name *distanti*.

Eysarcoris venustissimus (Schrank 1776), **revised status**

Cimex melanocephalus Fabricius 1775: 716–717 (primary junior homonym of *Cimex melanocephalus* Linnaeus 1767, Miridae)
Cimex venustissimus Schrank 1776: 80.
Eysarcoris melanocephalus: Hahn 1835: 130, fig. 211; Lethierry and Severin 1893: 140.
Eusarcoris venustissimus: Autran and Reuter 1888: 199.
Eysarcoris fabricii Kirkaldy 1904: 281; Kirkaldy 1909: 84, 379 (unnecessary new name for *Cimex melanocephalus* Fabricius 1775)

Cimex melanocephalus Fabricius, 1775, is preoccupied by *C. melanocephalus* Linnaeus, 1767, a species in the heteropteran family Miridae. Kirkaldy (1904) proposed *Eysarcoris fabricii* as a replacement name, but an available junior synonym already existed, *Cimex venustissimus* Schrank, 1776. *Eysarcoris venustissimus* should be the valid name used for this common Old World species.

Menida parva **Rider, new name**

Rhaphigaster parvulus Signoret 1858: 289 (primary junior homonym of *Rhaphigaster parvulus* Dallas 1851, *Acrosternum*)
Antestia parvula: Stål 1865: 211; Walker 1867: 281.
Menida parvula: Stål 1876: 99; Lethierry and Severin 1893: 174; Kirkaldy 1909: 133; Linnavuori 1982: 158, 160, figs. 258e, f, 261c; Linnavuori 1986: 131, 135, figs. 5a, 12c–f, 13a–f.
Menida signoreti Rider and Rolston 1995: 849 (primary junior homonym of *Menida signoreti* Stål 1876, *Menida;* new name for *Menida parvula* Signoret 1858)

Rider and Rolston (1995) proposed *Menida signoreti* as a replacement name for *Menida parvula* Signoret, 1858. They did not realize that Stål (1876) already had used this binomen in describing a species of

Menida Motshulsky, questionably from India. I herein propose *Menida parva* as another replacement name.

Menida versicolor (Gmelin 1790), **revised status**

Cimex histrio Fabricius 1787: 296 (primary junior homonym of *Cimex histrio* Linnaeus 1758; *Dinocoris*)

Cimex versicolor Gmelin 1790: 2155. (new name for *Cimex histrio* Fabricius 1787)

Pentatoma bengalensis Westwood 1837: 8, 36–37.

Rhaphigaster concinnus Dallas 1851: 285–286.

Rhaphigaster strachioides Walker 1867: 365.

Menida histrio: Stål 1876: 98.

Menida ceylanica Breddin 1909: 280–281, fig. 19.

Menida bengalensis: Kirkaldy 1909: 131, 381.

Fabricius (1787) described the taxon *Cimex histrio* for a species currently contained in the genus *Menida*. He apparently did not realize that this binomen had been used first 29 years previously by Linnaeus (1758) for a pentatomid species now residing in the genus *Dinocoris* Burmeister. Several other workers realized this and adopted Westwood's (1837) name *C. bengalensis* as the valid species name. They apparently did not realize that Gmelin (1790) had proposed *C. versicolor* as a replacement name for *C. histrio* Fabricius. *Menida versicolor* occurs throughout the Indo-Pakistan and Oriental regions, whereas *Dinocoris histrio* Linnaeus occurs in the Neotropics.

Menida versicoloratus **Rider, new name**

Pentatoma versicolor Palisot de Beauvois 1811: 114, pl. 8 fig. 8 (secondary junior homonym of *Cimex versicolor* Gmelin 1790, *Menida*)

Menida versicolor: Stål 1876: 98; Lethierry and Severin 1893: 175; Kirkaldy 1909: 133; Leston 1956: 625; Schouteden 1964: 94.

Most recent workers consider *Pentatoma versicolor* Palisot de Beauvois, 1811, to be a valid species in the genus *Menida*. This creates a case of secondary homonymy (see above discussion), which I propose to correct by proposing *versicoloratus* as a replacement name. This species occurs in tropical Africa.

Pentatoma zhengi **Rider, new name**

Pentatoma venosa Zheng and Ling 1983: 236–237, 238, figs. 16–23; Ling and Zheng 1987: 41, 43–45, 48; Zheng et al. 1987: 217 (primary junior homonym of *Pentatoma venosa* Förster 1891, Pentatomidae)

Zheng and Ling (1983) apparently were unaware that the binomen *Pentatoma venosum* already had been used for a fossil species of Pentatomidae (Förster 1891) when they used that name for an extant species occurring in the Yunnan Province of China. I propose *zhengi* as a replacement name.

Runibia dallasi **Rider, new name**

Pentatoma? *proxima* Dallas 1851: 255 (primary junior homonym of *Pentatoma proxima* Westwood 1837, *Nezara viridula*)

Runibia proxima: Stål 1861: 141; Lethierry and Severin 1893: 160; Kirkaldy 1909: 111; Van Duzee 1917: 57; Rolston 1976: 4; Froeschner 1988: 591.

Dallas (1851) described *proxima*, tentatively placing it in the genus *Pentatoma* Olivier (note question mark) thereby creating a junior primary homonym with *Pentatoma proxima* Westwood, 1837. Westwood's species is a junior synonym of *Nezara viridula* (Linnaeus). Stål (1861) transferred Dallas's species to *Runibia* Stål where it still is considered to be a valid species. It has been reported from Cuba, Jamaica, and the U.S. (Texas). I propose *R. dallasi* to eliminate the case of homonymy.

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MELZERIA HORNI GREEN (HEMIPTERA: COCCOIDEA: ERIOCOCCIDAE): REDESCRIPTION OF A POORLY KNOWN FELT SCALE

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Abstract.—The genus *Melzeria* and the only included species, *M. horni* Green, were described in 1930, but the appropriate family assignment was questionable. Since that time, no one has studied the species and it has not been included in any of the recent catalogs. The objective of this paper is to redescribe the species and provide evidence that supports its placement in the family Eriococcidae.

Key Words: Scale insect, Coccoidea, Eriococcidae, felt scale, first instar, Brazil

The genus *Melzeria* Green has been ignored by most coccidologists since it was described in 1930, probably because its family placement was uncertain. In the original description, Green (1930) suggested affinities with the Eriococcidae (= Eriococcinae), Pseudococcidae (= Dactylopiinae), and even Asterolecaniidae (= Asterolecaniinae). *Melzeria* was not included in the catalog of the Eriococcidae (Hoy 1963) even though Hoy treated many taxa that were questionable members of the family, nor was it treated in the Pseudococcidae catalog (Ben-Dov 1994). D'Araújo e Silva et al. (1968) omitted it from their exhaustive catalog of Brazilian insects.

This research was undertaken to appropriately recognize the status of *Melzeria horni* Green and to properly catalog the species in the current initiative called "ScaleNet," a database of scale insects of the world (for more information see Miller and Gimpel 1996, Ben-Dov et al. 1997, or the web site http://www.sel.barc.usda.gov/scalenet/scalenet.htm). The following characters place this species in the Eriococcidae: The presence of enlarged setae in the first instar; the reduced number of setae on the tibia; the presence of translucent pores on the hind pair of legs in the adult female; and the presence of microtubular ducts.

Terminology in the descriptions follows that of Miller and Miller (1993). Measurements and numbers are from 10 specimens when available, and are given as an average followed by the range in parentheses. Enlargements on illustrations are not proportional. Depository abbreviations are as follows: The Natural History Museum, London (BMNH); National Museum of Natural History, Beltsville, MD (USNM).

Melzeria Green

Melzeria Green 1930:215; Lepage 1938: 382; Borchsenius 1949:44; Morrison and Renk 1957:96; Morrison and Morrison 1966:118. Type species: *Melzeria horni* Green 1930, by original designation and monotypy.

Melzera Lindinger, 1937:189 (unjustified emendation).

Diagnosis.—*Adult female:* Body broadly oval; without protruding anal lobes. Microtubular ducts present, with "8-shaped" dermal orifice. Macrotubular ducts of 3 sizes, all with rim surrounding dermal orifice: largest-sized ducts with associated setae at dermal orifice; medium-sized ducts same shape as large ducts but smaller and without associated dermal setae; smallest size only slightly larger than microducts but with cup-shaped vestibule. Ventral surface with small sclerotized areas that may be ducts, but their structural details are not clear. Multilocular pores with 5-loculi. Anal ring simple, without pores, with enlarged area at posterior end. Labium 2-segmented. Claw with denticle.

First instar: With enlarged setae set in dermal pockets similar to species of *Ovaticoccus* Kloet and *Oregmopyga* Hoy. With microtubular ducts and quinquelocular pores. Labium 2-segmented. Anal ring simple, without pores.

Etymology.—This genus was named in honor of Dr. Julius Melzer who collected a number of scale samples in the Sao Paulo, Brazil area (Green 1930).

Notes.—This genus clearly belongs in the Eriococcidae by possessing microtubular ducts in the adult female and first instar, and by having characteristic enlarged setae that are set in dermal pockets in the first instar. Although the presence of the latter character may provide evidence of relationship between *Melzeria* and a group of North American taxa called ovaticoccins, i.e. *Cornoculus* Ferris, *Oregmopyga, Ovaticoccus,* and *Spiroporococcus* Miller (Miller and McKenzie 1967), *Melzeria* differs from these genera by possessing: large-sized macrotubular ducts with setae associated with the dermal orifice; macrotubular ducts with rim around dermal orifice; microtubular ducts simple, without two sclerotized parts to vestibule; labium 2-segmented.

Melzeria horni Green
(Figs. 1, 2)

Melzeria horni Green 1930:216; Lepage 1938:382; Borchsenius 1949:44; Morrison and Renk 1957:96; Morrison and Morrison 1966:118.
Melzera horni Lindinger, 1937:189.

Type material.—From the syntypes we have selected the adult female closest to the circular "TYPE" label as the lectotype and have placed a label on the back of the slide giving a map of the position of the specimen and the statement "*Melzeria horni*/ Green/ LECTOTYPE &/ PARALECTOTYPES." The label on the front of the slide states "*Melzeria/ horni*/ Green/ on foliage of ?/ Brasil, (Sao Paulo)/ coll. Julius Melzer/ per Dr. Horn . B-3." The slide also contains 2 paralectotype adult females and 2 embryos and is deposited in BMNH. In addition there are 3 paralectotype slides containing 3 adult females, 1 paralectotype slide containing 7 adult females, and 1 paralectotype slide containing 3 first instars in BMNH. In the USNM there are 3 paralectotype slides containing 2 adult females, 1 first instar. All material is from the same collection. A specific locality is given on a label with the dry material as "Santo Amaro."

Etymology.—This species was named in honor of Dr. W. Horn who started a manuscript on several species collected by Melzer. Unfortunately, a serious illness interrupted the work and E. E. Green was called upon to finish it (Green 1930).

Adult female (Fig. 1).—Field characteristics: According to Green (1930) "Mature insect concealed within the anterior extremity of an elongate, white, woolly ovisac, which is 2.5 mm long, and 1 mm wide. Adult female brown; ovate . . . ." An examination of the original dry material shows that the insect feeds on the under surface of the leaf around the edges. This habit differs widely from the feeding behavior of the related ovaticoccine genera.

Slide mounted specimens 1.4(1.2–1.7) mm long, 0.8(0.7–0.9) mm wide. Body broadly oval; dorsum with noticeable wrinkle pattern; anal-lobe area without protrusions.

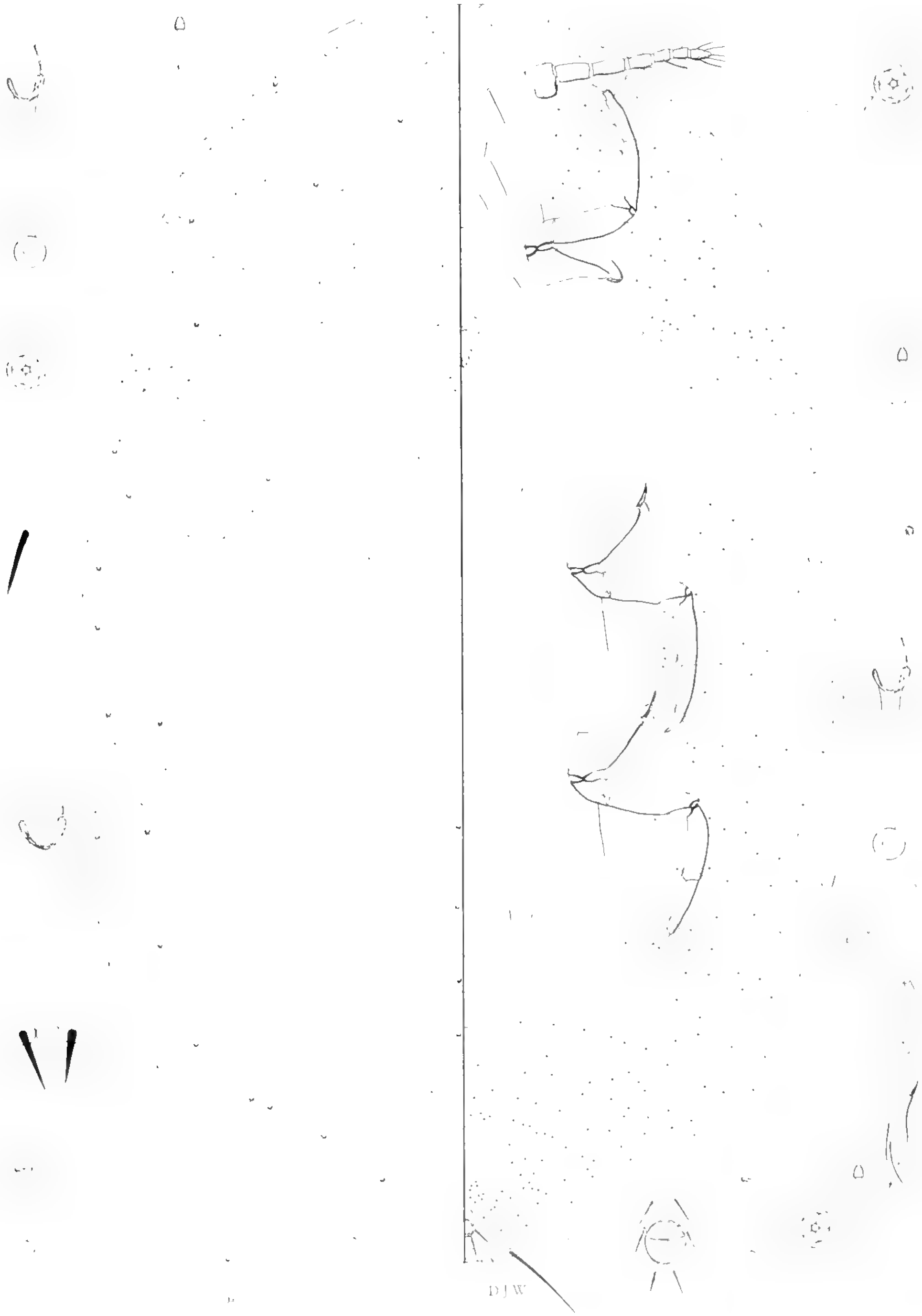

Fig. 1. Adult female, *Melzeria horni*. San Amaro, near São Paulo, Brazil, on foliage of unknown host, collected by Jules Melzer.

Dorsum with multilocular pores usually restricted to marginal areas near intersegmental line between pro- and mesothorax, occasionally with 1 or 2 pores near intersegmental line between meso- and metathorax. Macrotubular ducts of 3 sizes, all with rim surrounding dermal orifice: large-sized ducts most abundant around body margin, few in medial and mediolateral areas, ducts with 1–3 associated setae near dermal orifice; medium-sized ducts abundant over surface, same shape as large ducts but smaller and without associated setae; smaller-sized ducts restricted to posterior abdominal segments, about ¼ size of large ducts, with flattened vestibule. Microtubular ducts about same size as smallest macroducts, but with rounded vestibule and "8-shaped" dermal orifice. Setae inconspicuous, bristle shaped, with 14(12–16) setae on segment V, longest seta on segment VII 13(10–15) μ long.

Anal ring without pores, with 2 setae on each side of ring, longest seta 37(32–44) μ long; ring sclerotization broader at posterior end, forming plate.

Venter with multilocular pores nearly all with 5-loculi, abundant in marginal and submarginal areas, absent from medial areas of head, thorax, and anterior abdominal segments. Macrotubular ducts of 2 sizes: medium-sized ducts interspersed with multilocular pores; small-sized ducts most abundant on posterior abdominal segments. Microtubular ducts scattered along body margin. Small sclerotized spots present in medial areas of thorax may be ducts, but their structural details are not clear. Longest setae on segment VII 16(12–17) μ long; anal-lobe setae 119(109–131) μ.

Labium 2-segmented, 64(57–74) μ long. Antennae 7-segmented, 231(205–267) μ long. Legs conspicuous; hind coxa with 7(0–12) translucent pores on dorsal surface; hind femur with 4(0–12) translucent pores; hind tibia with 2(0–7) pores; hind femur with 2 setae; hind tibia with 3 setae; hind femur 122(106–138) μ long; hind tibia 104(93–114) μ long; tarsus 80(74–89) μ long; femur/tibia 1.2(1.1–1.4); tibia/tarsus 1.3(1.2–1.4); tarsal digitules about equal in size, with conspicuous club; claw digitules slightly different in size, slightly smaller than tarsal digitules, with conspicuous club; claw with noticeable denticle.

First Instar (sex not determined) (Fig. 2).—Slide mounted specimens 0.4(0.3–0.4) mm long, 0.2 mm wide. Body oval; anal-lobe area without protrusions.

Dorsum without multilocular pores and macrotubular ducts. Microtubular ducts in marginal line around body margin from head to segment VIII; with submarginal line from head to segment I. Setae of 2 kinds: Enlarged setae dome shaped, set in dermal pocket, present around body margin from prothorax to segment VIII; bristle-shaped setae present in submedial and submarginal lines, submarginal line present on head, thorax, and anterior abdomen, with 4 setae on segment V, longest seta on segment VII 8(7–9) μ long.

Anal ring without pores, with 3 setae on each side of ring; ring sclerotization forming plate.

Venter with multilocular pores with 5-loculi, with 1 present near spiracle and 1 present near body margin adjacent to posterior spiracle. Macrotubular and microtubular ducts absent. Setae arranged in 3 pairs of longitudinal lines (medial, mediolateral, and marginal); posterior setae in marginal line sometimes slightly enlarged. Longest setae on segment VII 6(5–9) μ long; anal-lobe setae 139(115–178) μ.

Labium 2-segmented, segmental line delimiting anterior segment weakly indicated, 35(32–40) μ long. Antennae 6-segmented, 84(80–86) μ long. Legs conspicuous; hind femur with 1 or 2 setae; hind tibia with 3 setae; hind femur 37(35–40) μ long; hind tibia 28(27–29) μ long; tarsus 22(19–24) μ long; femur/tibia 1.4(1.2–1.5); tibia/tarsus 1.3(1.1–1.5); tarsal digitules about equal in size, with conspicuous club; claw digitules about equal in size, slightly smaller than tarsal digitules, with conspicuous club; claw with noticeable denticle.

Fig. 2. First-instar nymph (sex undetermined), *Melzeria horni.* Santo Amaro, near São Paulo, Brazil, on foliage of unknown host, collected by Jules Melzer.

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A NEW SPECIES OF MYDAS FLY (DIPTERA: MYDIDAE) FROM MEXICO AND A NEWLY RECORDED SPECIES FROM MEXICO

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Abstract.—**Nemomydas alifoleyae, n. sp.**, is described from Oaxaca, Mexico. Male terminalia of the new species is illustrated. *Nemomydas hooki* Welch and Kondratieff is recorded for the first time from Mexico.

Key words: Mydidae, *Nemomydas,* Mexico, new species

Papavero (1996) recognized 38 species in nine genera of Mydas flies (Diptera: Mydidae) in Mexico. The following changes to this list are necessary: Kondratieff and Fitzgerald (1996) considered *Opomydas athamas* (Séguy) a synonym of *O. limbatus* (Williston); Welch and Kondratieff (1991) considered *Mydas quadrilineatus* Williston a synonym of *M. rufiventris* Macquart; Fitzgerald and Kondratieff (1995) added *Pseudonomoneura bajaensis* from Baja California; and Fitzgerald and Kondratieff (1997) described *P. calderwoodi*, also from Baja California. In this study we describe an additional species from Mexico, and record *Nemomydas hooki* Welch and Kondratieff (1990) from Mexico for the first time. These additions bring the total number of mydid species known from Mexico to 41.

Material was studied from Coleccion Entomologica, Instituto de Biologia, Universidad Nacional Autonoma de Mexico (UNAM).

RESULTS

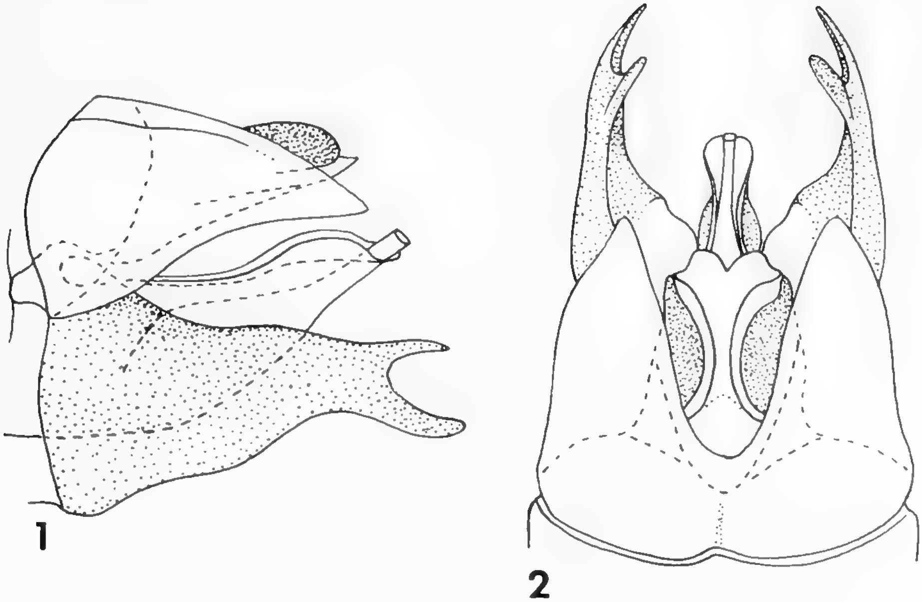
Nemomydas alifoleyae Fitzgerald and Kondratieff, new species
(Figs. 1, 2)

Holotype.—♂, Mexico, Oaxaca, Mpio Valle Nacional, San Mateo Yetla, 13 Sept. 1990, E. Barrera, E. Ramirez, & A. Cadenia, (UNAM).

Etymology.—The specific epithet is a patronym honoring Alison (Ali) Foley, who has provided great inspiration to the senior author.

Diagnosis.—*Nemomydas alifoleyae* belongs to a group of *Nemomydas* species, including *N. wendyae* Kondratieff and Welch, *N. sponsor* (Osten Sacken), *N. brachyrhynchus* (Osten Sacken), *N. lamia* (Séguy), and *N. bequaerti* (Johnson), which have the aedeagus apically expanded. *Nemomydas alifoleyae* is most similar to *N. wendyae*, but can be distinguished by the collar-like apical portion of the aedeagus (Fig. 1), whereas *N. wendyae* has only a small flange on the apical portion of the aedeagus (see Kondratieff and Welch 1990: 477, Fig. 5).

Description.—*Male:* Head shining black, black pilose on median portion of face, lateral of antenna base, and occiput; yellow pruinose on edge of occipital foramen, narrowly along inner margin of eye above antenna, and broadly on sides of face below antenna. Pedicel and scape dark brown black, black pilose. Flagellomere one light brown yellow on basal ⅔, dark brown on apical ⅓. Flagellomere two subequal to slightly shorter than flagellomere



Figs. 1, 2. *Nemomydas alifoleyae*, male terminalia. 1, Left lateral view. 2, Dorsal view.

one, club-shaped, dark brown except apical ⅓ silver pruinose dorsally. Proboscis approximately twice as long as subcranial cavity. Dorsum of thorax opaque black, with a pair of submedian yellow pruinose, black pilose, posteriorly converging stripes, and a similar pair of stripes laterally. Postpronotal lobe yellow pruinose. Scutellum black with thin yellow pruinosity, postscutellum yellow pruinose. Anepisternum, katepisternum and anterior portion of anepimeron shining black with metallic blue sheen. Remaining thoracic pleura thinly yellow pruinose, katatergite black pilose. Wing 11.0 mm long, brown fumose with metallic blue green sheen in certain light, veins brown. Halter black. Fore and mid legs with femora dark brown to black dorsally and light brown yellow ventrally with black setae, tibiae and tarsi brown with black setae. Hind femur slightly swollen distally, basal ½ white yellow with concolorous setae, apical ½ dark brown to black with black setae. Hind femur with three apical, one ventromedial and two ventrolateral strong, light brown spines. Hind tibia light brown on basal ¼, remaining portion of tibia and tarsus brown with black setae. Abdominal tergites black with narrow yellow posterior margin. Tergite one with long, sparse, yellow pile, tergite two with long white pile anterolaterally, bulla black, and remaining tergites with short black setae. Sternites brown, sternites two through four with very narrow yellow posterior margin and sparse yellow-white setae medially. In lateral view, gonocoxite with dorsal digitate process short, apically acute, ventral digitate process longer, apically narrowly rounded (Fig. 1). In lateral view, aedeagus broadly expanded apically with a collar-like fold around tubular medial portion of aedeagus (Fig. 1). In dorsal view, epandrium cleft approximately ⅔ its length, epandrial lobes triangular, apically acute (Fig. 2).

Female: Unknown.

Nemomydas hooki Welch and Kondratieff

Discussion.—*Nemomydas hooki* was recorded only from the post oak savannah region of Bastrop and Bexar counties, Texas (Welch and Kondratieff 1990). This is the first record of this species from Mexico.

Material examined.—MEXICO: *Vera-*

cruz: Playa Paraiso, 12 km al N. de Casitas, 25 May 1956, C. Bolivar, 1 ♂ (UNAM).

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SYSTENA CHEVROLAT (COLEOPTERA: CHRYSOMELIDAE: ALTICINAE): NOTES ON NOMENCLATURE, REDESCRIPTION OF THE GENUS, AND A PRELIMINARY DISCUSSION OF CHARACTERS AND PHYLOGENETIC RELATIONSHIPS

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Abstract.—A summary of the taxonomic history for *Systena* Chevrolat (Coleoptera: Chrysomelidae: Alticinae) is presented. Detailed discussion and illustration of morphological characters are presented based on stereo, compound, and scanning electron microscopy of dissected exemplar specimens for eight species of *Systena* from North, Central, and South America. A discussion of putative relationships of *Systena* to other alticine genera is presented.

Key Words: *Systena*, Alticinae, Chrysomelidae, adult, morphology, character, nomenclature, systematic, flea beetle, leaf beetle

To help provide a foundation for future generic-level phylogenetic studies in Alticinae, a nomenclatural discussion and detailed morphological redescription with preliminary phylogenetic discussion are provided for *Systena*. Although the genus *Systena* was proposed in 1836, the first discussion of morphological characters of the genus was presented by Clark (1865). However, as is typical of many early works, the characters he used were superficial and not extremely useful considering the paucity of knowledge of character distribution among Alticinae on a worldwide level. When characters are viewed in this context, as we aspire to do here, their value as diagnostic and evolutionary indicators is greatly enhanced.

TAXONOMIC HISTORY

Systena was proposed by Chevrolat (1836:390). Heikertinger and Csiki (1939) and Blackwelder (1946) incorrectly attribute authorship of *Systena* to Melsheimer (1847), who indicated Chevrolat as author of *Systena*. In Melsheimer (1847), one additional species, *Systena blanda*, was described, but no other species were listed. Chevrolat (1848) stated that *Systena* was proposed by "us" (meaning himself) and adopted by Dejean. In this work, *Systena s-littera* (Linnaeus) and *S. vittata* (Fabricius) were mentioned as additional members of the genus. Clark (1865) in his examination of South American Alticinae provided the first characterization of *Systena*, and probably for this reason, Gemminger

Table 1. Character state information for the eight *Systena* species used for the generic characterization. Character numbers refer to text. Symbol, "+" indicates that both states present or too difficult to interpret.

↘Taxa Characters→	5	10	15	20	23
Systena blanda (Melsheimer)	00101	00030	010+0	+0000	000
Systena carri Blake	00001	00020	01000	10??0	???
Systena championi Jacoby	00001	01020	01000	00010	000
Systena elongata Fabricius	00000	00020	01000	00010	000
Systena frontalis (Fabricius)	00001	00030	01000	00110	000
Systena marginallis (Illiger)	00001	00020	01000	00000	000
Systena oberthuri Baly	+0001	00030	01000	+0000	001
Systena s-littera (Linnaeus)	00001	00020	01000	+0000	000

and von Harold (1874), Hatch (1927), Horn (1889), and Leng (1920) considered him to be the author of the genus. However, the mere use of one or more available species-group names in combination or clearly included under a new genus-group name (as done by Chevrolat 1836), is sufficient for availability for names published before 1931 (ICZN [1985] Article 12 b-5; summarized in Barber and Bridwell 1940). Other authors who also correctly attribute to Chevrolat authorship of *Systena* include Chapuis (1875), Crotch (1873), Seeno and Wilcox (1982), and Poole and Gentili (1996). *Systena frontalis* (Fabricius) was designated as the type species by Monrós and Bechyné (1956).

METHODS

The discussion of the adult characters and terminology follows that of Konstantinov and Lopatin (1987), Konstantinov (1994) and Konstantinov and Vandenberg (1996). Hind wing terminology follows Kukalová-Peck and Lawrence (1993, Fig. 36) since they provided the most explicit hypotheses of homology based on examination of all beetle families. Metafemoral spring terminology follows Furth (1982). Many characters are described here for the first time. Morphological characters are based on at least two examples of dissected, disarticulated specimens of *Systena blanda* (Melsheimer), *S. carri* Blake, *S. championi* Jacoby, *S. elongata* Fabricius, *S. frontalis* (Fabricius), *S. marginallis* (Illiger), *S. oberthuri* Baly, and *S. s-littera* (Linnaeus). These taxa which occur in North, Central, and South America are suggested to represent the spectrum of morphological diversity for *Systena*. Characters, many of which are described for the first time in Chrysomelidae, are discussed in detail below. A subset of the characters and states is coded in Table 1 to explicitly indicate variability or constancy within *Systena*. The appendix provides a brief description of the characters and states used in Table 1.

Characters of adult exemplars were examined using a Leica MZ-APO stereoscope, Leitz Diaplan compound microscope fitted with transmitted light interference contrast apparati (ICT), and an AMRAY 1810 scanning electron microscope. To ease examination of sclerotized features, adult specimens were partially disarticulated and placed in hot KOH for several seconds. Stereo and compound microscopic illustrations were made using camera lucidas. Images were scanned at 600 dpi using a Nikon Scantouch scanner and enhanced using Adobe Photoshop 3.0 and labeled using Macromedia Freehand 5.5 on a Power Macintosh 8500/132 with 50 megabytes RAM.

REDESCRIPTION OF *SYSTENA* CHEVROLAT

Body (Fig. 1): Moderately elongate, flat in lateral view. Body length/width ratio as measured by length of elytra divided by greatest width, ranging from 1.42 (*S. s-littera*)–1.91 (*S. oberthuri*). Elytron without apical declivity.

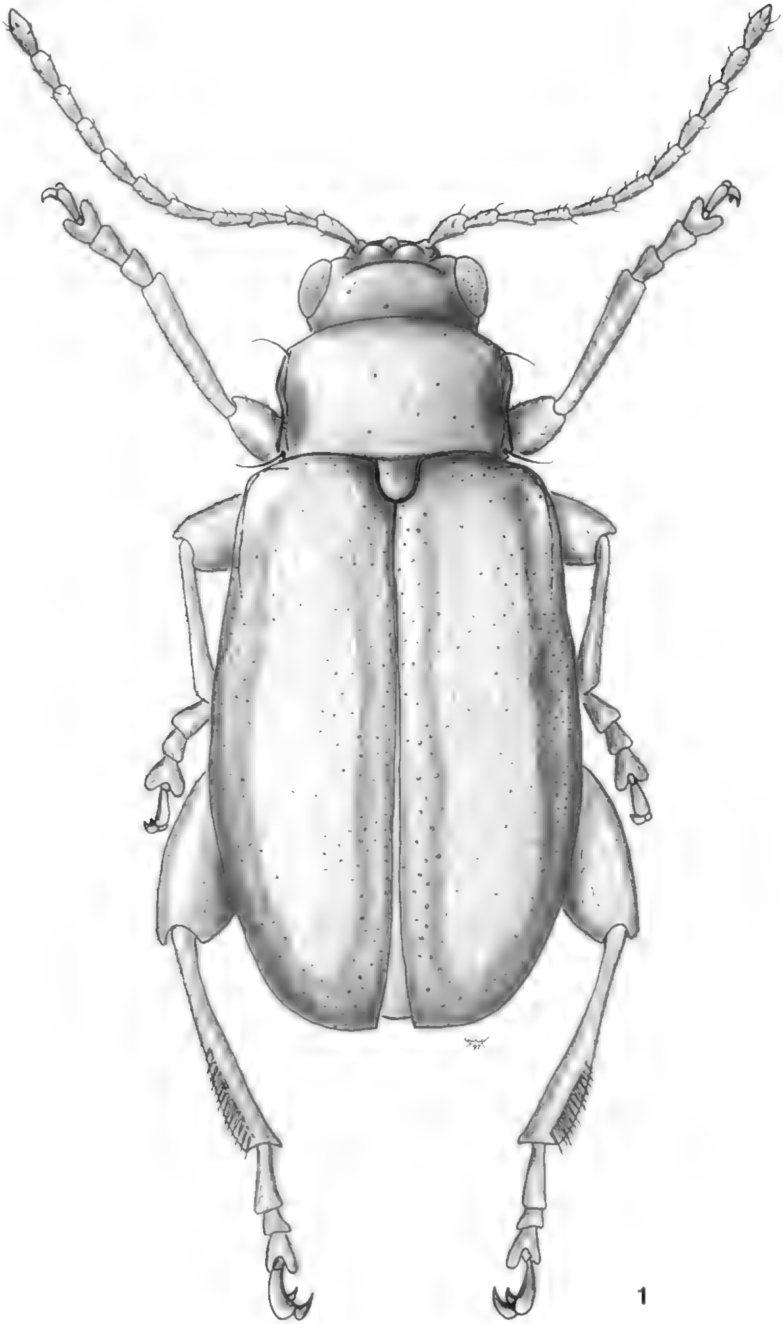

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Fig. 1. *Systena blanda*, male, dorsal view.

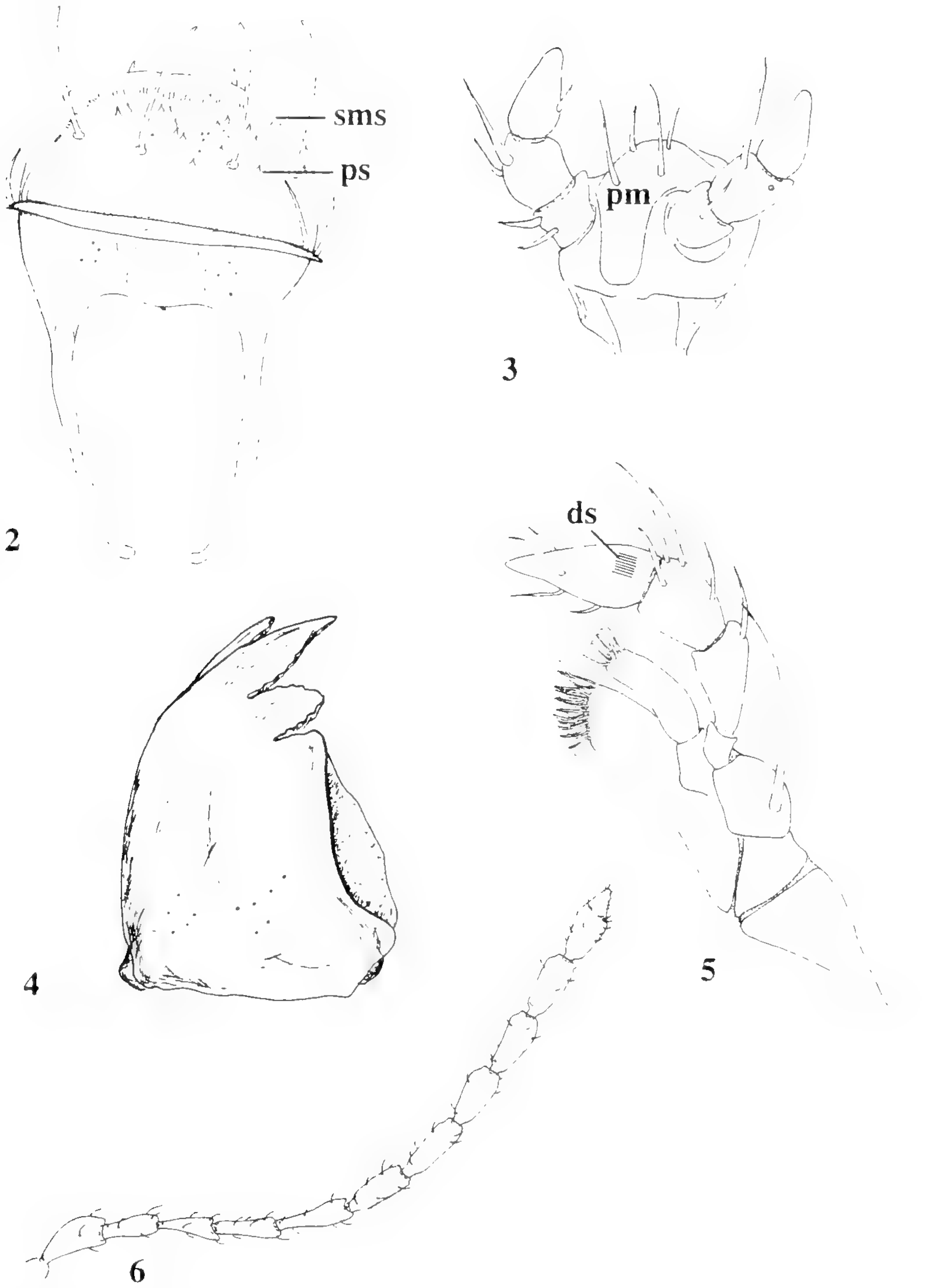
Head (Figs. 1, 7, 8): Antennal calli present, well developed, each as large as antennal socket, longer than wide, extending to antennal sockets. Supra-antennal sulcus distinct on anterior margin of antennal calli but otherwise shallow and not differentiated from surrounding area; not continuing beyond antennal socket. Supraorbital sulcus shallow, not well-differentiated from surrounding area. Supracallinal sulcus varies from well developed in *S. frontalis* to poorly developed in *S. blanda.* Anterofrontal ridge with distinct, narrow crest, lower than frontal ridge, contacting frontal ridge anteapically (before anterior end). Orbital sulcus absent (when present in other genera, extends from dorsal end of the supraorbital sulcus to dorsal margin of eye); dorsal margin of eye not demarcated from adjacent vertex. Frontal ridge well developed, extending between antennal calli to clypeus (declivous between antennal calli), not higher than rim of antennal socket when viewed from antero-ventral perspective along plane of labrum. Frontal-lateral sulcus poorly developed; region between frontal ridge and antennal socket not well differentiated. Subantennal sulcus absent. Subgenal suture well-developed. Tentorium incomplete, with only posterior arms extending dorsally less than one-fifth of distance from floor of the head to the vertex. Occipital opening nearly evenly oval, not subquadrate.

Mouthparts (Figs. 2–5): Labrum (Fig. 2) with submarginal row of fine sensilla on inner (ventral) surface; four long sensilla on outer (dorsal) surface; two short setae on mid-apical margin on inner (ventral) surface; and with erratic pattern of short, pitcher-shaped sensilla on inner (ventral) surface. Prementum (Fig. 3) with four setae (the posterior pair approximately the length of basal two labial palpomeres); base between labial palpi evenly rounded, not mildly acute. Apex of penultimate labial palpomeres with two long setae, the longest of which extends at least to apex of the apical palpomere. Apical maxillary palpomere (Fig. 5) about 1.5 times as long as penultimate palpomere, with small, basal, quadrate digitiform sensilla patch. Mandible (Fig. 4) with five teeth evenly distributed along inner (ventral) and outer (dorsal) surface. Mandibular teeth unevenly dull-serrate.

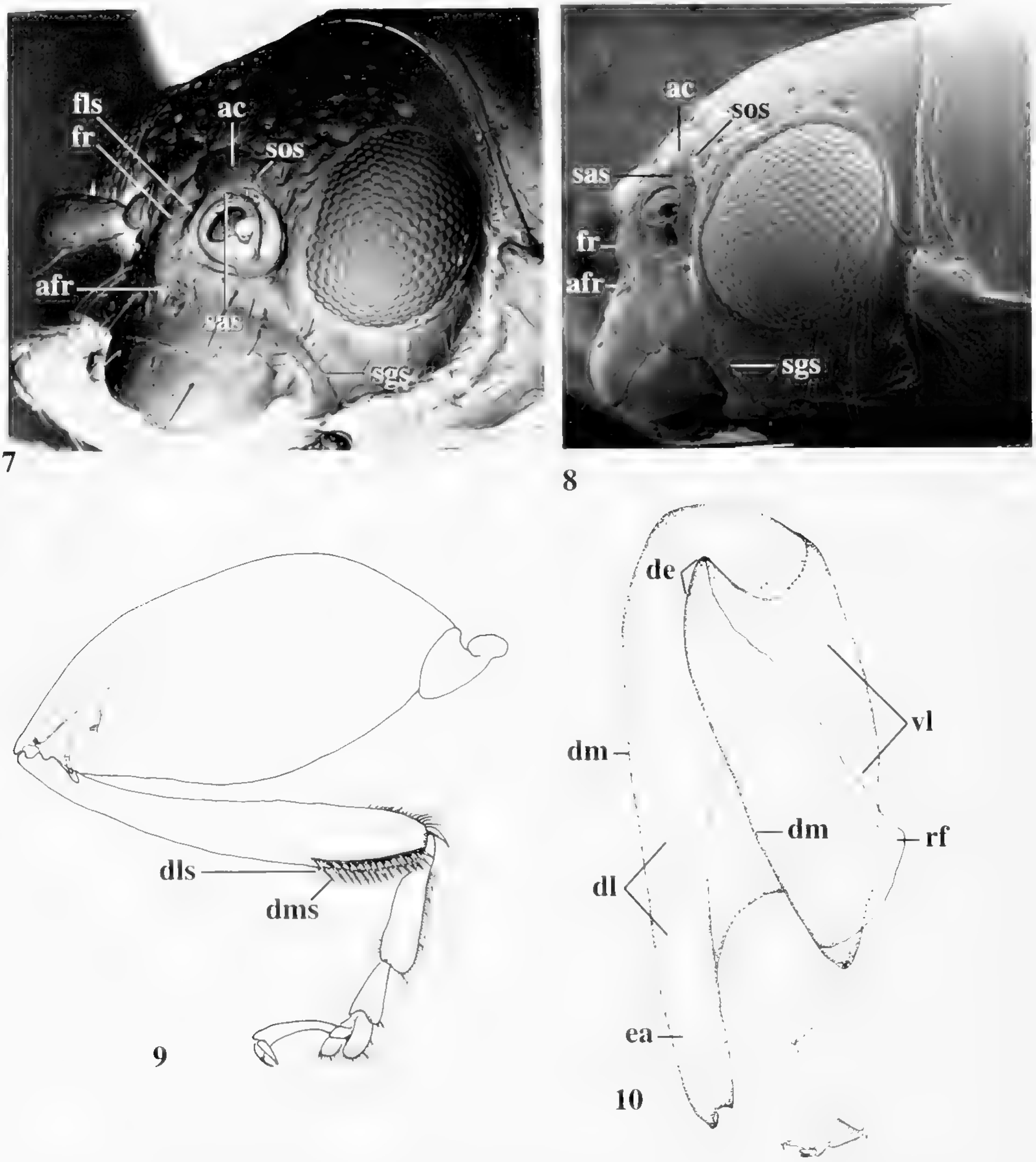
Antenna (Fig. 6): Apical antennomere constricted at apical two-thirds, becoming cone-shaped apically. Second antennomere shorter than third, longer than fourth. Fifth antennomere longer than fourth and sixth. Mesal margins of antennal sockets farther apart than diameter of antennal socket (Fig. 7).

Thorax: Pronotum (Fig. 1) without posterior (prebasal) transverse impression and without postero-lateral longitudinal impressions. Anterolateral and posterolateral corners of pronotum each bearing one long seta. Procoxal cavities closed (apex of intercoxal prosternal process contacting hypomeral projection). Intercoxal prosternal process strongly expanded apically (at least 2.0 times as wide at apex as narrowest region between procoxae). Mesocoxa (Fig. 32) broadly open laterally to mesepimeron (mesosternum and metasternum not contacting one another on the outer lateral margin of the mesocoxa). Intercoxal mesosternal process (Fig. 32) bilobed. Mesonotum (Fig. 34) strongly sclerotized and lacking stridulatory ridges. Mesoprescutum (scutellum, Fig. 34) is generally triangular, but more truncate posteriorly in *S. blanda* and *S. s-littera.* Metendosternite (Figs. 37, 38) with apex of anterior arms deflexed and tapering to a point; with long, narrow, dorsal ridge from anterior midpoint to posterior midpoint (Fig. 37); with poorly developed tendons of metafurcal-mesofurcal muscles; with poorly developed ventral process (Fig. 38) without visible contact to ventral projection; with poorly developed transverse connection from anterior arm into middle region. Metanotum (Fig. 33) less than 1.5 times as wide as long. Metanotal ridge *e* and c_2 fused, forming ridge *c,* thus appearing thickened at region where both converge with b_1 (terminology following Konstantinov, *in press*). Metanotal ridge *d* intersecting *c* at point one-third of *c*'s length before posterior end, distinctly posterior to midpoint on *c* (in *S. blanda, d* intersects *c* at its midpoint). Metanotal ridge b_1 intersecting *a* below the median groove.

Wings and legs: Elytral punctation irreg-



Figs. 2–6. Adult anatomy of *Systena blanda*. 2, Labrum, dorsal (outer) view. 3, Labium, posterolateral view. 4, Right mandible, ventral (inner) view. 5, Right maxilla, dorsal (outer) view. 6, Antenna. Abbreviations: ds = digitiform sensillum; pm = prementum; ps = pitcher sensilla; sms = submarginal sensilla.



Figs. 7–10. Adult anatomy of *Systena blanda*. 7, Head, anterolateral view. 8, Head, lateral view. 9, Left metafemur, posterior view. 10, Metafemoral spring, posterior view, dorsal side oriented to left. Abbreviations: ac = antennal callus; afr = anterofrontal ridge; de = declivous margin; dl = dorsal lobe; dls = dorsolateral apical spines; dm = dorsal margin; dms = dorsomesal apical spines; ea = extended arm; fls = frontolateral sulcus; fr = frontal ridge; rf = recurved flange; sas = supraantennal sulcus; sgs = subgenal suture; sos = supraorbital sulcus; vl = ventral lobe.

ular, confused arrangement (Figs. 1, 35). Ventrally elytra with two small, separate binding patches not extending beyond basal half of elytron (Fig. 35). Elytral apices rounded (Fig. 1, 35). Elytral epipleuron subvertical, continuous nearly to apex. Hind wing CuA_2 not attached to CuA in most species. In others such as *S. blanda, S. car-*

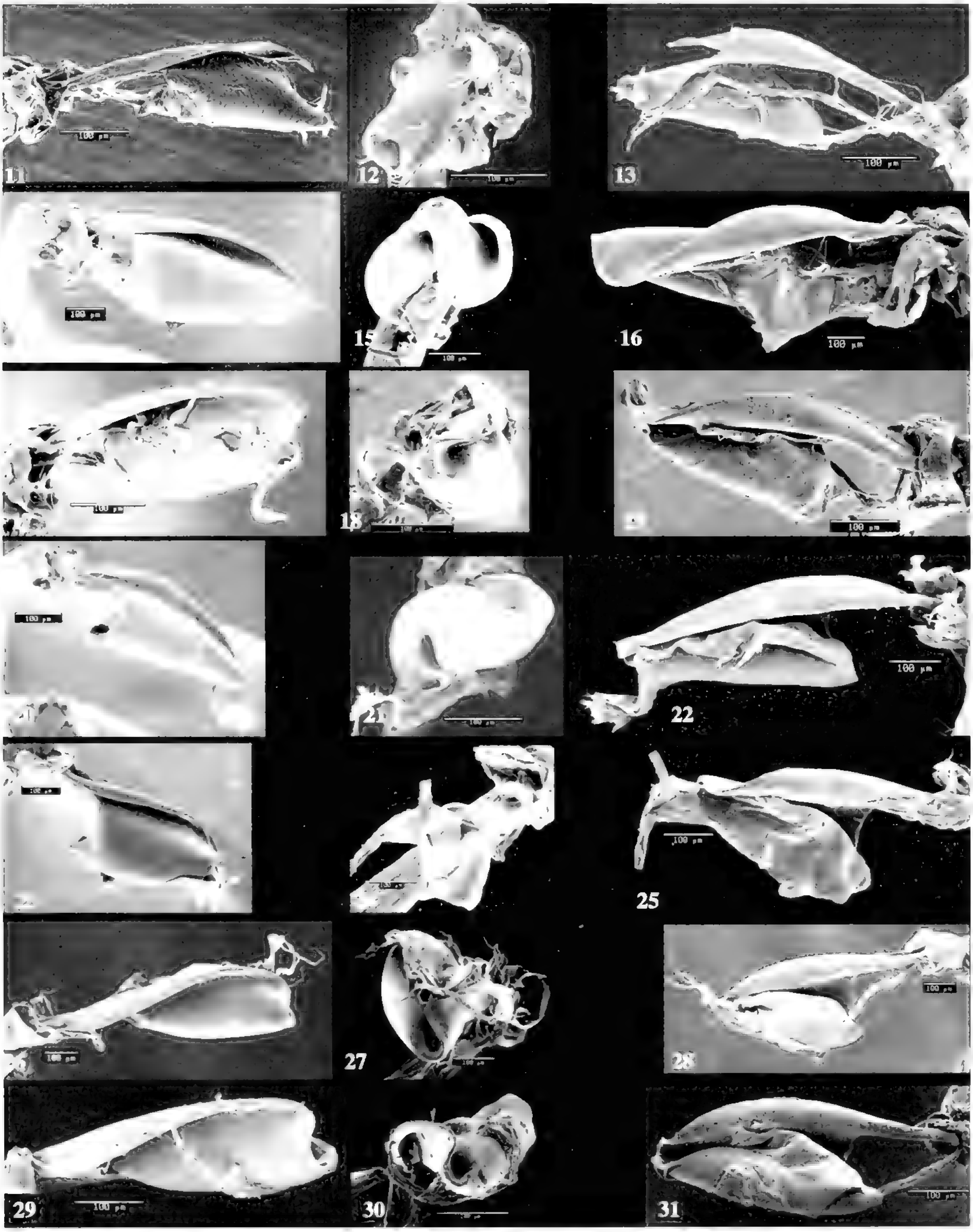
ri, S. oberthuri, and *S. s-littera,* a dark pigmentation appears to connect the CuA_2 to the CuA, this indicated by a "+" in Table 1. Hind wing AA unbranched and connected to CuA_{3+4} at about half the distance from the origin of CuA. Hind wing $RP\text{-}MP_2$ not reaching R_4. Hind wing venation not developed beyond basal ⅔ of wing. Dorsolateral apex of metatibiae with row of 22–30 small spines (Figs. 1, 9). Dorsomesal apex of metatibiae with row of 15–25 long, thick spines (Fig. 9). Dorsal surface of metatibiae convex at basal ¾. Apical ¼ nearly flat with small convexity near middle. Metafemur (Fig. 9) moderately broad (1.8—2.2 times longer than wide). First metatarsus moderately long, approximately ⅓ length of metatibia (Fig. 9). Tarsal claws appendiculate. Third metatarsomere bilobed. Metafemoral spring (Figs. 11–31) with variably developed recurved flange; elongated arm portion of dorsal lobe ranging from 0.25 to 0.35 length of metafemoral spring; dorsal margin of dorsal lobe variable in curvature; dorsal margin of the ventral lobe varies in the angle to the dorsal-ventral axis of the metafemoral spring; tightness of the coiling of the dorsal and ventral lobes variable.

Abdomen and genitalia: Apex of sternite VII of males with median truncate extension bordered by two apico-marginal impressions. Aedeagus from lateral view (Fig. 45) with only slight concavity along ventral profile; slight convexity along dorsal profile. Aedeagus apex arrow-shaped with fine striae at extreme apex (Fig. 46). Aedeagus apex dorsally with broad, flat, raised area extending anteriorly to narrow, raised ridge (Fig. 44). Central part of median lobe dorsally with broad ridge, narrowing anteriorly, and margined on either side by long narrow ridge (Fig. 44). Aedeagus from ventral view with basal opening slightly constricted posteriorly; posterior opening narrower than at anterior end (Fig. 46).

Female abdomen with seven visible tergites and seven pairs of spiracles. The last tergite, tergite VII, may be homologous with tergite VIII of other beetles, but more study on developmental segmentation needs to be done. [Cox (1996) showed variability in numbers of tergites on pupae within Alticinae but this variability was not discussed.] Tergite VII (Fig. 39) base of female with dense, microtrichia of two types: (a) compound (with 3–6 parallel spicules of differing lengths) and (b) spiniform (regular, ordered distribution, with short spicule originating from apex of triangular cuticular plate. Tergite VII apex of female with numerous long, tapering setae, evenly distributed. Apex with about 10–15 longer, apically-curved setae (Fig. 39). Sternite VII (fifth visible sternite) (Fig. 40) of female with about 12–16 long, apically-curved setae along apical margin. Otherwise with regularly distributed normal setae. Spermatheca (Fig. 43) with short, abruptly curved pump (apical region). Spermathecal duct (basal, sclerotized region, fig. 43) complex in shape, twisted. Spermathecal gland base extending nearly one-half length of sclerotized portion of spermathecal duct (basal region). Spermathecal gland surface micro-convoluted and irregular; nearly length of spermatheca. Vaginal palpus (Fig. 42) with 6–8 fleshy setae. Vaginal palpi slightly divergent at base, nearly contiguous at apex. Ventral, anterior sclerotization of vaginal palpi slender, longer than posterior sclerotization, nearly as long as posterior part of palpi behind point of their connection. Tignum apex (Fig. 41) (sternite VIII) unmodified, with apical margin of short setae. Tergite VIII (Fig. 41) of female with darkly pigmented lateral margins and an apical margin with row of short setae. In *A. frontalis,* this tergite is moderately and evenly sclerotized and spoon shaped.

DIAGNOSTIC CHARACTERS

The following characters are apparently unique (autapomorphies) for *Systena:* spermathecal duct irregulary shaped with several widened and curved regions (Fig. 43); basal, sclerotized portion of spermathecal gland long and roughly parallel sided (Fig. 43); and metanotal ridge *d* intersecting *c* at



Figs. 11–31. Right metafemoral springs of *Systena* spp. Dorsal lobes are oriented to the top except in the proximal end views in which the dorsal lobe is generally oriented to the top right. White bar represents 100 micrometers. 11, *S. blanda,* dorsal (posterior) view. 12, *S. blanda,* proximal end view. 13, *S. blanda,* ventral (anterior) view. 14, *S. championi,* dorsal (posterior) view. 15, *S. championi,* proximal end view. 16, *S. championi,* ventral (anterior) view. 17, *S. elongata,* dorsal (posterior) view. 18, *S. elongata,* proximal end view. 19, *S. elongata,* ventral (anterior) view. 20, *S. frontalis,* dorsal (posterior) view. 21, *S. frontalis,* proximal end view. 22, *S. frontalis,* ventral (anterior) view. 23, *S. marginallis,* dorsal (posterior) view. 24, *S. marginallis,* proximal end view. 25, *S. marginallis,* ventral (anterior)

point one-third of *c*'s length before posterior end, distinctly posterior to midpoint on *c*.

Characters which occur in *Systena* and other hypothetically closely related genera (potential synapomorphies for Systenini, see discussion below) include: parallel sided body (Fig. 1); elytron without apical declivity; frontal and anterofrontal ridges (Figs. 7, 8) well developed but not high; anterofrontal ridge lower than frontal ridge; and labrum with four long sensilla on outer (dorsal) surface (Fig. 2); apex of tergite VII of female with about 10–15 longer, apically-curved setae and compound microtrichiae (Fig. 39).

PRELIMINARY DISCUSSION OF RELATIONSHIPS OF *SYSTENA*

We provide here a summary of most of the genera that have been implicitly or explicitly suggested to share a close relationship to *Systena*. We have examined exemplars of these taxa and in cases where these do not represent the type species of the genus, we consider them representative of the genus.

Clark (1865) in the first characterization of the genus believed that *Systena* is closely related to *Oxygona* Chevrolat (now *Platiprosopus* Chevrolat). The diagnostic characters he provided to distinguish the two genera include the shape of the body and pronotum. In *Systena*, the body is more parallel-sided and narrower than in *Platiprosopus*, and the pronotum is more quadrate and rectilinear with the posterior corners sharp and not rounded. Our examination of *Platiprosopus acutangula* (Chevrolat) has shown other differences and similarities. We observed that *Platiprosopus* has the elytron with an apical declivity, labrum with at least 8 long setae, and fifth antennal segment longer than sixth but shorter than fourth. Our observations reveal a great similarity in the female genitalia (including the spermathecae) of the two genera. The setation of the last abdominal tergite in females of *Systena* and *Platiprosopus* are the same except there are many more compound microtrichia (Fig. 39a) distributed along the basal margin of the tergite in *Platiprosopus*.

Heikertinger and Csiki (1939) arranged a worldwide catalog based on their ideas about relationships among flea beetle genera. They placed *Systena* between *Prasona* Baly and *Agasicles* Jacoby. These taxa were followed by *Tanygaster* Blatchley, *Heikertingeria* Csiki, and *Acanthonycha* Jacoby. In 1962 Scherer synonymized *Prasona* with *Systena*, although he did not explicitly indicate, "New Synonymy." Scherer mentioned that Jacoby previously had reservations about the validity of *Prasona* (no reference indicated, however), but Jacoby did not formally synonymize them.

Our examination reveals that *Prasona* (based on *P. viridis* Baly) shares several putative synapomorphies with *Systena:* spermatheca with short, abruptly curved pump (Fig. 43), spermathecal duct wide, and metanotal ridge *d* intersecting *c* at point one-third of *c*'s length before posterior end, distinctly posterior to midpoint on *c* (Fig. 33). They also share the bilobed intercoxal mesosternal process (Fig. 32), and dorsally flattened apical fourth of the metatibia. Differences among these taxa include the shape of the spermathecal receptacle, posterior part of the tignum, abdominal tergites VIII and IX, median lobe of aedeagus, and the width of the frontal ridge. From other studies it is known that these latter characters typically vary at the species level. Therefore, we support the synonymy of *Prasona* with *Systena*. Our investigation of

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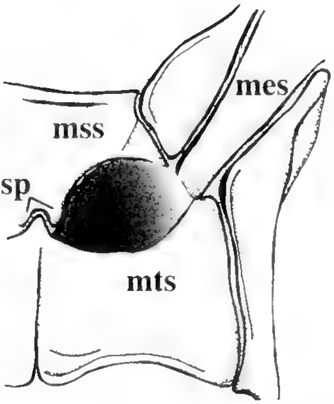
view. 26, *S. oberthuri*, dorsal (posterior) view. 27, *S. oberthuri*, proximal end view. 28, *S. oberthuri*, ventral (anterior) view. 29, *S. s-littera*, dorsal (posterior) view. 30, *S. s-littera*, proximal end view. 31, *S. s-littera*, ventral (anterior) view.



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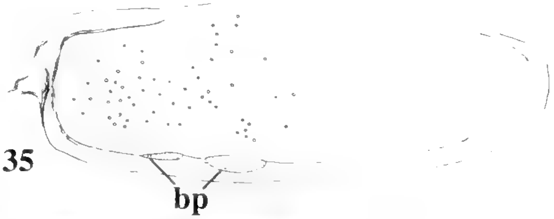

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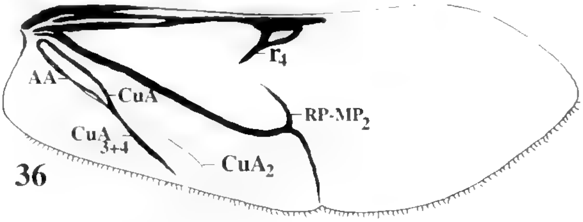

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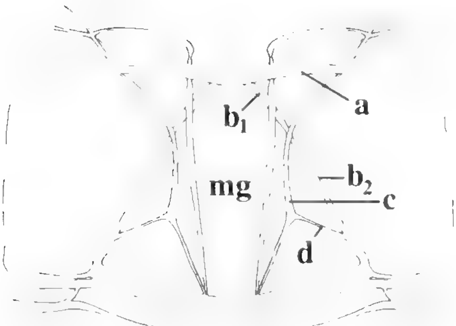

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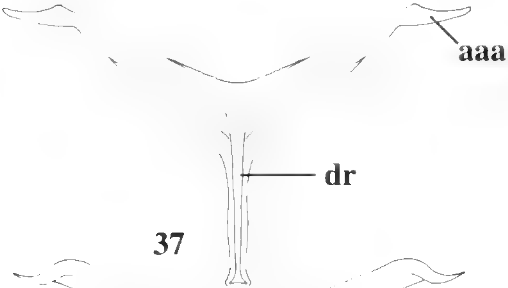

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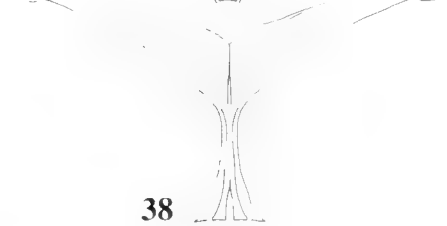

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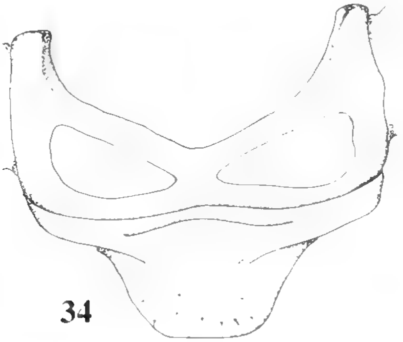

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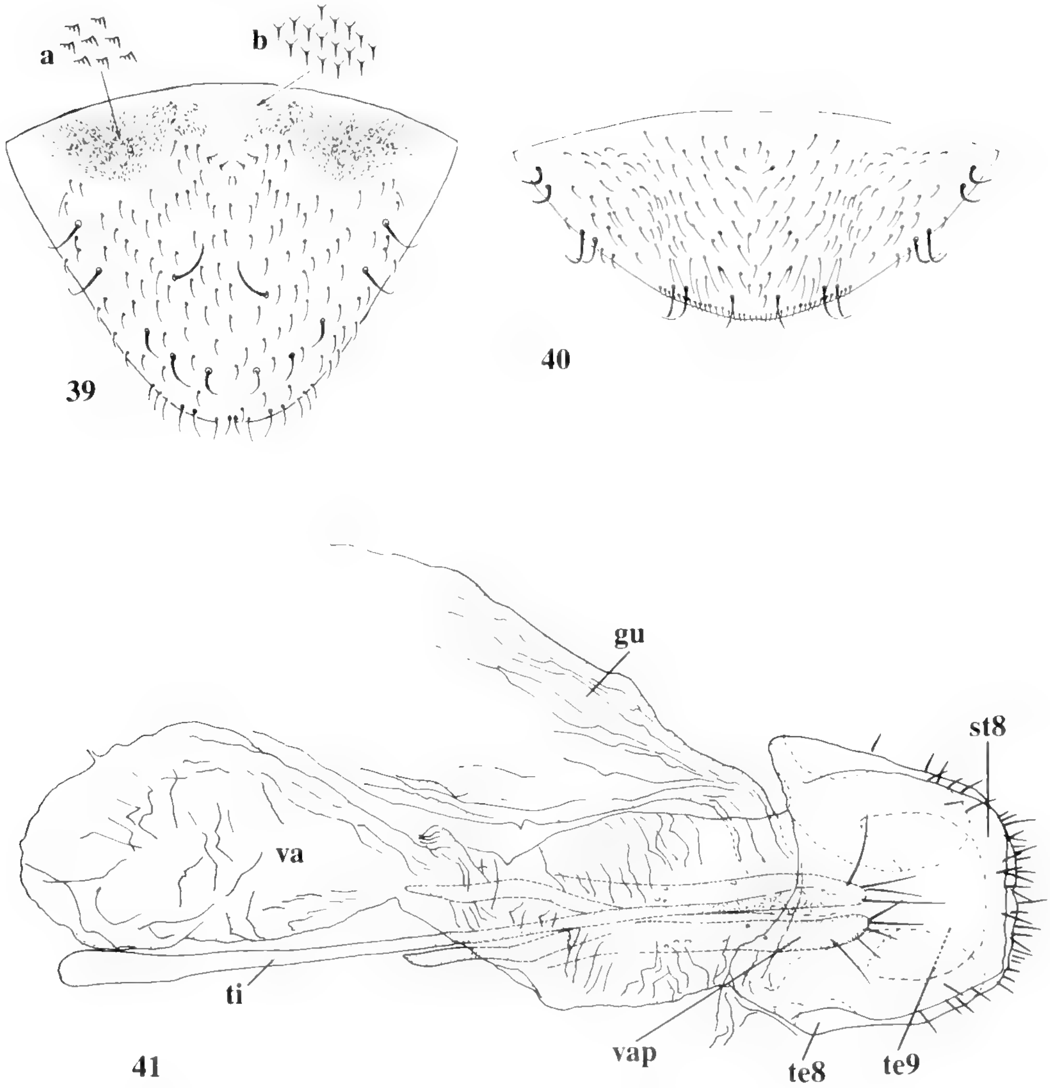
Figs. 32–38. Adult anatomy of *Systena blanda*. 32, Meso- and metasternum, left ventrolateral view. 33, Metanotum (abbreviations from Konstantinov, *in press*). 34, Mesonotum and scutellum. 35, Right elytron, ventral view. 36, Hind wing (terminology from Kukalová-Peck and Lawrence 1993). 37, Metendosternite, ventral view. 38, Metendosternite, dorsal view. Abbreviations: aaa = anterior arm apex; bp = binding patch; dr = dorsal ridge; mes = mesepimeron; mg = median groove; msp = mesosternal process; mss = mesosternum; mts = metasternum.



Figs. 39–41. Adult anatomy of *Systena blanda*. 39, Tergite VII, female (a) compound microtrichia, (b) spiniform microtrichia. 40, Sternite VII, female. 41, Female genitalia, oblique lateral view. Abbreviations: gu = digestive tract; st8 = sternite VIII; te8 = tergite VIII; ti = tignum; va = vaginal palpi.

Disonychodes exclamationis (Boheman) shows agreement in most characters with *Systena*.

Agasicles (based on *A. connexa* Boheman) has a well developed recurved flange of the metafemoral spring. The female genitalia are extremely unusual: tergite VII lacks the setal and microtrichial characters found in *Systena*; tergites VIII and IX of females are transformed into a strongly sclerotized plate with a very complicated shape; vaginal palpi are absent; the tignum is robust and strongly sclerotized; the spermathecal receptacle is wider than long; the basal part of the duct is horizontal; the basal part of the pump is long and extremely weakly sclerotized; and the horizontal part of the pump is short and sclerotized as strongly as the receptacle. On the metanotum, ridge *c* is extremely close to the median groove. The metendosternite has an extremely narrow stalk. The procoxal cavities are open behind. The dorsal side of the labrum has at least 6 setiferous pores. The anterofrontal ridge is extremely low, especially at the middle and has patches of setae laterally. The only character that is shared by *Agasicles* and *Systena* is the elongate, parallel sided body and elytron without an apical declivity. We therefore believe *Agasicles* is only distantly related to *Systena.*

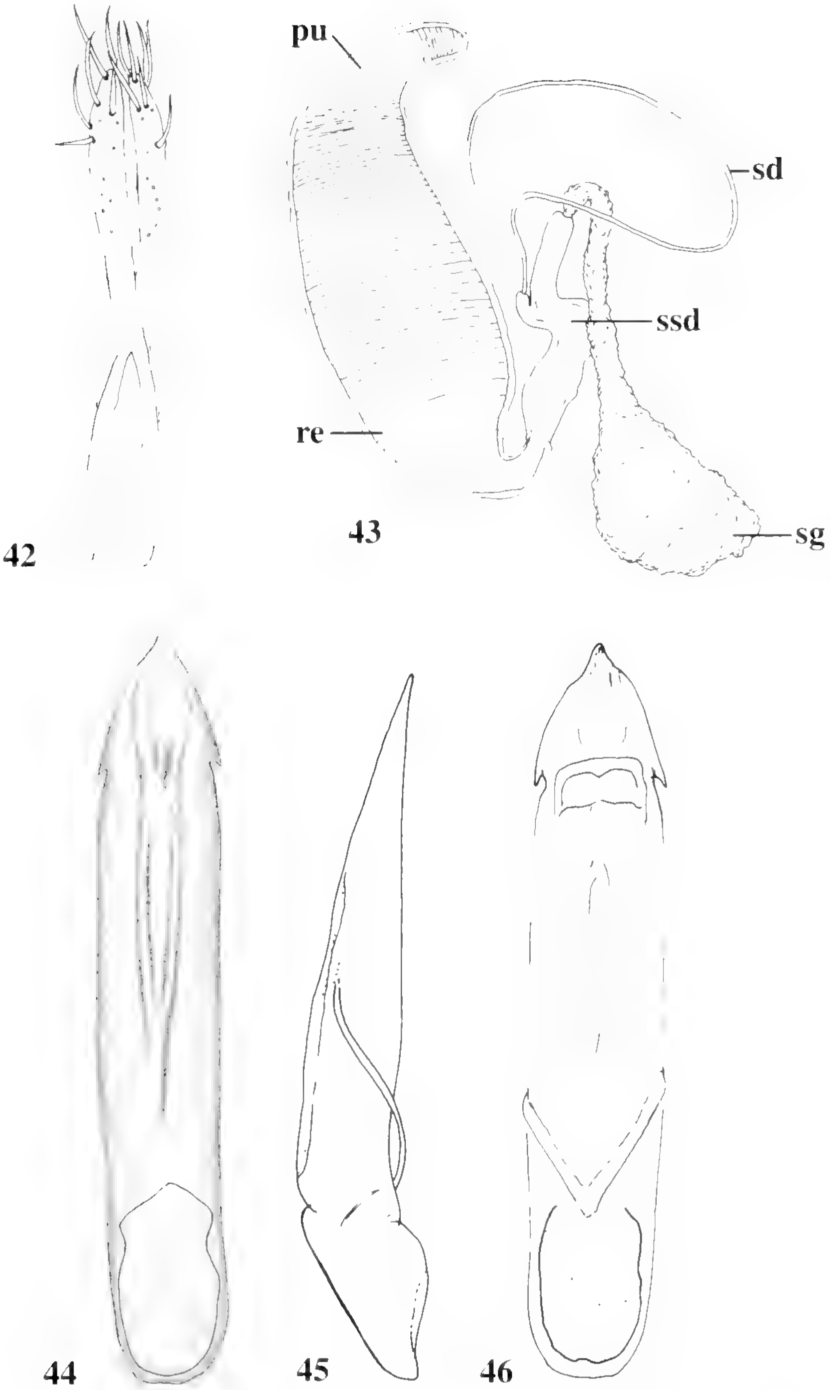
Our examination of specimens of *Heikertingeria* was limited since only males of an undetermined species were available for study. These specimens have an elytral apical declivity and a slightly convex dorsal surface of the metatibiae with an apically flat longitudinal ridge.

Like specimens of *Agasicles, Acanthonycha* females (*A. jacobyi* Bechyné) examined lacked the usually developed tergites VIII and IX and apparently also the vaginal palpi although there are 2 transverse sclerotized structures below tergite VII. The tignum in *Acanthonycha* is robust and more strongly sclerotized than in *Systena.* In *Acanthonycha,* the procoxal cavities are open behind, the intercoxal mesosternal process is narrow and not bilobed, the setation of tergite VII of females varies greatly from *Systena,* and the metendosternite has an extremely slender stalk.

Chapuis (1875) included *Systena, Prasona,* and *Chlamophora* Chevrolat (= *Clamophora* Jacoby) in the taxon called Crepidoderites (Crepiderini) based on the oblongo-oval or elongate shape of the body and the presence of the transverse impression on the pronotum. Horn (1889) also recognized the close relationship of *Chlamophora* with *Systena,* but believed it was a mistake to include them in the Crepidoderites and rather proposed a suprageneric taxon called Systenae. Specimens of *Chlamophora* (*C. meridionalis*) share similarities with *Systena* in the following character states: four long sensilla on the labrum; absence of supraorbital sulci; third metatarsomere bilobed; short, abruptly curved pump of spermatheca; curved setae on sternite VII of female; and well-developed supracallinal sulcus. Differences include the following: anterofrontal ridge with medial depression; antennal calli well-developed; pronotum with antebasal transverse and longitudinal impressions; strong elytral costae; metatibiae with long, well-defined ridge dorsally (at least ½ length of tibia); spermathecal duct coiled; and vaginal palpi robust, with long, strong sclerotization anteriorly. Some of these differences are shared with *Altica* Geoffroy, and the spermatheca in particular suggests that *Chlamophora* is more closely related to *Altica.*

Seeno and Wilcox (1982) recognized the tribe Systenini containing, besides the type genus, *Prasona, Egleraltica* Bechyné and Bechyné and *Pseudogona* Jacoby. The group of related genera separated from the tribe contains *Dysphenges* Horn, *Cyrsylus* Jacoby, *Trifiniocola* Bechyné and Bechyné, *Andiroba* Bechyné and Bechyné and *Agasicles.* No specimens of *Egleraltica, Dysphenges, Andiroba, Pseudogona, and Trifinocola* were available for examination, so Seeno and Wilcox's idea on their relationship to *Systena* cannot be addressed.

The last references to show a grouping of taxa with *Systena* are Furth (1985, 1989). It is unclear whether or not he intends the morphogroups to reflect potential phylogenetic affinity, although he has discussed patterns of congruence between metafemoral spring morphogroups to generic proximity in catalogues (Furth 1989: 499–503). Furth (1985) included *Systena* in morphogroup 3, containing *Dysphenges* Horn, *Phyllotreta* Chevrolat, *Pseudolampsis* Horn, *Pachyonychus* Chevrolat and *Lupraea* Jacoby. Our study of *Systena* metafemoral springs (Figs. 10–31) reveals extreme variation in the length of the dorsal lobe's extended arm, the curvature of the dorsal margin of the dorsal lobe, the angle of the dorsal margin of the ventral lobe to the dorso-ventral axis, the development of the recurve flange, and in the tightness of



Figs. 42–46. Adult anatomy of *Systena blanda*. 42, Vaginal palpi. 43, Spermatheca and gland. 44, Aedeagus, ventral sculpturing. 45, Aedeagus, lateral view. 46, Aedeagus, dorsal view. Abbreviations: pu = pump; re = receptacle; sd = spermathecal duct; sg = spermathecal gland; ssd = sclerotized spermathecal duct.

the coiling of the dorsal and ventral lobes. *Systena* approximates morphogroup 2 or 3, but we cannot unambiguously assign it because the differences between them are unclear. We extract their definitions here:

Morphogroup 2.—Furth (1980:267): "is distinctive but is apparently close to [morphogroup 1]"; Furth (1982:20): "very similar to morphogroup 1 with one major difference; the presence of the recurve flange as an extension of the ventral lobe. Sometimes the recurve flange is highly developed . . . yet in others . . . the recurve flange is only slightly developed."; Furth (1989: 508): "simple modification of morphogroup 1, possessing the addition of a well-developed recurve flange attached to the ventral lobe."

Morphogroup 3.—Furth (1980:267): "also distinctive from [morphogroup 1 and morphogroup 5] but seems to have some similarities to both"; Furth (1982:22): "relatively short extended arm of dorsal lobe which is significantly depressed apically and out of line from horizontal axis of dorsal lobe. Also the ventral lobe is extended into recurve flange, though not well developed"; Furth (1989:508): "has a shorter dorsal lobe (but noticeably longer than ventral lobe), apically depressed, with a small recurve flange."

It is clear that both morphogroups are characterized by a recurve flange but it is unclear how the flange differs, if at all. Apparently morphogroup 3 differs from 2 in having a "relatively short extended arm" although it is unclear if it is shorter relative to morphogroup 1 or 2 or both, and it is impossible to know at what point the extended arm becomes long enough to merit placement into another morphogroup. The apical depression of the dorsal lobe, characteristic of morphogroup 3, is unclear and is not strikingly different in any of the illustrations of Furth (1985, 1988, 1989).

Scanning electron microscopy is the best procedure to accurately determine the characteristics of the metafemoral spring. The views from the proximal end are particularly revealing of differences in the coiling of the dorsal and ventral lobes and the extent of the recurve flange. Compound microscopy is hampered because of the difficulty to position the metafemoral spring in a standard position for comparison with other taxa. A slight rotation on one axis can alter the appearance of structures or hide others. Compound microscopy does not always reveal the complicated folding patters accurately and does not always reveal the recurve flange when it is in fact present. The characteristics of the metafemoral spring defining the morphogroups should be reassessed with discrete states, perhaps in a matrix format so they can aid in identifying generic groups and be used in phylogenetic investigations. Only with explicit character states can genera be assigned unambiguously (since morphogroups were proposed, [Furth 1980], about 10 genera have been reassigned [Furth 1982, 1989]).

Comments on potential relationships of the remaining taxa in morphogroup 3 (Furth 1985) are listed here based on comparison with many of the character states found in the examined *Systena* species. *Pseudolampsis* (*P. guttata* LeConte) and *Pachyonychus* share many features (apically swollen last metatarsomere; short, straight, dorsally flat metatibia with preapically inserted metatarsus; flat and moderately wide frons) with Monoplatini, a well supported lineage in Alticinae, and are only distantly related to *Systena*. *Phyllotreta* species (including *Tanygaster*, synonymized by Smith, 1979) share with *Systena* a moderately flat body shape and elytra without an apical declivity. *Phyllotreta* differs by its undeveloped or extremely poorly developed supracallinal, midfrontal and suprafrontal sulci, much longer dorsolateral row of small spines on the apex of the metatibiae, arcuate intercoxal mesosternal process, open procoxal cavities, metendosternite well developed, with fully developed ventral process contacting the ventral projection, and fully developed tendons of the metafurcal-mesofurcal muscles. These differences and the fact that they share no presumed synapomorphies of Systenini, strongly suggests they belong in different alticine lineages. *Lupraea* (*L. longicornis* Jacoby) shares no provisional synapomorphies of Systenini. Several character states place it in different groups of genera: the orbit is extremely narrow, the frontoclypeal suture is undeveloped, the labrum has more than 15 setae on the dorsal surface, the antero and posterolateral callosities of pronotum are undeveloped, the lateral margin of the pronotum is broadly explanate, the prosternal intercoxal process is narrow and short, and the procoxal cavities are open. *Lupraea* also exhibit sexual dimorphism in the size of the eyes. *Cyrsylus* Jacoby specimens (based on *C. recticollis* Jacoby) also do not possess any of the provisional synapomorphies of Systenini. The remaining genera in Furth's (1985) morphogroup 3, *Glenidion* Clark and *Phydanis* Horn, were unavailable for examination, so comments on their relationship to *Systena* cannot be made here.

Our study suggests that many of these genera which have previously been aligned with *Systena*, either in a catalog listing or morphological grouping share few of the uncommon characters (provisional synapomorphies) of the tribe Systenini, and therefore probably belong to different alticine lineages. *Platiprosopus* seems to be the only genus that shares with *Systena* some of these characters.

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APPENDIX

Characters and states for *Systena* species compared in Table 1. More thorough descriptions given in text.

1. Body proportions ratio measured as length of elytron divided by greatest width of elytra. (0) 1.40–1.80; (1) >1.80
2. Elytron apex. (0) without apical declivity; (1) with apical declivity
3. Antennal calli. (0) as large as antennal socket, longer than wide; (1) not as large as antennal socket, wider than long
4. Anterofrontal ridge. (0) lower than frontal ridge; (1) higher than frontal ridge
5. Supracallinal sulcus. (0) well developed; (1) poorly developed (indistinct)
6. Orbital sulcus. (0) absent; (1) present
7. Frontal ridge. (0) well developed; (1) poorly developed
8. Dorsal surface of labrum. (0) with 4 setae; (1) with more or less setae
9. Fifth antennomere length relative to fourth and sixth. (0) longer than 4&6; (1) shorter than 4&6; (2) 4=5>6; (3) 4>5=6
10. Procoxal cavities. (0) closed; (1) open
11. Prosternal intercoxal process. (0) strongly expanded at apex; (1) narrowly expanded at apex
12. Mesoprescutum. (0) truncate posteriorly; (1) triangular in shape
13. Metendosternite anterior arms. (0) deflexed anteapically; (1) not deflexed at ends
14. Metanotal ridge *d*. (0) intersecting *c* at point one-third of *c*'s length before posterior end, distinctly posterior to midpoint on *c* (1) not as in *0, d* intersecting *c* at point much anterior (at least anterior to midpoint of *d*).
15. Elytral punctation. (0) irregular, confused; (1) arranged more or less in striae
16. CuA_2. (0) not attached to CuA; (1) reaching CuA
17. Dorsolateral apex of metatibia. (0) with 22–30 small spines; (1) less than 20 spines present
18. Coiling of dorsal lobe. (0) coiled nearly completely along dorso-ventral axis;

(1) coiled only at extreme distal end (near attachment to tibia).

19. Extended arm of metafemoral spring. (0) between 0.35 and 0.25 length of spring; (1) less than 0.25 length of spring.
20. Aedeagus apex. (0) arrow shaped with fine striae at extremity; (1) not arrow shaped and without striae.
21. Tergite VII of female. (0) with compound and spiniform microtrichiae; (1) without both types
22. Spermathecal duct. (0) irregulary shaped with several widened and curved regions; (1) not as in 0
23. Spermathecal gland. (0) basal, sclerotized portion long and roughly parallel sided; (1) not as in 0

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LARVAL MORPHOLOGY OF *SYSTENA BLANDA* MELSHEIMER (COLEOPTERA: CHRYSOMELIDAE: ALTICINAE)

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Abstract.—The first detailed morphological description and illustrations are presented for the larva of a species of *Systena* (Coleoptera: Chrysomelidae: Alticinae), *S. blanda* (Melsheimer). Compound microscopic examination of the head, antennae, mouthparts, and legs revealed characters typical of other soil dwelling and root feeding alticine genera.

Key Words: *Systena,* Alticinae, Chrysomelidae, larva, morphology, character, systematic, flea beetle, leaf beetle

The morphology and biology of many alticine larvae, particularly those including forest and agricultural pests have been studied by many workers, although much more is known for Old World taxa. Notable works on Old World taxa include those of Ogloblin and Medvedev (1971), Kimoto and Takizawa (1994) and Steinhausen (1994) who studied many genera of alticine larvae taxonomically, emphasizing characters of the anal plate and chaetotaxy. Other less expansive taxonomic works on alticines include: Reed (1927); Böving and Craighead (1931); Newton (1933); Anderson (1938); Paterson (1943); Dobson (1960); Yano (1963, 1965); Welch (1972); and Lee (1992).

Despite the contributions of these researchers, detailed larval morphology of *Systena* has heretofore remained undescribed. Chittenden (1900) provided minute illustrations of the larval habitus and anal plate of *Systena blanda* (Melsheimer) (this plate also reproduced in Chittenden 1902a) and a brief discussion of diagnostic characters of the anal plate. Drake and Harris (1931) provided a slightly larger lateral habitus illustration of the larva but no discussion of characters important in identification. Peters and Barton (1969) provided a brief description of the larva of *Systena frontalis* Fabricius but did not provide adequate detail to understand unique and shared characters of this and related taxa.

The purpose of this paper is to provide a thorough description of the larva of the pale-striped flea beetle, *Systena blanda* (Melsheimer). This species is widely distributed, ranging from the northeastern United States to California (Chittenden 1902b). Members of this species are encountered on a range of agricultural crops, having been reported on onions (Drake and Harris 1931); beans (Chittenden 1900, 1902a); corn (Chittenden 1900); cotton (Bissell 1941); and sugar-beets (Chittenden 1902b).

METHODS

Detailed morphological description and discussion are provided for the larva *Sys-*

tena blanda. Characters of larval exemplars of *S. blanda* were examined using a Leica MZ-APO stereoscope and Leitz Diaplan compound microscope fitted with transmitted light interference contrast apparati (ICT). Stereo and compound microscopic illustrations were made using camera lucidas. Images were scanned at 600 dpi using a Nikon Scantouch scanner and enhanced using Adobe Photoshop 3.0 and labelled using Macromedia Freehand 5.5.

DESCRIPTION

Systena blanda (Melsheimer), 1847

(Figs. 1–8)

Mature larva.—Body (Fig. 1) yellowish brown, moderately convex, C-shaped, long and slender. All segments elongate, with numerous scattered setae. Head, spiracles and anal plate brown; mandible, pronotum, and legs pale brown.

Head: Hypognathous, rounded, slightly sclerotized. Epicranial suture rather short, endocarina weakly developed. Frontal suture (Fig. 3) moderately divergent (about 40°) and nearly straight. Frons (Fig. 3) with 5 pairs of frontal setae and 1 pair of frontal sensilla; epistomal suture (Fig. 3) well developed. Antenna (Fig. 2) 2-segmented, segment 1 with a large conical sensory papilla, 4 setae and 2 sensilla, segment 2 short and small, with 1 long seta and 2 short setae. Clypeus (Fig. 4) trapezoidal, with 1 pair of clypeal setae and 1 pair of clypeal sensilla; labrum (Fig. 4) with 2 pairs of labral setae and 1 pair of labral sensilla; epipharynx (Fig. 4) with 6 pairs of epipharyngeal setae. Mandible (Fig. 6) palmate, well sclerotized, with 5 distal teeth, 2 mandibular setae and 1 mandibular sensillum, penicillus well developed with 3 long and straight lobes. Maxilla and labium (Fig. 5): Maxillary palp 3-segmented, segments 2 and 3 each with 1 seta and 1 sensillum, segment 1 without seta; palpifer with 2 setae; stipes with 2 setae; cardo with 1 seta on outer anterior margin. Galea broad, with 6 setae; lacinia with tightly bunched group of 6 setae. Ligula stump-like, separated from prementum, not extending from between labial palpi, with 2 pairs of setae and numerous minute micro-setae. Labial palp 2-segmented. Prementum with 2 pairs of setae and 1 pair of sensilla; postmentum with 3 pairs of setae.

Thorax: Pronotum pale brown, weakly sclerotized, with 12 pairs of setae. Mesothoracic spiracles annuliform, situated on epipleural anterior part; peritreme darker than adjacent cuticle. Legs (Fig. 8) rather stout; tibia with 8 setae (5 stout); tarsungulus falciform, moderately curved anteriorly, enlarged base with 1 seta; pulvillus whitish, bladder-like, as long as tarsungulus.

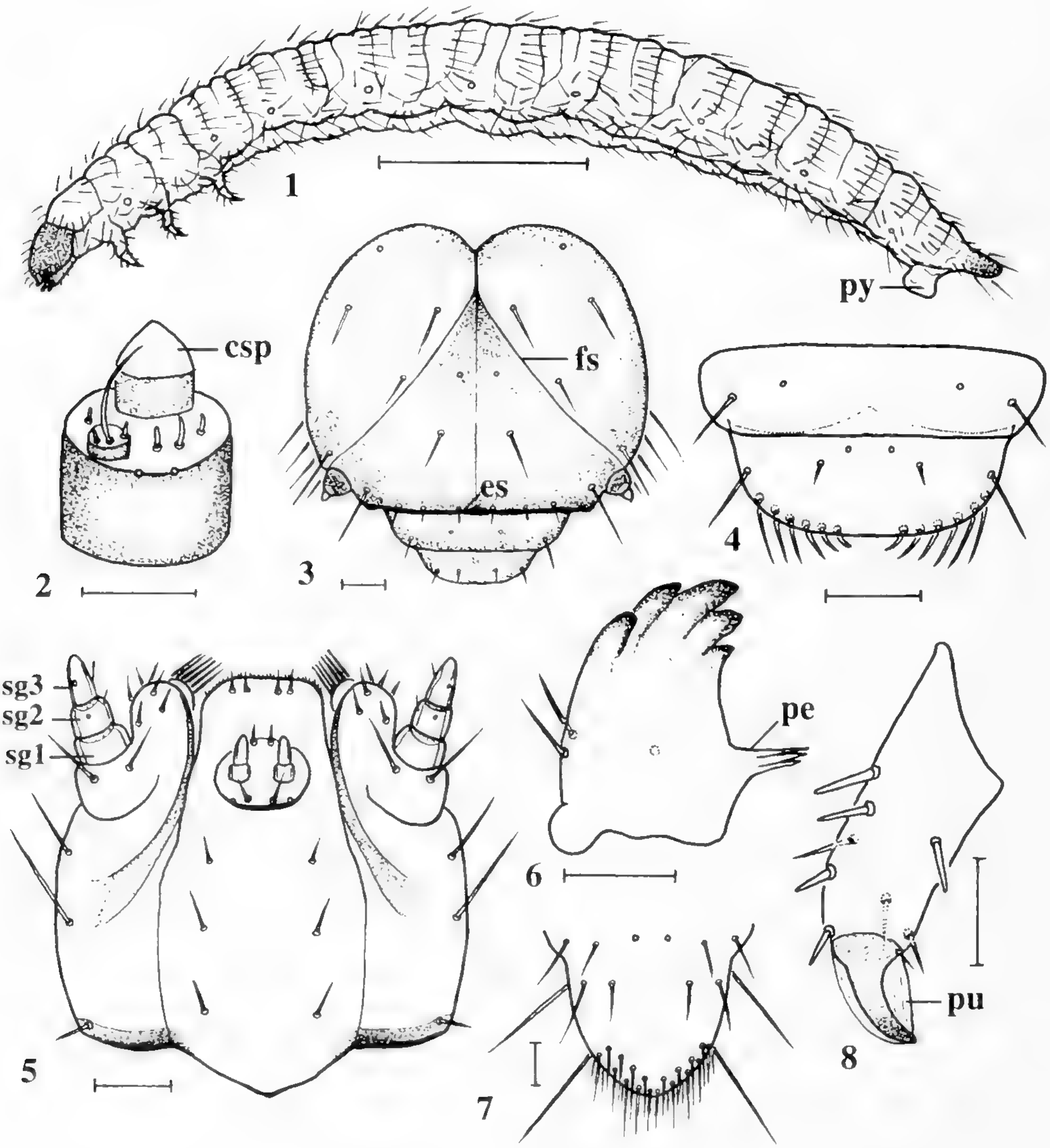
Abdomen: Typical abdominal segments with three folds. Abdomen with 8 pairs of spiracles, the peritremes circular. Epipleuron and pleuron each with 6 setae. Anal plate (Fig. 7) saddle- shaped, with 12 pairs of long setae (including 2 pairs of long setae on lateral margin of ventral side), 1 pair of medial sensillae, and about 20 additional, shorter setae at margin of apex of anal plate. Tenth abdominal segment well developed, straight, with ventrally directed pygopod (Fig. 1).

Body length: average 5.2 mm (n = 5). Head width: average 0.45 mm (n = 5).

Material examined.—Bard, California, 5 specimens, V-15-1913, H. Pinkus, collector. Deposited in the National Museum of Natural History, Smithsonian Institution, Washington, DC.

DISCUSSION

Alticine larvae can be categorized into three types based on their ecological association: (1) leaf living including external feeders and leaf miners; (2) stem borers; and (3) root feeders (soil dwelling). The morphology among these types is not always distinctive and convergence clearly exists when distantly related taxa share the same ecological association. Larval characters of external alticine leaf feeders are similar to many genera of galerucine larvae



Figs. 1–8. Larva of *Systena blanda*. 1, Mature larva, lateral view. 2, Antenna, dorsal view. 3, Head, dorsal view. 4, Clypeus, labrum and epipharynx, dorsal view. 5, Lower mouth parts, ventral view. 6, Mandible, buccal view. 7, Anal plate, dorsal view. 8, Left hind leg, dorsal view. Scale line = 1.0 mm (Fig. 1); 0.05 mm (Figs. 2–8). Abbreviations: csp = conical sensory papilla; es = epistomal suture; fs = frontal suture; pe = penicillus; pu = pulvillus; py = pygopod; sg# = segment number.

and are characterized by having a well developed tubercle, body densely covered with setae, and labial palp 2-segmented. Leaf mining and stem boring alticines are similar to hispine larvae and are characterized by having a flat body form, hind corners of epicranium largely produced posteriorly, antenna 1-segmented, cardo reduced or fused with stipes, 8th abdominal spiracle well developed, and labial palp 1-segmented and strongly reduced. Some leaf miners and stem borers have 1 pair of terminal spines on the anal plate. Characters of soil dwelling alticine larvae are very similar to those of external leaf feeders but are easily distinguished by their very long and slender body shape.

Systena blanda larvae feed on the underground portions of seedling onions, primarily on the subterranean leaf sheaths and rootlets (Drake and Harris 1931). This same feeding behavior probably applies to the other hosts, but has not been documented. The larvae expectedly have the characteristic appearance of root-feeding alticine larvae. In this respect, they are similar to *Chaetocnema* Stephens, *Epitrix* Foudras, *Hermaeophaga* Foudras, *Longitarsus* Berthold, *Phygasia* Dejean, *Phyllotreta* Chevrolat, *Pseudodera* Baly, and *Psylliodes* Berthold in the long, threadlike body and soil dwelling habits. Two-segmented antennae likely occur in all these genera based on other shared morphology, although the antennal morphology for larvae of *Phygasia, Phyllotreta, Pseudodera,* and *Psylliodes* is unknown. Diagnostic characters of *Systena* include: segment 2 of antenna with a long seta and 2 short setae (potentially shared with other genera), ligula with numerous setae anteriorly, mandible with long, stiff penicillus, legs with stout setae and anal plate with many setae posteriorly and 2 pairs of long setae on lateral margin of ventral side.

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STUDIES OF NEOTROPICAL CADDISFLIES LVI: DESCRIPTIONS OF FIVE NEW SPECIES OF THE GENUS *METRICHIA* ROSS (TRICHOPTERA: HYDROPTILIDAE) FROM PAKITZA, PERU, WITH A CHECKLIST AND BIBLIOGRAPHY OF THE DESCRIBED SPECIES OF THE GENUS

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Abstract.—Five new species of the genus *Metrichia* from Peru are described, diagnosed and figured: ***M. pakitza, M. diosa, M. madre, M. adamsae,*** and ***M. helenae.*** Full generic status for *Metrichia* is accepted, the 58 described species are listed with their authors, date of publication and known distribution, and a bibliography presented for the papers in which the species were described or new country records given.

Key Words: *Metrichia,* Trichoptera, Hydroptilidae, species list, bibliography, new species, Peru

The genus *Metrichia* has a wide distribution in the New World, being found from the southwestern United States south to central Chile and Argentina and all the larger Antillean islands. There seems to be a tendency for the species to breed in small, tumbling streams, cascades and springs. Adults are most frequently taken by sweeping near the larval site, but a Malaise trap at the same site will often produce large numbers. They are not commonly attracted to lights at night, but now and then a few specimens will show up. As a consequence of this restriction of habitat and retiring habits, a true understanding of their diversity is only slowly emerging.

The genus was erected by Ross in 1938 for the Texan species, *Orthotrichia nigritta* Banks. However, Flint in 1968a reduced *Metrichia* to the status of subgenus in *Ochrotrichia* due to the morphology of the head and thorax, spur count, structure of the male genitalia and especially on the near identical morphology of the larval stage. Subgeneric status has been followed by various authors at various times, most notably by Marshall (1979) in her reclassification of the family, and not by others (Blickle and Denning 1977, give cogent reasons). Marshall (1979) placed *Metrichia,* as a subgenus, in the subfamily Hydroptilinae but created the tribe Ochrotrichiini in which she included only the New World genera *Ochrotrichia* sensu stricto, *Metrichia* and *Rhyacopsyche.* Wiggins (1996) introduced several characteristics believed to distinguish the larvae of the two subgenera, and then recognized both at the full generic level. Although some recent larval collections are difficult to place generically, we follow Wiggins' lead in this paper and recognize the genus *Metrichia* as an independent genus. Jacquemart (1963) created the genus *Argentitrichia* for the single species *A. bulbosa* Jacquemart, 1963. Marshall (1979) correctly synonymized *Argentitrichia* with *Metrichia*; the species, however, is valid.

The first sketchy description of *Metrichia* larvae was for the type species by Edwards & Arnold (1961). The next description, somewhat more complete, was of the Puerto Rican *M. juana* (Flint) (as *Ochrotrichia juana,* Flint 1964). Wiggins (1996) gave the most complete description with figures of *M. nigritta,* together with a differential generic diagnosis. Botosaneanu & Flint (1982) reported on some larval morphology and showed interesting variation in larval case structure with the development of dorsal silken tubes, but all from unknown species in the genus. Nothing is reported on larval food habits.

Because the number of described species has increased rapidly in recent years, and their descriptions are widely scattered in the literature, we present the following checklist with known distributions. A few references are given in the Literature Cited which are not cited in the text; they contain published records for a species from a country that is not otherwise recorded.

aberrans (Flint 1972) .... Mexico
adamsae Flint & Bueno, herein .... Peru
anisoscola (Flint 1991) .... Colombia
araguensis (Flint 1981) .... Venezuela
arenifera (Flint 1980) .... Peru
argentinica Schmid 1958 ..... Argentina
arizonensis (Flint 1972) .... USA
avon (Bueno 1983) .... Mexico
bidentata (Flint 1983) .. Argentina, Chile
biungulata (Flint 1972) .... Panama
bola (Flint 1991) .... Colombia
bulbosa (Jacquemart 1963) ... Argentina
cafetalera Botosaneanu 1980 .. Cuba, Dominican Republic
campana (Flint 1968b) .... Dominica
carbetina (Botosaneanu 1994) ... Guadeloupe
ceer (Flint 1992) .... Puerto Rico
continentalis (Flint 1972) .... Panama
cuenca (Harper & Turcotte 1985) .. Ecuador
cuspidata (Flint 1991) .... Colombia
dietzi (Flint 1974) .... Guyana, Surinam
diosa Flint & Bueno, herein .... Peru
disparilis (Flint 1983) .... Argentina
espera Botosaneanu 1980 .... Cuba
excisa (Kumanski 1987) .... Cuba
exclamationis (Flint 1968b) ... Dominica, Guadeloupe
favus (Botosaneanu, in Botosaneanu & Alkins 1993) .... Trinidad
fontismoreaui (Botosaneanu 1991) .. Dominican Republic, Haiti
geminata (Flint 1996a) Tobago, Trinidad
helenae Flint & Bueno, herein ..... Peru
juana (Flint 1964) .... Puerto Rico
kumanskii (Botosaneanu 1991) .... Haiti
lacuna (Bueno 1983) .... Mexico
lemiscata (Flint 1972) .... Panama
lenophora (Flint 1991) .... Colombia
macrophallata (Flint 1991) ... Colombia
madre Flint & Bueno, herein .... Peru
madicola (Botosaneanu 1994) ... Guadeloupe
malada (Flint 1991) ..... Colombia, Peru
munieca Botosaneanu 1977 .... Cuba
neotropicalis Schmid 1958 .... Argentina, Chile, Peru
nigritta (Banks 1907, *volada* Blickle & Denning 1977, synonymy by Moulton, Stewart & Young 1994) .. El Salvador, Mexico, USA
pakitza Flint & Bueno, herein ...... Peru
patagonica (Flint 1983) ...... Argentina, Chile
penicillata (Flint 1972) ...... Guatemala
platigona (Botosaneanu, in Botosaneanu & Alkins 1993) .. Tobago, Trinidad, Venezuela
protrudens (Flint 1991) .... Colombia
quadrata (Flint 1972) .... Mexico
rawlinsi (Flint & Sykora 1993) .. Dominica
riva (Bueno 1983) .... Mexico
rona (Flint 1991) .... Colombia
sacculifera (Flint 1991) ...... Colombia
similis (Flint 1968b) .. Dominica, Guadeloupe
squamigera (Flint 1992) .... Puerto Rico
thirysae Jacquemart 1980 .... Chile
trigonella (Flint 1972) ..... Honduras, Mexico
trispinosa (Bueno 1977) .... Mexico

warema (Flint 1974)	Surinam
yalla (Flint 1968a)	Jamaica

The following five new species do not, on the whole, fit well into the species groups proposed by Flint (1972), nor do many of the other species described in recent years. It is apparent that a completely new approach to defining monophyletic groups will have to be taken, but with so many species yet to be made known such a study is still premature. The five species described here are all rather atypical of the genus in the structure of their abdomens. Most species have various sacs, pockets, and hair brushes on their abdomens. Only *M. helenae* of the Pakitza species clearly bears hair brushes. However, such brushes are easily removed from the abdomen during clearing and could have been lost from the other species, and small pockets between segments are difficult to see with material in the best of condition, which most of these examples are not. The wings of all specimens are completely denuded, thereby rendering it impossible to ascertain if any bear specialized patches of scales on their wings. The apex of the phallus of the unique specimen recorded as *Ochrotrichia (M.)* n. sp. 1 (Flint 1996b: 399) has been lost, rendering this specimen unfit for description.

The types of these species are presently held in trust at the National Museum of Natural History, Smithsonian Institution, for ultimate deposition at the Museo de Historia Natural, Universidad Nacional Mayor de San Marcos, Lima, Peru.

Metrichia pakitza Flint and Bueno, new species

(Figs. 1–3)

Ochrotrichia (*M.*) n. sp. 2, Flint 1996b: 399.

This species is not closely related to other described species, only the following, *M. diosa,* n. sp., being clearly related. Indeed, in most parts of the genitalia the two species appear nearly identical. However, the antennae in *M. pakitza* are unmodified, the segments being short and terete, and the clasper bearing a small apicoventral angle.

Adult.—Length of forewing, 1 mm. Color in alcohol, brown. Male antenna very short, hardly as long as width of head, of 17 segments, all short and cylindrical. Male abdomen lacking apparent modifications. Male genitalia: Ninth segment in lateral aspect one and one-half times longer than high; posterior margin nearly vertical, anterior margin narrowed and slightly produced anteriad. Cercus in lateral view thumblike. Tenth tergum lightly sclerotized, hoodlike. Dorsolateral hook in dorsal view, apex hooked laterad; in lateral view with apical portion curved sharply ventrad. Inferior appendages in lateral view broad basally, dorsal margin slightly sinuate, ending in an apicodorsal point, posterior margin concave with a smaller posteroventral angle. Phallus with two curved hooks arising at different levels of the apical portion, apicalmost hook shorter, midway between preapical hook and tip, preapical hook longer and straight in dorsal view.

Material.—Holotype, ♂. PERU: Madre de Dios: Manu, Pakitza, 12°7′S, 70°58′W, 250 m, Trail 2, 1st Stream, 14–23 September 1988, O. Flint & N. Adams, Malaise trap, night collection (NMNH).

Etymology.—Named for the locality in Peru where the species was collected.

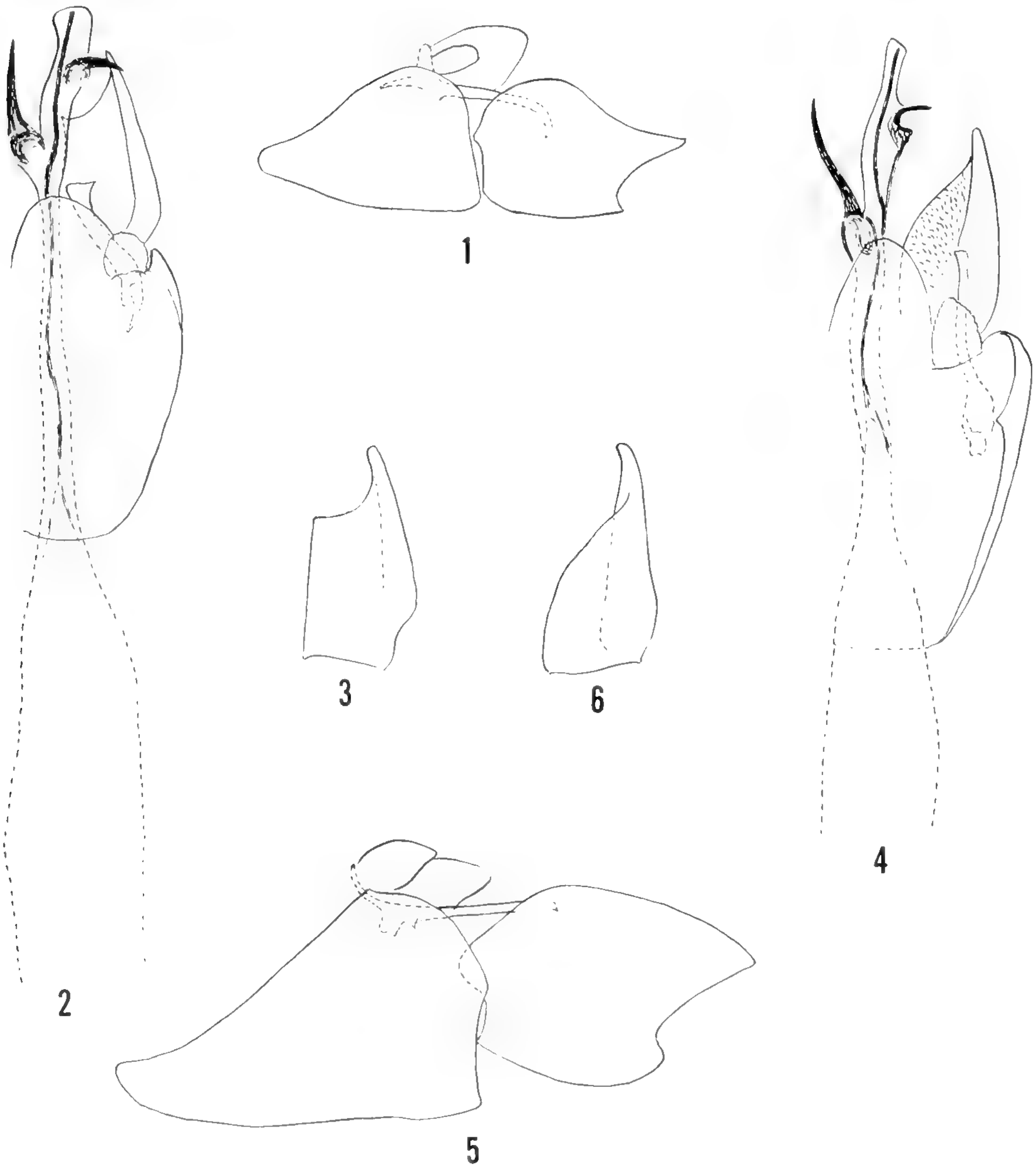
Metrichia diosa Flint and Bueno, new species

(Figs. 4–6)

Ochrotrichia (*M.*) n. sp. 4, Flint 1996b: 399.

This species is very closely related to *M. pakitza,* n. sp., being reliably distinguished by the presence of much compressed antennal segments and the lack of the apicoventral angle on the inferior appendages.

Adult.—Length of forewing, 2 mm. Color in alcohol, brown. Male antenna of 17 segments; segments 5–13 much compressed, about twice as high as long. Male



Figs. 1–6. *Metrichia.* 1–3, *M. pakitza.* 1, Male genitalia, lateral. 2, Same, dorsal. 3, Inferior appendage, ventral. 4–6, *M. diosa.* 4, Male genitalia, dorsal. 5, Same, lateral. 6, Inferior appendage, ventral.

abdomen without apparent modifications. Male genitalia: Ninth segment in lateral aspect about one and one-half times as long as high, posterior margin almost vertical; produced anteroventrally. Cercus in lateral aspect, hood-shaped. Dorsolateral hook long, slender; in lateral view apex with small ventral point. Inferior appendage in lateral view, longer than high, with the apicodorsal portion produced and angulate; in ventral aspect, with the basal portion wider than the apical, the inner margin sinuate; inner face covered by many micro spines. Phallus with two well developed spines, origins well separated, basal spine much longer than apical and nearly straight, preapical spine small and sharply curved laterad; internal tubule well developed.

Material.—Holotype, ♂. PERU: Madre de Dios: Manu; Pakitza, 11°56′S, 71°18′W, 250 m, kitchen stream, 12–18 September 1989, N. Adams et al., Malaise trap, night collection. Paratypes: Same data, 1 ♂ 3 ♀; same, but day collection, 1 ♂, 3 ♀; same, but Trail 2, 1st Stream, 14–23 September 1988, O. Flint & N. Adams, Malaise trap, day & night collection, 1 ♂ (NMNH).

Etymology.—*diosa*: Spanish word for goddess, also recalling the name of the Province, Madre de Dios.

Metrichia madre Flint and Bueno, new species

(Figs. 7, 8)

Ochrotrichia (*M.*) n. sp. 3, Flint 1996b: 399.

Because of the presence of a very long phallus with a long, dark, internal tubule and a short, ventrolateral hook, this species appears to be most similar to *M. neotropicalis* Schmid and *M. patagonica* (Flint). However, *M. madre* can be distinguished from those species by the triangular shape of the inferior appendages in ventral and dorsal view with their toothed posterodorsal margin.

Adult.—Length of forewing, 1.5 mm. Color in alcohol, brown. Male abdomen apparently without any modifications. Ninth segment in lateral aspect almost twice as long as high, the posterior margin arcuate; anterior margin narrowed and slightly produced anteroventrad. Cercus in dorsal view circular, in lateral view thumblike. Dorsolateral hook in dorsal view with subapical angulation, tip angled slightly mesad, in lateral view, apical portion elongate ventrad. Inferior appendage in dorsal view with the apical portion triangular; in lateral view, basodorsal lobe with row of small teeth along posterodorsal margin, ventrally produced in a pointed, triangular lobe. Phallus with a long, dark, internal tubule: apical portion tapering, with a small, dark, hook ventrobasally.

Material.—Holotype, ♂. PERU: Madre de Dios: Manu, Pakitza, 12°7′S, 70°58′W, 250 m, 14–23 September 1988, O. Flint & N. Adams, Trail 2, 1st Stream, Malaise trap, day & night collection (NMNH).

Etymology.—*madre*: Spanish word for mother, also recalling the name of the Province, Madre de Dios.

Metrichia adamsae Flint and Bueno, new species

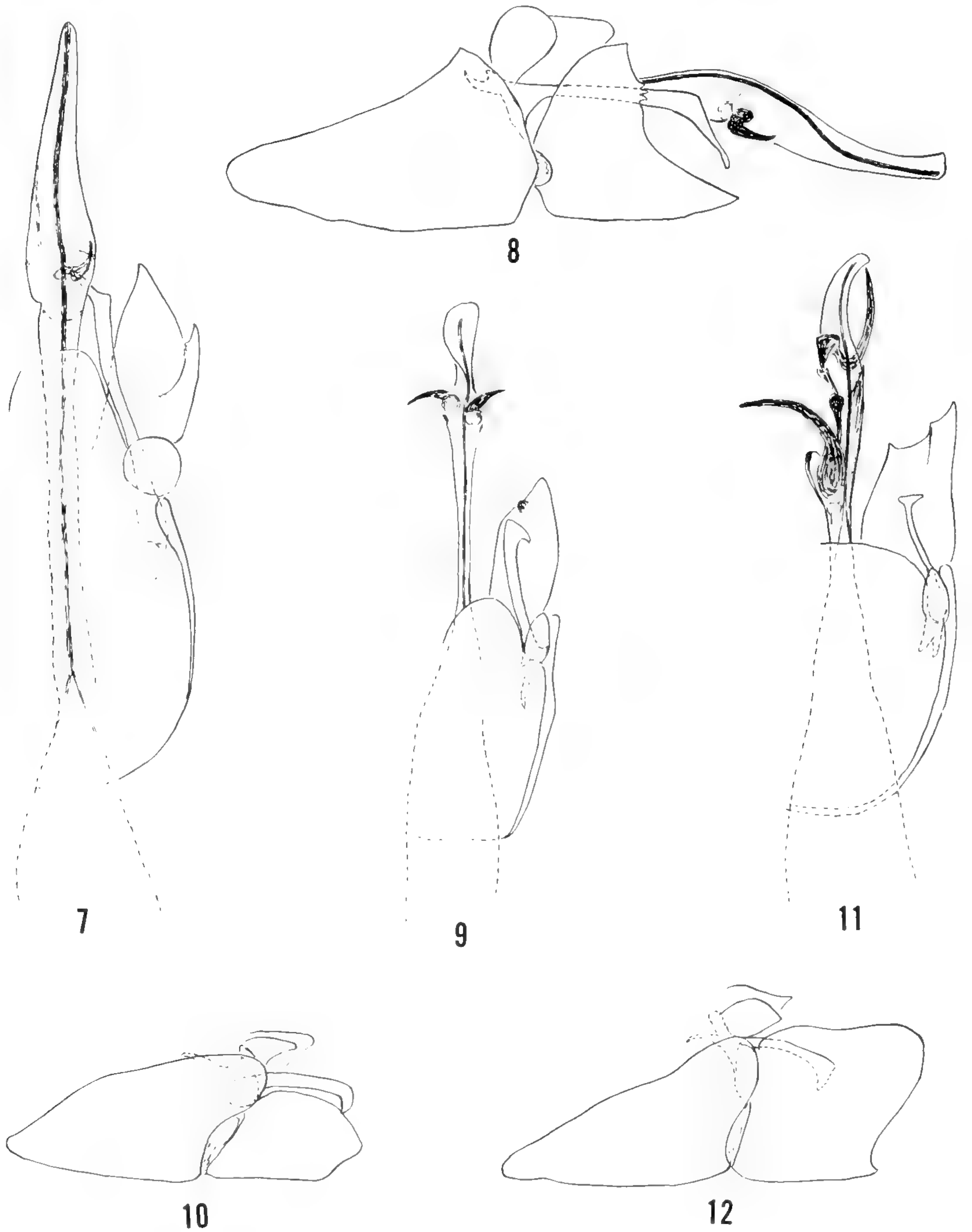
(Figs. 9, 10)

Ochrotrichia (*M.*) n. sp. 5, Flint 1996b: 399.

This species appears virtually identical in genitalia to *M. malada* (Flint), known from Colombia and Peru. It differs from that species in that the ninth segment is not quite twice as long as high, rather than three times as long, and in apparently lacking all modifications of the abdomen. The abdomen of the unique specimen of *M. adamsae* is not well cleared, thus obscuring any smaller or fainter structures, but nevertheless it seems to lack the many abdominal modifications of *M. malada*.

Adult.—Length of forewing, 2 mm. Color in alcohol, brown. Male antenna of 18 segments, unmodified. Male abdomen without apparent modifications. Male genitalia: Ninth segment almost twice as long as high in lateral aspect; posterior margin sinuate. Cercus ellipsoid. Tenth tergum lightly sclerotized, hoodlike. Dorsolateral hook in dorsal view long, slender, and almost straight with apex hooked laterad. Inferior appendage in lateral view longer than high, with posterior margin obtusely angled; in dorsal view with a small, dark tooth near the posterior margin. Phallus with two, equal-sized, curved hooks arising at almost same level subapically; internal tubule almost half length of phallus.

Material.—Holotype, ♂. PERU: Madre de Dios: Manu, Pakitza, 12°7′S, 70°58′W, 250 m, 9–14 September 1988, Trail 1, 1st



Figs. 7–12. *Metrichia.* 7, 8, *M. madre.* 7, Male genitalia, dorsal. 8, Same, lateral. 9, 10, *M. adamsae.* 9, Male genitalia, dorsal. 10, Same, lateral. 11, 12, *M. helenae.* 11, Male genitalia, dorsal. 12, Same, lateral.

Stream, O. S. Flint & N. Adams, Malaise trap, day collection (NMNH).

Etymology.—It is our pleasure to name this species after Nancy E. Adams, Specialist for Neuropteroids, who collaborated in the collection of this and other species here described.

Metrichia helenae Flint and Bueno, new species
(Figs. 11, 12)

Ochrotrichia (*M.*) n. sp. 6, Flint 1996b: 400.

This species seems closely related to *M. penicillata* (Flint) based on the overall similarity in shape and structure of the male genitalia. However, *M. helenae*, new species, can be distinguished from that species by the more quadrate shape of the inferior appendage which is not drawn out into an angle at midheight in lateral view. Although both species have lateral hair brushes between the fifth and sixth segments, *M. helenae* lacks the internal sacs of the fifth segment and the other modifications of the male abdomen.

Adult.—Length of forewing, 2 mm. Color in alcohol, brown. Male antenna of 19 segments, unmodified. Male abdomen with large hair brushes dorsolaterally between fifth and sixth segments. Male genitalia: Ninth segment in lateral view twice as long as high, posterior margin sinuate. Cercus leaf-shaped. Tenth tergum lightly sclerotized, small, hoodlike. Dorsolateral hook with apex enlarged, hammer-like, only half as long as inferior appendage; in lateral aspect, with apex hooked ventrad. Inferior appendage in lateral aspect, almost rectangular, apical margin slightly sinuate, with a small apicoventral point; in dorsal aspect mesal face with a small ridge ending in a point on posterior margin at midheight. Phallus with two well-developed, curved spines, origins well separated, apical trough broad and well sclerotized; ejaculatory duct well developed.

Material.—Holotype, ♂. PERU: Madre de Dios: Manu, Pakitza, 11°56′S, 71°18′W, 250 m, kitchen stream, 12–18 September 1989, N. Adams et al., Malaise trap, night collection. NMNH.

Etymology.—We have the pleasure to dedicate this species to the memory of a great lady and hostess, Helen S. Flint.

ACKNOWLEDGMENTS

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A NEW SPECIES OF *PIGRITIA* CLEMENS (LEPIDOPTERA: GELECHIOIDEA: COLEOPHORIDAE) FROM COSTA RICA

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Abstract.—***Pigritia marjoriella*, n. sp.**, is described from localities along the northwestern coast and Cordillero de Guanacaste, Costa Rica. A photograph of the imago and illustrations of wing venation and male and female genitalia are provided.

Key Words: Lepidoptera, Gelechioidea, Blastobasini, *Pigritia*, Guanacaste, Costa Rica

The Blastobasinae are generally small to medium sized, narrow-winged moths, with less than 150 species described worldwide. This number, however, greatly underestimates the species richness of the group, as there are hundreds of undescribed species, especially from the Neotropics, represented in museum collections throughout the world.

Through the efforts of "parataxonomists" associated with Instituto Nacional de Biodiversidad (INBio), Santo Domingo, Costa Rica, a large number of specimens of Costa Rican Blastobasinae has accumulated in recent years. The purpose of this paper is to describe *Pigritia marjoriella*, new species, based upon the material deposited in INBio. This represents the first of several studies by the author devoted to the Blastobasinae of Costa Rica.

Meyrick (1894) was the first to recognize the Blastobasinae as a monophyletic group. Recent studies by Adamski and Brown (1989) and Hodges (in press) have corroborated this notion and have established monophyletic groupings at the generic and familial levels within the Blastobasinae and Gelechioidea, respectively.

Kornerup and Wanscher (1978) is used as a color standard for the description of the adult vestiture. Genitalia were dissected as described by Clarke (1941), except mercurochrome and chlorazol black were used as stains. Pinned specimens and genital preparations were examined with dissecting and compound microscopes. Measurements of wings and genitalia were made using a calibrated ocular micrometer.

Pigritia marjoriella Adamski, new species
(Figs. 1–4)

Diagnosis.—Male with spatulate uncus; gnathos with two rounded dorsal lobes; elongate part of lower portion of valva slightly dilated apically, forming a bifurcate apex; female with microtriciate membrane surrounding ostium, dorsolateral portion of membrane with a slightly sclerotized semicircular depression; seventh sternum darkly pigmented on posterior half, except for a narrow area along median longitudinal axis; corpus bursae with three signa, one hornlike, and an opposable platelike pair.

Description.—*Head*: Vertex and frontoclypeus with mostly grayish-brown scales tipped with pale grayish brown; clypeus paler than vertex; labial palpus diminutive in male, appressed against frontoclypeus, extending to near horizontal midline of

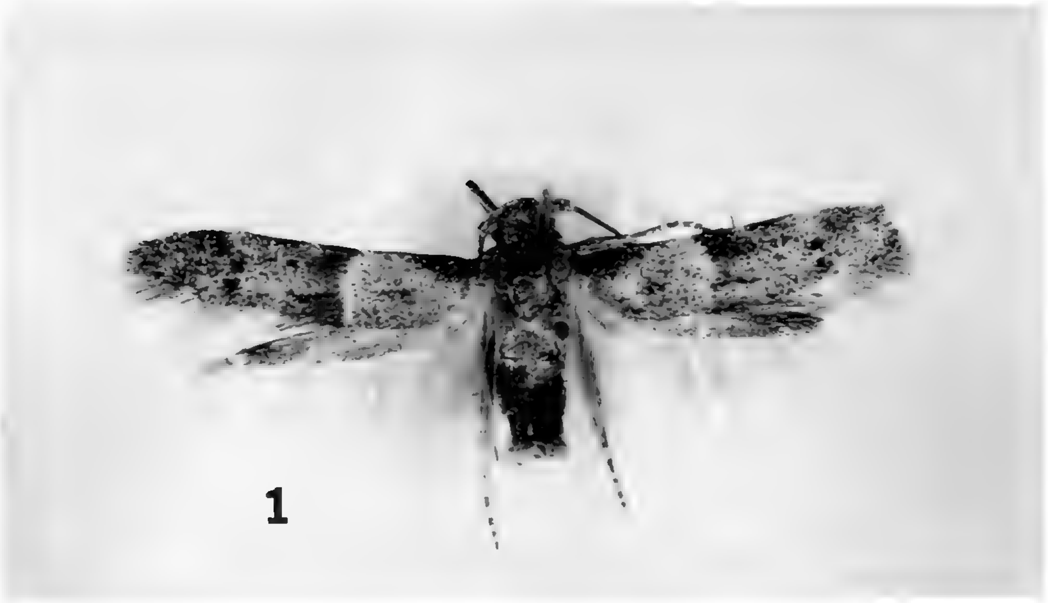

Fig. 1. Holotype of *Pigritia marjoriella*.

frontoclypeus; labial palpus in female nearly porrect, extending to vertex between antennae; outer surface of male labial palpus grayish brown with a few pale grayish-brown scales near apex, inner surface of labial palpus with a longitudinal depression; outer surface of female labial palpus mostly grayish brown intermixed with pale grayish-brown and white scales, apical and subapical areas with pale grayish-brown scales intermixed with white scales; inner surface similarly patterned, but paler; antennal pedicel and scape mostly grayish brown intermixed with pale grayish-brown and white scales, pedicel with mostly white scales aligned adjacent to bases of pecten; flagellum uniformly grayish brown; proboscis mostly white intermixed with few pale grayish-brown scales.

Thorax: Tegula and mesoscutum mostly grayish brown intermixed with pale grayish-brown scales, basal third paler than distal two-thirds; upper surface of legs mostly grayish brown intermixed with pale grayish-brown scales, apical and subapical areas of leg segments and tarsomeres (including midtibial scale tuft on metathoracic leg) pale grayish brown intermixed with white scales; ventral surface of legs white intermixed with few contrasting scales; forewing (Figs. 1, 2), length 5.1–8.0 mm (n = 376), mostly pale grayish-brown and white scales intermixed with grayish-brown scales; median fascia present, incomplete, or absent; median fascia grayish brown; a pair of grayish brown spots near distal margin of discal cell; midcell spot absent (present in many Blastobasinae); inner and outer fringe mostly grayish brown tipped with pale grayish brown, undersurface uniformly grayish brown; venation (Fig. 2) CuA_2 nearly perpendicular to (or slightly angled as CuA_1) cubitus of cell; hindwing with both surfaces uniform pale grayish brown, M_2 and M_3 fused along entire length (Fig. 2).

Abdomen: Upper surface white, sterna mostly white, intermixed with brown scales.

Male genitalia (Fig. 3): Uncus spatulate, apically emarginate; uncus setose on ventral surface, all setae aligned diagonally from midline; gnathos with two rounded apical lobes, slightly sclerotized at base; elongate

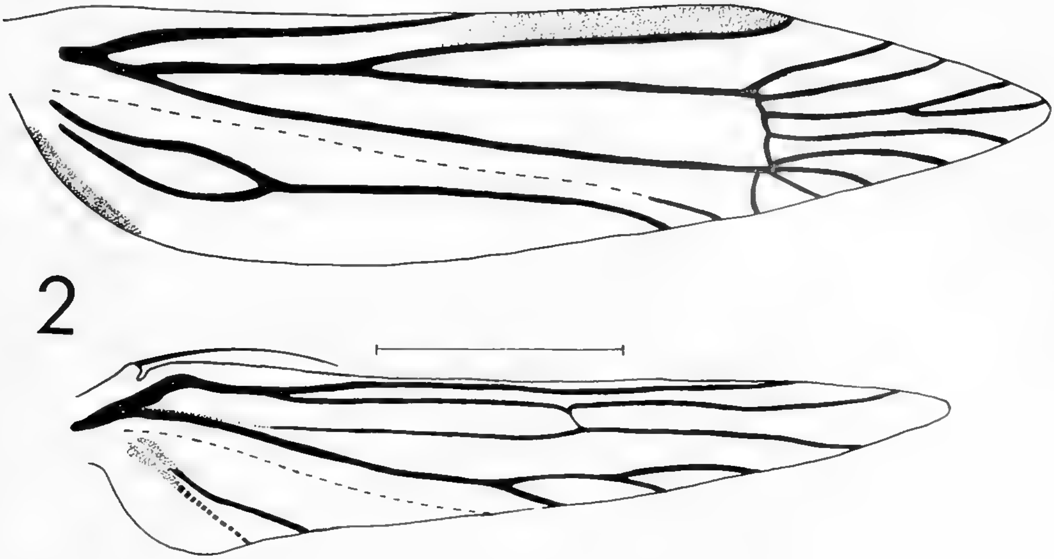

Fig. 2. Wing venation of *Pigritia marjoriella*. Scale line = 1.0 mm.

part of lower portion of valva slightly dilated apically, forming a bifurcate apex; proximal flange elliptical, with dense surface microtrichia, one setal cluster near distal margin and several setae along ventral margin; aedeagus with several stout anellar setae.

Female genitalia (Fig. 4): Ovipositor telescopic, in four membranous divisions posterior to eighth segment; ostium within membranous area posterior to seventh segment; membrane with dense microtrichia, dorsolateral portion of membrane with slightly sclerotized semicircular depression; seventh sternum darkly pigmented on posterior half, except for a narrow area along median longitudinal axis; inception of ductus seminalis proximal to ostium; ductus bursae slightly wider anteriorly than posteriorly, with rows of internal plates anteriorly; corpus bursae with three signa, one hornlike, and an opposable platelike pair.

Holotype.—♂, "Est.[ación] Murciélago, 8 km SO. de Cuajiniquil, P.N. Guanacaste, Prov[incia] Guanacaste, COSTA RICA, 100m. 6–24 Ene 1994, LN 320300–347200, #2557," "COSTA RICA, INBio, CR1001, 817543" [Bar code label]. Holotype not dissected. Deposited in the entomology museum at Instituto Nacional de Biodiversidad, Santo Domingo, Heredia, Costa Rica.

Paratypes.—375 paratypes: 5 ♂, 4 ♀ with the following data, "F[in]ca Jenny 30 km N de Liberia, P.N. Guanacaste, Prov. Guan., COSTA RICA, Mar. 1991. R. Espinosa. L-N-316200, 364400." One dissected male with the following label data, "INBio, Genitalia Slide by D. Adamski, No. 1, Sex: ♂" [yellow label]; 45 ♂, 20 ♀ with the above data, except, "Abr.," two dissected females with the following label data, "INBio, Genitalia Slide by D. Adamski No. 6, Sex: ♀" [yellow label], "INBio, Wing Slide by D. Adamski No. 73, Sex: ♀" [yellow label]; 21 ♂, 5 ♀ with the above data except, "May"; one dissected female with the following label data, "INBio, Genitalia Slide by D. Adamski, No. 5, Sex: ♀" [yellow label]; 60 ♂, 11 ♀ with the following data, except, "Jun," one dissected female with the following label data, "INBio, Genitalia Slide by D. Adamski No. 3, Sex: ♀" [yellow label]; 42 ♂,

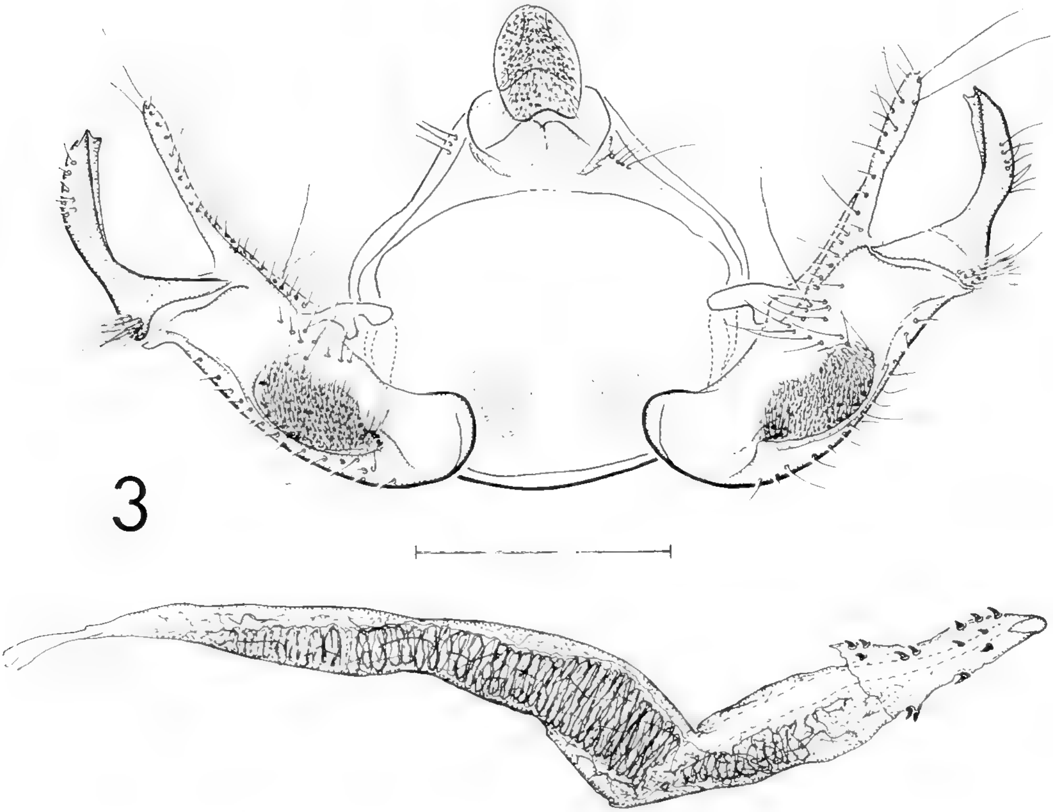

Fig. 3. Male genitalia of *Pigritia marjoriella*. Genital capsule above, aedeagus below. Scale line = 0.5 mm.

8 ♀ with the above data except, "Jul." one dissected female with the following label data, "INBio, Genitalia Slide by D. Adamski No. 4, Sex: ♀" [yellow label]; 24 ♂, 3 ♀ with the above label data except, "Ago."; 13 ♂, 2 ♀ with the following label data, "Finca Jenny, 30 km N de Liberia, P.N. Guanacaste, Prov. Guana., COSTA RICA, LN 316200–364400 #1678"; 2 ♂ with the above data except, "F[in]ca"; 10 ♂, 5 ♀ with the following label data, "Fca. Jenny, 30 km N de Liberia, P.N. Guanacaste, Prov. Guan. COSTA RICA, E. Araya, May 1991, L-N 316200, 364400"; 3 ♂, 1 ♀ with the above label data except, "E. Araya & R. Espinosa," and "Ago 1990"; 11 ♂ with the above label data except, "Set," one dissected male with the following label data, "INBio, Wing Slide by D. Adamski No. 72, Sex: ♂" [yellow label]; 2 ♂ with the above label data except, "Oct"; 2 ♂ with the above label data except, "Finca," "240 m, 6-13 Set., 1994, E. Arayat," "# 3223"; 4 ♂, 2 ♀ with the following label data, "Est. Murciélago, 8 km SO. de Cuajiniquil, P.N. Guanacaste, Prov. Guana., COSTA RICA, 100 m. 6–24 Ene 1994, C. Cano, LN 320300–347200, # 2557"; 2 ♂, 1 ♀ with the above data except, "F. A. Quesada," "# 2556"; 2 ♂ with the above label data except, "9 Feb.," "# 2650"; 1 ♂ with the above label data except, "Mar 1994," "# 2794"; 2 ♂, 1 ♀ with the above label data except, "7-25 Abr.," "C. Cano", "# 2808"; 1 ♂, 1 ♀ with the above label data except, "I. Curso, Microlepidop., Jul 1990"; 2 ♂ with the following

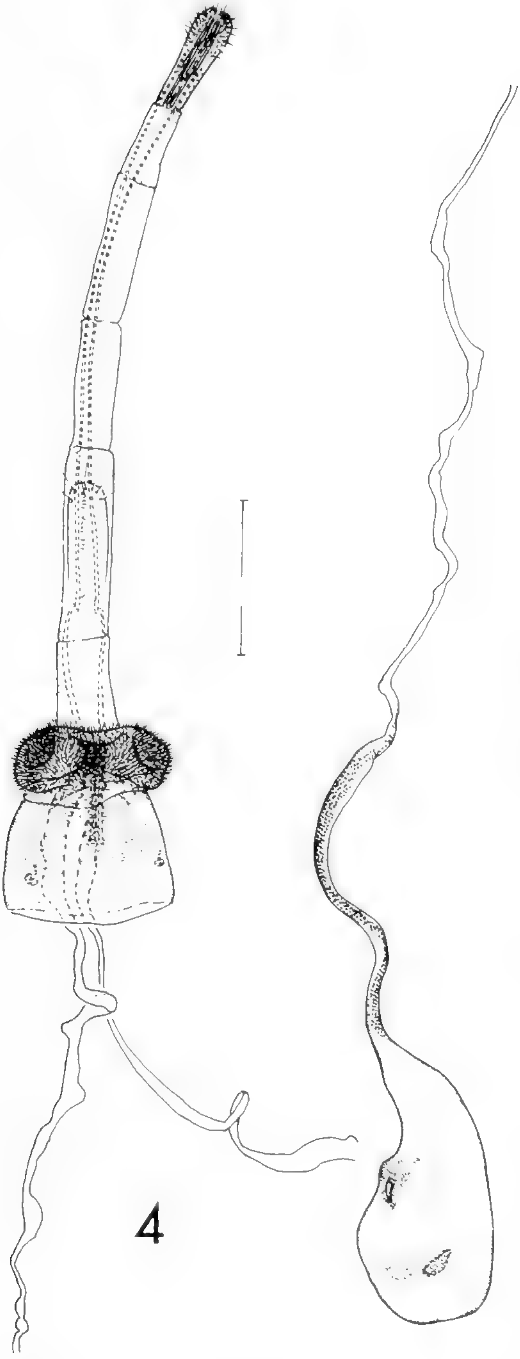

Fig. 4. Female genitalia of *Pigritia marjoriella*. Scale line = 1.0 mm.

data, "Est. Cacao, 1000–1400 m, lado SO Vol. Cacao Prov. Guan. COSTA RICA, C. Chaves, Mar. 1991, L-N 323300, 375700"; 8 ♂ with the above label data except, "Abr."; 1 ♂ with the above data except, "May"; 3 ♂ with the above data except, "C. Cano," "21 a 29 May 1992"; 1 ♂ with the above label data except, "C. Moraga, P. Rios, 21 a 29 May 1992"; 1 ♂ with the above label data except, "K. Taylor, 21 a 29 May, 1992"; 1 ♂ with the above label data except, "21 a 29 May 1992, D. Garcia"; 1 ♂ with the above label data except, "D. Garcia, Jun–Jul 1991"; 1 ♂ with the above data except, "C. Chaves, Jun 1991"; 1 ♂ with the above label data except, "II curso Parataxon., Jun 1990"; 1 ♂ with the above label data except, "C. Chaves, Set 1991"; 2 ♂ with the above label data except, "8–12 Oct 1991"; 8 ♂ with the above label data except, "23 Oct.–9 Nov."; 5 ♂, 1 ♀ with the following label data, "Playa Naranjo, P.N. Sta. Rosa, Prov. Guan. COSTA RICA, E. Alcazar, May 1991, L-N-309300–354200"; 3 ♂ with the following label data, "Cerro El Hacha, 300 m, 12 km SE de La Cruz, Prov. Guanacaste, COSTA RICA, 25 Jun 1992, III curso Parataxon. L-N 329200–368000"; 2 ♂ with the following label data, "Agua Buena, P.N. Guanacaste, Prov. Guana. COSTA RICA, 200 m 7–12 Feb 1994. E. López, L-N 334800–364100, # 2692"; 1 ♀ with the following label data, "Agua Buena, 220 m, P.N. Guanacaste, Prov. Guanacaste, COSTA RICA, Jun 1992, III curso Parataxon. L-N 334800–364100"; 2 ♂ with the following label data, "Vicinity Estac. Murcielago, 8 km SW Cuajiniquil, Guanacaste Prov. COSTA RICA, 100 m Jun 1989, GNP Biodiversity Survey L-N 320300–380200"; 2 ♂ with the following label data, "Est. Sta. Rosa, 300 m, P.N. Sta. Rosa, Prov. Guanacaste, COSTA RICA, 3 a 12 Jun 1992, III curso Parataxon. L-N 313000–359800"; 2 ♂ with the above label data except, "I curso Microlepidop. Jul 1990"; 1 ♂ with the following label data, "Est. Santa Rosa, Prov.

Guana. COSTA RICA, 300 m 25 Feb.–8 Mar. 1995, A. Picado. L-N 313300-359300, # 4546"; 1 ♂ with the following label data, "Est Santa Rosa, Prov. Guana. COSTA RICA, 300 m, 23 Feb.–7 Mar. 1995, F. Alvarado, L-N 313300-359300, # 4574"; 1 ♂ with the following label data, "Est. Las Pallas, P.N. Rincón de la Vieja, Prov. Guana. COSTA RICA, 800 m 21–25 Mar. 1993, D. Gracia, L-N 306300-388600, # 2765"; 1 ♀ with the above label data except, "10–13 Mar. 1994," "# 2767"; 1 ♂ with above label data except, "19 Jun–1 Jul 1993, K. E. Taylor," "# 2200"; 1 ♂ with the above label data except, "24 Nov a 26 ene 1993, J. Sihezar, G. Rodriguez"; 1 ♂ with the above label data except, "9 a 25 Feb. 1993, D. Garcia"; 1 ♂ with the following label data, "Tierras Morenas, Prov. Guana. COSTA RICA, 685 m, Mar. 1994, G. Rodriguez, L-S 283950–424500, # 2762"; 1 ♂ with the following label data, "Est. Maritza, 600 m lado O Vol. Orosi, Prov. Guanacaste, COSTA RICA, M. Ortiz, 27 Feb.–10 Mar. 1992, L-N 326900–373000"; 1 ♂ with the following label data, "Est. Los Almendros, P.N. Guanacaste, Prov. Guana. COSTA RICA, 300 m, 5–10 Abr. 1994, E. López, L-N 334800–369800, # 2830," "INBio, Genitalia Slide by D. Adamski, No. 2, Sex: ♂" [yellow label]. Two paratypes deposited in The Natural History Museum, London, England; ten paratypes in the National Museum of Natural History, Smithsonian Institution, Washington, D.C.; all other paratypes are in Instituto Nacional de Biodiversidad, Santo Domingo, Costa Rica.

Remarks.—*Pigritia marjoriella* probably is most closely related to *P. astuta* Meyrick than to other known species in the genus. Males of *P. astuta* have a more developed proximal flange and a reduced uncus; females of both species share the presence of dense surface microtrichia on the membrane surrounding the ostium. The presence of the spatulate uncus in the male and the trisignate corpus bursae in the female of *P. marjoriella* remains problematical in hypothesing relationships among *Pigritia*. Moreover, *P. marjoriella* is the only blastobasine with a well developed (not reduced) uncus and bifurcate apex of elongate part of lower portion of valva.

Etymology.—This species is named in honor of Marjorie Morales Acosta, whom I met during my first visit to Instituto Nacional de Biodiversidad in Santo Domingo, Costa Rica. She has given me an opportunity to acquire a unique insight into the cultural aspects of a great people.

Discussion.—Adamski and Brown (1989) provided a phylogenetic classification for the North American Blastobasinae that included evidence for the monophyly of *Pigritia* Clemens. Although their evidence was based primarily upon genitalic characters, the strong dimorphism in the size of the labial palpi of *P. marjoriella* is shared with *P. fidella* Dietz from North America. Other *Pigritia* species also exhibit sexual dimorphism in palpal size. Whether this feature evolved independently or is homologous (represents a synapomorphy) for two or more species can only be tested by phylogenetic analysis.

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I thank Mario Camacho, Jessica Zamora Gonzalez, and Eugenie Phillips Rodriguez of the National Biodiversity Inventory Division, Instituto Nacional de Biodiversidad, Santo Domingo, Heredia, Costa Rica, for their help, cooperation, and warm hospitality; K. Sattler, M. Shaffer, and K. Tuck of The Natural History Museum, London, England, for loan of lectotype and paralectotype of *Pigritia astuta* Meyrick; R.W. Hodges, formerly of the Systematic Entomology Laboratory, USDA, for his continued encouragement and support, and Carl Hansen of the Office of Imaging, Printing and Photographic Services for the photograph of the holotype of *Pigritia marjoriella*.

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NOMENCLATURAL CHANGES IN THE PENTATOMOIDEA (HEMIPTERA-HETEROPTERA: PENTATOMIDAE, TESSARATOMIDAE). III. GENERIC LEVEL CHANGES

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Abstract.—Numerous generic level nomenclatural problems in the Pentatomoidea (Heteroptera) are discussed and corrected. These corrections have necessitated twelve generic replacement names: ***Cachanocoris*** for *Sambirania* Cachan 1952; ***Grassatorama*** for *Grassator* Ruckes 1965; ***Jayma*** for *Melanocryptus* Linnavuori 1982; ***Kitsoniocoris*** for *Kitsonia* Gross 1975; ***Nkolbissonicoris*** for *Nkolbissonia* Linnavuori 1982; ***Platistocoris*** for *Platistus* Herrich-Schäffer 1853; ***Qadrianocoris*** for *Qadriana* Ahmad and Rana 1987; ***Ruckesiocoris*** for *Selenochilus* Ruckes 1964; ***Schraderiellus*** for *Schraderia* Ruckes 1959; ***Seansonius*** for *Knightiella* Ahmad and Khan 1980; ***Stevesonius*** for *Phyllocoris* Jeannel 1913; and ***Zhengius*** for *Tibetocoris* Zheng and Liu 1987. Nineteen **new combinations** are recognized: *Cachanocoris obscurus* (Cachan), *Grassatorama nigroventris* (Ruckes), *G. reticulatus* (Ruckes), *G. sinuatus* (Ruckes), *Jayma affinis* (Schouteden), *J. funebris* (Schouteden), *J. porosa* (Stål), *Kitsoniocoris rubrocoriosa* (Gross), *Nkolbissonicoris rubescens* (Linnavuori), *Platistocoris spiniceps* (Herrich-Schäffer), *Qadrianocoris pisheenensis* (Ahmad and Rana), *Ruckesiocoris nitidus* (Ruckes), *Schraderiellus cinctus* (Ruckes), *S. hughesae* (Ruckes), *Seansonius flavifrons* (Distant), *Stevesonius acutus* (Jeannel), *S. jeanneli* (Schouteden), *Zhengius spiniferus* (Zheng and Liu), and *Z. zhangmuensis* (Zhang and Lin). Three **new generic synonyms** also are proposed: *Dichelops (Neodichelops)* Grazia 1978 as a junior synonym of *D. (Diceraeus)* Dallas 1851; *Keriahana* Distant 1918 as a junior synonym of *Neostrachia* Saunders 1877; and *Acanthidiellum* Kirkaldy 1904 as a junior synonym of *Polycarmes* Stål 1867.

Key Words: nomenclature, systematics, Heteroptera, Pentatomidae, Tessaratomidae

While preparing a catalog of the Pentatomidae of the World, I have found many nomenclatural problems. Several of these already have been corrected (Rider and Rolston 1995, Rider 1997). The present paper addresses a number of generic level nomenclatural problems that have been discovered since publication of the above papers.

The problems dealt with in this paper are strictly of a nomenclatural nature. I do not intend to validate the taxonomy involved with the current problems. If current workers are taxonomically correct in their recent papers, then the names should be as proposed herein.

PENTATOMIDAE: DISCOCEPHALINAE

Grassatorama Rider, new name

Grassator Ruckes 1965: 123–125 (junior homonym of *Grassator* de Santis 1948, Hymenoptera)

The generic name *Grassator* was used first by de Santis (1948) for a genus of Hymenoptera. Not realizing this, Ruckes (1965) created a junior homonym when he used *Grassator* to contain three species of discocephaline pentatomids. I propose *Grassatorama* as a replacement name, creating the following **new combinations**: *Grassatorama nigroventris* (Ruckes), *G. reticulatus* (Ruckes), and *G. sinuatus* (Ruckes). *Grassatorama reticulatus* is known from Venezuela; the remaining two species are known only from Costa Rica.

Ruckesiocoris Rider, new name

Selenochilus Ruckes 1964: 129–131 (junior homonym of *Selenochilus* Chaudoir 1878, Coleoptera)

Ruckes (1964) used the name *Selenochilus* for a new discocephaline pentatomid genus, apparently not realizing that the name had been used previously for a genus of Coleoptera (Chaudoir 1878). There are no known junior synonynms, so I propose the replacement name *Ruckesiocoris*. This genus currently is monotypic, thus resulting in one **new combination**, *Ruckesiocoris nitidus* (Ruckes).

Schraderiellus Rider, new name

Schraderia Ruckes 1959: 3–5; Schrader 1960: 505; Rolston 1981: 41; Rolston 1992: 4, 9–10 (junior homonym of *Schraderia* Pfeffer 1888, Crustacea)

Ruckes (1959) apparently was unaware of Pfeffer's 1888 usage of *Schraderia* for a genus of Crustacea. There are no known junior synonyms, so I propose *Schraderiellus* as a replacement name. Acceptance of this replacement name results in two **new combinations,** *S. cinctus* (Ruckes) and *S. hughesae* (Ruckes).

PENTATOMIDAE: PENTATOMINAE

Cachanocoris Rider, new name

Sambirania Cachan 1952: 397, 427 (junior homonym of *Sambirania* Obenberger 1942, Coleoptera: Buprestidae)

Cachan (1952) apparently was unaware that *Sambirania* already had been used for a genus of buprestid beetles (Obenberger 1942) when he used the same name for a pentatomid genus. I propose *Cachanocoris* as a replacement name. The genus currently is monotypic, resulting in one **new combination,** *Cachanocoris obscurus* (Cachan). This species occurs in Madagascar.

Dichelops subgenus *Diceraeus* Dallas, 1851, **revised status**

Diceraeus Dallas 1851: 193, 208.

Dichelops (Neodichelops) Grazia 1978: 14, 63–65. **New synonymy**

The genus *Dichelops* Spinola contained at least two junior synonyms, *Zalega* Amyot and Serville and *Diceraeus* Dallas, when Grazia (1978) published her excellent revision of the genus. She divided the genus into three subgenera, *Neodichelops, Prodichelops*, and the nominate subgenus. *Prodichelops* was, and still is, monotypic, containing only the type species *Dichelops divisus* (Walker). *Neodichelops* contained four species, two of which she described as new (*D. lobatus* and *D. phoenix*). The other two were *Dichelops furcatus* (Fabricius), the type species of *Neodichelops*, and *Dichelops melacanthus* (Dallas), the type species for *Diceraeus*. As such, these two generic level names, as presently perceived, must be synonyms; *Diceraeus* is the older name, and *Neodichelops* becomes a junior synonym. The type species of *Zalega* is *Dichelops furcifrons* Amyot and Serville, a species presently recognized as belonging in the nominate subgenus. The **new combinations** are *Dichelops (Diceraeus) furcatus, D. (D.) lobatus, D. (D.) melacanthus,* and *D. (D.) phoenix.*

Kitsoniocoris Rider, new name

Kitsonia Gross 1975: 144 (junior homonym of *Kitsonia* Eames 1957, Mollusca)

Eames (1957) first used *Kitsonia* for a genus of fossil Mollusca, predating Gross' use of the same name by 18 years. I propose *Kitsoniocoris* as a replacement name, which also will establish one **new combi-**

nation, *Kitsoniocoris rubrocoriosa* (Gross). This species occurs in Australia.

Neostrachia Saunders, 1877, **revised status**

Neostrachia Saunders 1877: 103; Lethierry and Severin 1893: 158; Breddin 1898: 113–114; Bergroth 1901:254–255; Kirkaldy 1909:134.

Keriahana Distant 1918: 143–144; Ahmad et al. 1974: 19; Ahmad 1981: 26; Ahmad and Mohammad 1987: 155–157. **New syonymy.**

Saunders (1877) described *Neostrachia* to contain his new species, *N. hellenica* (the type species by monotypy), a species that later (Leston 1955) was determined to be a junior synonym of *Rhaphigaster bisignatus* Walker. Puton (1899) and, more recently, Leston (1955) considered *Neostrachia* to be a junior synonym of *Apines* Dallas. Several other workers (Breddin 1898; Bergroth 1901, 1914), however, considered *Neostrachia* either to be closely related to or synonymous with *Menida* Motschulsky.

Similarly, Distant (1918) described *Keriahana* for his previously described species *Menida elongata* (type species by original designation), a binomen that became a secondary junior homonym when *Rhaphigaster elongatus* Signoret was placed as a junior synonym of *Menida maculiventris* (Dallas). This case of secondary homonymy was recognized by Bergroth (1919) who proposed *Menida oblonga* as a replacement name. Most recent workers have followed Bergroth (1923) in considering *Keriahana* as a junior synonym of *Menida*. Ahmad and his colleagues, however, recently have resurrected the use of *Keriahana* and have placed in it *elongata* (= *oblonga*), *bisignata,* and a new species *islamabadensis* Ahmad and Mohammad. If these three species represent a genus distinct from both *Apines* and *Menida,* the valid name should be *Neostrachia.* This grouping contains the type species for both *Keriahana* and *Neostrachia,* with the latter having priority. The two type species are obviously closely related as Leston (1955) considered *elongata* to be a junior synonym of *bisignata.*

The actual relationship among the genera included within the Menidini is in desperate need of study. *Menida,* itself, is large and diverse and may eventually be split into a number of different genera once a thorough revision is completed.

Nkolbissonicoris **Rider, new name**

Nkolbissonia Linnavuori 1982: 123, 133 (junior homonym of *Nkolbissonia* Dajoz 1978, Coleoptera)

Dajoz's (1978) usage of *Nkolbissonia* for a genus of Cerylonidae (Coleoptera) occurred four years prior to Linnavuori's (1982) proposed usage of the same name for a single new species of Pentatomidae. I propose *Nkolbissonicoris* as a replacement name which will result in one **new combination,** *N. rubescens* (Linnavuori). This species occurs in Cameroon, Africa.

Platistocoris **Rider, new name**

Platistus Herrich-Schäffer 1853: 167; Kirkaldy 1909: 238; Rider 1993: 417–418 (junior homonym of *Platistus* Rafinesque-Schmaltz 1815, Pisces)

In 1815, Rafinesque proposed the generic name *Platistus* as a replacement name for *Platystacus* Bloch, a genus in the Pisces. Amyot (1845) first used *Platistus* for a genus of Pentatomidae, but this work has been placed on the Official List of Rejected Works because it is largely mononomial. Herrich-Schäffer (1853), following Amyot, first used *Platistus* in a binomial sense when he listed it in the index to his Wanzenartigen Insecten for a species he originally described as *Aelia spiniceps* (see Rider 1993 for more detailed history). Both Amyot (1845) and Herrich-Schäffer (1853) apparently were unaware of Rafinesque-Schmaltz's prior usage of the name. No known synonyms are available, so I propose *Platistocoris* as a replacement name.

This will create one **new combination,** *Platistocoris spiniceps* (Herrich-Schäffer).

Polycarmes Stål, 1867

Acanthidies Montrouzier 1855: 95 (primary junior homonym of *Acanthidium* Lowe 1839, Pisces, as emended in 1858; as barren division of *Pentatoma*)

Acanthidium Montrouzier 1858: 251–253 (emendation; genus not described; 3 spp., *cinctum, armigerum, punctatissima* described; *A. foetidum* only mentioned)

Polycarmes Stål 1867: 509; Stål 1876: 37, 44; Lethierry and Severin 1893: 100; Kirkaldy 1909: 195.

Acanthidiellum Kirkaldy 1904: 280 (new name for *Acanthidium* Montrouzier 1855). **New synonymy.**

Acanthidium (as *Acanthidies*) was proposed by Montrouzier (1855) as a subgenus of *Pentatoma* Olivier. Originally, Montrouzier described eight new species and one new variety in *Pentatoma,* but he did not assign any of these taxa to subgenera. This formally left *Acanthidium* without any included species until 1858 when Montrouzier described *A. armigerum, A. cinctum,* and *A. punctatissimus. Acanthidium* Montrouzier, 1858, is, however, a primary junior homonym (in the emended form) of the fish genus *Acanthidium* Lowe, 1839. Kirkaldy (1904) proposed *Acanthidiellum* as a replacement name. The species, *A. foetidum,* is only mentioned in this paper and was not described until 1861 when Signoret described "*Spudaeus foetidum* (Mihi)." That form of presentation (with mihi in parentheses) seems to indicate that Signoret recognized the species previously had not been described, but he recognized that it previously had been assigned to another genus. Kirkaldy (1909), in the text and in a footnote, designated "*foetidum*" the type species of *Acanthidium* Montrouzier, 1858, but this is incorrect as *foetidum* was not an included valid (was undescribed) species.

Acanthidium cinctum was moved (Stål 1872) to the Asopinae, but its proper placement was not known until Schouteden (1907) placed it as a junior synonym of *Andrallus spinidens* (Fabricius). Stål (1867) erected the genus *Polycarmes* and designated *Acanthidium punctatissimus* as type species. *Acanthidium armigerum* was considered *incertae sedis* by both Stål (1876) and Lethierry and Severin (1893); Kirkaldy (1909) tentatively placed it in *Polycarmes,* but Horváth (1915) stated that it was probably allied to the rhynchocorine genus *Vitellus* Stål.

Designation of *Acanthidium cinctum* as type species would displace the well-known and often used generic name *Andrallus* Bergroth. Designation of either *A. armigerum* or *A. punctatissimus* as type species would allow for the continued use of *Polycarmes* because it is nearly 40 years older than Kirkaldy's replacement name. Because the identity of *A. armigerum* is somewhat tentative, while the identity of *A. punctatissimus* is better known, I select *A. punctatissimus* as type species for *Acanthidium,* thus making *Polycarmes* and *Acanthidiellum* objective synonyms.

Qadrianocoris Rider, new name

Qadriana Ahmad 1981: 21, 51 (not described); Ahmad and Rana 1987: 355–356 (junior homonym of *Qadriana* Bilqees 1971, Vermes)

Ahmad (1981) provided a key to the pentatomid genera occurring in Pakistan. *Qadriana* was included in the key (p. 21) and was later (p. 51) listed along with its only included species. In both places, the generic name was followed by "(MS)" indicating that Ahmad considered this to be only a manuscript name that would be properly described later. *Qadriana* was described formally in 1987 by Ahmad and Rana. At any rate, they apparently were not aware that *Qadriana* had already been used (Bilqees 1971) for a genus of trematodes. I propose *Qadrianocoris* as a replacement name. This results in a single **new combination,** *Q. pisheenensis* (Ahmad and Rana). This species occurs in Pakistan.

Seansonius **Rider, new name**

Knightiella Ahmad and Khan 1980: 85–86 (junior homonym of *Knightiella* Carvalho and Drake 1943, Heteroptera: Miridae)

Ahmad and Khan (1980) apparently were unaware of the earlier usage (Carvalho and Drake 1943) of the generic name *Knightiella* when they proposed this name for the single species *Stenozygum flavifrons* Distant. I herein solve this case of homonymy by proposing *Seansonius* as a replacement name. This creates a single **new combination,** *Seansonius flavifrons,* for this New Caledonian species.

Zhengius **Rider, new name**

Tibetocoris Zheng and Liu 1987: 288, 294 (junior homonym of *Tibetocoris* Hutchinson 1934, Miridae)

Zheng and Liu (1987) overlooked Hutchinson's 1934 usage of the generic name *Tibetocoris* in the heteropteran family Miridae when they described *Tibetocoris* as a new genus of Pentatomidae. There are no known junior synonyms; I propose *Zhengius* as a replacement name, thus, resulting in two **new combinations,** *Zhengius spiniferus* (Zheng and Liu) and *Z. zhangmuensis* (Zhang and Lin).

PENTATOMIDAE: PHYLLOCEPHALINAE

Jayma **Rider, new name**

Melanocryptus Linnavuori 1982: 20, 33 (junior homonym of *Melanocryptus* Cameron 1902, Hymenoptera)

Linnavuori's (1982) usage of the generic name *Melanocryptus* is preoccupied by the hymenopteran genus *Melanocryptus* Cameron, 1902. There is no available junior synonym, so I propose *Jayma* as a replacement name. *Jayma* currently contains three species: *J. affinis* (Schouteden), **new combination;** *J. funebris* (Schouteden), **new combination;** and *J. porosa* (Stål), **new combination.**

TESSARATOMIDAE: NATALICOLINAE

Stevesonius **Rider, new name**

Phyllocoris Jeannel 1913:109–110; Kumar 1974:676; Rolston et al. 1994:42 (junior homonym of *Phyllocoris* Costa 1847, Anthocoridae)

Costa (1847) described *Phyllocoris* as a new genus in the hemipteran family Anthocoridae. Jeannel (1913) created a junior homonym by describing *Phyllocoris* as a new genus in the pentatomoid family Tessaratomidae. There are no known junior synonyms, so I propose *Stevesonius* as a replacement name. This genus presently contains two species, both now **new combinations,** *Stevesonius acutus* (Jeannel) and *S. jeanneli* (Schouteden).

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IMMATURE LIFE STAGE DESCRIPTIONS AND DISTRIBUTION OF *CULOPTILA CANTHA* (ROSS) (TRICHOPTERA: GLOSSOSOMATIDAE)

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Abstract.—The eggs, larvae of all instars, larval cases, and pupae of *Culoptila cantha* (Ross) are described for the first time. The distribution of the species is provided.

Key Words: *Culoptila*, Glossosomatidae, Trichoptera, eggs, larvae, pupae, cases, descriptions, distribution

The primarily Neotropical glossosomatid genus *Culoptila* Mosely contains 17 species from the new world (Morse, in prep.) including four from the United States: *C. cantha* (Ross), *C. thoracica* (Ross), *C. kimminsi* Denning, and *C. moselyi* Denning. All four are found in the Southwest, and *C. cantha* and *C. thoracica* are also recorded from the East (Flint 1974).

Wiggins (1977, 1996a) provided the only illustration of a *Culoptila* larva, *C. moselyi*, and indicated that its cases are composed of small uniform rock fragments with partial silk collars on the periphery. There have been no reported correlations or descriptions of the larvae or cases of the other three North American species, or of any *Culoptila* pupa.

Materials and Methods

Specimens of *C. cantha* came primarily from a large riffle of the Brazos River located approximately 35 km below Morris Sheppard Dam in Palo Pinto County, Texas, and were collected from January, 1995, to March, 1997. A recent description of this site can be found in Houghton and Stewart (1998a). Additional specimens were examined from the Illinois Natural History Survey, Champaign, IL (INHS); Montana Entomology Collection, Bozeman, MT (MTEC); and the National Museum of Natural History, Smithsonian Institution, Washington, D.C. (USNM). Literature records, and databases from the California Academy of Sciences (CAS), Clemson University Arthropod Collection (CUAC), INHS, MTEC, Royal Ontario Museum (ROM), USNM, the University of Minnesota Insect Collection (UMSP), and the University of North Texas Insect Collection (UNT) were searched for the distribution of *C. cantha*.

Larvae and pupae were collected from rocks using soft-touch forceps and with a two-stage dip net with mesh sizes of 1.00 and 0.15 mm. Measurements for determination of larval instars were made with an Olympus Cue-2 Image Analyzer attached to an Olympus dissecting microscope. The length of the head capsule was measured from the anterior margin of the frons to the posterior margin of the coronal suture, and was plotted against the length of the prothoracic mid-dorsal ecdysal suture to determine instar size range and number (Daly

1985). Larval illustrations were based on these measurements. Larvae and pupae were reared in an aerated 20 L aquarium with a MaxiFlow MJ500 power head providing current within an Environmental Growth Chamber to associate the life stages using the metamorphotype method (Milne 1938), and to obtain adults.

Larvae, pupae, and cases of *C. cantha* were studied and illustrated using a drawing tube attached to a Wild M2A dissecting microscope and slide mounts of specimens viewed under an Olympus CH2 compound microscope. Individuals were prepared for illustration by soaking overnight in 10% KOH and by blowing out any degraded viscera with an abdominal EtOH injection (Moulton and Stewart 1996). Voucher specimens of all life stages have been deposited in the UNT and the USNM.

Culoptila cantha (Ross)

Protoptila cantha Ross 1938: 113.
Culoptila cantha: Schmid 1982: 24.

Type locality.—Wyoming: Carbon Co (= Parco), North Platt R.

Nearctic distribution (Fig. 1). —UNITED STATES: ARIZONA: Maricopa Co: Sycamore Cr. (ROM); Coconino Co: nr. Flagstaff, Oak Cr. (INHS); Mohave Co. nr. Hackberry (USNM); Pinal Co: nr. Superor (INHS); Yavapi Co: Clear Cr. (USNM), Beaver Cr., Beaverhead Sp., Fossil Cr., Hassayampa R., Josephine Tunnel Sp., Oak Cr., Page Sp., Sycamore Cr., Red Tank Dr., Verde R. (INHS); COLORADO: Archulata Co: Piedra R. (ROM); Jackson Co (Ruiter 1990); Mesa Co: Colorado R. (Herrmann et al. 1986, USNM); Moffat Co: Yampa R. (Herrmann et al. 1986, USNM); IDAHO: Canyon Co: Boise R. (Ross 1938); Franklin Co: Bear R. (CAS); MARYLAND: Montgomery Co: Plummer's Island (Ross 1938); MAINE: Aroostook Co: Black R. (USNM), nr. Ashland (CAS); Franklin Co: Carrabassett R. (Blickle and Morse 1966); MONTANA: Gallatin Co: Madison R. (CAS, USNM); Madison Co: Madison R. (MTEC); NEW MEXICO: Catron Co: nr. Glenwood, Whitewater Cr. (INHS); Taos Co: Rio Grande R. (USNM); OKLAHOMA: Marshall Co: nr. L. Texoma (INHS); PENNSYLVANIA: Bradford Co: Susquehanna R. (INHS); SOUTH DAKOTA: Custer Co: Hot Springs Cr. (CAS); TEXAS: Bell Co (S. R. Moulton II, personal communication); Blanco Co: Pedernales R. (INHS); Brewster Co (S. R. Moulton II, personal communication); Cooke Co: Williams Cr. (K. D. Alexander, personal communication); Denton Co: Hickory Cr. (UNT); Kimble Co: S. Llano R. (S. R. Moulton II, personal communication); Medina Co: Medina R. (USNM); Palo Pinto Co: Brazos R. (Moulton et al. 1993); UTAH: Summit Co: (R. W. Baumann, personal communication); Washington Co: Mill Cr. (CAS); Uintah Co: Green River (ROM); WYOMING: Carbon Co (= Parco): N. Platte R. (Ross 1938); Converse Co: N. Platte R. (Ruiter and Lavigne 1985); Natrona Co: N. Platte R. (Ruiter and Lavigne 1985); Platte Co: N. Platte R. (Ruiter and Lavigne 1985), Bluegrass R. (CAS); Teton Co: Yellowstone National Pk. (Schmid 1982, CAS). CANADA: NEW BRUNSWICK: nr. Fredricton (CAS); St. Croix R. (Peterson and van Eeckhaute 1990); SASKATCHEWAN: S. Saskatchewan R. (Schmid 1982).

Pupa (Fig. 2).—Male and female pupae 2.5–3.0 and 4.0–5.5 mm, respectively, in body length. Mandible with large preapicomesal tooth and many smaller, basomesal teeth; two setae laterally near base. Two setae below each eye and near each mandibular base. Labrum dome-shaped; three setae arising basally on each side. Pair of anteromesal hook plates on segments III–VIII, segment IV with additional pair of posteromesal hook plates. All anterior hook plates similar in structure except hook plates on segment III each with 5–6 denticles, all others with 7–10 denticles. Posterior hook plates on segment IV wider, each with 12–16 denticles. Abdomen without setae, setal fringes, or anal processes.

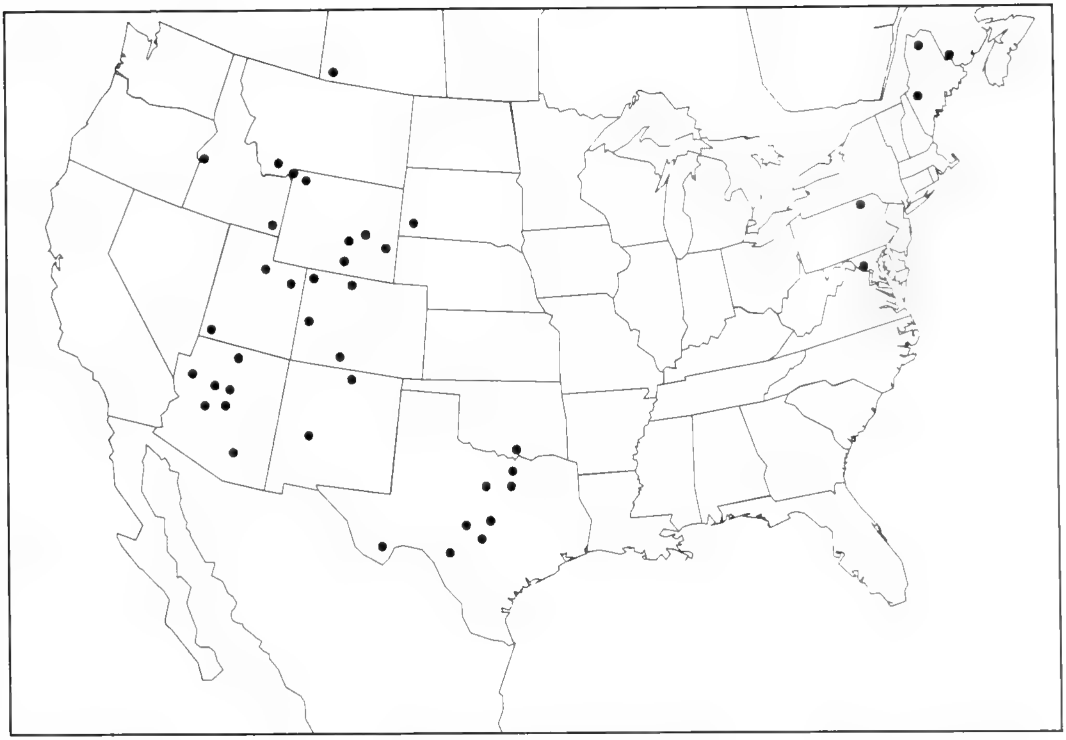

Fig. 1. Nearctic distribution of *Culoptila cantha*. Each dot represents the county and approximate location of a listed record.

Larva.—Five instars; relative sizes indicated by scale on Figs. 3, 4 (see Houghton and Stewart 1998a for precise size ranges). First and second instars obtained only in fine mesh of two-stage dip net and not within cases.

Instar I (Fig. 3A): Setae, legs, and anal prolegs long compared to major body segments. Head and thorax disproportionally larger than abdomen. Meso- and metanota unsclerotized. Tarsal claws without setae. Anal claws similar to those of later instars.

Instars II—IV (Figs. 3B–D): Exhibiting general *Culoptila* characteristics (Wiggins 1996a). Morphological changes largely matter of proportion in successive instars; legs, anal prolegs, and setae decreasing in size relative to body segments, abdomen increasing in size relative to head and thorax, and sclerites and pigment patterns becoming more evident.

Instar V (Fig. 4): Typical of Protoptilinae (Wiggins 1996a), 2.5–3.0 mm in body length, with retractable anal papillae. Live color pale red with black sclerites; cream color with brown sclerites when preserved in EtOH. Two types of thoracic setae present: slender, darkly-pigmented typical setae, and very slender, translucent setae. (Translucent setae and attachment points best viewed on slide mount of cleared specimen under compound microscope.) Live late fifth stadium prepupae darker red in color, less active than earlier fifth stadium, and with shortened, thickened abdomen.

Head (Figs. 4A–C): Dark brown with lighter dorsum and ocular areas. Frontoclypeus with shallow and broad anteromesal notch; three setae arising from each tentorial region. Scattered setae of various lengths around each eye. Three setae arising from each side of anterior margin of labrum. Many short setae on dorsal surface of labium. Venter of head capsule brown

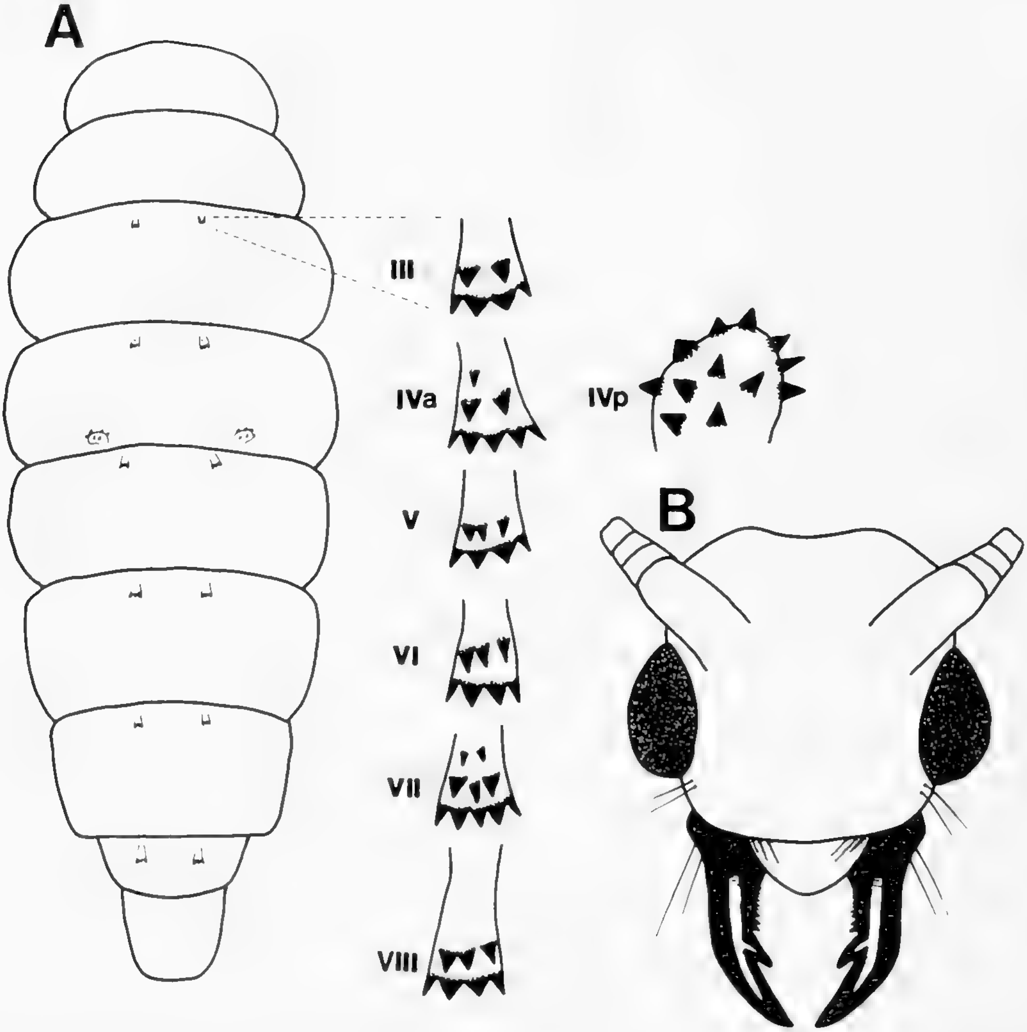

Fig. 2. *Culoptila cantha*, pupa. A, Abdomen with magnified detail of hook plates of each segment (dorsal). B, Head capsule with mandibles, antennal bases, and setal arrangement (antero-dorsal). III–VIII = hook plates of respective abdomenal tergum; a = anterior; p = posterior.

with two longer than broad triangular mental sclerites, each bearing single seta.

Thorax (Figs. 4A, C): Pronotum heavily sclerotized, dark brown, with anterior one-third markedly lighter than posterior two-thirds. Posterior often, but not always, with 2–6 light spots. Midlateral regions each with darkened area. Four and two setae arising from each anterolateral and midlateral region, respectively. One typical and one translucent setae arrising from posterolateral region. Two typical setae and one translucent seta on either side of mid-dorsal ecdysial suture on posterior one-third of pronotum. Mesonotum largely membranous, with one large mesal and two smaller lateral sclerites; sclerites lightly sclerotized and fading over time in EtOH causing inconsistent determination of shape among individuals. Mesal sclerite longer than wide, sinuosly bi-emarginate anteriorly, and evenly rounded posteriorly. Lateral sclerites sub-triangular, each with posteromesal notch. SA1 each with one typical and one translucent seta. SA2 setae absent. SA3 each with single typical seta. Metanotum largely membranous with pair of sub-triangular lateral sclerites. SA1 each with single translucent seta. SA2 and SA3 each with single typical seta. Foretrochantin hook-like, bearing two setae. Meso- and metathoracic episternal sclerites each with single seta. Legs similar in length and shape with major setae on all leg segments except trochanters. Apicoventral margin of each tibia with stout spur. Tarsal claws similar and typical of genus (Wiggins 1996a), each with stout basal seta much shorter than claw and basal process shorter than adjacent basal seta.

Abdomen (Fig. 4A): Shape typical of family (Wiggins 1996a). Segments I–V with one pair of dorsal, ventral, and lateral setae. Segments VI and VII each with one pair of dorsal and lateral setae. Segment VIII with two pairs of dorsal setae, two pairs of lateral setae, and one pair of ventral setae. Tergite IX with two pairs of setae arising laterally and medially. Lateral sclerites appearing fused to ventral sole plates, each bearing four setae. Anal claws with three hooks and two short setae.

Case.—Third through fifth instar larvae found in typical glossosomatid saddle-cases composed of small inorganic particles. Cases without the peripheral silk collars found on *Culoptila moselyi* cases (Wiggins 1996a) (Figs. 5A, B). Case lengths (n = 15 each) of third, fourth and fifth instars 2.0–2.5 mm, 2.5–3.0 mm and 3.5–4.5 mm, respectively; approximate particle sizes 0.1–0.50 mm, 0.25–1.0 mm and 0.5–2.0 mm, respectively. All larval cases of similar shape; some with approximately uniform particles (Type I) (Fig. 5A), and others with one or two larger side stones (Type II) (Fig. 5B).

Egg.—Obtained from live females, bright orange; 0.2 mm in diameter. Gravid females with three to six spherical masses with 15–20 eggs in each mass. Each egg mass enclosed in gelatinous covering. Soft and amorphic, without a distinct chorion.

DISCUSSION

Larva.—We were unsuccessful in incubating eggs obtained from live *C. cantha* females. Therefore, first instars were not positively correlated by rearing. Presumed first instars were obtained only in the fine mesh of the two-stage dip net samples. They were abundant following peak *C. cantha* emergence and before the appearance of later instars, and they formed a distinctive size class (Fig. 3). They displayed the glossosomatid characteristics of largely membranous meso- and metanota, a tergal sclerite on segment IX, a single metanotal SA3 seta, and anal prolegs broadly joined to the abdomen. The only other glossosomatid known to occur at this site, *Protoptila alexanderi* Ross, appears to be univoltine with late instar larvae occurring only in July (Houghton and Stewart 1998b).

First and second instar larvae of *C. cantha* were never found in cases. Two possible explanations for this are: (1) first and second instars are free-living or (2) the kick-netting procedure may have destroyed all early instar cases or caused the larvae to vacate them. It is not probable that kick-netting would have demolished all small cases if they had been present, and no crushed early instar larvae were found in crushed cases. Anderson and Bourne (1974) found that *Agapetus bifidus* Denning constructed cases as first instars.

Third through fifth instars key to *Culoptila* using Wiggins (1996a). It appears that Wiggins' (1977, 1996a) character of "tarsal claws with basal seta stout, larger than process at base of claw" is diagnostic for the United States species. *Culoptila cantha* differs from Wiggins' (1977, 1996a) description of *C. moselyi* mainly in the placement of pronotal setae.

Pupa.—Both male and female pupae key to Glossosomatidae using Wiggins (1996b) although the final couplet: "Segments VIII and/or IX with pair of *small* hook plates . . ." (emphasis ours) is slightly misleading. The hook plates of *C. cantha* on segment

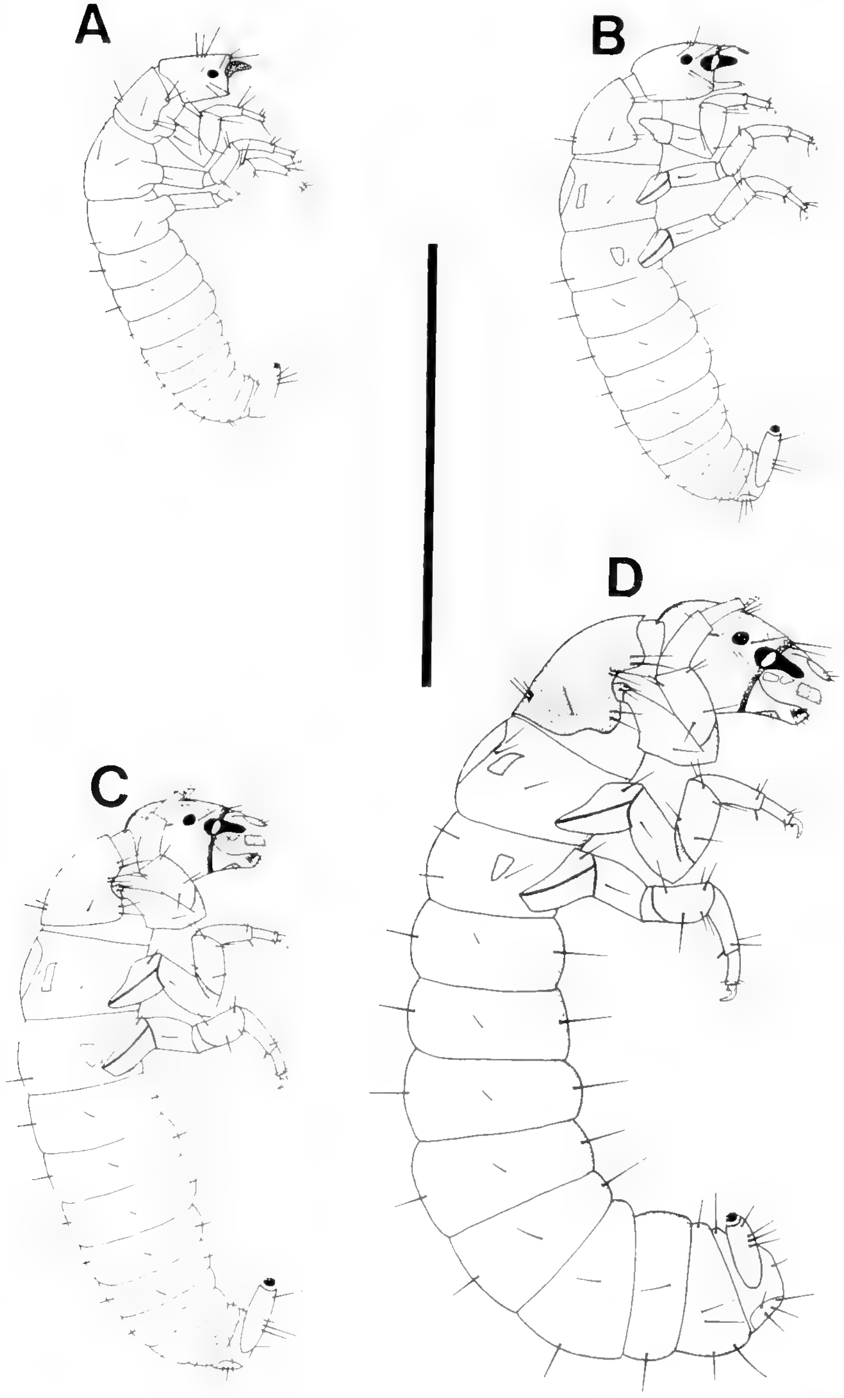

Fig. 3. Instars I–IV of *Culoptila cantha*: relative habitus size based on mean prothoracic length. A, First instar. B, Second instar. C, Third instar. D, Fourth instar. Scale bar = 1 mm.

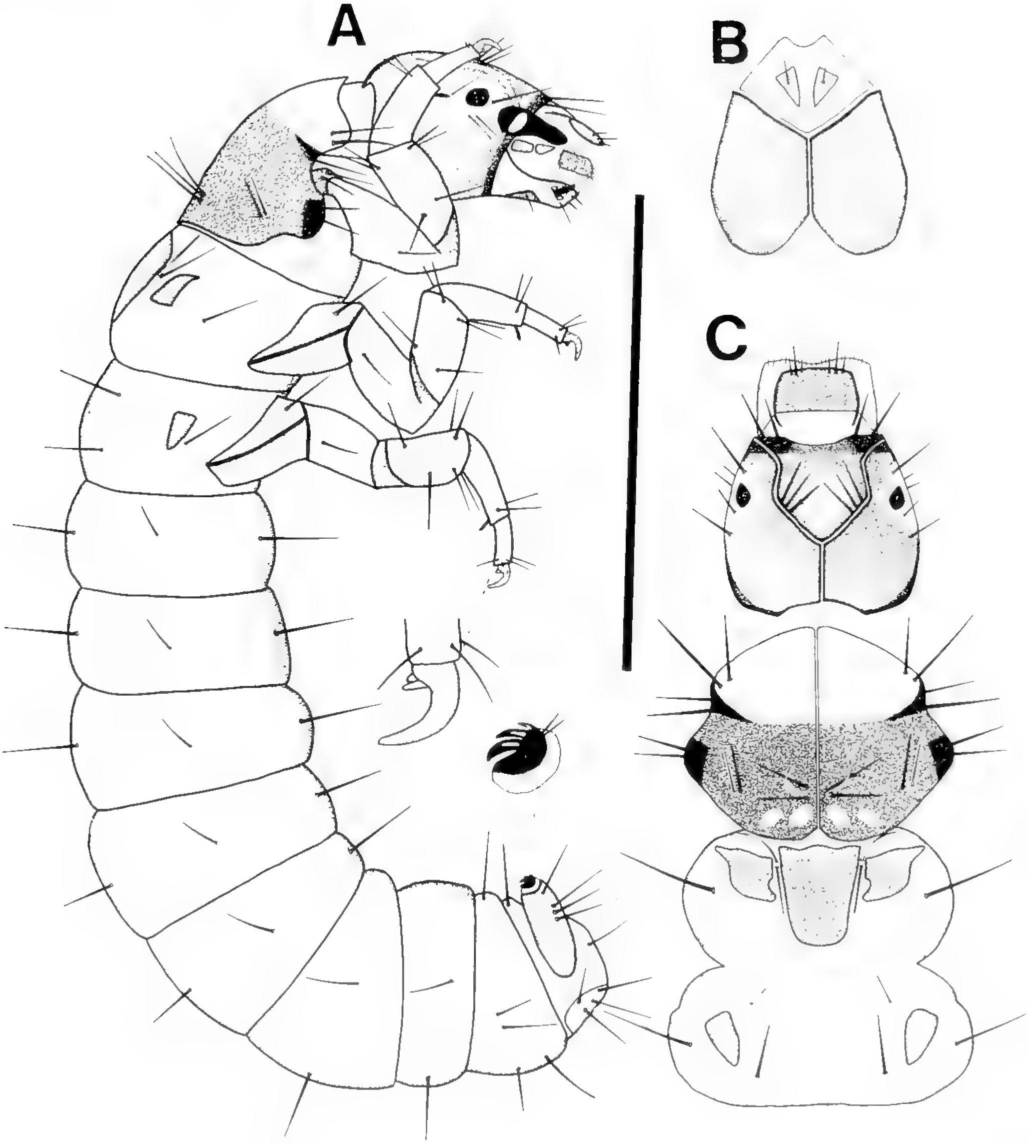

Fig. 4. *Culoptila cantha*, fifth instar; relative size based on mean prothoracic length. A, Habitus, with detail of mesothoracic claw and anal prolegs. B, Head capsule (ventral). C, Head and thorax (dorsal). Scale bar = 1 mm.

VIII are slightly longer than those of the preceeding segments and it does not have a pair on segment IX. The abdomen of *C. cantha* differs from previous glossosomatid pupal descriptions (Wiggins 1996b, Craft and Morse 1997) in that it lacks setae.

The pupa of *C. cantha* also differs in the finer details from previous descriptions within its subfamily Protoptilinae. It differs from Edwards and Arnold's (1961) description of *Protoptila arca* Edwards and Arnolds in having a pair of setae near each mandibular base, and from Ross' (1944) description of *Protoptila lega* Ross in having many basomesal teeth notably smaller than the preapicomesal tooth and in its preapi-

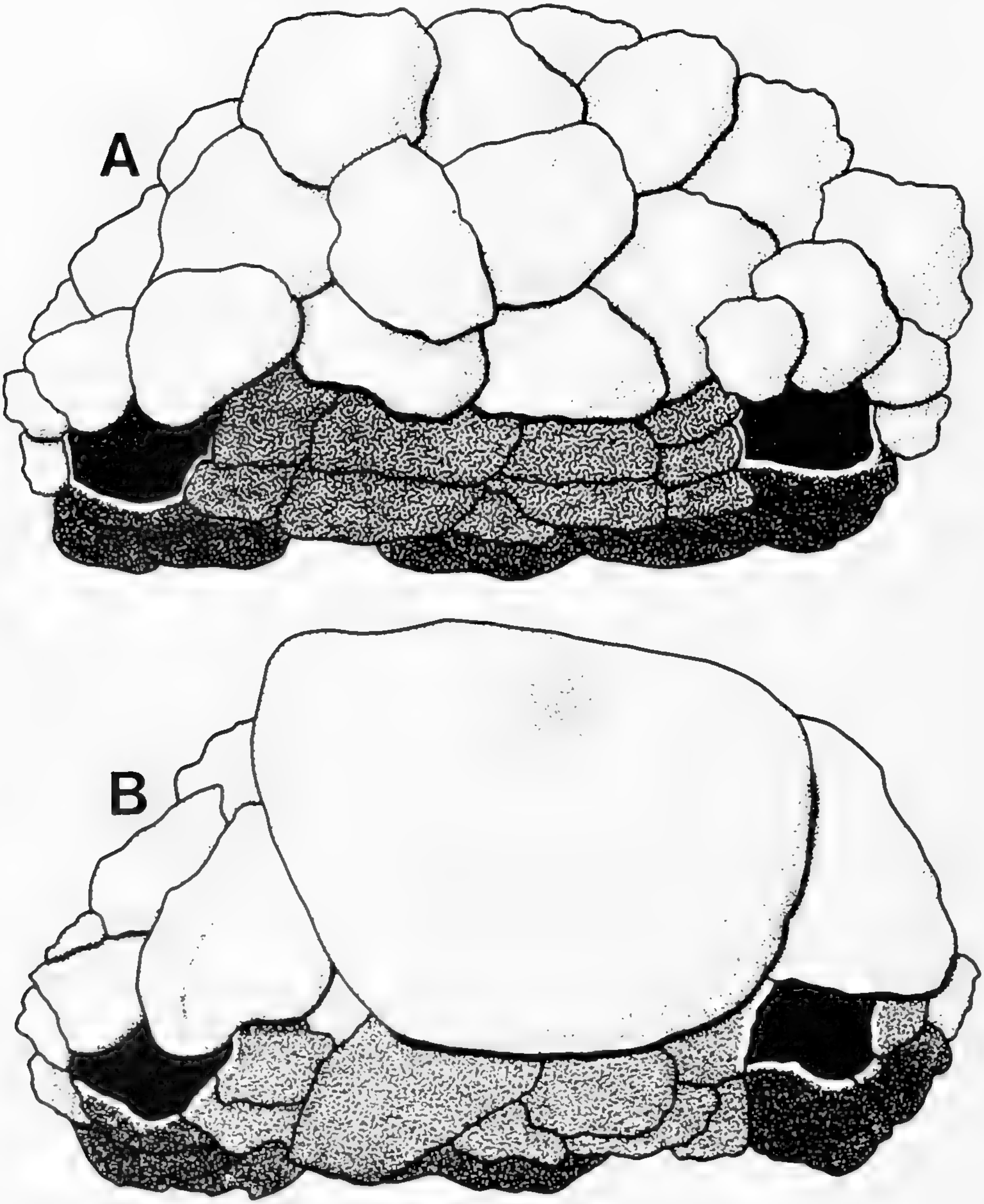

Fig. 5. Variation in *Culoptila cantha* cases. A, Field-collected Type I case with uniform substrate composition (ventrolateral). B, Field-collected Type II case with large side stones (ventrolateral).

comesal tooth being considerably shorter than its apical tooth. Neither of these descriptions included the pupal abdomen. It differs from Flint's (1962) description of *Matrioptila jeanae* (Ross) in having hook plates on segment VIII, a wider posterior hook plate on segment IV, and in lacking an "anterior setal group" on either side of the labrum. Its mandibles, however, look similar to those of *M. jeanae.*

Case.—Wiggins (1996a) described *C. moselyi* cases as being composed of small uniform inorganic particles, and indicated that this attribute could be used to separate larvae of *Culoptila* from *Protoptila*, whose cases have two large side stones. The Type I and II cases of *C. cantha* (Fig. 5) indicate that the uniformity of case particles is not a good character for separating these two genera. Often a *C. cantha* larva found in one type of case in the field made the other type case after forced removal and placement in an aquarium. Many individuals with different case types were reared to the adult stage and were confirmed as *C. cantha*. *Protoptila alexanderi* was found in small numbers at the Brazos River site, and after examining a series of 12 late instar cases, we were unable to separate them from the variable *C. cantha* cases.

Distribution.—*Culoptila cantha* is distributed throughout the western U.S., with isolated populations in the northeastern U.S. (Fig. 1). The type locality and many other reported collecting localities were in large river habitats with circumneutral pH (Ross 1938, Peterson and van Eeckhaute 1990, Moulton et al. 1993, Wiggins 1996a). However, some adults have been caught near spring habitats in Arizona and at two intermittent northern Texas streams (Fig. 1). Herrmann et al. (1986) reported *C. cantha* from an altitudinal range of 1494–1801 m in Colorado. It has not been reported from the Neotropics (R. W. Holzenthal, J. Bueno-Soria, personal communications).

The apparent absence of *C. cantha* from the central and southeastern U.S. despite heavy collecting at least in the Southeast (e.g. Etnier and Schuster 1979; Harris et al. 1991; J. C Morse, personal communication) is difficult to explain without a better understanding of *Culoptila* phylogeny. *Culoptila thoracica* has been reported from North Carolina (Flint 1974). Some other Nearctic species of Trichoptera exhibiting disjunct distributions include *Marilia flexuosa* Ulmer (Odontoceridae) and *Neotrichia collata* Morton (Hydroptilidae); the former occurs throughout the American Southwest and Interior Highlands, and has been recorded from Vermont and Ontario; the latter is found in the eastern U.S. with a population in Utah (B. J. Armitage, personal communication; Moulton and Steward 1996).

MATERIAL EXAMINED

ARIZONA: Yavapai Co., Clear Cr. Cmp., SE Camp Verde, 17-VI-68, Flint and Menke, 1 ♂, 4 ♀♀ (USNM). COLORADO: Moffat Co., Yampa R., below Maybell, 03-VIII-73, R. W. Baumann and A. Brower, 13 ♂♂, 19♀♀ (USNM). MONTANA: Madison Co., Madison R., Norris, Drift, 27-VI-1978, unknown collector, 5 ♂♂ (MTEC). PENNSYLVANIA: Bradford Co., Susquehanna River, nr. Athens, 05-VIII-1937, J. H. Eddleson, 2 ♂♂, 2 ♀♀ (INHS). SOUTH DAKOTA: Custer Co., Hot Springs, Hot Springs Ck., unknown collector, 8 ♂♂ (MTEC). TEXAS: Cooke Co., Williams Creek, 11 km W. Era, 10-IV-1996, K. D. Alexander, 1 ♂; same except 09-X-1996, 1 ♂; Denton Co., Hickory Creek, nr. Water Research Field Station, 24-VI-1994, R. J. Currie, 1 ♂ (UNT); Palo Pinto Co., Brazos River at Route 4 Br., 10 km SE Graford, 21-I-1995, D. C. Houghton, 14 larvae, 3 ♂ metamorphotypes, 2 ♀ metamorphotypes; same except 20-IV-1995, 12 larvae, 14 pupae, 6 ♂ metamorphotypes, 4 ♀ metamorphotypes; same except 14-X-1995, 12 pupae; same except 10-II-1996, 21 larvae; same except 15-III-1996, 13 larvae, 17 pupae; same except 15-III-1996, 9 larvae, 14 pupae.

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A NEW SPECIES OF *NEOLASIOPTERA* FELT (DIPTERA: CECIDOMYIIDAE) ON *CUPHEA CARTHAGENENSIS* (JACQ.) MACBRIDE (LYTHRACEAE) IN BRAZIL, WITH NOTES ON ITS BIOLOGY

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Abstract.—***Neolasioptera cupheae* Gagné, n.sp.,** is described from *Cuphea carthagenensis* in Rio de Janeiro State in Brazil. It forms a multilocular, spheroid-cylindrical stem gall covered with a dense coat of glandular trichomes that exude a sticky resin. The gall occurs throughout the year, with the highest numbers in February and March, and the lowest in June. Four species of parasitoid wasps belonging to the families Eulophidae, Ceraphronidae, Eupelmidae, and Platygasteridae were obtained in low numbers from the galls.

Key Words: gall midge, stem gall, parasitoids

Cuphea, the largest genus of Lythraceae, comprises some 260 species and is a common component of the Neotropical herbaceous flora. Although many Neotropical plant genera are host to a great number of galls (Fernandes et al. 1988, Gagné 1994, Monteiro et al. 1994), only three kinds of galls are known from *Cuphea.* Two are flower bud galls that are known from Middle America and Ecuador, one formed by *Asphondylia* sp. (Diptera: Cecidomyiidae), the other by *Mompha* sp. (Lepidoptera: Momphidae) (Graham 1995). The third kind is a conspicuous stem swelling, 0.5–1.5 cm long and 0.3–1.0 cm wide, covered with resinous trichomes (Figs. 1, 2). This gall was first reported in Gagné (1994) and is formed by a new species of *Neolasioptera* Felt that is named and described here.

Cuphea carthagenensis (Jacq.) Macbride, the host of the new cecidomyiid, is herbaceous, grows to 1 m high, and is widely distributed in Brazil and elsewhere in South America. It occurs in dense clumps along roadsides in areas of lowland Atlantic forest, including the Poço das Antas Biological Reserve in the municipality of Silva Jardim, State of Rio de Janeiro, in southeastern Brazil.

The new gall midge species is placed in *Neolasioptera* by virtue of having none of the losses and modifications that would place it in any more narrowly defined genus of the tribe Alycaulini. *Neolasioptera* is a large genus of some 70 described species in the Neotropical Region and about the same number in the Nearctic Region (Gagné 1994). No key to all species is available, but these species are evidently monophagous or closely oligophagous, and distinct species may even occur on the same host species (Gagné and Boldt 1995, Plakidas 1994).

MATERIALS AND METHODS

Cuphea carthagenensis was examined biweekly for the presence of galls in an area of approximately 200 m² (100 m × 2 m) in the Poço das Antas Biological Reserve. Surveys were also made in six other municipalities: Teresópolis, Parati, Angra dos Reis, and Guapimirim, all in Rio de Janeiro State; Linhares, Espírito Santo; and Campinas, São Paulo. A selection of galls was collected biweekly to obtain gall makers and parasitoids. Larvae and pupae were excised from some galls, adults were reared from others, and all specimens were preserved in 70% ethanol. Some larvae and adults were mounted for microscopic study in Canada balsam, using the method outlined in Gagné (1989, 1994). In the description of the new species, anatomical terminology of the adult stage follows McAlpine et al. (1981) and that of the larval stage follows Gagné (1989). The holotype and some paratypes of the new species will be deposited in the Museu Nacional do Rio de Janeiro; the remaining paratypes are deposited in the National Museum of Natural History, Smithsonian Institution, Washington, D.C. (USNM). The field work was done by F.F.F. Ferraz and R. F. Monteiro, the description of the new species by R.J. Gagné.

***Neolasioptera cupheae* Gagné, new species**

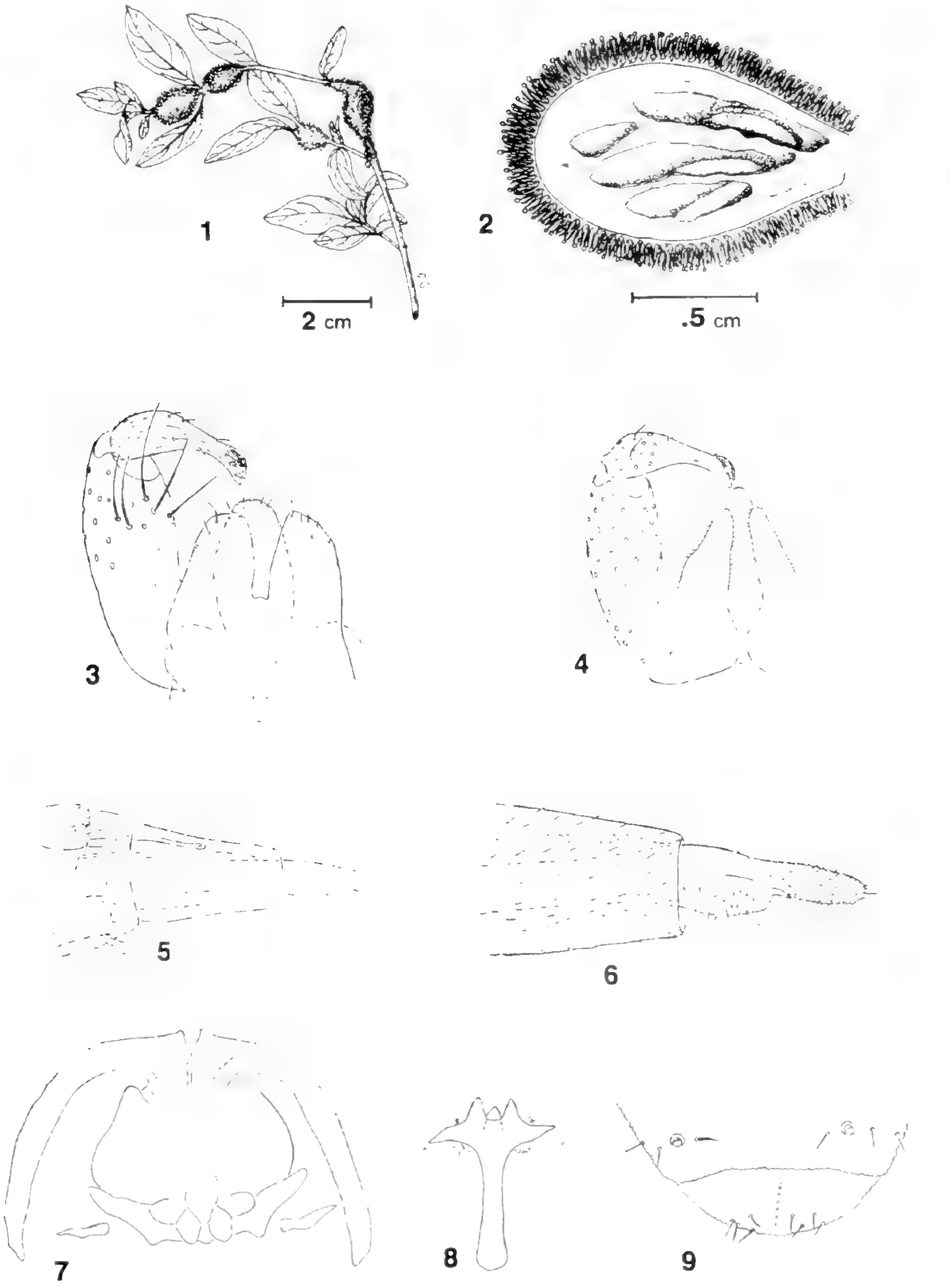
(Figs. 1–9)

Adult.—Antenna with 12–13 flagellomeres in ♂ (n = 3), 16–17 in ♀ (n = 2). Mouthparts: labrum as wide as long; labellum semicircular in frontal view, with 7–8 lateral setae; palpus 4 segmented. Thoracic vestiture: scutum with dorsocentral and lateral rows of setae, covered elsewhere with scales except in three narrow longitudinal stripes; anepisternum with scales on dorsal half; katepisternum without scales; anepimeron with 12–14 setae and a few scales. Wing length: ♂, 1.5–1.7 mm (n = 3); ♀, 1.7–1.9 mm (n = 2). R5 about as long as half length of wing.

Male abdomen: First through 7th tergites rectangular, about 3 times as wide as long, with single row of sparse setae along posterior margin, a pair of trichoid sensilla on anterior margin, those on 6th and 7th tergites set anteriad of sclerotized part of tergites, and covered elsewhere with scales; 8th tergite defined only by 1–3 scales laterally and a pair of trichoid sensilla set on smooth, non-setulose area. Second through 6th sternites quadrate; 6th, 7th, and 8th sternites successively shorter, the 7th and 8th shorter than wide; all sternites with mostly single row of setae posteriorly, several lateral setae at midlength, a pair of trichoid sensilla anteriorly on all but 8th sternite, and covered elsewhere with scales. Genitalia as in Figs. 3–4: hypoproct entire, similar to cercal lobe in size, with pair of posterior setae; aedeagus approximately as long as hypoproct; gonostylus largest at base, setulose basally, striate beyond.

Female abdomen: First through 6th tergites rectangular, about twice as wide as long, with vestiture as in male except all trichoid sensilla situated on setulose portion of tergites; 7th tergite much smaller than sixth, barely wider than long, with posterior row of setae, anterior pair of trichoid sensilla, and scales covering only posterior half; eighth tergite divided longitudinally into two elongate sclerites, weakly sclerotized on available specimens, each of the 2 sclerites with trichoid sensillum on the broad base and several short setae anteriorly. Second to 7th sternites rectangular, with setae posteriorly, laterally, and mesally, a pair of anterior trichoid sensilla, and covered elsewhere with scales. Eighth sternite undefined. Protrusible part of ovipositor (Figs. 5, 6) of moderate length for genus, about 3 times length of 6th tergite; fused cerci elongate-cylindrical, evenly covered with setae and setulae; hypoproct elongate, narrow, with 2 apical setae.

Pupa.—*Head* (Fig. 7): Antennal bases pointed apically; cervical sclerite with two elongate setae; face without ventral projections, with pair of papillae, one with seta,



Figs. 1–9. 1, 2, Gall of *Neolasioptera cupheae* on *Cuphea carthagenensis*. 1, Branch with galls. 2, Cross-section of gall. Figs. 3–10, *Neolasioptera cupheae*. 3, Male genitalia (in part, dorsal). 4, Same (ventral). 5, Female postabdomen from 7th segment to end, inclusive (dorsolateral). 6, Detail of same beyond 8th tergite (dorsolateral). 7, Pupal head and associated structures (ventral). 8, Third larval instar spatula and associated papillae (ventral). 9, Third larval instar eighth and terminal segments (dorsal).

on each side of base of labrum. Prothoracic spiracle elongate, pointed apically. Abdominal tergites evenly covered with weak setulae.

Last larval instar. Length ca. 3 mm (n = 2). Spatula (Fig. 8) tridentate anteriorly, the middle tooth slightly shorter. Papillae: laterals 4, 2 with setae; terminals (Fig. 9) 8, with setae of approximately equal length; otherwise as for the genus (Gagné 1994).

Specimens examined.—Holotype: ♂, ex stem swelling of *Cuphea carthagenensis,* BRAZIL, Silva Jardim, Rio de Janeiro, 25-ix-1995, F.F.F.Ferraz, to be deposited in the Museu Nacional do Rio de Janeiro. Other specimens, same data as holotype, 2 ♂, 2 ♀, 2 pupae, 2 pupal exuviae, 3 last larval instars, will be deposited in the Museu Nacional do Rio de Janeiro and the USNM.

Remarks.—The illustrations should serve to distinguish the new species. Noteworthy characters that in combination should serve to distinguish this species from other *Neolasioptera* species are: the extension of the gonostylus mesad of the tooth (Figs. 3, 4), the elongate cylindrical fused female cerci (Figs. 5, 6), the shape of the larval spatula (Fig. 8), and the presence of 8 terminal larval papillae.

BIOLOGICAL ASPECTS OF *N. CUPHEAE* AND ITS GALL

The gall is first apparent at the apex of a shoot, but the shoot quickly grows beyond the gall, leaving behind a more or less cylindrical swelling encircling the stem (Fig. 1). Lateral shoots and flowers, and resulting fruit, occasionally grow from galled tissue so the galls do not appear to hinder more distal growth. Seedlings of *C. carthagenensis* may bear a single gall, but mature plants may have as many as 80. After galls become apparent, trichomes begin to grow from the surrounding surface, eventually forming a dense coat 1.0 mm thick, covered with a gummy, resinous substance that accumulates at the extremities of the trichomes (Fig. 2). Small insects can be found throughout the year stuck to the trichomes. Among the insects found there were microhymenopterans, including some specimens of *Quadrastichus* sp. and several specimens of a ceraphronid species, both parasitoids reared from the galls. This is reminiscent of another sticky gall made by an unrelated cecidomyiid on a *Machaerium* (Fabaceae), also in Brazil (Fernandes et al. 1987).

Each gall contains one to 18 chambers (avg. = 4.29; SD = 2.91; N = 62), each chamber with a single cecidomyiid larva (Fig. 2). Unlike galls of many *Neolasioptera,* the inner surface of these chambers is not lined with a fungal mycelium. Larvae in the same gall were frequently of different sizes, and some galls contained both larvae and pupae. Pupation takes place in the gall. When the adult is ready to emerge, the pupa breaks through the epidermis at the end of a tunnel previously formed by the mature larva. The pupa exits only part way out of the gall and then lodges itself there, immediately after which the adult breaks through the anterior end of the pupa. The adult took from 20 to 30 minutes to emerge from the pupa, and often several adults emerged over a period of hours from the same gall, each through a separate hole. From first notice of a slight swelling of the stem to the time adults left the galls took about 30 days.

Neolasioptera cupheae is multivoltine and is present all year with overlapping generations. The abundance and density of galls was greatest in summer (February and March) when the average of galls per plant reached 8.4 galls per plant (SD = 13.55, range = 1–87): in summer of 1995 48% of the 283 plants in the study area were galled. In winter, a local, short, dry period, galls are not as common: in winter of 1995, gall density was only 1.6 per galled plant (SD = 0.89) and only 3.7% of 133 plants had galls.

Of 140 galls kept in rearing chambers during this study, only 16 (11.4%) yielded parasitoid Hymenoptera. These parasitoids belonged, in order of decreasing numbers, to: *Quadrastichus* sp. (Eulophidae), a solitary endoparasitoid; a ceraphronid, a gregarious endoparasitoid; a eupelmid, a solitary ectoparasitoid; and a platygasterid, a solitary endoparasitoid. The number of parasitoids appears to be lower than that found associated with some other gall midges (Fernandes et al. 1987, Hawkins and Goeden 1984). It is possible that the resin-covered trichomes covering the galls affect the number of parasitoids in the galls.

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TAXONOMIC REVIEW OF THE GENUS *GROUVELLINUS* CHAMPION (COLEOPTERA: ELMIDAE) FROM TAIWAN AND JAPAN

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Abstract:—The species of *Grouvellinus* from Taiwan and Japan are reviewed. Seven species and one subspecies, ***G. pilosus*, n. sp., *G. montanus*, n. sp., *G. hygropetricus*, n. sp.**, and *G. babai babai* Nomura from Taiwan, and *G. marginatus* (Kôno), *G. nitidus* Nomura, *G. subopacus* Nomura and ***G. babai satoi*, n. ssp.** from Japan, are described or redescribed. Male genitalia of all species are depicted. A lectotype for *G. marginatus* is designated.

Key Words: Elmidae, *Grouvellinus*, review, new species, new subspecies, Taiwan, Japan

The generic name *Grouvellinus* was proposed by Champion (1923) as a replacement name for the homonyms *Microdes* Motschulsky (1859) and *Grouvelleus* Zaitzev (1908). The genus is widely distributed in the Oriental and Palaearctic regions (Brown 1981, Jäch 1984, Jäch and Kodada 1995), and 31 species are known so far.

Until now, three species of *Grouvellinus* were known from Japan (*G. marginatus* (Kôno), *G. subopacus* Nomura and *G. nitidus* Nomura), and one was described from Taiwan (*G. babai* Nomura). Nomura (1963) published a key to the Japanese and Taiwanese species of *Grouvellinus*. However, the identification of these species has remained somewhat ambiguous. In this paper we review the previously described species and describe three new species and a new subspecies. In addition, we also provide a revised key which contains more reliable characters.

MATERIAL AND METHODS

Descriptions are mainly based on alcoholic material and SEM micrographs. Body length (BL) is the sum of pronotal and elytral lengths (PL + EL); body width (BW = EW) means the broadest width of elytra. The first strial interval of elytra means the sutural interval (in contrast to Nomura (1962, 1963) who regarded the space between the first two striae as the first interval). The scale bar in illustrations represents 0.1 mm unless indicated otherwise. Descriptions and illustrations of spines in the ejaculatory duct are omitted. Except the data of holotypes, the collector is omitted in collecting data if the specimen(s) was sampled by the senior author.

To facilitate SEM observation, the mud-coated specimens are treated with hydrochloric acid (HCl) for 1 minute and then soaked in water for about 30 seconds; the specimens are then transferred to a small vial containing water, and then placed in an ultrasonic cleaning device for about 2 minutes. SEM micrographs are made with a Hitachi S-2400 at 20KV.

ACRONYMS

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ramento, U. S. A. (Dr. W. D. Shepard)
DEI –Deutsches Entomologisches Institut, Eberswalde, Germany (Dr. L. Zerche)
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NMW –Naturhistorisches Museum Wien, Austria (Dr. M. A. Jäch)
NSMT –National Science Museum (Natural History), Tokyo, Japan
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TAXONOMY

KEY TO THE SPECIES AND SUBSPECIES OF *GROUVELLINUS* FROM TAIWAN AND JAPAN

1. Prosternal process less than ⅓ as wide as pronotum (Figs. 30–36); elytral striae deeply notched (Fig. 20); each ventrite with surface granulate (Fig. 40) 2
– Prosternal process subquadrate, broad, about ⅓ as wide as pronotum (Fig. 29); elytral striae not deeply notched (Fig. 19); only last ventrite granulate and the rest punctate (Fig. 39); Taiwan . . . . *G. pilosus*, n. sp.
2. Body elongately obovate (Fig. 28), with BL/BW about 2.1–2.4 (elytra with EL/EW about 1.5–1.7) 3
– Body obovate and stout (Fig. 27), with BL/BW about 2.0 (EL/EW about 1.3–1.4); Amami and Okinawa Islands . . . . *G. subopacus* Nomura
3. Male genitalia from 400–700 μm in length; body length not longer than 2.3 mm in male and 2.5 mm in female 4
– Male genitalia about 750–800 μm long; body size large, 2.3–2.6 mm in male and 2.5–2.7 mm in female; Taiwan *G. hygropetricus*, n. sp.
4. Pronotal disc smooth and shining (Figs. 3–4, 11) 5
– Pronotal disc scabrous, shagreen-like or densely punctate (Figs. 7–9) 6
5. Pronotum more or less strongly convex (Fig. 46B); surface of sublateral gibbosity of pronotum smooth, with only a few superficial punctures (Fig. 11, GB); Japan . . . . *G. nitidus* Nomura
– Pronotum evenly convex (Fig. 46A); surface of pronotal gibbosity scabrous or densely granulate (Figs. 3–4); Taiwan . . . . *G. montanus*, n. sp.
6. Male genitalia larger (ca. 500 μm); paramere elongate and slender, about 1.9 times as long as basal piece (Fig. 52); Japan . . . . *G. marginatus* (Kôno)
– Male genitalia smaller (ca. 400–440 μm); paramere shorter, about 1.4 times as long as basal piece (Figs. 50–51) . . . *G. babai* Nomura . . . 7
7. Body 1.9–2.2 mm in length; pronotum with surface shagreened; abdomen very densely granulate on all ventrites (Fig. 41); Taiwan . . . . *G. babai babai* Nomura
– Body 1.6–1.8 mm in length; pronotum with surface densely punctate; first abdominal ventrite with fewer granules on disc than those on other ventrites (Fig. 42); Yaeyama Islands . . . . *G. babai satoi*, n. ssp.

Grouvellinus pilosus Jeng and Yang, new species

(Figs. 1, 2, 12, 19, 29, 37, 39, 47)

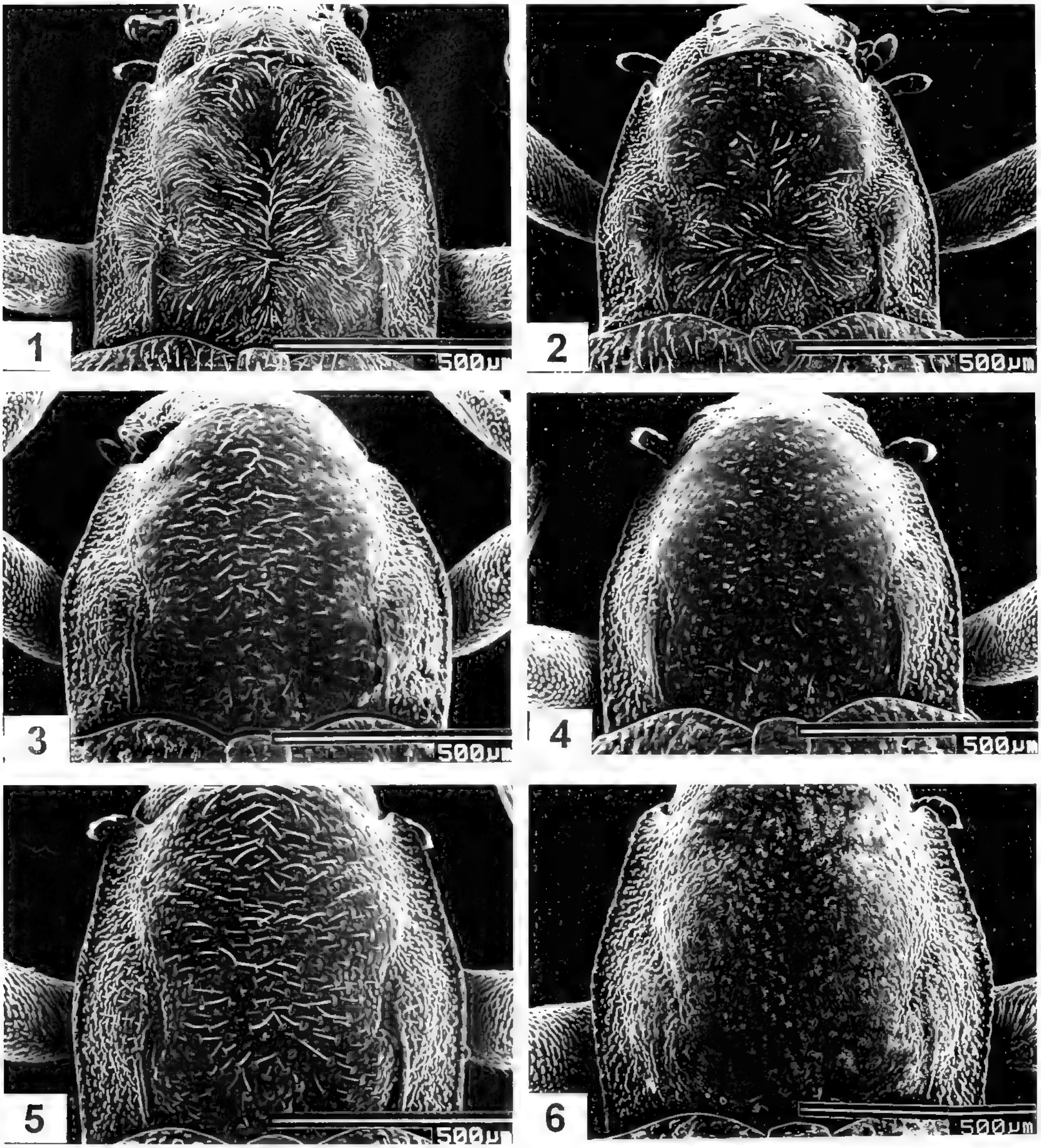
Type locality.—Neishuangshi, Shihlin, Taipei City, northern Taiwan.

Description.—BL: 1.8–2.1 mm (male), 2.0–2.2 mm (female); BW: 0.9–1.0 mm (both sexes).

Body shape elongate obovate, subparallel. Dorsum brown, shining, with bronze lustre; elytra sometimes paler than pronotum. Venter brown to dark brown, weakly lustrous. Legs brown. Antenna, mouthparts and tarsi yellowish brown.

Head with surface smooth, sparsely and superficially punctate. Frons with 3 or more longitudinal rows of pubescence. Clypeus with lateral sides broadly rounded; pubescence on disc denser than on frons. Labrum smooth, pubescent only laterally, and very finely punctate apically.

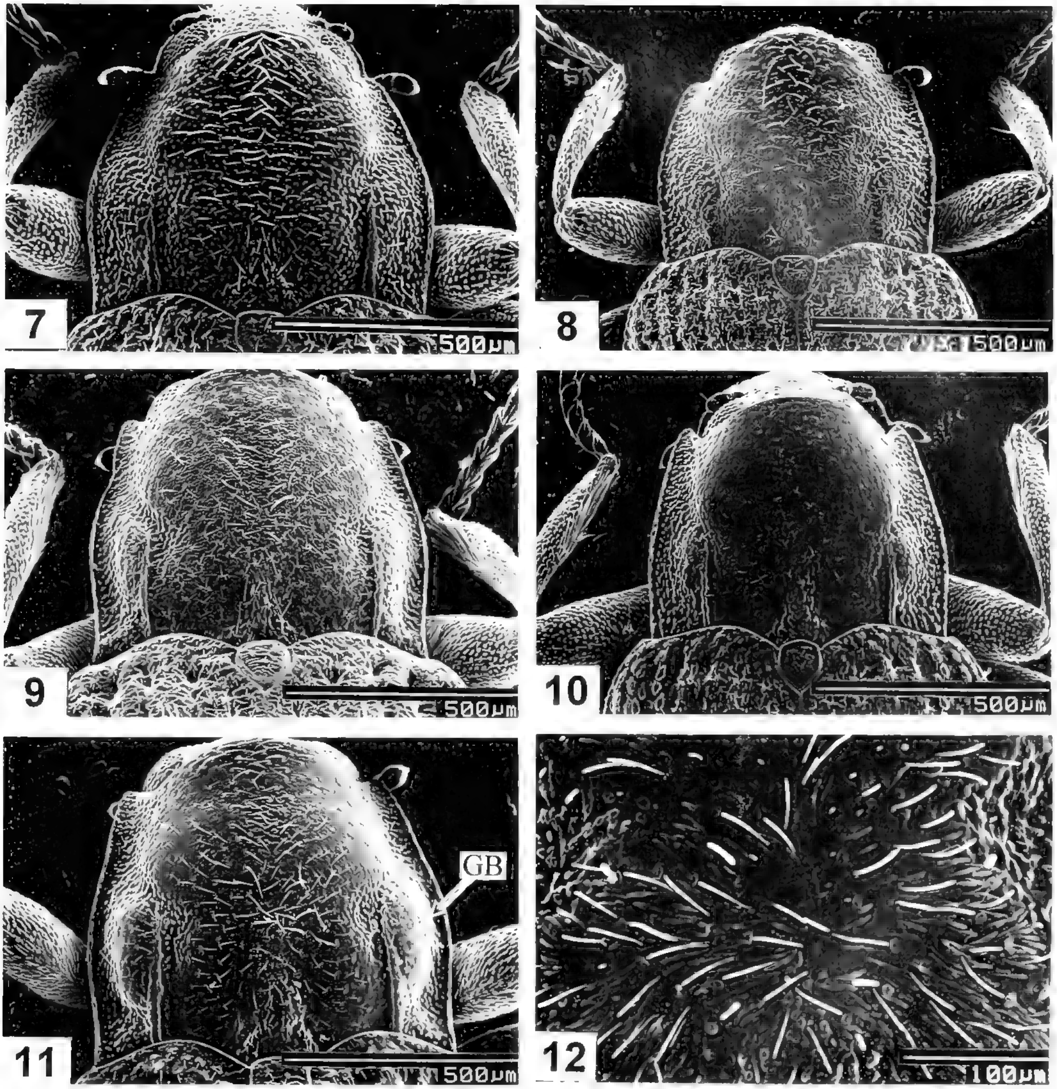
Pronotum (Figs. 1–2) evenly convex, 1.3 times as broad as long; broadest at basal ⅖; surface (Fig. 12) weakly scabrous, accompanied with dense and superficial punc-



Figs. 1–6. Pronotum. 1, 2, *Grouvellinus pilosus*. 3, 4, *G. montanus*. 5, 6, *G. hygropetricus*.

tures, and densely covered with long, adpressed, decumbent pubescence. Sublateral carinae subparallel, extending from base to basal ⅖; an oblique impression on each side extending from apical end of carina to near anterior angle. Base with two elongate oval impressions in front of anterior angles of scutellum.

Elytra (Fig. 19) 1.3 times as broad as pronotum, 1.5–1.6 times as long as broad, with conspicuous sexual dimorphism (elytral apex more acute in female but conjointly rounded in male). Sides subparallel in basal ⅔ and thence tapering arcuately to conjoint apex. Strial punctures in basal half deep and large, subcircular, separated from each other by 1 to 2 times their diameters; punctures becoming smaller and more



Figs. 7–12. Pronotum. 7, *Grouvellinus babai babai*. 8, *G. babai satoi*. 9, *G. marginatus*. 10, *G. subopacus* 11, *G. nitidus*. 12, G. *pilosus*, central disc of pronotum. GB sublateral gibbosity of pronotum.

widely separated (about 2–3 their diameters) in apical half. Strial intervals flat, minutely punctate and densely pubescent; interval 2 broad, about 2–3 times as broad as the diameter of basal punctures; intervals 3 and 4 about 1–1.5 times as wide as puncture diameter; interval 3 broadly and weakly convex at base; interval 7 with a row of weak granules.

Prosternal process (Fig. 29) about ⅓ as wide as pronotum, subquadrate, strongly rimmed, with a transverse, smooth elevation at base. Metasternum (Fig. 37) coarsely punctate; female with disc narrowly depressed along the median suture, and male with disc broadly impressed. Abdomen (Fig. 39) with the ventrites I–II deeply and coarsely punctate on disc; ventrites III–IV sparsely and minutely punctate; ventrite V granulate throughout.

Male genitalia (Fig. 47) long and slender, about 580 µm in length; penis surpassing parameres, distinctly narrowed at basal $\frac{1}{5}$, broadest at basal $\frac{2}{5}$ and thence tapering toward apex. Ventral sac with lateral sides weakly sclerotized. Paramere slender and subparallel at apical half, with apex slightly dilated.

Variation.—The density of pronotal pubescence is variable, possibly due to age and detrition (Figs. 1, 2).

Type series.—Holotype ♂ (NMNS): "TAIWAN: Taipei city, Shihlin: Neishuangshi, 30.IV.1987, Wong K. C. leg." Paratypes (CSUS, DEI, NMW, NTU, OMNH, NWU): 2 ♀, same data as for holotype; 1 ♂ and 4 ♀, same locality, 25.VII.1986, Wong K. C. leg.; 2 ♀, same locality, 28.VIII.1986, Wong K. C. leg.; 2 ♂ and 6 ♀, same locality, 25.IX.1986, Wong K. C. leg.; 1 ♀, same locality, 18.X.1985, Wong K. C. leg.; 1 ♂, same locality, 28.V.1987, Wong K. C. leg.; 2 ♂ and 10 ♀, same locality, 20.VI.1987, Wong K. C. leg.; 2 ♀, same locality, 30.VII.1987, Wong K. C. leg.; 1 ♀, same locality, 27.VIII. 1987, Wong K. C. leg.; 1 ♀, Taipei County, Pinglin: Daiyukushi, 31.VIII.1987, Wong K. C. leg.; 1 ♀, same locality, 21.VI.1988, Wong K. C. leg.; 1 ♂, same locality, 7.VII.1989, Wong K. C. leg.; 1 ♂ and 3 ♀, Taipei County, Pinglin: Beishihshi, 21.VI.1988, Wong K. C. leg.; 1 ♂ and 1 ♀, Taipei County, Tongho, XI.1989, Wong K. C. leg.; 2 ♀, Taipei County, Wanli: Malienshi, 13.VIII.1990; 2 ♂ and 3 ♀, Taipei County, Sanshah: Yomushi, 16.VIII.1990; 2 ♀, Taipei County, Jingmeishi: Shuangshiko, 30.IV.1993, Lee C. F. leg.; 1 ♀, Taipei County, Wulai: Tonghoshi, 9.IX.1993; 1 ♀, Taipei County, Shinshen: Nanshihshi, 10.IX.1993.

Additional material examined.—3, "Anko/ TAIHOKU/ FORMOSA/ 20.iv.1941/ COL. S. MIYAMOTO"; 4, "Seitan, Sinten/ TAIHOKU/ FORMOSA/ 11.v.1941/ COL. S. MIYAMOTO"; 8, "Anko/ TAIHOKU/ FORMOSA/ 25.v.1941/ COL. S. MIYAMOTO"; 1, "Anko/ Taihoko/ vi.1941/ S. Miyamoto" (TARI), 6 ♂ and 11 ♀, Taipei County, Sanji: Balienshi, 25.VII.1990 (NTU). Two specimens labeled "Seitan, Sinten/ TAIHOKU/ FORMOSA/ 11.v.1941/ COL. S. MIYAMOTO" (TARI) were designated as "cotypes" of "*Hapgroelmis formosanus*" by Y. Miwa during 1941–45. However this name was never published.

Differential diagnosis.—This new species is characterized by its long and dense pubescence on the dorsal surface, indistinct carina on 7th strial interval of elytra, subquadrate prosternal process, punctation on metasternum and abdominal ventrites, and characteristic male genitalia. It is somewhat difficult to group this new species with the other congeneric members as a subgroup. It can be separated from all the other species from Taiwan and Japan by the key provided above. *G. pelacoti* Delève from Vietnam also possesses long pubescent pattern, but its male genitalia are larger and more robust than those of *G. pilosus,* and its parameres taper uniformly toward their apices.

Distribution.—Known only from northern Taiwan. All localities are below 500 m. Most of the specimens were collected from creeks or streams with clear water and only few individuals were found in slightly polluted streams.

Etymology.—The specific name *pilosus* (Latin, hairy) refers to the long dorsal pubescence.

***Grouvellinus montanus* Jeng and Yang, new species**

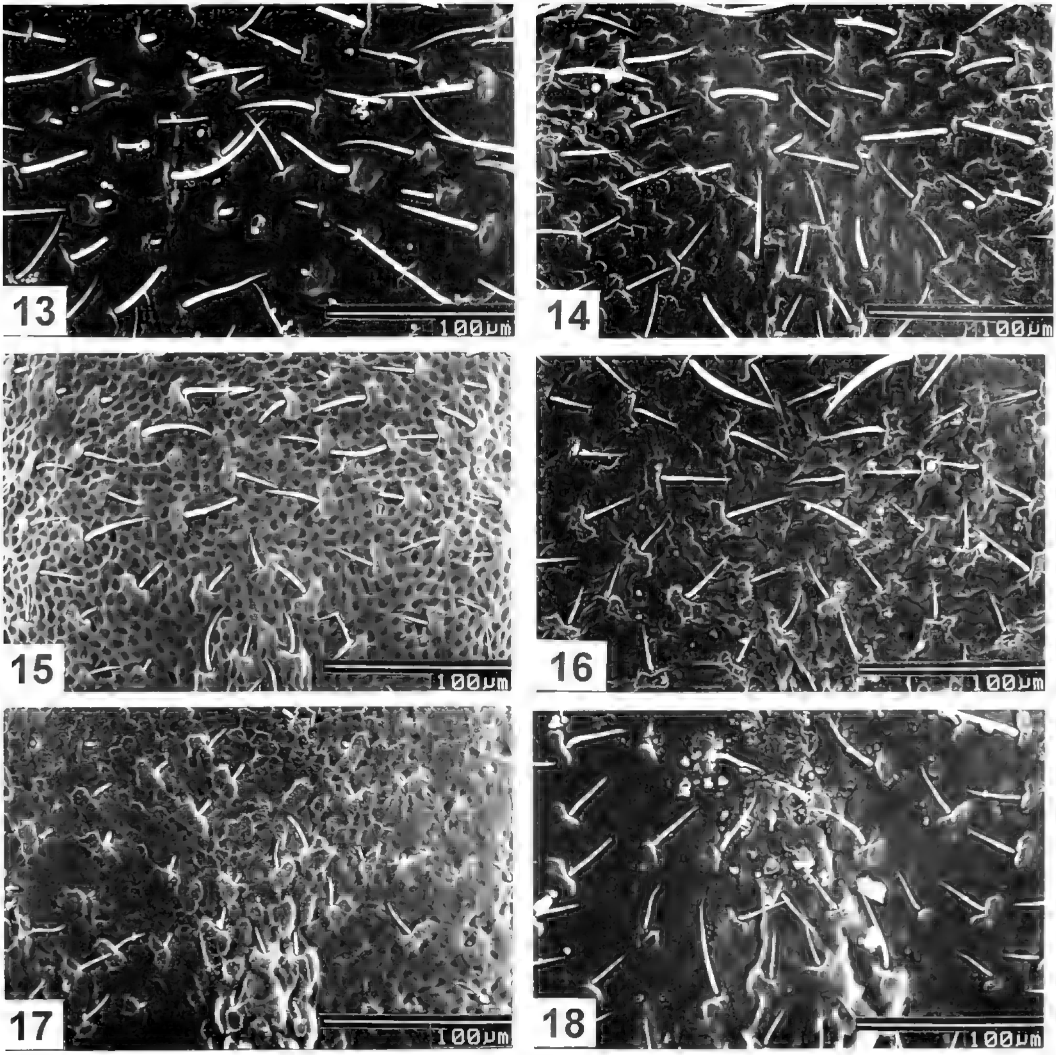
(Figs. 3, 4, 20, 30, 46A, 48)

Type locality.—A branch of San-Guang Stream, near Chiduan, Ilan County, northeastern Taiwan.

Description.—BL:2.0–2.3 mm (male), 2.3–2.5 mm (female); BW: 0.9–1.0 mm (male), 1.0–1.1 mm (female).

Body shape elongate obovate, subparallel. Dorsal surface dark brown to black, with strong bronze lustre. Venter brown and opaque. All femora and tibiae dark reddish brown. Antenna, mouthparts and tarsi yellowish brown.

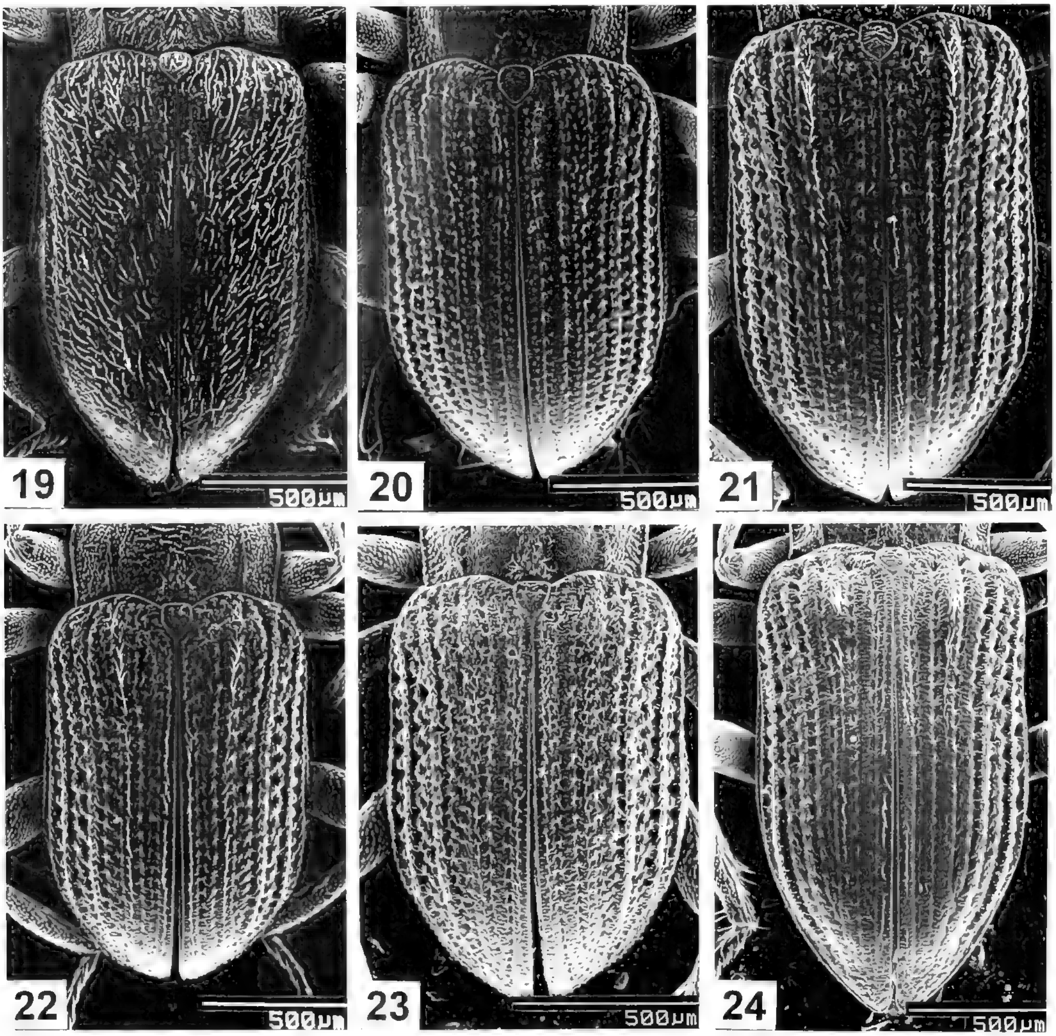
Head with frons weakly coriaceous,



Figs. 13–18. Central disc of pronotum. 13, *Grouvellinus hygropetricus.* 14, *G. babai babai.* 15, *G. babai satoi.* 16, *G. marginatus.* 17, *G. subopacus.* 18, *G. nitidus.*

somewhat densely granulate, covered with sparse and indistinctly patterned pubescence. Clypeus with surface similar to that of frons, and coarsely punctate at sides. Labrum smooth, weakly punctate and densely pubescent laterally.

Pronotum (Figs. 3–4) 1.1 times broader than long, broadest at basal 2/5 or subparallel from there to basal angles; surface smooth, sparsely punctate in apical half of disc; granulation on disc variable among populations: distinct granulation pattern (Fig. 3, from type locality) accompanied by a slightly scabrous surface, especially pronounced at base of the disc; weak granulation pattern (Fig. 4, from Mt. Taiping) appears on smooth pronotal surface, and each granule with a small adjacent pit making it look like a puncture rather than a granule. Sublateral gibbosity roughly granulate. Sublateral carinae present and each with an oblique impression from apex of carina to near anterior angle. Base with two elongate oval or round impressions in front of scutellum.



Figs. 19–24. Elytra. 19, *Grouvellinus pilosus*, female. 20, *G. montanus*, male. 21, *G. hygropetricus*, female. 22, *G. babai babai*, male. 23, *G. babai satoi*, male. 24, *G. marginatus*, female.

Elytra (Fig. 20) 1.3 times as broad as pronotum, and about 1.6 times as long as broad, with conspicuous sexual dimorphism (elytral apex more acute in female but conjointly rounded in male); sides subparallel at apical ⅓ and thence tapering arcuately to conjoint apex. Striae deeply notched, strial punctures on disc quite large, subcircular, separated longitudinally from each other by ⅓ or ½ their diameters. Strial intervals moderately convex, but first two intervals usually flat in aged adults; surface transversely rugose, each interval with one or two rows of superficial granules and pubescence; interval 3 broadly and weakly elevated at base where it bears an indistinct tuft of pubescence; intervals 5, 7, 8 carinate.

Prosternum (Fig. 30) with prosternal process subparallel sided, moderately broad, a little broader than ¼ of pronotal width, with apex broadly rounded. Metasternum strongly coriaceous, coarsely granulate; disc concave along sulcus in female and broadly depressed in posterior half area in male. All abdominal ventrites with discs granulate throughout.

Male genitalia (Fig. 48) about 525 μm long, subparallel-sided; penis reaching slightly beyond paramere, dilated at basal ⅓ and becoming thinner toward apex in dorsal view. Ventral sac shorter than parameres. Parameres close to each other dorsally at basal 1/6 and thence gradually diverging toward apex; ventral margins characteristically sinuous in lateral view.

Variation.—Two patterns of pronotal granulation have been mentioned above. The lustre, surface of pronotum, and pubescence on elytra usually vary greatly, especially when comparing teneral adults with older ones.

Type series.—Holotype ♂ (NMNS): "TAIWAN: Ilan County, Chiduan (alt. 1200 m), 2.II.1992, Jeng M. L. leg.". Paratypes (CSUS, DEI, NMW, NTU, OMNH, TARI, NWU): 5 ♂ and 12 ♀, same data as of holotype; 14 ♂ and 12 ♀, same locality and collector, 29.III.1991; 15 ♂ and 11 ♀, type locality, 2.XI.1996; 5 ♂ and 5 ♀, type locality, 26.VI.1992, Lee C. F. leg.; Ilan County, Mt. Taiping (alt. 2000 m), 8.VIII.1991; 1 ♂ and 1 ♀, same locality, 11.VIII.1990, Chang S. J. leg.; 2 ♀, Ilan County, Nan-ao: Shenmi Lake (Mysterious Lake), 5.VI.1993 (alt. 1200m); 1 ♂ and 1 ♀, Nantou County, Dongpu: Yunlong Fall (alt. 1600m), 13.VI.1992; 2 ♀, Nantou County, Dongpu: Lerler (alt. 1250m), 1.II.1993; 1 ♂, Taichung County, Wuling (alt. 1900 m), 1.I.1988, Wong K. C. leg.; 1 ♂, Hwalien County, Lien-hwa Chi (alt. 1200 m), 5.IX.1988, Tseng J. S. leg.

Additional material examined.—1 ♀, Taichung County, Wuling, 18.VIII.1987, Wong K. C. leg.; 1 ♀, same locality and collector, 9.IX.1987; 1 ♀, Nantou County, Dongpu: Yunlong Fall, 19.III.1989; 4 ♂ and 1 ♀, type locality, 29.III.1991 (NTU).

Differential diagnosis.—In Nomura's key, this species will go to *G. nitidus* Nomura at couplet 3 due to its smooth and shining pronotum. However *G. montanus* is characterized by its distinct pronotal granulation pattern and male genitalia. Male genitalia of *G. nitidus* (Fig. 54) are much larger than those of *G. montanus* (ca. 670 μm vs. 525 μm), and the parameres of the latter are also distinctive in shape. This new species also resembles *G. hygropetricus* from Taiwan, especially old adults. They can be distinguished from each other by their body size and shape of male genitalia as described in the key.

Distribution.—This species is distributed in higher montane areas (about 1000–2000 m) in northeastern and central Taiwan. Occasionally we found this species and *G. babai* coexisting in creeks at 1000–1200 m. In such a case, one or the other species is much more abundant. All habitats are unpolluted.

Etymology.—The specific name *montanus* (Latin, montane) is in reference to its distribution in montane creeks and streams.

Grouvellinus hygropetricus Jeng and Yang, new species

(Figs. 5, 6, 13, 21, 31, 40, 49)

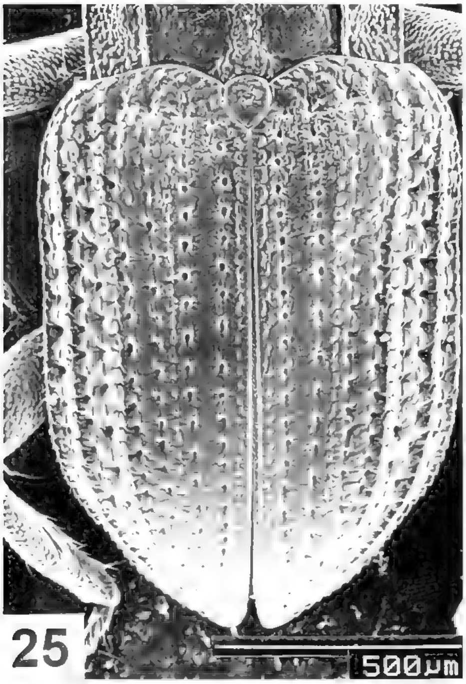
Type locality.—Wulai, Taipei County, northern Taiwan.

Description.—BL: 2.3–2.6 mm (male), 2.5–2.7 mm (female); BW: 1.0–1.2 mm (both sexes).

Body shape elongate obovate, subparallel. Dorsum shining, dark brown to black; old adults may lose lustre and look opaque. Venter and legs reddish brown. Antenna, mouthparts and tarsi yellowish brown.

Head coriaceous, superficially granulate. Vertex, lateral sides of clypeus and anteriolateral sides of labrum with long pubescence, but more sparse on vertex than on the rest. Clypeus coriaceous. Labrum smooth, weakly and sparsely punctate.

Pronotum (Figs. 5–6) evenly convex, 1.1 times broader than long, broadest point just behind middle. Surface of the disc smooth and shining in apical half, with conspicuous granulation; granules separated from each other by 1–3 times their diameters; basal half of the disc slightly coriaceous, particularly pronounced in median area (Fig. 13); sublateral areas coarsely granulate. Sublateral carinae present in basal ⅖; an oblique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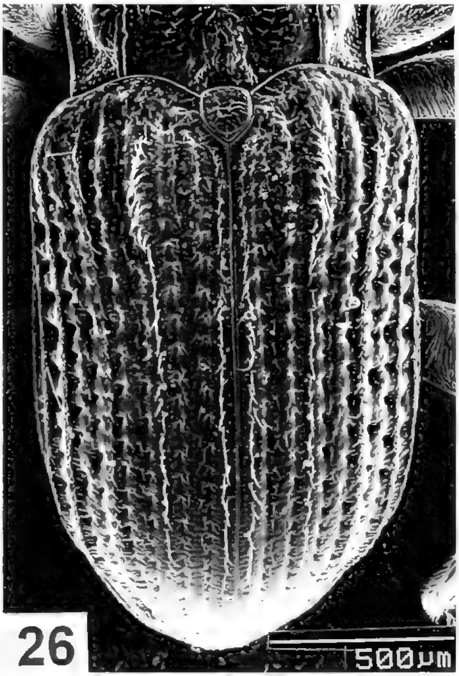
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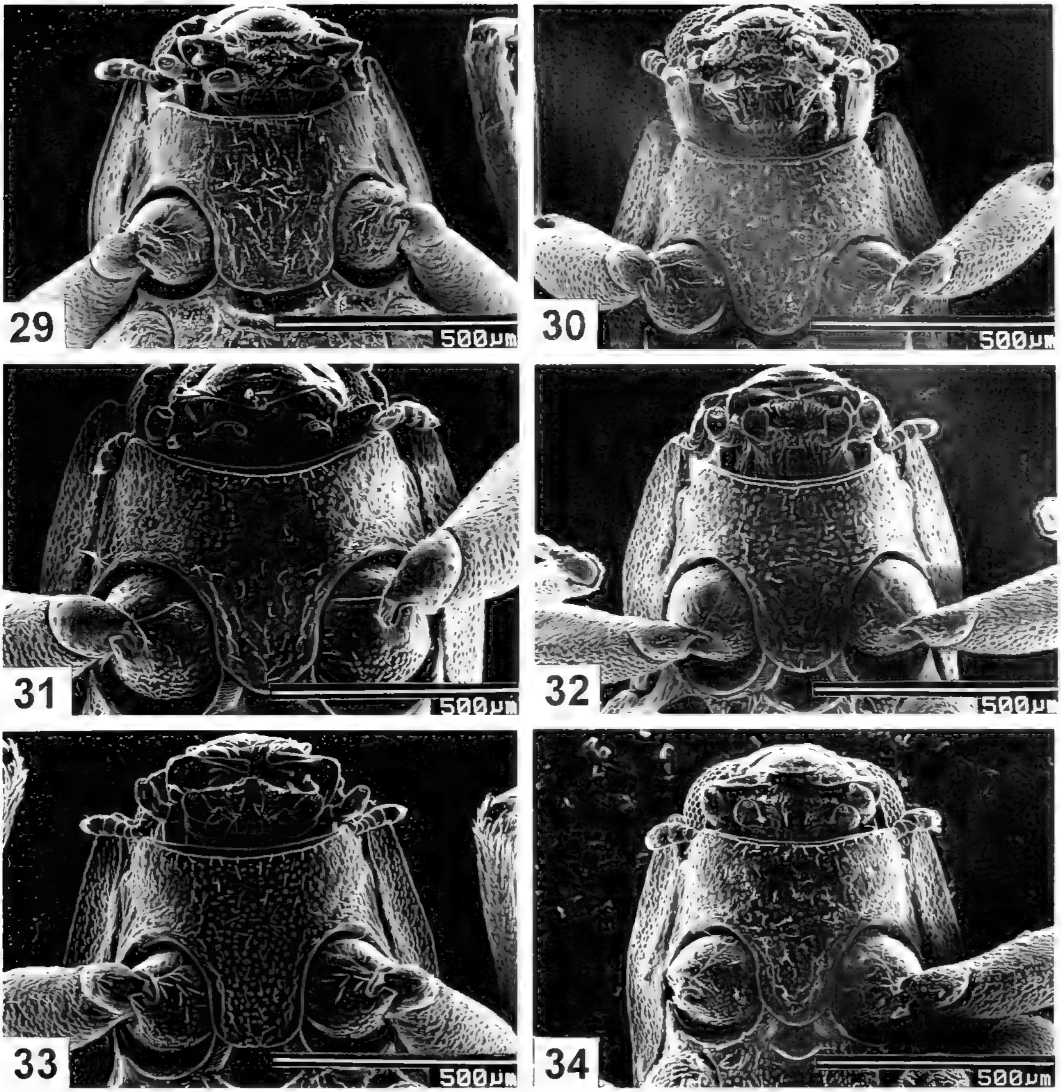
Figs. 25–28. 25, *Grouvellinus subopacus*, male elytra. 26, *G. nitidus*, male elytra. 27, *G. subopacus*, male habitus. 28, *G. babai satoi*, male habitus.



Figs. 29–34. Prosternum. 29, *Grouvellinus pilosus.* 30, *G. montanus.* 31, *G. hygropetricus.* 32–33, *G. babai babai.* 34, *G. marginatus.*

impression on each side extending from apex of carina to near anterior angle. Each sublateral gibbosity slightly convex and coarsely granulate. Base with two shallow impressions just before scutellum.

Elytra (Fig. 21) 1.2 times broader than pronotum, 1.7 times longer than broad, with conspicuous sexual dimorphism (elytral apex more acute in female but conjointly rounded in male); weakly serrate along lateral margin. First stria quite narrow, with punctures small and shallow; punctures of other striae larger and deeper on disc but becoming finer and shallower on apical declivity. Strial interval with surface transversely rugose; each interval with a row of granules; First two intervals flat; interval 3 moderately convex and a little broader at base; pubescent tuft on base of third interval present or entirely absent; intervals 5, 7 and 8 moderately carinate. Prosternum (Fig. 31) with prosternal process weakly rimmed, transversely convex at base and broadly rounded at apex. Metasternum coarsely and densely granulate, with disc broadly depressed in male but flat and weakly concave in female. Abdomen (Fig. 40) with all ventrites granulate throughout; granules on central area much more sparse than on sublateral areas.

Male genitalia (Fig. 49) about 780 μm long. Penis weakly dilated at basal ⅓, and slightly blunt at apex; parameres almost contiguous dorsally, with ventral margin almost straight in lateral view; paramere about 1.5 times longer than basal piece. Male genitalia of this species are the largest among species from Taiwan and Japan.

Variation.—The coloration, lustre, pronotal granulation, and density of setae on the dorsum are highly variable among individuals of different ages (cf. Figs. 5 and 6).

Type series.—Holotype ♂ (NMNS): "TAIWAN: Taipei County, Wulai (alt. 150 m), 8.IX.1993, Jeng M. L. leg." Paratypes (CSUS, DEI, NMW, NTU, OMNH, TARI, NWU): 6 ♂ and 13 ♀, identical data with holotype; 13 ♂ and 8 ♀, same habitat, 16.IX.1993; 1 ♀, type locality, 12.IX.1992, Lee C. F. leg.; 4 ♂ and 3 ♀, Taoyuan County, Shuenyuen (alt. 1000 m), 18.III.1996, Wang L. J. leg.; 1 ♂, Hwalien County, Yuli: Nan-an Fall (alt. 210m), 27.III.1993.

Additional material examined.—6, Taipei City, Neishuangshi: Sant Fall, 3.IV.1991; 4, type locality, 8.IX.1993; 6, type locality, 16.IX.1993; 1, Taipei City, Shihlin: Pingdengli, 8.VI.1997 (NTU).

Differential diagnosis.—This species is somewhat similar to the preceding species in coloration, lustre, pronotal granulation, and elytral striae and intervals. *Grouvellinus hygropetricus* differs from the preceding species by its larger body size, pronotal surface which is smooth in apical half but coriaceous in basal half, reddish-brown femora and tibiae, and distinctive male genitalia. *Grouvellinus subopacus* also has reddish-brown legs, but it is much smaller (1.6–1.8 mm) than this species and its body form is more stout.

Distribution.—Taiwan. The habitats at Neishuangshi, Shuenyuen and Wulai (type locality) are similar: a steep rock wall with seepage water (hygropetric habitat). A lot of dehydrated individuals were found dead on the rocks due to a severe drought when we collected this species at the type locality. Living adults refuged in small pits or cracks of rocks with a little water flow and moist mosses. At another locality, Nan-an Fall, widely separated from the other localities, one specimen was collected from benthos of a stream. It is still not clear at present whether this species is continuously distributed from northern to southeastern Taiwan.

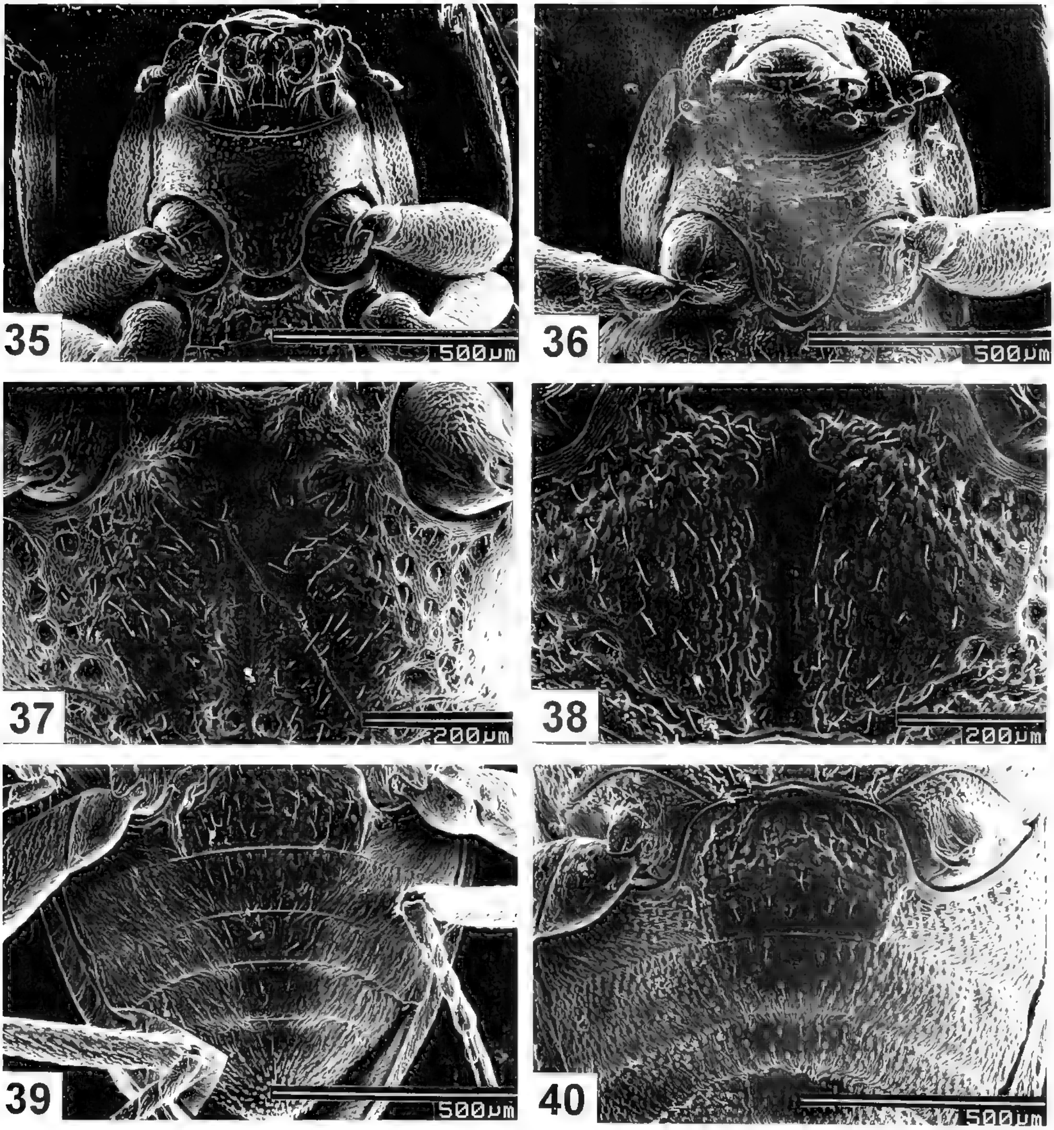
Etymology.—The specific name is derived from *hygro*-(wet) and *-petricus* (pertaining to rocks (Latin)), referring to its unusual microhabitat (seepage water on rocks), which differs from that of all the other *Grouvellinus* species from Taiwan and Japan.

Grouvellinus babai babai Nomura
(Figs. 7, 14, 22, 32, 33, 38, 41, 50)

Grouvellinus babai Nomura 1963: 54.

Type locality.—Near Mt. Neng-Gao, Nantou County, central Taiwan.

Redescription.—BL: 1.8–2.3 mm, BW: 0.9–1.0 mm. Dorsal surface brown to dark brown, with weak bronze lustre. Pronotum (Fig. 7) evenly convex, with surface shagreened and moderately pubescent (Fig. 14); sublateral carinae present; granulation on each sublateral gibbosity similar to that on disc. Elytra (Fig. 22) with conspicuous sexual dimorphism (elytral apex more acute in female but conjointly rounded in male); punctural striae deeply notched; strial intervals 1–4 transversely rugose, each with 1–2 rows of pubescence; interval 3 feebly convex basally, with or without pubescent tuft; intervals 5, 7 and 8 carinate, strial interval 8 partially concealing interval 9 in dorsal view. Prosternal process (Figs. 32–33) about ¼ as broad as pronotum, with apex round or truncate. Metasternum (Fig.



Figs. 35–40. 35, *Grouvellinus subopacus*, prosternum. 36, *G. nitidus*, prosternum. 37, *G. pilosus*, male metasternum. 38, *G. babai babai*, male metasternum. 39, *G. pilosus*, abdominal ventrites. 40, *G. hygropetricus*, abdominal ventrites.

37) coarsely shagreened. Abdomen (Fig. 41) with each ventrite densely granulate throughout. Male genitalia (Fig. 50) about 440 µm long; penis conspicuously dilated at basal ⅖ in dorsal view; paramere about 1.4 times as long as basal piece, slightly sinuate dorsally.

Differential diagnosis.—This species is most closely related to *G. marginatus* (Kôno) from Japan. According to Nomura's key (1963), they can be distinguished from each other by their lustre, body size and the elevation and pubescence of elytral strial interval 3 (cf. Figs. 9, 24). Generally it is true that *G. babai* is less shining than *G. marginatus*; however, this character does not apply to old and extremely eroded specimens. The other characters are quite variable in *G. babai.* Valuable and reliable taxonomic characters are in the male genitalia. Male genitalia of *G. babai* are smaller than those of *G. marginatus*; the parameres are wide and short in *G. babai*, but slender and long in *G. marginatus*; the penis of the former has the lateral sides conspicuously sinuous in dorsal view while the latter has them gradually tapering toward apex. A similar situation is also found in *G. caucasicus* vs. *G. rioloides* (cf. Jäch 1990).

Morphologically both *G. babai* and *G. marginatus* can be grouped with *G. caucasicus* (Motschulsky), *G. rioloides* (Reitter), *G. duplaris* Champion and *G. brevior* Jäch by their similar male genitalia and pronotal surface (cf. Jäch 1984, 1990). However a thorough investigation of their synapomorphic characters and phylogenetic relationships is necessary.

Type material.—Holotype ♂ (NSMT): "Nankoson, M. Formosa, 22. Nov. 1962, leg. K. Baba\HOLOTYPE, *Grouvellinus babai* Nomura (1963)"; 2 paratypes, with the same data as holotype (NWU). The remaining paratypes are to be deposited in NSMT, NWU and also possibly in Dr. K. Baba's collection. Besides type material, 416 adults from many localities of Taiwan were also examined.

Distribution.—Widely distributed throughout Taiwan from lowland through montane areas at about 1200 m. They prefer microhabitats with cobbles or rocks encrusted with algae in fast water. Occasionally they can be found in somewhat polluted streams.

Grouvellinus babai satoi, Jeng and Yang, new subspecies

(Figs. 8, 15, 23, 28, 42, 51)

Type locality.—Hakusui-Ke, Takeda, Is. Ishikagi, Japan.

Type series.—Holotype male (NWU), "JAPAN: Is. Ishikagi, Takeda: Hakusui-ke, 17.VII1996, M. L. Jeng leg.". Paratypes (CSUS, NMW, NTU, TARI, NWU): 22 ♂ and 24 ♀, same data with holotype; 5 ♂ and 11 ♀, Is. Iriomote, Nishifunatsuki-gawa, 18.VII.1996, M. Satô leg.; 1 ♂ and 4 ♀, Is. Iriomote, Nishifunatsuki-gawa, 29.X.1997, M. Kimura leg; 1 ♂ and 2 ♀, Is. Iriomote, Kampirei, 23.III.1995, M. Satô leg.; 1 ♂ and 1 ♀, Is. Iriomote, Kampirei, 19.VII.1996, M. Satô leg.

Differential diagnosis.—BL: 1.5–1.7 mm (male), 1.6–1.8 mm (female); BW: 0.7–0.8 mm (both sexes); male genitalia about 340 μm long. This new subspecies is very similar to the nominotypical subspecies from Taiwan except for its much smaller body size and male genitalia (Fig. 51) which do not overlap quantitatively with those of *G. babai babai.* The ventral margin of the paramere is sinuate laterally in *G. babai satoi* but nearly straight in *G. babai babai.* Furthermore, they can be separated from each other by the pronotal surface which is very finely punctate (Figs. 8, 15) in *G. babai satoi* but shagreened in populations of *G. babai babai.* Generally the granulation of the abdominal ventrites of *G. babai satoi* (Fig. 42) is sparser than in *G. babai babai.*

Distribution.—Is. Ishikagi and Is. Iriomote of Japan.

Etymology.—Named for Dr. M. Satô who has immensely contributed to the taxonomy of the water beetles of Japan and the adjacent areas.

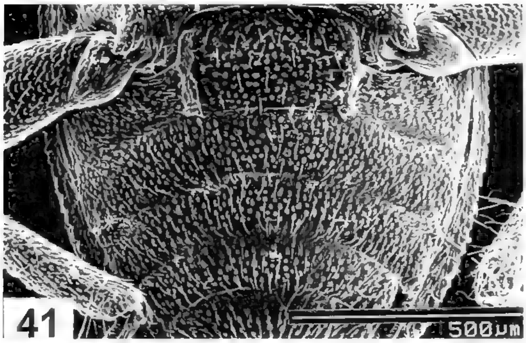
Grouvellinus marginatus (Kôno)

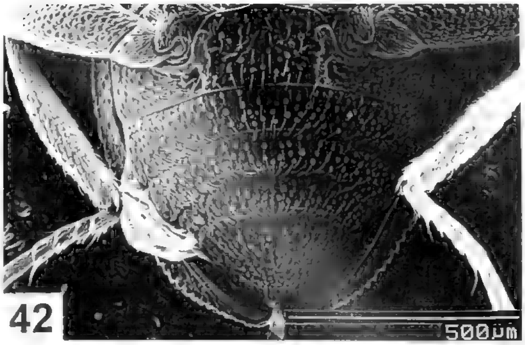
(Figs. 9, 16, 24, 34, 43, 52)

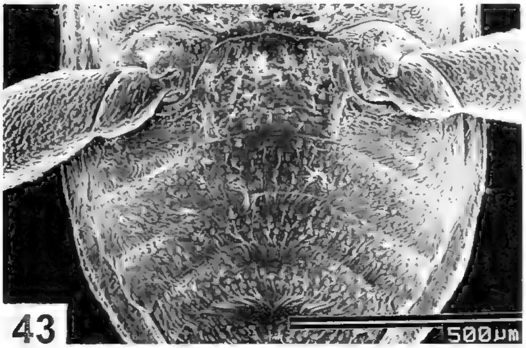
Grouvelleus marginatus Kôno 1934:127.
Grouvellinus marginatus (Kôno): Nomura 1957: 44; 1960:36; 1963: 52; Satô 1965: 83; 1977: 4; 1985: 438.

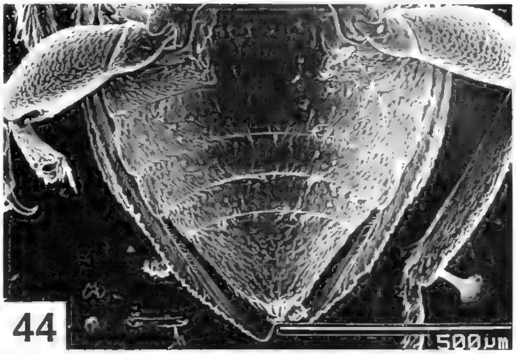
Type locality.—Koyadaira, Awa, Shikoku, Japan.

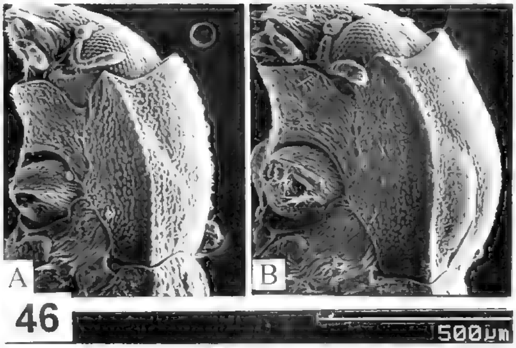
Redescription.—BL: 2.2–2.5 mm, BW: 1.0–1.1 mm. Dorsal surface brown to dark brown, with bronze lustre. Pronotum (Fig. 9) subquadrate or slightly broader than long; evenly convex, with shagreened surface (Fig. 16) similar to G. *babai*; sublateral carinae present; surfaces of each sublateral gibbosity identical to that of the disc. Elytra (Fig. 24) with conspicuous sexual dimorphism (elytral apex more acute in female











Figs. 41–46. 41, *Grouvellinus babai babai*, abdominal ventrites. 42, *G. babai satoi*, abdominal ventrites. 43, *G. marginatus*, abdominal ventrites. 44, *G. subopacus*, abdominal ventrites. 45, *G. nitidus*, abdominal ventrites. 46A, *G. montanus*, evenly convex pronotum. 46B, *G. nitidus*, strongly convex pronotum.

but conjointly rounded in male); posterolateral margin very weakly crenate; punctural striae deeply notched; surface of strial intervals 1–4 transversely rugose; the 3rd interval broadly elevated at base where it bears a tuft of golden pubescence; interval 5 granulate; intervals 7 and 8 carinate; interval 9 partially concealed by interval 8 in dorsal view. Prosternal process (Fig. 34) about as broad as ⅓ width of the pronotum, with apex rounded. Metasternum coarsely shagreened. Abdominal ventrites I–V (Fig. 43) with surface moderately granulate. Male genitalia (Fig. 52) about 500 µm long; paramere elongate and slender, 1.9 times longer than basal piece; penis gradually tapering toward apex, and slightly sinuate near apex.

Type material.—Lectotype ♂ (here designated, DEI), "Shikoku: Awa, Koyadaira: Japon: 31-7-13 Edme Gallois\Syntypus\ *Grouvelleus marginatus* Kôno det. H.

Kôno\DEI Eberswalde\Microdes marginatus Kono\LECTOTYPE *Grouvellinus marginatus* (Kôno) des. Jeng and Yang 1997." One male and a female paralectotypes with the same data as holotype (DEI); 2 paralectotype females, "Shikoku: Awa, Koyadaira: Japon: 29-7-13\Paratype *Grouvelleus marginatus* Kôno" (handwriting, NWU). The depository of the remaining paralectotypes, neither in NSMT nor in Hokkaido University, is unknown.

Material examined.—1, Okube, Mie Pref., 28.XI.1965, M. Satô; 2, Nr. Nisumi, Shimane Pref., 27.VII. 1979, T. Shimomura; 1, Ozegahara, Gumma Pref., Aug. 20–24, 1979, M. Satô leg.; 1, Sai-kawa, Ishikawa Pref., 27.V.1976, R. Ohgushi (NWU and NTU); 4, "Japan, Sakaguchi\Kishu (in Chinese), VI. 1931\Grouvelleus marginatus Kono, 1934, det. H. Kono" (NSMT, examined by K. Mizota).

There were sixty-six specimens denoted by Kôno as "types," but no holotype was mentioned in the original description. Gaedike (1985) indicated that there are 3 syntypes deposited in DEI. It is interesting that the type material from NWU bears handwritten "paratype" labels. It is possible that Kôno had labeled a "holotype" from the type series by himself.

Differential diagnosis.—This species is quite similar to *G. babai*. The most reliable characters to separate them are in the male genitalia which have been described above.

Distribution.—Japan (Honshu, Shikoku, Kyushu, Yaku-shima).

Grouvellinus subopacus Nomura
(Figs. 10, 17, 25, 27, 35, 44, 53)

Grouvellinus subopacus Nomura 1962: 48; 1963: 52; Satô 1964: 5; 1965: 83; 1977: 5; 1985: 438.

Type locality.—Taken, Amami-Ôshima, Japan.

Redescription.—BL: 1.6–1.8 mm, BW: 0.7–0.9 mm. Dorsal surface dark brown, with very weak lustre; femur and tibia reddish brown. Pronotum (Fig. 10) evenly convex; surface (Fig. 17) densely and superficially punctate, very similar to that of *G. babai satoi*; sublateral carinae present; each sublateral gibbosity with surface coarsely granulate. Elytra (Fig. 25) comparatively wide, EL/EW about 1.3–1.4; elytral apex of female somewhat broadly rounded, but still acute than that of male; posterolateral margin serrate; punctate striae deeply notched, stria 6 with punctures separated from each other longitudinally by a noticeable granule; strial intervals 1–2 broad and flat, with surface irregularly rugose; interval 3 weakly convex basally, without pubescent tuft on base but with a row of superficial granules along interval; interval 5 similar to 7, composed of a noticeable granulate row; strial interval 9 entirely concealed by interval 8 from dorsal view. Prosternal process (Fig. 35) about ¼ as wide as pronotum, with apex broadly rounded. Abdominal ventrites (Fig. 44) with central disc nearly bare and sparsely granulate but sublateral areas thickly covered with plastron and densely granulate. Tarsus usually shorter than tibia in middle and hind legs. Male genitalia (Fig. 53) about 430 μm long; penis surpassing parameres, dilated at basal ⅓ and gradually tapering toward apex in dorsal view; parameres slender and elongate, 1.6 times longer than basal piece, with ventral margin nearly straight in lateral view.

Material examined.—2, (Ryukyus), Yona, Okinawa, 13 VIII 1969, Y. Hori leg.; 1, Is. Okinawa, Kunigami, Tima-gawa, 22.VII.1996;1, Is. Okinawa, Kunigami, Hiji-gawa, 21.VII.1996; 4, Is. Okinawa, Ohgimi, Taiho-gawa, 21. VII. 1996. The holotype female was not examined; it is possibly deposited in NSMT.

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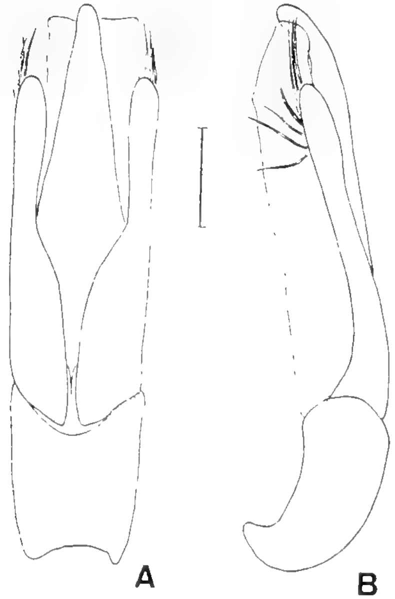
Figs. 47–50. Male genitalia; A = dorsal aspect, B = lateral aspect. 47, *Grouvellinus pilosus*, paratype from type locality. 48, *G. montanus*, paratype from type locality. 49, *G. hygropetricus*, paratype from type locality. 50, *G. babai babai*, specimen from Ilan County.



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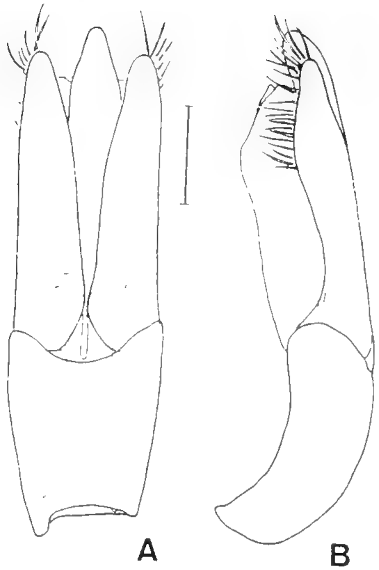

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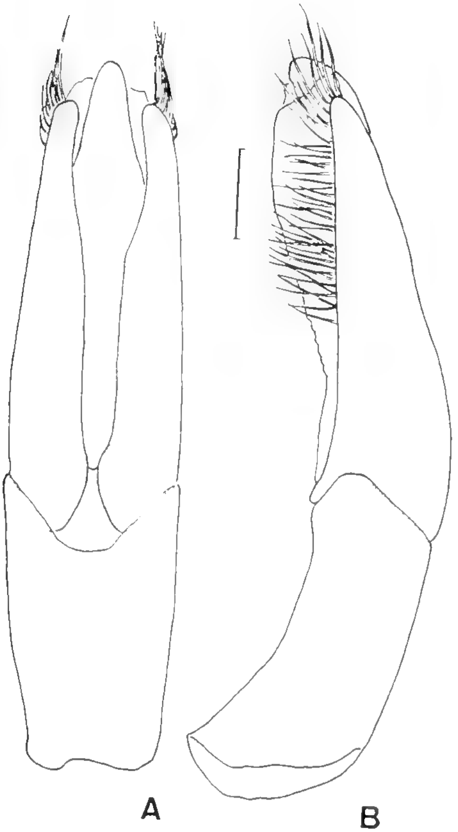

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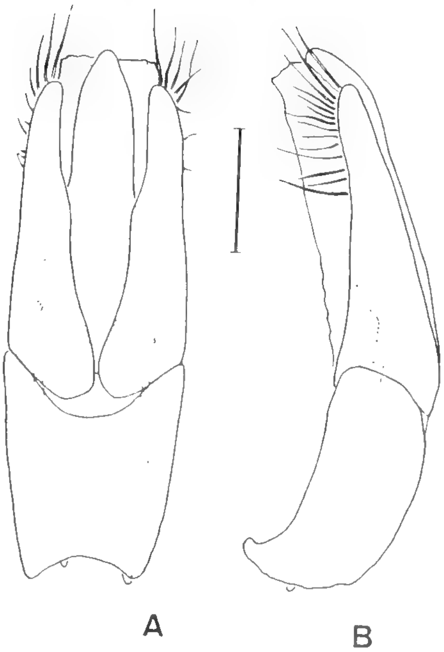

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Differential diagnosis.—This species is characterized by its small and broad body, densely punctate surface of the pronotum, granulation of elytral stria 6 and strial interval 3, and its male genitalia. Furthermore it is the smallest species possessing the sublateral carina of the pronotum and the elevated strial interval 5 of elytra. *Grouvellinus babai satoi* possesses many features similar to *G. subopacus*, but they can be easily distinguished from each other by their body form (Figs. 27 vs. 28) and the male genitalia.

Nomura (1962, 1963) stated that the first four strial intervals of the elytra of this species are flat, and denoted it as one of the key characters to distinguish it from other congeners from Japan and Taiwan. However, all material from Okinawa we examined do have their interval 3 more or less convex basally; it is possibly a geographic variation. In addition, Nomura also described that the tarsus is shorter than the tibia in this species. It is generally true that this character is stable in this species, but it is not a useful feature due to its instability in other species.

The phylogenetic affinity of *G. subopacus* is still in question. Although this species looks very different from *G. babai satoi* in body shape and male genitalia, it is interesting that the pronotal surface and the structure of elytral stria 6 is similar to that of *G. babai satoi*. Whether these characters possess phylogenetic value needs more thorough investigation.

Distribution.—Japan (Amami-Ôshima, Tokuno-shima, Is. Okinawa).

Grouvellinus nitidus Nomura
(Figs. 11, 18, 26, 36, 45, 46B, 54)

Grouvellinus nitidus Nomura 1963: 52; Satô 1977: 4; 1985: 438.

Type locality.—Ryûzu, Nikko, Honshu, Japan.

Redescription.—BL: 2.1–2.3 mm, BW: 1.0–1.1 mm. Dorsum dark brown with strong lustre. Pronotum (Fig. 46B) strongly convex at basal ⅖; surface (Figs. 11, 18) smooth and shining, sparsely granulate; sublateral carinae present; each sublateral gibbosity weakly and sparsely punctate. Elytra (Fig. 26) with conspicuous sexual dimorphism (elytral apex more acute in female but conjointly rounded in male); striae deeply notched; intervals weakly wrinkled; interval 3 broadly and distinctly elevated at base and usually with a tuft of pubescence in young adults; interval 5 with a row of granules; intervals 7–8 carinate. Prosternal process (Fig. 36) a little narrower than ¼ pronotal width, with apex rounded. Abdominal ventrites (Fig. 45) sparsely granulate on central disc but becoming denser on sublateral areas; plastron present on sublateral sides of each ventrite and apical areas of ventrites II–V, but absent on discs. Male genitalia (Fig. 54) about 670 µm long, general appearance quite similar to those of *G. hygropetricus*. but a little smaller; penis broadest at basal ¼ and thence gradually tapering toward apex in dorsal view, apical part slender in lateral view; parameres long and slender, widely separated dorsally, with ventral margin weakly sinuous in lateral view; paramere about 1.9 times as long as basal piece.

Variation.—The pubescence pattern of the elytra is very variable. According to Nomura's (1963) key, the pubescence on intervals 1 and 3 is fine and indistinct; but this is in contrast to the individual shown in Fig. 26 of which pubescent tuft is dense and distinct.

Type material.—Paratypes: 5: "Mamogawa-toge, Niigata Pref., 9. VIII.1961, M.

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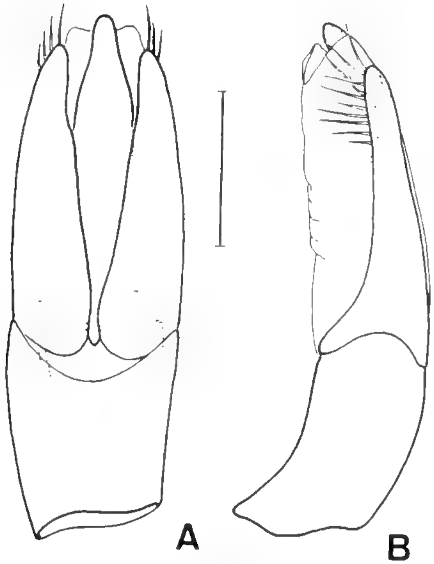
Figs. 51–54. Male genitalia; A = dorsal aspect, B = lateral aspect. 51, *Grouvellinus babai satoi*, paratype from type locality. 52, *G. marginatus*, specimen from Shimane Pref. 53, *G. subopacus*, specimen from Is. Okinawa. 54, *G. nitidus*, paratype from Mamogawa-toge.



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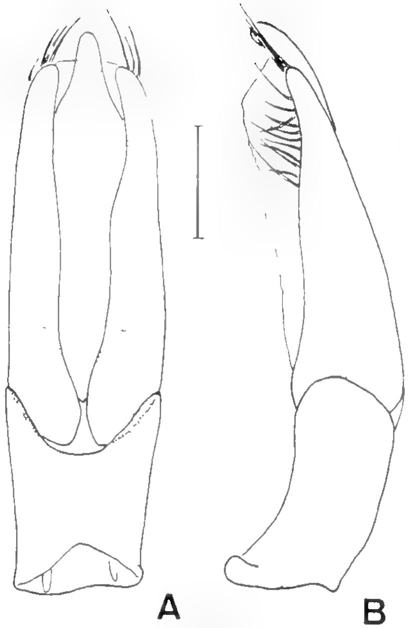

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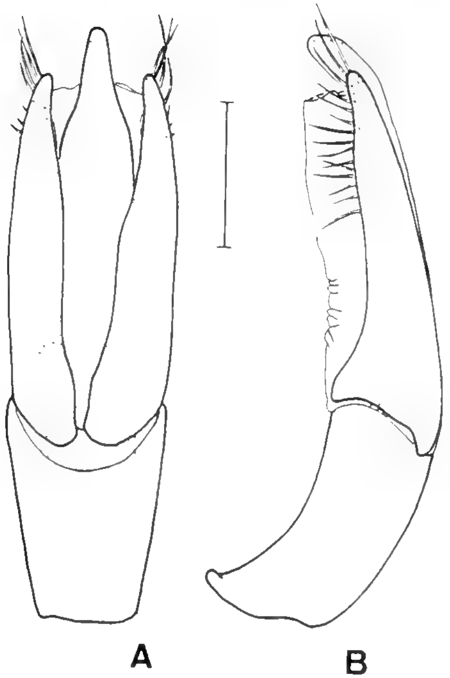

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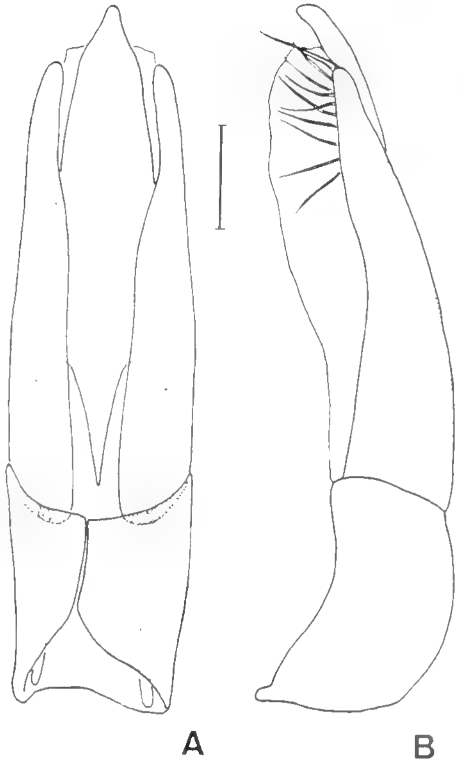

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Satô leg.\PARATYPE *Grouvellinus nitidus* Nomura (1963)" (NWU and NTU). The holotype male was not examined; it is deposited in NSMT; the remaining paratypes are in NSMT and NWU.

Differential diagnosis.—This species resembles *G. montanus* from Taiwan in the smooth surface and granulation pattern of the pronotum. It can be distinguished from *G. montanus* by its distinctive shape, the larger size of the male genitalia, and the scarcely granulate surface of the sublateral gibbosity of the pronotum. The male genitalia of this species is also somewhat similar to that of *G. hygropetricus*. The basal piece of *G. nitidus* is comparatively short while that of *G. hygropetricus* is long. In addition, they can be separated from each other by the surface of the pronotal gibbosity which is smoother in *G. nitidus* but roughly granulate in *G. hygropetricus*.

Distribution.—Japan (Honshu).

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Sincere thanks are due to Dr. M. Satô (NWU), Dr. M. A. Jäch (NMW) and Dr. L. Zerche (DEI) for sending us specimens for investigation. We are also obliged to Dr. M. A. Jäch, Mr. D. S. Boukal (Czech Academy of Science), Dr. H. P. Brown (OMNH) and Dr. W. D. Shepard (CSUS) for reading the manuscript. Mr. K. Mizota (Hokkaido University) helped check specimens in NSMT; Miss Shao-Shi Jen, Mrs. Jin-Yen Lin and Mr. Ji-Yuan Tang assisted in taking SEM micrographs. This study was financially supported by the National Science Council, grant no. NSC86-2313-B002-079.

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DISCOVERY, ABUNDANCE, AND DISTRIBUTION OF THE EXOTIC APPLE TORTRIX, *ARCHIPS FUSCOCUPREANUS* WALSINGHAM (LEPIDOPTERA: TORTRICIDAE), IN THE NORTHEASTERN UNITED STATES

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Abstract.—The apple tortrix, *Archips fuscocupreanus* Walsingham, has infested unsprayed apple, *Malus domestica* Borkhausen, at Hamden, New Haven Co., Connecticut, since at least 1982. Adults reared in 1982 represent the first North American records of this Oriental pest of fruit trees. Among 10 tortricids on unsprayed apple trees at Hamden, the apple tortrix rated fourth in abundance, comprising 8.6% of 255 larvae sampled in May 1997. To determine the geographic range of the apple tortrix, pheromone-baited wing traps were placed in unsprayed trees of apple or crab-apple, *Malus* spp., at 30 sites in Connecticut and at one or more sites in 25 other states in the eastern United States. In addition, tortricid adults reared from larvae collected on rosaceous plants in southern New England were examined. Based on our evidence from the eastern United States, the apple tortrix currently is known from four counties in Connecticut and one in Massachusetts. All of the locations are within 15 km of the Atlantic Ocean. Pheromone traps used in the survey also attracted the red-banded leafroller, *Argyrotaenia velutinana* (Walker), and *Phtheochroa riscana* (Kearfott), which, like the apple tortrix, are species of Tortricinae. The apple tortrix may be spread to new areas by the transport of nursery plants infested with the inconspicuous black egg masses.

Key Words: abundance, apple, apple tortrix, *Archips fuscocupreanus*, distribution, exotic pest, Tortricidae

Immigrant insects have had a profound and lasting effect upon agriculture in North America and elsewhere. Every year new pests are detected, and researchers begin to explore methods to limit their impact. The coding moth, *Cydia pomonella* (Linnaeus), and the Oriental fruit moth, *Grapholita molesta* (Busck), are notorious exotic tortricids that have increased the cost of managing fruit orchards in North America. These are only two examples of 31 exotic tortricid species known to be established in North America (Miller 1997). In this report, we increase the total to 32 by documenting that the apple tortrix, *Archips fuscocupreanus* Walsingham, is present in the northeastern United States where it may pose a new threat to the fruit and nursery industries.

The apple tortrix is a pest of fruit and ornamental trees in Japan and Korea (Oku 1967, Yasuda 1975, Sekita et al. 1994). Oku (1967) has reported that the larvae have a broad host range, attacking plants in more than 10 families. Oku (1967, 1970), Yasuda (1975), Sekita and Yamada (1990), and others have presented details of the life history. In Japan, the apple tortrix is univoltine, overwintering as an egg in a black egg mass. In spring, larvae hatch and feed on leaves, and later on flowers and fruits. Larvae may use all of these plant parts to construct their shelters. The distinctive last-instar larvae have an orange or brownish orange head. Adults emerge during early summer, and after mating females lay eggs in masses on trunks and branches of woody plants. According to Oku (1967), adults fly from late June to early August. Sekita and Yamada (1990) have reported a shorter flight period of mid-June to early July.

Here we document that *A. fuscocupreanus* has been in the United States since at least 1982. In addition, we give details of its relative abundance at the site of its first collection and describe its distribution in the eastern United States.

MATERIALS AND METHODS

Identification.—Adult males were identified by comparing the pattern and coloration of forewings, the costal fold of the forewings, and genitalia to descriptions and illustrations in the Japanese literature (Yasuda 1975) and to specimens examined at the Smithsonian Institution. *Archips fuscocupreanus* and the similar European (or filbert) leafroller, *A. rosanus* (Linnaeus), may inhabit plants at the same locality; however, males of these two can be separated easily by the size of the male costal fold (Fig. 1). Voucher specimens of adults are deposited at The Connecticut Agricultural Experiment Station, New Haven, at the National Museum of Natural History, Smithsonian Institution, Washington, D.C., and at The Natural History Museum, London. The first specimens from North America are deposited at The Connecticut Agricultural Experiment Station.

Relative abundance.—On 21 May 1997, the relative abundance of tortricid larvae in an orchard of unsprayed apple trees, *Malus domestica* Borkhausen, at Lockwood Farm, Hamden, New Haven Co., Connecticut, was determined by sampling 10 randomly selected trees for 10 min/tree. Larvae were confined singly in translucent plastic portion cups (Comet Products, Chelmsford, MA) with apple foliage, and were reared to adults to confirm their identity. The cups (28 ml) were placed in plastic trays (Bio-Serv, Frenchtown, NJ) in clear plastic boxes (23 × 31 × 10.5-cm [high]) with 25 ml of water in the bottom to increase humidity. Foliage was replaced twice weekly. Larvae were kept in a room adjusted to 21 ± 1°C and a 15L:9D photoperiod.

Distribution.—Distributional records for *A. fuscocupreanus* are based on adults reared from larvae or captured in pheromone traps. In 1997, larvae were sampled at one site in Massachusetts and two in Connecticut, and reared to adults as described above. Additional records of reared *A. fuscocupreanus* were obtained by identifying tortricid adults in the insect collection at The Connecticut Agricultural Experiment Station.

In 1997, pheromone-baited Pherocon IC wing traps (Trécé, Inc., Salinas, CA) were monitored by the senior author in Connecticut and by cooperators in 25 other states in the eastern United States (Fig. 2). Each trap was baited with a gray rubber sleeve stopper (#1888, West Co., Lionville, PA) impregnated with 0.8 mg (*Z*)-11-tetradecenyl acetate (Albany International, Needham Heights, MA) and 0.2 mg (*E*)-11-tetradecenyl acetate (Pherobank Wageningen, Wageningen, The Netherlands), which were dissolved in hexane before dispensing them onto each stopper (100 μl/stopper). Ando et al. (1981) found that this blend of chemicals attracted males of the apple tortrix in Japan. Lures were suspended about 2–3 cm below the top of the traps in plastic lure holders (USDA holders used in the National APHIS, PPQ Exotic Pest Detection Program). A single trap was used at each trapping location except Hamden where four traps were deployed. Each trap was hung at a height of 1.5–2 m above ground in an unsprayed tree of apple or crab-apple, *Malus* spp., about 4–6 weeks after bloom. Bloom across the eastern United States was estimated by survey participants. Traps in

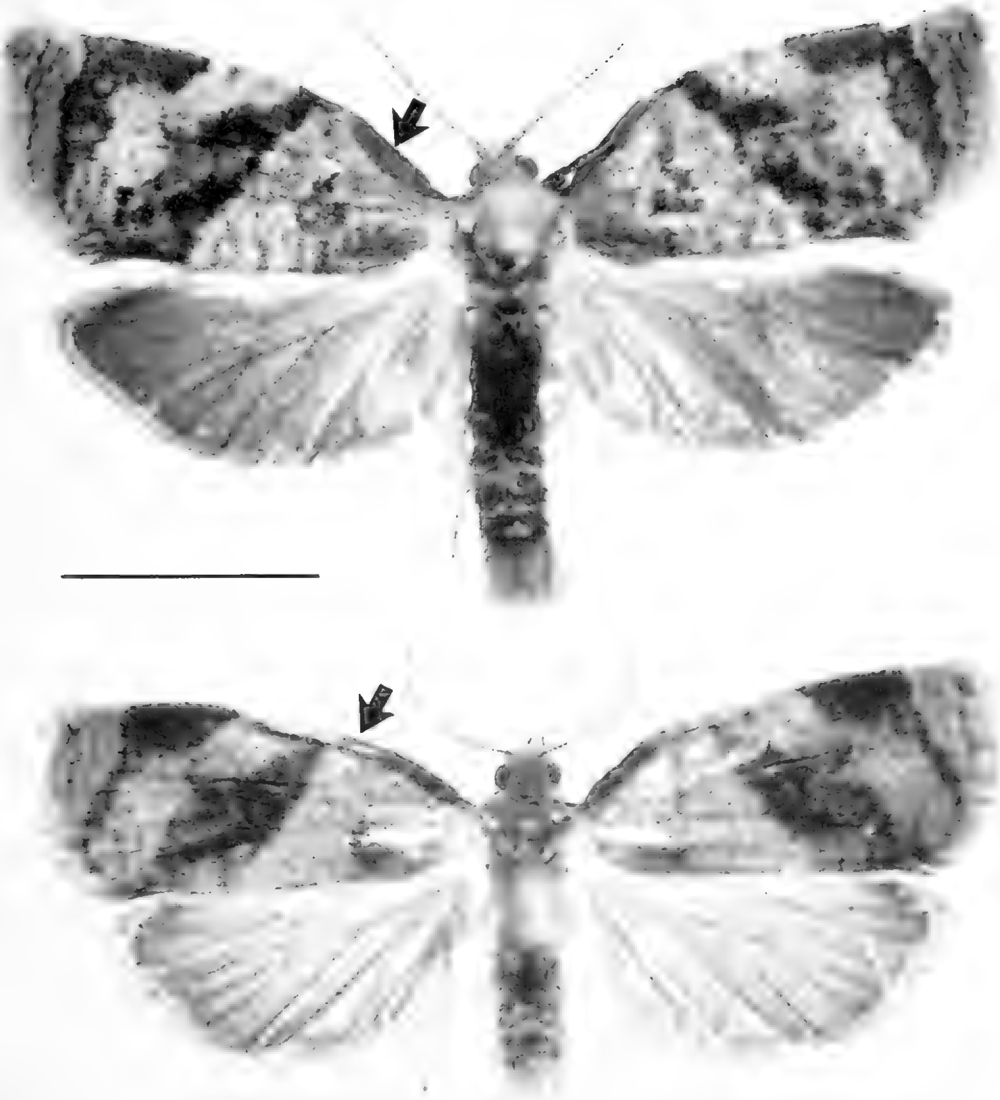

Fig. 1. Adult males of the apple tortrix, *Archips fuscocupreanus* (top), and the European leafroller, *A. rosanus* (bottom). Arrows point to the costal fold. The costal fold of *A. fuscocupreanus* is thick and extends about one-third of the length of the costal margin of the forewing, whereas that of *A. rosanus* is comparatively thin and extends about one-half of the length of the costal margin. Horizontal line = 5 mm.

Fig. 2. Location of pheromone-baited wing traps operated for 4 weeks in June and July 1997 to detect the apple tortrix, *Archips fuscocupreanus*. Each solid circle indicates a county where one or more pheromone traps were placed.

Connecticut and northward were deployed after the first catch on the night of 19–20 June in the traps at Hamden. Unless otherwise stated, all traps remained in the field for 4 weeks, and bottoms were changed after 2 weeks. To prevent the accidental introduction of insects into new areas, trap bottoms were frozen before they were shipped to Connecticut to be examined.

RESULTS AND DISCUSSION

Discovery and relative abundance at Hamden.—Based on two adults reared from larvae collected on unsprayed apple trees,

Table 1. Relative abundance (% total) of tortricid larvae sampled on 10 unsprayed apple trees at Lockwood Farm, Hamden, Connecticut, on 21 May 1997.

Species	No. larvae ± SE/tree	% Total larvae
Archips fuscocupreanus Walsingham	2.2 ± 1.7	8.6
A. griseus (Robinson)	0.3 ± 0.2	1.2
Choristoneura rosaceana (Harris)	0.2 ± 0.2	0.8
Hedya chionosema (Zeller)	0.4 ± 0.2	1.6
H. dimidioalba (Retzius)[1]	0.9 ± 0.3	3.5
Olethreutes malana (Fernald)	2.6 ± 0.5	10.2
Pandemis limitata (Robinson)	0.1 ± 0.1	0.4
Pseudexentera mali Freeman	4.3 ± 1.0	16.9
Spilonota ocellana (Denis & Schiffermüller)	14.4 ± 0.5	56.5
Unknown tortricine	0.1 ± 0.1	0.4
Total larvae	255	

[1] Senior synonym of *H. nubiferana* (Haworth)

the apple tortrix has been present at Lockwood Farm, Hamden, New Haven Co., Connecticut, since at least 1982. These moths are the first North American specimens of this exotic tortricid. Additional adults were reared from larvae collected on apple at Hamden in 1983, 1984, and 1994–97.

On 21 May 1997, ten species of tortricid larvae were collected on apple trees at Hamden (Table 1). Among the 10 species, the apple tortrix rated fourth in abundance. This exotic tortrix is now common at this Hamden site where it was first found.

Distribution.—The apple tortrix was identified among tortricid adults reared from larvae, captured in pheromone traps, or both in four counties in Connecticut and in one county in Massachusetts (Fig. 3). All of these counties border the Atlantic Ocean, and every population of the apple tortrix is located within 15 km of the ocean. We suspect that additional populations will be found in other coastal counties between Massachusetts and northern New Jersey. The apple tortrix also is established in six coastal counties in the state of Washington (E. LaGasa, personal communication).

Pheromone traps captured not only *Archips fuscocupreanus,* but also the red-banded leafroller, *Argyrotaenia velutinana* (Walker), and *Phtheochroa riscana* (Kearfott) (Table 2), both of which easily can be distinguished from the apple tortrix. No males of *Archips rosanus* were captured in pheromone traps. In Connecticut, the number of trapped adults ranged from 0–105 for *Archips fuscocupreanus,* 0–59 for *Argyrotaenia velutinana,* and 0–17 for *P. riscana. Archips fuscocupreanus* was captured at 6/28 (21.4%) sites, *Argyrotaenia velutinana* at 26/28 (92.9%) sites, and *P. riscana* at 22/28 (78.6%) sites. Males of the red-banded leafroller apparently entered the traps because the lures had two chemicals that are major components of the female sex pheromone (Roelofs et al. 1975).

Based on this survey, the apple tortrix has a limited distribution in the northeastern United States. Its ability to migrate and colonize new areas is unknown. The preference of females to oviposit on the bark of trees, however, raises the concern that the movement of nursery stock may spread the apple tortrix to new areas. The long-term impact of this exotic moth on cultivated and wild trees is unknown, but, based on its damage and host range in Japan (Oku 1967, 1970; Sekita et al. 1994), it is likely to attain pest status in North America. If the apple tortrix achieves pest status, it could disrupt ongoing and developing IPM programs in North American fruit orchards.

DISTRIBUTIONAL DATA

Localities are given by state, county, and nearest town. Multiple towns listed after

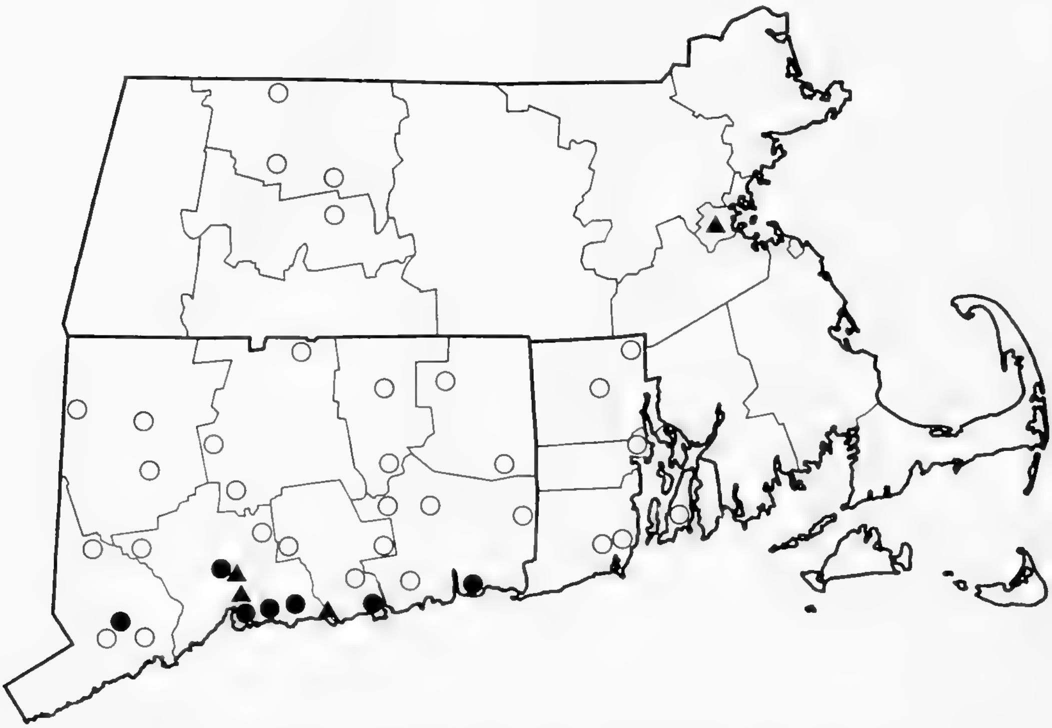

Fig. 3. Distribution of the apple tortrix, *Archips fuscocupreanus*, in southern New England. Solid circles show where males were captured in pheromone traps; hollow circles indicate where males were not captured in traps. Solid triangles show where larvae were collected and reared to adults.

some counties represent different sites. If two localities in one town were surveyed, additional information is given. Records of reared moths include the host plant and the date of larval collection; only rearing records before 1995 and the first records for a locality are reported here. For sites with the apple tortrix, the number of moths captured in pheromone traps or reared is enclosed in parentheses.

Rearing records.—CONNECTICUT: New Haven Co., Hamden, *Malus domestica*, 20 May 1982 (2), late May 1983 (1), 4 June 1983 (1), 21 May 1984 (18), 27 May 1994 (3); Madison, *Rosa rugosa* Thunberg, 2 June 1997 (2); New Haven, East Rock Park, *Prunus serotina* Ehrhart, 8 June 1983 (3), 8 June 1984 (4). MASSACHUSETTS: Suffolk Co., Jamaica Plain, *Prunus salicina* Lindley, 4 June 1997 (2).

Positive trapping records.—CONNECTICUT: New London Co., Groton, 26 June–1 July (2). See Table 2 for the six additional Connecticut localities where moths were captured in pheromone traps.

Negative trapping records.—ARKANSAS: Benton Co., Rogers. CONNECTICUT: see Table 2. DELAWARE: Kent Co., Rising Sun; New Castle Co., Newark. GEORGIA: Union Co., Blairsville. ILLINOIS: Champaign Co., Urbana. INDIANA: La Porte Co., Waterford; Porter Co., Washington; Tippecanoe Co., West Lafayette. KENTUCKY: Boone Co., Hebron; Woodford Co., Pinckard, Pisgah. MAINE: Kennebec Co., Winthrop. MARYLAND: Montgomery Co., Burtonsville. MASSACHUSETTS: Franklin Co., Colrain, Conway, Leverett; Hampshire Co., Amherst. MICHIGAN: Grand Traverse Co., Williamsburg; Leelanau Co., Suttons Bay; Manistee Co., Onekama; Mason Co., Ludington; Oakland Co., Clarkston; Oceana Co., Shelby. MISSISSIPPI: Oktibbeha Co.,

Table 2. Number of the three most abundant Tortricidae (Tortricinae) caught in pheromone traps in Connecticut during 4 weeks in June and July 1997. Abbreviations: AT = apple tortrix, *Archips fuscocupreanus*; RBLR = red-banded leafroller, *Argyrotaenia velutinana*, and PR = *Phtheochroa riscana*.

			Number of moths[1]		
County	Town	Trapping dates	AT	RBLR	PR
Fairfield	Brookfield	25 June–22 July	0	2	2
	Easton[2]	25 June–22 July	6	16	1
	Easton[3]	25 June–22 July	0	46	11
	Trumbull	25 June–22 July	0	22	2
Hartford	Burlington	25 June–22 July	0	3	0
	Southington	23 June–20 July	0	26	2
	Suffield	25 June–22 July	0	5	3
Litchfield	Goshen	25 June–22 July	0	1	0
	Morris	25 June–22 July	0	3	2
	Sharon	25 June–22 July	0	13	0
Middlesex	Deep River	23 June–20 July	0	14	1
	Durham	25 June–22 July	0	44	1
	East Haddam	23 June–20 July	0	22	15
	Old Saybrook	23 June–20 July	14	5	5
New Haven	Branford	23 June–20 July	10	33	3
	Guilford	23 June–20 July	2	15	2
	Hamden[3]	19 June–16 July	75	—[4]	—[4]
	Meriden	23 June–20 July	0	36	1
	New Haven	27 June–24 July	105	0	10
	Southbury	25 June–22 July	0	31	1
New London	Bozrah	23 June–20 July	0	50	6
	Colchester	23 June–20 July	0	9	8
	East Lyme	23 June–20 July	0	59	17
	Voluntown	23 June–20 July	0	4	0
Tolland	Columbia	23 June–20 July	0	26	13
	Tolland	23 June–20 July	0	0	0
Windham	Eastford	23 June–20 July	0	2	0
	Plainfield	23 June–20 July	0	55	3

[1] Four pheromone traps were operated at Hamden, and one at all other sites.

[2] Orchard Lane, Slady Orchard.

[3] State Road 58, Aspectuck Valley Orchard.

[4] Species was present but not counted.

Mississippi State. MISSOURI: Howard Co., New Franklin; Wright Co., Mt. Grove. NEW HAMPSHIRE: Cheshire Co., Walpole; Hillsborough Co., Lyndeborough; Rockingham Co., Deerfield, Londonderry. NEW JERSEY: Cumberland Co., Deerfield. NEW YORK: Columbia Co., Taghkanic; Dutchess Co., LaGrange; Monroe Co., Brockport; Niagara Co., Appleton; Ontario Co., Geneva; Orleans Co., Albion; Rensselaer Co., Castleton-on-Hudson; Wayne Co., Williamson, Wolcott. NORTH CAROLINA: Henderson Co., Hendersonville; Wake Co., Raleigh. OHIO: Hancock Co., Fostoria; Seneco Co., New Riegel. PENNSYLVANIA: Adams Co., Fairfield; Centre Co., State College; Perry Co., New Bloomfield. RHODE ISLAND: Kent Co., Warwick; Newport Co., Middletown; Providence Co., Cumberland, Greenville; Washington Co., Kingston, East Farm, Mark Glen Court. SOUTH CAROLINA: Charleston Co., Mt. Pleasant; Colleton Co., Hendersonville; Greenville Co., Simpsonville; Horry Co., Conway; Lexington Co., West Columbia; Marlboro Co., Bennettsville. TENNESSEE: Dyer Co., Dyersburg; Fayette Co., Somerville; Grundy Co., Tracy City; Haywood Co., Stanton; Jefferson Co., Strawberry Plains; Knox Co., Knoxville;

Madison Co., Jackson; Obion Co., Shawtown; Williamson Co., Nolensville. VERMONT: Addison Co., West Cornwall; Chittenden Co., Burlington; Windham Co., Putney. VIRGINIA: Augusta Co., Steeles Tavern; Craig Co., New Castle. WEST VIRGINIA: Jefferson Co., Bardane, Kearneysville; Nicholas Co., Summersville. WISCONSIN: Dane Co., Madison; Milwaukee Co., Milwaukee.

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REVISION OF NORTH AMERICAN *ALEIODES* WESMAEL (PART 4): THE *ALBITIBIA* HERRICH-SCHAEFFER AND *PRAETOR* REINHARD SPECIES-GROUPS (HYMENOPTERA: BRACONIDAE: ROGADINAE) IN THE NEW WORLD

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Abstract.—The *Aleiodes albitibia* Herrich-Schaeffer species-group is defined to include one Holarctic species, *A. albitibia* Herrich-Schaeffer, recorded here for the first time in North America. The *Aleiodes praetor* Reinhard species-group is defined to include *A. texanus* Cresson, *A. graphicus* (Cresson), **n. comb.**, and ***A. ceratomiae* Marsh and Shaw, n. sp.** *Aleiodes fumipennis* Cresson is a **new synonym** of *A. texanus* Cresson. The *A. albitibia* species-groups is regarded as monophyletic based on a smooth and polished mesopleuron and an unusual feature of the mummification process: an inflated bubble-like area is formed anteriorly in the notodontid hosts. The *A. praetor* species-group is regarded as monophyletic based on the strongly sinuate hindwing vein RS, compact flagellomeres, large ocelli, and parasitism of Sphingidae. The *A. albitibia* and *A. praetor* groups share an unusual feature of the mummification process: decapitation of the host larva. A key to the New World species of the *A. praetor* species-group is provided, and species treatments are given for Nearctic species, including diagnostic characters, distribution, and biological information.

Key Words: Braconidae, *Aleiodes*, parasitoids, revision

The rogadine braconid genus *Aleiodes* Wesmael is worldwide in distribution, but is particularly species-rich in the Holarctic Region. *Aleiodes* is diverse in North America, with at least 90 species in the United States and Canada (Shaw et al. 1997). This paper is the fourth contribution in a series of papers on *Aleiodes* species-groups, intended to provide a complete revision of the genus for North America (Shaw et al. 1997, Shaw et al. 1998, Marsh and Shaw 1998). In this paper we treat two distinctive monophyletic assemblages, the species of the *Aleiodes albitibia* and *praetor* species-groups, as they occur in North America. Our definition of species-groups includes all species known to us, worldwide. However, because our main intent is to provide a revision for species occurring in the United States and Canada, species treatments are limited to the Nearctic fauna. The European species are currently being revised by Kees van Achterberg and Mark Shaw.

Aleiodes species are koinobiont endoparasitoids of lepidopteran larvae, especially macrolepidoptera of the superfamilies Noctuoidea and Geometroidea, and to a lesser extent, Arctioidea, Sphingoidea, and Papilionoidea (Shaw et al., 1997). The method of parasitism, unique to the tribe Rogadini, is noteworthy: the *Aleiodes* larva completes its feeding and pupates within the shrunken and mummified remains of the host caterpillar (Figs. 1, 2). In most cases, the form of the mummy caused by a particular *Aleiodes* species is characteristic for that host and parasitoid, so the mummified remains are of considerable diagnostic and phylogenetic value and should be retained with the parasitoid, when reared. For more complete discussions of *Aleiodes* biology, readers may refer to Shaw (1983, 1994), Shaw and Huddleston (1991), Shaw (1995), and Shaw et al. (1997).

Members of the *albitibia* group are restricted to parasitism of Notodontidae, and have a smooth and highly polished mesopleuron (Fig. 14). An unusual feature of this group is that an inflated bubble-like area is formed anteriorly in the mummified host larva (Fig. 1). Shaw (1983) speculated that this may be an adaptation allowing the host mummy to float in marshy habitats. Members of the *praetor* group are restricted to parasitism of Sphingidae, have a strongly sinuate RS vein in the hindwing (Fig. 17) that sometimes nearly reaches the wing margin, large ocelli (Figs. 10–12), and compact flagellomeres (Fig. 13). These are the only *Aleiodes* known to parasitize sphingids, so the caudal horn of the mummy is of great diagnostic value (Fig. 2). Sometimes the caudal horn falls off as the mummy overwinters, but a distinct socket is still present. The *albitibia* and *praetor* groups may be sister-taxa, since they include the only *Aleiodes* species that cause decapitation of the host larva during the mummification process. Sometimes the host head capsule remains attached by a thin strip of cuticle, but it usually falls off as the mummy overwinters. Therefore these are the most common groups where host mummies are normally found with head capsules missing (Figs. 1, 2). In other species-groups, to a limited extent, the host head capsule may be lost as the mummy ages and is exposed to weather. However, in these cases it appears to be a more random and irregular event.

METHODS

Species covered in this paper can be identified as members of the subfamily Rogadinae using the keys of Shaw and Huddleston (1991) or Shaw (1995). Our definition of *Aleiodes* follows that of van Achterberg (1991), Shaw (1993), and Shaw et al. (1997). Specimens can be determined as *Aleiodes* using the keys of Marsh et al. (1987), van Achterberg (1991), or Shaw (1997). Specimens keyed through Marsh et al. (1987) will key to couplet 185, at which point they can be separated from *Rogas* by the presence of a discrete median carina on the propodeum (Figs. 4, 6, 8), the lack of a foveate sternaulus on the mesopleuron, and the lack of a blunt basal tooth on the tarsal claw. In practice, more than 99% of U.S. and Canadian specimens encountered will be *Aleiodes*, as *Rogas* is only infrequently encountered north of Mexico. The species-groups of *Aleiodes* from North American north of Mexico can be keyed using the key provided in Shaw et al. (1997).

Morphological terminology follows that of Marsh (1989), Shaw (1993), Goulet and Huber (1993), and Shaw et al. (1997). Microsculpture terminology follows that of Harris (1979). A complete labeled diagram of wing veins was provided by Shaw et al. (1997), and veins of particular importance for the *praetor* species-group are indicated on figures 3, 5, and 7.

The tarsal claw of both groups are similar in having basal pectins of spine-like seta placed extremely close to the base of the claw (Figs. 15, 16). This has some diagnostic value, but can only be studied by use of scanning electron microscopy or dissection and slide-mounting of claws for study by compound microscope. When viewed by dissecting microscope this structure usually remains hidden at the extreme base of the claw, and the claws appear simple.

Authorship of new species is attributed to the senior authors (PMM and SRS) in the order indicated.

ALEIODES ALBITIBIA SPECIES-GROUP

Included species.—*Aleiodes albitibia* (Herrich-Schaeffer 1838) and *A. fuscipennis* (Szépligeti, 1904).

Diagnostic characters.—Central disc of mesopleuron smooth and highly polished (Fig. 14); tarsal claw with broad gap between apical claw and basal pectin of 4–5 spine-like setae, gap 3× broader than basal width of largest spine-like seta in pectin; spine-like setae of tarsal pectin largest apically, gradually smaller basally; parasitoids of Notodontidae and possibly Geometridae; host mummy with an unusual expanded balloon-like anteroventral area (Fig. 1).

Remarks.—The European species, *A. albitibia* (Herrich-Schaffer), has a circumpolar distribution, and is recorded here for the first time in North America.

Aleiodes albitibia (Herrich-Schaeffer)
(Figs. 1, 9, 14)

Rogas albitibia Herrich-Schaeffer 1838: 156. Transferred to *Aleiodes* by van Achterberg 1991.

Aleiodes heterogaster Wesmael 1838:94. Designated as type-species of *Aleiodes* by Viereck 1914. Synonymized with *albitibia* by van Achterberg 1991.

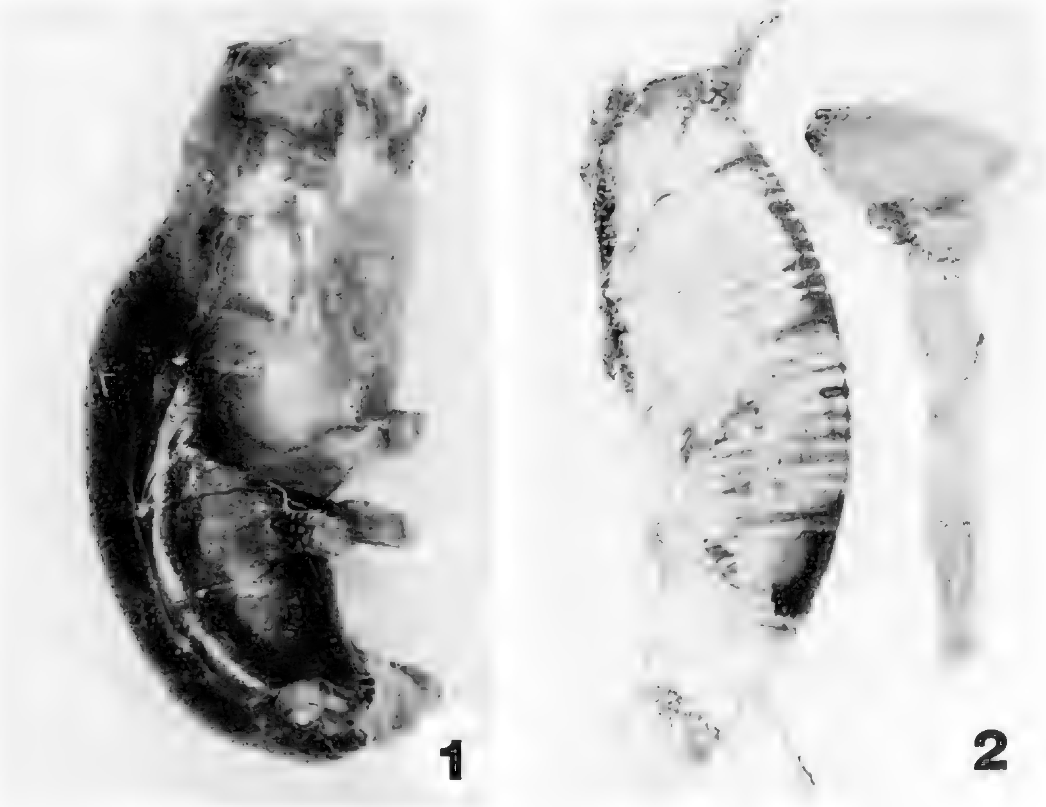
Diagnosis.—*Color*: head black, malar space and mouth parts yellow, antenna black; pronotum black, mesonotum black to honey yellow, scutellum honey yellow, mesopleuron honey yellow, occasionally black on upper anterior corner, venter honey yellow, propodeum black dorsally, honey yellow laterally, occasionally entirely honey yellow; metasomal terga usually black, first tergum with narrow medial yellow area and second tergum widely yellow medially, occasionally first and second terga almost entirely honey yellow, metasomal sterna yellow; legs honey yellow, hind tibia light yellow on basal half, brown on apical half, hind tarsus brown; wings hyaline, veins and stigma black, stigma occasionally with weak lighter spots at apex and base. Body length, 4.5–5.5 mm; forewing length, 4.0–5.0 mm. *Head:* eyes and ocelli large, covering most of head; 41–45 antennomeres, first flagellomere equal in length to second, all flagellomeres slightly longer than wide; malar space short, slightly less than basal width of mandible and ¼ eye height; temple narrow, slightly less than ½ eye width; occipital carina absent dorsally, meeting hypostomal carina; oral space small and circular, width equal to malar space; clypeus not swollen; ocelli large (Fig. 9), ocellocular distance about ½ diameter of lateral ocellus; face coriaceous rugulose, frons, vertex and temple coriaceous, occiput smooth and shining; maxillary palpus not swollen; mandibles small, tips not crossing when closed. *Mesosoma*: pronotum coriaceous rugose; mesonotum and scutellum coriaceous; notauli finely scrobiculate, meeting posteriorly on small rugose area; mesopleural disc smooth and shining (Fig. 14), subalar sulcus rugose, sternaulus absent; propodeum coriaceous rugose, median carina complete. *Metasoma*: short, not carapace-like but terga 4 and beyond very short and hardly exposed; first tergum rugose costate, length slightly less than apical width, median carina complete; second tergum rugose costate, median carina complete; third tergum rugose costate on basal ⅔, median carina present on basal ⅓; remainder of terga coriaceous; ovipositor about ⅓ length of hind basitarsus. *Legs:* tarsal claws with broad gap between apical claw and basal pectin of 4–5 spine-like setae, gap 3× broader than basal width of largest spine-like seta in pectin; spine-like setae of tarsal pectin largest apically, gradually smaller basally; inner spur of hind tibia less than ½ length of basitarsus; hind coxa smooth dorsally. *Wings:* forewing with vein r ½ length of 3RSa and ⅔ length of m-cu, vein 1cu-a beyond 1M by distance slightly greater than length of 1cu-a, vein 1CUa nearly ½ length of 1CUb; hind wing with vein RS arched medially, marginal cell narrowest in middle, vein 1r-m equal in length to 1M, M+CU nearly twice as long as 1M, vein m-cu represented by short stub.

Specimens examined.—CANADA, ALBERTA: 1 ♂, 5.3 mi. S Waterton Gates W1. N. P., ex. *Caripeta divisata.* BRITISH COLUMBIA: 1 ♂, Terrace, May 31, 1962, ex *Caripeta divisata;* 1 ♂, Kootemay Bay, March 3, 1951, ex. *Caripeta divisata;* 1 ♂, St. Mary's Bay, April 17, 1961, ex *Caripeta divisata.* QUEBEC: Old Chelsea, Summit King Mtn., 1150', June 16, 1961, J. R. Vockeroth. IRELAND: 1 ♀, Athdown, 1 female, Co. Wi., A.M.G., host 4.ix.1938, em. 9.vii.1938, ex *Notodonta dromedarius,* A.W. Stelfox collection; 1 ♂, Athdown, Co. Wi., A.W.S., (1) 12.6. 1940, A.W. Stelfox collection; 1 ♀, Upper Liffey V., Co. Wi., reared specimen ex *Notodonta dromedarius,* A.W. Stelfox collection; 1 ♀, Co. Kd., A.W.S., Sept. 1946, ex larval skin of *Notodonta* sp. at Skerries Bog, em. June 1947, A.W. Stelfox collection. UNITED STATES, CALIFORNIA: 1 ♀, Calaveras Co., 4.8 km S. West Point, July 26, 1980, Stanley C. Williams; 1, ♀, Trinity Co., Alt. 5500, June 14, 1934. GEORGIA: 2 ♀, Forsyth, May 5–14, 1971, F. T. Naumann. ILLINOIS: 1 ♀, Carbondale, May 8, 1925, T. Frison. MAINE: Mt. Desert, Great Pond, July 16, 1918. MARYLAND: 1 ♀, Beltsville, June 3, 1988, G. Steck. MASSACHUSETTS: 1 ♂, Hyannis Port, July 4, 1909. MICHIGAN: 1 ♀, Midland Co., August 19, 1940. MISSOURI: 9 ♀, Williamsville, June 16, 1969 to June 19, 1970, J. T. Becker, Malaise trap. NEW YORK: 1 ♂, Ithaca, July 15, 1907. NORTH CAROLINA: 5 ♂, Highlands, May 26 to June 4, 1957, W. R. M. Mason and J. R. Vockeroth. OHIO: 4 ♀, 5 ♂, Shadywilde, Selma, June 18, 1963 to August 8, 1966, R. S. Boone, at light. OREGON: 2 ♀, Benton County, 10 mi NW Corvallis, Berry Cr., August 11, 1985, J. C. Miller and B. Scaccia. Deposited in USNM, CNC, RMSEL, MCZ, TAMU, UCD.

Distribution.—Previously recorded by Shenefelt (1975) as occurring in the Palearctic region (Belgium, England, Finland, France, Germany, Hungary, Ireland, Netherlands, Russia, Sweden, and Switzerland). Recorded here for the first time as being widely distributed over Canada and the entire northern United States, from Quebec south to Georgia, west to British Columbia, Oregon, and California. Because this is the first published record of this species being present in North America, a complete list of specimens examined is given above.

Biology.—Two specimens from Oregon were reared from the notodontid *Nadata gibbosa* (J.E. Smith) collected on *Quercus garryana* Hooker. In Europe, this species has been reared from other arboreal notodontids including *Notodonta dromedarius* (L.) and *Phaeosia* sp. (Shenefelt 1975, Shaw 1983). The host mummies that we have seen from Europe and Oregon are very similar in appearance (see Fig. 1). Four specimens from Canada were labeled as reared from the geometrid *Caripeta divisata* Wlk., but this record needs confirmation.

The unusual form of the mummy (Fig. 1), with an expanded bubble-like area antero-ventrally, is unique for the genus. The mummy is also unusual for *Aleiodes* in that no antero-ventral "glue-hole" is formed, and the mummy is not stuck to the substrate. Shaw (1983) speculated that this swollen area may serve as an "air sac" allowing the host mummy to float in water. The preserved mummies that we examined (N = 7) all had a swollen antero-ventral area that is of equivalent size to the posterior area, and the head capsule was always off or missing. Thus the anterior "chamber" often has a visible hole that could be interpreted as an exit hole. The edges around the anterior hole are slightly ragged, as are the edges around the posterior exit hole. Interiorly, the anterior and posterior chambers are divided by a tough wall of



Figs. 1, 2. Mummified host remains, lateral view. 1, Mummy of the notodontid *Caripeta divisata* associated with *Aleiodes albitibia*; note expanded, lighter-colored, anteroventral area (upper right). 2, Mummy of an unidentified sphingid associated with *A. texanus* and head capsule from another dead host larva (upper right); note caudal horn (bottom center) and absence of head capsule on mummy (upper left).

silk, and both chambers are lightly lined by silk. However, we only observed larval and pupal remains in the posterior chamber. Thus, the presence of a silk lining in the anterior chamber suggests that the inflated area may be partly the result of structural reinforcement by silk during late instar larval feeding. The anterior openning may be the result of a weakened area due to feeding by the parasitoid larva, or might result from a later process of inflation of the "air sac" area.

Comments.—*Aleiodes albitibia* can be easily distinguished from all other North American species by the central disc of the mesopleuron, which is smooth, highly polished, and devoid of setae (Fig. 14). Other North American species either have visible microsculpture in this area, or if it appears polished (rarely), then the central disc is also punctate and setose. It differs from its South American relative, *A. fuscipennis* (Szépligeti), by having hyaline wings. *A. fuscipennis* has smokey black wings and the dorsa of the mesosoma and metasoma are bright reddish orange.

The North American specimens of *A. albitibia* examined show more range of color variation (often being more orange or yellow) as compared with European specimens (which have more extensive black color on the body).

AEIODES PRAETOR SPECIES-GROUP

Included species.—*Aleiodes praetor* Reinhard 1863 (= *Neorhogas luteus* Szépligeti 1906), *A. texanus* Cresson 1869 (= *A. fumipennis* Cresson 1869), *A. graphicus* (Cresson) 1872, **new combination**, and *A. ceratomiae* Marsh and Shaw, **new species**.

Diagnostic characters.—flagellomeres compact (Fig. 13); radiellan cell narrowest medially, wider apically; radiellan vein strongly sinuate (Fig. 17), sometimes nearly touching wing margin medially; malar space/mandibular base length less than 1; rounded protuberance present at propodeal apex; tarsal claw with very broad gap between apical claw and basal pectin of 6–10 spine-like setae, gap 7–8× broader than basal width of largest spine-like seta in pectin; spine-like setae of tarsal pectin largest apically or preapically, gradually smaller basally; parasitoids of Sphingidae.

Remarks.—This is a well-supported, circumpolar monophyletic group, associated with Sphingidae *sensu stricto*. All *Aleiodes* known to be associated with Sphingidae can be assigned to this group. The mummies with a caudal horn are distinctive and diagnostic (Fig. 2), but the caudal horn sometimes falls out, leaving a distinct pit, as the mummy ages. The host mummy is attached to the substrate by a very large anteroventral glue-hole. The head capsule is either decapitated, or remains by a small piece of cuticle that is prone to breaking away as the mummy ages (overwinters). Consequently, the host mummies are usually found without the head capsule, or with the head capsule detached.

This group has been treated as a genus and a subgenus, *Neorhogas*, by Szepligeti (1906) and van Achterberg (1991), respectively.

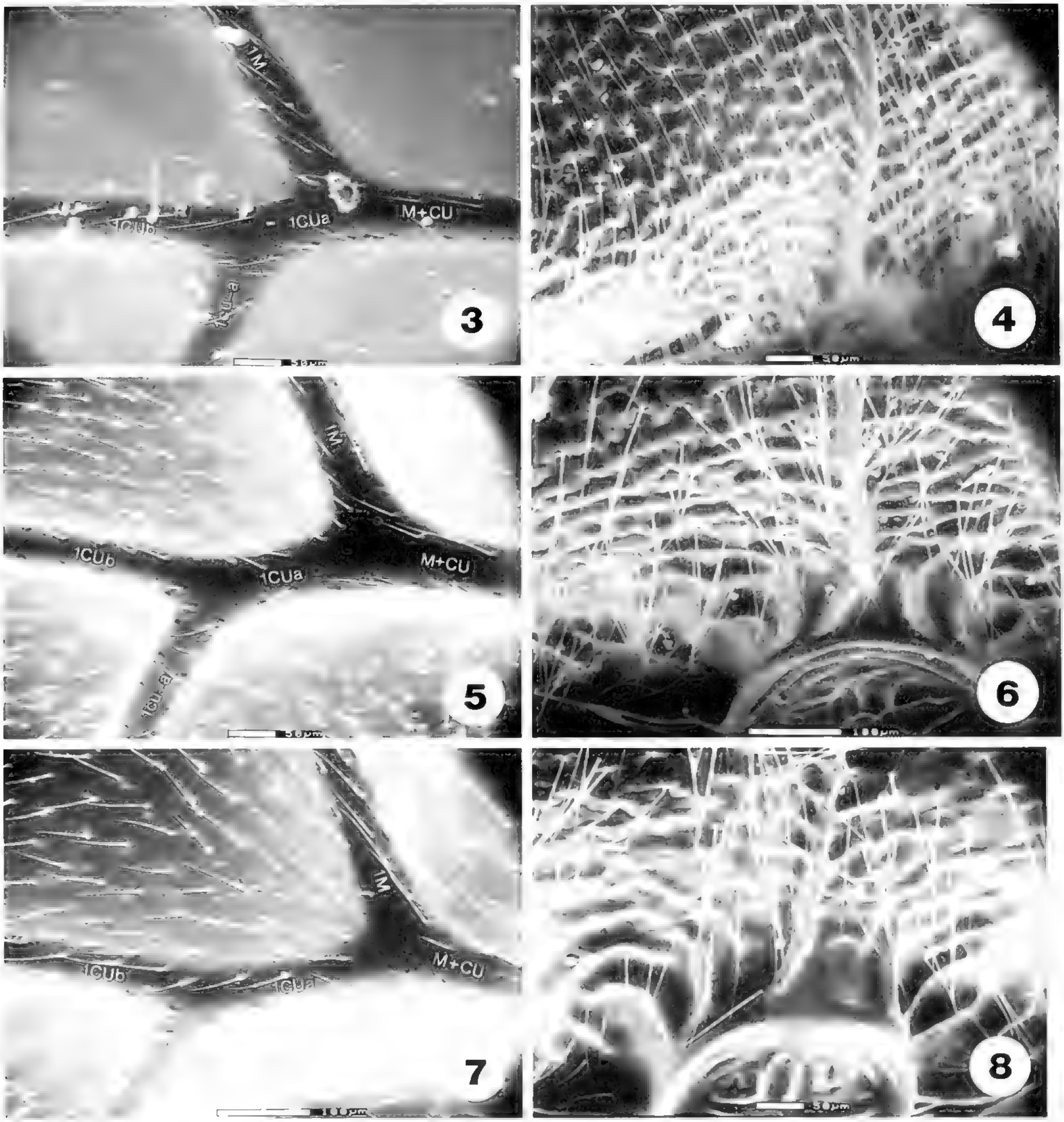
KEY TO THE NORTH AMERICAN SPECIES OF THE *A.* PRAETOR SPECIES-GROUP

1. Head orange or yellow, same color as rest of body, occasionally with some black markings but never entirely black . . . . *A. graphicus* (Cresson)
– Head entirely black or dark brown, differently colored than at least propodeum . . 2
2(1). Metasoma black, at least beyond first tergum; vein lcu-a of forewing nearly interstitial with vein 1M, vein 1CUa nearly absent (Fig. 3); ocelli exceptionally large, lateral ocellus nearly touching eye margin (Figs. 10, 18) . . . *A. ceratomiae*, new species
– Metasoma red; vein 1cu-a of forewing not meeting vein 1M, vein 1CUa about as long as 1cu-a (Fig. 7); ocelli not so large, lateral ocellus clearly separated from eye margin (Figs. 12, 19) . . . . *A. texanus* Cresson

***Aleiodes ceratomiae* Marsh and Shaw, new species**

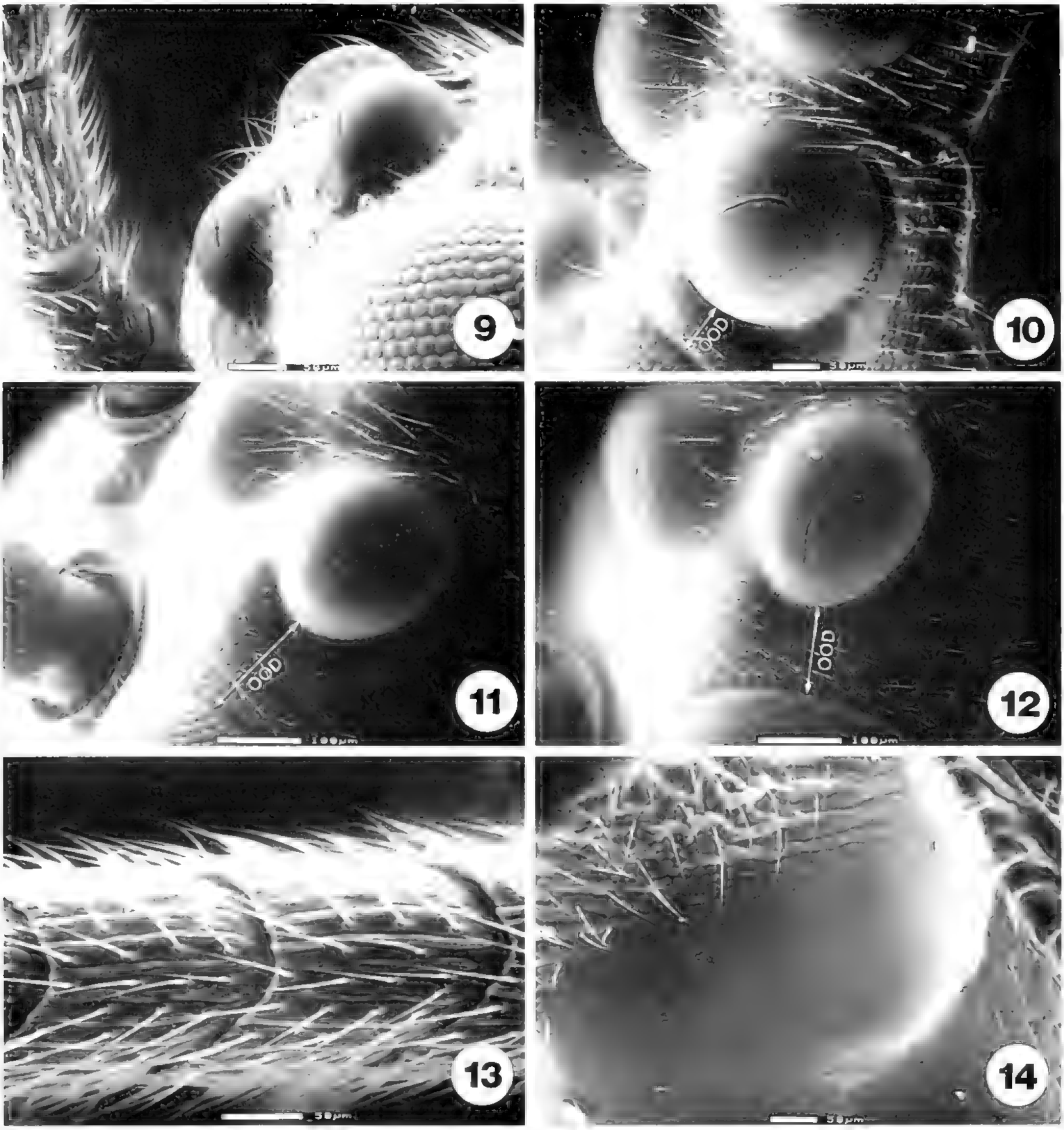
(Figs. 3, 4, 10, 18)

Female.—*Body color*: head and antenna black, malar space yellow at base of mandible, mandible yellow medially, basal palpal segment black, remainder yellow; ocelli white; propleuron, pronotum, mesonotum and dorsoanterior corner of mesopleuron black, rest of mesosoma and propodeum yellow; metasoma black, occasionally first tergum yellow at base, ovipositor sheath black; legs yellow except fore and middle apical tarsal segments, apical half of hind tibia, and hind tarsus which are all black; wings hyaline. Body length, 9 mm; forewing length, 8 mm. *Head*: eyes and ocelli enormous, covering most of head (Figs. 10, 18); 65–66 antennomeres, first flagellomere only slightly longer than second, those beyond first at least slightly longer than wide; malar space short, ⅖ eye height and ¾ basal width of mandible; temple narrow, ½ eye width; occipital carina meeting hypostomal carina; oral space small and circular, width slightly greater than malar space and half the face length; clypeus weakly swollen; ocelli enormous, lateral ocelli sometimes nearly touching eyes, lateral ocellus 3.5 to 6× greater than ocell-ocular distance (Fig. 10); face weakly rugulose, coriaceous on and above clypeus, with median longitudinal ridge below antenna; frons rugulose; vertex and temple coriaceous; maxillary palpus not swollen; mandible small, tips not overlapping when closed. *Mesosoma*: pronotum coriaceous rugulose; mesonotum and scutellum coriaceous; notauli scrobiculate, meeting posteriorly in triangular rugose area; mesopleuron very finely coriaceous,



Figs. 3–8. Left forewing venation and propodeal sculpture of *Aleiodes praetor*-group species. Environmental scanning electron micrographs at 200× magnification. 3, 4, *A. ceratomiae*. 5, 6, *A. graphicus*. 7, 8, *A. texanus*.

smooth dorsally, subalar sulcus rugose; sternaulus weakly impressed; propodeum coriaceous rugulose dorsally, coriaceous laterally, median carina complete, semicircular carina at apex of propodeum only weakly developed (Fig. 4). *Metasoma*: first tergum striate rugulose, slightly longer than apical width, median carina complete; second tergum striate rugulose, median carina complete; third tergum striate rugulose at base, remainder coriaceous, median carina absent; fourth and following terga coriaceous; ovipositor barely exerted, sheaths about ⅓ length of hind basitarsus. *Legs*: tarsal claw with very broad gap between apical claw and basal pectin of 5–7 spine-like setae, gap 8× broader than basal width of largest spine-like seta in pectin; second spine-like seta from apex of tarsal pectin largest, gradually smaller spines basally; in-



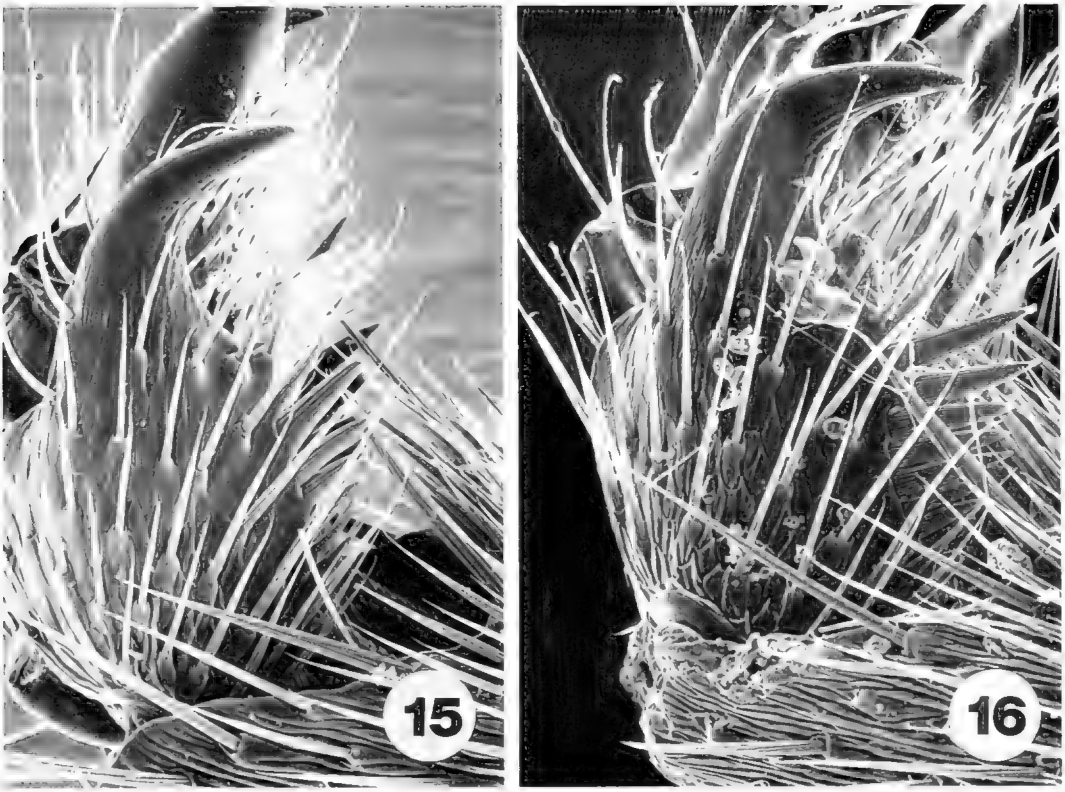
Figs. 9–14. 9–12, Dorsolateral views of head showing ocelli and ocell-ocular distances (OOD). 9, *Aleiodes albitibia*, 250×. 10, *A. ceratomiae*, 200×. 11, *A. graphicus*, 180×. 12, *A. texanus*, 180×. 13, Flagellum of *A. texanus*, 350×. 14, Smooth mesopleural disc of *A. albitibia*, lateral view, 200×.

ner spur of hind tibia less than ½ length of hind basitarsus; hind coxa coriaceous dorsally. *Wings*: forewing sparsely setose (Fig. 3), with vein or equal in length to 3RSa and m-cu, vein 1cu-a nearly interstitial with 1M, vein 1CUa very short and sometimes nearly absent (Fig. 3); hind wing with vein RS strongly arched, marginal cell extremely narrow in middle, vein 1r-m shorter than 1M, vein M + CU longer than 1M, vein m-cu only weakly indicated by short infuscated line.

Male.—Essentially as in female.

Holotype.—♀: CONNECTICUT, Putnam, from sphingid larva on ash, ex host August 2, 1956, *Ceratomia amyntor*, A. B. Klots. Deposited in USNM.

Paratypes.—CONNECTICUT: 1 ♂, Put-



Figs. 15, 16. Tarsal claws; note pectin of stout spine-like setae at extreme base. 14, *Aleiodes graphicus*, 469×. 16, *A. texanus*, 551×.

nam, A.B. Klots, host: *Ceratomia undulosa* (Walker) Sphingidae pupa in rear end of host larva 20 July 1956, ex pupa July 14, 1957. NEW HAMPSHIRE: 1 ♀, Durham, July 14, 1946, R. L. Blickle collr. NEW YORK: 1 ♀, Ithaca, at light, July 10, 1937, P. P. Babyi coll.; 1 ♂, Six Mile Creek, Ithaca, August 21, 1954, D. M. Anderson. ONTARIO: 1 ♀, N. Burges Twp., Lanark Co., August 8, 1981, D. M. Wood; 1 ♂, Belleville, April 30, 1930, C. W. Smith, host sphingid. Deposited in USNM, RMSEL, CAS, CNC, CUI.

Distribution.—Known only from eastern Canada and the northeastern United States.

Biology.—Reared from the sphingids *Ceratomia amyntor* (Geyer) and *C. undulosa* (Walker). The host mummy is only about 15mm long, indicating that the host is killed at an early stage of development (probably third instar).

Comments.—This species is quite distinct from *A. graphicus* and *A. texanus*, from which *A. ceratomiae* can be distinguished by its much larger ocelli (Fig. 10), hyaline and sparsely setose wings with vein 1cu-a nearly interstitial with vein 1M (Fig. 3), vein 1CUa very short to nearly absent, less coarse propodeal sculpture (Fig. 4), and metasoma mostly black. This species has enormous ocelli (Fig. 10), that are much larger than in any other known North American species of Braconidae.

Etymology.—The specific name refers to the hosts from which this species was reared.

Aleiodes graphicus (Cresson), **new combination**

(Figs. 5, 6, 11, 15, 17)

Rogas graphicus Cresson 1872: 188.

Diagnosis.—Body unicolored yellowish

orange, except antenna, ocellar triangle, tip of mandible, palpi, and legs at least from apex of femur apically black, wings dark; body length 7.0–8.0 mm; 55–60 antennomeres, most flagellomeres as long as wide; malar space shorter than basal width of mandible; face and frons rugulose, vertex and temple smooth; oral opening small and circular, diameter about equal to basal width of mandible; ocelli large (Fig. 11), diameter of lateral ocellus 1.5× greater than ocell-ocular distance; mesosoma largely smooth and shining, notauli strongly scrobiculate, scutellum margined by strong carina, propodeum rugulose, lateral corners protruding, median carina complete, semicircular carina at apex of propodeum well developed (Fig. 6); metasomal terga 1–3 costate-rugose, median carina strong and complete on terga 1–2, and basal half of tergum 3; tarsal claw with very broad gap between apical claw and basal pectin of 8–9 spine-like setae (Fig. 15), gap 8× broader than basal width of largest spine-like seta in pectin; spine-like setae of tarsal pectin largest apically, gradually smaller spines basally; forewing with vein or nearly as long a 3RSa, second submarginal cell quadrate, nearly rectangular; vein 1cu-a beyond 1M by distance equal to or slightly less than length of 1cu-a (Fig. 5); hind wing with vein RS strongly sinuate, marginal cell very narrow in middle.

Type material examined.—*Rogas graphicus* Cresson, lectotype male (designated by Cresson 1916), USA, Texas, Belfrage (ANSP), type # 2749, tip of left antenna missing; 1 paralectotype male, same data.

Distribution.—Recorded from Arizona, Colorado, Iowa, Kansas, New Mexico, South Dakota, Texas, and Wyoming.

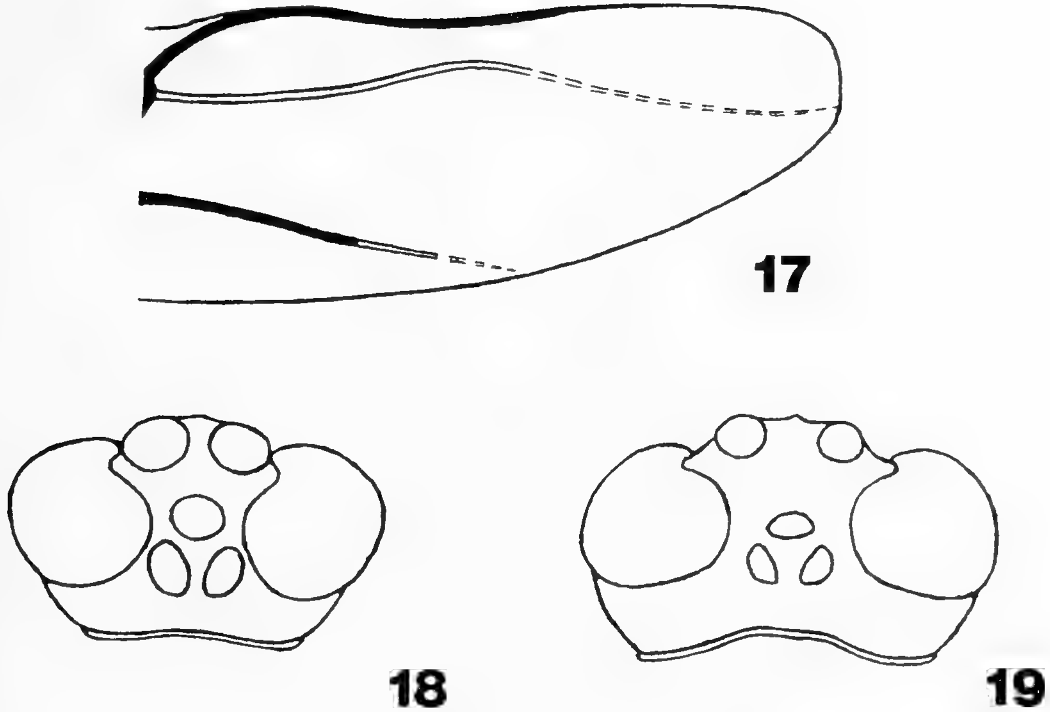
Biology.—This is a parasitoid of unknown sphingid species. There is a reared specimen in the AEI collection, but the host is not identified. In form, the mummy is similar to that produced by *A. texanus,* but the *A. graphicus* mummy has distinctive black markings and is clearly a different host species than utilized by *A. texanus.*

Comments.—*Aleiodes graphicus* is most similar to *A. texanus,* which also has dark wings. However, *A. texanus* has extensive black markings on the head and mesonotum, and so cannot possibly be confused with this mostly yellowish orange species. Until recently *graphicus* was classified as a species of *Rogas* (Marsh 1979), but it is correctly placed in the genus *Aleiodes.*

Aleiodes texanus Cresson
(Figs. 2, 7, 8, 12, 13, 16, 19)

Aleiodes texanus Cresson 1869:378.
Aleiodes fumipennis Cresson 1869:378. **New synonymy**.

Diagnosis.—Body bicolored, head including antenna and mouthparts black, mesosoma varying from entirely black to entirely reddish orange except propodeum always reddish orange, metasoma entirely reddish orange, legs varying from entirely black to reddish orange, wings dusky, veins black; body length, 7.0–8.5 mm; 58–62 antennomeres; malar space varying from slightly less to slightly longer than basal width of mandible; head smooth and polished, face often rugulose below antennae; oral opening small and circular, diameter equal to basal width of mandible; ocelli large (Fig. 12), diameter of lateral ocellus 1.0–2.3× greater than ocell-ocular distance; mesosoma smooth, pronotum rugose dorsally; propodeum rugulose, lateral corners protruding, median carina complete, semicircular carina at apex of propodeum well developed (Fig. 8); metasomal terga 1–2 strongly costate-ruguse, median carina complete; tergum 3 costate rugose on basal half, median carina occasionally indicated on basal ⅕; tarsal claw with very broad gap between apical claw and basal pectin of 8–10 spine-like setae (Fig. 16), gap 8× broader than basal width of largest spine-like setae of tarsal pectin largest apically, gradually smaller spines basally; forewing with vein or equal to 3RSa, second submarginal cell quadrate, nearly rectangular; vein 1cu-a beyond 1M by distance equal to or slight-



Figs. 17–19. 17, Hind wing of *Aleiodes graphicus* indicating sinuate RS vein. 18, 19, Head in dorsal view showing size and configuration of ocellar triangle. 18, *A. ceratomiae*. 19, *A. texanus*.

ly greater than length of 1cu-a (Fig. 7); hind wing with vein RS strongly arched medially, sometimes nearly touching wing margin, marginal cell very narrow medially, vein m-cu absent or weakly indicated by short fuscous line.

Type material examined.—*Aleiodes texanus* Cresson, lectotype female (designated by Cresson 1916), type # 1655, Texas (ANSP). *Aleiodes fumipennis* Cresson, holotype female, Illinois (ANSP).

Distribution.—Occurs throughout the eastern United States from Massachusetts west to Montana, southwards to the Gulf Coast, Texas, and northern Mexico.

Biology.—Reared from the Walnut Sphinx *Laothoe (= Cressonia) juglandis* (J.E. Smith) and other unidentified sphingids. Recently reared in Florida from sphingid larvae on grape, either *Amphion nessus floridensis* B.P. Clark or *Darapsa myron* (Cramer), or both (D. Wahl and K. R. Sime, personal communication). The host was most likely the latter but died before the identifying features developed. In all cases the host mummy was completely decapitated and firmly attached to the substrate.

Comments.—*Aleidoes texanus* is a fairly common species in North America. It is similar to *A. ceratomiae* in having extensive black on the mesosoma, but can be distinguished by the red metasoma and smaller ocelli. *A. texanus* is morphologically similar to *A. graphicus,* but can be distinguished by the black head and longer vein 1CUa (Fig. 7). Individuals of *A. texanus* exhibit a wide range of color variation on the mesosoma, from mostly black to mostly red, but the mesosoma is always bicolored with at least the pronotum black and the posterior red. Since *A. fumipennis* Cresson was separated from *A. texanus* only by color characters of the mesosoma, *A. fumipennis* is newly synonymized under *A. texanus.* We have seen a few individuals with unusually small ocelli, but whether or not these represent a new sibling species cannot be determined without more biological information.

ACKNOWLEDGMENTS

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Additional thanks are due to Ms. Isobel Nichols for preparation of ink illustrations, and also to Ms. Teresa Williams, of the Western Research Institute, for assistance with the Environmental Scanning Electron Microscope and photography.

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A REVISION OF THE GENUS *OBRIMA* WALKER (LEPIDOPTERA: NOCTUIDAE), WITH A DESCRIPTION OF A NEW SPECIES FROM COSTA RICA AND NOTES ON ITS NATURAL HISTORY

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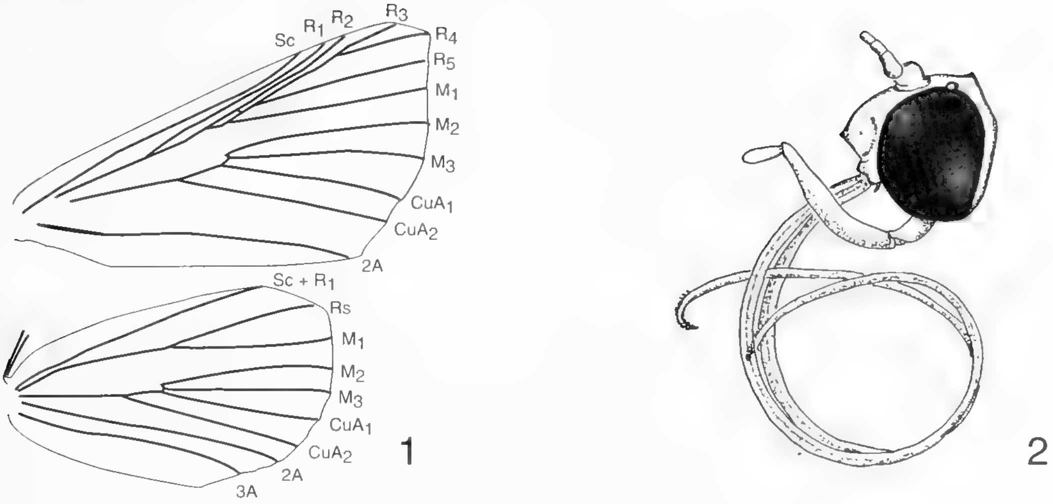
Abstract.—The genus *Obrima* Walker contains three species of essentially Neotropical distribution: *Obrima pyraloides* Walker, distributed from Mexico to Paraguay; *Obrima rinconada* Schaus from Guatemala and Mexico, to southwestern United States in Arizona and southwestern Texas; and ***Obrima cymbae* Pogue, n. sp.,** known only from Costa Rica. *Obrima pyraloides* was reared on *Lonchocarpus minimiflorus* Donn., *Lonchocarpus phlebophyllus* Standley and Steyerm., and *Lonchocarpus orotinus* Pittier (Fabaceae), while *Obrima cymbae* was reared on *Lonchocarpus orotinus.*

Key Words: *Obrima cymbae, Obrima pyraloides, Obrima rinconada,* Ophiderinae, *Lonchocarpus,* tropical dry forest, Area de Conservación Guanacaste

The genus *Obrima* Walker is currently placed in the Catocalinae (Kitching and Rawlins 1998). The Catocalinae are "quadrifid" noctuids based on the presence of a strong vein M_2 of the hindwing (Fig. 1). Included in the Catocalinae are the Ophiderinae, except those genera that have specialized apical armature on the proboscis modified to pierce thick-skinned fruit or mammalian skin which are placed in the Calpinae (Kitching and Rawlins 1998). The basis for separating these two subfamilies was of the presence of spines on the mesothoracic tibia, an entirely unreliable character that should not be used (Kitching 1984). *Obrima* was originally described by Walker (1856) to include *Obrima pyraloides.* Schaus (1894) later described *Obrima rinconada* from Mexico.

Obrima cymbae, n.sp., and its host plant, *Lonchocarpus orotinus,* are endemic to Guanacaste Province, Costa Rica. *Obrima pyraloides* also feeds on this endemic species, as well as on two other *Lonchocarpus.* The host range of *Obrima pyraloides* is probably broader than is recorded because the Costa Rican hosts do not occur over the rest of its range (Fig. 21). Nothing is known about the host(s) of *Obrima rinconada,* but by looking at the distribution of *Lonchocarpus* one can make inferences. The distribution of *Obrima rinconada* extends from southern Arizona and Texas to western Guatemala (Fig. 21). *Lonchocarpus* does not occur in the southern United States so another host, possibly in the same family, is likely.

Obrima occurs from the southwestern United States south through Mexico, Dominica, Central America, Venezuela, Bolivia, and Paraguay. In the northern hemisphere, the flight period of *Obrima* is during the



Figs. 1, 2. *Obrima pyraloides.* 1, Wing venation. 2, Head.

first half of the rainy season, from late April through August. Host plants and other aspects of the natural histories of *Obrima pyraloides* and *Obrima cymbae* are described below. A total of 99 specimens were examined from the National Museum of Natural History, Smithsonian Institution, Washington, D.C. (USNM), Instituto Nacional de Biodiversidad, Santo Domingo de Heredia, Costa Rica (INBio), and Eric H. Metzler collection (EHM) for this study.

Obrima Walker

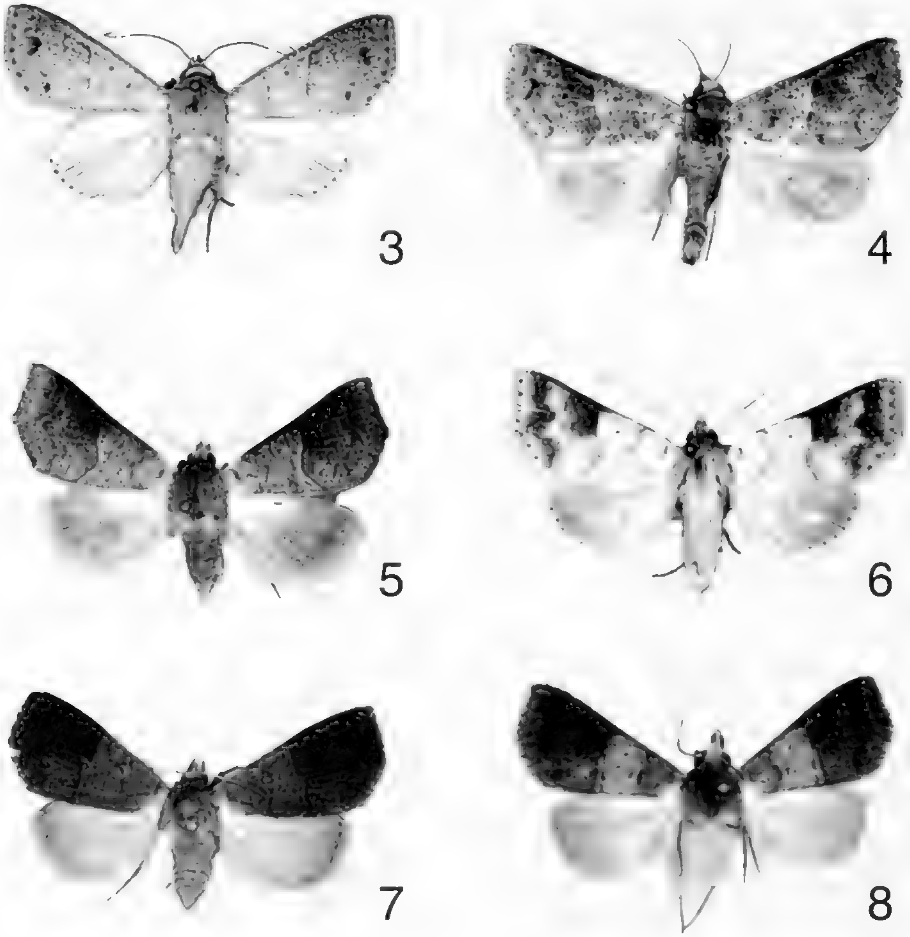
Obrima Walker, 1856: 134.—Nye, 1975: 343.—Poole, 1989: 708.—Poole and Gentili, 1996: 759.

Type species: *Obrima pyraloides* Walker, 1856, by monotypy.

Diagnosis.—*Obrima* can be distinguished from the similarly appearing genera *Ensipia* Walker, *Juncaria* Walker, and cream-colored species of *Herminodes* Guenée by the conical-shaped unscaled frons and large signum in the female genitalia that has a bifurcate apex and a central groove formed by the lateral margins curving toward the center line (Fig. 18–20).

Description.—*Adult* (Figs. 1–20). Forewing length 13.5–21.5 mm.

Head: Vestiture smooth. Frons bare, modified into a conical projection. Eye well developed. Ocellus present. Antenna filiform, scaled dorsally, setose ventrally. Labial palpus porrect, apical segment forms close to a right angle with second segment. Maxillary palpus 2-segmented. *Thorax:* Vestiture smooth. Prothoracic tibia dorsally with tuft of elongate hairs, epiphysis large extending to apex of prothoracic tibia, with a dense scale brush beneath. Legs lacking spines. Mesothoracic tibia dorsally concave to retain a hair pencil from base; dense dorsal brush of hair-like scales present from apex of first tarsomere to base of third tarsomere; apical spurs short, longest not reaching apex of first tarsomere, shortest spur 0.75 × length of longest. Metathoracic tibial base ventrally with patch of stiff hair-like scales; 2 pairs of apical spurs, basal pair with shortest spur more than 0.5 × length of longest, distal pair with shortest spur less than 0.5 × length of longest. *Forewing:* Male length 13.5–21 mm, female length 14.5–21.5 mm. Accessory cell present. R_2, R_{3+4}, and R_5 connate. Outer margin forming obtuse angle at vein M_3. *Hindwing:* Vein M_2 present, CuA appearing 4-branched. *Male genitalia:* Uncus curved, setose, apical spine decurved. Valve narrow, clasper present. Vesica with 3 or 4 di-



Figs. 3–8. Adults of *Obrima*. 3, *O. pyraloides*, ♂. 4, *O. rinconada*, ♂, holotype. 5, *O. rinconada*, ♀. 6, *O. rinconada*, ♀. 7, *O. cymbae*, ♂. 8, *O. cymbae*, ♂

verticula. Two cornuti, elongate, contained within first diverticula. *Female genitalia:* Ductus bursa simple, rectangular, divided by membrane. Corpus bursa with striate convolutions. Signum elongate, apex bifurcate into pointed and truncate projections, central groove formed by lateral margins curving toward center line.

Obrima pyraloides Walker
(Figs. 1–3, 9, 10, 18, 21)

Obrima pyraloides Walker, 1856:135.—Nye, 1975: 343.—Poole, 1989: 708.

Diagnosis.—*Obrima pyraloides* is a medium sized moth with forewing ground color cream, median line straight, postmedial line with black spots in cells M_1 and CuA_2, and termen curved at vein M_3 as compared to angulate in *Obrima rinconada.* The female is more brown than the paler male.

Description.—*Adult Male. Head:* Labial palpus rufous, apical segment cream. Frons with scales adjacent to eye rufous, remainder cream; vertex cream. Antennal scape cream; flagellar scales cream. *Thorax:* Dorsum cream. Underside with scale collar adjacent to eye rufous from just above forewing to labial palpus, sternum pale rufous, remainder white. Prothoracic tibia rufous and cream; tarsus rufous. Mesothoracic tibia cream mixed with rufous; tarsus buff.

Metathoracic tibia cream with a few rufous scales; tarsus cream becoming pale gray distally. *Forewing* (Figs. 1, 3): Length 17–18 mm; ground color cream to pale brown; antemedial line indistinct, cream bordered by pale gray proximately; orbicular spot small, black; median line cream bordered by pale gray distally, straight; costal patch distal to median line absent; postmedial line with distinct black spots, largest in cells M_1 and CuA_2; black spots along outer margin; termen curved at vein M_3; fringe cream; underside ground color cream. *Hindwing* (Fig. 3): Ground color cream. *Abdomen:* Cream. *Genitalia* (Figs. 9, 10): Uncus curved dorsad, setose, equal width throughout length (in lateral view), apical spine decurved. Valve with parallel sides, distal 0.25 curved dorsad, apex round. Clasper wide. Vesica with 4 diverticula, 1 shortest, 2 elongate and above 3 and 4.

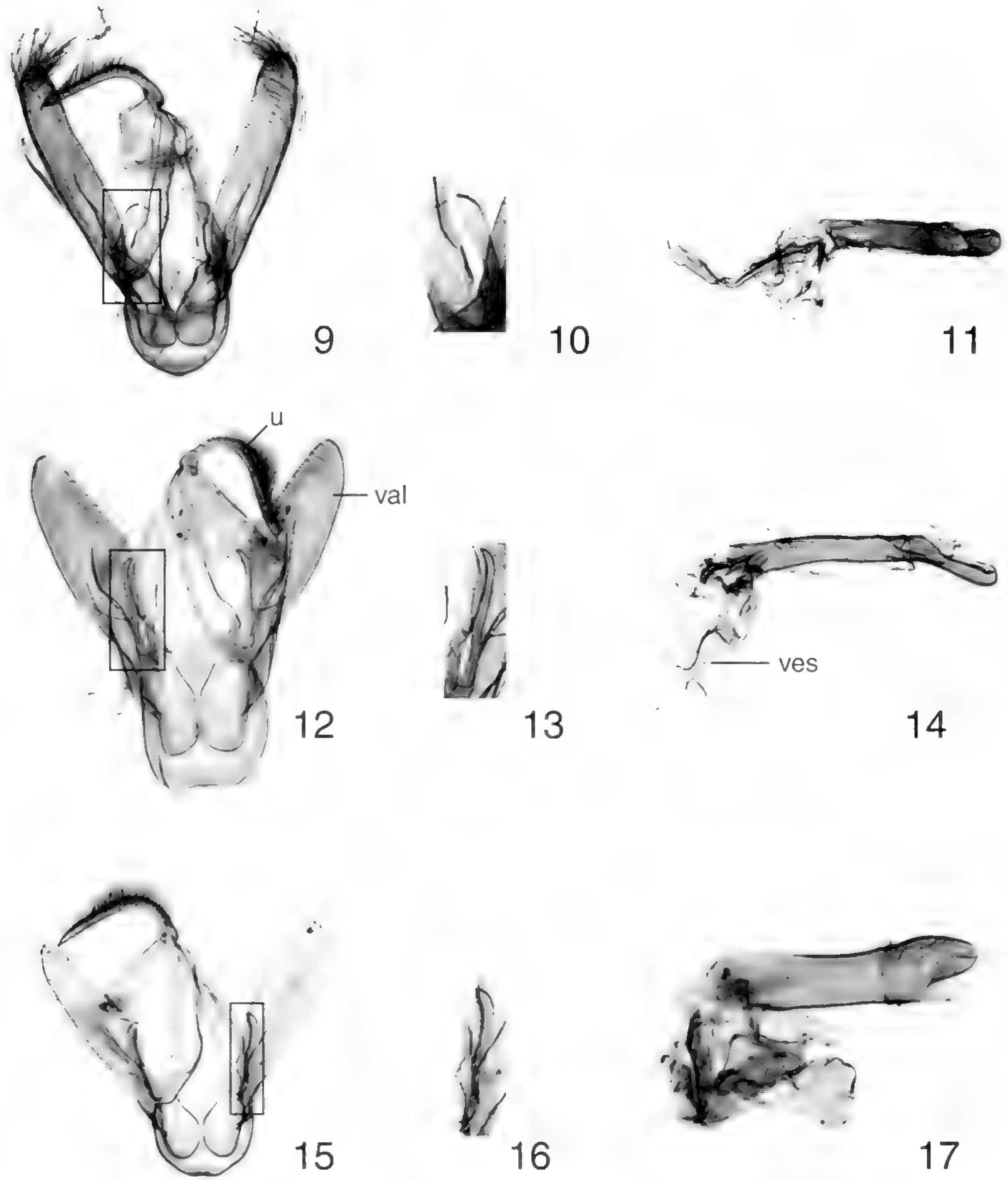
Adult female.—Similar to male except forewing length 15.5–18.0 mm and ground color pale brown. *Genitalia* (Fig. 18): Postvaginal plate wider than long. Ductus bursa with length less than 2 × width. Corpus bursa elongate, juncture with ductus bursa gradual. Signum straight; less than 0.25 × length, extends into ductus bursa, apex truncate.

Type material.—Holotype ♂, in The Natural History Museum, London. Type locality is Honduras.

Immature stages.—In the lowland dry forests of the Area de Conservación Guanacaste (ACG), northwestern Costa Rica (Janzen 1988a, b, 1993), the larvae feed on the new and maturing leaves of *Lonchocarpus minimiflorus, Lonchocarpus phlebophyllus,* and *Lonchocarpus orotinus* (Fabaceae) during the first 30 days of the rainy season, usually in May (Janzen and Hallwachs 1997). The relatively naked last instar larva is gray with yellow-cream dots, has several large black spots on the ventral side, and has a gray head with fine black lines. The very tough-walled rust-colored cocoon is spun in the litter during the first 1–3 weeks of the rainy season, and eclosion occurs (in captivity) three weeks to two months later (Janzen and Hallwachs 1997). Adults of this apparently univoltine tropical dry forest species first appear in the thousands (DHJ, unpublished data) at lights about a week before the rainy season begins, the same time the *Lonchocarpus* host plants are beginning leaf bud break, and then occur rarely throughout the first half of the rainy season. *Obrima pyraloides* adults persist in the habitat as nonreproductive individuals during the second half of the rainy season and all of the dry season. This reproductive pattern is commonplace for moths in the ACG dry forest (Janzen 1987).

Distribution (Fig. 21).—Recorded from lowland tropical dry forests in Mexico, Costa Rica, Panama, Venezuela, Paraguay, and Dominica.

Material examined.—46 ♂ and 16 ♀. BOLIVIA: Mutum, 20 miles W. of Porto Suarez, 1500 ft., 7–14 Nov. 1927, at light, C.L. Collenette, 1 ♀. COSTA RICA: Guanacaste Prov.: Colorado, 31 March 1988, W.E. Steiner, J.M. Hill, J.M. Sweringen, J.M. Mitchell, 1 ♂; Candelaria Mts., Underwood, 1 ♂; San Jose, H. Schimdt, 1 ♂, 1 ♀, 23 May 1922, H. Schimdt, 1 ♀. DOMINICA: Grand Savane, 7 June 1964, O.S. Flint, Jr., 1 ♂, (green label, genitalia slide, USNM 44078), 1 ♀; July 1905, E.A. Agar, 1 ♂. GRENADA: 20–29 Apr. 1968, C. de Worms, 1 ♀. JAMAICA: sea level, Mar. 1968, G. Newman, 1 ♂; N. Coast, S. level, Mar. 1961, G. Newman, 1 ♂; Oracabessa, sea level, Mar.–Apr. 1962, G. Newman, 1 ♂. MEXICO: Sinaloa: Venadio, Collection Wm. Schaus, 3 ♂ (white label, genitalia slide: USNM 435, J.G. Franclemont), 1 ♀ (white label, genitalia slide: USNM 436, J.G. Franclemont); Nuevo Leon: Rinconada, Collection Wm. Schaus, 2 ♂, 2 ♀, Dognin Collection, 1 ♂; Veracruz: Orizaba, Dognin Collection,1 ♂. PANAMA: Barro Colorado Is., 1–9 May 1964, W.D. & S.S. Duckworth, 1 ♂. PARAGUAY: [No specific locality], Pouillon, Dognin Collection, 2 ♂. VENEZUELA: Guárico: Hato Masa-



Figs. 9–17. Male genitalia. 9, *Obrima pyraloides,* genitalia. 10, *O. pyraloides,* clasper. 11, *O. pyraloides,* aedoeagus. 12, *O. rinconada,* genitalia. 13, *O. rinconada,* clasper. 14, *O. rinconada,* aedoeagus. 15, *O. cymbae,* genitalia. 16, *O. cymbae,* clasper. 17, *O. cymbae,* aedoeagus. Abbreviations: u, uncus; val, valve; ves, vesica.

gual, 45 km S Calabozo, 8.[°] 57['] N 67.[°] 58['] W, Gal[le]ry Forest #4, 75 m[eters], 13 Apr. 1988, M. Epstein & R. Blahnik, 2 ♂, Gal[le]ry Forest #5, 15–17 Apr. 1988, 1 ♀ (green label, genitalia slide, USNM 44072), Gal[le]ry Forest #6, 17 Apr. 1988, 1 ♂, Gal[le]ry Forest #7, 19–21 Apr. 1988, 1 ♂ (green label, genitalia slide, USNM 44080), Gal[le]ry Forest #8, 19–21 Apr. 1988, 1 ♂ (green label, genitalia slide, USNM 44079), Gal[le]ry Forest #9, 10 ♂ (green labels, genitalia slides, USNM

44073, 44081), Gal[le]ry Forest #10, 23–24 Apr. 1988, 4 ♂ (green label, genitalia slide, USNM 44071), Gal[le]ry Forest #16, 6–8 May 1988, Gal[le]ry Forest #20, 13–16 May 1988, 9 ♂, 3 ♀, Gal[le]ry Forest #23, 21 May 1988, 1 ♀, Gal[le]ry Forest #24, 25 May 1988, 1 ♂, 1 ♀, Gal[le]ry Forest #28, 3–5 June 1988, 1 ♂, 1 ♀.

Discussion.—There is some sexual dimorphism with the female having more speckling of brown and black scales across the forewing giving an overall darker appearance. This speckling also occurs in the male, but is less marked. The hindwing in both sexes can have a variable amount of dark scaling along the outer margin. The greatest variation occurs in Venezuela.

Obrima rinconada Schaus
(Figs. 4–6, 12–14, 19, 21)

Obrima rinconada Schaus, 1894: 240.—Poole, 1989: 708.

Obrima pimaensis Barnes and Benjamin, 1925a: 126.—Poole, 1989: 708 [jr. syn. of *rinconada*].

Obrima rinconada primaensis Barnes and Benjamin, 1925b: 168, [incorrect subsequent spelling of *pimaensis*].

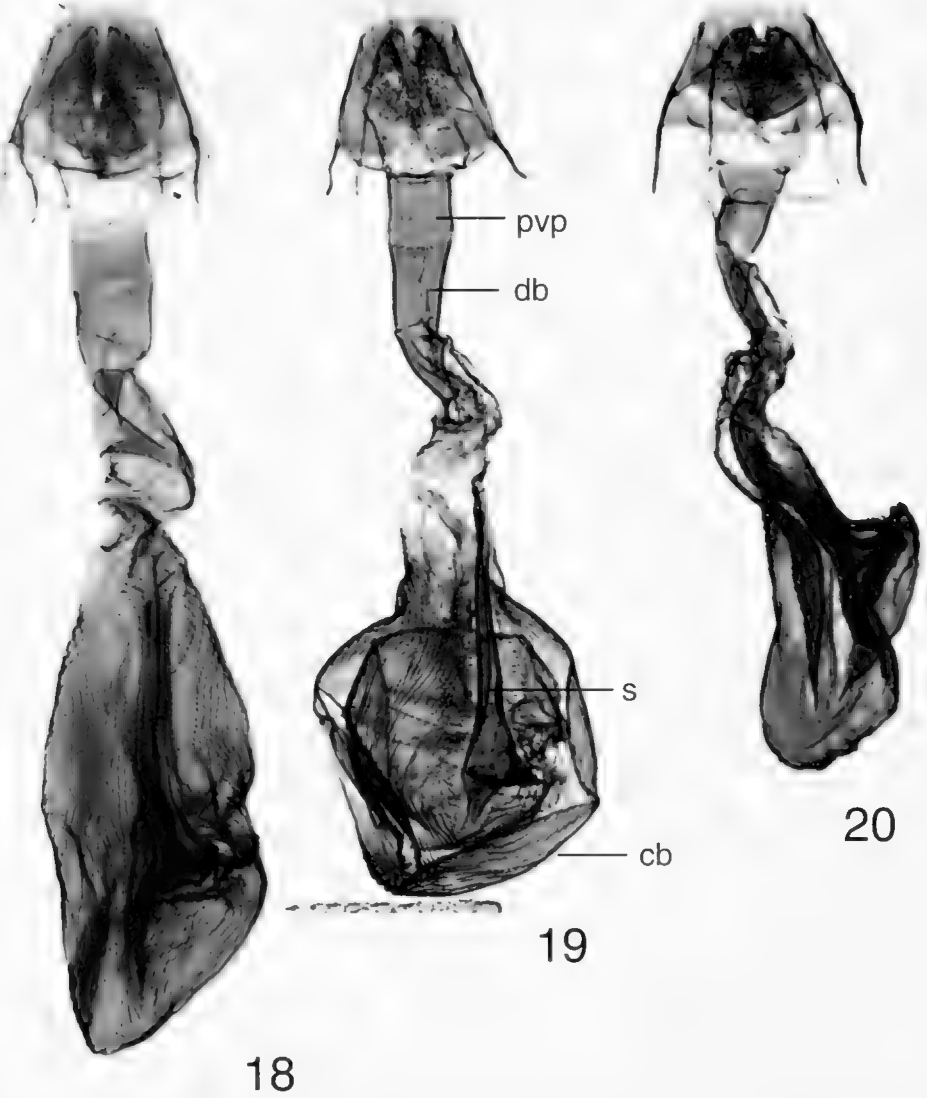
Diagnosis.—*Obrima rinconada* is a medium sized moth with cream to pale brown ground color suffused with brown scales giving a speckled appearance. The forewing has the median line curved and variably outlined in brown, postmedial line with black spots in cells M_{1-2}, and termen more sharply angulate at vein M_3 than in the other two species of *Obrima*. The female is more speckled and the postmedial spots are less distinct than in the male.

Description.—*Adult Male. Head:* Labial palpus rufous, apical segment cream. Frons with scales adjacent to eye rufous, remainder cream; vertex cream. Antennal scape cream; flagellar scales cream. *Thorax:* Dorsum cream mixed with brown. Underside with scale collar adjacent to eye rufous from just above forewing to labial palpus, sternum rufous, remainder white. Prothoracic tibia rufous and cream; tarsus rufous. Mesothoracic tibia cream mixed with rufous; tarsus buff. Metathoracic tibia cream with a few rufous scales; tarsus cream becoming pale gray distally. *Forewing* (Figs. 4–6): Length 18–21 mm; ground color cream to pale brown; antemedial line indistinct, gray; orbicular spot small, black; median line cream bordered by pale gray distally, curved from R vein to inner margin; costal patch distal to median line pale brown, indistinct; postmedial line with largest black spots in cells M_{1-2}, spots surrounded by brown scales, thus almost appearing as a band; black spots along outer margin; termen sharply angled at vein M_3; fringe cream; underside ground color cream. *Hindwing* (Figs. 4–6): Ground color buff. *Abdomen:* Buff. *Genitalia* (Figs. 12–14): Uncus curved dorsad, setose, wider at middle than at base and apex (in lateral view), decurved apical spine. Valve with dorsal margin bowed in middle, apex round. Clasper narrow. Vesica with 3 diverticula: first divided, second and third elongate, third recurved.

Adult female.—Essentially as described for male except , Forewing length 19–21.5 mm; ground color pale brown to gray; black spots along outer margin faint to absent in some specimens. Postmedial line with indistinct black spots in cells M_{1-2}. *Genitalia* (Fig. 19): Postvaginal plate longer than wide. Ductus bursa sclerotized, with length more than 2 × width. Corpus bursa round, juncture with ductus bursa distinct. Signum straight; more than 0.5 × length extends into ductus bursa, apex a truncate.

Type material.—Holotype, ♂, in the USNM with following 4 labels: 1) Rinconada, V. Cruz, 2) Collection Wm. Schaus, 3) Type No.10492 U.S.N.M (red label), 4) Obrima Rinconada type. Schs. (hand written).

Obrima pimaensis was described from a male holotype and 4 male paratypes, all in the USNM. The holotype has the following 2 labels: 1) Baboquivari Mts., Pima Co., Ariz., El. approx. 5000 ft., 15–30 June



Figs. 18–20. Female genitalia. 18, *Obrima pyraloides*. 19, *O. rinconada*. 20, *O. cymbae*. Abbreviations: pvp, postvaginal plate; db, ductus bursae; s, sterigma; cb, corpus bursae.

1923. O.C. Poling, Coll., 2) Obrima pimaensis, Holotype ♂ B. & Benj. (label bordered with red and red lines, hand written). The 4 paratypes have the same labels as holotype, except the second label says "Paratype" instead of "Holotype".

Immature stages.—Unknown.

Distribution (Fig. 21).—Recorded from Mexico, Guatemala, and the United States from southern Arizona and southwestern Texas.

Material examined.—18 ♂ and 6 ♀. GUATEMALA: San Marcos: 17.3 km SE Talisman, Rio Cabuz at Hwy. CA2, 14°51′N, 092°04′W, 200 mts., 23 May 1973, Erwin & Hevel, Central American Expedition, 1973, 1 ♂. MEXICO: Nuevo Leon, Rinconada, Collection Wm. Schaus,

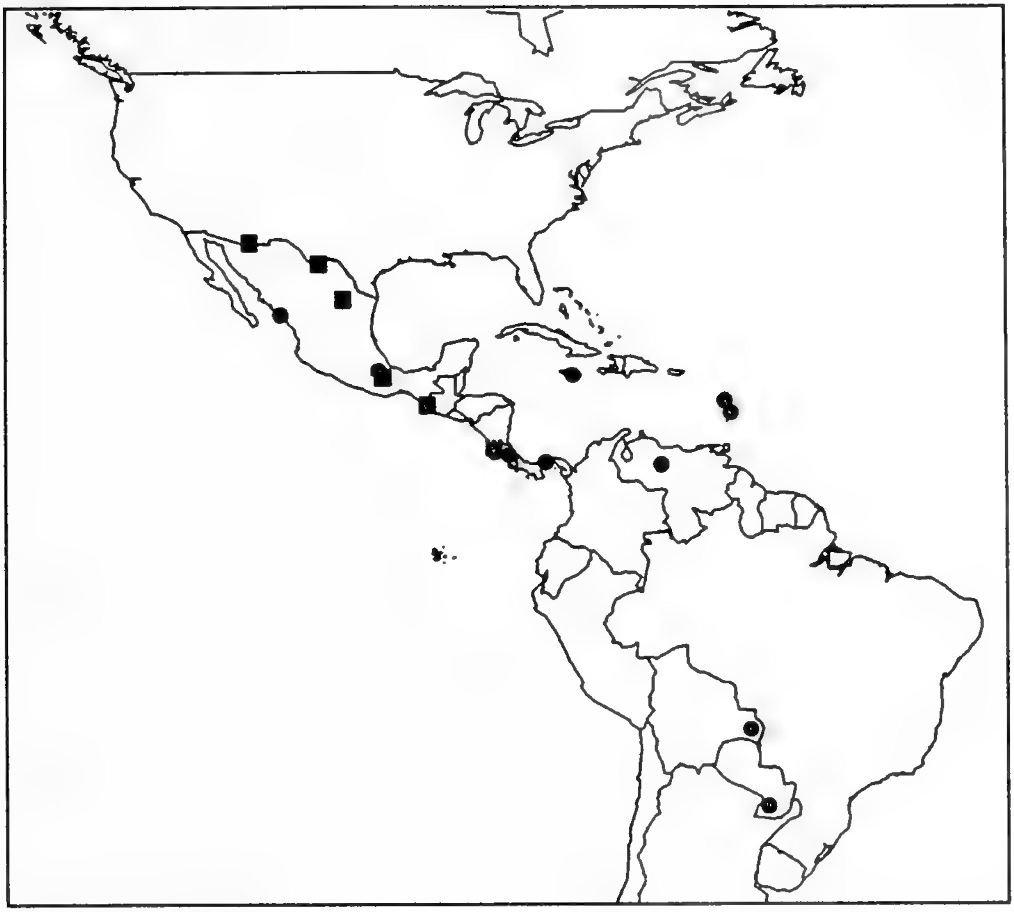


Fig. 21. Distribution of *Obrima*. Solid squares *O. rinconada;* circles *O. pyraloides;* shaded-square *O. cymbae*.

5 ♂ (green labels, genitalia slides, USNM 44074, 44075, 44083), (white label, genitalia slide: USNM 433, J.G. Franclemont), 3 ♀ (green label, genitalia slide, USNM 44084), (white label, genitalia slide: USNM 434, J.G. Franclemont), Dognin Collection, 2 ♂; Sinaloa: Venadio, Collection Wm. Schaus, 1 ♂ (green label, genitalia slide, USNM 44082). Oaxaca: 36.3 km N. Oaxaca, Hwy. 190, 1981 mts., 21 May 1973, Erwin & Hevel, Central American Expedition, 1973, 1 ♀. ARIZONA: So. Arizona, July 15–30, 1 ♂; Cochise Co., Huachuca Mts., Ash Canyon Rd. (½ mi W. Hwy. 92, Lot 4: 5100 ft. el.), N. McFarland, *Hab.* Is OAK-manzanita + grassland, at uv. light, L 6–82, 1 ♀, M 8–83, 1 ♂, 26 Jun. 81, 1 ♀. Pima Co., Baboquivari Mts., El. Approx. 5000 ft., 15–30 June 1923, O.C. Poling, Coll., 4 ♂. Santa Cruz Co., Madera Canyon, 5100′, Santa Rita Mts., July 10–26, 1964, D.R. Davis, 1 ♂; T20S. R14E. Sec. 2, Madera Canyon, Santa Rita Lodge, el. 4840′, 5 July 1987, Eric H. Metzler 1 ♂ (EHM). TEXAS: Brewster Co., Big Bend Nat'l. Pk., Green Gulch, 5400′, 2–4 VI 86, leg. E.C. Knutson, 1 ♂.

Discussion.—This species shows stronger sexual dimorphism than does *Obrima pyraloides,* with the female more speckled than the male, resulting in a more brown to gray forewing ground color. The spotting along the postmedial line is also indistinct to absent in the female. The shape of the median line is straight in *Obrima pyraloides* and forms an obtuse angle below the discal cell in *Obrima rinconada.*

Obrima cymbae Pogue, new species

(Figs. 7, 8, 15–17, 20, 21)

Diagnosis.—This is the smallest species of *Obrima* and has the forewing ground color a dark-reddish brown and termen not as angulate at vein M_3 as in *Obrima rinconada.*

Description.—*Adult Male. Head:* Labial palpus dark reddish brown, apical segment mixed with a few cream scales. Frons with scales adjacent to eye dark reddish brown, remainder dark reddish brown tipped with white; vertex dark reddish brown tipped with white. Antennal scape cream with a few rufous scales; flagellum scales cream. *Thorax:* Dorsum dark reddish brown tipped with white. Underside with scale collar adjacent to eye dark reddish brown from just above forewing to labial palpus, sternum paler, remainder white. Prothoracic tibia dark brown with some scales tipped white; tarsus dark brown. Mesothoracic tibia dark reddish brown tipped with white; tarsus grayish-brown. Metathoracic tibia rufous mixed with cream; tarsus grayish brown. *Forewing* (Figs. 7, 8): Length 13.5–15 mm; ground color reddish brown to dark reddish brown; antemedial line indistinct, gray; orbicular spot minute, consisting of only a few scales, dark brown; median line gray bordered by cream scales proximally; costal patch distal to median line dark brown; postmedial line indistinct, cream, bordered by gray distally, sinuous; black spots along outer margin (can be indistinct or absent); fringe rufous; underside ground color cream. *Hindwing* (Figs. 7, 8): Ground color rufous. *Abdomen:* Rufous. *Genitalia* (Figs. 15–17): Uncus curved dorsad, setose, equal width throughout length (in lateral view), decurved apical spine. Valve with dorsal margin bowed in middle, apex narrowed. Clasper wide. Vesica with 4 diverticula, first shortest, second bulbous and lateral to third and fourth.

Adult female.—Similar to male except forewing 14.5–16.0 mm. *Genitalia* (Fig. 20): Postvaginal plate wider than long. Ductus bursa with length less than 2 × width. Corpus bursa elongate, juncture with ductus bursa gradual. Signum sinuous; less than 0.25 × length extends into ductus bursa, apex truncate.

Type material.—Holotype, ♂, in INBio with following label: "Voucher-INBio data base-Costa Rica, 96-SRNP-2011, Testigo-base de datos INBio-Costa Rica". Type locality is Costa Rica, Provincia Guanacaste, Area de Conservación Guanacaste, Sector Santa Rosa, Area Administrativa, 280 m, LN 313400 LE 358900, May 12, 1996, wild-caught adult, D. H. Janzen and W. Hallwachs. Paratypes: 4 ♂, 6 ♀. Deposited in the USNM; American Museum of Natural History, New York, New York; Canadian National Collection, Ottawa, Canada; and The Natural History Museum (British Museum), London, England. COSTA RICA: Provincia Guanacaste, Area de Conservación Guanacaste, Sector Santa Rosa, Area Administrativa, 280 m, LN 313400 LE 358900, D. H. Janzen and W. Hallwachs: wild caught adults at light: 1 ♂, 9 May 1996,96-SRNP 2006; 3 ♀, 12 May 1996, 96-SRNP-2008, 96-SRNP-2009, 96-SRNP-2010. Ojochal, 10 m, LN 308550 LE 355200, D. H. Janzen and W. Hallwachs: reared adults eclosing from cocoons in captivity: 1 ♂, 12 Aug 1994, 94-SRNP-1675; 1 ♂, 7 Jul 1994, 94-SRNP-1670; 1 ♀, 28 Jul 1994, 94-SRNP-1677; 1 ♂, 28 Jun 1994, 94-SRNP-1680. Vado Rio Nisperal, 10 m, LN 309450 LE 355300, D. H. Janzen and W. Hallwachs: reared adults eclosing from cocoons in captivity: 1 ♀, 17 Jun 1994, 94-SRNP-1704; 1 ♀, 20 Jul 1994, 94-SRNP-1707.

Immature stages.—In the lowland dry forests of the Area de Conservación Guanacaste (ACG), northwestern Costa Rica (Janzen 1988a, b, 1993), the larvae feed on the new and maturing leaves of *Lonchocarpus orotinus* (Fabaceae) during the first 30 days of the rainy season, usually in May

(Janzen and Hallwachs 1997). The relatively naked last instar larva is grayish green. The very tough-walled pink to rust-colored cocoon is spun in the litter during the first few weeks of the rainy season, and eclosion occurs (in captivity) 1–2 months later (Janzen and Hallwachs 1997). The reproductive biology of *Obrima cymbae* appears to be essentially identical to that of *Obrima pyraloides* except that the former is apparently restricted to a single species of *Lonchocarpus* as a larval food plant.

Distribution (Fig. 21).—Known only from Sector Santa Rosa, Area de Conservación Guanacaste, northwestern Costa Rica.

Discussion.—This species can be easily distinguished from the other two species of *Obrima* by its smaller size and reddish-brown forewing ground color.

Etymology.—In recognition of the contribution of Thom Gerst and Cymba Yanagita Gerst to the development of INBio (Instituto Nacional de Biodiversidad) in Costa Rica, *Obrima cymbae* is named in honor of Cymba Yanagita Gerst.

ACKNOWLEDGMENTS

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ACALYPTRATE DIPTERA ASSOCIATED WITH WATER WILLOW, *JUSTICIA AMERICANA* (ACANTHACEAE)

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Abstract.—The temporal distribution of 28 species of acalyptrate Diptera associated with water willow, *Justicia americana* (L.) Vahl, from northeastern Ohio and western Pennsylvania are given. Monocultural stands in three streams were sampled. Some species used the plant directly for food or respiration, whereas others utilized the sediments, detritus, algae, and microbes present among the rhizomes and roots. Three species of shore fly (Ephydridae), *Hydrellia griseola* (Fallén), *Notiphila carinata* Loew, and *Parydra quadrituberculata* Loew, and the stem-boring agromyzid, *Melanagromyza dianthereae* (Malloch), dominated numerically. The temporal distribution of the dominant species varied between sites, demonstrating that similar vegetation at different sites does not necessarily support identical dipteran communities. Biological observations on *M. dianthereae* are given.

Key Words: Macrophytes, *Justicia*, Ephydridae, Agromyzidae, *Melanagromyza dianthereae*, streams

Diptera frequently are the dominant group of animals encountered in marshes (e.g. Davis and Gray 1966; Scheiring and Foote 1973; Todd and Foote 1987a, 1987b; Larson and Foote 1997). Lush stands of emergent macrophytes provide a complex three dimensional habitat that harbors diverse insect communities (e.g. Todd and Foote 1987a).

Justicia americana (L.) Vahl is a dicotyledon that grows in shallow waters of intermediate-sized streams in northeastern North America. A few investigators have studied the life history of certain Diptera associated with *J. americana* (Malloch 1920, Deonier et al. 1979), but no comprehensive list of Diptera associated with this macrophyte has been compiled. Herein, we present the results of a survey of the acalyptrate Diptera taken from *J. americana* in northeastern Ohio and western Pennsylvania. Differences in species composition, diversity, and temporal distribution are compared among sites.

Melanagromyza dianthereae (Malloch) (Agromyzidae) is a stem borer of *J. americana*, but no detailed data on the immature stages are available (Malloch 1920, Spencer and Steyskal 1986). Therefore, we present observations on the general biology of this species.

MATERIALS AND METHODS

Three sites in three watersheds were sampled during the summer of 1996. Little Beaver Creek, in Beaver Creek State Park (OH, Columbiana Co.) is an intermediate order stream, 20 to 30 m wide in the sampling area. The canopy shaded less than 10% of the stream. *Justicia americana* grew in shallow water along each bank, but only the southern bank was sampled as it was easily accessible and supported the densest growth. The second site was an unnamed tributary of the Connoquenessing Creek (hereafter referred to as Harmony Creek) located near Harmony (PA, Butler Co.). This was the smallest stream sampled, ranging from 12–15 m in width, and had a canopy coverage of approximately 75%. *Justicia americana* grew throughout the stream but was densest near the banks. The third site was Wolf Creek, located approximately 4 km northeast of Slippery Rock University (PA, Butler Co.). This stream ranged from 15–20 m in width, and the canopy coverage was less than 25%. Wolf Creek supported a dense growth of *J. americana* along the banks and within the stream channel (Fig. 1).

The visually densest monocultural stands of *J. americana* were sampled at each site. On each sampling date, six 10 m transects were walked in 10 paces, with one back and forth swing with a standard aerial sweep net (30.5 cm diameter) executed per pace. The acalyptrate Diptera were aspirated from the net, brought back to the laboratory, frozen at approximately −10° C overnight, and subsequently pinned and labeled. Additional specimens were collected by general sweeping with an aerial net.

Three pan traps per site per sampling date were placed within the densest stands of *J. americana* after sweep sampling was completed. The 20 × 15 × 4 cm pans were painted yellow (Disney et al. 1982), and each end tied to a plant stem with string. Approximately 1.5 cm of water to which a drop of liquid detergent was added was placed in the pans. Pans were left for approximately 24 h. Trapped insects were stored in 70% ethanol and identified but were not included in the quantitative data, as most pans became inundated due to fluctuating water levels, currents, or human disturbance.

As a measure of diversity, the Shannon-Weaver Index (Pielou 1966) was used because it incorporates both species richness and evenness. Separate measures of diversity (s), richness (H′), and evenness (J′) were calculated for each site. Sorensen's Index of Similarity ($S = 2C/[A + B]$) was used to compare the degree of similarity of the dipteran assemblages between each site, where A and B are the numbers of species found at the two sites compared, and C is the number of species each site has in common (Sorensen 1948). A value of zero indicates complete dissimilarity, whereas 1.00 indicates complete similarity. Although some of the acalyptrates encountered have an unknown or questionable association with *J. americana* (see below), all species obtained during quantitative sampling were included in these calculations.

To obtain data on the biology of *M. dianthereae,* plants were collected from Beaver Creek on 3 July ($n = 28$), 21 July ($n = 33$), and 9 August ($n = 20$), and from Harmony Creek on 7 July ($n = 47$), placed in a large cooler with stream water to keep the rhizomes moist, and transported back to the laboratory. We split open stems, and any immature stages present were placed in breeding jars or preserved in 70% ethanol. Observations of stem damage by larvae were recorded. To obtain eggs, we placed portions of stem in 0.5 cm of water within breeding jars with field-collected females. Breeding jars were kept in the laboratory at 20° C in a 14:10 light:dark photoperiod.

Specimens of Diptera obtained have been deposited in the personal collection of JBK, the Carnegie Museum of Natural History (Pittsburgh, PA), and the Ohio Biological Survey's Museum of Biological Diversity (Columbus, OH).

RESULTS

A total of 747 acalyptrate Diptera of 28 species and 23 genera was collected. Each site yielded a different assemblage of species (Table 1). Beaver Creek had the highest species richness with 28 species, followed by Harmony Creek and Wolf Creek with 16 and 12, respectively (Fig. 2). Ephydridae dominated (68.5%) with 512 specimens of 10 species and 7 genera. Adults of *M.*

Fig. 1. *Justicia americana* growing in Wolf Creek.

Table 1. Species of acalyptrate Diptera collected from *J. americana* at each site.

Species	Beaver	Wolf	Harmony
Agromyzidae			
Cerodontha dorsalis Malloch	X		X
Melanagromyza dinathereae (Malloch)	X	X	X
Phytoliriomyza spp.	X		X
Chloropidae			
Apotropina hirtoides (Sabrosky)	X	X	X
Chlorops certimus Adams	X		X
Elachiptera erythropleura Sabrosky	X		X
Eribolus nanus (Zetterstedt)	X		X
Gaurax spp.	X		
Thaumatomyia glabra (Meigen)	X		
Drosophilidae			
Drosophila macrospina Stalker and Spencer	X	X	
D. palustris Spencer	X		
Scaptomyza spp.	X	X	
Ephydridae			
Athyroglossa granulosa (Cresson)	X	X	X
Discocerina obscurella (Fallén)	X	X	X
Hydrellia griseola (Fallén)	X	X	X
Notiphila carinata Loew	X	X	
Ochthera anatolikos Clausen	X	X	X
Parydra aquila (Fallén)	X		
P. quadrituberculata Loew	X	X	X
P. unitubercula Loew	X		
Scatella favillacea Loew	X		X
S. picea (Walker)	X	X	X
Zeros flavipes Williston	X		
Sciomyzidae			
Dictya steyskali Valley	X		X
Sepedon armipes Loew	X	X	X
S. pusilla Steyskal	X		
Sphaeroceridae	X	X	X
Tephritidae			
Euaresta bella (Loew)	X		

dianthereae represented 14.3% of the total acalyptrates collected. All species obtained in pan traps were also collected with an aerial net.

Hydrellia griseola, Notiphila carinata, and *Parydra quadrituberculata* represented 87.7% of the total Ephydridae collected, with 449 specimens (60.1% of total acalyptrates). Each species was encountered during quantitative sweeping at each site with the exception of *N. carinata,* of which only several specimens were taken during general sweeping at Harmony Creek. *Hydrellia griseola* was the most abundant ephydrid collected (43.9% of all Ephydridae), followed closely by *P. quadrituberculata* (40.5%).

Changes in total numbers of acalyptrates did not follow any consistent pattern among sites. The number of flies collected at Beaver Creek peaked in early July (Fig. 3a). Wolf Creek had a relatively constant number of flies throughout the summer (Fig. 3b). In contrast, numbers were low at Har-

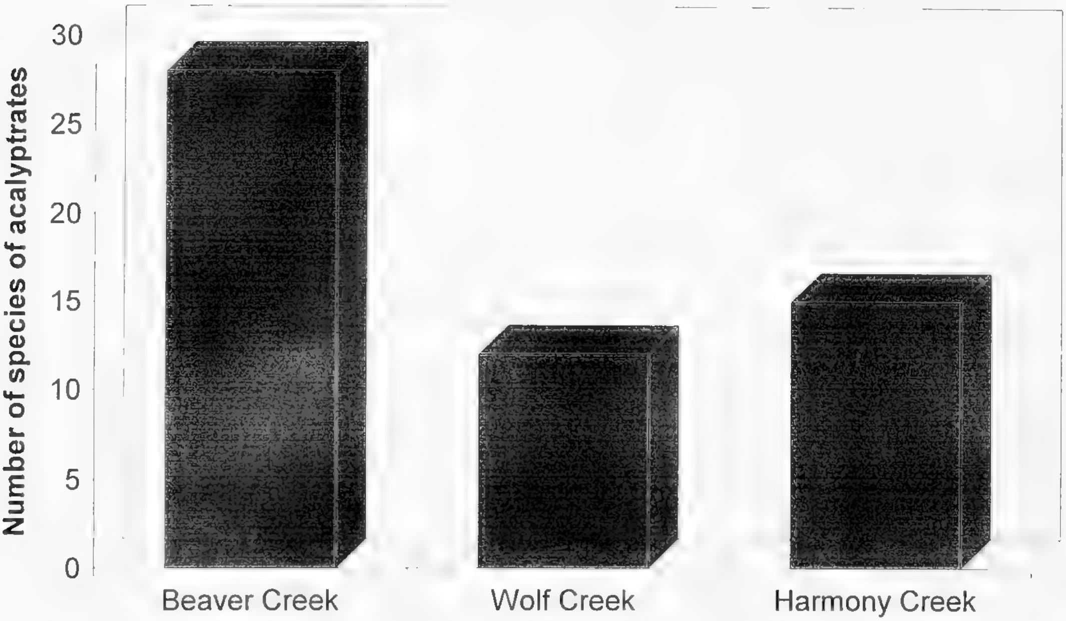

Fig. 2. Number of acalyptrate species collected from each site.

mony, but increased sharply on 24 August (Fig. 3c).

Values of species diversity (s), species richness (H′), and evenness (J′) are given in Table 2. Similarity (S) of Beaver Creek vs. Wolf Creek was 0.60, Beaver Creek vs. Harmony Creek was 0.73, and Wolf Creek vs. Harmony Creek was 0.64.

The total number of species collected at Beaver Creek peaked in early July (Fig. 3a), with Wolf Creek and Harmony Creek each exhibiting a similar but less dramatic trend (Fig. 3b, c). Total Ephydridae followed essentially the same trends as total individuals at each site (Fig. 4a–c), as did ephydrid species diversity (Fig. 4a–c). Numbers of *H. griseola* and *P. quadrituberculata* also followed the same trends as total individuals. Compared to total individuals, *N. carinata* exhibited a delay in maximum numbers at Beaver Creek, was collected in low numbers at Wolf Creek, and was absent in quantitative sweeps at Harmony Creek. The other abundant species, *M. dianthereae,* was abundant only at Beaver Creek where it peaked in early July. This species remained at relatively low and constant numbers at the other two sites (Fig. 5a–c).

Biology of Melanagromyza dianthereae

Spencer and Steyskal (1986) reported that *M. dianthereae* had been taken in Illinois, Indiana, and Maryland. Our records from Ohio and Pennsylvania are, to our knowledge, the first for these states.

Of 128 plants examined, 55 (42.97%) contained larvae or puparia, or had stem damage consistent with that of *M. dianthereae.* The stems of plants with larval mines had slightly enlarged areas, usually between the first and second nodes. These swollen areas were periodically inundated as water levels fluctuated.

Larval mines were in the center of the stem, inside the plant's outer vascular bundles. The central area of mined stems remained intact, as each contained a single pith core that larvae did not consume. Mines measured approximately 20.0 × 3.0 mm when puparia were present. The anterior end of larvae and puparia faced the apex of the plant. Prior to pupation, larvae created a small channel from the mine to

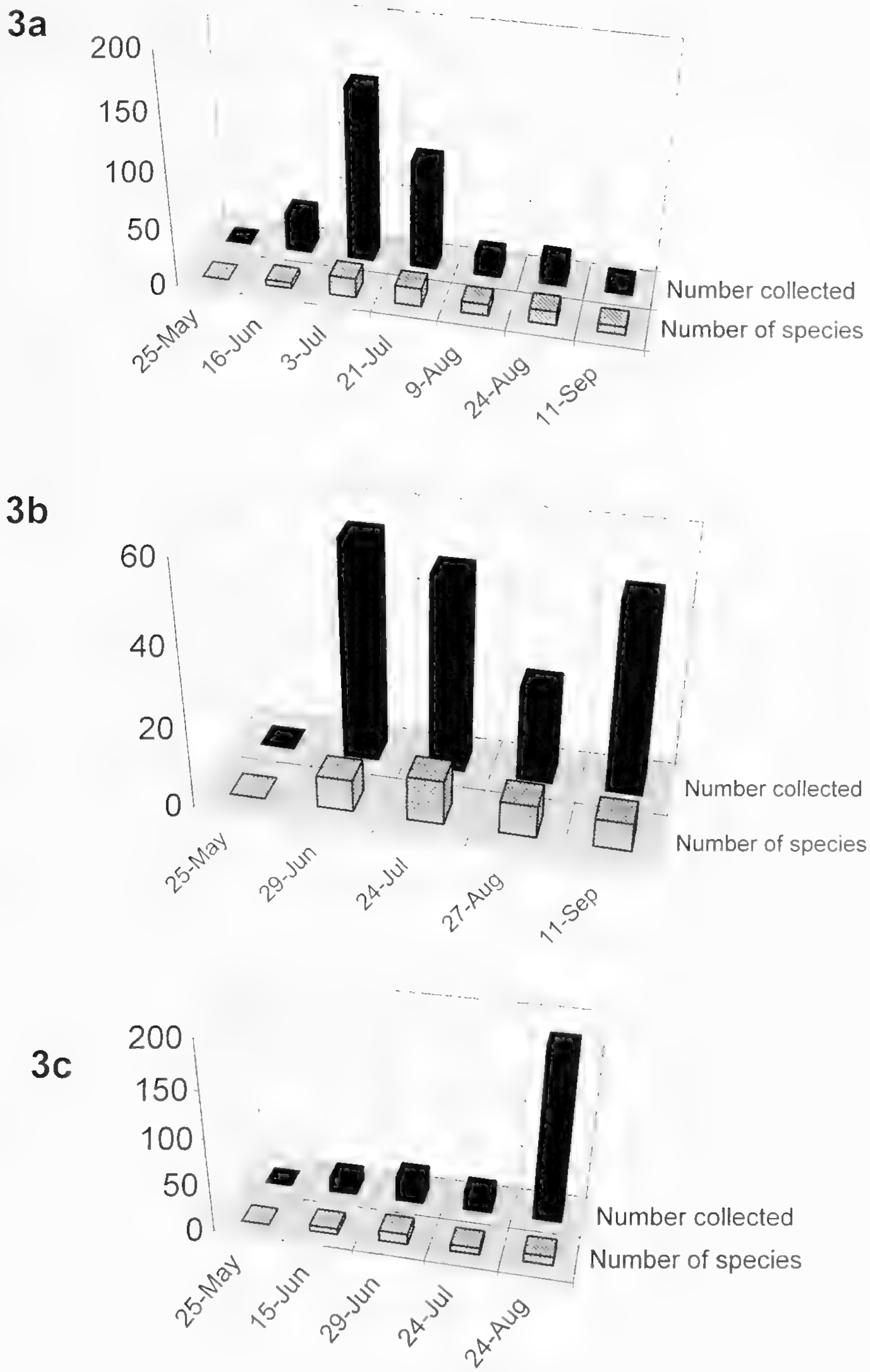

Fig. 3. Numbers and species of acalyptrates collected at Beaver Creek (a), Wolf Creek (b), and Harmony Creek (c).

Table 2. Values for species diversity (s), richness (H′), and evenness (J′) of the acalyptrate Diptera collected at each site.

	s	H′	J′
Beaver Creek	28	1.00	0.31
Harmony Creek	16	0.74	0.24
Wolf Creek	12	0.92	0.34

the epithelial layer of the stem. Puparia were found within these channels. Mines with puparia alone had exit holes in the epithelium of the stem at the end of the channel.

A puparium collected on 9 August was entirely pale, suggesting that it had recently metamorphosed. By 21 August, a well-developed fly was seen through the transparent pupal skin. The adult emerged 27 August. The pupal period thus was approximately 19 days at laboratory temperatures.

A male and female placed in a breeding jar were observed to copulate several times during a 48 h period. The female laid 37 eggs on the stem and was occasionally observed to have her head under water while she grasped the stem. The abdomen was above the water surface while eggs were attached to the stem.

Because no eggs hatched, the incubation period was not determined. No more than three eggs were found on any one field-collected plant.

Several puparia yielded undetermined parasitic wasps (Hymenoptera: Braconidae), all apparently conspecific. One pupa of *M. dianthereae* collected 7 July (Harmony site, from below the first node of the plant stem) exhibited internal damage, although the pupal skin was intact. One adult wasp was observed through the pupal skin to move out of the posterior end of the developing fly, but remained within the puparium until it emerged 8 July.

Discussion

Life history information on *Melanagromyza dianthereae* (Malloch 1920, Spencer and Steyskal 1986, this study) and the absence of this species from stands of adjacent riparian vegetation (Keiper, pers. obs.) indicate that it is probably a specialist stem-borer of *J. americana. Notiphila carinata* is a detritivore found in anoxic sediments, and pierces roots of *J. americana* (its only known host) with respiratory spiracles to obtain oxygen (Deonier et al. 1979). *Hydrellia griseola* is a polyphagous leaf miner (Deonier 1971) that has not been reported to attack *Justicia*. However, we encountered many adults during quantitative sampling (n = 197) and in the surviving pan traps, suggesting that it is indeed associated with this macrophyte. *Cerodontha dorsalis* and *Phytoliriomyza* spp. also have phytophagous larvae (Spencer and Steyskal 1986), but we obtained no evidence associating them with *J. americana* as a host plant.

Stands of *J. americana* cause deposits of sand and sediment to accumulate, resulting in the formation of semi-aquatic habitats. Larvae of *P. aquila, P. unituberculata,* and *P. quadrituberculata* consume diatoms (Deonier and Regensburg 1978, Thier and Foote 1980) and are associated with the deposits of diatom-laden sediments. Larvae of *Scatella* spp. feed on algae and Cyanobacteria (Foote 1977, Zack and Foote 1978, Connell and Scheiring 1981), and their food sources undoubtedly also flourish among the roots and rhizomes.

Discocerina obscurella, A. hirtoides, Gaurax spp., and Sphaeroceridae are detritivores and may take advantage of the deposits of decaying material among the stems and rhizomes. *Athyroglossa granulosa* is also a scavenger, but has been reared only from decaying skunk cabbage (*Symplocarpus foetidus* (L.) Nutt.) (Grimaldi and Jaenike 1983). Larvae of *Scaptomyza* spp. have been described as generalists, feeding on fungi, rotting leaves, and fermenting fruit (reviewed by Ferrar 1987).

Predators encountered include *O. anatolikos,* the adults and larvae of which prey on a variety of insects (cf., Simpson 1975). The snail-killing Sciomyzidae encountered probably fed on snails within the stands.

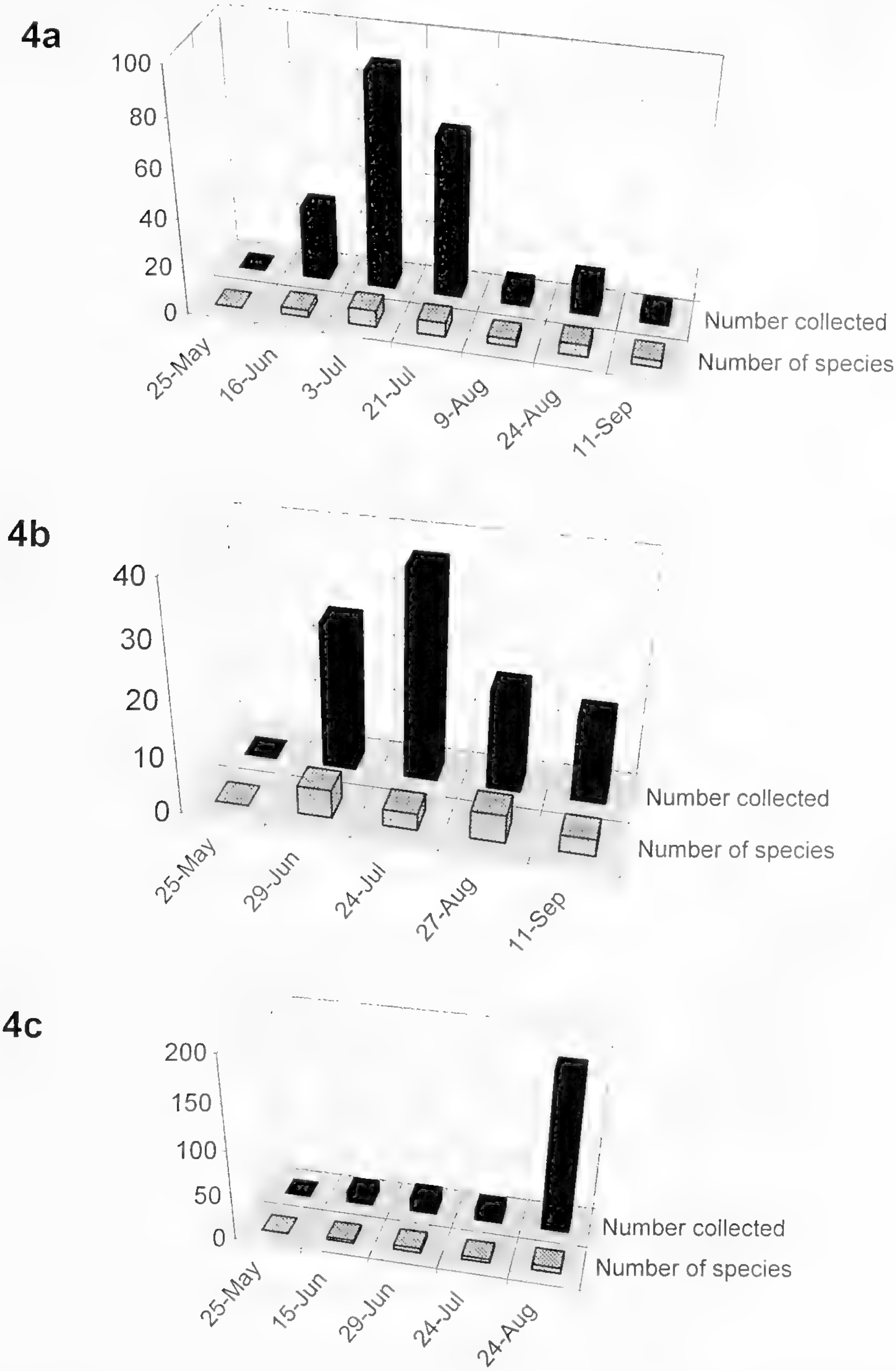

Fig. 4. Numbers and species of Ephydridae collected at Beaver Creek (a), Wolf Creek (b), and Harmony Creek (c).

Dictya steyskali and *S. armipes* are known to feed on aquatic pulmonate snails (Gastropoda: Pulmonata) in shallow water (Neff and Berg 1966, Valley and Berg 1977). *Thaumatomyia glabra* preys on root aphids (Homoptera) infesting sugar beets (Parker 1918, as *Chloropisca glabra* Meigen), and is therefore probably an incidental.

Other acalyptrates encountered undoubtedly do not have a direct association with *J. americana,* but may benefit from its presence as a refuge or source of nectar. The tephritid *E. bella* is a seed predator of common ragweed (*Ambrosia artemisiifolia* L.) (Foote et al. 1993), and *C. certimus* a stem borer of sedges (Cyperaceae) (Rogers et al. 1991). *Zeros flavipes* was reported from damp soil near the edges of ponds (Scheiring and Connell 1979), but it is unknown whether this species inhabits the wet sediment deposits around water willow. *Elachiptera erythropleura* is a secondary invader of damaged monocots (Valley et al. 1969) and general detritivore (Wendt 1968), whereas *E. nanus* is a secondary invader of *Carex* (Cyperaceae) (Valley et al. 1969). Possible associations between *J. americana* and the remaining acalyptrates remains unknown.

Todd and Foote (1987a) suggested that the structural complexity of yellow water lily, *Nuphar lutea* L., provides hiding places from predators, protection from adverse weather conditions, and oviposition sites. *Justicia americana* probably provides these benefits as well. Plants grow to approximately 1 m tall, and produce dense stands which completely cover the water and substrate under the plants in many areas. Herbivores, detritivores, and algivores are represented, and the predators mentioned above probably hunt within the spatially complex stands. Thus, water willow supports a multi-trophic dipteran community.

Although Ephydridae constituted over a third (n = 11) of the total number of species recorded from *J. americana,* this number is much lower than the numbers of species of shore flies associated with other wetland plants. For instance, Todd and Foote (1987a) recorded 13 species from *Sparganium eurycarpum* Engelm., 14 from *Eleocharis smallii* Britt., 14 from *Typha latifolia* L., and 21 from *N. lutea.* Ten species of *Notiphila* alone were encountered in *N. lutea,* whereas only one has been recorded from *J. americana.* Since both *J. americana* and *N. lutea* are dicotyledons, we speculate that flowing water constitutes a selective pressure that relatively few acalyptrates have overcome. Therefore, aquatic macrophytes growing in lotic environments may be used less by acalyptrate Diptera than those in still water. Habitat instability has been implicated with a reduction in the species richness of Diptera (e.g. Steinly 1986).

The temporal pattern of species diversity was very similar among the three sites, with very few species encountered at the beginning of the summer, a peak in diversity during late June and July, and a modest drop in numbers as summer progressed (Fig. 3a–c). Somewhat surprisingly, the species assemblages were quite different at each site as indicated by Table 1 and the intermediate values of S. The temporal distribution of the dominant species also varied among sites (Fig. 5a–c). The most anomalous data were collected at Harmony Creek. Why did the numbers of *H. griseola* and *P. quadrituberculata* explode at the end of the summer, and why were so few *N. carinata* obtained here? Beaver Creek and Wolf Creek were more pristine areas than Harmony Creek, which was bordered by a housing development on one side and a golf course on the other. Perhaps *N. carinata* is sensitive to human disturbances. Beaver Creek was the largest stream, and harbored the highest numbers of *N. carinata.* Perhaps more sediments are deposited among the plants, providing an enhanced habitat for this species. These observations suggest that, although sites may support similar vegetation, the acalyptrate Diptera community may be dissimilar in species composition, proportions, and temporal distribution.

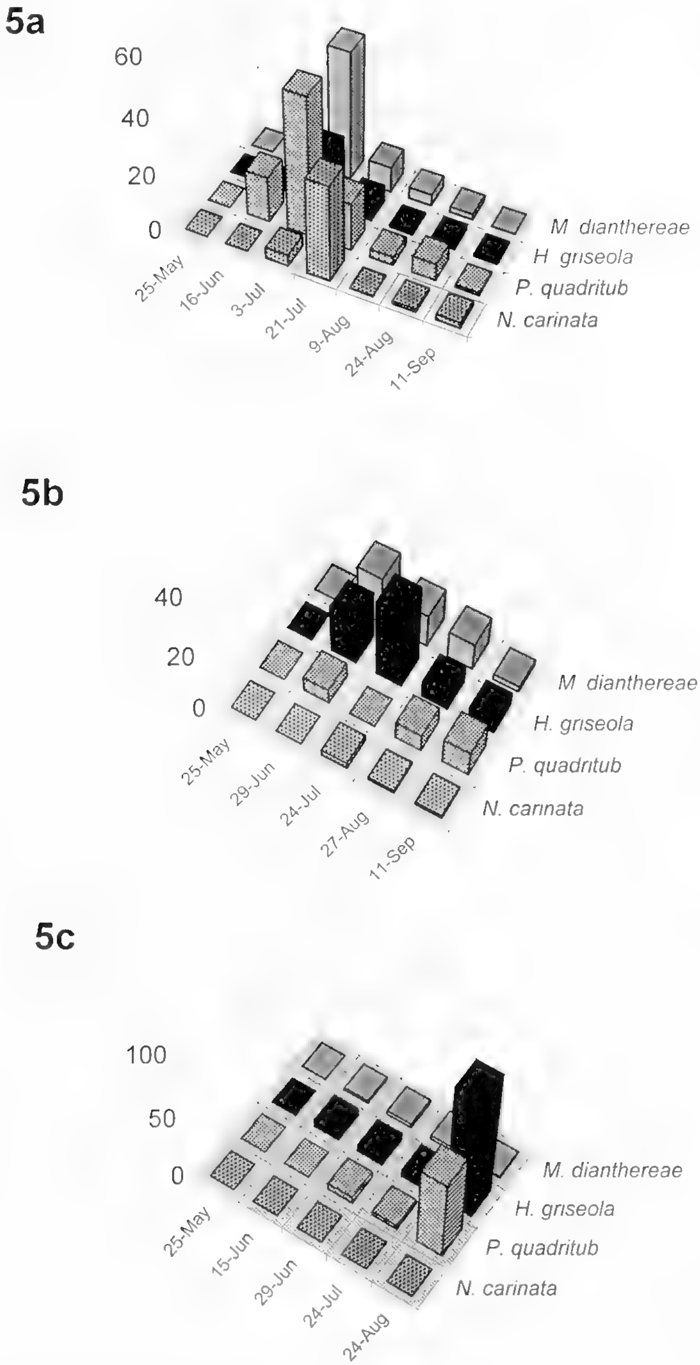

Fig. 5. Total number of dominant acalyptrate Diptera from Beaver Creek (a), Wolf Creek (b), and Harmony Creek (c).

We suggest that surveys of the acalyptrate Diptera associated with *Justicia americana* be conducted in other areas of North America for comparison to our data. Our sites were less than 100 km from each other, yet we found notable differences among them. Comparisons of sites further away would give insight into differences in the phenology and composition of species from geographically isolated stands of this widespread constituent of some lotic communities.

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ANTENNAL AND OTHER CHARACTERS USEFUL IN IDENTIFICATION OF THE APHIDOIDEA (HOMOPTERA)

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Abstract.—Aphids, adelgids, and phylloxerans are soft-bodied insects that damage ornamental plants and agricultural crops by sucking plant sap or through the transmission of plant viruses. Identification, even to family, of these insects can be difficult. This article contains information on antennal characters that are useful in recognition of the developmental forms of aphids, adelgids, and phylloxerans.

Key Words: Aphids, adelgids, phylloxerans, antennae, morphs

Homopterous insects are an interesting and diverse group. The structure of the piercing-sucking mouthparts distinguishes members of the Homoptera from other insects (Blackman 1974). Identification at family level can be a challenge because there are few characters that separate homopterous families.

The Aphidoidea contains three families: Aphididae (aphids), Adelgidae (adelgids), and Phylloxeridae (phylloxerans or phylloxerids). The subfamilies in the Aphididae are given family status by some workers (Heie 1987, Foottit and Richards 1993). Members of the Aphidoidea often have complex life cycles, including variable successions of morphologically different developmental forms (morphs) and alternation of hosts between a primary host (often a woody plant) and a secondary host (usually an herbaceous plant). Aphids are found on a broad range of plant families, adelgids are limited to conifers, and phylloxerans are found on deciduous plants. For a discussion of and keys to aphidoid immatures, see *Immature Insects* (Stoetzel 1991).

Most aphidoid morphs have piercing-sucking mouthparts, but some sexual forms (sexuales) have rudimentary or vestigial mouthparts. Many species have wax glands. Aphids are distinctive in having paired cornicles (siphunculi) located on the fifth or sixth abdominal segments, but some lack these structures. Cornicles have many shapes and sizes and are known to emit an alarm pheromone (Nault et al. 1973, Dixon 1985). The ninth abdominal tergite is modified into a cauda (tail) that is variable in shape and size.

Identification, even to family, of some of the forms in the Aphidoidea can be difficult. This article contains information on antennal characters that is useful in recognition of the variable forms in the Aphidoidea. As in all insects, the antennae in the Aphidoidea consist of two, round, basal segments called the scape and pedicel and a usually multisegmented and elongated flagellum. The scape and pedicel are without special characters, but the flagellum is distinctive and provides characters for distinguishing among the aphidoid families and between the Aphidoidea and other insects.

APHIDIDAE
(Fig. 1)

Most aphids have 4-, 5-, or 6-segmented antennae. Rarely, in *Dasyaphis* (Takahashi 1965) and *Nipponaphis* (Miyazaki 1987), the flagellum is one segmented with two primary sensoria and a faint distinction between base and unguis. The basal two segments, the scape and pedicel, are without differences. The flagellum is distinctive in possessing primary and often secondary sensoria (rhinaria) and an ultimate segment divided into a base and unguis (processus terminalis or terminal process). The presence of one primary sensorium on the ultimate segment at the juncture of the base and the unguis and another primary sensorium on the distal or apical portion of the penultimate segment is distinctive. No other insect taxon displays these antennal characters. When present, secondary sensoria can be found on one or all of the ultimate 2–4 antennal segments of adults. Secondary sensoria do not occur on antennae of immatures. Antennal sensoria are variable in shape (circular, oval, annular, irregular) and size and are olfactory in function (Dunn 1978, Shambaugh et al. 1978, Bromley and Anderson 1979). The similarity of the primary sensoria with secondary sensoria in some species, especially in the Pemphiginae, make it difficult to determine the division of the ultimate antennal segment into a base and unguis.

Stem mothers (fundatrices) are nearly always wingless, usually have 5-segmented antennae (Fig. 1A), and may have secondary sensoria on the last 3 segments. Their immature stages have 4- or 5-segmented antennae. Wingless females (apterae) and their immature stages usually have 5- or 6-segmented antennae (Fig. 1B). Winged females (alatae) usually have 5- or 6-segmented antennae (Fig. 1C) and usually have secondary sensoria on one or more of the terminal segments. Their immature stages usually have 5- or 6-segmented antennae. Egg-laying females (oviparae) are usually wingless and usually have 5- or 6-segmented antennae (Fig. 1D). Their immature stages usually have 5- or 6-segmented antennae. Males are winged or wingless, usually have 5- or 6-segmented antennae (Fig. 1E), and usually have many secondary sensoria on all flagellar segments. Their immature stages usually have 5- or 6-segmented antennae. The antennae of all the morphs of *Myzus persicae* (Sulzer), the green peach aphid, are illustrated in Fig. 1.

ADELGIDAE
(Fig. 2)

Adelgids have 3-, 4- or 5-segmented antennae. The basal two segments, the scape and pedicel, are without differences. The flagellum differs in all forms. Adelgids have a complex life cycle that often spans two years. Most species alternate hosts between *Picea* spp. (spruce), and a specific species but any of a number of species of other conifer genera. Some species do not have a secondary host but complete their development on spruce. Some species do not return to spruce but remain on the nonspruce coniferous host (Annand 1928, Carter 1971).

Wingless females (Fig. 2A) and their immature stages have 3-segmented antennae and could be confused with phylloxerans except for the presence of 4 or 5 abdominal spiracles, an abundance of wax glands usually arranged in plates, and the presence of a sclerotized ovipositor in the adults. Winged females (Fig. 2B) have 5-segmented antennae. Each of the terminal three segments has a large sensorium. No other insect displays these antennal characters. Egg-laying females (oviparae) (Fig. 2C) are wingless. They and their immature stages have 4-segmented antennae with the third segment longer than the fourth. The wingless males and their immature stages have 4-segmented antennae (Fig. 2D) with the third segment longer than the fourth. The antennae of all the morphs of *Adelges cooleyi* (Gillette), the Cooley spruce gall adelgid, are illustrated in Fig. 2.

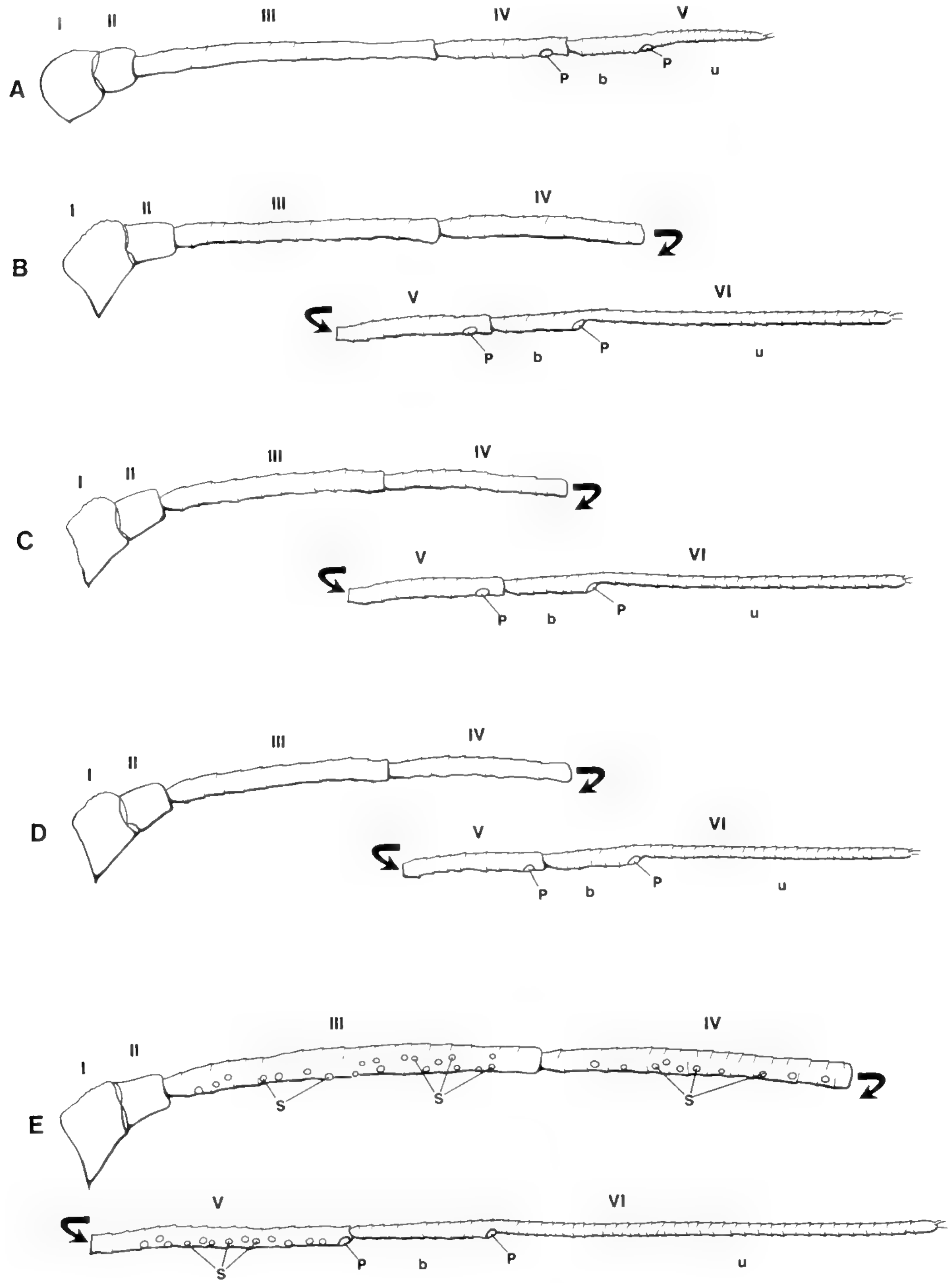

Fig. 1. Aphididae antennae, *Myzus persicae*. A, Stem mother or fundatrix. B, Wingless female or aptera. C, Winged female or alata. D, Egg-laying female or ovipara. E, Male. Abbreviations: P = primary sensorium; S = secondary sensorium; b = base of ultimate antennal segment; u = unguis portion of ultimate antennal segment.

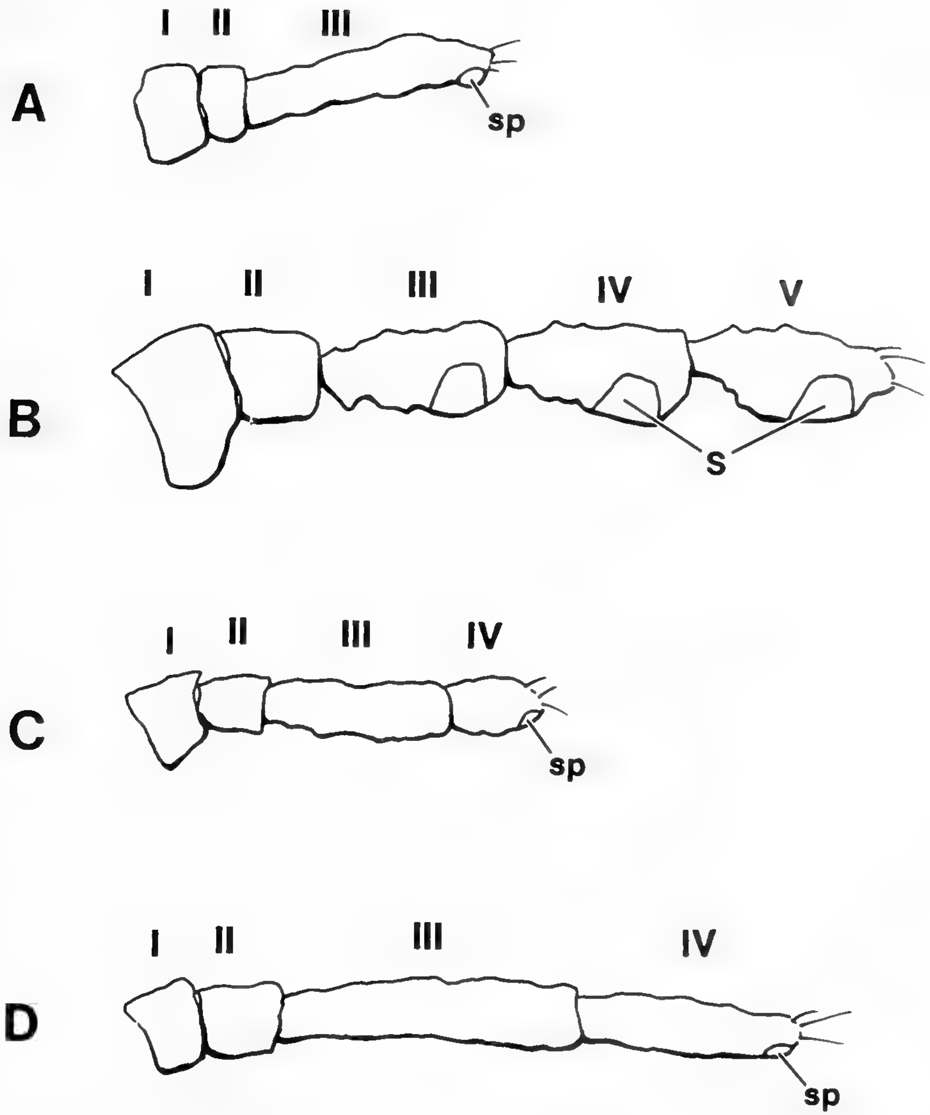

Fig. 2. Adelgidae antennae, *Adelges cooleyi*. A, Wingless female or aptera. B, Winged female or alata. C, Egg-laying female or ovipara. D, Male. Abbreviations: S = sensorium; sp = sensory peg.

PHYLLOXERIDAE
(Fig. 3)

Phylloxerids have 3-segmented antennae. The basal two segments, the scape and pedicel, are without differences. In all species the flagellum ends in a sensory peg or sensorium that differs in size and location. Some winged adult females have one or two additional sensoria on the flagellum. In *Phylloxera notabilis* Pergande, winged females have what appear to be 4-segmented antennae because the sensorium on the third segment usually is divided into two elongate masses, but the constriction between these areas is not articulated. The most studied species of phylloxeran is *Daktulosphaira vitifoliae* (Fitch), the grape phylloxeran, a worldwide pest of *Vitis*. Most species of phylloxerans develop on species of *Carya* where they produce galls on leaves

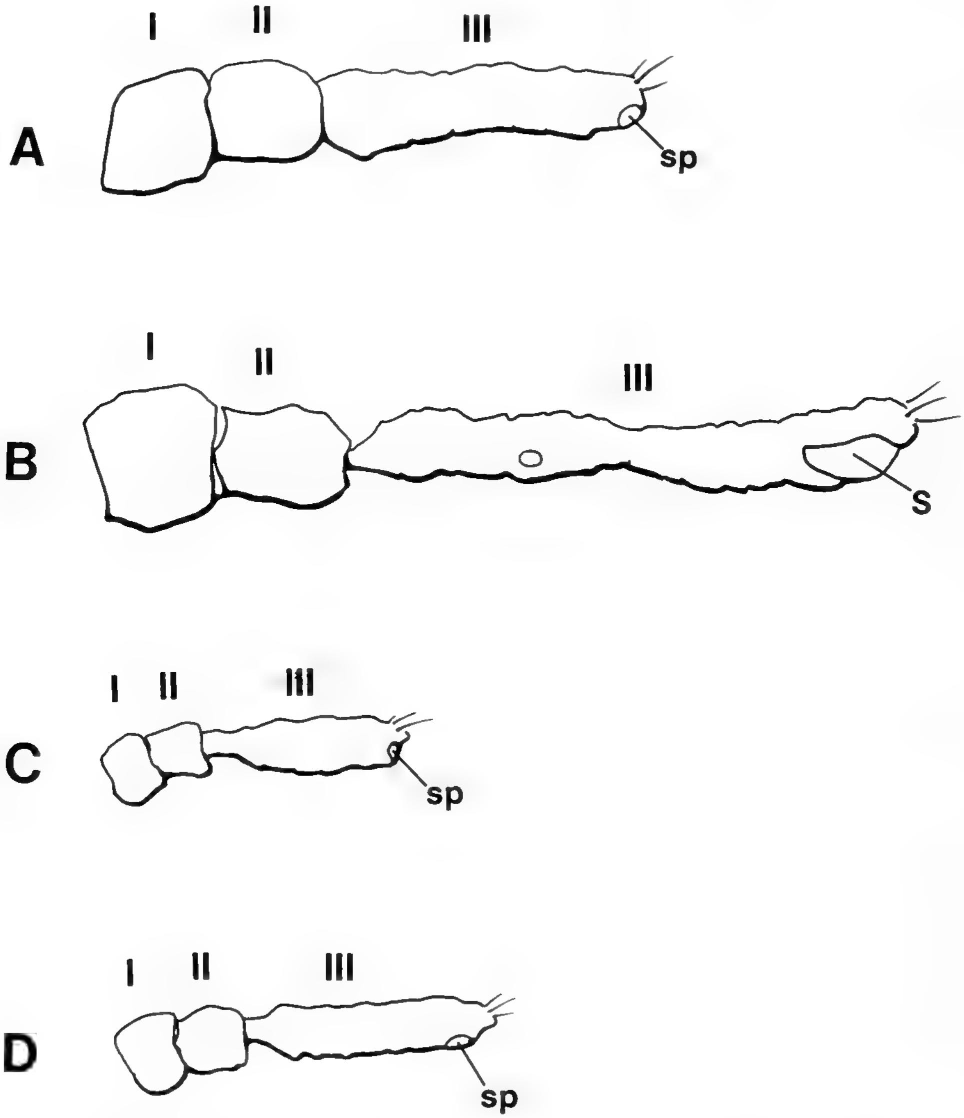

Fig. 3. Phylloxeridae antennae, *Phylloxera devastatrix.* A, Stem mother or fundatrix. B, Winged female or alata. C, Egg-laying female or ovipara. D, Male. Abbreviations: S = sensorium; sp = sensory peg.

and stems (Pergande 1904, Stoetzel 1981). Some species have been shown to alternate between species of *Carya* and *Quercus* or *Castanea* (Stoetzel 1985a).

Wingless and winged females and their immature stages have 3-segmented antennae (Figs. 3A, 3B) and could be confused with adelgids except that adults have a vulva instead of a sclerotized ovipositor and lack the wax glands and plates found in most adelgids. Egg-laying females (oviparae) have vestigial mouthparts and are wingless. They and their immature stages have 3-segmented antennae (Fig. 3C). Males have vestigial mouthparts and are wingless. They and their immature stages have 3-segmented antennae (Fig. 3D). The immatures of the sexuales are unique in that they are pupiform larvae which do not feed or move except for undulating motions during molting (Stoetzel 1985b). The antennae of all the morphs of *Phylloxera devastatrix* Pergande, the pecan phylloxera, are illustrated in Fig. 3.

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NOTE

Biological Notes on *Ochrotrichia xena* (Ross) (Trichoptera: Hydroptilidae), a Species Newly Recorded from Ohio

Ochrotrichia xena (Ross), an uncommonly collected microcaddisfly in North America, has been reported from Arkansas (Bowles and Mathis 1989. Journal of the Kansas Entomological Society 62: 234–244), Illinois (Ross 1944. Illinois Natural History Survey Bulletin 23: 1–326), Kentucky (Resh 1975. Transactions of the Kentucky Academy of Science 36: 6–16), Indiana, Missouri (Waltz and McCafferty 1983. Purdue University Agricultural Experimental Station Bulletin 978: 1–25), and Tennessee (Edwards 1966. Journal of the Tennessee Academy of Science 141: 116–128). We report *O. xena* as new for Ohio, and give biological notes on larvae collected in northeastern Ohio.

The first record of *O. xena* for Ohio was obtained from adults reared from larvae collected in the South Fork of Eagle Creek (41° 13′ 36″ N, 81° 04′ 15″ W) in the Ravenna Arsenal, Portage County. A second record for the state, provided by Dr. Oliver S. Flint (Smithsonian Institution, Washington, DC), is 3 June 1953, near a tributary of the Stillwater River, Miami County (A. R. Gaufin, collector).

Fifth-instars were obtained from filaments of *Cladophora* on 13 May 1996 from a riffle in the South Fork of Eagle Creek. The water temperature was 9.5° C; flow rates, 40–50 cm sec^{-1}; depths, 10–15 cm.

Larvae were returned to the laboratory on the day collected, and placed in aerated rearing chambers (Keiper and Foote 1996. Hydrobiologia 339: 137–139) containing stream water, small stones, and filaments of *Cladophora*. Ross (1944) noted that the larva of *O. xena* has a white spot on the center of the head. This allowed us to separate larvae of *O. xena* from those of the co-occurring *O. wojcickyi* Blickle which lack this spot.

Larvae moved along algal filaments and macerated cells, breaking the cell wall in many places along its length to obtain the cellular contents. This is similar to Nielsen's (1948. Det Kongelige Danske videnskabernes selskabs Biologiske Skrifter 5: 1–200) description of feeding by larvae of an European species of *Hydroptila* Dahlman. However, he observed that *Hydroptila* larvae moved algal filaments with their fore legs to their mouth parts and pierced individual cells. *Hydroptila* larvae generally have a serrated left mandible and a knifelike right mandible, each specialized respectively for gripping and piercing cell walls of green algae (Nielsen 1948; J. B. Keiper, unpublished data). The feeding behavior of *O. xena* contrasts to that of *Hydroptila*, and is reflected by the structure of their robust mandibles (Fig. 1) which appear suited for crushing food items.

On 19 May, larvae moved from the *Cladophora* to a rock substrate where they attached and sealed their cases, and pupated. On 27 May, two males of *O. xena*, several undetermined *Ochrotrichia* Mosely fe-

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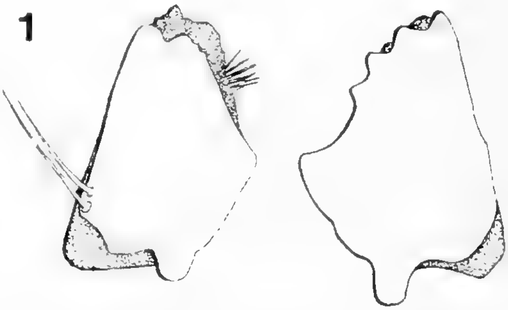

Fig. 1. Ventral view of mandibles of *Ochrotrichia xena*.

males, and one *O. wojcickyi* male emerged in the laboratory. Additional males of *O. xena* emerged on 30 May, 1 June, and 2 June 1997.

We thank B. J. Armitage, Ohio Biological Survey, for providing distributional data on Ohio Hydroptilidae and S. C. Harris, Clarion University, PA, for confirming the identification of *O. xena*. We are indebted to the United States Army and the help of T. Morgan for providing access to South Fork of Eagle Creek as it flows through Ravenna Arsenal. These observations were made during a larger study partially funded by Sigma Xi Grants-in-Aid of Research.

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NOTE

First records of the Nymphomyiidae (Diptera) in Nepal

The Nymphomyiidae are one of the most specialized and distinctive families of nematocerous Diptera. These flies usually colonize cool, pristine, headwater streams where all life stages may frequent current-exposed habitats (0.5–1.0 m/s). Larvae are collector-gatherers or grazers, feeding on the thin films of algae, bacteria and other organic matter (= periphyton) on current-exposed rocks. Adults possess wings at emergence, but few details of flight behavior exist. Data for several species suggest that adults mate soon after emergence, crawl beneath the water *in copula*, and the female attaches eggs to the coupled bodies (Courtney 1994. Smithsonian Contributions to Zoology 550: 1–41). Adults of at least some species die *in copula*. In fact, *N. walkeri* (Ide) was for several years known only from "apterous" (i.e. dealate) adults, most as copulating pairs (e.g. Ide 1965. The Canadian Entomologist 97: 496–507; Cutten and Kevan 1970. Canadian Journal of Zoology 48: 1–24; Mingo and Gibbs 1976. Entomological News 87: 184–185). It is now assumed that the wingless condition is related to oviposition behavior. The vestigial mouthparts and poorly developed digestive tract suggest an ephemeral adult life, but adults of some species can survive several days in the laboratory (Courtney 1994).

The phylogenetic position of the Nymphomyiidae is among the more controversial issues in dipterology. The family was considered by many workers to be the most primitive group of Diptera (e.g. Rohdendorf 1974. The Historical Development of Diptera. [translated from Russian]. Hocking, Oldroyd and Ball (editors). University of Alberta Press, Edmonton. 360pp.; Ide 1965, Cutten and Kevan 1970, Hackman and Väisänen 1982. Annales Zoologici Fennici 19: 209–219; Griffiths 1990. Quaestiones Entomologicae 26: 117–130). Other studies (Courtney 1994) suggest that nymphomyiids are related to the Culicomorpha. Most recent analyses (e.g. Wood and Borkent 1989. pp. 1333–1370. *In* McAlpine and Wood (coordinators). Manual of Nearctic Diptera, Volume 3. Research Branch, Agriculture Canada Monograph 32; Courtney 1990. Canadian Journal of Zoology 68: 556–578; Courtney, 1991. Systematic Entomology 16: 137–172; Oosterbroek and Courtney 1995. Zoological Journal of the Linnean Society 115: 267–311) support the hypothesis that nymphomyiids belong to the infraorder Blephariceromorpha, as sister-group to the Deuterophlebiidae + Blephariceridae.

The Nymphomyiidae were revised recently (Courtney 1994) to include seven species: three from northeastern Asia (*Nymphomyia alba* Tokunaga, *N. levanidovae* Rohdendorf and Kalugina, and *N. rohdendorfi* Makarchenko), two from eastern North America (*N. dolichopeza* Courtney and *N. walkeri* (Ide)), and one each from Hong Kong (*N. holoptica* Courtney) and the Himalayas (*N. brundini* (Kevan)). Previous records from the Himalayas were limited to five pupal exuviae and two adult males (see Courtney [1994] for a re-interpretation of Cutten and Kevan's [1970] "female" specimen). All were collected November, 1961, in Darjeeling District, India (Brundin 1966. Kungliga Svenska Vetenskapsakademiens Handlingar 11: 1–472). This note reports on the first collections of Himalayan Nymphomyiidae in over 30 years, the first records of the family in Nepal, and the discovery of larvae that appear to be *N. brundini*.

As part of an ongoing study of the mosquito fauna of Nepal (see Darsie, Courtney and Pradhan. 1996. Journal of the American Mosquito Control Association 12: 130–134), a survey of the "Midwestern Region" was conducted in 1994. The survey included nearly three months of field work, one in Himalayan foothill zone around Jumla (29°16′N 82°11′E, 2340m). While based in Jumla, a one-week trek to Rara Lake National Park provided opportunities to sample aquatic habitats for mosquitoes and other insects. Rock-wash methods (Courtney 1991. Journal of the North American Benthological Society 10: 177–197; Courtney 1994) were used to gather benthic samples at several streams between Jumla and Rara Lake, in hopes of collecting nymphomyiids and early instar larvae of other torrenticolous insects. Using these methods, nymphomyiids were collected at two streams, Chauta Khola and Ghatta Khola. Both are tributaries of the Sinja Khola, in the northern part of Jumla District approximately 25 km NNW of Jumla. Nymphomyiid collection data were as follows: NEPAL, Jumla District, Chauta Khola above Chauta, 29°26′N 82°06′E, 2780m, 14 September 1994, coll. G.W. Courtney (1 ♂ pupa and 25 larvae–6, 1, 10, 8 of instars I–IV, respectively); Ghatta Khola below Gorasina, 29°26′N 82°02′E, 3100m, 17 September 1994, coll. G.W. Courtney (1 larva—instar I). Voucher specimens are deposited in the National Museum of Natural History, Smithsonian Institution, Washington, DC, and the Iowa State Insect Collection, Ames, IA.

Both Chauta Khola and Ghatta Khola are cool, small (approx. 5m wide), mountain streams flowing through mixed conifer-deciduous forest. The headwaters of both sites are dominated by open meadows; however, nymphomyiid collections were from reaches where riparian forest and herbaceous cover were well developed, especially at Chauta Khola. The latter site could be categorized as "torrential," and was dominated by large substrates and extensive whitewater areas. As is typical of many nymphomyiid sites in eastern North America, both Nepal sites contained many rocks covered with aquatic moss. Moss-covered substrates were the source of nymphomyiid material. Although sampled during the monsoon and after several days with periodical rains, both streams were clear and approximately 7°C. At Chauta Khola, nymphomyiids were sympatric with larvae of *Deuterophlebia* sp. and larvae and pupae of *Blepharicera* sp.

Nymphomyiids from Chauta Khola appear to be conspecific with the Indian species *N. brundini*. The male pupa and adult genitalia (dissected from the pupa) closely match the description of *N. brundini* (see Courtney 1994), and the larval postmentum is similar to that of several species not easily separated (including *N. brundini*'s sister-species, *N. holoptica*). Assuming the Chauta Khola larvae and pupa are conspecific, the larval records are the first for *N. brundini*. The lack of associated life stages makes me less confident about the identity of the Ghatta Khola instar-I larva. However, Ghatta Khola and Chauta Khola are tributaries of the same major river (Sinja Khola) and separated by only about 5km. The proximity of these sites and the general lack of sympatry in the family (Courtney 1994) suggest that the Ghatta Khola and Chauta Khola nymphomyiids are conspecific. Females of *N. brundini* remain unknown.

These records extend the known distribution of *N. brundini* nearly 700km westward. The lack of records from intervening areas presumably reflects the lack of collection, rather than the absence of nymphomyiids. Additional records and new species of nymphomyiids are expected in other parts of the Himalayas and southeast Asia. However, as recommended elsewhere (Courtney 1994), the key to future discoveries will be to adopt rock-wash and other collection methods that effectively sample the habitats of these unusual flies.

I thank K.B. Shrestha for assistance on the Rara Lake trek, the National Geographic Society for supporting field work through grant no. 5249-94, and R. J. Gagné, E.S. Krafsur and D. R. Smith for reviewing an earlier draft of this paper. This is paper no. J-17741 of the Iowa Agriculture and Home Economics Experiment Station, and supported by Hatch Act and State of Iowa funds.

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NOTE

New Distributional Data for *Liliacina diversipes* (Kirby) (Hymenoptera: Tenthredinidae: Selandriinae) in the United States

The first report of the Mexican and Central American *Liliacina diversipes* (Kirby) in the United States was from Gainesville, Florida, in July and August, 1987 (Smith. 1990. Proceedings of the Entomological Society of Washington 92: 812). Since, I have seen specimens from several additional localities, some with earlier collection dates. The species is now known to occur in Georgia, Florida, Louisiana, and South Carolina; thus, it is apparently widespread in the southeastern United States. Earlier collection dates are 1985 from Louisiana and 1933 from South Carolina. The species has obviously been present but unnoticed in this country for much longer than expected. It is a component of and related to the Neotropical fauna and is not known from intermediate localities between southern Mexico and southeastern United States.

Records.—FLORIDA: Alachua Co., Gainesville, 3-17-VII-1987 (1 ♀), 10-31-VIII-1987 (1 ♀) (Smith 1990). GEORGIA: Jones Co., 25-VI-1-VII-1993 (1 ♀). LOUISIANA: East Baton Rouge Parish, Louisiana State University Campus, 28-IV-1985, D.A. Rider (1 ♀). SOUTH CAROLINA: Pickens Co., Sassafras Mtn, 31-V-1933, O.L. Cartwright (1 ♀).

I thank the following for allowing examination of specimens: V.L. Moseley, Louisiana State University, Baton Rouge; B. Robinson and J. Morse, Clemson University, Clemson, SC; and J. Pickering, University of Georgia, Athens. H. Goulet, Agriculture and Agri-Food Canada, Ottawa, called my attention to some of the records.

David R. Smith, *Systematic Entomology Laboratory, PSI, U.S. Department of Agriculture, % National Museum of Natural History, MRC 168, Washington, DC 20560 U.S.A. (e-mail: dsmith@sel.barc.usda.gov).*

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A REVISION OF THE FAMILY TETHINIDAE (DIPTERA) FROM THE CARIBBEAN, GULF OF MEXICO, AND BERMUDA

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Abstract.—Beach flies (Diptera: Tethinidae) of the Caribbean, Gulf of Mexico, and Bermuda are revised. The beach-fly fauna of this area comprises three genera (*Dasyrhicnoessa, Pelomyiella,* and *Tethina*) and 12 species, including the following new species (type locality in parenthesis): ***Tethina albitarsa*** (ECUADOR. Manabi: Bahia), ***T. cohiba*** (GRAND CAYMAN. George Town Harbour (19°18′N, 81°22.9′W)), ***T. lisae*** (JAMAICA. Clarendon: Jackson Bay (17°44.7′N, 77°12.6′W)). Five **new synonyms** are proposed (junior synonyms cited first): *Tethina chilensis* Malloch = *Rhicnoessa texana* Malloch, *Tethina carioca* Prado and Tavares and *Rhicnoessa variseta* Melander = *Rhicnoessa willistoni* Melander, *Tethina brasiliensis* Prado and Tavares and *Rhicnoessa seriata* Melander = *Tethina xanthopoda* Williston. *Dasyrhicnoessa lasiophthalma* was probably introduced into the region. The remaining species tend to be widespread and frequently are locally abundant. These factors have contributed in part to some species being described multiple times.

Key Words: Revision, Diptera, Tethinidae, *Dasyrhicnoessa, Pelomyiella, Tethina,* Caribbean, Gulf of Mexico, Bermuda

The Caribbean species of the dipterous family Tethinidae have never been treated comprehensively even though they are abundant and relatively diverse on beaches within the region. This deficiency is not uncommon, however, and characterizes most insect families occurring there, especially groups that have relatively few species, that are collected infrequently despite being common locally, and that have no species of known economic importance. Although the Tethinidae lack pestiferous species, study of the family is warranted, as the species comprise an important component of the beach fauna. Beyond satisfying the immediate objective-a taxonomic revision of the Caribbean fauna-we are also seeking to discover and contribute toward other aspects of their natural history, such as their distribution, historical biogeography, ecology, behavior, and biodiversity. The underlying basis for all of these studies is the taxonomy of the included taxa. In this same series on Caribbean acalyptrate Diptera of marine and freshwater beaches and shorelines, a faunistic revision has been published on the Canacidae (Mathis 1989), and another for the family Ephydridae is in progress. Beyond this faunistic study, we also have a comprehensive phylogenetic study in progress for both the Tethinidae and Canacidae that will hopefully clarify the relationships of these two families.

The historical record concerning Tethinidae in the Caribbean began slightly more than a century ago when S. W. Williston (1896) described two species (*Anthomyza cinerea* (= *Tethina willistoni* (Melander) and *Rhicnoessa xanthopoda*) from specimens collected on the island of St. Vincent. During the intervening 100 years, several other species have been reported from the Caribbean (Melander 1952, Mathis and Munari 1995), and herein we revise 12 species in three genera that occur in the Caribbean, Gulf of Mexico, and on Bermuda. Because many species of Tethinidae are widespread, especially those that occur in coastal marine habitats, we have examined most New World species, including primary types, to determine the correct identifications and valid names for the included species.

The impetus for this project initially resulted from field work on the Diptera of mangroves, sometimes called the mangal (Tomlinson 1986), that are associated with Belizean cays, especially those within the Stann Creek District. With funding from the Caribbean Coral Reef Ecosystems Program (CCRE), field work has been conducted on the mangrove habitats of Twin Cays, with reconnaissance work on several of the nearby cays as well. On seven field trips to these cays (1984–1993), we have made particular effort to collect specimens of the family Tethinidae. From our beginnings in Belize, we extended our field work to most of the major islands of the West Indies and elsewhere in the Caribbean, Gulf of Mexico, and on Bermuda as follows: Antigua (1989), Barbados (1996, 1997), Bermuda (1991), Cuba (1983, 1994), Dominica (1989, 1991), Dominican Republic (1995), Grand Cayman (1994), Grenada (1996, 1997), Jamaica (1996), Mexico (1985), Puerto Rico (1995), St. Lucia (1991), St. Vincent (1989, 1991, 1997), Trinidad (1993) and Tobago (1993, 1994), and the United States (Florida, 1989). In addition, Warren Steiner and W. W. Wirth made special efforts to collect Tethinidae on visits to Anguilla, Antigua, Curaçao, Dominica, Jamaica, and Puerto Rico, and Norman E. Woodley collected on Bermuda. These specimens were graciously made available to our study.

Methods.—The descriptive terminology, with the exceptions noted in Mathis and Munari (1996), follows that published in the *Manual of Nearctic Diptera* (McAlpine 1981). Because specimens are small, usually less than 4 mm in length, study and illustration of the male terminalia required use of dissecting and compound microscopes. We have followed the terminology for most structures of the male terminalia that other workers in Tethinidae have used (see references in Mathis and Munari 1996). The terminology for structures of the male terminalia is labeled on Figs. 4, 8, 9 and is not repeated on comparable illustrations of other species. The descriptions of new species are based primarily on their respective holotypes with variation being accounted for in the remarks section.

States of Mexico are abbreviated as follows: Baja California Norte (BCN), Chiapas (CHI), Quintana Roo (QNR), Tabasco (TAB), Yucatan (YUC).

Key to Genera of Tethinidae from Bermuda, the Caribbean, and Gulf of Mexico

1. Gena with scattered setulae; peristoma bearing row of weak setulae; frons bare or with a few weak and scattered setulae. Cell bm and discal cell confluent, crossvein bm absent. Prescutellar acrostichal setae absent; scutum smooth, at most with a few scattered setulae; postpronotum with 1 or 2 setae, lacking a ventral seta that is dorsoclinate (Pelomyiinae) . . . . *Pelomyiella* Hendel 1934

– Gena bare; peristoma bearing row of strong, dorsally curved setae; frons with 2 rows of interfrontal setulae, often seta-like. Cell bm and discal cell distinct. Crossvein bm present. Prescutellar acrostichal setae present; scutum bearing numerous rows of coarse setae arising from punctures; postpronotum with 3 or more setae, the ventral seta dorsoclinate (Tethininae) 2

2. Eyes densely though minutely setulose. A true vibrissal seta present on vibrissal angle (lacking shiny tubercle above the foremost strong peristomal seta). Male with an anterior surstylarlike lobe in addition to true surstylus, which is fused to epandrium in some species . . . . *Dasyrhicnoessa* Hendel 1934

– Eye bare or sparsely setulose. A true vibrissal seta absent but foremost peristomal setae inclinate and simulating vibrissae (the bare vibrissal angle a shiny tubercle above each false vibrissae). Male lacking a surstylarlike lobe but with a true surstylus usually positioned ventrad of epandrium and articulating with it . . . . *Tethina* Haliday 1837

SUBFAMILY PELOMYIINAE

Genus *Pelomyiella* Hendel

Pelomyiella Hendel 1934: 39. Type species: *Pelomyia hungarica* Czerny, original designation.—Curran 1934: 331 [key].—Melander 1952: 196 [revision Nearctic species].—Vockeroth 1965: 727 [Nearctic catalog].—Soós 1984: 167 [Palearctic catalog].—Mathis and Munari 1996: 10–11 [world catalog].

Diagnosis.—*Pelomyiella* is distinguished from other genera of the family by the following combination of characters:

Head: Head higher than long; frons bearing some setulae in addition to larger setae; fronto-orbital and orbital setae usually with similar orientation, mostly reclinate or lateroclinate; fronto-orbital setae 2 (anterior seta in *P. mallochi* very short and weak, sometimes difficult to see); paravertical setae more or less convergent. Face vertical, not produced; face and peristoma microtomentose, without shiny stripes. Eye round, appearing bare, setulae very sparse or lacking. Gena high, more than half eye height; gena bearing few to many scattered setulae between eye and ventral row of setulae. Palpus and proboscis usually normally developed; clypeus small, if exposed not protruding anteriad beyond oral margin.

Thorax: Scutum with numerous rows of coarse setulae arising from punctures; scutellar disc bare; postpronotum with 3 or more setae, ventral seta curved upward; acrostichal setulae lacking; prescutellar acrostichal setae present. Wing with costa not spinose; vein A_1+CuA_2 short, much shorter than discal cell; wing usually shorter, about twice as long as wide (less often 2.5 to 3 times); cell bm and discal cell distinct. Mid and hind tibiae evenly setulose, lacking anterodorsal or posterodorsal setae.

Abdomen: Tergites wider than long; tergite 6 well differentiated from short syntergosternite 7+8 (long in *Horaismoptera* and some Apetaeninae), the latter forming a dorsal pregenital sclerite. Male terminalia: Epandrium extended ventrad as a ventral lobe; ventral lobe broadly fused with epandrium and situated ventrad of epandrium; surstylus greatly reduced, bearing some setulae, articulated with sternite 10, situated about level with cerci along posterior margin of epandrium; aedeagus long, sinuous, bearing dorsal pubescence.

Discussion.—Our study of *P. melanderi, P. mallochi,* and *P. maritima,* as differentiated in Melander's key (1952), reveals problems with their recognition as distinct species. Melander acknowledged that these species are very similar, stating specifically that *P. mallochi* and *P. melanderi* are ". . . closely allied," and that the only differences between them are the size of the anterior fronto-orbital setae, the coloration of the genal setulae, and the coloration of the tibiae. Indeed, the only differences we have discovered between *P. maritima* and the other two so-called species seems to be the pallor of the body, including the legs and antennae and the length of the anterior fronto-orbital seta. Elsewhere in the Tethinidae (see discussion section under some *Tethina* species) we found that strength of setae and body coloration are usually unreliable characters, frequently demonstrating considerable variation, and that species based solely on these were unsupported by other characters. Moreover, we found that the structures of the male terminalia of the three *Pelomyiella* "species" appear to be essentially identical. We are thus of the opinion that these three taxa are probably conspecific and that there is variation in the external characters, especially color. Unfortunately the type series of *P. maritima* comprises females only, and we are hesitant to formally propose the synonymies that are indicated in our preliminary study.

KEY TO SPECIES OF *PELOMYIELLA* FROM BERMUDA, THE CARIBBEAN, AND GULF OF MEXICO

1. Body largely dark olivaceous grayish microtomentose; antenna mostly black; legs, including coxae, mostly or wholly black . . . . *P. mallochi* (Sturtevant)
– Body pale yellowish to whitish gray, microtomentose; antenna mostly yellow; coxae and femora largely whitish gray, tibiae and tarsi mostly pale yellow . . . . . *P. maritima* Melander

1. *Pelomyiella mallochi* (Sturtevant)

Pelomyia mallochi Sturtevant 1923: 7 [Massachusetts: Barnstable County, North Falmouth; HT ♀, AMNH].

Pelomyiella mallochi: Hendel 1934: 52 [key], 53 [generic combination, citation].—de Meijere 1939: 162 [citation].—Melander 1952: 196–197 [revision].—Collin 1960: 191 [citation].—Vockeroth 1965: 727 [Nearctic catalog]; 1987: 1076–1077 [figures of head and wing].—Cole 1969: 386 [distribution, diagnosis].—Bährmann 1982: 75–78 [ecology, citation, Germany].—Szadziewski 1983: 47–48 [citation, figures of ♂ terminalia].—Gorczytza 1988: 304, 307 [figure of habitus and head, citation, ecology].—Roháček 1992: 129 [biology, citation, Czech Republic and Slovakia].—Beschovski 1994: 18 [review, figures of ♂ terminalia].—Mathis and Munari 1996: 10 [world catalog].

Tethina parvula of authors, not Loew 1869 [misidentification].—Malloch 1913: 147 [generic combination, citation].—Melander 1913: 297 [key].

Diagnosis.—This species is distinguished from congeners by the following combination of characters: Body largely dark olivaceous grayish microtomentose; anterior fronto-orbital seta much shorter than posterior seta; antenna largely yellow; setulae of gena pale; legs, including coxae, mostly pale yellow; tibiae usually brownish at apices.

Specimens examined.—Nearctic. UNITED STATES. *Texas. Galveston:* Galveston Island (25°10′N, 95°5′W), 14 May 1993, D. and W.N. Mathis (1 ♂, 2 ♀; USNM).

Distribution.—*Nearctic:* Canada (BC, MB, NT, SK), USA (AK, CA, CO, CT, ID, KS, MA, MD, ME, MI, MT, ND, NV, NY, OR, RI, SD, TX, UT, WA, WY). *Neotropical:* Mexico (BCN). *Palearctic:* Austria, Bulgaria, Czech Republic, Denmark, England, France, Germany, Greenland, Hungary, Italy, Mongolia, Netherlands, Poland, Slovakia, Tibet, Yugoslavia.

Remarks.—This very widespread species is apparently Holarctic in distribution and occurs sympatrically with *P. maritima* along the coast of Texas. Unlike most species of Tethinidae, this species is found inland as well as along maritime coasts.

2. *Pelomyiella maritima* (Melander)
(Figs. 1, 2)

Tethina maritima Melander 1913: 297.

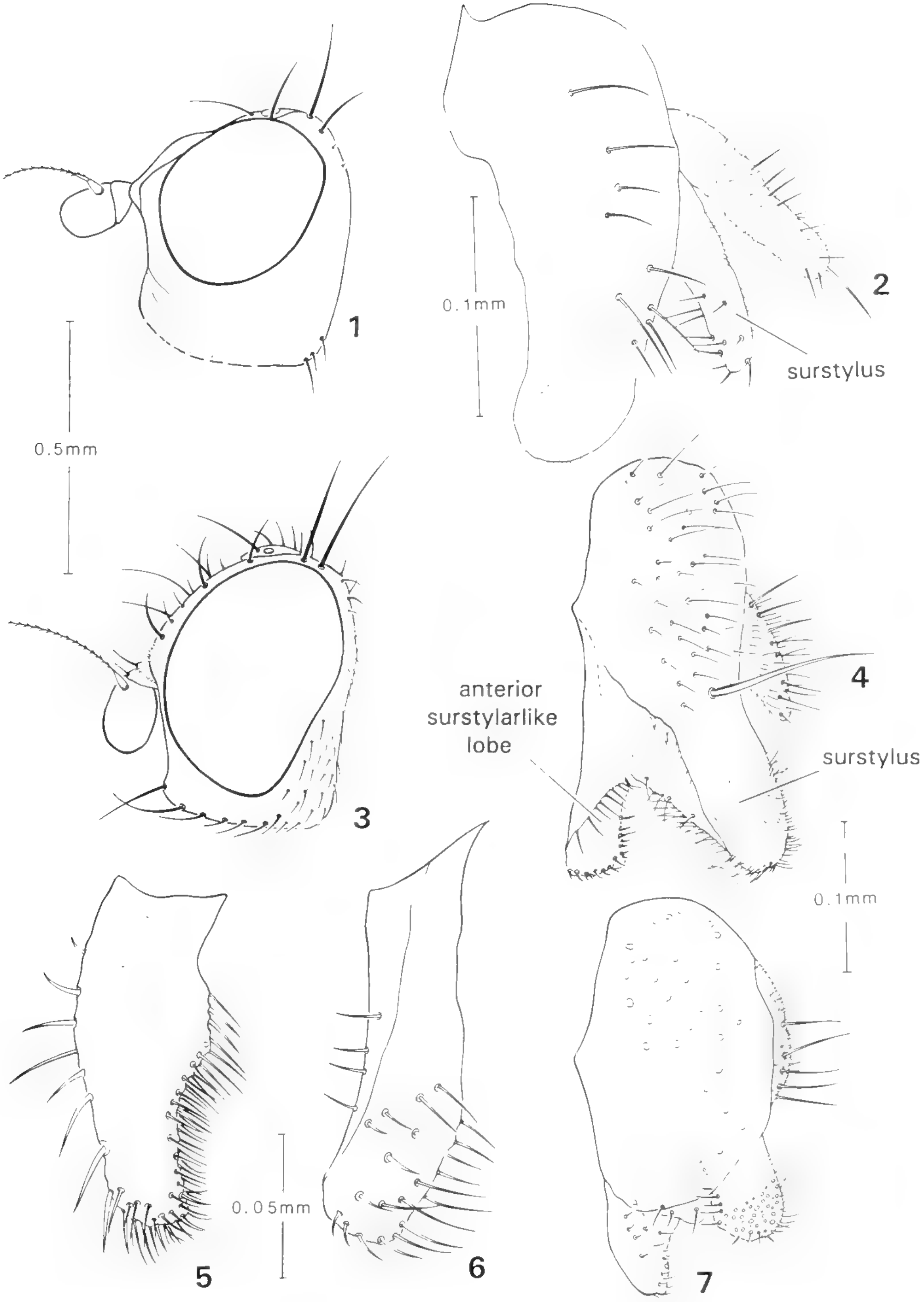
Pelomyia maritima: Sturtevant 1923: 7 [generic combination].

Pelomyiella maritima: Hendel 1934: 53 [generic combination].—Melander 1952: 197 [revision].—Vockeroth 1965: 727 [Nearctic catalog].—Mathis and Munari 1996: 11 [world catalog].

Diagnosis.—This species is distinguished from congeners by the following combination of characters: Body pale, yellowish to whitish gray; antenna largely yellow; coxae and femora whitish gray, apical apex of femora, tibiae, and most tarsomeres yellow (apical two tarsomeres blackish brown).

Type material.—The syntype series of three ♀ is labeled "Galveston Jn 00 [Jun 1900] Tex[as]/ALMelander Collection 1991 [green stippling toward right side of label]." Each of the syntypes is double mounted (glued to a paper triangle or rectangle), is in fair condition (right side completely obscured by glue, several setae missing, one has the left wing missing), and is deposited in the USNM.

Distribution.—*Nearctic:* USA (MD, MS, TX).



Figs. 1–7. 1–2, *Pelomyiella maritima*. 1, Head, lateral view. 2, External male terminalia, lateral view (New Mexico. Dona Ana: Las Cruces). 3–5, *Dasyrhicnoessa lasiophthalma* (Belize. Stan Creek: Tobacco Range). 3, Head, lateral view. 4, External male terminalia, lateral view. 5, Anterior surstylarlike lobe, posterior view. 6–7, *D. ferruginea* (Seychelles. Mahé: Anse Aux Pins). 6, Anterior surstylarlike lobe, posterior view. 7, External male terminalia, lateral view.

SUBFAMILY TETHININAE

Genus *Dasyrhicnoessa* Hendel

Dasyrhicnoessa Hendel 1934: 38. Type species: *Rhicnoessa fulva* Hendel, original designation.—Malloch 1935: 93 [discussion].—Sasakawa 1974: 2–5 [revision Oriental species].—Steyskal and Sasakawa 1977: 394 [Oriental catalog].—Hardy and Delfinado 1980: 370 [revision Hawaiian species].—Mathis and Munari 1996: 11–13 [world catalog].

Diagnosis.—*Dasyrhicnoessa* is distinguished from other genera of the family by the following combination of characters:

Head: Frons bearing some setulae in addition to larger setae; fronto-orbital and orbital setae usually with similar orientation, mostly reclinate or lateroclinate; fronto-orbital setae 3–4; paravertical setae more or less convergent. Face lacking shiny tubercle above vibrissal pore; vibrissal seta present on apex of vibrissal angle. Eye mostly densely covered with small, pale, interfacetal setulae. Gena bare except for a ventral or nearly ventral row of setulae; gena narrow, about ⅛–⅓ eye height. Palpus and proboscis usually normally developed; clypeus small, if exposed not protruding anteriad beyond oral margin.

Thorax: Scutum with numerous rows of coarse setulae arising from punctures; scutellar disc bare; postpronotum with 3 or more setae, ventral seta curved upward; acrostichal setulae in two or more complete or nearly complete rows; prescutellar acrostichal setae present; scutellar disc bare except for marginal setae. Wing with costa not spinose; vein A_1+CuA_2 short, much shorter than discal cell; wing usually short, about twice as long as wide (less often 2.5 to 3 times); cell bm and discal cell distinct. Mid and hind tibiae evenly setulose, lacking anterodorsal or posterodorsal setae.

Abdomen: Tergites wider than long; tergite 6 well differentiated from short syntergosternite 7+8, the latter forming a dorsal pregenital sclerite. Male terminalia: Epandrium with a posterior (true) surstylus, articulating with 10th sternite. In some species, articulating broadly with ventral margin of epandrium, in others, reduced and positioned more dorsad, along posterior margin of epandrium. Anterior process a surstylarlike lobe, not articulating with 10th sternite but only with anterior margin of epandrium. This lobe much reduced in some species (absent in *D. platypes* Sasakawa) and positioned more or less medially along anterior margin of epandrium. Aedeagus long, sinuous, ribbonlike.

Discussion.—Woodley and Hilburn (1994) and Mathis and Munari (1996) first recorded this genus from the New World (as *D. ferruginea* (Lamb)), and here we provide detailed locality data and descriptive documentation for the genus and the only known species that occurs there. We first discovered the genus and species on barrier islands off the coast of Belize and at the western margin of the Caribbean. Since then, we have found it in the United States (FL), Mexico (Tabasco), on the Lesser Antilles (Dominica, St. Lucia, St. Vincent), and Bermuda in the western North Atlantic. The genus was probably introduced through human commerce and is now widespread throughout the Caribbean Region and perhaps beyond. Elsewhere, the genus occurs primarily within the Pacific and Indian Ocean basins where 14 species have been described thus far (Mathis and Munari 1996).

Dasyrhicnoessa is distinctive and is easily distinguished, especially from other genera of the subfamily Tethininae, by the densely setulose eyes, prominent oral vibrissal seta, an anterior surstylarlike lobe, and a posterior (true) surstylus in males.

3. *Dasyrhicnoessa lasiophthalma* (Malloch) (Figs. 3–7)

Tethina lasiophthalma Malloch 1933: 17 [Marquesas. Hivaoa: Tahauku; HT ♂, BPBM].—Munari 1988: 48 [synonymy with *D. ferruginea* (Lamb), misidentification].

Dasyrhicnoessa lasiophthalma: Sasakawa 1974: 2 [generic combination].—Steyskal and Sasakawa 1977: 394 [Oriental catalog].

Dasyrhicnoessa ferruginea of authors, not Lamb [misidentification].—Munari 1986: 49 [discussion, Seychelles].—Woodley and Hilburn 1994: 53 [list, Bermuda].—Mathis and Munari 1996: 12 [world catalog].

Diagnosis.—This species is distinguished from congeners by the following combination of characters: Thorax dark orangish brown; acrostichal setulae in 6 rows; legs yellow; forefemur bearing comb of closely set, peglike setae along distal half of anteroventral surface; midfemur bearing comb of setae on distal half of posteroventral surface; length of anterior surstylarlike lobe equal to or slightly shorter than surstylus (Fig. 4); anterior surstylarlike lobe somewhat kidney shaped (Fig. 5); surstylus bearing normal to slightly developed setae, none thickly developed.

Specimens examined.—Nearctic. BERMUDA. *Hamilton:* Shelly Bay (beach, 32°19′N, 64°44′W), 31 May 1991, W.N. Mathis (1 ♀; USNM). *Pembroke:* Admiralty House Park (seaweed on beach), 15 Nov 1987, D.J. Hilburn, N.E. Woodley (1 ♀; USNM). *St. George's:* Tucker's Town Bay (beach, 32°20′N, 64°41′W), 31 May 1991, N.E. Woodley (3 ♂, 1 ♀; USNM). UNITED STATES. *Florida. Monroe:* Big Pine Key (near Cactus Hammock), 1–2 May 1986, W.E. Steiner (1 ♀; USNM); Lower Matecumbe Key, 3 May 1986, D.S. Bogar, W.E. Steiner (1 ♀; USNM); Upper Key Largo, 1 May 1986, D.S. Bogar, W.E. Steiner (3 ♂, 1 ♀; USNM).

Neotropical. BAHAMAS. *Abaco Cays:* Allans Cay, 9 May 1953, E.B. Hayden (1 ♀; USNM). *New Providence Island:* Nassau, 16 Apr 1953, E.B. Hayden (2 ♀; USNM). South Bimini, May–Aug 1951, M. Cazier, W. Gertsch, C. and P. Vaurie (9 ♂, 16 ♀; USNM). BELIZE. *Stann Creek:* Carrie Bow, 4–22 Mar 1984, 1988, W.N. Mathis (2 ♀; USNM); Glover's Reef, Long Cay, 27–28 Jul 1989, W.N. Mathis (1 ♀; USNM); Glover's Reef, Middle Cay, 28 Jul 1989, W.N. Mathis (3 ♀; USNM); Glover's Reef, Southwest Cay, 26 Jul 1989, H.B. Williams, W.N. Mathis (3 ♂, 1 ♀; USNM); Man of War Cay, 2 Jun 1985, W.N. Mathis (9 ♂, 7 ♀; USNM); Round Cay (near Coco Plum Cay), 23 Mar 1988, W.N. Mathis (1 ♂, 4 ♀; USNM); Tobacco Range, 30 Jul 1989, W.N. Mathis (16 ♂, 5 ♀; USNM); Twin Cays (Aanderaa Flats, E shore East Island, S end East Island, West Bay), 17–21 Mar 1988, W.N. Mathis (6 ♂, 4 ♀; USNM). MEXICO. *Tabasco:* Paraíso (5 km E), 6 May 1985, A. Freidberg, W.N. Mathis (3 ♂; USNM). West Indies. CUBA. *Havana:* Jibacoa Beach (57 km E Havana), 26 Apr 1983, W.N. Mathis (3 ♂, 2 ♀; USNM). *Matanzas:* Playa Larga, 1 May 1983, W.N. Mathis (1 ♂; USNM). DOMINICA. Cabrits, 22 Mar 1989, W.N. Mathis (1 ♂; USNM). ST. LUCIA. Soufrière (beach, 13°51′N, 61°04′W), 11–12 Jun 1991, D. and W.N. Mathis (7 ♂, 2 ♀; USNM). ST. VINCENT. *Charlotte:* Owia Salt Pond (13°22.5′N, 61°08.5′W), 29 Mar 1989, W.N. Mathis (6 ♂; USNM). *St. Andrew:* Buccament Bay (13°11′N, 61°16′W), 25–28 Mar 1989, W.N. Mathis (4 ♂, 2 ♀; USNM).

Distribution.—*Australasian/Oceanian:* Marquesas. Oriental: China (Hong Kong), Philippines. *Nearctic:* Bermuda, USA (FL). *Neotropical:* Bahamas (South Bimini), Belize, Mexico (TAB), West Indies (Cuba, Dominica, St. Lucia, St. Vincent).

Remarks.—This species was known previously only from the Pacific area, and its occurrence in the Caribbean, Gulf of Mexico, and on Bermuda represents a significant range extension.

Although only recently recorded from the study area (Woodley and Hilburn 1994, Mathis and Munari 1996), specimens from the Bahamas were collected in the early 1950's. These dates indicate that the species has been in the area, probably as an introduction, for several decades before being reported.

Munari (1988) recently synonymized this name with *D. ferruginea* (Lamb), a species that was described from specimens collected on the Seychelles (Mahé). We also made direct comparisons with specimens collected on the Seychelles and found small but consistent differences (Figs. 4–7), especially in the shape of the anterior surstylarlike lobe, which in *D. ferruginea* is spatulate (Fig. 6), not kidney shaped (Fig. 5) with an indentation, and having the surstylus bearing many thickened, peglike setulae (Fig. 5). These comparisons, and the differences noted, lead us to doubt the conspecificity of these specimens, and we feel it best to consider the two taxa as distinct species. Our identification is based on direct comparison of type material from the Marquesas, characters of the male terminalia in particular, with specimens from Belize, St. Lucia, St. Vincent, and Bermuda.

Genus *Tethina* Haliday

Tethina Haliday, in Curtis 1837: 293 [published in synonymy; first made available by use in Haliday 1838: 188]. Type species: *Opomyza (Tethina) illota* Haliday 1838, subsequent monotypy (Haliday 1838: 188).—Becker 1905a: 234 [Palearctic catalog].—Malloch 1934: 453 [revision species of Chile, discussion, key].—Melander 1952: 199 [revision Nearctic species].—Foster 1976b: 2–3 [Neotropical catalog].—Thompson and Mathis 1980: 86 [citation, nomenclature].—Mathis and Munari 1996: 13–19 [world catalog].

Rhicnoessa Loew 1862: 174. Type species: *Rhicnoessa cinerea* Loew (= *Anthomyza grisea* Fallén), monotypy.—Loew 1865: 34–39 [revision].—Becker 1905b: 252 [Palearctic catalog].—Collin 1911: 234 [probable synonymy with *Tethina*].—Melander 1913: 298 [key to Nearctic species].—Hendel 1917: 46 [synonymy in key].—Curran 1934: 331 [key].—Melander 1952: 200 [revision Nearctic species].

Phycomyza Melander 1952: 198. Type species: *Rhicnoessa milichioides* Melander, original designation.—Foster 1976a: 338 [synonymy].

Diagnosis.—*Tethina* is distinguished from other genera of the family by the following combination of characters:

Head: Frons bearing some setulae in addition to larger setae; fronto-orbital and orbital setae usually with similar orientation, mostly reclinate or lateroclinate; fronto-orbital setae 3–4; paravertical setae more or less convergent. Face with shiny tubercle above vibrissal pore present. Eye appearing bare, setulae very sparse or lacking. Gena bare except for a ventral or nearly ventral row of setulae; gena high in many species, height 0.5–0.75 that of eye height. Palpus and proboscis usually normally developed; clypeus small, if exposed not protruding anteriad beyond oral margin.

Thorax: Scutum with more or less numerous rows of coarse setulae arising from punctures; scutellar disc bare; postpronotum with 3 or more setae, ventral seta curved upward; acrostichal setulae in two or more complete or nearly complete rows; prescutellar acrostichal setae present. Wing with costa not spinose; vein A_1+CuA_2 short, much shorter than discal cell; wing usually shorter, about twice as long as wide (less often 2.5 to 3 times); cell bm and discal cell distinct. Mid and hind tibiae evenly setulose, lacking anterodorsal or posterodorsal setae.

Abdomen: Tergites wider than long; tergite 6 well differentiated from short syntergosternite 7+8, the latter forming a dorsal pregenital sclerite. Male terminalia: Surstylus positioned at ventral margin of epandrium, usually broadly articulated externally with epandrium, internally with 10th sternite; aedeagus usually very long and sinuous, either thick and straplike or narrow and ribbonlike; aedeagus micropubescent dorsally.

Discussion.—Among genera of Tethinidae, *Tethina* has by far the most species worldwide, with almost half of the described species (62 of 132) currently recognized in the family (Mathis and Munari 1996). Nine species of *Tethina* are recorded from the study area, including three that are new.

KEY TO SPECIES OF *TETHINA* FROM BERMUDA, THE CARIBBEAN, AND GULF OF MEXICO

1. Gena high, at least 0.5 eye height 6
– Gena short, less than 0.5 eye height 2
2. Apex of scutellum with yellowish to reddish spot (may vary in size but always obvious) . . . . *T. xanthopoda* (Williston)
– Apex of scutellum uniformly gray microtomentose 3
3. Mid- and hindtibiae black on apical ⅓; first 3 tarsomeres white to pale yellow . . . . *T. albitarsa*, new species
– Mid- and hindtibiae all yellow 4
4. Hindfemora of ♂ not particularly swollen; surstylus armed with many short, well-developed, thick toothlike setulae . . . . *T. texana* (Melander)
– Hindfemora of ♂ distinctly swollen; surstylus not armed with toothlike setulae 5
5. Surstylus curved anteriorly, ending in an acute point, densely setulose with well-developed setae over most of surface . . . . *T. cohiba*, new species
– Surstylus paddle shaped, with well-developed setae along margin only . . . *T. setulosa* Malloch
6. Body whitish 7
– Body distinctly gray to grayish brown . . . . *T. willistoni* (Melander)
7. Surstylus in lateral view curved anteriorly . . . . *T. albula* Loew
Surstylus in lateral view straight 8
8. Surstylus in posterior view with median margin curved and rounded sparsely setulose . . . . *T. lisae*, new species
– Surstylus in posterior view with median margin straight, bearing dense row of setulae . . . . *T. bermudaensis* (Melander)

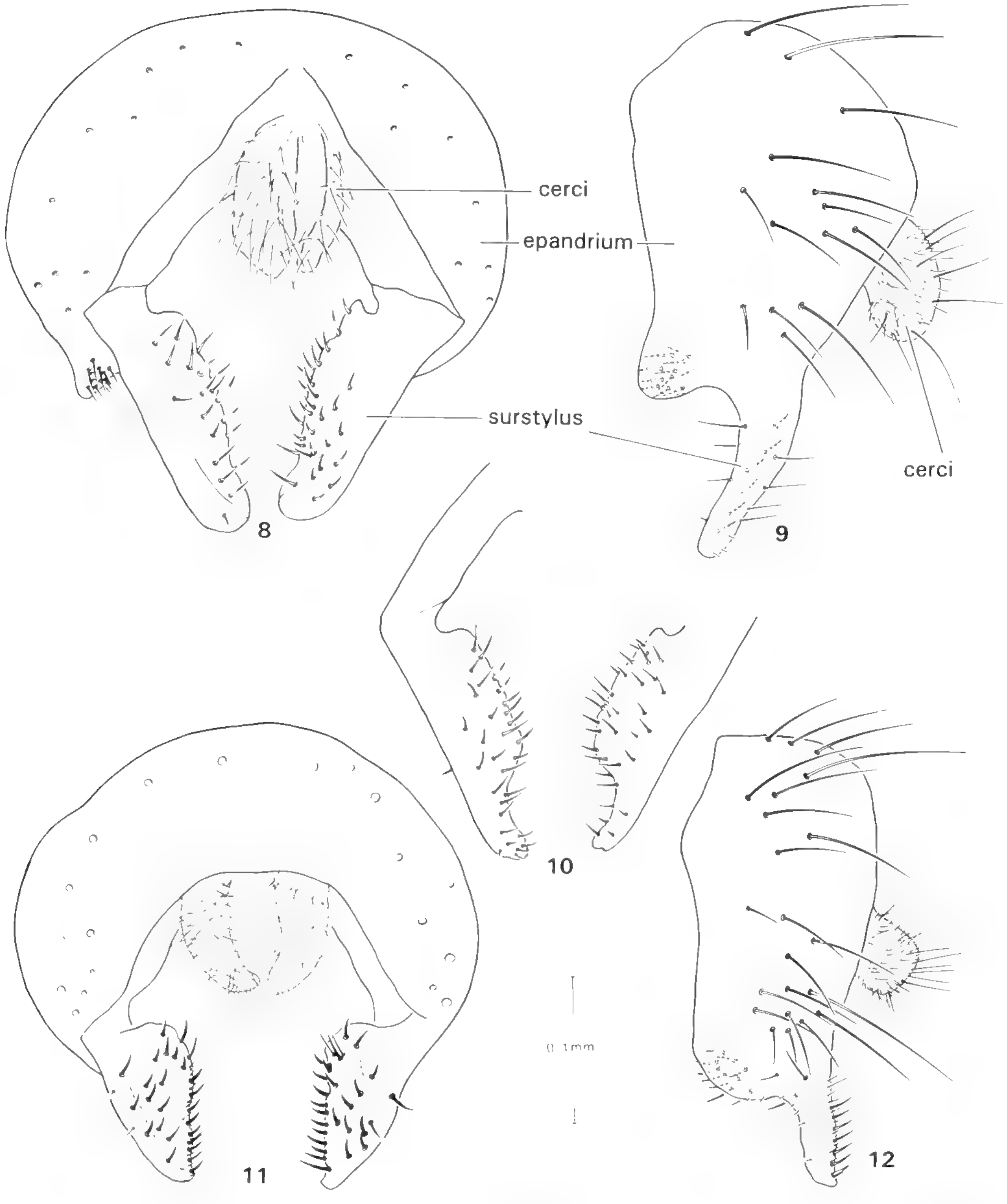
4. *Tethina albula* (Loew)
(Figs. 8–10, 13)

Rhicnoessa albula Loew 1869: 44.—Malloch 1913: 147 [citation].—Melander 1913: 298 [key].—Hendel 1934: 43 [key], 46 [citation].—Hennig 1937: 140 [citation].—Melander 1952: 202 [citation].

Tethina albula: Curran 1934: 330 [generic combination].—Vockeroth 1965: 727 [Nearctic catalog].—Prado and Tavares 1966: 431 [revision].—Foster 1976b: 2 [Neotropical catalog].—Mathis and Munari 1996: 14 [world catalog].

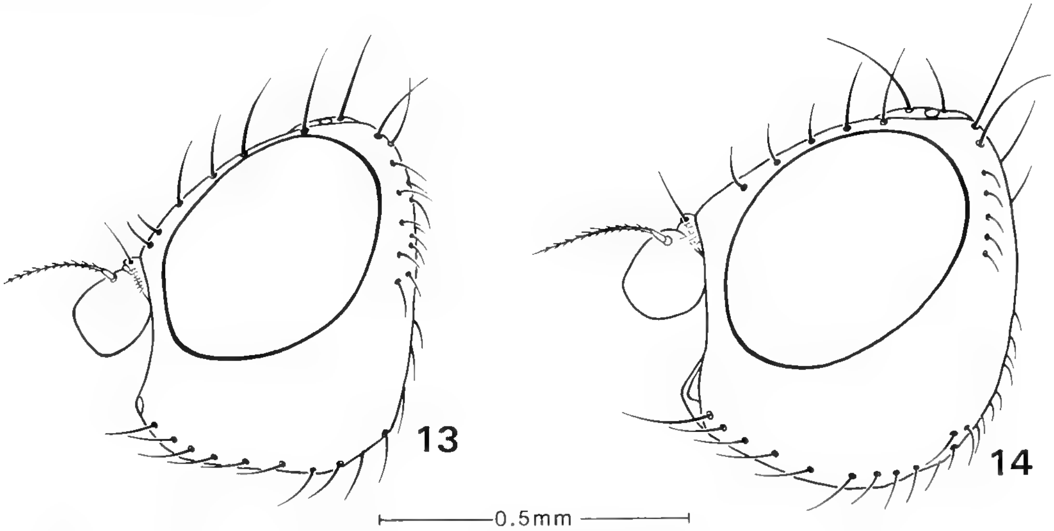
Diagnosis.—This species is distinguished from congeners by the following combination of characters: Body length 1.60–3.15 mm; body with gray to whitish gray microtomentum; setae generally white to mostly black (Guyana specimens); gena high, greater than 0.5 eye height; 4 irregular rows of acrostichal setulae; scutellum uniformly gray, lacking a spot; femora mostly yellow to mostly gray; hindfemora of male similar to or only slightly more swollen than fore- and midfemora; tibiae yellow; basal 4 tarsomeres yellow, apical tarsomere brown; surstylus articulated with and broadly attached to epandrium, narrowly spatulate in posterior view (Figs. 8, 10), length 2.5× width, apex broadly rounded; median margin bearing irregular row of sparse setulae along entire length, setulae moderately well developed; surstylus in lateral view (Figs. 9, 10) narrow, height 3.5× width, gently curved anteriorly, basal portion produced anteriorly as a lateral lobe that bears a patch of setulae mesally; aedeagus thick, straplike, bearing dense velvety hairlike pubescence on dorsal surface.

Type material.—The syntype series, labeled "Loew Collection" and comprising one ♂ (only two legs and a left wing remain) and four females (one bearing a red "Type" label (13444); MCZ), does not allow for accurate and reliable identification of this species. Osten Sacken, however, collected and retained a male (head missing) from the type locality (Newport, Rhode Island) when he collected the type series. Osten Sacken's practice was to retain a few specimens of species represented by a long series, sending the majority to Loew for description. That retained, headless male, which is presumably conspecific with the type series, was identified, dissected, and is the basis for our diagnosis of this species.



Figs. 8–12. 8–10, *Tethina albula*. 8, External male terminalia, posterior view (Florida. Monroe: Bahia Honda Key). 9, Same, lateral view. 10, Surstylus, posterior view (Florida. Lee: Bonita Beach). 11–12, *T. bermudaensis* (Mexico. Tabasco: Paraíso (5 km E). 11, External male terminalia, posterior view. 12, Same, lateral view.

Other specimens examined.—Nearctic. UNITED STATES. *Florida. Flager:* Washington Oaks Gardens (5 km S Marineland), 18 Apr 1989, D. and W.N. Mathis (1 ♂; USNM). *Lee:* Bonita Beach (seashore), 17 Apr 1970, W.W. Wirth (1 ♂; USNM). *Monroe:* Bahia Honda Key (seashore), 11 Apr 1970, W.W. Wirth (2 ♂; USNM). *Volucia:* Ormond Beach 25 Apr 1952, C.W. Sabrosky (5 ♂; USNM).



Figs. 13–14. Heads of *Tethina* species. 13, *T. albula*, lateral view. 14, *T. willistoni*, lateral view.

Neotropical. BAHAMAS. *Exuma Cays:* Leaf Cay of Allens Cays, 7 Jan 1953, E.B. Hayden, L. Giovannoli (1 ♂; USNM). BELIZE. *Belize:* Lighthouse Reef, Half Moon Cay (17°12′N, 87°31′W), 1 Apr 1993, W.N. Mathis (1 ♂; USNM). GRAND CAYMAN. Bodden Town (beach; 19°17′N, 81°14.8′W), 26 Apr 1993, W.N. Mathis (15 ♂, 6 ♀; USNM). Breaker (1.5 km W); 19°18′N, 81°10.9′W), 29 Apr 1994, W.N. Mathis (11 ♂, 2 ♀; USNM). Double Head (19°23.4′N, 81°22.3′W), 27 Apr 1994, D. and W.N. Mathis (1 ♂; USNM). George Town Harbour (19°18′N, 81°22.9′W), 28–29 Apr 1994, W.N. Mathis (1 ♂; USNM). GUYANA. Hope Beach (6°44.7′N, 57°57.3′W), 14–22 Apr 1994, 1995, W.N. Mathis (8 ♀, USNM). Mahaica (6°42.8′N, 57°55.6′W), 14–22 Apr 1994, 1995, W.N. Mathis (38 ♂, 1 ♀; USNM). MEXICO. *Quintana Roo:* Cancun Island, 25 Mar 1974, D.J. Pletsch (1 ♂; USNM). TRINIDAD. *St. Andrew:* Lower Manzanilla (14 km S; 10°23′N, 61°01′W), mouth of Nariva River, 20 Jun 1993, W.N. Mathis (1 ♂; USNM). TURKS AND CAICOS. *West Caicos:* 4 Feb 1953, E.B. Hayden, L. Giovannoli, G.B. Rabb (1 ♂, 1 ♀; USNM).

Distribution.—*Nearctic:* USA (DE, FL, MA, MD, NC, NY, SC, RI, VA). *Neotropical:* Bahamas, Belize, Guyana, Mexico (QNR), Trinidad, Turks and Caicos, West Indies (Grand Cayman).

Remarks.—*Tethina albula* and *T. bermudaensis* are often collected together, and we have not discovered any external characters that distinguish between them. Structures of the male terminalia must be examined to distinguish the two species.

The surstylus of *T. albula* is curved forward in lateral view and is spatulate in posterior view. The surstylus of *T. bermudaensis* is smaller and triangular in posterior view. We have noted variation, however, in the width of the surstylus of *T. albula* in posterior view. There is also some variation in setal color, especially among specimens from Guyana. Some variation was also noted in the shape of the surstylus in posterior view among specimens from Lee County, Florida (Fig. 10).

5. *Tethina bermudaensis* (Melander)
(Figs. 11, 12)

Rhicnoessa bermudaensis Melander 1952: 203.

Tethina bermudaensis: Vockeroth 1965: 727 [generic combination, Nearctic catalog].—Woodley and Hilburn 1994: 53–54 [list, Bermuda].—Mathis and Munari 1996: 15 [world catalog].

Diagnosis.—This species is distinguished from congeners by the following combination of characters: Body length 1.70–2.90 mm; body generally whitish gray, microtomentose; setae generally white to slightly off white; gena high, greater than 0.5 eye height; 4 irregular rows of acrostichal setulae; scutellum uniformly gray, lacking a spot; femora mostly yellow to mostly gray; hindfemora of male similar to or only slightly more swollen than fore- and midfemora; tibiae yellow; basal 4 tarsomeres yellow, apical tarsomere brown; surstylus articulated with and broadly attached to epandrium, broadly spatulate/triangular in posterior view (Fig. 11), length twice width, apex broadly rounded; median margin bearing a row of short, stout setulae along entire length; surstylus in lateral view (Fig. 12) narrow, tapered to apical point, height 2.5× width, basal portion produced anteriorly as a broadly rounded lateral lobe bearing several short setulae mesally; aedeagus thick, straplike.

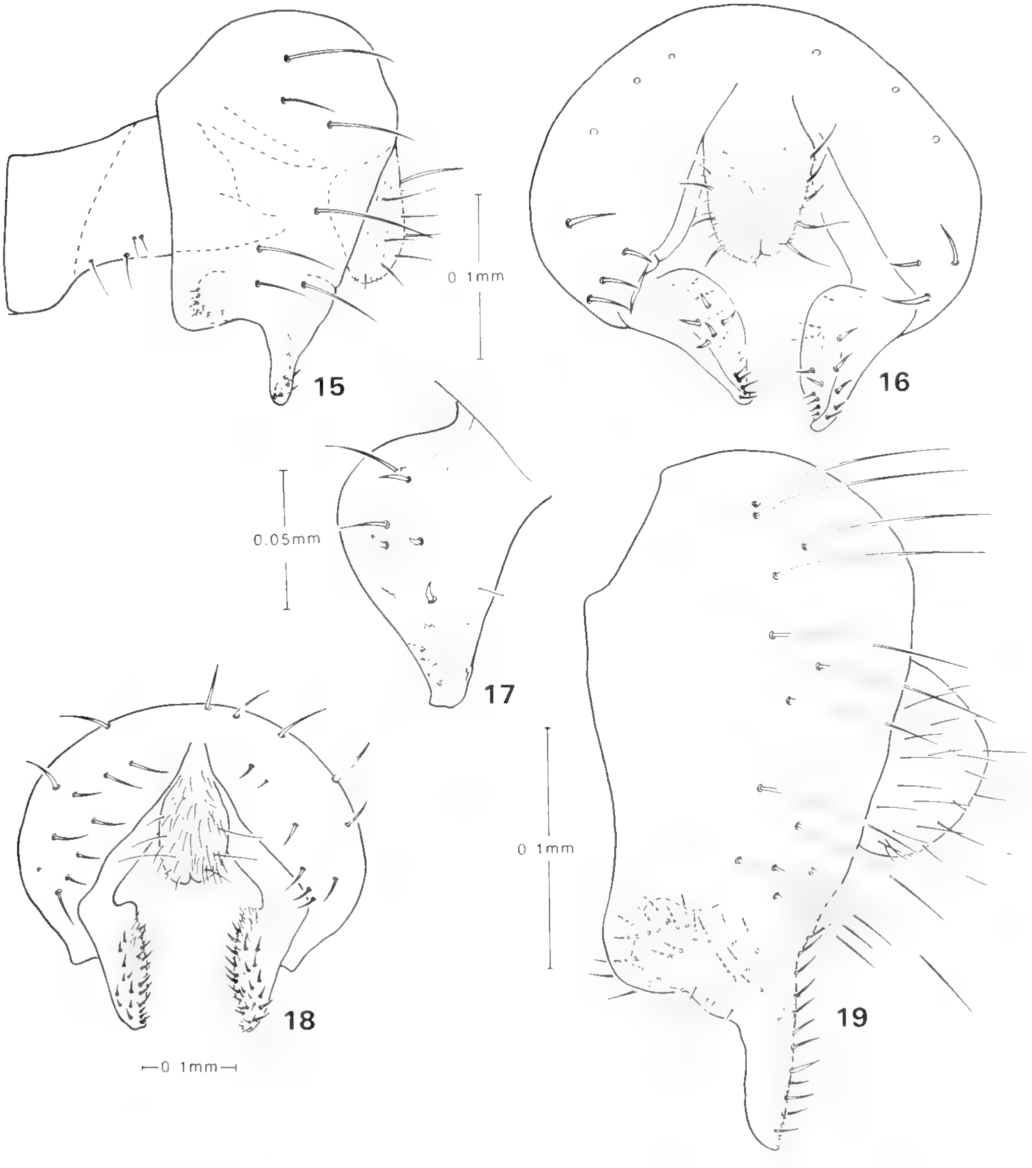
Type material.—The lectotype ♂, here designated, is labeled "BERMUDA Cooper ISL 25 Jan [19]34 ALMelander/ALMelander Collection 1961 [right third of label with green stippling]/PARATYPE Rhicnoessa bermudaensis Melander [yellow]/ LECTOTYPE ♂ Rhicnoessa bermudaensis Melander By Foster and Mathis [handwritten except for "LECTOTYPE" and "By"; black submarginal border]." The lectotype is double mounted (minuten in a cardboard rectangle), is in excellent condition (the abdomen has been removed and dissected; the parts are in an attached microvial), and is deposited in the USNM. Paralectotypes are as follows: 27 specimens (12 ♂, 15 ♀; USNM) bearing the same locality label data as the lectotype. *BERMUDA*. Castle Island, 25 Jan 1934, A.L. Melander (2 ♂; USNM). A male from Cooper Island was labeled by Melander with a holotype label and the remaining syntypes bear paratype labels. One female also bears an "allotype" label. Melander (1952), however, did not designate a holotype, and all specimens of the type series are thus syntypes, necessitating our lectotype designation here.

Other specimens examined.—Nearctic. BERMUDA. *Devonshire:* Devonshire Bay (32°18′N, 64°44′W), 29 May 1991, N.E. Woodley (14 ♂, 9 ♀; USNM). *Paget:* Paget Marsh (32°17′N, 64°47′W), 3 Jun 1991, W.N. Mathis (9 ♂; USNM). *Pembroke:* Admiralty House Beach (82°18′N, 64°48′W), 15 Nov 1987, D.J. Hilburn, N.E. Woodley (16 ♂, 7 ♀; USNM); Spanish Point beach (32°18′N, 64°49′W), 2 Jun 1991, W.N. Mathis, N.E. Woodley (10 ♂, 2 ♀; USNM). *Southampton:* Horseshoe Bay (seaweed on beach), 15 Nov 1987, D.J. Hilburn, N.E. Woodley (10 ♂, 6 ♀; USNM). *St. George's:* Tucker's Town Bay (beach; 32°20′N, 64°41′W), 31 May 1991, W.N. Mathis (25 ♂, 5 ♀; USNM). *Warwick:* Warwick Long Bay Beach (32°15′N, 64°48′W), 30 May–18 Nov 1987, 1991, D.J. Hilburn, W.N. Mathis, N.E. Woodley (14 ♂, 7 ♀; USNM). UNITED STATES. *Florida. Lee:* Bonita Beach (seashore), 17 Apr 1970, W.W. Wirth (3 ♂; USNM); Sanibel Island, Lighthouse Park, 17 Apr 1989, D. and W.N. Mathis (2 ♂; USNM). *Sarasota:* Crescent Beach (intertidal rocks), 20 May 1973, W.W. Wirth (1 ♂; USNM). *Volucia:* Ormond Beach 25 Apr 1952, C.W. Sabrosky (2 ♂; USNM).

Neotropical. CUBA. *Havana:* Havana (beach; 23°5.8′N, 82°27.7′W), 2–14 Dec 1994, W.N. Mathis (1 ♂; USNM); Jibacoa Beach (57 km E Havana), 26 Apr 1983, W.N. Mathis (20 ♂, 7 ♀; USNM). MEXICO. *Tabasco:* Paraíso (5 km E), 6 May 1985, A. Freidberg, W.N. Mathis (33 ♂, 18 ♀; USNM).

Distribution.—*Nearctic:* Bermuda, USA (CT, DE, FL, MA, MD, NC, SC, VA). *Neotropical:* Cuba, Mexico (TAB).

Remarks.—This species is indistinguishable externally from *T. albula* and is often collected with the latter. We can distinguish



Figs. 15–19. 15–17, *Tethina lisae* (Jamaica. Clarendon: Jackson Bay). 15, External male terminalia, lateral view. 16, Same, posterior view. 17, Surstylus, posterior view. 18–19, *T. willistoni.* 18, External male terminalia, posterior view (Tobago. St. David: Plymouth). 19, Same, lateral view.

between these two species only on the basis of structures of the male terminalia.

6. *Tethina lisae* Foster and Mathis, new species
(Figs. 15–17)

Diagnosis.—This species is distinguished from congeners by the following combination of characters: Body with whitish gray microtomentum; setae generally white except sometimes apical and preapical scutellar setae and at most 1 dorsocentral seta black; gena high, greater than 0.5 eye height; 4 irregular rows of acrostichal setulae; scutellum uniformly gray, lacking yellowish to reddish spot; femora mostly light, yellowish gray; hindfemora of male similar to fore- and midfemora, not noticeably more swollen; tibiae and basal 4 tarsomeres yellow, apical tarsomere yellow; surstylus articulated with and narrowly attached to epandrium (base of surstylus only half width of epandrium), in posterior view with broad spatulate flange mesally (Fig. 16), median margin essentially bare, lacking robust setulae (Fig. 17); surstylus in lateral view (Fig. 15) narrowly triangular, tapered to rounded point at apex, basal portion produced anteriorly as a lateral lobe that bears a few, scattered setulae mesally; aedeagus thin, ribbonlike.

Description.—Body length 1.40–2.30 mm; body generally whitish gray, microtomentose; setae generally white except sometimes apical and preapical scutellar setae and at most 1 dorsocentral seta black.

Head: All setae white, inserted in dark setal bases if arising from gray microtomentose area; vertex whitish gray, microtomentose; ocellar tubercle bearing 5 short setulae, approximately half length of ocellar setae; frons yellowish, microtomentose; 5 interfrontal setae, proclinate and convergent; row of 6 convergent inner fronto-orbital setae; row of 4 divergent outer fronto-orbital setae; 3 short setulae just above antennae. Antenna pale yellow except slightly brownish at base of arista; 1st flagellomere pubescent; arista brownish, sparsely pubescent. Gena high, height 0.5 or more that of eye, white, microtomentose, becoming gray posteriorly; postgena gray. Peristomal setae with 4 directed dorsally, 5th directed anteriorly, yellowish tubercle dorsad of anteriormost seta. Palpus white; labellum long, yellowish.

Thorax: Generally whitish gray, microtomentose; scutellum uniformly gray, lacking yellowish to reddish spot. Setae generally white except for black apical scutellar setae; acrostichal setulae in 4 irregular rows; dorsocentral setae 6 (2+4); proepisternum and proepimeron each with a seta. Coxae yellowish gray; femora mostly yellow basally, remainder gray; hindfemora of male similar to fore- and midfemora, not noticeably more swollen; tibiae and basal 4 tarsomeres yellow, apical tarsomere brown. Wing with costa extended to vein M.

Abdomen: Coloration as for thorax; all setae and setulae white. Male terminalia (Figs. 15–17): Surstylus articulated with and narrowly attached to epandrium (base of surstylus only half width of epandrium), in posterior view with broad spatulate flange mesally (Fig. 17), median margin essentially bare, lacking robust setulae (Fig. 16); surstylus in lateral view (Fig. 15) narrowly triangular, tapered to rounded point at apex, basal portion produced anteriorly as a lateral lobe that bears a few, scattered setulae mesally; aedeagus thin, ribbonlike.

Type material.—The holotype ♂ is labeled "*JAMAICA. Clarendon:* Jackson Bay, 17°44.7′N, 77°12.6′W[,] 13 May 1996, D. and W. Mathis, H. Williams/ USNM ENT 00140643 [a plastic barcode label]/HOLOTYPE Tethina lisae ♂ Foster and W.N. Mathis USNM [red; species name and "♂ and Foster" handwritten]." The holotype is double mounted (minuten in block of plastic), is in excellent condition, and is deposited in the USNM. Other paratypes are as follows: JAMAICA. same label data as the holotype (3 ♂, 1 ♀; USNM). JAMAICA. *Manchester:* Alligator Pond (17°52.1′N, 77°33.9′W), 8 May 1996, D. and W.N. Mathis, H. Williams (3 ♂, 2 ♀; USNM). *St. Elizabeth:* Port Kaiser (17°51.9′N, 77°35.7′W), 8 May 1996, D. and W.N. Mathis, H. Williams (2 ♂, 2 ♀; USNM); near Port Kaiser (17°52.3′N, 77°34.9′W), 8 May 1996, D. and W.N. Mathis, H. Williams (1 ♂; USNM). *Trelawny:* Falmouth (bay shore), 1 Mar 1969, W.W. Wirth (5 ♂, 4 ♀; USNM).

Other specimens examined.—Neotropical. ANGUILLA. Mead's Bay (18°11′N, 63°08.5′W), 26 Mar 1992, W.E. Steiner, J.M. Swearingen (1 ♂, 1 ♀; USNM).

Distribution.—*Neotropical:* West Indies (Anguilla, Jamaica).

Remarks.—This species differs from *T. willistoni, T. albula,* and *T. bermudaensis* in having the apical scutellar setae and at most one pair of dorsocentral setae black. All other setae are white, apparently without variation (variable in *T. willistoni*). Also the male terminalia of this species are obviously different, i.e. the aedeagus is ribbonlike, placing this species closer to *T. xanthopoda*.

Etymology.—The specific epithet, *lisae*, is a genitive patronym to recognize Lisa Neu Foster, wife of the first author, whose patience and support contributed to finishing this paper.

7. *Tethina willistoni* (Melander)
(Figs. 14, 18, 19)

anthomyza cinerea Williston 1896: 444 [preoccupied, Loew 1862].

Rhicnoessa willistoni Melander 1913: 298 [new name for *T. cinerea* of Williston, not Loew].—Hendel 1934: 51 [citation].—Melander 1952: 209 [citation].

Tethina willistoni: Foster 1976b: 3 [Neotropical catalog; generic combination].—Mathis and Munari 1996: 19 [world catalog].

Rhicnoessa variseta Melander 1952: 209. **new synonym.**

Tethina variseta: Vockeroth 1965: 728 [generic combination, Nearctic catalog].—Hardy and Delfinado 1980: 378–379 [citation, figs. of head, ♂ terminalia, spermathecae, Oahu, Kauai, Maui, Kahoolawe, Hawaii, French Frigate Shoal].—Mathis and Sasakawa 1989: 668 [Australasian/Oceanian catalog].—Mathis and Munari 1996: 19 [world catalog].

Tethina carioca Prado and Tavares 1966: 433 [figs. of ♂ terminalia and wing].—Foster 1976b: 2 [Neotropical catalog]. **new synonym.**

Diagnosis.—This species is distinguished from congeners by the following combination of characters: Body length 1.65–3.0 mm; body generally gray; at least apical scutellar setae black, often with other black setae, otherwise setae white; gena high, greater than 0.5 eye height; 4 irregular rows of acrostichal setulae; scutellum uniformly gray, lacking a spot; femora mostly yellow to mostly gray; hindfemora of male similar to or only slightly more swollen than fore- and midfemora; tibiae and basal 4 tarsomeres yellow, apical tarsomere brown; surstylus articulated with and broadly attached to epandrium, broadly spatulate in posterior view (Fig. 18), narrowed apically, length 3× width, apex broadly rounded; median margin bearing moderately dense patch of robust setulae along entire length (Fig. 18), apex truncate, width less than 0.5 width basal margin; surstylus in lateral view (Fig. 19) narrow, posterior margin almost a straight line; aedeagus thick, straplike.

Type material.—The neotype ♂ of *A. cinerea* Williston, here designated, is labeled "W.I. St. Vincent: Wallilabou-beach [13°15′N, 61°16′W], 27 March 1989 Wayne N. Mathis/NEOTYPE Anthyomyza cinerea ♂ Williston by Foster and Mathis [red, handwritten]." The neotype is double mounted (minuten in a plastic block), is in excellent condition, and is deposited in the USNM.

Although Williston (1896: 444) noted that there were 12 specimens in the original type series, none is apparently extant today. In our search for syntypic specimens, we specifically surveyed collections that are known to be depositories for specimens that H.H. Smith collected on St. Vincent, i.e. the Natural History Museum (London), the principal depository for primary types that H.H. Smith collected on St. Vincent, the American Museum of Natural History, and the University of Kansas. Our examination of collections elsewhere likewise did not reveal any syntypes. The neotype specimen that we have selected is from the type locality and represents the species that is most likely to have been represented by the specimens Williston studied and named. We have six additional males from the type locality that bear the same label information. To stabilize the nomenclature of this species, we deem it necessary to designate a neotype, especially as this is a variable species (see "Remarks" section below) and could be confused with other species occurring in the Caribbean that have a high gena and generally pale colored setae (see "Key").

The lectotype ♂ of *R. variseta,* here designated, is labeled "[U.S.A.] CoronaDelMar 29/6/42 [29 Jun 1942] CAL[ifornia] A L Melander/ALMelander Collection 1961 [green stippling on right side]/HOLOTYPE Rhicnoessa variseta Melander [red]/LECTOTYPE Rhicnoessa variseta ♂ Melander By Foster and Mathis [handwritten except for "LECTOTYPE" and "By"; black submarginal border]." The lectotype is double mounted (minuten in a rectangular card on end), is in excellent condition, and is deposited in the USNM. Although the lectotype bears a "HOLOTYPE" label, it was published as a syntype, and thus the need for our lectotype designation. The other syntypes, all from California (Los Angeles and Orange Counties) are paralectotypes. We studied in detail (abdomen removed and dissected, the parts are in an attached microvial) a male paralectotype from the type locality that was directly compared with the lectotype.

The holotype ♂ of *Tethina carioca* is labeled "[Brazil. Ilha do] Governador: Galeão [,] Rio [de Janeiro] -Brasil. 11.X.66 [11 Oct 1966] Lopes and Prado/Tethina carioca n.sp Prado and Tavares det/Holotypus [red]/ N. 13.356 [number handwritten] DIPTERA Inst. Oswaldo Cruz [black margin]." The holotype is double mounted (minuten partially wound around base pin), is in excellent condition (abdomen removed, dissected, parts are in an attached microvial), and is now deposited in MZSP.

Specimens examined.—Neotropical. ANGUILLA. Mead's Bay (18°11.2′N, 63°08.5′W), 26 Mar 1992, W.E. Steiner, J.M. Swearingen (1 ♀; USNM). Sandy Ground (18°12.3′N, 63°05.5′W), 27 Mar 1992, W.E. Steiner, J.M. Swearingen (1 ♂, 2 ♀; USNM). ANTIGUA. Dutchman Bay, 7 Jan 1965, W.W. Wirth (1 ♀; USNM). BAHAMAS. *New Providence:* Nassau, 16 Apr 1953, E.B. Hayden (1 ♀; USNM). BARBADOS. *Christ Church:* Rockley Beach (13°04.3′N, 59°35.2′W), 21 May–1 Sep 1996, 1997, D. and W.N. Mathis, H. Williams (5 ♂; USNM). *St. Andrew:* Long Pond (13°15.1′N, 59°33.3′W), 21 May–11 Sep 1996, 1997, D. and W.N. Mathis, H. Williams (17 ♂, 1 ♀; USNM). *St. Peter:* Six Mens Bay (13°16.5′N, 59°38.8′W), 22 May–12 Sep 1996, D. and W.N. Mathis, H. Williams (11 ♂; USNM). BARBUDA. Cocoa Point, 28 Apr 1958, J.F.G. Clarke (1 ♀; USNM). BELIZE. *Stann Creek:* Carrie Bow (16°48′N, 88°05′W), 1 Jun 1985, W.N. Mathis (1 ♂; USNM). *Belize:* Lighthouse Reef, Half Moon Cay, 1 Apr 1993, W.N. Mathis (3 ♀; USNM). COSTA RICA. *Guanacaste:* Murciélago, 1 Apr 1988, W.E. Steiner, J.M. Hill, J.M. Swearingen, J.M. Mitchell (1 ♀; USNM); Playa Tamarindo, 27–29 Mar 1987, W.E. Steiner, J.M. Hill (2 ♀; USNM). CURACÃO. Coral Specht (3 km E Willemstad), 8–15 Feb 1987, W.E. Steiner, J.M. Swearingen (7 ♀; USNM). Playa Kalki, 14 Feb 1987, W.E. Steiner, J.M. Swearingen (11 ♂, 23 ♀; USNM). DOMINICA. Cabrits Swamp (15°35′N, 61°29′W), 23 Feb–22–25 Mar 1965, 1989, W.N. Mathis, W.W. Wirth (7 ♂, 2♀; USNM). Coulibistri, 21 Mar 1989, W.N. Mathis (21 ♂, 1 ♀; USNM). Dublanc, 21 Mar 1989, A. Freidberg (1 ♂, 2 ♀; USNM). Grande Savane (pond margin), 20 Mar 1965, W.W. Wirth (2 ♀; USNM). Layou, 12 May 1966, G.S. Steyskal (7 ♂, 10♀; USNM). Layou River mouth, 9 Jan–24 Mar 1965, W.W. Wirth, G.C. Steyskal (15 ♂, 8 fe; USNM). Macoucheri (seashore), 1 Feb 1965, W.W. Wirth (2 ♂, 3 ♀; USNM). Mero (seashore), 14 Jan 1965 W.W. Wirth (7 ♂, 3 ♀; USNM). Pagua Bay, 18 Feb 1965, W.W. Wirth (2 ♂, 3♀; USNM). Portsmouth, 2 Apr–Jul 1966, 1976, R.J. Gagné, N.L.H. Krauss (1 ♂, 1♀; USNM). St. David Bay (sea shore), 23 Jan 1965, W.W. Wirth (3 ♂, 2 ♀; USNM). Soufrière Bay, 24 Mar 1989, W.N. Mathis (6 ♂, 2 ♀; USNM). Woodford Hill, 27 Feb 1965, W.W. Wirth (2 ♂, 4 ♀; USNM). DOMINICAN REPUBLIC. *La Altagracía:* Bayahibe (18°22.3′N, 68°50.4′W), 13 May 1994, W.N. Mathis (9 ♂; USNM). *La Romana:* Isla Saona, Catuano (18°11.7′N, 68°46.8′W), 13 May 1995, W.N. Mathis (1 ♂; USNM). *Monte Cristi:* Monte Cristi (beach; 19°51.5′N, 71°39.5′W), 18 May 1995, W.N. Mathis (5 ♂, 1 ♀; USNM). *San Pedro de Macoris:* Playa Juan Dolio, 16 Nov 1984, R. Faitoute, P.S. Spangler (8 ♂, 3 ♀; USNM). GRAND CAYMAN. Bodden Town (beach; 19°17′N, 81°14.8′W), 26 Apr 1993, W.N. Mathis (4 ♂; USNM). Breaker (1.5 km W); 19°18′N, 81°10.9′W), 29 Apr 1994, W.N. Mathis (1 ♂; USNM). George Town Harbour (19°18′N, 81°22.9′W), 28–29 Apr 1994, W.N. Mathis (22 ♂; USNM). GRENADA. *St. George:* Beauséjour Bay (12°05.5′N, 61°44.9′W), 21 Sep 1996, W.N. Mathis (5 ♂, 1 ♀; USNM). *St. John:* Gouyave Bay (12°09.6′N, 61°44′W), 21 Sep 1996, W.N. Mathis (8 ♂, 2 ♀; USNM). *St. Patrick:* Bathway Beach (12°12.6′N, 61°36.7′W), 18–20 Sep 1996, W.N. Mathis (2 ♂; USNM); Levera Bay (12°13.6′N, 61°36.6′W), 18 Sep 1996, W.N. Mathis (3 ♂; USNM). JAMAICA. *Clarendon:* Farquhars Beach (17°50.9′N, 77°22.8′W), 9 May 1996, D. and W.N. Mathis, H. Williams (2 ♂; USNM); Jackson Bay (17°44.7′N, 77°12.6′W), 13 May 1996, D. and W.N. Mathis, H. Williams (3 ♂, 1 ♀; USNM). *Manchester:* Alligator Pond (17°52.1′N, 77°33.9′W), 8 May 1996, D. and W.N. Mathis, H. Williams (6 ♂; USNM). MONTSERRAT. Plymouth (0–100 m), Jul 1967, 1971, 1972, N.L.H. Krauss (19 ♂, 15 ♀; USNM). *PANAMA.* Garachipe River 14 Feb 1952, F.B. Blanton (1 ♂; USNM). PUERTO RICO. Arecibo (beach; 18°28.7′N, 66°42′W), 23 Sep 1995, D. and W.N. Mathis (7 ♂, 1 ♀; USNM). Bahía Salinas (beach; 17°57.5′N, 67°12′W), 20 Sep 1995, D. and W.N. Mathis (2 ♂, 1 ♀; USNM). Naguabo, Playa de Naguabo (18°11′N, 65°43′W), 17 Feb 1996, W.E. Steiner, J.M. Swearingen (1 ♂, 1 ♀; USNM). Playa de Guayanilla (18°0.4′N, 66°46.1′W), 19 Sep 1995, D. and W.N. Mathis (6 ♂, 1 ♀; USNM). Punta Jacinto (near Guanica; 17°57′N, 66°52.6′W), 20 Sep 1995, D. and W.N. Mathis (3 ♂; USNM). San Juan (beach east; 18°27.6′N, 65°59.5′W), 24 Sep 1995, D. and W.N. Mathis (1 ♂; USNM). ST. CROIX. Hams Bay (17°46′N, 64°53′W), 14 Feb 1996, W.E. Steiner, J.M. Swearingen (9 ♂, 5 ♀; USNM). ST. LUCIA. Soufrière (beach; 13°51′N, 16°54′W), 11–12 Jun 1991, W.N. and D. Mathis (5 ♂, 1 ♀; USNM). ST. VINCENT. *Charlotte:* Spring (13°11.1′N, 61°08.5′W), 6 Sep 1997, W.N. Mathis (5 ♂; USNM); Yambou River (13°09.8′N, 61°08.7′W), 8–10 Sep 1997, W.N. Mathis (4 ♂; USNM). *St. Andrew:* Buccament Bay (near beach; 13°11′N, 61°16′W), 8 Jun 1991, D. and W.N. Mathis (3 ♂; USNM). *St. Patrick:* Cumberland Bay (13°16′N, 61°16′W), 28 Mar–15 Sep 1989, 1997, A. Freidberg, W.N. Mathis (2 ♂; USNM); Wallilabou (beach; 13°15′N, 61°16′W), 27 Mar 1989, W.N. Mathis (7 ♂; USNM). TOBAGO. *St. David:* Plymouth (beach; 11°13.2′N, 60°46.7′W), 19 Apr 1994, W.N. Mathis (7 ♂, 1 ♀; USNM). *St. John:* Charlotteville (beach; 11°19.5′N, 60°32.9′W), 16–18 Apr–10–16 Jun 1993, 1994, D. and W.N. Mathis (54 ♂, 13 ♀; USNM); Charlotteville (5 km S; 11°18.9′N, 60°34.5′W), Hermitage River and beach, 22 Apr–11 Jun 1993, 1994, D. and W.N. Mathis (17 ♂, 1 ♀; USNM); Speyside (11°18′N, 60°32′W), 13–15 Jun 1993, W.N. Mathis (5 ♂, 2 ♀; USNM). *St. Paul:* Delaford, Kings Bay (11°16′N, 60°32.8′W), 13 Jun 1993, W.N. Mathis (19 ♂, 2 ♀; USNM). TURKS and CAICOS. *South Caicos:* 11 Feb 1953, E.B. Hayden, G.B. Rabb (1 ♂; USNM).

Distribution.—*Australasian/Oceanian:* Hawaii (Hawaii, Kahoolawe, Kauai, Maui, Oahu). *Nearctic:* U.S.A. (CA). *Neotropical:* Bahamas, Belize, Brazil (RJ), Curaçao, Ecuador, Mexico (CHI), Panama, Peru, Tobago, Turks and Caicos, West Indies (Anguilla, Antigua, Barbados, Barbuda, Dominica, Dominican Republic, Grand Cayman, Grenada, Jamaica, Montserrat, Puerto Rico, St. Croix, St. Lucia, St. Vincent).

Remarks.—The variation in setal coloration and size of *T. willistoni* is remarkable. While we have seen virtually no variation in structures of the male terminalia, the variation in external characters is as follows: the more robust specimens have mostly stout, black setae and in general present a very "bristly" habitus (similar to *T. spinulosa* and *T. horripilans*). Smaller, more delicate specimens have only the apical scutellar setae black with all other setae being white. Many specimens fall between these two extremes, making it virtually impossible to distinguish between *T. willistoni* and other species on the basis of external structures alone.

8. *Tethina texana* (Malloch)

Figs. 20–22, 24

Rhicnoessa texana Malloch 1913: 148.—Hendel 1934: 50 [citation].—Melander 1952: 208 [citation].

Tethina texana: Sturtevant 1923: 7 [generic combination].—Vockeroth 1965: 728 [Nearctic catalog].—Woodley and Hilburn 1994: 54 [as *Tethina* sp.].—Mathis and Munari 1996: 19 [world catalog].

Tethina chilensis Malloch 1934: 455.—Foster 1976b: 2 [Neotropical catalog].—Mathis and Munari 1996: 15 [world catalog]. **new synonym.**

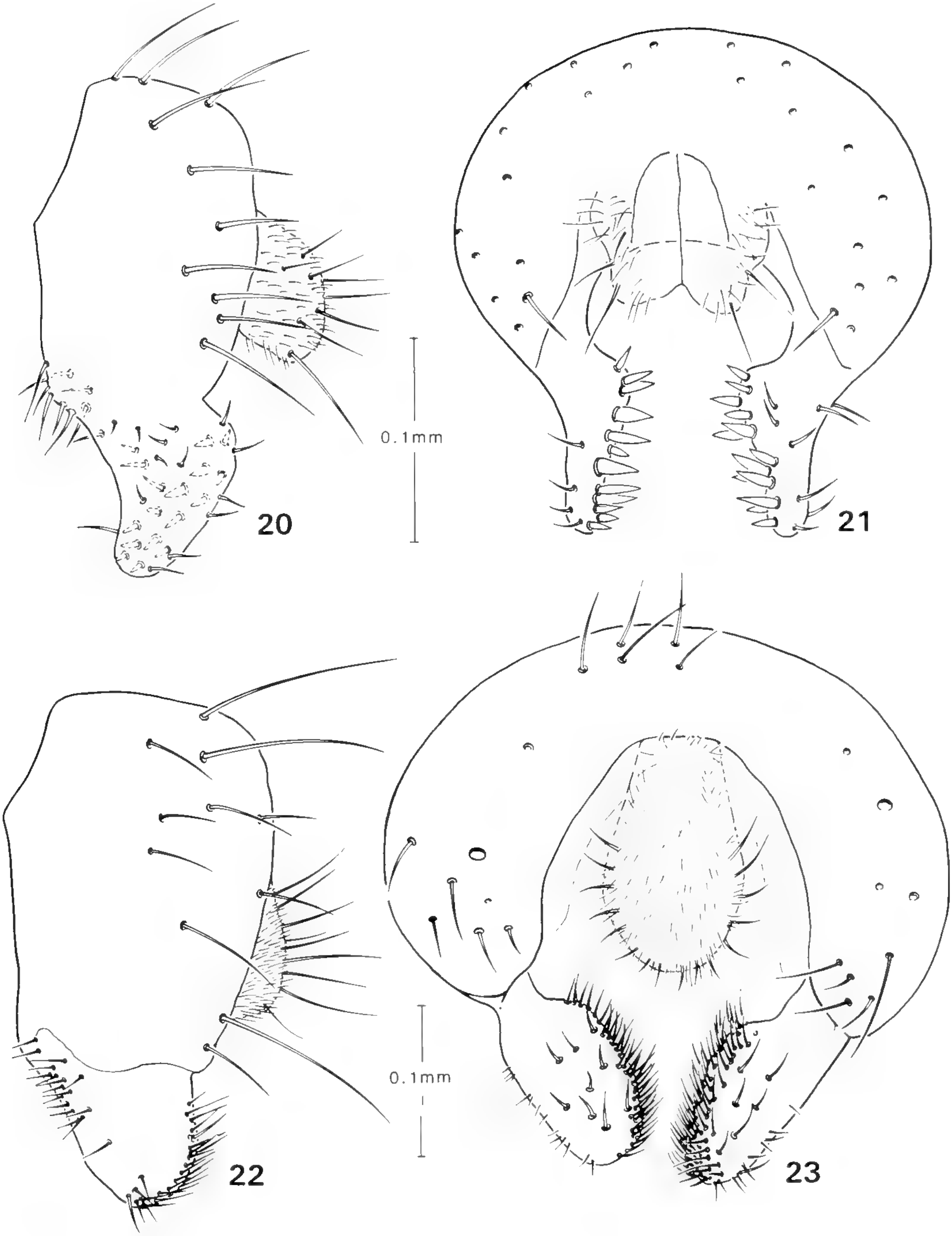
Diagnosis.—This species is distinguished from congeners by the following combination of characters: Body generally gray; setae black; gena short, less than 0.5 eye height; generally 4 irregular rows of acrostichal setulae (some Mexican specimens with only 2 rows); scutellum uniformly gray, lacking a spot; femora mostly yellow to mostly gray; hindfemora of male similar to or only slightly more swollen than fore- and midfemora; tibiae and basal 4 tarsomeres yellow, apical tarsomere brown; surstylus articulated with and broadly attached to epandrium, boot-shaped in posterior view (Fig. 21), narrowed apically, length 2.5× width, apex narrowly rounded; median margin bearing moderately dense patch of very thick, short setulae (length of setulae 2–2.5× width) along entire length (Fig. 21); surstylus in lateral view (Fig. 20) broadly spatulate with slight curve anteriorly, external surface bearing very sparse, scattered setulae; aedeagus thin, ribbonlike.

Type material.—The holotype ♀ of *R. texana* is labeled "[U.S.A.] Corpus Chr[isti] 12 Apr [19]06 T[e]x[as] [date handwritten]/FCPratt Collector/Type No. 15807 U.S.N.M. [red; "15807" handwritten]/Rhicnoessa texana Malloch Type [black submargin; handwritten]." The holotype is double mounted (glued to a paper point), is in excellent condition, and is deposited in the USNM (15807). We also studied the male paratype from "St. Augustine" [probably equals Augustine, in Jeff Davis Co.], Texas. The paratype had its abdomen removed and dissected; the parts are in an attached microvial.

The holotype ♂ of *T. chilensis* is labeled "Angol [blacked out] Chile DSBullock/Antofagasta Ap. 11, 1931 [handwritten]/Type No. 50447 U.S.N.M. [red; "50447" handwritten]/Tethina chilensis Type det. JRMALLOCH [species name and "Type" handwritten; black submargin]. The holotype is double mounted (glued to a paper point), is in poor condition (several setae missing or displaced, pedicel and 1st flagellomere of right antenna missing, some tarsomeres missing; abdomen removed and dissected, the parts in an attached microvial), and is deposited in the USNM (50447).

Specimens examined.—Nearctic. BERMUDA. *Paget:* Hungry Bay (beach; 32°17′N, 64°45′W), 2 Jun 1991, W.N. Mathis (1 ♂; USNM). *Pembroke:* Spanish Point beach (32°18′N, 64°49′W), 2 Jun 1991, W.N. Mathis (2 ♂; USNM). UNITED STATES. *Texas.* Jess Davis: Augustine, 22 Mar 1908, E.S. Tucker (1 ♂; USNM).

Neotropical. CHILE. *Antofagasta:* Antofagasta, 11 Apr 1931, D.S. Bullock (1 ♂, 1 ♀; holotype and allotype respectively; USNM). MEXICO. *Chiapas:* Puerto Arista, 18 May 1985, A. Freidberg, W.N. Mathis (1 ♂; USNM). *Tabasco:* Paraíso (5 km E),



Figs. 20–23. 20–21, *Tethina texana.* 20, External male terminalia, lateral view (Mexico. Tabasco: Paraíso). 21, Same, posterior view. 22–23, *T. xanthopoda.* 22, External male terminalia, lateral view (Grand Cayman. Georgetown Harbour). 23, Same, posterior view.

6 May 1985, A. Freidberg, W.N. Mathis (3 ♂; USNM).

Distribution.—*Nearctic:* Bermuda, USA (TX). *Neotropical:* Chile, Mexico (CHI, TAB).

9. *Tethina xanthopoda* (Williston)
(Figs. 22, 23, 25)

Anthomyza xanthopoda Williston 1896: 445.

Rhicnoessa xanthopoda: Czerny 1902: 256 [generic combination].—Melander 1913: 298 [key].—Hendel 1934: 51 [citation].—Melander 1952: 209 [citation].

Tethina xanthopoda: Foster 1976b: 3 [generic combination, Neotropical catalog].—Woodley and Hilburn 1994: 54 [list, Bermuda].—Mathis and Munari 1996: 19 [world catalog].

Rhicnoessa seriata Melander 1952: 206. **new synonym.**

Tethina seriata: Vockeroth 1965: 728 [generic combination, Nearctic catalog].—Mathis and Munari 1996: 18 [world catalog].

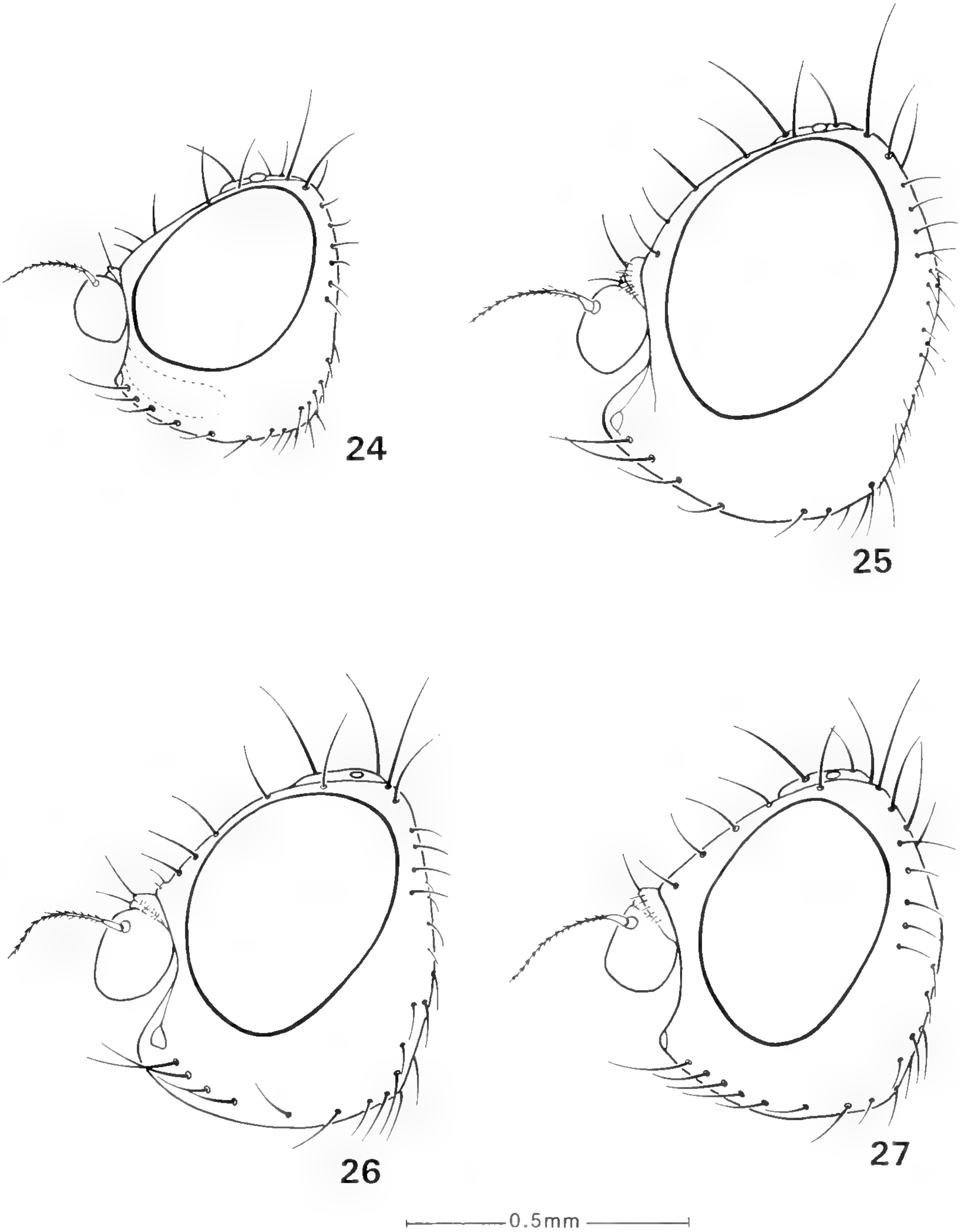
Tethina brasiliensis Prado and Tavares 1966: 435 [figs. of ♂ and ♀ terminalia].—Foster 1976b: 2 [Neotropical catalog]. **new synonym.**

Diagnosis.—This species is distinguished from congeners by the following combination of characters: Body length 1.70–3.10 mm; body with gray microtomentum; setae generally black; gena short, less than 0.5 eye height; 4 somewhat irregular rows of acrostichal setulae; apex of scutellum with yellowish to reddish spot (sometimes variable in size but always obvious); femora yellow; hindfemora of male similar to or only slightly more swollen than fore- and midfemora; tibiae and basal 4 tarsomeres yellow, apical tarsomere brown; surstylus articulated with and broadly attached to epandrium, broadly spatulate in posterior view (Fig. 23), length less than twice width, median margin bearing dense patch of robust setulae along entire length (Fig. 23), apex broadly rounded; surstylus in lateral view (Fig. 22) broadly developed, lateral margin only slightly narrowed posteriorly, apex broadly rounded, lateral surface mostly bare, basal portion only slightly produced anteriorly, bearing moderately dense patch of setulae; aedeagus narrow, ribbonlike.

Type material.—The lectotype ♂ of *T. xanthopoda,* here designated, is labeled "Windward side St. Vincent, W.I. H. H. Smith./W. Indies. 1907-66./Anthomyza xanthopoda Will [handwritten, red]/LECTOTYPE ♂ Anthomyza xanthopoda Williston By Wayne N. Mathis [handwritten except for "LECTOTYPE" and "By"; black submarginal border]." The lectotype is double mounted (smaller pin in a rectangular paper card), is in good condition (abdomen has been removed, dissected, and the parts are in an attached microvial), and is deposited in the BMNH. The syntype series comprised three specimens. The whereabouts of the other two specimens, which are automatically paralectotypes, is unknown.

The lectotype ♂ of *R. seriata,* here designated, is labeled "Miami FL[ORID]A 20 Apr '30 [20 Apr 1930] ALMelander/HOLOTYPE Rhicnoessa seriata Melander [red]/ALMelander Collection 1961 [green stippling on right one-third of label]/LECTOTYPE Rhicnoessa seriata Melander ♂ By Foster and Mathis [handwritten except for "LECTOTYPE" and "By"; black submarginal border]." The lectotype is double mounted (minuten in a rectangular card), is in excellent condition (the abdomen has been removed, dissected, and the parts are in an attached microvial), and is deposited in the USNM.

The holotype ♂ of *Tethina brasiliensis* is labeled "[Ilha do] Governador Rio [de Janeiro,] Brasil [,] H.S. Lopes XI.63 [Nov 1963]/Tethina brasiliensis n.sp. Prado and Tavares det/Holotypus [red]/N. 13.358 DIPTERA Inst. Oswaldo Cruz [black border]." The holotype is double mounted (minuten partially wound around base pin), is in excellent condition (abdomen removed, dis-



Figs. 24–27. Heads of *Tethina* species. 24, *T. texana,* lateral view. 25, *T. xanthopoda,* lateral view. 26, *T. setulosa,* lateral view. 27, *T. cohiba,* lateral view.

sected, parts are in an attached microvial), and is now deposited in MZSP.

Other specimens examined.—Nearctic. BERMUDA. *Devonshire:* Devonshire Bay (32°18′N, 64°44′W), 29 May 1991, N.E. Woodley (1 ♂, 1 ♀; USNM). *Hamilton:* Shelly Bay Beach (32°19′N, 64°44′W), 31 May 1991, W.N. Mathis, N.E. Woodley (21 ♂, 3 ♀; USNM). *Pembroke:* Admiralty House Beach (82°18′N, 64°48′W), 2 Jun–15 Nov 1987, 1991, D.J. Hilburn, W.N. Mathis, N.E. Woodley (4 ♂; USNM); Spanish Point beach (32°18′N, 64°49′W), 2 Jun 1991, W.N. Mathis (1 ♂; USNM). UNITED STATES. *Alabama. Baldwin:* Robertsdale, 24 Jun 1952, A.H. Sturtevant (1 ♀; USNM). *Florida. Collier:* Marco, 28 Mar 1954, K.V. Krombein (1 ♀; USNM); Naples, 27 Jan 1932, A.L. Melander (1 ♂; USNM). *Dade:* Miami, 20 Apr 1930, A.L. Melander (2 ♂; USNM). *Franklin:* Apalachicola, Sep 1954, H.D. Staker (1 ♂; USNM). *Indian River:* Vero Beach, J.R. Malloch (3 ♀; USNM). *Lee:* Bonita Beach, 17 Apr 1970, W.W. Wirth (1 ♂; USNM). *Monroe:* Bahia Honda Key, 11 Apr 1970, W.W. Wirth (4 ♂; USNM); Big Pine Key, Cactus Hammock, 27 Feb 1984, W.E. Steiner, J.M. Swearingen (9 ♂, 7 ♀; USNM); Long Key, 24 Jun 1953, M.R. Wheeler, A.H. Sturtevant (8 ♂; USNM); Lower Matecumbe Key, 3 May 1986, D. Bogar, W. Steiner (1 ♂, 1 ♀; USNM); Tavernier, 25 Jun 1953, M.R. Wheeler (1 ♂; USNM). *Sarasota:* Crescent Beach, 20 May 1973, W.W. Wirth (4 ♂, 3 ♀; USNM).

Neotropical. ANGUILLA. Blowing Point (18°10.5′N, 63°5.8′W), 29 Mar 1992, W.E. Steiner, J.M. Swearingen (10 ♂, 9 ♀; USNM). ANTIGUA. near airport, 19 Mar 1989, A. Freidberg, W.N. Mathis (53 ♂, 2 ♀; USNM). Dutchman Bay, 7 Jan 1965, W.W. Wirth (1 ♂, 1 ♀; USNM). BAHAMAS. *Abaco Cays:* Great Sale Cay, 10 May 1953, L. Giovannoli, G.B. Rabb (12 ♂, 1 ♀; USNM). *Bimini:* 22–31 Jan 1968, G.M. Stokes (2 ♀; USNM). *Eleuthera:* Governors Harbour, 31 Mar 1953, L. Giovannoli, E.B. Hayden (31 ♂, 24 ♀; USNM). *Exuma Cays:* Warderick Wells Cay, 10 Jan 1953, L. Giovannoli, (1 ♀; USNM). *Grand Bahama:* west end, 12 May 1953, E.B. Hayden, L. Giovannoli, G.B. Rabb (2 ♂; USNM). *Great Inagua:* Matthew Town, 31 Jan 1953, E.B. Hayden, G.B. Rabb (1 ♀; USNM). *New Providence:* Nassau, 5–16 Apr 1953, E.B. Hayden, G.B. Rabb (14 ♂, 2 ♀; USNM). *North Bimini:* Apr 1968, G.M. Stokes (1 ♀; USNM). *South Bimini Island:* 10–14 Apr–Jul 1951, 1952, M. Cazier, W. Gertsch, E. Mayr, C. and P. Vaurie (16 ♂, 3 ♀; USNM). BARBADOS. *Christ Church:* Rockley Beach (13°04.3′N, 59°35.2′W), 31 Aug 1997, W.N. Mathis (6 ♂; USNM). BARBUDA. Spanish Point, 29 Apr 1958, J.F.G. Clarke (1 ♂, 1 ♀; USNM). BELIZE. *Belize:* Lighthouse Reef, Half Moon Cay (17°12′N, 87°31′W), 1 Apr 1993, W.N. Mathis (12 ♂, 7 ♀; USNM). Turneffe Islands, Blackbird Caye (17°19′N, 87°48′W), 27–30 Mar 1993, W.N. Mathis (12 ♂, 1 ♀; USNM). Turneffe Islands, Calabash Caye (17°17′N, 87°48′W), 27–30 Mar 1993, W.N. Mathis (23 ♂, 4 ♀; USNM). *Stann Creek:* Carrie Bow Cay, 15 Jan–30 Jul 1984, 1985, 1987, 1988, 1989, C. Feller, W.N. Mathis, H.B. Williams (37 ♂, 71 ♀; USNM). Coco Plum Cay, 24 Jun 1990, C. Feller, H.B. Williams (2 ♂, 2 ♀; USNM). Dangriga (16°58′N, 88°13′W), 3–4 Apr 1993, W.N. Mathis (5 ♂, 2 ♀; USNM); Glover's Reef, Long Cay 27–28 Jul 1989, W.N. Mathis (1 ♂; USNM); Glover's Reef, Northeast Cay 27 Jul 1989, W.N. Mathis (1 ♂; USNM). Man of War Cay, 24 Jun–31 Jul 1989, 1990, C. Feller, W.N. Mathis, H.B. Williams (4 ♂; USNM). Salt Creek (12 N Dangriga), 28 Mar 1988, W.N. Mathis (1 ♂; USNM). CUBA. *Havana:* Havana (beach; 23°5.8′N, 82°27.7′W), 2–14 Dec 1994, W.N. Mathis (16 ♂; USNM); Jibacoa Beach (57 km E Havana), 26 Apr 1983, W.N. Mathis (1 ♀; USNM). *Matanzas:* Playa Larga (1 km E), 2 May 1983, W.N. Mathis (8 ♂, 5 ♀; USNM). *Sancti Spiritus:* Playa Ancón (21°44.1′N, 79°59.9′W), 12 Dec 1994, W.N. Mathis (1 ♀; USNM). CURACAO. Playa Kalki, 14 Feb 1987, W.E. Steiner, J.M. Swearingen (2 ♂; USNM). DOMINICA.

Calibishie (seashore), 27 Feb 1965, W.W. Wirth (1 ♀; USNM). Layou River mouth, 9 Jan–24 Mar–4 Oct 1965, 1966, A.B. Gurney, W.W. Wirth (6 ♂, 2 ♀; USNM). Macoucheri (seashore), 1 Feb 1965, W.W. Wirth (1 ♀; USNM). Pagua Bay, 18 Feb 1965, W.W. Wirth (1 ♀; USNM). St. David Bay (sea shore), 23 Jan 1965, W.W. Wirth (3 ♂; USNM). Woodford Hill, 27 Feb 1965, W.W. Wirth (4 ♂; USNM). DOMINICAN REPUBLIC. *Azua:* Puerto Viejo (18°20.9′N, 70°50.4′W), 14 May 1995, W.N. Mathis (8 ♂; USNM). *La Altagracía:* Bayahibe (18°22.3′N, 68°50.4′W), 13 May 1994, W.N. Mathis (8 ♂; USNM). *La Romana:* Isla Saona, Catuano (18°11.7′N, 68°46.8′W), 13 May 1995, W.N. Mathis (12 ♂, 1 ♀; USNM). *San Pedro de Macoris:* Playa Juan Dolio, 16 Nov 1984, R. Faitoute, P.S. Spangler (2 ♂, 3 ♀; USNM). GRAND CAYMAN. Bodden Town (beach; 19°17′N, 81°14.8′W), 26 Apr 1993, W.N. Mathis (10 ♂; USNM). Breaker (1.5 km W); 19°18′N, 81°10.9′W), 29 Apr 1994, W.N. Mathis (5 ♂; USNM). Double Head (19°23.4′N, 81°22.3′W), 27 Apr 1994, D. and W.N. Mathis (4 ♂; USNM). George Town Harbour (19°18′N, 81°22.9′W), 28–29 Apr 1994, W.N. Mathis (10 ♂; USNM). GRENADA. *St. Andrew:* Pearls Airport (12°08.7′N, 61°36.6′W), 15 Sep 1997, W.N. Mathis (4 ♂; USNM). *St. George:* Beauséjour Bay (12°05.5′N, 61°44.9′W), 21 Sep 1996, W.N. Mathis (6 ♂; USNM). *St. Patrick:* Levera Bay (12°13.6′N, 61°36.6′W), 18 Sep 1996, W.N. Mathis (1 ♂; USNM). GUYANA. Hope Beach (6°44.7′N, 57°57.3′W), 14 Apr 1994, W.N. Mathis (1 ♂; USNM). JAMAICA. *Clarendon:* Barnswell Beach (17°45.′N, 77°08.5′W), 13 May 1996, D. and W.N. Mathis, H. Williams (9 ♂; USNM); Jackson Bay (17°44.7′N, 77°12.6′W), 13 May 1996, D. and W.N. Mathis, H. Williams (2 ♂; USNM). *Manchester:* Alligator Pond (17°52.1′N, 77°33.9′W), 8 May 1996, D. and W.N. Mathis, H. Williams (2 ♂, 1 ♀; USNM). *St. Catherine:* Port Henderson (bay shore), 24 Feb 1969, W.W. Wirth (1 ♂; USNM). *St. Elizabeth:* Black River (18°01.4′N, 77°51.1′W), 11 May 1996, D. and W.N. Mathis, H. Williams (2 ♂ USNM); Port Kaiser (17°51.9′N, 77°35.7′W), 8 May 1996, D. and W.N. Mathis, H. Williams (1 ♂; USNM). *St. Thomas:* Rozelle (17°52.3′N, 76°27.7′W), 14 May 1996, D. and W.N. Mathis, H. Williams (1 ♂; USNM). *Trelawny:* Falmouth (bay shore), 1 Mar 1969, W.W. Wirth (1 ♂, 8 ♀; USNM). *Westmoreland:* Negril Beach (mangrove, rocky shore), 12 Mar 1970, W.W. Wirth (1 ♂, 2 ♀; USNM). MEXICO. *Quintana Roo:* Cancun, 25 Mar–29 Oct 1974, 1975, D.J. Pletsch (7 ♀; USNM). *Yucatan:* Pajaros Isla, 4 Jul 1961, F.R. Fosberg (1 ♂; USNM). PANAMA. *Canal Zone:* Mojinga Swamp, 13 Jan 1953, F.S. Blanton (1 ♂; USNM). *Darien:* Garachine, Feb 1953, F.S. Blanton (1 ♂; USNM). PUERTO RICO. Arecibo (beach; 18°28.7′N, 66°42′W), 23 Sep 1995, D. and W.N. Mathis (10 ♂; USNM). Cabo Rojo (S Mayaguez), 8 Apr 1972, L. Knutson (5 ♂, 4 ♀; USNM). Fajardo, Las Croabas (Seven Seas Beach; 18°23′N, 65°37′W), 17 Feb 1996, W.E. Steiner, J.M. Swearingen (2 ♀; USNM). Guanica, 22 Jun 1952, F.S. Blanton (1 ♀; USNM). Naguabo, Playa de Naguabo (18°11′N, 65°43′W), 17 Feb 1996, W.E. Steiner, J.M. Swearingen (29 ♂, 27 ♀; USNM). Playa de Guayanilla (18°0.4′N, 66°46.1′W), 19 Sep 1995, D. and W.N. Mathis (5 ♂; USNM). San Juan (beach east; 18°27.6′N, 65°59.5′W), 24 Sep 1995, D. and W.N. Mathis (13 ♂, 2 ♀; USNM). ST. LUCIA. Soufrière (beach; 13°51′N, 16°54′W), 11–12 Jun 1991, W.N. and D. Mathis (6 ♂; USNM). ST. VINCENT. *St. Andrew:* Buccament Bay (near beach; 13°11′N, 61°16′W), 8 Jun 1991, D. and W.N. Mathis (2 ♂, 1 ♀; USNM). *St. Patrick:* Cumberland Bay (13°16′N, 61°16′W), 8–10 Jun 1991, D. and W.N. Mathis (4 ♂; USNM). TOBAGO. *St. David:* Plymouth (beach; 11°13.2′N, 60°46.7′W), 19 Apr 1994, W.N. Mathis (9 ♂, 1 ♀; USNM). *St. John:* Charlotteville (beach; 11°19.5′N, 60°32.9′W), 16–18 Apr–10–16 Jun 1993, 1994, D. and W.N. Mathis (21 ♂; USNM); Charlotteville (5 km S; 11°18.9′N, 60°34.5′W), Hermitage River and beach, 22 Apr–11 Jun 1993, 1994, D. and W.N. Mathis (9 ♂, 10 ♀; USNM); Speyside (11°18′N, 60°32′W), 13–15 Jun 1993, W.N. Mathis (6 ♂, 2 ♀; USNM). *St. Patrick:* Pigeon Point (beach; 11°9.7′N, 60°50′W), 19 Apr 1994, D. and W.N. Mathis (2 ♀; USNM). *St. Paul:* Delaford, Kings Bay (11°16′N, 60°32.8′W), 21 Apr–13 Jun 1993, 1994, D. and W.N. Mathis (17 ♂; USNM). Crown Point Hotel (light trap), Apr 1959, R. Darsie (1 ♂, 5 ♀; USNM). TRINIDAD. *St. Patrick:* Chatham (beach; 10°05′N, 61°44′W), 25 Jun 1993, W.N. Mathis (8 ♂, 1 ♀; USNM). TURKS AND CAICOS: *West Caicos:* 4 Feb 1953, E.B. Hayden, L. Giovannoli, G.B. Rabb (1 ♂, 3 ♀; USNM).

Distribution.—*Nearctic:* Bermuda, USA (AL, FL). *Neotropical:* Bahamas, Belize, Brazil Bahia, Rio de Janeiro, Rio Grande do Norte), Guyana, Mexico (QNR, YUC), Panama, Trinidad and Tobago, Turks and Caicos, West Indies (Antigua, Barbados, Barbuda, Cuba, Curaçao, Dominica, Dominican Republic, Grand Cayman, Grenada, Jamaica, St. Lucia, St. Vincent).

Remarks.—This widespread species can easily be distinguished from *T. cohiba* (often collected at the same locality) in having an obvious reddish yellow spot on the apex of the scutellum. Some specimens must be examined with the scutellum oriented to be directly viewed from behind and with good lighting. In most specimens, however, the spot is immediately obvious. Additional external characters include the mostly yellow femora, which are moderately swollen, as in *T. cohiba*.

10. *Tethina setulosa* Malloch
(Figs. 26, 28, 29)

Tethina setulosa Malloch 1934: 454.—Foster 1976b: 2 [Neotropical catalog].—Mathis and Munari 1996: 18 [world catalog].

Rhicnoessa setulosa: Hennig 1937: 139 [generic combination, citation].

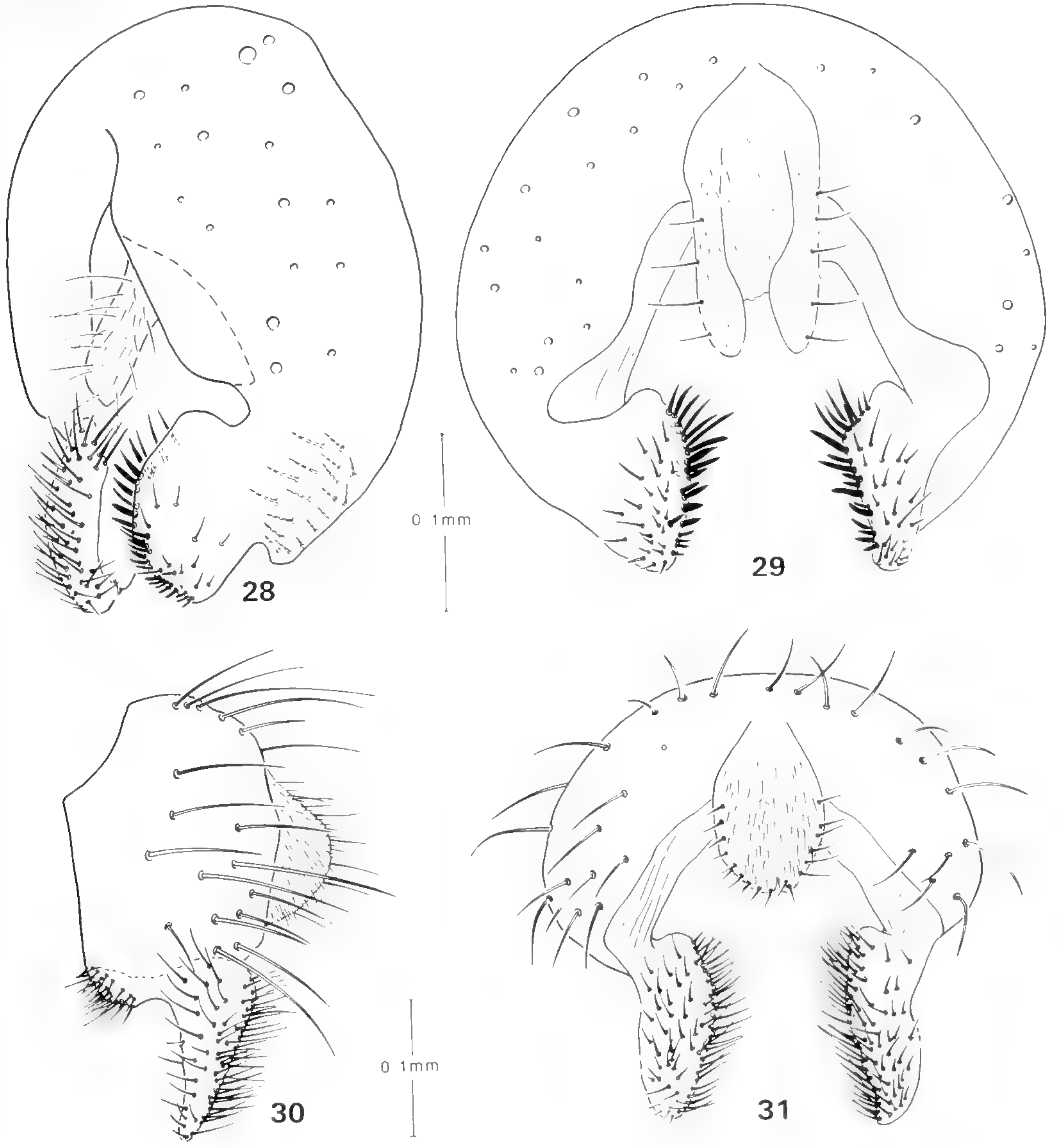
Diagnosis.—This species is distinguished from congeners by the following combination of characters: Body length 1.85–2.70 mm; body generally with gray microtomentum; setae generally black; gena short, less than 0.5 eye height; 4 somewhat irregular rows of acrostichal setulae; scutellum uniformly gray, lacking apical spot; femora mostly gray; hindfemora of male distinctly swollen, distinctly larger than fore- and midfemora; tibiae and basal 4 tarsomeres yellow, apical tarsomere brown; surstylus articulated with and broadly attached to epandrium, broadly spatulate in posterior view (Fig. 29), length about equal to width, median margin bearing dense patch of robust setulae along entire length (Fig. 29); surstylus in lateroblique view (Fig. 28) broadly rounded, constricted anteriorly, external surface bearing numerous setulae; aedeagus thin, ribbonlike.

Type material.—The holotype ♂ of *Tethina setulosa* is labeled "Angol [crossed out] Chile DSBullock/Tocopilla [Antofagasta] Ap. 10, [19] 31 Sea Beach [handwritten]/ Type No. 50448 U.S.N.M. [red; "50448" handwritten]/Tethina setulosa Type Det. JRMALLOCH [species name and "Type" handwritten; black submargin]." The holotype is directly pinned, is in good condition (abdomen removed and dissected, the parts are in an attached microvial), and is deposited in the USNM (50448).

Specimens examined.—Neotropical. CHILE. *Antofagasta:* Tocopilla, 10 Apr 1931, D.S. Bullock (1 ♂; the holotype; USNM). MEXICO. *Tabasco:* Paraíso (5 km E), 6 May 1985, A. Freidberg, W.N. Mathis (4 ♂; USNM).

Distribution.—*Neotropical:* Chile (Tarapaea to Antofagasta), Mexico (TAB).

Remarks.—This species is typically quite robust and very setose. Males have both fore- and hindfemora swollen, the hindfemora being much more swollen than the fore, however. All setae are generally very stout and well developed.



Figs. 28–31. 28–29, *Tethina setulosa*. 28, External male terminalia, lateroblique view (Mexico. Tabasco: Paraíso). 29, Same, posterior view. 30–31, *T. cohiba*. 30, External male terminalia, lateral view (Jamaica. St. Elizabeth: Port Kaiser). 31, Same, posterior view.

11. *Tethina cohiba* Foster and Mathis, new species

(Figs. 27, 30, 31)

Diagnosis.—This species is distinguished from congeners by the following combination of characters: Body with gray microtomentum; setae generally black; gena short, less than 0.5 eye height; 4 somewhat irregular rows of acrostichal setulae; scutellum uniformly gray, lacking yellowish to reddish spot; femora mostly gray; hindfemora of male usually distinctly swollen, noticeably larger than fore- and midfemora; tibiae and basal 4 tarsomeres yellow, apical tarsomere yellow; surstylus articulated with and broadly attached to epandrium, narrowly spatulate in posterior view (Fig. 31), length about 2.5× width, apex narrowly rounded, median margin bearing dense patch of robust setulae along entire length (Fig. 31); surstylus in lateral view (Fig. 30) becoming narrowed toward apex, apex pointed, lateral surface bearing numerous setulae, basal portion produced anteriorly as a lateral lobe that bears dense patch of setulae; aedeagus narrow, ribbonlike.

Description.—Body length 1.60–2.70 mm; body with gray, microtomentum; setae generally black.

Head (Fig. 27): All setae black except for white postgenal setulae; vertex whitish gray, microtomentose; ocellar tubercle bearing 2 proclinate setae; frons dark yellow, microtomentose; 3 interfrontal setae, proclinate and convergent; row of 6 convergent inner fronto-orbital setae; row of 4 divergent outer fronto-orbital setae; 1 convergent outer fronto-orbital seta just dorsad of antenna. Antenna dark yellow, concolorous with frons except slightly browner at base of arista; 1st flagellomere pubescent; arista brownish, sparsely pubescent. Gena short, height less than 0.5 that of eye, white, microtomentose, becoming gray posteriorly; postgena yellowish gray, with setulae white. Peristomal setae with 5 directed dorsally, 6th directed anteriorly, yellowish tubercle dorsad of anteriormost seta. Palpus yellow; labellum long, yellow.

Thorax: Generally gray, microtomentose; scutellum uniformly gray, lacking yellowish to reddish spot. Setae generally black; acrostichal setulae in 4 irregular rows; dorsocentral setae 6 (2+4); proepisternum and proepimeron each with a seta. Coxae mostly yellowish, with pale setulae except hindcoxal setae black; femora mostly light brown to yellowish, midfemur yellow; fore- and hindfemora of male swollen with hindfemur distinctly so; tibiae and basal 3 tarsomeres yellow, 4th tarsomere slightly brown, apical tarsomere brown. Wing with costa extended to vein M.

Abdomen: Coloration as for thorax; all setae and setulae black. Male terminalia (Figs. 30–31): Surstylus articulated with and broadly attached to epandrium, narrowly spatulate in posterior view (Fig. 31), length about 2.5× width, apex narrowly rounded, median margin bearing dense patch of robust setulae along entire length (Fig. 31); surstylus in lateral view (Fig. 30) becoming narrowed toward apex, apex pointed, lateral surface bearing numerous setulae, basal portion produced anteriorly as a lateral lobe that bears dense patch of setulae; aedeagus narrow, ribbonlike.

Type material.—The holotype ♂ is labeled "BWI. GRAND CAYMAN. George TownHarbour[,] 19°18′N, 81°22.9′W[,] 28–29 April 1994 [,] Wayne N. Mathis/HOLOTYPE Tethina cohiba ♂ Foster and W.N. Mathis USNM [red; species name and "♂ and Foster" handwritten]." The holotype is double mounted (minuten in block of plastic), is in excellent condition, and is deposited in the USNM. Other paratypes are as follows: GRAND CAYMAN. same label data as the holotype (10 ♂; USNM). Bodden Town (beach; 19°17′N, 81°14.8′W), 26 Apr 1994, W.N. Mathis (4 ♂; USNM). Breaker (1.5 km W); 19°18′N, 81°10.9′W), 29 Apr 1994, W.N. Mathis (4 ♂; USNM). Heritage Beach (19°18′N, 81°9.8′W), 28 Apr 1994, W.N. Mathis (1 ♂; USNM).

Other specimens examined.—Neotropical. ANGUILLA. Blowing Point (18°10.5′N, 63°5.8′W), 29 Mar 1992, W.E. Steiner, J.M. Swearingen (2 ♂, 4 ♀; USNM). Sandy Ground (18°12.3′N, 63°05.5′W), 27 Mar 1992, W.E. Steiner, J.M. Swearingen (3 ♂; USNM). ANTIGUA. Dutchman Bay, 7 Jan 1965, W.W. Wirth (7 ♂, 1 ♀; USNM). near airport, 19 Mar 1989, A. Freidberg, W.N. Mathis (4 ♂, 1 ♀; USNM). BAHAMAS. *Abaco Cays:* Great Sale Cay, 10 May 1953, L. Giovannoli, G.B. Rabb (3 ♂, 3 ♀; USNM). *Eleuthera Island:* James Citern, 1 Apr 1953, E.B. Hayden, L. Giovannoli (1 ♂; USNM). *Exuma Cays:* Leaf Cay of Allens Cay, 7 Jan 1953, E.B. Hayden, L. Giovannoli (1 ♂; USNM). *New Providence Island:* Nassau, 16 Apr 1953, E.B. Hayden (1 ♀; USNM). *North Bimini:* Alicetown, 30

Dec 1952, L. Giovannoli (3 ♀; USNM). BELIZE. *Stann Creek:* Coco Plum Cay, 24 Jun 1990, C. Feller, H.B. Williams (2 ♂; USNM). Dangriga (16°58′N, 88°13′W), 3–4 Apr 1993, W.N. Mathis (1 ♂; USNM). CUBA. *Havana:* Jibacoa Beach (57 km E Havana), 26 Apr 1983, W.N. Mathis (7 ♂, 2 ♀; USNM). *Matanzas:* Playa Larga (1 km E), 2 May 1983, W.N. Mathis (3 ♂, 2 ♀; USNM). DOMINICA. Calibishie (seashore), 27 Feb 1965, W.W. Wirth (1 ♀; USNM). Clarke Hall, 11–20 Jan 1965, W.W. Wirth (1 ♂; USNM). Pagua Bay, 18 Feb 1965, W.W. Wirth (2 ♂; USNM). St. David Bay (sea shore), 23 Jan 1965, W.W. Wirth (1 ♂, 1 ♀; USNM). Woodford Hill, 27 Feb 1965, W.W. Wirth (2 ♂, 1 ♀; USNM). DOMINICAN REPUBLIC. *La Altagracía:* Bayahibe (18°22.3′N, 68°50.4′W), 13 May 1994, W.N. Mathis (1 ♂; USNM). *Monte Cristi:* Monte Cristi (beach; 19°51.5′N, 71°39.5′W), 18 May 1995, W.N. Mathis (2 ♂; USNM). *San Pedro de Macoris:* Playa Juan Dolio, 16 Nov 1984, R. Faitoute, P.S. Spangler (5 ♂, 2 ♀; USNM). GRENADA. *St. George:* Beauséjour Bay (12°05.5′N, 61°44.9′W), 21 Sep 1996, W.N. Mathis (2 ♂; USNM). JAMAICA. *Clarendon:* Jackson Bay (17°44.7′N, 77°12.6′W), 13 May 1996, D. and W.N. Mathis, H. Williams (1 ♂; USNM). *Manchester:* Alligator Pond (17°52.1′N, 77°33.9′W), 8 May 1996, D. and W.N. Mathis, H. Williams (9 ♂; USNM). *St. Elizabeth:* Black River (18°01.4′N, 77°51.1′W), 11 May 1996, D. and W.N. Mathis, H. Williams (1 ♂; USNM). *St. Elizabeth:* Port Kaiser (17°51.9′N, 77°35.7′W), 8 May 1996, D. and W.N. Mathis, H. Williams (6 ♂; USNM). *St. Thomas:* Rozelle (17°52.3′N, 76°27.7′W), 14 May 1996, D. and W.N. Mathis, H. Williams (2 ♂; USNM). *Trelawny:* Falmouth (bay shore), 1 Mar 1969, W.W. Wirth (10 ♂; USNM). *Westmoreland:* Negril (S beach; 18°67.7′N, 78°21.4′W), 11 May 1996, D. and W.N. Mathis, H. Williams (1 ♂; USNM); Negril Beach (mangrove, rocky shore), 12 Mar 1970, W.W. Wirth (1 ♂; USNM). MEXICO. *Quintana Roo:* Cancun Island, 25 Mar-29 Oct 1974, 1975, D.J. Pletsch (5 ♂, 1 ♀; USNM). *Tabasco:* Paraíso, 6 May 1985, A. Freidberg, W.N. Mathis (6 ♂; USNM). PANAMA. Jacque River, 26 Jul 1952, F.S. Blanton (1 ♂; USNM). PUERTO RICO. Cayo Abogado, 8 Sep 1967, Heatwole (1 ♂; USNM). Fajardo, Las Croabas (Seven Seas Beach; 18°23′N, 65°37′W), 17 Feb 1996, W.E. Steiner, J.M. Swearingen (95 ♂, 22 ♀; USNM). Naguabo, Playa de Naguabo (18°11′N, 65°43′W), 17 Feb 1996, W.E. Steiner, J.M. Swearingen (10 ♀; USNM). TOBAGO. *St. David:* Plymouth (beach; 11°13.2′N, 60°46.7′W), 19 Apr 1994, W.N. Mathis (2 ♂; USNM). *St. John:* Charlotteville (5 km S; 11°18.9′N, 60°34.5′W), Hermitage River and beach, 22 Apr–11 Jun 1993, 1994, D. and W.N. Mathis (3 ♂; USNM). TRINIDAD. *St. Patrick:* Chatham (beach; 10°05′N, 61°44′W), 25 Jun 1993, W.N. Mathis (7 ♂, 3 ♀; USNM). TURKS AND CAICOS. *West Caicos:* 4 Feb 1953, E.B. Hayden, L. Giovannoli (1 ♂; USNM). VIRGIN ISLANDS. *St. John:* Francis Bay, 25 Mar 1958, J.F.G. Clarke (1 ♀; USNM).

Distribution.—*Neotropical:* Bahamas, Belize, Mexico (QNR), Panama, Trinidad and Tobago, West Indies (Anguilla, Antigua, Cuba, Dominica, Dominican Republic, Grand Cayman, Grenada, Jamaica, Puerto Rico).

Remarks.—This species is distinguished externally from *T. xanthopoda* by the entirely grayish hindfemur, which is often quite swollen in the male. The degree of enlargement, however, varies, especially in less robust specimens. Additionally, the femora, after drying, are often collapsed laterally and therefore flattened, making it difficult to discern if they are swollen. The apex of the scutellum is always clearly gray microtomentose without a reddish yellow spot. The male terminalia (Figs. 30, 31) are obviously quite different and easily distinguish between the species.

Etymology.—The specific epithet, *cohiba,* recognizes the first author's preference in cigars from Cuba, the island from which specimens of this species were first identified. Males of *T. cohiba* have swollen hindfemora, reminiscent of cigars.

12. *Tethina albitarsa* Foster and Mathis, new species
(Figs. 32–34)

Diagnosis.—This species is distinguished from congeners by the following combination of characters: Body with gray microtomentum, thorax brownish dorsally, becoming light gray laterally; setae generally black except for peristomal setulae; gena short, less than 0.5 eye height; 4 irregular rows of acrostichal setulae; scutellum uniformly gray, lacking yellowish to reddish spot; forefemora distinctly gray; mid- and hindfemora yellow at base, otherwise gray; fore- and hindfemora of male distinctly swollen, distinctly larger than midfemora, with hindfemora distinctly larger than forefemora; forefemur with straight row of short setae on apical third of anteroventral surface; mid- and hindtibiae black on apical ¼–⅓, basal 3 tarsomeres whitish, appearing velvety ventrally; foretibia with patch of fine setulae on apical half of posterior surface, appearing velvety; surstylus articulated with and broadly attached to epandrium, in posterior view (Fig. 34) quite broadly spatulate, length about 2× width, apex rounded, median margin bearing patch of stout setulae along apical half, dorsolateral surface of surstylus bearing scattered setulae; surstylus in lateral view (Fig. 33) long and narrow, height 3.5× width, apex narrowly rounded; aedeagus thin, ribbonlike.

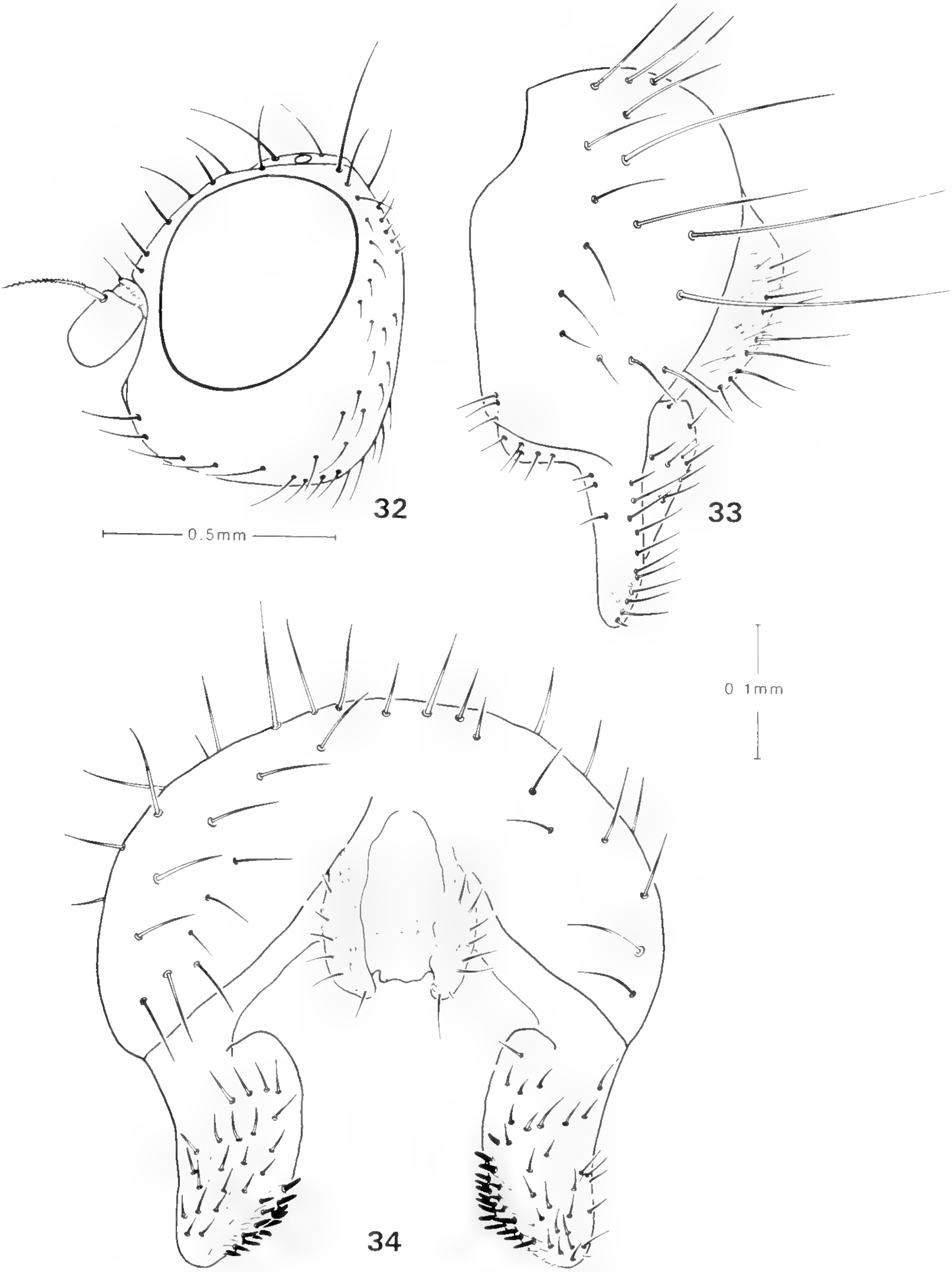
Description.—Body length 2.30–3.70 mm; body with gray microtomentum, thorax brownish dorsally, becoming light gray laterally; setae generally black except for peristomal setulae;

Head (Fig. 32): All setae black. Vertex dark gray, microtomentose; ocellar tubercle bearing 1 ocellar seta and 2 shorter setulae; postocellar seta 1; frons yellow; interfrontal setae 3, proclinate; fronto-orbital setae as 1 row of median, short, proclinate setulae and 4 divergent, lateral setae. Antenna with scape and pedicel yellow; 1st flagellomere brownish; arista brown, sparsely pubescent. Face white; facial tubercle yellow; peristomal setae as 6 dorsally directed setae, pale; 1 false oral vibrissal seta, pale. Gena short, less than 0.5 eye height, white, microtomentose; postgena gray with pale setae. Palpus white; labellum long, yellow.

Thorax: Scutum generally brownish, microtomentose, coloration extended ventrad to middle of anepisternum, thereafter gray, microtomentose; scutellum lacking yellowish to reddish spot. Acrostichal setulae in 4 irregular rows; dorsocentral setae 6 (2+4); proepisternum and proepimeron each bearing 1 pale yellow seta (all other thoracic setae black). Coxae yellow, all setae pale; forefemora distinctly gray, mid- and hindfemora yellow at extreme base, otherwise gray; forefemur bearing row of 10 short setulae along distal third of anteroventral margin; fore- and hindfemora of male somewhat swollen, larger than midfemora, with hindfemora distinctly larger than forefemur; femora of female not swollen; femoral setae generally black except for a few ventral, pale setae; mid- and hindtibiae brown on apical ¼–⅓, otherwise yellow; foretibia with patch of fine setulae on apical half of posterior surface, appearing velvety; basal 3 tarsomeres whitish to pale yellow; distal 2 tarsomeres brown.

Abdomen: All setae and setulae black; distal margins of segments white, remainder brown to nearly black. Male terminalia (Figs. 33, 34): Surstylus articulated with and broadly attached to epandrium, in posterior view quite broadly spatulate, length about 2× width, apex rounded, median margin bearing patch of stout setulae along apical half, dorsolateral surface of surstylus bearing scattered setulae; surstylus in lateral view (Fig. 33) long and narrow, height 3.5× width, apex narrowly rounded; aedeagus thin, ribbonlike.

Type material.—The holotype ♂ is labeled "ECUADOR: Manabi Pr. Bahia[,] 10 Jan 1978[,] Wayne N. Mathis/HOLOTYPE ♂ Tethina albitarsa Foster and W.N. Mathis



Figs. 32–34. *Tethina albitarsa.* 32, Head, lateral view. 33, External male terminalia, lateral view (Panama. Jacque River). 34, Same, posterior view.

USNM [red; "♂", species name, and "and Foster" handwritten]." The holotype is double mounted (minuten in block of plastic), is in excellent condition, and is deposited in the USNM. Other paratypes are as follows: same label data as the holotype (15 ♂, 14 ♀; USNM).

Other specimens examined.—Neotropical. PANAMA. *Canal Zone:* Mojinga Swamp, Ft. Sherman, 13 Jan 1953, F.S. Blanton (2 ♀; USNM). *Darien:* Garachine, Feb 1953, F.S. Blanton (1 ♀; USNM). Jacque River, 20–26 Jul 1952, F.S. Blanton (3 ♂, 15 ♀; USNM).

Distribution.—*Neotropical:* Ecuador, Panama.

Etymology.—The specific epithet, *albitarsa*, refers to the white basal three tarsomeres of each leg.

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AMNH	American Museum of Natural History, New York, New York (Dr. David A. Grimaldi)
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CNC	Canadian National Collection, Ottawa, Canada (Dr. James E. O'Hara and Mr. Bruce Cooper)
MZSP	Museu de Zoologia da Universidade de São Paulo, São Paulo, Brazil (Dr. Francisca C. do Val)

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THE HOST RANGE OF *FALCONIA INTERMEDIA* (DISTANT) (HEMIPTERA: MIRIDAE): A POTENTIAL BIOLOGICAL CONTROL AGENT FOR *LANTANA CAMARA* L. (VERBENACEAE)

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Abstract.—The mirid bug *Falconia intermedia* (Distant) is endemic to the Neotropics where it is found on various species of *Lantana*. Host range tests were conducted in Mexico to ascertain whether the insect warranted further consideration as an agent for the biological control of *Lantana camara* which is a serious weed in many tropical and subtropical countries. In these tests, *F. intermedia* oviposited, and immatures developed, only on *L. camara;* evidence that the bug was narrowly stenophagous. Permission to introduce this insect into quarantine facilities in Queensland for further study was obtained.

Key Words: Mexico, biocontrol of weeds, *Adfalconia,* introduction into Australia

The woody shrub *Lantana camara* L. (family Verbenaceae; subfamily Verbenoideae) is a very serious rangeland weed in many sub-tropical and tropical countries (Palmer and Pullen 1995) and has long been a target for biological control (Perkins and Swezey 1924). During a recent survey of North America (Palmer and Pullen 1995), *Falconia intermedia* (Distant) (Hemiptera: Miridae) was found feeding on and damaging various *Lantana* spp. and was identified as a potential biological control agent for lantana. *Falconia* is a poorly known Neotropical genus comprised of 24 morphologically diverse species (Schuh 1995). The generic placement of some species, including *F. intermedia,* and their relationship to the genus *Adfalconia* are in need of study (T. J. Henry, personal communication).

This report describes aspects of the biology, phenology and host range of *F. intermedia* determined during our study of the insect in 1991 to support an application to import *A. intermedia* into quarantine facilities in Australia for more detailed studies.

BIOLOGY

The eggs are a translucent pale green with a brownish operculum. They are elongate-elliptical in longitudinal section with the operculum flattened, and round in cross-section. The eggs are inserted into the leaf at the anal end via a small stalk-like process (J. R. Baars, personal communication). Most eggs are also covered to a greater or lesser extent in a black or dark reddish resinous substance which can sometimes coat the entire egg except the operculum. Eggs are placed individually or in groups of 2–3 over the whole of the underside of leaves.

Under high densities, eggs may also be found along the invaginated veins on the adaxial leaf surface.

The 1st instar is pale green with red eyes. The nymphs are very active and quickly move to the other side of the leaf when disturbed. At high densities, nymphs were observed to wander along stems and move from the plant onto the litter surface. Nymphs develop through to adults in approximately 15–20 days. Male adults straddle final instar female nymphs, and mating occurs soon after the female undergoes its final moult.

PHENOLOGY, HOST RANGE, AND DISTRIBUTION

Falconia intermedia was found on three species of *Lantana* all of which are within the section *camara; L. camara, L. urticifolia* Mill. and *L. hirsuta* Mart. & Gal. It occurred throughout the growing season (July–January) but populations increased as the season progressed. Large numbers were sometimes found causing obvious damage to their host plants towards the end of the growing season. Heavily infested plants assumed a yellowish-silver look and could be recognised as stressed from a distance.

We also collected *Falconia semirasa* (Distant) from *Lippia myriocephala* Schlecht. and Cham., another verbenaceous host. The hosts of other species of *Falconia* and *Adfalconia,* however, are generally not known, but none is known to be detrimental to agricultural crops.

The insect was found at various localities in Mexico, including Jalapa and Córdoba (State of Veracruz) and Cuernavaca (State of Morelos). It was also found at various locales in Honduras where it appeared to be more generally distributed.

MATERIALS AND METHODS

The following host specificity studies were conducted in Cuernavaca, Mexico:

(1) First experiment.—Eight plant species closely related to and including *Lantana camara* were selected for the experiment (Table 1). One potted plant of each species was placed into a standard gauzed cage (1 × 1 × 0.6 m) so the insects could freely choose between the eight plant species. Each cage, with its eight plant species, represented a replication.

Table 1. Numbers of nymphs and adults found on various plant species in two experiments conducted to determine the host range of *F. intermedia.*

Plant Species	Experiment No.	Mean No. of Nymphs	Mean No of Adults
Verbenacea			
Lantana camara L.	1	82.0	6.5
Lantana camara L.	2	27.5	5.0
Lantana montevidensis (K. Spreng.) Briq.	2	0.0	0.0
Verbena carolina	1	0.0	0.0
Clerodendrum sp.	1	0.0	0.0
Duranta repens L.	2	0.0	0.0
Petrea volubilis L.	1	0.0	0.0
Lamiaceae			
Ocimum basilicum L.	2	0.0	0.0
Ajuga reptans L.	2	0.0	0.0
Salvia splendens F. Sellow ex Roem. & Scult.	1	0.0	0.0
Nepeta mussinii K. Spreng. ex Henckel	1	0.0	0.0
Bignoniaceae			
Jacaranda mimosifolia Humb. & Bonl.	2	0.0	0.0
Boraginaceae			
Borago officinalis L.	1	0.0	0.0
Borago officinalis L.	2	0.0	0.0
Solanaceae			
Lycopersicon lycopersicum L.	2	0.0	0.0
Solanum melongena L.	1	0.0	0.0

Adult insects were collected by aspiration from a laboratory culture which had been established using material collected from *L. hirsuta* growing near Jalapa. Twelve adults were introduced into the first cage and 30 adults into a second. No attempt was made to place them on *L. camara.* The plants were observed every few days and at the end of 6 weeks the plants were bagged. The leaves of each plant were then examined under a microscope and nymphs and adults counted.

(2) Second experiment.—A similar de-

sign to the first experiment was used with a different selection of eight plant species (Table 1) being utilized. The insects were also taken from the laboratory culture described above. This time three leaves infested with all stages of the insect were attached to each of the test plants with paper clips. Observations were again made every few days and after approximately six weeks all the plants were bagged and assessed under the microscope.

RESULTS

(1) First experiment.—The mirid was not seen on any plant other than *L. camara* during the period of observation. On *L. camara,* both the insect and mottling of the leaves caused by feeding were seen. Counts at the end of the trial revealed that both nymphs and adults were present on the *L. camara* but were not present on any other plant (Table 1).

(2) Second experiment.—During the course of the experiment the mirid was not seen on any plant other than *L. camara.* On this plant both the insect and mottling of the leaves were seen. Counts at the end of the trial revealed that both nymphs and adults were present on the *Lantana camara* but were not present on any other plant (Table 1).

DISCUSSION

Based on these tests, *F. intermedia* would appear to be a promising biocontrol agent for lantana. Particularly favourable characteristics are its ability to attain high populations very quickly and to damage the plant considerably as seen by field observations.

The two host range trials indicated that this mirid has a very limited host range. Although the host testing list was not extensive (comprising 13 plant species) it did include phylogenetically close taxa and should accurately indicate the host range of this insect. These studies therefore indicate that *F. intermedia* warrants further study to obtain approval for its release in Australia and in other countries such as South Africa where lantana is also a problem.

The insect was imported into quarantine facilities in Brisbane in 1993 and again in 1994 but in both instances failed to survive on the cultivars offered as hosts. Imported adults successfully oviposited but emerging nymphs did not survive beyond a few days. Further experimentation in collaboration with scientists in South Africa is planned to determine what factors caused the demise of the laboratory colonies. Unfavourable laboratory conditions or unsuitable Australian cultivars are suggested.

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THE GENERA *MACROXYELA* KIRBY AND *MEGAXYELA* ASHMEAD (HYMENOPTERA: XYELIDAE) IN NORTH AMERICA

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Abstract.—Five species of *Megaxyela,* including ***Megaxyela alisonae,* n. sp.,** and two species of *Macroxyela* occur in North America. *Macroxyela bicolor* MacGillivray is a **new synonym** of *Macroxyela ferruginea* (Say). The species are keyed, described and illustrated, and biological information is summarized. Hosts include hickory, pecan, and elm.

Key Words: *Megaxyela, Macroxyela,* Xyelidae, *Ulmus, Carya,* pecan, North America

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The large xyelids of the genera *Megaxyela* and *Macroxyela* are among the most intriguing groups of sawflies because of their odd appearance, scarcity, and probable primitive status in the Symphyta and Hymenoptera. They are apparently two relic genera in a family with a long fossil record (Rasnitsyn 1969). *Megaxyela* occurs only in eastern Asia and eastern North America, and *Macroxyela* only in North America. Larvae of both genera are associated with angiospermous trees, whereas all other Xyelidae are associated with conifers. They are seldom collected, although *Macroxyela ferruginea* (Say) can be collected in numbers on its host during its flight time. Why *Megaxyela* is so scarce is puzzling. Such large (10–15 mm long) and colorful insects with long hindlegs (Fig. 3) certainly should be sighted more frequently by collectors.

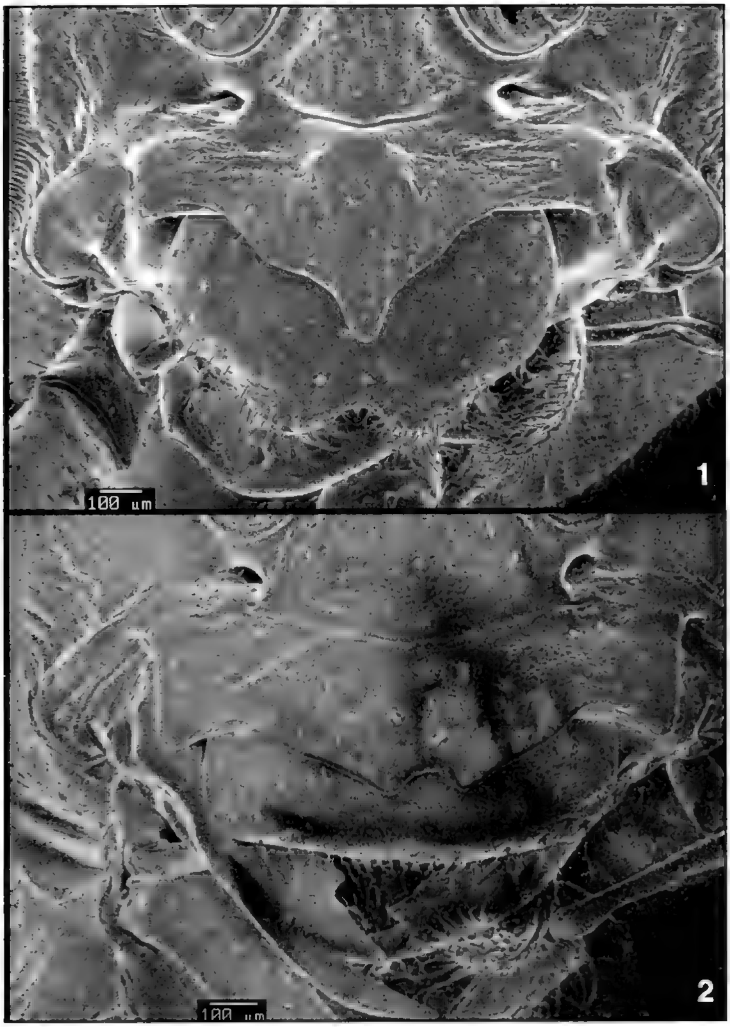
Both genera were revised by Ross (1932), but few specimens were available to him, and he was not able to resolve sex associations or present a complete concept of the North American fauna. Although he did not use subfamily or tribal categories for Xyelidae, he suggested that *Megaxyela* and *Macroxyela* form a natural unit based on wing venation and that *Xyela* Dalman, *Neoxyela* Curran (= *Xyela*) and *Pleroneura* Konow form a separate closely related group. Smith (1967) proposed a classification based on larval and adult characters and concluded that *Macroxyela* and *Megaxyela* form the tribe Macroxyelini in the subfamily Macroxyelinae. The other tribe of Macroxyelinae, Xyeleciini, includes *Xyelecia* Ross, a genus found in western North America and Japan.

We have accumulated about 600 specimens of the genera *Megaxyela* and *Macroxyela* and are now able to resolve some questions and present a more complete picture of species composition in North America. We recognize five species of *Megaxyela* and two species of *Macroxyela.*

Specimen depositories and acronyms used are in Acknowledgments.

TRIBE MACROXYELINI

The Macroxyelini differ from other Xyelidae by wing venation (Figs. 4–6): forewing



Figs. 1–2. Clypeus and labrum. 1, *Megaxyela aviingrata*. 2, *Macroxyela ferruginea*.

with vein Rs1; C free from Sc forming costal and subcostal cells; vein Sc2 distinct; Sc2 joining Sc + R1 apical to separation of Rs; hindwing with two closed submarginal cells (1Rs and 2Rs) (wing venation terminology follows Goulet and Huber 1993). Also, the apical filament of the antenna is short, one-quarter to one-third the length of the third segment, and 5–11 segmented, and the tarsal claws have a long inner tooth, nearly as long as the outer tooth.

KEY TO GENERA OF MACROXYELINI

1. Clypeus with large median triangular tooth and labrum rounded with notch on anterior margin (Fig. 1); forewing with Sc2 joining Sc + R1 ¼ to ½ distance between separation of Rs and stigma (Fig. 4); labial palpus 4-segmented . . . . *Megaxyela*
– Clypeus with small anterior median notch and labrum broad, rectangular, and nearly truncate anteriorly (Fig. 2); forewing with Sc2 joining Sc + R1 very slightly apical to juncture of Rs with Sc + R1 (Figs. 5, 6); labial palpus 3-segmented . . . . *Macroxyela*

GENUS *MEGAXYELA* ASHMEAD

Megaxyela Ashmead 1898: 214.—Ross 1932: 161–164 (N. Amer. species; syn.: *Odontophyes, Paraxyela*).—Ross 1951: 7 (N. Amer. catalog).—Smith 1978: 24

(world catalog).—Smith 1979: 10 (N. Amer. catalog).—Shinohara 1992: 783–786 (Asian species). Type species: *Xyela major* Cresson. Orig. desig.

Odontophyes Konow 1899: 42. Type species: *Pleroneura aviingrata* Dyar. By monotypy.

Megaloxyela Schulz 1906: 88. Emendation.

Paraxyela MacGillivray 1912: 294. Type species: *Xyela tricolor* Norton. Orig. desig.

Clypeus with sharp, median triangular tooth and labrum rounded with anterior, median notch (Fig. 1); labial palpus 4-segmented; forewing with Sc long, Sc2 joins Sc+R1 ¼ to ½ distance between the separation of Rs and stigma. Antennal flagellum 6–11 segmented. General habitus of all species similar to that of *M. alisonae,* n. sp. (Fig. 3).

Few specimens are available for study, but we have seen enough (about 65) to resolve several problems, including species identity and association of sexes, and present a better understanding of the North American fauna. We recognize five species.

The genus occurs only in eastern North America and eastern Asia. Shinohara (1992) treated three species from eastern Asia, *M. gigantea* Mocsáry from eastern Russia (Primorski Krai), Korea, and China; *M. togashii* Shinohara from Japan; and *M. parki* Shinohara from Korea.

Two species groups are apparent. The Asian species and *Megaxyela major, M. aviingrata,* and *M. alisonae* from North America form one group characterized by the short sheath with the ventral and dorsal margins curving mesally to an acute apex (Figs. 7–9), a thick hindbasitarsus (Fig. 15), the lance lacking dorsal teeth, and the lancet having indistinct serrulae (except *M. alisonae*) (Figs. 16–19). The other group includes the North American *Megaxyela tricolor* and *M. bicoloripes,* which have a long sheath, straight on its ventral margin (Figs. 10, 11), a slender hindbasitarsus (Fig. 14), the lance with distinct teeth at its apex, and the lancet with clearly defined serrulae at its apex (Figs. 22–29).

Known host plants are members of the Juglandaceae. The hosts for the North American *Megaxyela aviingrata* (Dyar) and *M. major* (Cresson) are *Carya* spp. and perhaps *Juglans* spp. The hosts for *M. gigantea* in eastern Asia are *Juglans* spp. and *Pterocarya* spp. (Shinohara 1992). The few known aspects of their biology is given under each species. A brief account of *M. gigantea* in Korea by Sato (1941), as given by Shinohara (1992), is noteworthy in that it contains some unusual habits for sawflies: "This species has a univoltine life cycle, with adult appearance from late April to early May. The female lays an egg along the midrib on the upper surface of the apical part of a newly growing leaf. Before oviposition, the female stands on the under surface of the leaf, with the head directing toward the base of the leaf. Then the female bends the tip of her abdomen to the upper surface of the apex of the leaf and oviposits there, folding by hind legs the apex of the leaf in half along the midrib upward and attaches the folded halves with glutinous material. One egg is laid per leaf. The larval period is from late May to early June. The larva always starts feeding from the apex of the leaf and coils on the midrib at rest. The larva has four molts and overwinters in the soil."

KEY TO NEARCTIC SPECIES OF *MEGAXYELA*

1. Legs black or orange brown, usually with hindtarsus white 2
– Legs bright orange with hindtibia and tarsus black or hindtibia black and hindtarsus white 3
2. Entirely black except for white hindtarsal segments 2–5 or 3–5; sheath about 2.5× longer than broad (Fig. 8) . . . . *aviingrata* (Dyar)
– Usually entirely orange brown, sometimes various black markings on dorsum of head, thorax, and/or abdomen and on femora and tibiae; sheath about 3× longer than broad (Fig. 7) . . . . *major* (Cresson)
3. Thorax black; sheath longer than hindtarsus, about 4× longer than broad (Fig. 11) (legs with hindtibia and hindtarsus black; hindbasitarsus

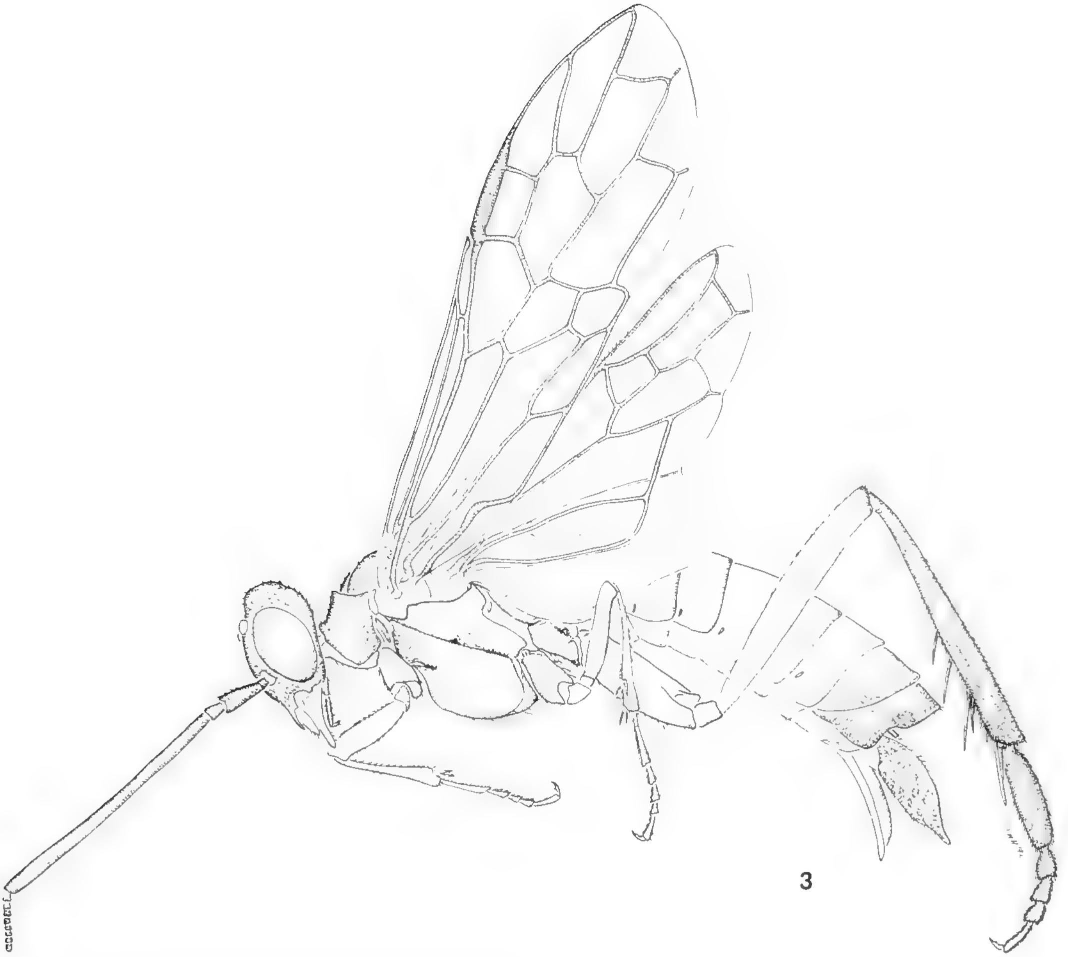


Fig. 3. Habitus of *Megaxyela alisonae*, length 12 mm.

slender, as in Fig. 14, about 6.5× longer than broad) . . . . *tricolor* (Norton)

– Thorax black with mesosternum and mesepisternum orange; sheath shorter than hindtarsus and less than 3× longer than broad (Figs. 9, 10) 4

4. Hindtarsal segments 2–5 white; hindbasitarsus slender, about 6.5× longer than broad and tarsal segments 2–4 much longer than broad (Fig. 14); sheath at apex in lateral view nearly straight below, slightly emarginate on dorsum (Fig. 10) . . . . *bicoloripes* (Rohwer)

– Hindtarsal segments 2–5 black; hindbasitarsus broad, about 3.5× longer than broad and tarsal segments 2–4 about as long as broad (Figs. 15); sheath at apex in lateral view emarginate on both dorsal and ventral margins (Fig. 9) . . . . *alisonae*, new species

Megaxyela alisonae Smith and Schiff, new species

(Figs. 3, 9, 15, 20, 21)

Female.—Length, 10.5–12.0 mm. Antenna black with scape brownish. Head black with clypeus, labrum, mouthparts, and mandible white, tips of mandibles brownish, and apical labial palpal segment blackish. Thorax orange with pronotum, mesonotum, and upper corners of mesepisterum and mesepimeron black to purplish metallic; posterolateral portion of pronotum sometimes dark orange; mesonotal lateral lobe may be partly orange; tegula white. Abdomen or-

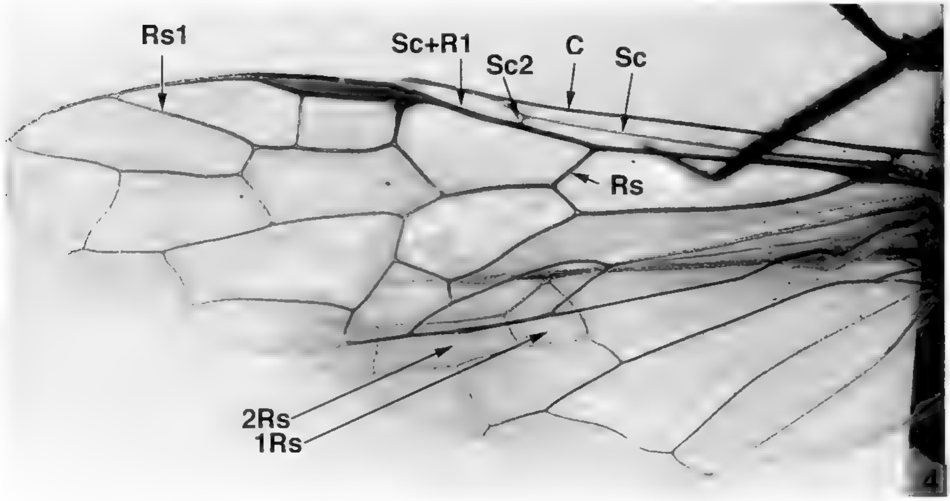


Fig. 4. Wings of *Megaxyela major*.

ange, terga with narrow black posterior margins; apical tergum black or about half of 8th and all of 9th black; sterna with posterior margins narrowly white; sheath black; basal plate orange. Legs orange with extreme tip of hindfemur, hindtibia, and hindtarsus black.

Antennal filament 9-segmented and subequal in length to scape; antennal length about 2.3× head width. Hindbasitarsus thick, about 3.5× longer than broad. Length of hindbasitarsus about 0.8× length of remaining tarsal segments combined; length of hindtarsus about 0.7× length of hindtibia. Sheath (Fig. 9) length about 1.1× length of basal plate and 0.6× length of hindtibia. Lance with serrate dorsal margin (Fig. 20); serrulae of lancet small, narrowly pointed at apices (Fig. 21).

Male.—Unknown

Holotype.—♀, labeled "U.S.A.: Pinebush, N.Y.: Albany Co., 42.42.45–75.52.53, 21 May 1983, T. McCabe, 100 m." Deposited in the New York State Museum, Albany, New York.

Paratypes.—NEW YORK: Ithaca, 21 May '36 (1 ♀, UCB). OHIO: Franklin Co., 5-22-79 (1 ♀, OSU).

Distribution.—New York, Ohio.

Etymology.—The specific epithet is in memory of Alison Wyn Schiff who was greatly amused by her brother's (NMS) choice of an entomological career.

Host.—Unknown.

Discussion.—The sheath shape (Figs. 7–9) and thick hindbasitarsus (Fig. 15) are similar to *Megaxyela major* and *M. aviingrata*. The largely orange thorax, abdomen, and legs and the serrate dorsal margin of the lance and distinct serrulae of the lancet will separate *M. alisonae* from those species.

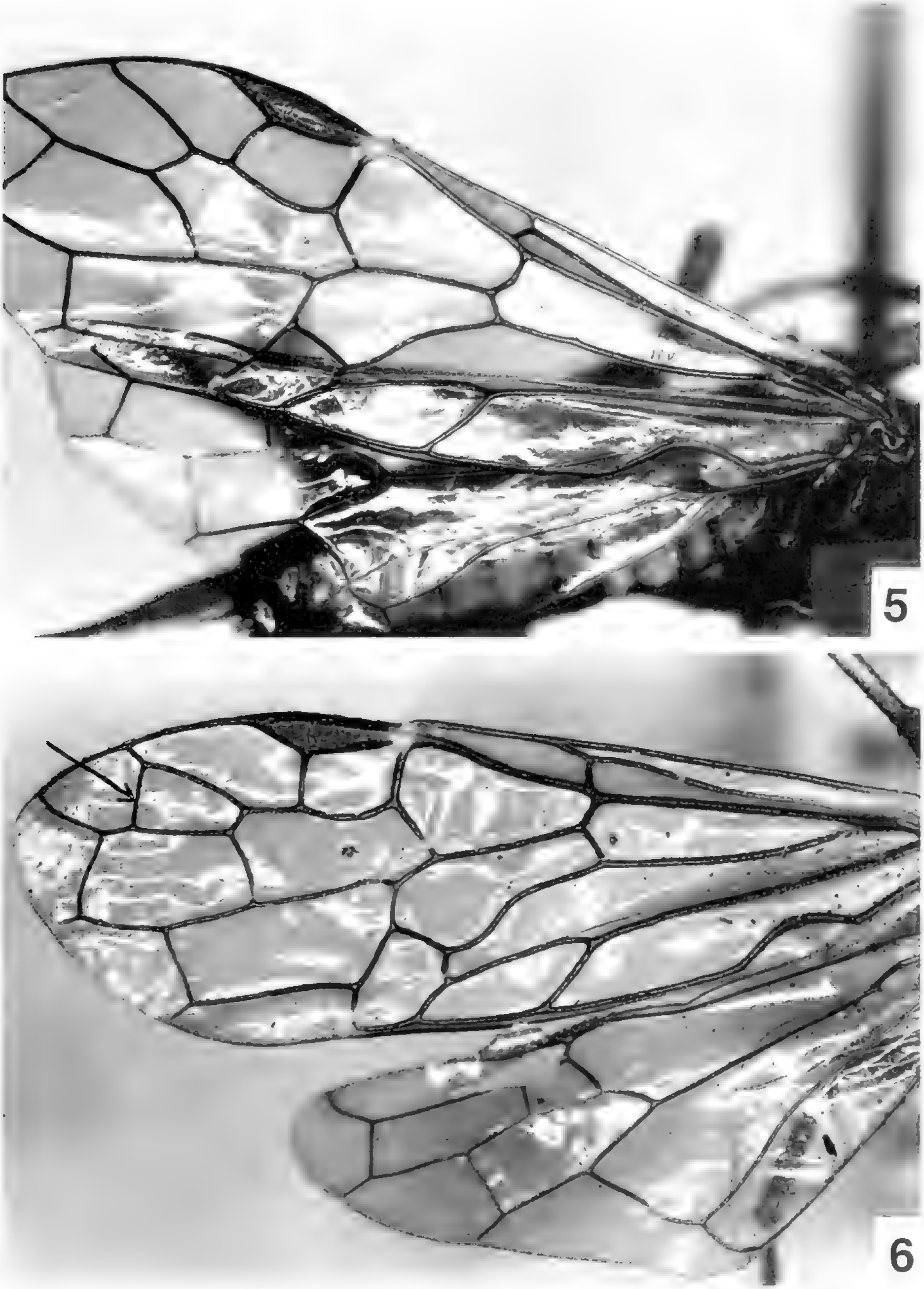
Megaxyela aviingrata (Dyar)
(Figs. 1, 8, 16, 17)

Pleroneura aviingrata Dyar 1898a: 213.—Dyar 1899: 127 (larva).—Smith 1978: 26 (as a syn. of *M. tricolor*).—Smith 1979: 10.—Smith 1987: 386 (lectotype).

Odontophyes aviingrata: Konow 1899: 42.—MacGillivray 1906: pl. 23, fig. 32 (wings).

Megaxyela aviingrata: Ross 1932: 163.—Ross 1951: 7.—Burks 1958: 8.

Female.—Length, 11.0–12.5 mm. Black with following white: labrum except for black apical margin, labial palpus except for black apical segment, extreme apices of fore- and midtrochanters and most of hindtrochanter; extreme apices of fore- and midtibiae; hindtarsal segments 2 or 3 to 5 with



Figs. 5–6. Wings. 5, *Macroxyela ferruginea*. 6, *M. aenea*; arrow points to crossvein in cell Rs1.

sometimes extreme apex of hindbasitarus whitish and basal part of hindtarsal segment 2 blackish. Apex of mandible brownish. Wings hyaline with veins and stigma black.

Antennal filament 8–9 segmented; antennal length about 1.9× head width. Hindbasitarsus broad, about 3.5 × or more longer than broad (similar to Fig. 15). Length of hindbasitarus about 0.7 × length of remaining tarsal segments combined; length of hindtarsus 0.8× length of hindtibia. Sheath (Fig. 8) about 1.1× length of basal plate and 0.6× length of hindtibia. Dorsal margin of lance smooth, without serrations; lancet without discernible teeth (Figs. 16, 17).

Male.—Length, 11.0 mm. Color and structure as for female. Genitalia similar to that of *M. major* (Fig. 33).

Specimens examined.—20 ♀, 1 ♂.

Distribution.—INDIANA: Pine, V-21-05. KANSAS: Riley Co. MASSACHUSETTS: Boston, V-18-15. MISSISSIPPI: State College, 3-24-32, pecan L834-13; 3-27-31, pecan L834-9; 4-28-31, pecan L834-11; 3-31, adult L777-22; Oktibbeha Co., Starkville, III-23-1975, in black light trap edge of deciduous woods. MISSOURI: Columbia, 9-30-56 (male). NEW YORK: Ithaca, IV-29-13; V-9-36; Bedford Park (Dyar 1898b). OKLAHOMA: Oklahoma City, V-4-1964, on pecan (larvae). ONTARIO: Guelph, VIII-8-86; Hamilton, V-18-80. PENNSYLVANIA: Notch, V-13 & 15-13 (larvae). Ross (1951) gave the distribution as eastern, west to Illinois. Ross (1932) stated that he collected two larvae on hickory at Charleston, Ill., May 31, 1931, and his record may be based on this larval collection. Identification of larvae, however, is tenuous. The identity of the two records from larvae need confirmation.

Lectotype.—The female designated by Smith (1987) is in the USNM; it was reared from larvae on hickory from Bedford Park, New York, by Dyar.

Hosts.—*Carya* sp. and pecan are the only definite hosts recorded. The records from pecan are from Mississippi (see Distribution). Dyar (1898a) observed larvae which he called *M. aviingrata* on hickory and butternut at other locations, but his rearings from these collections were not successful. Several species of *Megaxyela* are possible in the area of his collections, and it is possible these larvae may be something else. Ross (1951) recorded "*Hicoria*," and Burks (1958) recorded *Carya* sp. and *Juglans cinerea* L. Both of their records of *Juglans* are based on Dyar's observations of larvae.

Biology.—Dyar's rearings bear his code "3C" (Smith 1987). Dyar (1898a) reared this species and presented some sketchy notes. He stated "curious larva resembling the excrement of birds"..."on the young tender leaves of the hickory and butternut in May. The larvae disappear by the end of the month and reappear the following season. The larva is solitary, if abundant there may be several on one leaf. In the natural position of rest, curled spirally around a leaf petiole. . . ." "Enters the earth without ultimate stage. Single brooded, feeding only on immature leaves." His larval records are: Staten Island, N.Y., June 1; Bellport, Long Island; Bedford Park, N.Y., May 25; and Fort Lee and Plainfield, N.J., May 16.

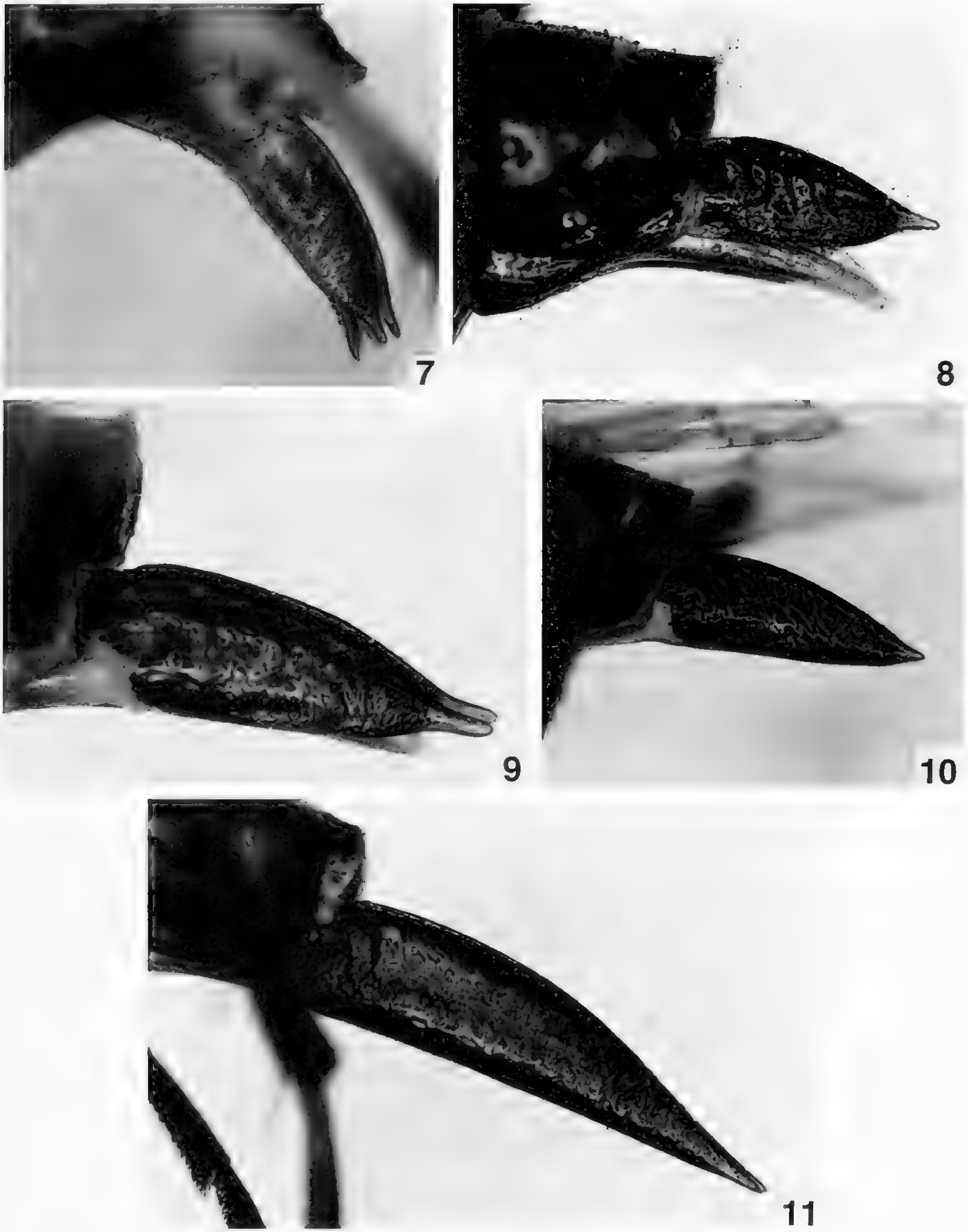
Discussion.—Only one male (a specimen collected in Missouri) was available for study. This species closely resembles *M. major,* except for the black coloration and stouter sheath (about 2.5× longer than broad; Fig. 8). Both *M. aviingrata* and *M. major* have a similar distribution and both have been recorded from pecan in Mississippi.

Megaxyela bicoloripes (Rohwer)
(Figs. 10, 14, 26–29, 34)

Odontophyes bicoloripes Rohwer 1924: 215.

Megaxyela bicoloripes: Ross 1932: 163.—Ross 1951: 7.—Smith 1978: 24.—Smith 1979: 10.

Female.—Length, 10–11 mm. Antenna black. Head black with clypeus and labrum white; apex of mandible and mouthparts brownish. Thorax mostly orange with pronotum, mesonotum, metanotum, upper corner of mesepisternum, upper half of mesepimeron, and upper corner of metapleuron black; tegula white. Abdomen black dorsally and laterally, orange ventrally; basal plates orange; segments with a narrow white posterior margin; sheath black with extreme apex dark orange. Legs orange



Figs. 7–11. Female sheaths. 7, *Megaxyela major*. 8, *M. aviingrata*. 9, *M. alisonae*. 10, *M. bicoloripes*. 11, *M. tricolor*.

with extreme apex of hind femur black on outer surface, hindtibia black, hindbasitarsus black with extreme apex white; and hind tarsal segments 2–5 white (segment 2 sometimes black at extreme base). Head, body and legs except tarsi with faint dark purplish tinge. Wings hyaline; veins and stigma black.

Antennal length about 1.9× head width; apical filament 9-segmented (in one specimen; others broken) and subequal in length to scape. Hindbasitarsus about 6.5× longer than broad and length about 0.6× length of remaining tarsal segments combined; hindtarsus about 0.7× length of hindtibia. Sheath (Fig. 10) length about 1.1× length of basal plate and about 0.8× length of hindtibia. Lance (Figs. 26, 28) with dorsal serration restricted to distal third; lancet (Figs. 27, 29) with fine serration on distal quarter.

Male.—Length, 9.5 mm. Coloration as for female; hypandrium black to dark orange. Antennal filament 9-segmented. Genitalia as in Fig. 34.

Specimens examined.—4 ♀, 1 ♂.

Distribution.—MICHIGAN: Washtenaw Co., Ann Arbor, IV-21-32. MISSISSIPPI: Agricultural College, 4-16-15 (holotype). MISSOURI: Boone Co., Columbia, 4-26-73; 4-25-73. PENNSYLVANIA: Spring Br., V-7-1945, H.K. Townes; Ross (1932) designated an allotype from "Penn."; we did not see this specimen. VIRGINIA: Arlington, VIII-21-51.

Holotype.—Female, USNM type no. 26040, labeled "Barbarin.AE., A&M.C, 4/6/15." Rohwer (1924) gave the type locality as "Agricultural College, Mississippi"; The collector is A.E. Barbarin

Host.—Unknown.

Discussion.—*Megaxyela bicoloripes* and *M. tricolor* form a group based on the shape of the sheath, lance and lancet, and slender hindtibia, as outlined in the introduction to the genus. The mostly orange legs, orange mesosternum and mesepisternum, and sheath shape distinguish *M. bicoloripes* from *M. tricolor*, which has the thorax entirely black. Furthermore, the sheath is shorter than the hindtarsus and about 3× longer than broad in *M. bicoloripes*, whereas that of *M. tricolor* is much longer than the hindtarsus and about 6.5× longer than broad (compare Figs. 10, 11).

Megaxyela major (Cresson)
(Figs. 4, 7, 18, 19, 33)

Xyela major Cresson 1880: 34.—Cresson 1916: 5 (lectotype).

Macroxyela major: Kirby 1882: 351.

Megaxyela major: Ashmead 1898: 214.—MacGillivray 1906: pl. 23, fig. 32 (wings).—Ross 1932: 162 (syn.: *ferruginea* Bridwell).—Ross 1951: 7.—Smith 1978: 25 (syn.: *langstoni* Ross).—Smith 1979: 10.

Odontophyes ferruginea Bridwell 1906: 94.

Megaxyela langstoni Ross 1936: 131.—Ross 1951: 9.—Webb 1980: 132.

Female.—Length, 9.5–11.5 mm. Mostly orange to reddish brown with yellowish and sometimes black markings, usually with following more yellowish: eye orbits, or much of head and mouthparts except for postocellar area; tegula; fore- and midlegs, hindtrochanter; basal third of hindtibia, hindbasitarus and sometimes two or more following segments; hind margin of abdominal segments; and sheath. Following may be blackish: frons; part of cervical sclerites; upper corner of mesepisternum; small spots anteriorly on mesoprescutum, lateral portions of mesonotal lateral lobes; small lateral spots on metanotum; hindcoxa except apex; apical half hindfemur and hindtibia; center of basal plates; terga 6–7. Wings hyaline to a slightly yellowish tinge; veins brown; forewing stigma black, sometimes with apical half yellowish.

Antennal filament 6–7 segmented, shorter than scape; antenna about 2.1× head width. Hindtarsus 0.7× length of hindtibia; hindbasitarsus about 0.9× length of remaining tarsal segment combined and and about 4.2× longer than broad. Sheath (Fig. 7) about 1.2× length of basal plate and 0.6× length of hindtibia. Dorsal margin of lance without teeth; lancet without discernible teeth (Figs. 18, 19).

Male.—Length, 9.0–10.5 mm. Coloration and variation similar to that of female, sometimes with slightly more extensive

Figs. 12–15. 12–13, Female sheaths. 12, *Macroxyela ferruginea*. 13, *M. aenea*. 14–15, Hindtarsus. 14, *Megaxyela bicoloripes*. 15, *M. alisonae*.

black marks at same spots and thoracic and abdominal dorsum. Genitalia as in Fig. 33.

Specimens examined.—32 ♀ and ♂; about 15 vials of larvae.

Distribution.—ALABAMA: Madison Co., VI-1962, pecan (larvae); Mobile Co., IV-8-1963, on pecan (larvae). ARKANSAS: Sheridan, IV-22-25, on pecan leaves (larvae). FLORIDA: Alachua Co., 9 mi. NW Gainesville, UF Hort. Unit, 19-III-1977; Monticello, IV-10-1963, on pecan (larvae). GEORGIA: Byron, 4-17-4-20-81, IV-21-1977, on pecan (larvae); Thomson, McDuffie Co., IV-26-1960, ex pecan (larvae); Jasper Co., IV-30-1958, on pecan (larvae); Jonesboro, IV-29-1959, pecan trees (larvae); Ty Ty, IV-1-1964, on pecan (larvae). IOWA: Story Co., state nursery, April 6, 1978. KANSAS: Baldwin (holotype, *O. ferruginea*); Douglas Co., V-1933; Burlington, on pecan, V-2-25 (larvae). MISSISSIPPI: State College, Apr. 7, 1932 and March 24, 1932, reared from pecan, J.M. Langston (mostly paratypes of *M. langstoni*), 4-27-31, pecan L838B; 4-7-32; Lucedale, reared from pecan, emerged April 20, 1930, and March 28 and April 2, and April 9, 1931, H. Dietrich (some paratypes of *M. langstoni*); Ag. Coll. Miss., 4-10-1915, pecan. MISSOURI: St. Joseph, V-3-1939. NEW YORK: McLean, IV-26-1913. OKLAHOMA: Latimer Co., IV-1989; Cleveland Co., IV-8-1931; Madil, Marshall Co., IV-28-64, on pecan (larvae). PENNSYLVANIA: Huntingdon, VI-3-34; Dauphin Co., VI-8-34, on hickory (larvae). SOUTH CAROLINA: Clemson, IV-20-1975; Beaufort Co., IV-18-1959, on pecan (larvae). TENNESSEE: McNairy Co., V-13-71, on pecan (larvae). TEXAS: "Tex."; Concan, 4-14-49; Waco, on leaves of pecan, IV-21-1906 (larvae); Fredericksburg, IV-21-1960, pecan foliage (larvae). VIRGINIA: Miners Hill, on hickory, V-14-12 (larvae, identity ?). Records are for adults unless otherwise indicated.

Types.—*Xyela major* Cresson was described from a female and a male from "Texas (Belfrage)," The lectotype, chosen by Cresson (1916), is at ANSP, Type No. 330.

Odontophyes ferruginea Bridwell was described from one female. The holotype is in the USNM, with type labels and "Baldwin, Kansas," "Bridwell, Apr.," and "on early shrub willow." This is one of the darker specimens with blackish marks on the frons, mesonotum, and abdominal terga.

The holotype of *Megaxyela langstoni* Ross is at the INHS (Webb 1980). It is from State College Mississippi, April 7, 1932, coll. J.M. Langston, reared from pecan (*Carya pecan* A. & G.). Both sexes were described, and Ross (1936) also designated an allotype and 9 paratypes.

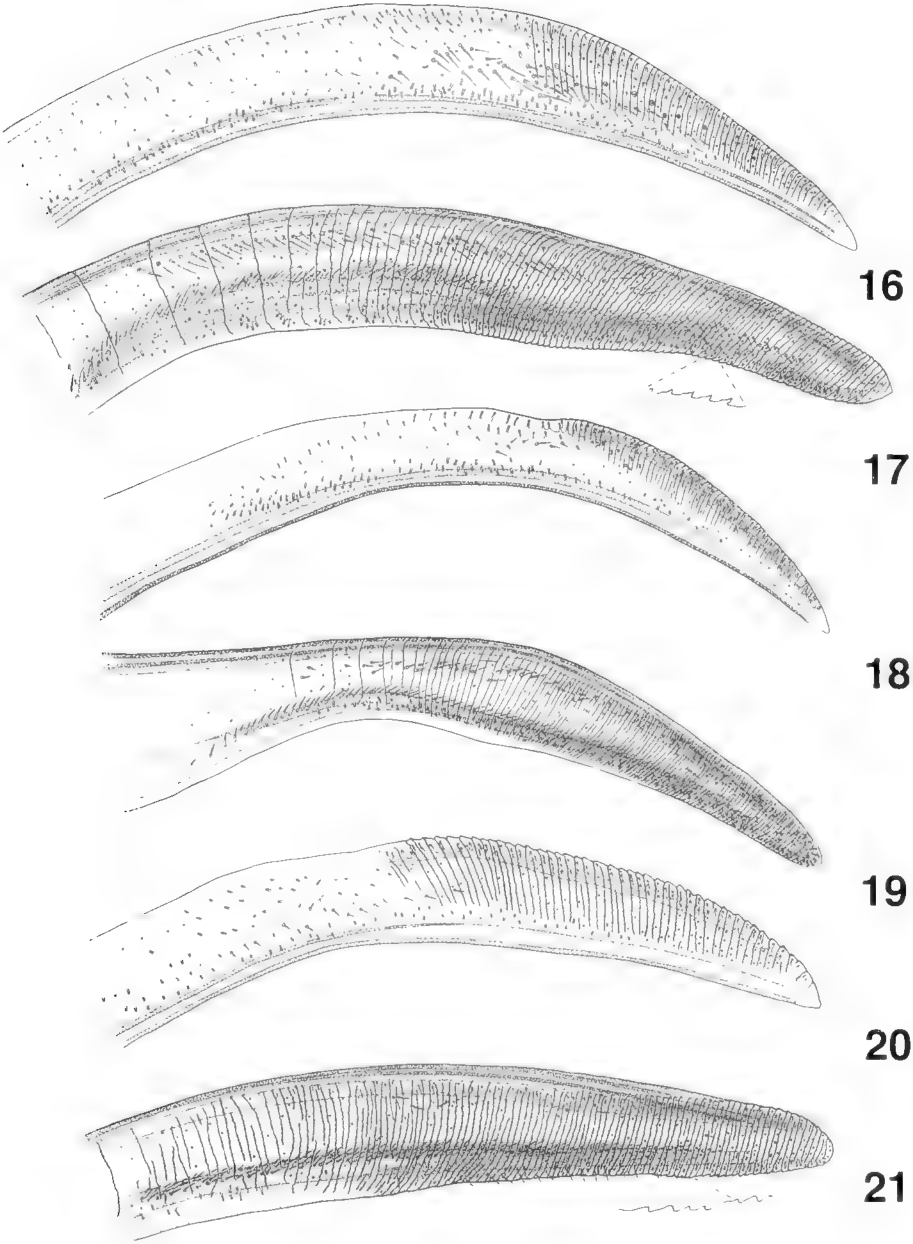
Hosts.—*Carya illinoensis* (Wang.) K. Koch (pecan). An adult was collected on "early shrub willow" (Bridwell 1906).

Discussion.—Ross (1936) stated that the larvae recorded by Dyar (1898b: 175) and Yuasa (1923) were *M. major*. Yuasa's "*Megaxyela* sp. 1" may also be *M. major. Megaxyela langstoni* larvae have a large dark area on the pronotum and penultimate abdominal segment. Yuasa's sp. 1 has these areas with a pair of black spots. Also, *M. major* appears to be a solitary feeder on pecan and some other hickories, whereas *M. langstoni* is gregarious. The dark areas on the pronotum and penultimate abdominal segment are variable and cannot be used for species separation. We cannot comment on the solitary vs. gregarious feeding habit.

Ross (1936) separated *Megaxyela langstoni* from *M. major* by the chestnut abdominal dorsum (not mostly black as in *M. major*), black area at base of the stigma, and less yellow at the base of the hindfemur and hindtibia. Examination of the specimens at hand show considerable color variation, and we believe Ross' *M. langstoni* is one of the paler color forms of *M. major*. Ross also stated that the sheath is shorter than the hindbasitarsus in *M. langstoni* (longer than in *M. major*). However, the sheath appears to be longer than the hindbasitarsus in the specimens Ross examined.

In summary, there seems to be behavioral, color and morphological variation within *M. major*, but, at present, it appears most likely that this is intraspecific variation rather than several cryptic species. Additional specimens, especially from intermediate localities, are needed to elucidate the full extent of this variation.

Dyar (1898b) attempted rearing some larvae under his code "7D." These were on hickory, Fort Lee, N.Y., Bronx Park, N.Y., and Bedford Park, N.Y. No adults were obtained, and thus the identity of his speci-



Figs. 16–21. Female ovipositors. 16, Lance of *Megaxyela aviingrata*. 17, Lancet of *M. aviingrata*. 18, Lance of *M. major*. 19, Lancet of *M. major*. 20, Lance of *M. alisonae*. 21, Lancet of *M. alisonae*. Figs. 16–21 drawn to same scale.

mens are unknown. Authors, e.g. Ross 1932, Smith 1987, recording Dyar's rearings as *M. major* may or may not be correct.

Megaxyela major belongs to the group of species with *M. aviingrata* and *M. alisonae* which have a thick hindbasitarus (Fig. 15) and similar sheath shape (Figs. 7–9). It can be distinguished from those species by the nearly entirely orange-brown coloration, but with various degrees of black on the dorsum of the head, thorax, abdomen, femora, and tibiae.

Megaxyela tricolor (Norton)
(Figs. 11, 22–25, 35)

Xyela tricolor Norton 1862b: 144.
Macroxyela tricolor: Kirby 1882: 351.
Paraxyela tricolor: MacGillivray 1912: 294.
Megaxyela tricolor: Ross 1932: 162.—Ross 1951: 7.—Smith 1978: 26.—Smith 1979: 10.

Female.—Length, 10 mm. [Antennae missing.] Head and thorax black with a purplish metallic tinge; clypeus white except for black narrow margins and central spot; labrum white with apical half black; mandible brown to black at base underneath; mouthparts brown; and tegula white. Legs orange, spot on outer surface of mid- and hindcoxa, spot at base of outer surface of hindcoxa, extreme apex on outer surface of hindfemur black, all hindtibia and hindtarsus black. Abdomen black with white narrow posterior margin on each segment, basal plate of sheath brown to orange; and sheath black. Wings hyaline with veins and stigma black.

Hindbasitarsus slender, about 6.5× longer than broad and about 6× length of remaining tarsal segments together; length of hindtarsus about 0.8× length of hindtibia. Sheath (Fig. 11) unusually long and slender, about 1.6× length of basal plate and about 1.3× length of hindtibia. Lance (Figs. 22, 24) with dorsal serrations restricted to apical third or less; lancet (Figs. 23, 25) with distinct teeth only on ventral margin of apical quarter.

Male.—Length, 9.0–9.5 mm. Coloration mostly same as for female; antenna black; clypeus and mandible mostly whitish; hypandrium sometimes dark orange. Apical antennal filament 6–8 segmented with length subequal to length of scape; antennal length 2.1× head width. Otherwise similar to female. Genitalia as in Fig. 35.

Specimens examined.—1 ♀, 4 ♂.

Distribution.—CONNECTICUT: Storrs, May 1935. ILLINOIS: Algonquin; Urbana, April 12, 1891 (Ross 1932; specimen not seen). KANSAS: holotype, no further data. MISSOURI: Sapp, V-10-56. ONTARIO: Simcoe, 2-V-55. Locality unknown: One male labeled "16093" possibly from Illinois, at INHS.

Holotype.—At ANSP, male, labeled "Ks.," red label "Type No. 331," and "tricolor." Norton described the species from "One specimen from Kansas."

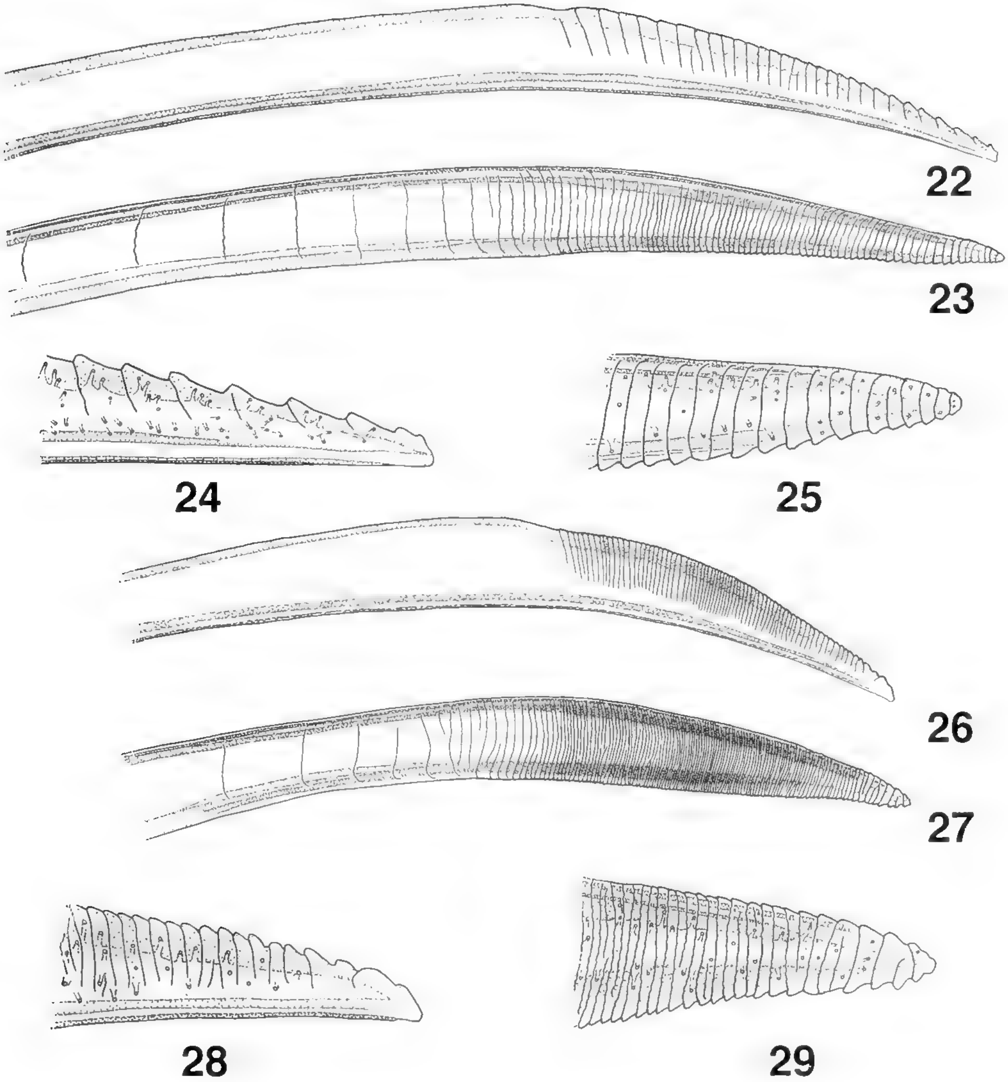
Host.—Unknown.

Discussion.—For separation from *M. bicoloripes,* see the preceeding key and discussion of that species. We have seen only one female (from Ontario), and this is associated with males only by the coloration. Previously, *M. tricolor* was known only from several males and *M. bicoloripes* only from females. Because of the similarity of *M. tricolor* and *M. bicoloripes,* Ross (1932) thought they may eventually be shown to be opposite sexes of the same species. Our studies show that there are two separate species involved.

Genus *Macroxyela* Kirby

Macroxyela Kirby 1882: 351.—Ashmead 1898: 214 (in key).—Ross 1932: 164 (revision; syn.: *Protoxyela* MacGillivray).—Ross 1951: 7 (N. Amer. catalog).—Smith 1978: 23 (world catalog).—Smith 1979: 10 (N. Amer. catalog). Type species: *Xyela ferruginea* Say. Orig. desig.
Protoxyela MacGillivray 1912: 295. Type species: *Xyela aenia* (!) Norton. Orig. desig.

Median lobe of clypeus notched medially, with two small round lobes, on each side of emarginated meson and labrum short, rectangular, nearly truncate anteriorly (Fig. 2). Labial palpus 3-segmented. Forewing with Sc short, Sc1 joining Sc + R1 very



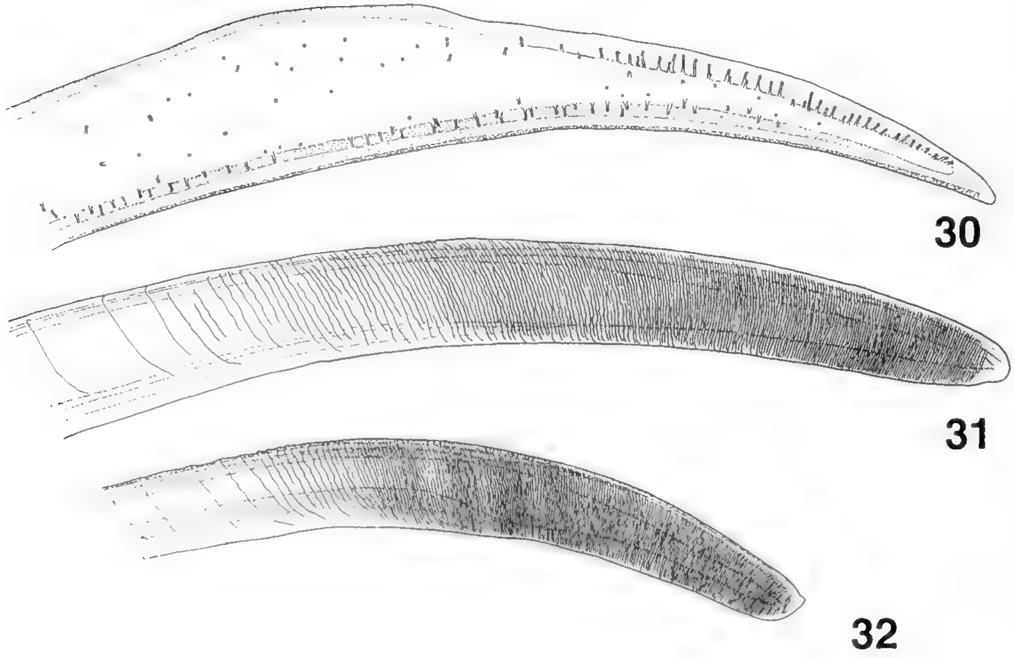
Figs. 22–29. Female ovipositors. 22, Entire lance of *M. tricolor*. 23, Entire lancet of *M. tricolor*. 24, Apex of lance of *M. tricolor*. 25, Apex of lancet of *M. tricolor*. 26, Entire lance of *M. bicoloripes*. 27, Entire lancet of *M. bicoloripes*. 28, Apex of lance of *M. bicoloripes*. 29, Apex of lancet of *M. bicoloripes*. Figs. 22–29 drawn to same scale.

slightly apical to juncture of Rs with Sc + R1 (Figs. 5, 6).

Two species are known for this exclusively North American genus. *Macroxyela ferruginea* is by far the most commonly collected species. The larva feeds on elm; further biological notes are given under that species.

KEY TO SPECIES OF *MACROXYELA*

1. Sheath slender, about 4× longer than broad (Fig. 12); radial region of forewing with 3 cells (in 85% of specimens examined) (Fig. 5), if with 4 cells, then crossvein in cell Rs1 located toward distal portion of cell; female mostly reddish brown; male black or with abdomen partly to mostly reddish . . . . . *ferruginea* (Say)
– Sheath stouter, about 3× longer than broad



Figs. 30–32. Female ovipositors. 30, Entire lance of *Macroxyela ferruginea*. 31, Entire lancet of *M. ferruginea*. 32, Entire lancet of *M. aenea*. Figs. 30–32 drawn to same scale.

(Fig. 13); radial region of forewing with 4 cells, cell Rs1 divided by a crossvein at center of cell (Fig. 6); both sexes concolorous black to bronze . . . . *aenea* (Norton)

Macroxyela aenea (Norton)
(Figs. 6, 13, 32, 37, 38)

Xyela aenea Norton 1872: 86.—Cresson 1928: 3.

Macroxyela aenea: Kirby 1882: 351.—Ross 1932: 165.—Ross 1951: 7.—Smith 1978: 23.—Smith 1979: 10.

Protoxyela aenea: MacGillivray 1912: 296.

Female.—Length, 7.5–9.0 mm. Black with antennal segments 1 and 2 dark orange, antennal filament brownish, and with following usually orange brown to orange: supraclypeal area, clypeus, labrum, mouthparts, anterior pronotum or all pronotum, mesoscutellum, sometimes mesosternum; legs (except hindtibia and hindtarsus usually blackish; sometimes venter of abdomen; and basal half or only apical margin of sheath; apical margins of abdominal segments yellowish. Abdomen with metallic bronze tinge.

Head and thorax finely punctate and shagreened; abdomen more shining with fine transverse microsculpture. Cell Rs1 of forewing divided into two cells (Fig. 6).

Male.—Length, 7.0–8.0 mm. Black, mostly like female, except thorax entirely black and hypandrium pale orange. Genitalia as in Fig. 37.

Specimens examined.—32 ♀ and ♂.

Distribution.—ILLINOIS: Pope Co., Burden Falls, April 20, 1960; Dixon Springs, IV-3-1948; Camp Point, Adams Co., IV-23-1960, on elm. INDIANA: Perry Co., T4S R1W S36, 21 April 1978. GEORGIA: Jones Co., 1–8 March 1994. LOUISIANA: Tallulah. MISSISSIPPI: Clarksdale, 3-10-55. MISSOURI: Webster Grove, 3-26-21, 3-31-25. NORTH CAROLINA: Orange Co., Chapel Hill, 8 Oct. 1963. OKLAHOMA: Latimer Co., in flight trap,

III-1986, IV-1987, III-1987, III-1989; Stillwater, 1948; Seminole Co., Wewoka, III-29-1966. TEXAS: types, no further data, as well as several other specimens labeled "Tex."; Harrison Co., 3 mi. E. Karnack, on pine, 6-III-1972. WISCONSIN: Dane Co., April 14, 1915. Ross (1932) recorded Staten Island, N.Y., a locality we were unable to verify.

Lectotype.—At ANSP, male, labeled "Tex." and red label "Type No. 332 Xyela aenea Norton." Norton described the species from "Texas. Five specimens." The one labeled as type is the lectotype as designated by Cresson (1928).

Host.—Unknown.

Discussion.—The division of cell Rs1 of the forewing is more consistent than in *M. ferruginea.* Of the 32 specimens examined, only 2 had this crossvein absent in one of the forewings and none in both forewings. Other distinguishing features of *M. aenea* are the shorter, stouter female sheath (compare Figs. 12, 13), and the concolorous black to bronze coloration in both sexes (usually reddish brown in *M. ferruginea*). Nothing is known of the habits of *M. aenea.* Records indicate a more southerly distribution than for *M. ferruginea* whose northernmost record is Madison, Wisconsin, although there is substantial overlap between the species.

Macroxyela ferruginea (Say)
(Figs. 2, 5, 12, 30, 31, 36, 38)

Xyela ferruginea Say 1824: 310.

Macroxyela ferruginea: Kirby 1882: 351, pl. 14, fig. 1.—Young 1899: 41 (larva, habits; syn: *infuscata* Norton).—MacGillivray 1906: pl. 23, fig. 33 (wings).—Garlick 1923: 256–257 (adult feeding habits).—Yuasa 1923: 41 (larva).—Ross 1932: 165 (syn.: *obsoleta* MacGillivray, *distincta* MacGillivray).—Smith et al. 1943: 382 (Kansas).—Ross 1951: 7.—Maxwell 1955: 17 (internal larval anatomy).—Smith 1967: 379–380 (larva).—Smith 1978: 23.—Smith 1979: 10.

Xyela infuscata Harris 1835: 583 (*nomen nudum*).—Rohwer 1920: 515.

Xyela infuscata Norton 1862a: 224.

Macroxyela infuscata: Kirby 1882: 351.

Macroxyela obsoleta MacGillivray 1912: 294.—Frison 1927: 234.

Macroxyela bicolor MacGillivray 1912: 294.—Frison 1927: 234.—Ross 1932: 166.—Ross 1951: 7 (syn.: var. *harti* Ross).—Smith 1978: 23.—Smith 1979: 10. **New synonymy.**

Macroxyela distincta MacGillivray 1912: 295.—Frison 1927: 234.

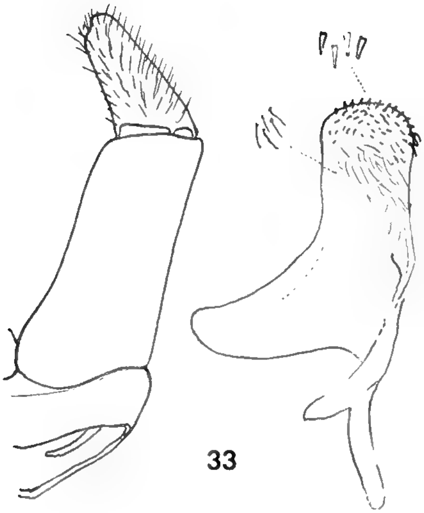
Macroxyela bicolor var. *harti* Ross 1932: 166.

Female.—Length, 7.5–9.0 mm. Mostly reddish brown; clypeus, labrum, and mouthparts sometimes more yellowish, mesosternum usually black; in darker forms, antennal flagellum, head between eyes, and ocellar area blackish; mesonotal lateral lobes, sometimes most or all of thorax ventrally and laterally, basal 3 to 5 abdominal segments, hindcoxa, hindtibia and apex of sheath sometimes black, with various combinations. Abdominal segments usually with yellowish apical margins, especially noticeable on venter. Wings hyaline to very lightly, uniformly infuscated, or rarely darkly infuscated.

Head and thorax finely shagreened; abdomen more shining, with fine transverse microsculpture. Apical antennal filament 5–6 segmented, slightly shorter than scape. Forewing with cell Rs1 not divided in most specimens.

Male.—Length, 7.0–8.0 mm. Mostly black with following reddish-brown to orange: most of clypeus, labrum and mouthparts; most of legs beyond coxae (inner surfaces of fore and mid tibiae, sometimes tarsi, and sometimes apical portion of hindcoxa paler); apical 3 or 5 abdominal segments on venter and sometimes laterally; genitalia. Some forms with almost entirely orange abdomen. Genitalia as in Fig. 36.

Specimens examined.—462 ♀ and ♂.



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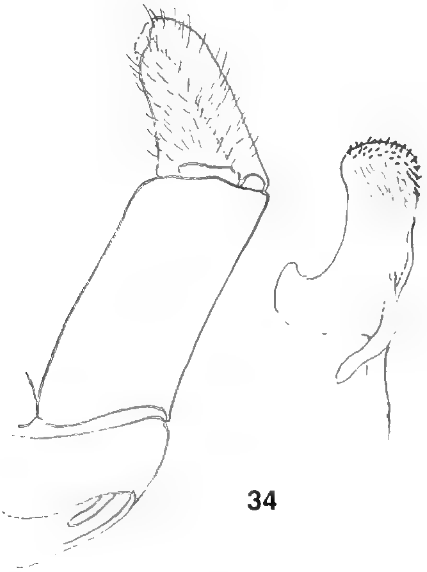

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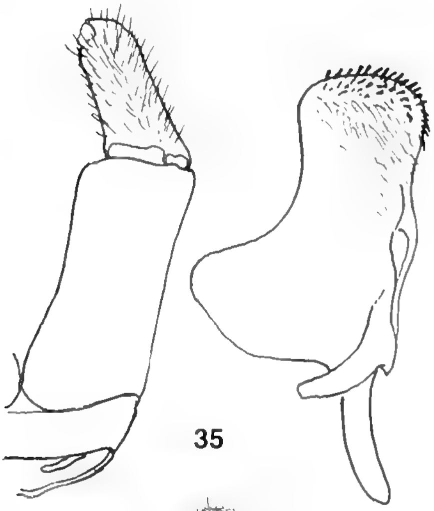

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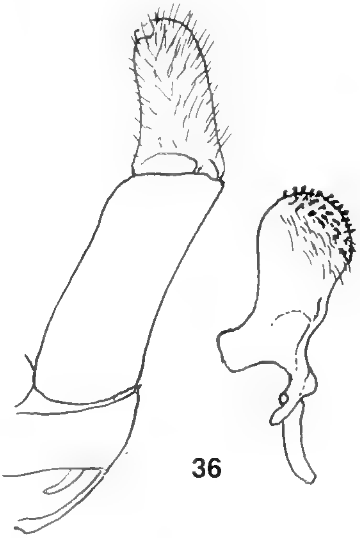

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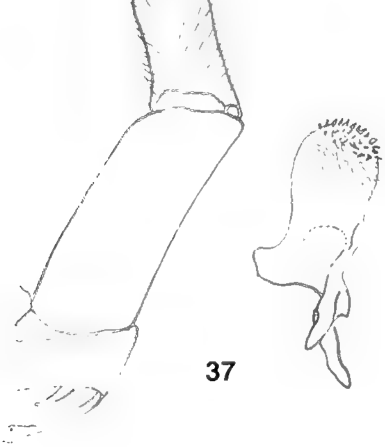

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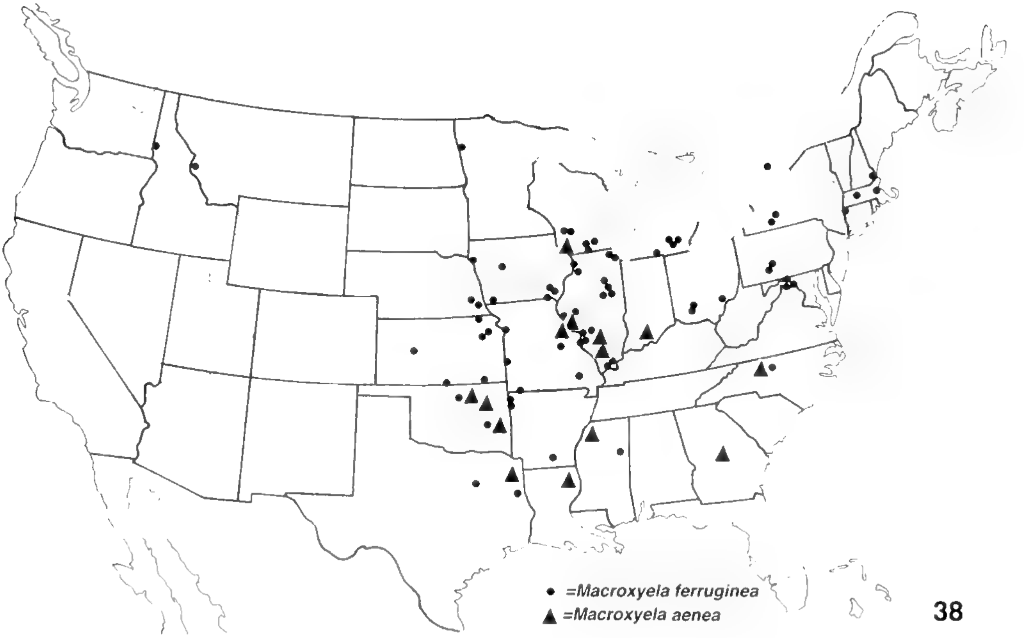

Fig. 38. Distribution of *Macroxyela*. Circles = *M. ferruginea*. Triangles = *M. aenea*.

Distribution.—Specimens examined from the following states and provinces, (Fig. 38): Arkansas, Connecticut, Idaho (Moscow), Illinois, Iowa, Kansas, Maine, Maryland, Massachusetts, Michigan, Minnesota, Mississippi, Missouri, Montana (Lost Horse, Ravalli Co., 7-2-49), Nebraska, New Hampshire, New York, North Carolina, Ohio, Oklahoma, Ontario, Pennsylvania, Texas,Virginia, West Virginia, Wisconsin.

Types.—The type of *Xyela ferruginea* Say is lost. Say described the female and stated "Inhabits Arkansa." The description agrees with the concept of this species.

Norton described Xyela *infuscata* from a male, "One specimen in Harris's Coll. Mass." Rohwer (1920) stated the type is no. 186 in the Harris Collection (MCZ), is in good condition, and, according to Harris' manuscript list, was collected April 25, 1827.

Macroxyela bicolor MacGillivray was described from a male, "Columbus, Ohio, Professor J.S. Hine, collector." It is at INHS (Webb 1980), labeled "947" and "Columbus, Ohio J.S. Hine."

Macroxyela obsoleta MacGillivray was described from a female labeled "Ithaca, N.Y., J.O. Martin, collector." It is at INHS (Webb 1980), labeled "Ithaca, N.Y., Apr. '97."

Macroxyela distincta MacGillivray was described from a female and a male from "Ithaca, N.Y, J.O. Martin, collector." The lectotype female, designated by Frison (1927) is at INHS (Webb 1980), labeled "Ithaca, N.Y., April 3, '97."

Macroxyela bicolor var. *harti* Ross, described from a male is at INHS (Webb

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Figs. 33–37. Male genitalia, dorsal view, right half of genital capsule, and lateral view of penis valve with dorsal side to left. 33, *Megaxyela major*. 34, *M. bicoloripes*. 35, *M. tricolor*. 36, *Macroxyela ferruginea*. 37, *M. aenea*.

1980), labeled "Havana, Illinois, April 1896 (C.A. Hart)."

Hosts.—*Ulmus americana* L. (Young 1899, Garlick 1923); on elm (Yuasa 1923). We collected adults from *Ulmus carpinifolia* Gleditsch at the University of Virginia Blandy Experimental Farm and State Arboretum of Virginia, Clarke Co.; very few were on American elm, *U. americana*, and some exotic elms in the same vicinity in the Arboretum. Specimens collected in Malaise traps were in a nearby woodlot where slippery elm, *Ulmus rubra* Mühl., is present, but we cannot confirm this as a host. Most collection records from label data are from elm or *Ulmus* sp.

Biology.—The description of the larva and biological notes by Young (1899) are the first published on *M. ferruginea*. His classical observation of the active pupa phenomenon has not been reported since. According to Young "Larvae sit curled around the young leaves or terminal buds with the front part of their body free. They feed by eating a line across the bunch of leaves, thus truncating them all. A single brood each year, the adults appearing in April. A few days before the appearance of the adult the larva which has lain in the larval state in its cocoon until this time changes to an active pupa, which bursts its cocoon and comes forth without shedding its skin and exists then as an active pupa at the surface of the ground from twenty-four to forty-eight hours. It then sheds its skin and becomes the true imago. Larvae enter the ground about June 1st." He describes the cocoon as a light shell of sand held together by a few strands of silk.

Garlick (1923) reported on adult seasonality and feeding habits at Lawrence, Kansas. Adults were abundant in spring, March 30 to April 24, especially the week of April 10–17. The first specimen was found on March 30, and the last on April 24. They fed on buds of American elm and to a lesser extent buds of pear and plum. The buds are grown in length, but leaves hardly begun to show. Adults gnaw a hole in the side of the bud ⅔ up from the base and eat only the central part, working down and enlarging the hole as necessary. They left the bud an empty shell and so badly injured that no further growth of the bud was possible. About 200 specimens were netted, the sex ratio being 5 females to 1 male. Many of these voucher specimens are in the collection of the Snow Entomological Museum, University of Kansas.

Smith et al. (1943) reported that this is a common sawfly in Kansas and occurs only in early spring in April and May.

NMS collected adults and observed them in abundance on three elms at the Beltsville Agricultural Research Center, Prince George's Co., Maryland. Hundreds of individuals were netted while they flew from the ground to the branches of the trees above. However, diligent searching of the ground over several weeks failed to find "active pupae" as described by Young (1899). After continual observations, it became easy to distinguish *M. ferruginea* from other insects because of their slow flight, shiny wings, and because *M. ferruginea* would land on the twigs of the elm trees while other insects would hover near the branches, but seldom land. The elm trees where quite large (15 m) and only the lowest branches were attainable for collecting even with an extended net handle (3 m). Nonetheless, examination of the upper branches of the trees with binoculars revealed thousands of adults on two trees in 1994.

Specimens were netted during the following periods: 8–14 April 1993, 31 March–5 April 1994, and 16 March–15 April 1995. During these periods, NMS looked for individuals at least once a day. *Macroxyela ferruginea* only flew when it was warm and sunny. On cold or windy days, even in the middle of the flight period, no individuals were caught. Males emerged before females in 1995, the first male (followed by many others) was caught on 15 March and the first female not until 29 March. The sex ratio was notably biased toward females after 1 April. Collections in 1993 and 1994 were not started prior to catching the first female specimens so presumably collections started in the middle of the flight period. Probably Garlick (1923) collected late in the flight period after males had flown. Sex ratio among (NMS) specimens (not necessarily a uniform sampling) is 124 m to 30 f (but at least 30 females were ground up for allozyme studies and a large number for sterol analysis). Rare individual males with red abdomens (formerly *M. bicolor*) were collected occasionally in the middle of the flight period (first part of April), and, since there were no associated females, we presume they are merely a sexually dimorphic color form of *M. ferruginea.*

Discussion.—Cell Rs1 of the forewing is not divided in most specimens examined. Of 461 specimens examined, 5 specimens had this cell divided in both forewings and 26 specimens had this cell divided in one of the two forewings. In most instances the division of this cell is not as uniform as in *M. aenea.* The cell may be smaller, or the crossvein dividing the cell may be partially atrophied; the crossvein is not centrally located as in *M. aenea* but toward the apex of the cell. For other characteristics, see the key to species and discussion under *M. aenea.*

About five specimens examined had rather darkly infuscated wings. They were from Missouri, Ohio, and Illinois. About ten males examined had a red abdomen. Some of these were collected in the same situation and at the same trees as the typically-colored black specimens, and we found no structural differences between the two. We examined red abdomen specimens from Maryland, Missouri, Illinois, Mississippi, Ohio, and Pennsylvania. NMS collected several red abdomen forms when making large collections in Maryland. This red form was described as *M. bicolor* by MacGillivray (1912). *Macroxyela bicolor* var. *harti* Ross (1932) is also this red form, but the wings are infuscated with deep brown and are strongly violaceous at the base. This is similar to the specimens with darkly infuscated wings as cited above. We regard these as color variants; thus, their synonymy above.

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NOTES ON THE HOST, EGG, AND PUPARIUM OF *STYLOGASTER BIANNULATA* (SAY) (DIPTERA: CONOPIDAE)

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Abstract.—The egg and puparium of *Stylogaster biannulata* (Say) (Diptera: Conopidae) are described and illustrated in detail based on examination by scanning electron microscopy. This species was reared from *Gryllus rubens* Scudder in Florida, a new host record. Previous literature is reviewed in light of this new data.

Key Words: *Stylogaster biannulata,* Conopidae, hosts, egg, puparium, *Gryllus rubens*

The genus *Stylogaster* Macquart has about 85 species distributed primarily in tropical regions in both hemispheres (Smith 1979: fig. 1). The greatest diversity is in the New World where 63 species occur (Camras and Parrillo 1985), two of which are found in the Nearctic Region. This paper reports new data on hosts and immature stages for *Stylogaster biannulata* (Say) which occurs from Rhode Island to Nebraska, south to Texas, Florida, and Veracruz, Hidalgo, and San Luis Potosi in Mexico (Camras 1965, Camras and Parrillo 1985). The other Nearctic species, *S. neglecta* Williston, is known from Massachusetts to Nebraska, south to Arizona, Georgia, and Sinaloa and Chiapas in Mexico; its biology remains completely unknown.

HOSTS OF *STYLOGASTER*

The enigmatic biology of *Stylogaster* has been the subject of much speculation ever since Bates (1863: 365) published one of the first naural history observations of *Stylogaster* females hovering over advancing swarm raids of army ants of the genus *Eciton* Latreille. Early authors [see Aldrich (1930) for a good summary] were of the opinion that *Stylogaster* must have been using army ants as hosts. Lopes (1937) found eggs of *Stylogaster* on an unspecified orthopteran and a cockroach. Later observations, particularly detailed ones by Rettenmeyer (1961), showed that the conopids were ovipositing on insects displaced by the advancing ants, as well as other insects, especially tachinid flies of the genera *Calodexia* Wulp and *Androeuryops* Beneway looking for hosts displaced by the ants. However, Rettenmeyer was of the opinion that cockroaches and possibly other orthopteroid insects were the most likely hosts of *Stylogaster,* and eggs were inserted accidentally into tachinids utilizing the same hosts. He did, however, note (1961: 1015) that one of 17 *Stylogaster* eggs found on tachinids had initiated development, so he did not completely discount tachinids as hosts. Stuckenberg (1963), Smith (1967, 1969), and Smith and van Someren (1985) discussed the occurrence of *Stylogaster* eggs on various calyptrate Diptera, primarily Muscidae, in the Afrotropical Region. Some of these flies were associated with driver ants while others were associated with animal dung (and in the latter case *Stylogaster* eggs were found on flies outside of the geographic distribution of driver ants). Stuckenberg (1963) was of the opinion that because *Stylogaster* eggs were more common on dung-breeding muscids he studied than was observed by Rettenmeyer (1961) in Panama, it was more likely that flies were the true *Stylogaster* hosts in Africa. Smith (1979) noted that *Stylogaster liepae* Smith was collected while hovering over a bird nest, and speculated that perhaps they were looking for flies attracted to dung or carrion in or near the nest.

All of the above evidence concerning *Stylogaster* hosts is circumstantial. It was not until Smith and van Someren (1985) reported dissecting larvae of *Stylogaster varifrons* Malloch from cockroach nymphs and a larva of *S. westwoodi* Smith from a gryllid cricket that unequivocal host associations were known. Adults of both species were seen ovipositing on their hosts being displaced by army ants in a garden in Kenya.

One of us (NEW) was sent a collection of Diptera reared from *Gryllus* spp. by Thomas J. Walker and his associates near Gainesville, Alachua County, Florida. While most of the specimens were Tachinidae of the genera *Ormia* Robineau-Desvoidy and *Anisia* Wulp, it was surprising to find some specimens of *Stylogaster biannulata* in the lot. Most of the *Stylogaster* specimens had been reared from *Gryllus rubens* Scudder with a couple being reared from unidentified *Gryllus*. Susan Wineriter (personal communication) provided some details about how these collections were made. The crickets were collected mostly in sound traps (Walker 1986) with some taken in pitfall traps. Crickets were held alive in the lab individually to check for parasites for up to 9 d, the main aim being to study the parasitism level in the crickets by *Ormia ochracea* (Bigot). It was estimated that about 1000 crickets were censused, and from these only 25–30 puparia of *Stylogaster biannulata* were obtained. Puparia were obtained from crickets collected in May, August, September, October, November, and December. Although not observed, the larvae probably emerged from their cricket hosts because puparia were found outside the host. In a few cases more than one *S. biannulata* puparium came from a single cricket, and in at least one case *S. biannulata* and the tachinid *Anisia gilvipes* (Coquillett) successfully parasitized a single cricket. In the three cases where data were recorded, the *S. biannulata* adults emerged 19–25 days after their puparia were formed.

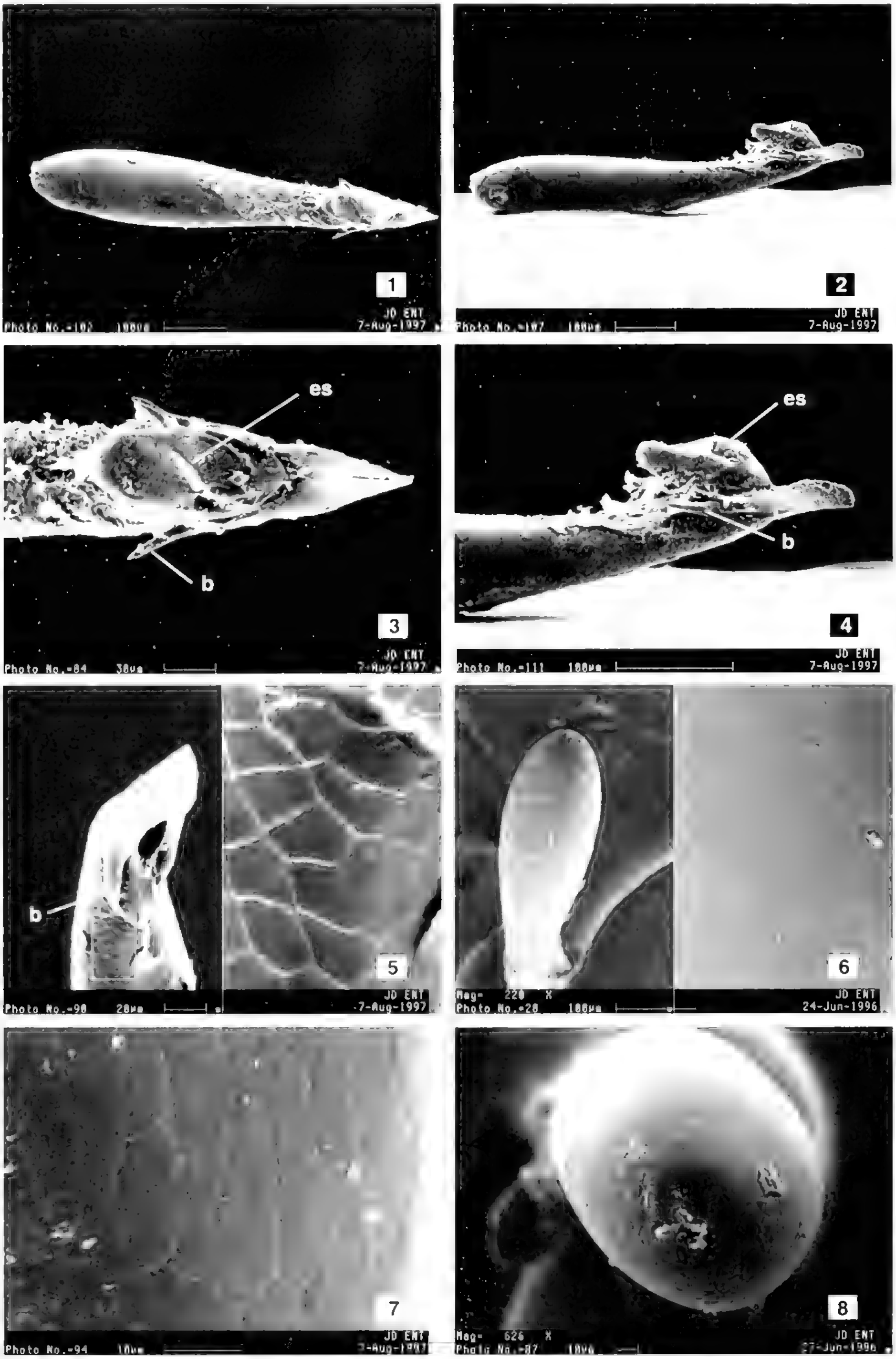
Nothing is known about how *Stylogaster biannulata* locates its host. It certainly is not dependent on above-ground army ants as they do not occur in the United States.

THE EGG OF *STYLOGASTER BIANNULATA*

The eggs of *Stylogaster* were first described by Lopes (1937). Subsequently it was discovered that the eggs have species-specific characters which have been illustrated for many species (Lopes 1938, Lopes and Monteiro 1959, Monteiro 1960, Smith 1967, 1979). The end opposite the micropyle is pointed and has subapical barbs, and this end is embedded in the insect victim at the time of oviposition. The actual mechanism of oviposition is unknown (Kotrba 1997, reviews the data on this subject).

We obtained about a dozen eggs from a female of *Stylogaster biannulata* that was collected at Lick Creek Park, Brazos County, Texas. A figure (Smith and Peterson 1987: fig. 54.25) of the egg of this species has been published but no further descriptive details were given. Because the egg has not been described in detail, we present information on its morphology, based on scanning electron microscope examination. SEMs have been published only for *S. macalpini* Smith (Smith 1979: figs. 24–25) and *S. westwoodi* (Hinton 1981: plate 119).

Description.—Clavate in shape (Fig. 1), nonmicropylar end narrow, slightly arcuate ventrally (Fig. 2), sharply pointed in ventral view (Fig. 3), blade-like in lateral view



Figs. 1–8. Egg of *Stylogaster biannulata*. 1, Whole egg, ventral view. 2, Whole egg, lateral view. 3, Non-micropylar end, ventral view. 4, Non-micropylar end, lateral view. 5, Non-micropylar end, posterolateral view, with inset showing surface sculpture of adjacent area. 6, Whole egg, anterolateral view of micropylar end, with inset showing surface sculpture of egg body. 7, Surface sculpture of egg body at higher magnification. 8, Micropylar end, showing concentric surface sculpture. Abbreviations: *b*, barb; *es*, eversible sac.

(Fig. 4); with a single pair of small, lateral, subapical barbs (Figs. 3–5, *b*); small eversible sac present between bases of barbs (Figs. 3–4, *es*), when not inflated this region appearing as a cavity (Fig. 5); entire surface, except pointed end, with reticulate surface sculpturing forming irregular cells, the sculpturing strongest and appearing scale-like near barbs (Fig. 5), the cells becoming more elongate and less strongly indicated on main body (Figs. 6, 7), then small and roughly concentric around micropylar end (Fig. 8). Length 0.65 mm (n = 1).

Remarks.—Unfortunately the eggs we examined were embedded in glue on a point with the specimen from which they came, and we were unable to clean them completely. In hydrated specimens, the eversible sac appears regularly rounded, as in Smith and Peterson (1987: fig. 54.25), not irregular as in the SEMs. Lopes (1937) concluded that the larva enters the host through this structure. Rettenmeyer (1961) postulated that this sac was inflated when the egg was inserted into a host and helped hold the egg in place and possibly also absorbed nutrients from the host. Based on osmotic manipulations, Stuckenberg (1963) was of the opinion that the eversible sac functioned at least in part in erecting the lateral barbs. Hinton (1981) was skeptical of this theory as he thought the barbs were more or less immovable. We found some evidence to support Stuckenberg's idea. In Fig. 5, an egg in which the sac is not everted, the barbs are more closely appressed to the surface of the egg, while in Fig. 3, where the sac is everted, the barbs are more erect.

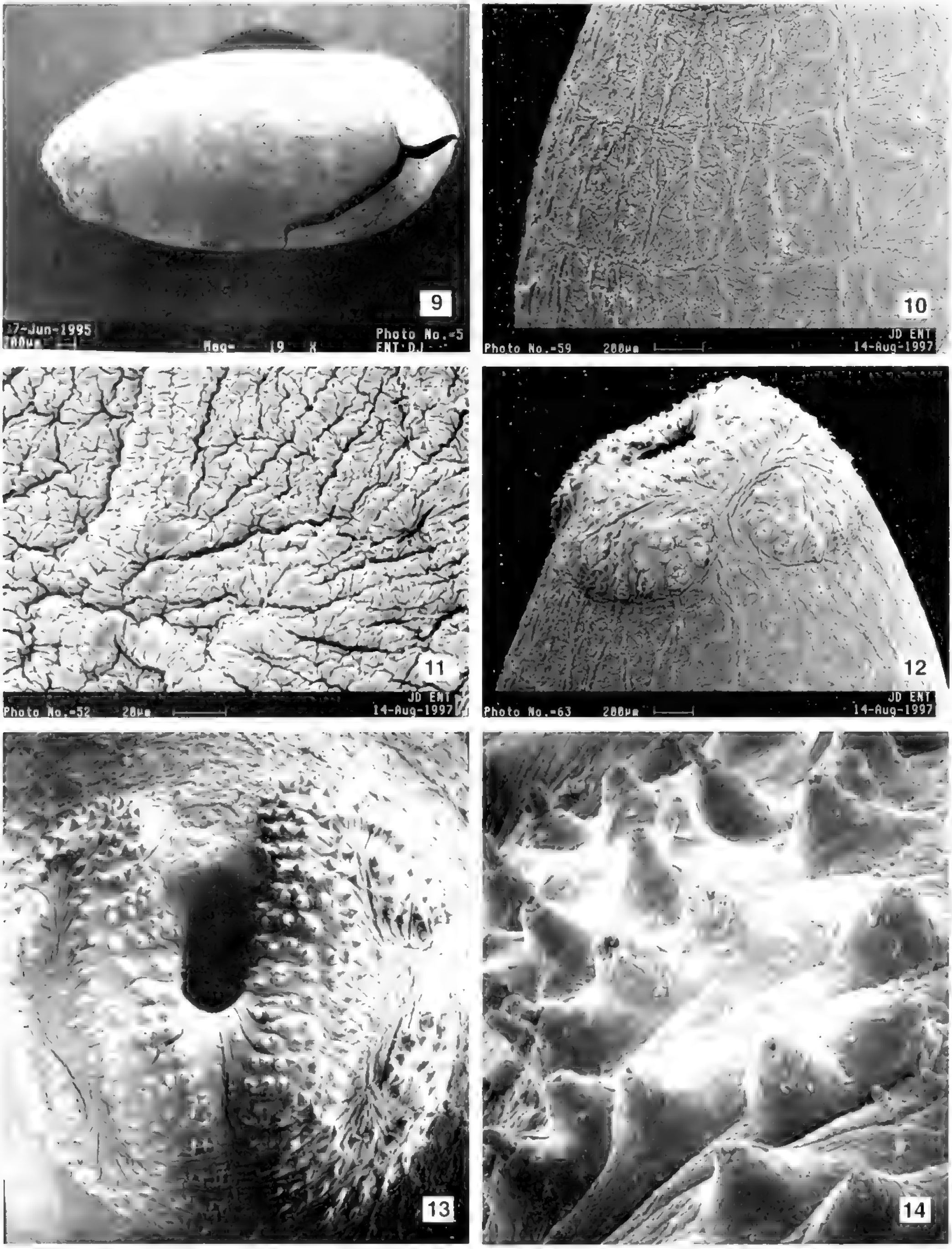
How the larva hatches from the egg is still uncertain. Rettenmeyer (1961: fig. 1) illustrated an egg found on a tachinid with a larva just emerging from the micropylar end, and therefore discounted Lopes' (1937) theory that the larva emerged through the eversible sac. Smith and van Someren (1985) also reported observing eggs that had embryoes visible inside that were facing the micropyle. However, the empty eggs of *S. varifrons* present on cockroach nymphs from which they dissected larvae were intact, indicating that the larvae had entered the host from near or through the sac.

THE PUPARIUM OF *STYLOGASTER BIANNULATA*

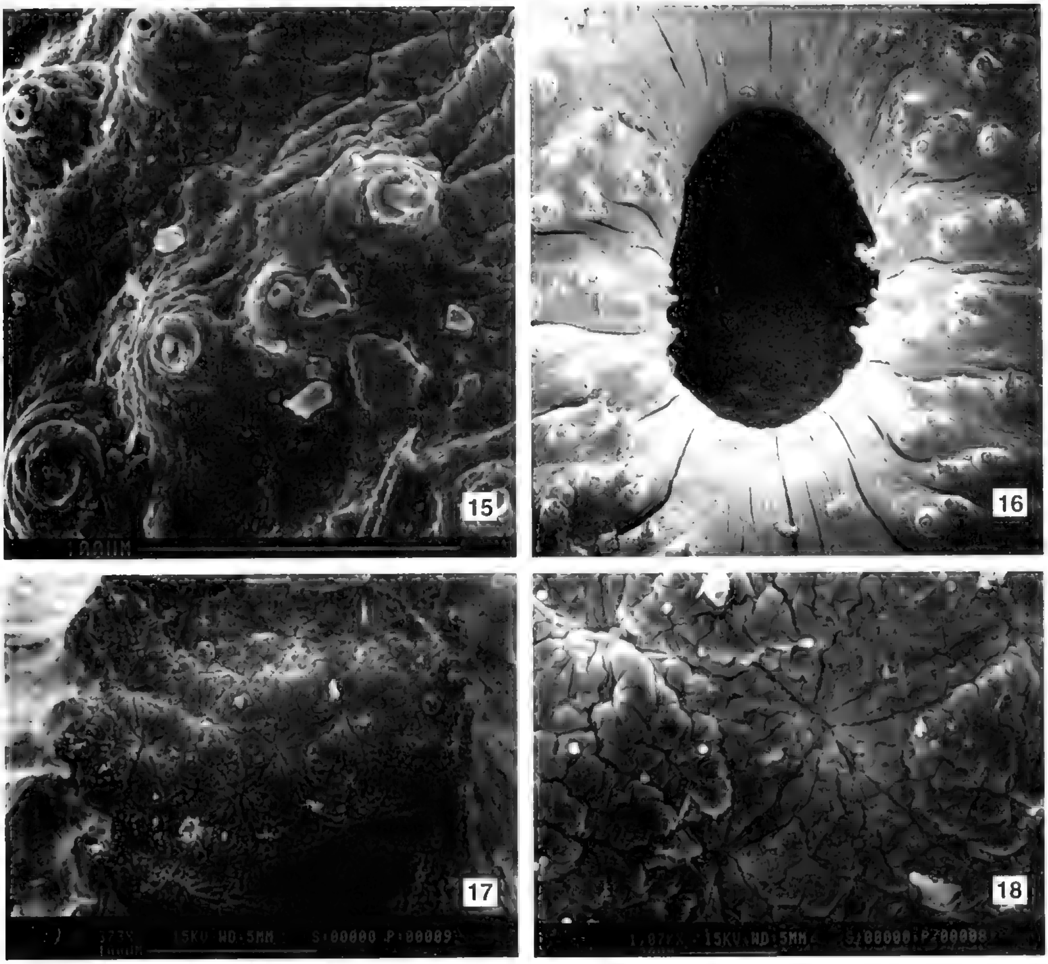
We examined 29 or 30 puparia obtained from the rearings of *S. biannulata* from *Gryllus* already discussed in the section on hosts. All specimens are now housed at the National Museum of Natural History, Smithsonian Institution, Washington, D.C. As this life stage is unknown for any *Stylogaster,* we are describing it here.

Description.—Reddish brown to dark brown; ovoid (Fig. 9), surface finely wrinkled with crisscrossing network of slightly raised bands (Figs. 10, 11, *rb*), at higher magnification the surface appears more deeply wrinkled (Fig. 11); posterior end with lateral raised areas that are bilobed (nearly c-shaped; Figs. 12, 13), with numerous raised, cone-shaped tubercles that end in a pore (Figs. 14, 15; peg-like exudate present in many pores is apparently a result of drying); posterior end near apex with deep cavity with ovoid opening (Fig. 16); inner surface of cavity finely wrinkled (Figs. 17, 18), with larger wrinkles more or less radiating from slightly depressed points. Length 4.3–5.9 mm.

Remarks.—The structure of the puparium closely reflects the larval description provided by Smith and van Someren (1985). The bilobed, laterally raised areas on the posterior end presumably correspond to the tracheal system, and the sunken cavity on the posterior end was also noted in the larval description. We were not able to describe the larval cephalopharyngeal skeleton that is present inside the anterior end of the puparium. It is extremely small, and we were not successful in several attempts in removing it from the tissue in which it was embedded. What we could see corresponds with the larval mouthparts described by Smith and van Someren (1985: figs. 10, 11).



Figs. 9–14. Puparium of *Stylogaster biannulata*. 9, Whole puparium, lateral view. 10, Surface sculpture of main body of puparium. 11, Higher magnification view of surface sculpture of main body of puparium. 12, Posterior end of puparium, lateral view. 13, Posterior end of puparium, posterior view. 14, Conical tubercles of tracheal tissue on posterior end of puparium. Abbreviation: *rb*, raised band.



Figs. 15–18. *Stylogaster biannulata.* 15, Conical tubercles of tracheal tissue on posterior end of puparium 16, Posterior cavity of puparium. 17, Inner surface of internal cavity of purparium. 18, Inner surface of internal cavity of puparium, higher magnification

We consider it doubtful that the second instar larvae that Rettenmeyer (1961: 1016) speculated might be *Stylogaster* are this genus. The large mouthparts and simple posterior spiracles Rettenmeyer described are not at all like those of the larvae described by Smith and van Someren (1985) and the puparia we examined.

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NEW TAXONOMIC DEFINITION OF THE GENUS *NEUCENTROPUS* MARTYNOV (TRICHOPTERA: POLYCENTROPIDAE)

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Abstract.—The genera *Neucentropus* Martynov and *Kyopsyche* Tsuda constitute a monophyletic group, such that *Kyopsyche* is a **new synonym** of *Neucentropus* and the type species of *Kyopsyche*, *Kyopsyche japonica* Tsuda 1942, is transferred into *Neucentropus* (**new combination**). *Neureclipsis mongolica* Schmid 1970, is transferred to *Neucentropus* as a **new synonym** of *Neucentropus mandjuricus* Martynov 1907. *Neucentropus mandjuricus* and *Neucentropus japonicus* males are diagnosed. *Kyopsyche tsukuiensis* Kobayashi 1984, is transferred to *Plectrocnemia* (**new combination**).

Key Words: Oriental Region, Palearctic Region, *Kyopsyche*, *Neureclipsis*, *Plectrocnemia*

The genus *Neucentropus* Martynov was established for *Neucentropus mandjuricus* Martynov 1907, based on a single female specimen from northeastern China (Manchuria). Martynov (1934) later associated the male of the species based on material from the Ussuri River, Russia. Tsuda (1942) established the genus *Kyopsyche* based on a Japanese species *Kyopsyche japonica* Tsuda 1942, whose male genitalia are very similar to those of *N. mandjuricus*, although their venation is different. Schmid (1970) described a Mongolian species *Neureclipsis mongolica* whose male genitalia are very similar to those of *N. mandjuricus*. Kobayashi (1984) published a second species of *Kyopsyche*, *K. tsukuiensis*. Based on characters of venation and male genitalia, *K. tsukuiensis* is a typical *Plectrocnemia* Stephens species (**new combination**) and will be excluded from further discussion. Thus, as presently constituted, *Kyopsyche* is monobasic and *Neucentropus* includes two species.

Despite the similarity of the male genitalia of the three species, *Neucentropus mandjuricus*, *Kyopsyche japonica* and *Neureclipsis mongolica*, Schmid (1970) and Tsuda (1942) did not compare them. Neither Schmid nor Tsuda mentioned Martynov's (1907, 1934) works and Schmid (1970) did not mention Tsuda's (1942) work. In his *Trichopterorum Catalogus*, Fischer (1972) first noticed the confusion and listed the only then-known species of the older genus *Neucentropus*, *N. mandjuricus*, under the more recent genus *Kyopsyche*.

In 1988, 1989 and 1990, we collected many specimens of *N. mandjuricus* in southern China (Jiang-su and Jiang-xi Provinces). In this paper, we redescribe the species and discuss the status of the two similar species, *Neureclipsis mongolica* and *Kyopsyche japonica*.

MATERIALS AND METHODS

Specimens were collected by members of the Nan-jing Agricultural University and

Clemson University "Caddisfly Team" using a 15-watt BL ultraviolet light suspended before a sheet and over a funnel leading to a container of ethanol.

In this paper, we use the terminology of Hamilton (1986) for male genitalia and wing venation. The terminology for female genitalia follows that of Schmid (1980).

Voucher specimens described in this paper are deposited in the Department of Plant Protection, Nan-jing Agricultural University, Nan-jing, People's Republic of China (NAU), and the Clemson University Arthropod Collection, Clemson University, South Carolina, U.S.A. (CUAC).

DISCUSSION

We compared the venation, maxillary palpi, labial palpi and male genitalia of our specimens from southern China with Martynov's illustrations of *Neucentropus mandjuricus,* but no difference was found. We also compared the male genitalia with those of *Neureclipsis mongolica* illustrated by Schmid and found no difference. Thus, by this conclusion, not only *Kyopsyche* but now also *Neucentropus* are each monobasic.

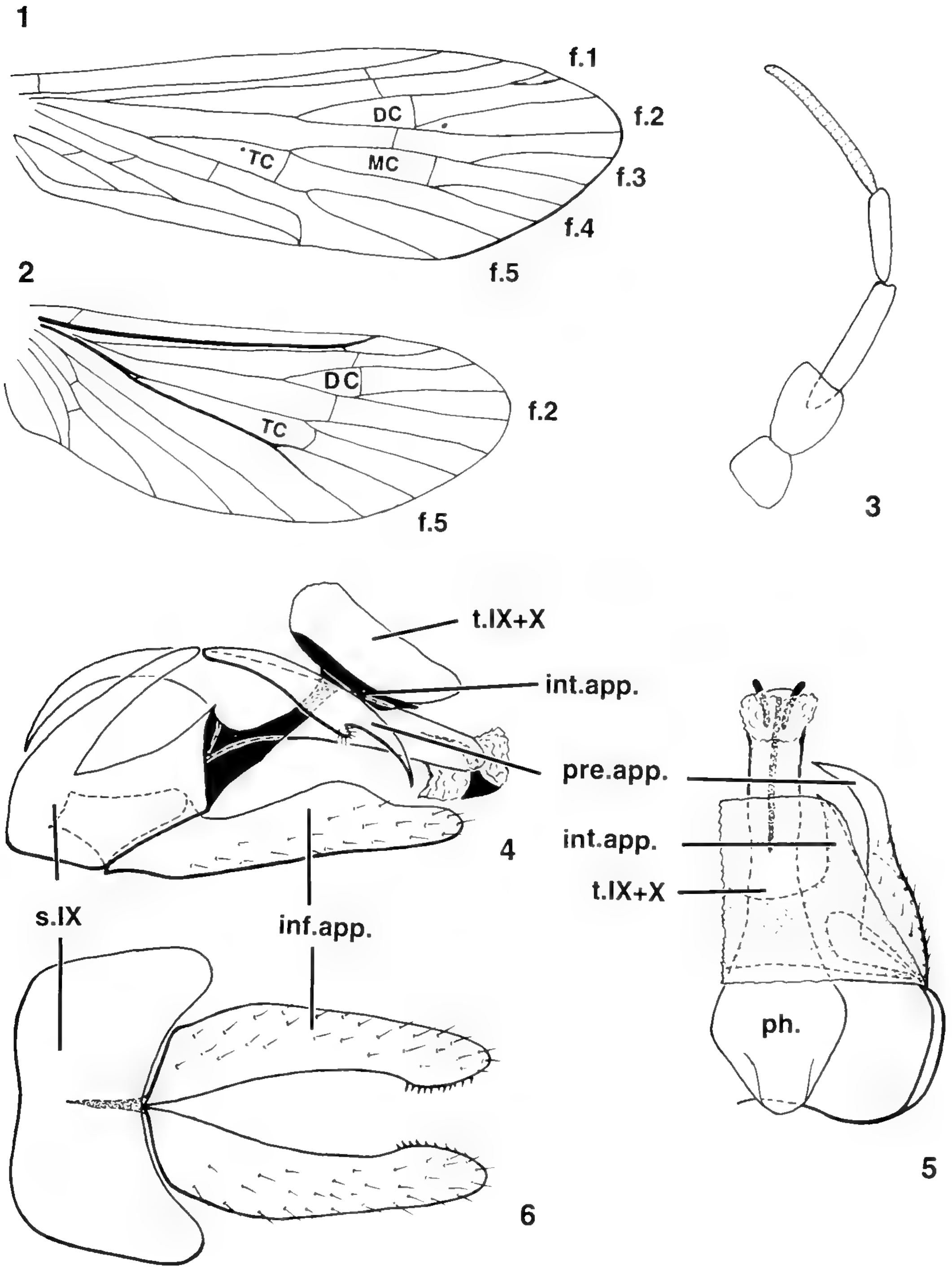
The venation of *Neucentropus* is almost the same as that of the genus *Holocentropus* McLachlan except the second cross-vein is absent from the costal area of the fore wing in the type species of *Neucentropus* (Martynov 1934; plesiomorphy; Fig. 1) and Fork 1 of the fore wing is much shorter than in *Holocentropus* (apomorphy 1; Figs. 1, 14). The second segment of each maxillary palp has a ventral projection in *Neucentropus* (Martynov 1934; apomorphy 2; Fig. 3). The male genitalia of *Neucentropus* have narrow preanal appendages each curved mesad and tapered to an acute apex (apomorphy 3; Figs. 4, 5, 12, 13); the phallus has a pair of tiny sclerotized lobes in the apical membranes (apomorphy 4; Figs. 5, 12); and sternum IX has a pair of deep incisions laterally (apomorphy 5; Fig. 4).

Hind wing Fork 3, present in females of *N. mandjuricus* (Fig. 8) and present apparently in both sexes of *K. japonica* (since Tsuda did not mention any venational sexual dimorphisms, Fig. 15) but absent in the males of *N. mandjuricus* (Fig. 2), varies in females of *N. mandjuricus* from about one-half to one-third of the length of Cell R5. The presence of hind wing Fork 3 in *Kyopsyche* and female *N. mandjuricus* is probably secondary, since it occurs in Polycentropodidae more than once. For example, it is fused (absent) in most *Plectrocnemia* species but present in *Plectrocnemia tortosa* Banks (Li and Morse, in press). Other venational differences (Figs. 1, 2, 7, 8, 14, 15), apparently all *Kyopsyche* autapomorphies, include the facts that the second cross-vein in the costal area of the fore wing is present in *Kyopsyche* and absent in *Neucentropus,* the crossvein cu2-1a is present in *Neucentropus* and absent in *Kyopsyche,* and each hind wing Sc is complete to the wing margin in *Neucentropus* but incomplete in *Kyopsyche* beyond the sc-r1 crossvein.

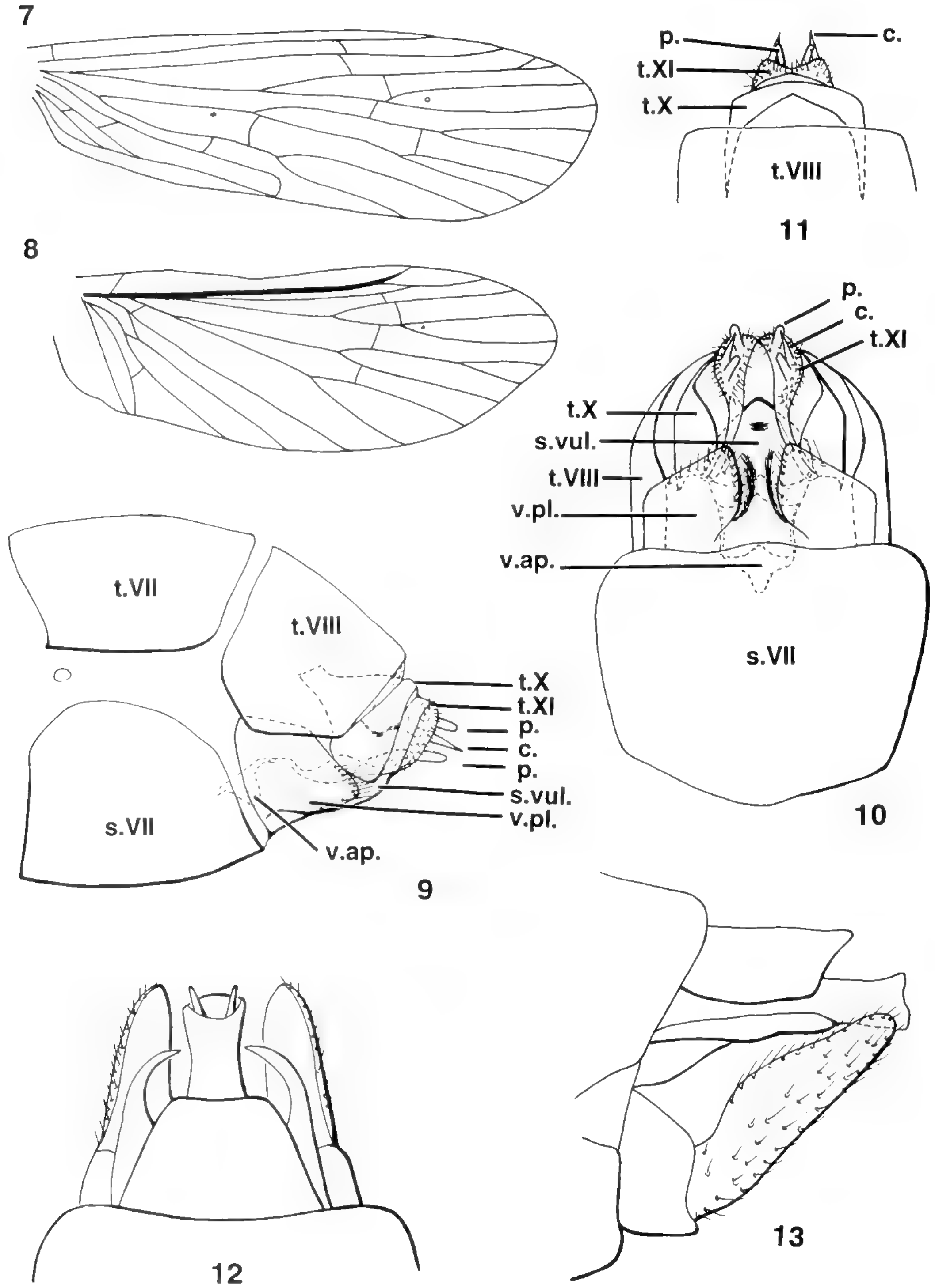
Although the venation of the genera *Neucentropus* and *Kyopsyche* is different, the male genitalia of the two genera are very similar. According to Tsuda's (1942) illustrations, the males of *Kyopsyche* also have synapomorphies 1, 3, and 4 of *Neucentropus.* Apomorphies 2 and 5 might also be present in *Kyopsyche,* but Tsuda did not illustrate these, such that further study is needed.

From the discussion above, noting at least three uniquely shared synapomorphies, the two genera *Neucentropus* and *Kyopsyche* constitute a monophyletic group for which there is no reason to keep them as monobasic genera.

This result supports Fischer's (1972) suggestion that *Neucentropus* and *Kyopsyche* should be one genus. However, because *Neucentropus* was described prior to *Kyopsyche,* his action is not consistent with the Principle of Priority (International Union of Biological Sciences 1985). Therefore, we consider *Kyopsyche* a junior synonym of *Neucentropus.*



Figs. 1–6. Male adult of *Neucentropus mandjuricus*. 1, Right fore wing, dorsal. 2, Right hind wing, dorsal. 3, Left maxillary palp, ventral. 4, Male genitalia, right lateral. 5, Male genitalia, dorsal, right side omitted. 6, Male genitalia, ventral. Abbreviations: DC = discoidal cell; f.1 = Fork 1; f.w = Fork 2; f.3 = Fork 3; f.4 = Fork 4; f.5 = Fork 5; inf. app. = inferior appendage; int. app. = intermediate appendage; MC = median cell; ph. = phallus; s.IX = sternum IX; pre. app. = preanal appendage; TC = thyridial cell; t.IX+X = tergum IX+X.



Figs. 7–13. Characters of *Neucentropus mandjuricus* and *N. japonicus*. 7–11, Female adult of *N. mandjuricus*. 7, Right fore wing, dorsal. 8, Right hind wing, dorsal. 9, Female genitalia, let lateral. 10, Female genitalia, ventral. 11, Female genitalia, dorsal. 12–13, Male adult of *N. japonicus* (redrawn from Tsuda 1942, figs. 22a–

In conclusion, the newly defined genus *Neucentropus* includes *N. mandjuricus* Martynov and *N. japonicus* (Tsuda) (**new combination**). Genus *Kyopsyche* is a **new synonym** of *Neucentropus*. *Neureclipsis mongolica* Schmid should be transferred to *Neucentropus* and is a **new synonym** of *Neucentropus mandjuricus* Martynov.

Neucentropus Martynov

Neucentropus Martynov 1907: 18. Type species: *Neucentropus mandjuricus* Martynov. By monotypy.

Kyopsyche Tsuda 1942: 259, 263; Fischer 1972: 53 (synonym by implication, in that Fischer listed *Neucentropus mandjuricus* as a species of *Kyopsyche*). **New synonym.** Type species: *Kyopsyche japonica* Tsuda. Original designation.

Included species.—*Neucentropus mandjuricus* Martynov, 1907; *Neucentropus japonicus* (Tsuda 1942), **new combination**.

Description.—Maxillary palpi each with first segment short and stout; second segment slightly longer than first, about same thickness, with long and broad ventral projection; third segment more slender, slightly longer than first and second segments combined; fourth segment about as long as second; fifth longest, length slightly less than that of last two segments combined (Fig. 3).

Spur formula: 3, 4, 4.

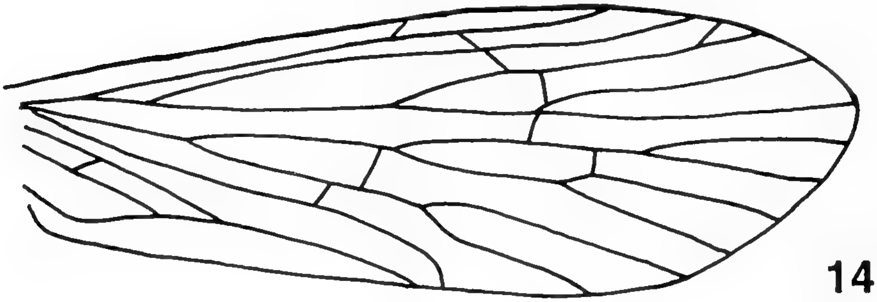
Wing venation: Fore wings (Figs. 1, 7, 14) each with or without second cross-vein in costal area; with Forks 1, 2, 3, 4 and 5, and with discoidal, median and thyridial cells (DC, MC, and TC, respectively); Fork 1 rather short, one-half to one-third as long as its stem; crossvein 1a-2a present, crossvein cu2-1a present or absent. Hind wings (Figs. 2, 8, 15) each with Forks 2 and 5 and with DC and TC, Sc complete to wing margin or incomplete beyond sc-r1 crossvein, and Fork 3 present or absent.

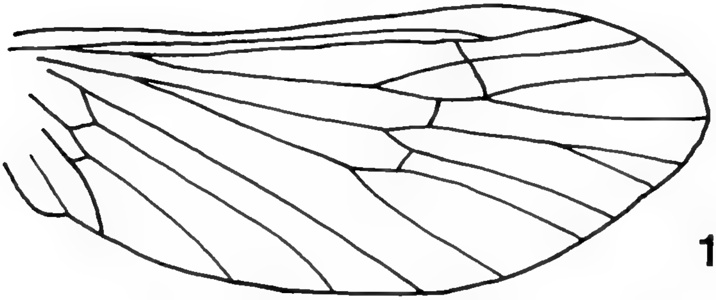
Male genitalia: Tergum IX+X (t.IX+X) broad and truncate apically in dorsal view, with intermediate appendages (int.app.) underneath (Figs. 4, 5). Preanal appendages (pre.app.) narrow, apically acute, curved mesad (Figs. 4, 5, 12, 13). Sternum IX (s.IX) broad, slightly concave in middle of posterior margin in ventral view (Fig. 6); divided by deep posterior triangular incision on each side, posterior point of dorsal part articulating with base of its preanal appendage, ventral part connected with tergum IX+X by pair of narrow bridges (Figs. 4, 5). Inferior appendages (inf.app.) each one-segmented, simple, without any projections; broadly convex on dorsal margin at middle in lateral view (Figs. 4, 13); curved mesad slightly at apex (Fig. 6). Phallus (ph.) simple sclerotized tube, broad at base, membranous at apex, with pair of small sclerotized lobes in apical membrane (Figs. 5, 12).

Female genitalia: Tergum VIII (t.VIII) larger than ventral plates (v.pl.; Fig. 9), truncate in dorsal view (Fig. 11). Pair of ventral plates subrectangular, transverse in ventral view (Fig. 10), and median triangular sclerite (vulvar scale, s.vul.) extending between ventrolateral margins of tergum X (t.X). Transverse tergum X short dorsomesally (Fig. 11), longer laterally (Fig. 9), with pair of anterolateral apodemes reaching middle of tergum VIII (Figs. 9, 11). Segment XI (t.XI) short, transverse, attached to ventral edge of tergum X, with short acute cercus (c.) and two obtuse papillae (p.) on posterior margin of each side. Vaginal apparatus (v.ap.) having short anterior sclerite with anteromesal hump and posteromesal hump and transverse posterior sclerite above vulvar scale (Figs. 9, 10).

←

b). 12, Male genitalia, dorsal. 13, Male genitalia, left lateral. Abbreviations: c. = cercus; p papilla; s. vul. = vulvar scale; s.VII = sternum VII; t.VII = tergum VII; t.VIII = tergum VIII; t.X = tergum X; t.XI = tergum XI; v. pl. = ventral plate.





Figs. 14–15. Wings of *Neucentropus japonicus*. 14, Right fore wing, dorsal. 15, Right hind wing, dorsal.

Neucentropus mandjuricus Martynov (Figs. 1–11)

Neucentropus mandjuricus Martynov 1907: 19, figs. 1–2 (female); Martynov 1934: 243–244, 338, figs. 175, 176a–c (male and female).

Neureclipsis mongolica Schmid 1968: 10, figs. 8–9 (male and female). **New synonym**.

Kyopsyche mandjuricus: Fischer 1972: 53.

Diagnosis.—Very similar to the only other species in the genus, *N. japonicus* (Tsuda); however, the venation is slightly different: in *N. mandjuricus*, each fore wing lacks a second cross-vein in the costal area and has crossvein cu2-1a (Fig. 1); each hind wing has Sc complete to the wing margin and each hind wing of males lacks Fork 3 (Fig. 2). The male genitalia of *N. mandjuricus* are almost the same as those of *N. japonicus* except that the preanal appendages each have a short, setose ventral process at the middle of the ventral edge in *N. mandjuricus* (Fig. 4).

Material examined.—100 ♂, Chang-jiang (Yangtze) River, Nan-jing, Jiang-su Province, 6 June 1989, You-wen Li (NAU); 43 ♂, 36 ♀, Hong-ze, Jiang-su Province, 24 September 1988, Chang-hai Sun (33 ♂, 26 ♀ NAU; 10 ♂, 10 ♀ CUAC); 2 ♂, Chang-he River, Buo-yang, Muo-dao-shi, Jiang-xi Province, 6 June 1990, 30 m elevation, John C. Morse & Lian-fang Yang (NAU).

Distribution.—Widely distributed in Jiang-su and Jiang-xi Provinces of southern China (Oriental Biogeographic Region); northeastern China, southern Ussuri region of Russia, and Mongolia (Palearctic Biogeographic Region).

Neucentropus japonicus (Tsuda), **new combination** (Figs. 12–15)

Kyopsyche japonica Tsuda 1942: 264–265, figs. 21–22a–b (♂ described).

Diagnosis.—In *N. japonicus*, each fore wing (Fig. 14) possesses a second crossvein in the costal area and has no cu2-1a crossvein, each hind wing (Fig. 15) apparently has Fork 3 present in both sexes and the apex of Sc does not meet the wing margin, being not evident beyond the Sc-R1 crossvein (note that it is not indicated whether these are male or female wings). In the male genitalia, there is no setose lobe on the ventral edge of each preanal appendage (Fig. 13). Female specimens were included in the type series, but were not described other than to say that "middle leg of female strongly broadened."

Material examined.—None.

Distribution.—Japan.

ACKNOWLEDGMENTS

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100(4), 1998, pp. 672–673

A NEW SPECIES OF *CEPHALOLEIA* CHEVROLAT (COLEOPTERA: CHRYSOMELIDAE: HISPINAE) FROM COSTA RICA

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Abstract.—***Cephaloleia disjuncta,* new species,** is described from La Selva Biological Station, Costa Rica. An updated key to the Central American species is presented.

Key Words: *Cephaloleia,* Chrysomelidae, new species

The genus *Cephaloleia* Chevrolat contains 185 described species (Uhmann 1957), 88 of which occur in Central America (Staines 1996). The genus is widespread from Mexico to Argentina. Adults and larvae feed in the rolled leaves or flowers of various genera of Zingiberaceae, Heliconiaceae, Maranthaceae, Cyclanthaceae, Costaceae, and Arecaceae (Jolivet 1989).

In a canopy fogging sample as part of the Arthropods of La Selva Survey, a single specimen of an underscribed species of *Cephaloleia* was found. This is described and placed in my 1996 revision.

Measurements were taken with an ocular micrometer. Pronotal length and width were taken along the midlines. Elytral width was measured at the humeri. Elytral length was measured from the base to the apex. Total length was measured from the base of the antennae to the apex of the elytra. In recording label data from the type specimen, a double slash (//) divides data on different labels. Brackets ([]) contain descriptive or explanatory information.

Cephaloleia disjuncta Staines, new species
(Fig. 1)

Holotype:—♀// COSTA RICA, Heredia, Est. Biol. La Selva, 50–150 m, 10°26′N 84°01′W, Jan 1994, INBIO-OET// Vitex cooperi FOT/16/30, 5 Enero 1994// bar code 068725// HOLOTYPE Cephaloleia disjuncta Staines 1997 [red label] (deposited in Instituto Nacional de Biodiversidad, Costa Rica).

Description.—Reddish yellow; head and antenna black; pronotal and elytral markings black. *Head:* Sparsely punctate; medial carina present; slightly depressed between eyes; frons not projecting. *Antenna:* Segment I incrassate; II transverse, slightly rounded; III-X transverse, subequal in length; XI rounded at apex. *Pronotum:* Side margins sinuate, canaliculate anteriorly; anterior angles with rounded tooth; posterior angles acute; depressed laterally; with scattered large punctures, mostly basally; black medial spot on anterior margin behind head; pronotal length 1.3 mm (n = 1); pronotal width 1.9 mm. *Scutellum:* Pentagonal; yellowish brown. *Elytra:* Side margins smooth; puncture rows moderately impressed; transverse fascia before midline, apical third black; elytral length 5.1 mm; elytral width 2.3 mm. *Venter:* Prosternum yellowish; meso- and metasterna yellowish at middle, black and punctate at sides; abdominal sterna 1 and 2 yellowish, suture between sterna almost obsolete; sterna 3–5 black with golden setae. *Legs:* Femora ro-

Fig. 1. *Cephaloleia disjuncta.*

bust, yellowish with black at apices; tibiae spatulate at apices; tarsi black. *Total length:* 6.9 mm.

Immature stages.—Unknown.

Host plant.—Adult collected fogging *Vitex copperi* Standley (Verbenaceae).

Distribution.—Costa Rica.

Etyomology.—From *disjunctus* (Latin) = separate, distinct.

Specimen examined.—COSTA RICA: Herédia- Est. Biol. La Selva, 5 Enero 1994.

Remarks.—*Cephaloleia disjuncta* is known only from the holotype. It keys to couplet 30 in Staines (1996). The key is modified as follows to include *C. disjuncta.*

30(29). Pronotum with medial vitta; Panamá to Ecuador . . . . *laeta* Waterhouse
5 – Pronotum with spot(s) 30a
3 30a. Vertex of head sparsely striate-punctate; antennal segment III triangular, 1 ½ times the length of II; side margins of pronotum parallel; pronotum with two spots; elytra black with four yellowish maculae; suture between abdominal sterna 1 and 2 complete; Costa Rica to Panamá . . . . *ornatrix* Donckier
5 – Vertex of head sparsely punctate; antennal segment III transverse, slightly longer than II; side margins of pronotum sinuate; pronotum with one macula; elytra reddish-yellow with black transverse fascia before middle and apical third black; suture between abdominal sterna 1 and 2 obsolete in middle; Costa Rica . . . . *disjuncta,* new species

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LIFE HISTORY AND DESCRIPTIONS OF IMMATURE STAGES OF *TRUPANEA ACTINOBOLA* (LOEW) (DIPTERA: TEPHRITIDAE) ON *ACAMPTOPAPPUS SPHAEROCEPHALUS* (HARVEY AND GRAY) GRAY (ASTERACEAE) IN SOUTHERN CALIFORNIA

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Abstract.—*Trupanea actinobola* (Loew) is an oligophagous, bivoltine fruit fly (Diptera: Tephritidae) infesting flower heads of *Acamptopappus, Amphipappus, Bailyea, Chlorocantha, Gutierrezia, Psilostrophe,* and *Trichoptilium* spp. (Asteraceae) in southern California, and other plant genera throughout much of the United States. Two different-sized morphs are reported from California; the smaller one and subject of the present paper, is associated with *Acamptopappus, Amphipappus,* and *Gutierrezia* spp. in the subtribe Solidagininae of the tribe Astereae; the larger is associated with *Bailyea, Psilostrophe,* and *Trichoptilium* spp. in the subtribe Gaillardiinae of the tribe Helenieae. An uncommon, apparently intermediate-sized, presumably different biotype reared from flower heads of *C. spinosus,* a plant introduced into southern California from Mexico and Central America, may belong to a different, eastern United States' form of *T. actinobola* with different host affinities in the tribe Astereae. *Trupanea actinobola sensu lato* has now been reported from five tribes, eight subtribes, 14 genera, and 27 species of Asteraceae. The egg, first-third instars, and puparium obtained from *Acamptopappus sphaerocephalus* (Harvey and Gray) Gray are described and figured. The third instar larva bears a pair of elongated integumental petals dorsomediad of the mouth hooks, which have not been seen in the eight other California congeners described to date. The metathoracic lateral spiracular complex consists of a verruciform sensillum, and the abdominal lateral spiracular complex consists of a placoid-type sensillum; thus the lateral spiracular complex is the only morphological feature observed to differ among third instars of each of nine species of *Trupanea* studied to date. The life cycle of *T. actinobola* in southern California is of the aggregative type. Eggs are laid in closed, preblossom flower heads and inserted through the overlapping phyllaries. First instars feed on the ovules and florets, second instars on ovules, and third instars principally on the soft achenes. The receptacles of infested flower heads are not pitted by larval feeding. Four species of chalcidoid Hymenoptera were reared from individual puparia and mature flower heads bearing puparia of *T. actinobola* as solitary, primary, larval-pupal endoparasitoids: *Eurytoma veronia* Bugbee (Eurytomidae), *Halticoptera* sp. (Pteromalidae), *Mesopolobus* sp. (Pteromalidae), *Pteromalus* sp. (Pteromalidae).

Key Words: Insecta, *Trupanea,* Asteraceae, nonfrugivorous Tephritidae, biology, taxonomy of immature stages, flower-head feeding, biotypes, host-plant range, parasitoids.

Trupanea actinobola (Loew) (Diptera: Tephritidae), as currently described, is a highly variable species belonging to one of the larger and more widespread genera of nonfrugivorous fruit flies in North America and California (Foote and Blanc 1963, Foote et al. 1993). Being of little or no economic importance, most species of *Trupanea* remained little known (Foote 1960, Foote et al. 1993) until detailed life histories of eight species from southern California were published (Cavender and Goeden 1982, Goeden 1987, 1988, Goeden et al. 1998, Goeden and Teerink 1997c, 1998, Headrick and Goeden 1991, Knio et al. 1996b), along with descriptions of the immature stages of seven of these species (Cavender and Goeden 1982, Goeden et al. 1998, Goeden and Teerink 1997c, 1998, Headrick and Goeden 1991, Knio et al. 1996a, Teerink and Goeden 1998). In this paper we describe the life history and immature stages of a ninth species, *T. actinobola*.

MATERIALS AND METHODS

This study was based in large part on dissections of subsamples of flower heads of *A. sphaerocephalus* (Harvey and Gray) Gray infested by *T. actinobola* from samples collected during 1991–1997 in the low-elevation, Colorado (northern Sonoran) Desert and high-elevation, eastern Mojave Desert in southern California in the manner described by Goeden (1985, 1992). The principal study sites were both on *A. sphaerocephalus* at the margins of the Colorado Desert at the north end of Mason Valley, 650-m elevation, San Diego Co., and at Snow Creek, San Gorgonio Pass, at 370-m elevation, Riverside Co. One-liter samples of excised, immature and mature flower heads containing eggs, larvae, and puparia were transported in cold-chests in an air-conditioned vehicle to the laboratory and stored under refrigeration for subsequent dissection, photography, description, and measurement. Twenty-eight eggs, 20 first-, 12 second-, and 12 third-instar larvae, and 6 puparia dissected from flower heads were preserved in 70% EtOH for scanning electron microscopy (SEM). Additional puparia were placed in separate, glass shell vials stoppered with absorbant cotton and held in humidity chambers at room temperature for adult and parasitoid emergence. Specimens for SEM were hydrated to distilled water in a decreasing series of acidulated EtOH. They were osmicated for 24 h, dehydrated through an increasing series of acidulated EtOH and two, 1-h immersions in Hexamethlydisilazane (HMDS), mounted on stubs, sputter-coated with a gold-palladium alloy, and studied with a Philips XL30-FEG scanning electron microscope in the Institute of Geophysics and Planetary Physics, University of California, Riverside.

Most adults reared from isolated puparia were individually caged in 850-ml, clear-plastic, screened-top cages with a cotton wick and basal water reservoir and provisioned with a strip of paper toweling impregnated with yeast hydrolyzate and sucrose. These cages were used for longevity studies in the insectary of the Department of Entomology, University of California, Riverside, at 25 ± 1°C, and 14/10 (L/D) photoperiod. Virgin male and female flies obtained from emergence vials were paired ($n = 3$) in clear-plastic petri dishes provisioned with a flattened, water-moistened pad of absorbant cotton spotted with honey (Headrick and Goeden 1991, 1994) for observations of their courtship and copulation behavior.

Plant names used in this paper follow Hickman (1993) and Bremer (1994); tephritid names and adult terminology follow Foote et al. (1993). Terminology and telegraphic format used to describe the immature stages follow Knio et al. (1996a), Goeden et al. (1998), Goeden and Teerink (1997a, b, c, 1998), Teerink and Goeden (1998) and our earlier works cited therein. Means ± SE are used throughout this paper. Voucher specimens of *T. actinobola* and its parasitoids reside in the research collections

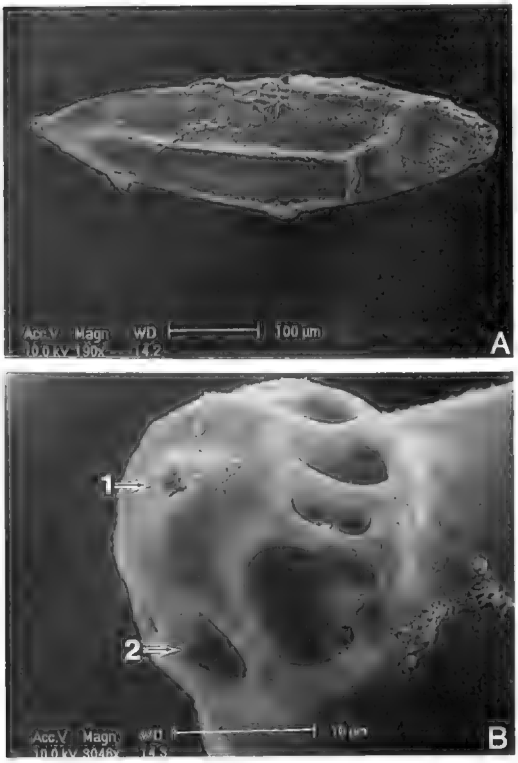

Fig. 1. Egg of *Trupanea actinobola:* (A) habitus, pedicel to left; (B) pedicel, 1 micropyle, 2—aeropyle.

of RDG; preserved specimens of eggs, larvae and puparia are stored in a separate collection of immature Tephritidae maintained by JAT.

RESULTS AND DISCUSSION

Taxonomy

Adult.—*Trupanea actinobola* was first described by Loew (1873) as *Trypeta actinobola.* It was renamed *Urellia actinobola* by Coquillett (1899), and transferred to *Trupanea* by Benjamin (1934). A lectotype was designated by Foote (1960). Benjamin (1934), Foote (1960), Foote and Blanc (1963), and Foote et al. (1993) pictured the wing pattern of the female and male, which unlike some *Trupanea* spp., e.g. *T. bisetosa* (Coquillett), *T. imperfecta* (Coquillett), *T. jonesi* Curran, and *T. nigricornis* (Coquillett), is not sexually dimorphic. Benjamin (1934) also sketched the antenna of the adult male, the male genitalia viewed from the posterior and side, the head of the adult female in frontal view, and the oviscape and fully extended ovipositor in dorsal view.

Size differences noted in adults reared from different subtribes of hosts are illustrated by measurements of thoracic dorsa listed in Table 1 and are fully discussed below relative to hosts of *T. actinobola.*

Immature stages.—The anterior spiracle, posterior spiracular area, and posterior spiracle of the puparium, and the dorsal aspect of the puparium itself were sketched by Benjamin (1934). The third instar of *T. actinobola* was described and the anterior spiracle, cephalopharyngeal skeleton, last abdominal segment, and posterior stigmatic chamber were drawn by Phillips (1946). Otherwise, the eggs, first and second instars, and puparium heretofore have not been described nor illustrated.

Egg: Thirty-one ova of *T. actinobola* dissected from a single, mature, field-collected female were white, opaque, smooth, elongate-ellipsoidal, 0.59 ± 0.004 (range, 0.56–0.64) mm long, 0.15 ± 0.002 (range, 0.14–0.18) mm wide, smoothly rounded at tapered basal end, pedicel 0.02 mm long (Fig. 1A), with raised micropyle (Fig. 1B-1) and a single row of aeropyles (Fig. 1B-2).

The egg of *T. actinobola* is longer than that of *T. californica* Malloch (Headrick and Goeden 1991), and shorter and narrower than other previously described *Trupanea* species (Goeden 1987, 1988, Goeden and Teerink 1997c, 1998, Goeden et al. 1998, Knio et al. 1996a). Pedicel and aeropyles are similar in size and shape to the other *Trupanea* species with the exception of *T. bisetosa,* which bears 1–2 rows of aeropyles (Knio et al. 1996a).

Third instar: White, barrel-shaped, tapering anteriorly, rounded posteriorly, minute acanthae circumscribe the intersegmental lines (Fig. 2A); gnathocephalon conical (Fig. 2B), rugose pads dorsal and lateral to mouth lumen (Fig. 2B-1); dorsal sensory organ a dome-shaped papilla (Fig. 2B-2, 2C-1); subdorsal sensilla laterad of dorsal sensory organ; anterior sensory lobe (Fig. 2B-3, 2C) with terminal sensory organ (Fig. 2C-2), pit sensory organ (Fig. 2C-3), lateral sensory organ (Fig. 2C-4), and supralateral sensory organ (Fig. 2C-5); stomal sense organ ventrolaterad of anterior sensory lobe (Fig. 2D-1); elongated integumental petals dorsomediad of mouth hook (Fig. 2D-2); mouth hook tridentate (Fig. 2D-3); median oral lobe laterally flattened, tapering anteriorly (Fig. 2D-4); six pit sensilla circumscribe gnathocephalon posteriorad of rugose pads (Fig. 2B-4); prothorax with minute acanthae dorsally and ventrally (Fig. 2E-1); rugose pads circumscribe prothorax anteriorly (Fig. 2E-2); single row of verruciform sensilla circumscribe prothorax posteriorad of rugose pads (Fig. 2E-3); stelex sensillum located dorsomedially (Fig. 2E-4); anterior thoracic spiracle on posterior margin of prothorax bears 3–4 rounded papillae (Fig. 2E-5); metathoracic lateral spiracular complex consists of a spiracle (Fig. 2F-1) and a verruciform sensillum (Fig. 2F-2); abdominal lateral spiracular complex consists of a spiracle (Fig. 2G-1) and a placoid-type sensillum (Fig. 2G-2); caudal segment with minute acanthae dorsally and ventrally; stelex sensilla circumscribe caudal segment in 2-dorsal, 4-ventral arrangement (Fig. 2H-1); pair of verruciform sensilla dorsolaterad of posterior spiracular plates (Fig. 2H-2); posterior spiracular plates bear three ovoid rima, ca. 0.028mm in length (Fig. 2H-3), and four interspiracular processes, each with 2–4 branches, longest measuring 0.012 mm (Fig. 2H-4); intermediate sensory complex consists of a medusoid sensillum and a stelex sensillum (Fig. 2H-5).

The third instar larva of *Trupanea actinobola* is similar in general habitus to *T. bisetosa, T. californica, T. jonesi, T. nigricornis* and *T. signata* (Goeden and Teerink 1997c; Goeden et al. 1998; Headrick and Goeden 1991; Knio et al. 1996a). *Trupanea pseudovicina* Hering differs in general habitus in being elongate-cylindrical (Goeden and Teerink 1998), and *T. conjuncta* (Adams) differs in having a punctate integument (Teerink and Goeden 1998). The gnathocephalon is very similar in sensory structures to all other *Trupanea* species previously described, however *T. actinobola* bears an elongated pair of integumental petals dorsomediad of the mouth hooks, which have not been seen in other *Trupanea* species previously studied (Goeden and Teerink 1997c, 1998, Goeden et al. 1998, Headrick and Goeden 1991, Knio et al. 1996a, Teerink and Goeden 1998). The rugose pads are smooth, not serrated as in *T. jonesi, T. nigricornis, T. pseudovicina,* and *T. signata* (Goeden and Teerink 1997c, 1998, Goeden et al. 1998, Knio et al. 1996a). Minute acanthae on the prothorax do not completely circumscribe the segment as in the other *Trupanea* species (Goeden and Teerink 1997c, 1998, Goeden et al. 1998, Headrick and Goeden 1991, Knio et al. 1996a, Teerink and Goeden 1998). The lateral spiracular complex is unique among the *Trupanea* species previously studied. *Trupanea actinobola* differs from *T. jonesi* in lacking the stelex sensillum in the metathorax (Goeden et al. 1998), and from *T. signata* in lacking a verruciform sensillum in the abdominal segments (Goeden and Teerink 1997c). The caudal segment of *T. actinobola* bears fewer minute acanthae than other *Trupanea* species studied, and these acanthae do not completely circumscribe the posterior spiracular plates. The rimae are shorter (0.028 mm) than rimae in other Trupanea species (0.034–0.04 mm) (Goeden and Teerink 1997c, 1998, Goeden et al. 1998, Headrick and Goeden 1991, Knio et al. 1996a, Teerink and Goeden 1998).

Second instar: White, barrel-shaped, tapering anteriorly, rounded posteriorly, minute acanthae circumscribe intersegmental lines (Fig. 3A); gnathocephalon conical; rugose pads dorsal and lateral of mouth lumen (Fig. 3B-1); dorsal sensory organ a dome-shaped papilla (Fig. 3B-2, 3C-1); subdorsal sensilla laterad of dorsal sensory organ (Fig. 3C-2); anterior sensory lobe bears the terminal sensory organ (Fig. 3C-3), pit sen-

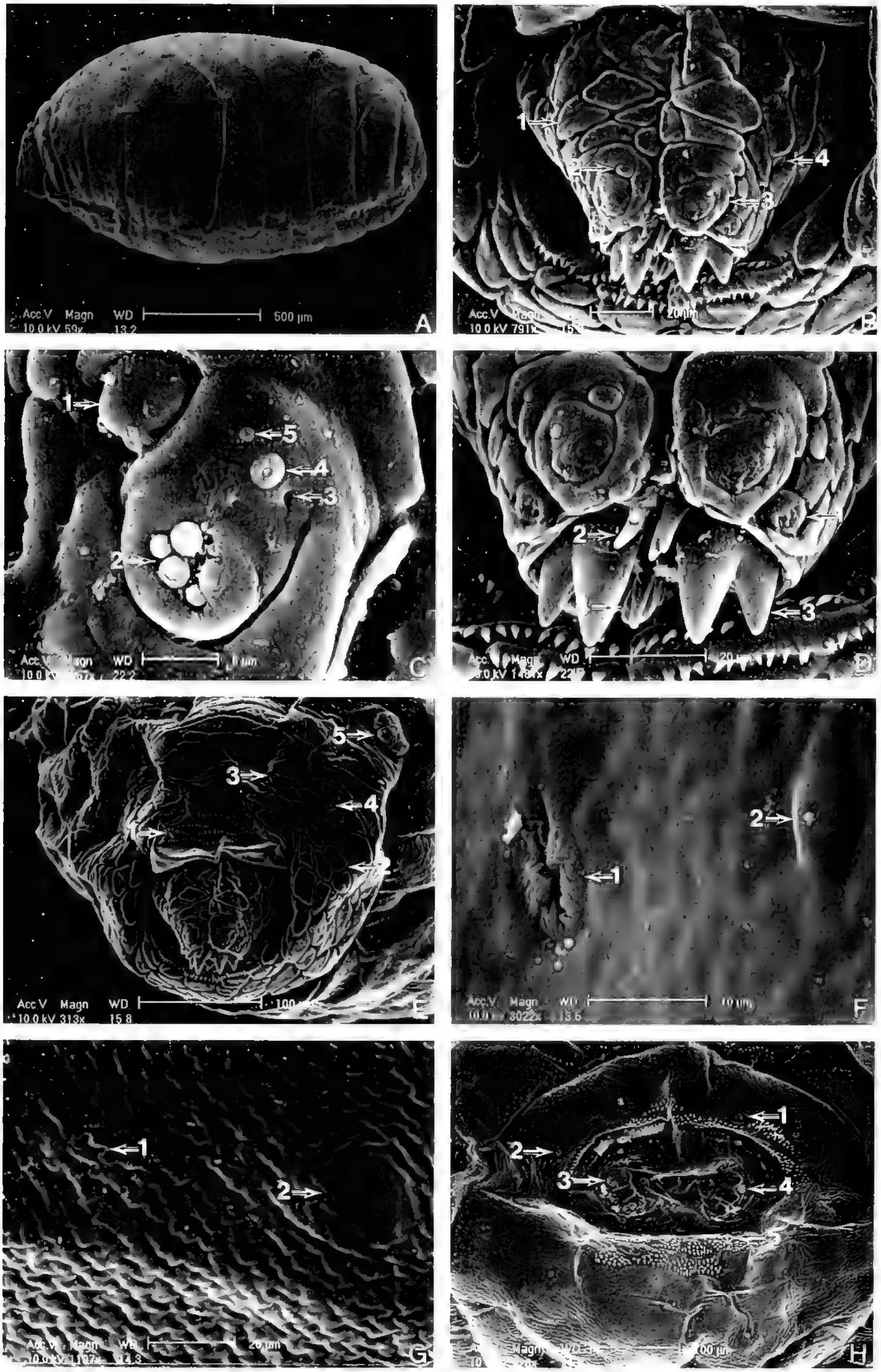

Fig. 2. Third instar of *Trupanea actinobola:* (A) habitus, anterior end to left; (B) gnathocephalon, anterior view, 1, rugose pads, 2, dorsal sensory organ, 3, anterior sensory lobe, 4, pit sensillum; (C) anterior sensory lobe, 1, dorsal sensory organ, 2, terminal sensory organ, 3, pit sensory organ, 4, lateral sensory organ, 5, supralateral sensory organ; (D) gnathocephalon, anterior view, 1, stomal sense organ, 2, integumental petals, 3,

sory organ (Fig. 3C-4), lateral sensory organ (Fig. 3C-5), and supralateral sensory organ (Fig. 3C-6); stomal sense organ ventrolateral of anterior sensory lobe (Fig. 3B-3); mouth hooks bidentate (Fig. 3B-4, 3D-1); median oral lobe laterally flattened (Fig. 3B-5, 3D-2); minute acanthae dorsally and ventrally on anterior margin of prothorax (Fig. 3D-3); rugose pads (Fig. 3D-4) and verruciform sensilla circumscribe prothorax; anterior thoracic spiracles bear 3–4 rounded papillae (Fig. 3E); metathoracic lateral spiracular complex consists of a spiracle and a verruciform sensillum; abdominal lateral spiracular complex not seen; posterior spiracular plates bear three ovoid rimae, ca. 0.014 mm in length (Fig. 3F-1), and four interspiracular processes, each with 1–3 branches, longest measuring 0.01 mm (Fig. 3F-2); intermediate sensory complex consists of a medusoid sensillum (Fig. 3F-3) and a stelex sensillum (Fig. 3F-4).

The second instar is very similar to the third instar in general habitus and sensory structures, but differs in that the mouth hooks are bidentate and the integumental petals are not elongated. The rugose pads and minute acanthae on the prothorax are weakly defined. Rugose pads are lacking in the second instars of *T. pseudovicina* (Goeden and Teerink 1998), and *T. conjuncta* (Teerink and Goeden 1998). The interspiracular processes have fewer branches than the third instar.

First instar: White, elongate-cylindrical, tapering anteriorly, rounded posteriorly, minute acanthae circumscribe intersegmental lines (Fig. 4A); gnathocephalon smooth, lacking rugose pads (Fig. 4C); dorsal sensory organ a dome-shaped papilla (Fig. 4B-1); subdorsal sensilla laterad of dorsal sensory organ (Fig. 4B-2); anterior sensory lobe (Fig. 4C-1) bears the terminal sensory organ (Fig. 4B-3), pit sensory organ (Fig. 4B-4), lateral sensory organ (Fig. 4B-5), and supralateral sensory organ (Fig. 4B-6); stomal sense organ ventrad of anterior sensory lobe (Fig. 4C-2); integumental petals dorsad of mouth hooks (Fig. 4C-3); mouth hooks bidentate (Fig. 4C-4); median oral lobe laterally flattened (Fig. 4C-5); labial lobe attached to median oral lobe, with two pore sensilla (Fig. 4C-6); minute acanthae on ventral margin of prothorax (Fig. 4C-7); prothorax smooth lacking rugose pads; anterior thoracic spiracle not present; lateral spiracular complex not seen; stelex sensilla circumscribe caudal segment in 2-dorsal, 4-ventral arrangement (Fig. 4D-1); posterior spiracular plates bear two ovoid rimae, ca. 0.006 mm in length (Fig. 4D-2), and four interspiracular processes each with 1–3 branches, longest measuring 0.006 mm (Fig. 4D-3); intermediate sensory complex consists of a medusoid sensillum (Fig. 4D-4), and a stelex sensillum (Fig. 4D-5).

The first instar differs from the second instar in lacking rugose pads on the gnathocephalon and prothorax. There are fewer minute acanthae ventrally on the anterior margin of the prothorax and circumscribing the intersegmental lines. The integumental petals in the first instar consist of a single pair of enlarged petals; the later instars have more, but smaller petals with the exception of the single pair of elongated petals seen in the third instar. The dorsal sensory organ, subdorsal sensilla, and anterior sensory lobe are very similar in the later instars, but the stomal sense organ is greatly reduced. The interspiracular processes are not greatly reduced as in *T. jonesi* (Goeden et al. 1998).

Puparium: Black, elongate-cylindrical, minute acanthae circumscribe intersegmen-

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mouth hooks, 4, median oral lobe; (E) anterior view, 1, minute acanthae, 2, rugose pads, 3, verruciform sensillum, 4, stelex sensillum, 5, anterior thoracic spiracle; (F) metathoracic lateral spiracular complex, 1, spiracle, 2, verruciform sensillum; (G) abdominal lateral spiracular complex, 1, spiracle, 2, placoid-type sensillum; (H) caudal segment, 1, stelex sensillum, 2, verruciform sensillum, 3, rima, 4, interspiracular process, 5, intermediate sensory complex.

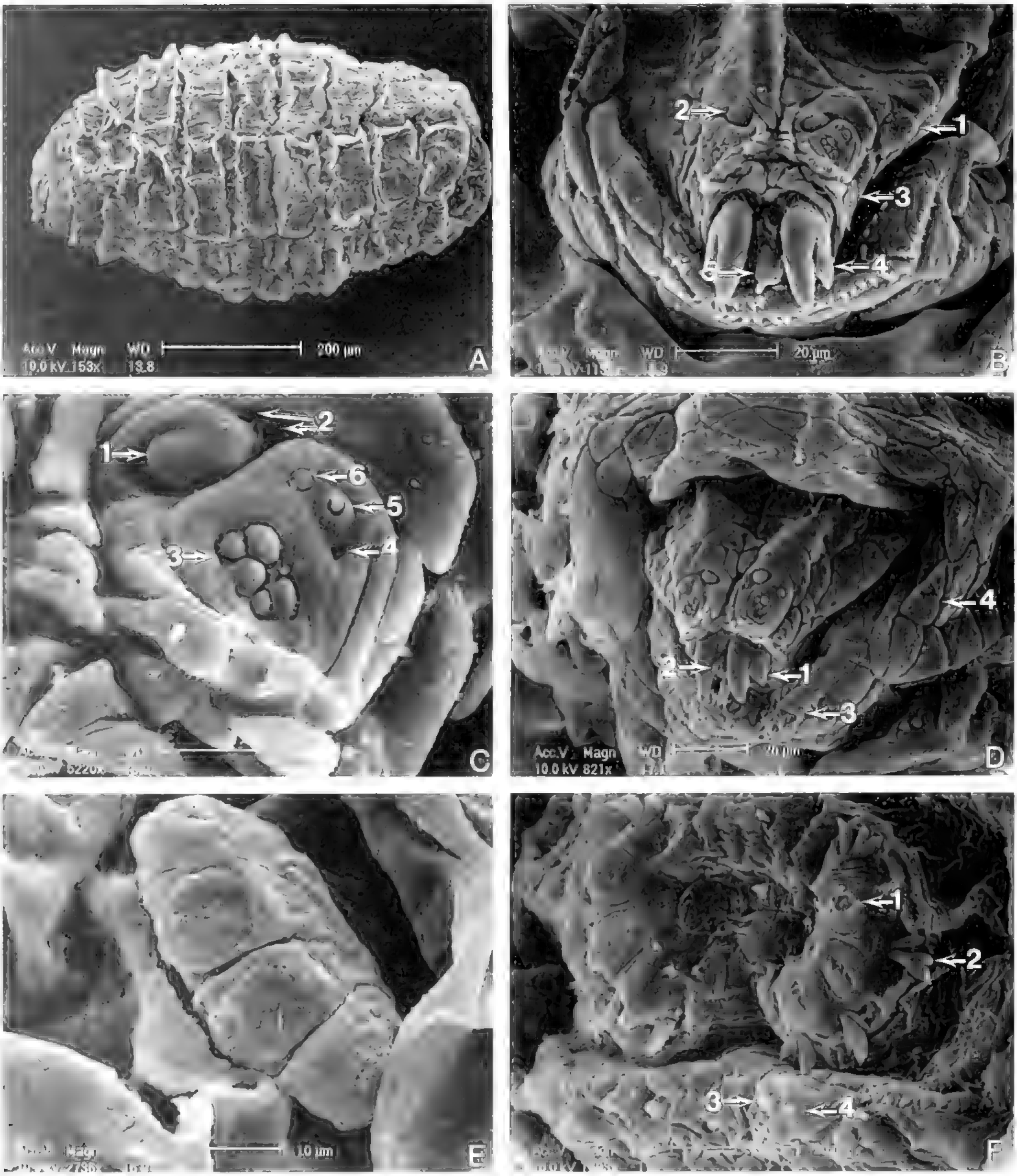

Fig. 3. Second instar of *Trupanea actinobola*. (A) habitus, anterior to left; (B) gnathocephalon, anterior view, 1, rugose pads, 2, dorsal sensory organ, 3, stomal sense organ, 4, mouth hooks, 5, median oral lobe; (C) anterior sensory lobe, 1, dorsal sensory organ, 2, subdorsal sensilla, 3, terminal sensory organ, 4, pit sensory organ, 5, lateral sensory organ, 6, supralateral sensory organ; (D) anterior view, 1, mouth hooks, 2, median oral lobe, 3, minute acanthae, 4, rugose pads; (E) anterior thoracic spiracle; (F) caudal segment, 1, rima, 2, interspiracular process, 3, intermediate sensory complex, medusoid sensillum, 4, intermediate sensory complex, stelex sensillum.

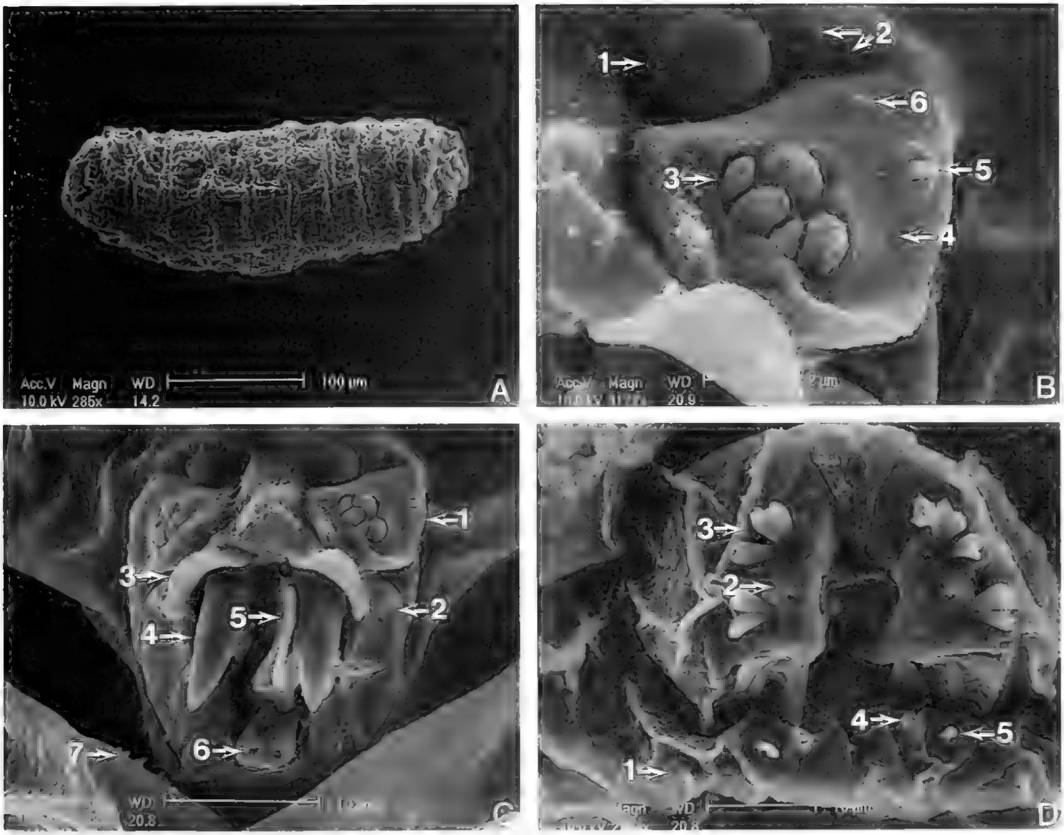

Fig. 4. First instar of *Trupanea actinobola:* (A) habitus, anterior to right; (B) anterior sensory lobe, 1—dorsal sensory organ, 2—subdorsal sensilla, 3—terminal sensory organ, 4—pit sensory organ, 5—lateral sensory organ, 6—supralateral sensory organ; (C) gnathocephalon, anterior view, 1—anterior sensory lobe, 2—stomal sense organ, 3—integumental petal, 4—mouth hooks, 5—medial oral lobe, 6—labial lobe pore sensillum, 7—minute acanthae; (D) caudal segment, 1—stelex sensillum, 2—rima, 3—interspiracular process, 4—intermediate sensory complex, medusoid sensillum, 5—intermediate sensory complex, stelex sensillum

tal lines (Fig. 5A); anterior end bears the invagination scar (Fig. 5B-1), and anterior thoracic spiracle (Fig. 5B-2); caudal segment circumscribed by minute acanthae (Fig. 5C-1), stelex sensilla in 2-dorsal, 4-ventral arrangement (Fig. 5C-2); two verruciform sensilla dorsolaterad of posterior spiracular plates (Fig. 5C-3); posterior spiracular plates bear three ovoid rimae (Fig. 5C-4), and four interspiracular processes, each with 2–4 branches (Fig. 5C-5); intermediate sensory complex consists of a medusoid sensillum and a stelex sensillum (Fig. 5C-6). Forty-nine puparia averaged 1.98 ± 0.02 (range, 1.72–2.37) mm in length; 0.93 ± 0.01 (range, 0.72–1.13) mm in width.

Puparia of *T. actinobola* are similar in size to *T. californica* (Headrick and Goeden 1991), but smaller than the other *Trupanea* species previously studied (Goeden 1987, 1988, Goeden and Teerink 1997c, 1998, Goeden et al. 1998, Knio et al. 1996a).

DISTRIBUTION AND HOSTS

The distribution of *T. actinobola* in North America north of Mexico as mapped by Foote et al. (1993) included two or more locations each in Alabama, Arizona, California, Colorado, Florida, Georgia, Idaho, Indiana, Iowa, Kansas, Michigan, Montana, Nevada, New Mexico, New York, South Carolina, Texas, Utah, and Wyoming; single locations each in Delaware, Indiana, Kentucky, Louisiana, Mississippi, Nebraska, Oklahoma, and Tennessee, and Ontario and Saskatchewan, Canada; and general state records only for South Dakota and Virginia.

Benjamin (1934) reported *T. actinobola* as reared from *Aster adnatus* Nuttall, *A. carolinianus* Walter, *A. simmondsii* Small, *Balduina* (as *Actinospermum*) *angustifolia* (Pursh) B. L. Robinson, *Coreopsis* sp., and *Hieracium* sp. Stegmaier (1968) noted that Benjamin (1934) also listed *Erigeron quercifolius* Lange, *E. vernus* (L.) Torrey and Gray, and *Solidago* sp. as hosts, but did not report rearing the flies from these plant species. Stegmaier (1968) studied *T. actinobola* on *E. strigosus* Muhlenberg in Florida, and reported that Phillips (1946) had reported "*E. sondbergiana* (author unknown)" as another larval host from New York. Foote (1960) added *Solidago chapmanii* Torrey and Gray and *S. serotina* Aiton as additional hosts of reared adults of *T. actinobola.* Finally, Wasbauer (1972) added *Hieracium pamiculatum* L., *Pyrrhopappaus* (as *Sitilias*) *caroliniana* (Walter) deCandolle, *Solidago caesia* L. [cited in error from, but not in, Stegmaier (1968)], and *S. stricta* Aiton. Of these purported hosts only *E. strigosus* occurs in California as a scattered adventive weed (Hickman 1993). We have not sampled flower heads of *E. strigosus,* but *T. actinobola* has not been reared from a total of at least 75 1-liter samples of mature flower heads from other 12 species of *Erigeron* (Goeden 1985, 1992, unpublished data). Similarly, *T. actinobola* has neither been reared from a total of 60 samples of flower heads of 14 *Aster* spp., from 20 samples of flower heads of six *Coreopsis* spp., nor from 40 samples of flower heads from six other species of *Solidago* from California collected to date (Goeden 1985, 1992, unpublished data; see corrections below). Therefore, the above host records compiled in Wasbauer (1972) remain unconfirmed for *Aster, Erigeron, Coreopsis,* or *Solidago* spp. in California, which suggests that they instead refer to one or more, different, eastern-U.S., host-based biotype(s) of *T. actinobola,* or to another, as yet undistinguished, separate species of *Trupanea.*

To further explore the latter possibilities, the senior author reexamined all reared voucher specimens of *T. actinobola* reported by Goeden (1985, 1992) using the latest version of separate keys for each sex of *Trupanea* in Foote et al. (1993), and found several, mostly single, reared specimens, he misidentified since 1980. During this period, the principal characters separating this variable tephritid species from its close congeners were better defined in keys (Foote and Blanc 1963, Foote et al. 1993) and became better known and appreciated as a series of reared specimens of most California species also were acquired for comparison by RDG. Accordingly, it was determined that rearing records for *T. actinobola* from flower heads of the following hosts in Goeden (1985, 1992) were erroneous and should be reassigned to *T. wheeleri: Achillea millefolium* L., *Aster occidentalis* (Nuttall) Torrey and Gray, *Brickellia oblongifolia* Nuttall, *Ericameria* (as *Haplopappus*) cooperi (Gray) Hall, *Erigeron foliosus* Nuttall, *Eriophyllum ambiguum* (Gray) Gray, *Hazardia* (as *Haplopappus*) *squarrosus* Hooker and Arnott, *Lepidospartum squamatum* (Gray) Gray, *Orochaenactis thysanocarpha* (Gray) Coville, *Porophyllum gracile* Bentham, and *Solidago confinis* Gray. Of these plant species, *B. oblongifolia* and *H. squarrosus* already were reported as hosts of *T. wheeleri* (Goeden 1985, 1992). Similarly, the rearing record from *Ericameria* (as *Haplopappus*) *bloomeri* Gray for *T. actinobola* in Goeden (1992) should instead be reassigned as new for *T. femoralis;* whereas, the rearing record from *Heterotheca grandiflora* Nuttall for *T. actinobola* in Goeden (1985) should be reassigned as new for *T. radifera.* Host records for *T. ac-*

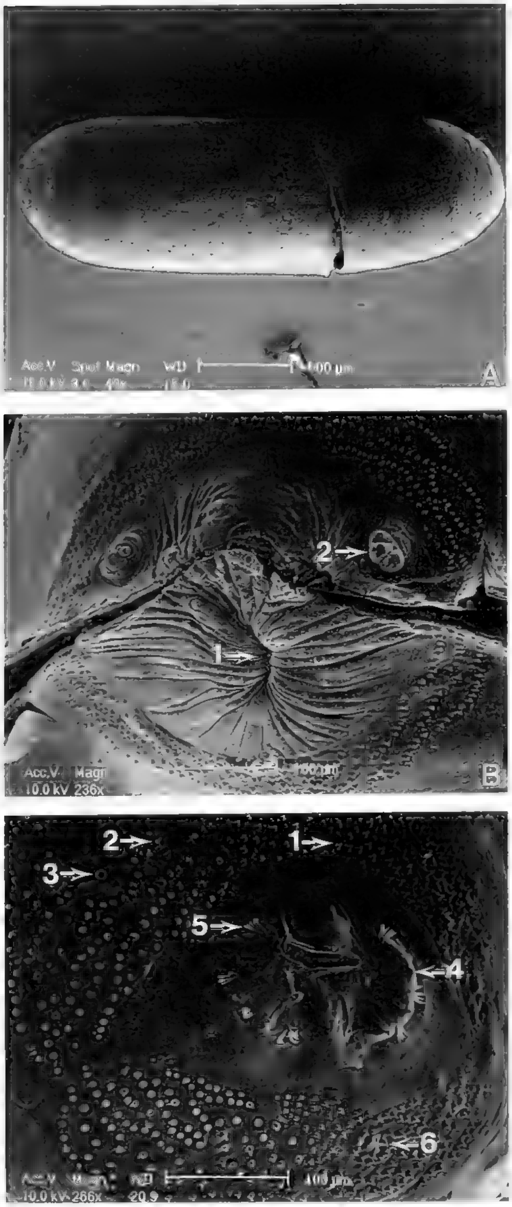

Fig. 5. Puparium of *Trupanea actinobola:* (A) habitus, anterior to right; (B) anterior end, 1—invagination scar, 2 anterior thoracic spiracle; (C) caudal end, 1—minute acanthae, 2—stelex sensillum, 3—verruciform sensillum, 4—rimae, 5—interspiracular process, 6—intermediate sensory complex.

tinobola from *Trixis californica* Kellogg in Goeden and Ricker (1989) should be reassigned wholly or in large part to *T. arizonensis* Malloch, as suggested by Goeden (1992), who reported it as the only known host plant of the latter species. Finally, *Dyssodia* (= *Thymophylla*) *pentachaeta* (deCandolle) Robinson should be reassigned from *T. actinobola* to *Trupanea vicina* (Wulp), which previously was reported as reared from another species of *Dyssodia* (Goeden 1985). Consequently, instead of the nine tribes, 22 genera, and 38 species reported by Goeden (1992), *T. actinobola,* as updated and corrected to date, has now been reported from five tribes, eight subtribes, 14 genera and 27 species of Asteraceae (Wasbauer 1972, Goeden 1985, 1992, Hickman 1993, Bremer 1994). The five tribes are the Astereae, Heleniae, Gnaphalieae, Lactuceae, and Mutiseae; the eight subtribes are the Asterinae, Coreopsidinae, Gailardiinae, Gnaphaliinae, Hieraciinae, Microseridinae, Nassauviinae, and Solidagininae (Bremer 1994).

However, ignoring the above-mentioned, mostly out-of-State, host records compiled by Wasbauer (1972), as well as those noted above as previously assigned in error by RDG to *T. actinobola* (Goeden 1985, 1992), now leads us to conclude that this tephritid in California is less widely oligophagous than previously surmized. We now believe that among host plants reported to date from California, a smaller form or biotype of *T. actinobola* (Table 1) is confined to *Acamptopappus sphaerocephalus, A. shockleyi* Gray, *Amphipappus fremontii* Torrey and Gray, *Gutierrezia californicum* (deCandolle) Torrey and Gray, *G. microcephala* (deCandolle) Gray, and *G. sarothrae* (Pursh) Britton and Rusby (Goeden 1985, 1992), all found in the subtribe Solidagininae of the Astereae (Bremer 1994). In addition, a larger form or biotype (Table 1) that also keys to *T. actinobola* in Foote et al. (1993) has been recovered from flower heads of *Bailyea multiradiata* Harvey and Gray, *B. pleniradiata* Harvey and Gray, *Psilostrophe cooperi* (A. Gray) E. Greene, and *Trichoptilium incisum* (Gray) Gray, all of which belong to the subtribe Gaillardiinae of the tribe Helenieae. *Psilostrophe*

Table 1. Mean lengths (mm) of thoracic dorsa of three presumed biotypes of *T. actinobola* individually reared from flower heads of different host genera in southern California.

Host-plant	Sex	Mean Length[a] ± SE (Range)	N
Acamptopappus sphaerocephalus	♂	0.84^{b} ± 0.02 (0.77–1.00)	12
	♀	0.91^{b} ± 0.02 (0.86–0.99)	12
A. shockleyi	♂	0.76^{b} ± 0.01 (0.66–0.83)	12
	♀	0.82^{b} ± 0.02 (0.76–0.93)	12
Bailyea multiradiata	♂	1.32^{c} ± 0.01 (1.26–1.39)	12
	♀	1.37^{c} ± 0.02 (1.22–1.47)	12
B. pleniradiata	♂	1.16^{c} ± 0.02 (1.03–1.28)	12
	♀	1.21^{c} ± 0.03 (0.97–1.31)	12
Chloracantha spinosus	♂	1.11 ± 0.02 (1.08–1.13)	3
	♀	1.08 ± 0.03 (1.02–1.17)	4

[a] Means followed by a different letter were significantly different at 0.05 as determined by Tukey's test.

cooperi is a newly reported host for *T. actinobola,* 2 ♂ and 5 ♀ having been reared from flower heads collected at Mercury Mountain, San Bernardino Co., on 7.iv.1992. Unfortunately, we have little-studied this larger form to date, which conceivably may be a separate species.

An analysis of variance followed by Tukey's test for differences in means showed that adults reared from *Acamptopappus* spp. were significantly smaller than adults reared from *Bailyea* spp. (Table 1). Other smaller differences were also identified among adults reared from each host plant species, and between sexes, but the major difference was between those reared from the two genera. In addition, seven specimens of intermediate size (3 ♂ and 4 ♀) have been reared from *Chloracantha* (= *Aster*) *spinosus* L. (Table 1), a weedy plant species introduced to California from Mexico and Central America, which may represent a third biotype like that reported from *Aster* spp. in the eastern U.S., and belonging to the subtribe Asterinae of the tribe Astereae. Again, were it not for the voucher specimens and series of reared specimens of *Trupanea* spp. available to us for study, we could not have determined the host ranges of these separate size-morphs of *T. actinobola* in California with this degree of certitude (Table 1). *Trupanea actinobola sensu lato* attacks additional host plants and genera outside of California, as the records in Wasbauer (1972) indicate, but whether as host-based biotype, or as yet undistinguished, additional, separate species, remains a question for future studies by others outside of California to answer.

BIOLOGY

Egg.—In 31 closed, preblossom, immature flower heads of *A. sphaerocephalus* averaging 2.1 ± 0.1 (range, 0.9–3.36) mm in diam (Fig. 6A), a total of 56 eggs and an average of 1.8 ± 0.2 (range, 1–5) eggs were inserted pedicel-last, mostly through the phyllaries. Most were deposited parallel to the receptacle and between the florets on the periphery of the flower head (Fig. 6B). In only five flower heads (16%) were a few eggs among those deposited placed at acute angles to the long axis of a head or perpendicular to the receptacle (Fig. 6B). Only two of the 56 eggs (3.6%) were inserted partially into separate florets. Most eggs were oviposited singly (Fig. 6B) or side-by-side in pairs by one or more females. Stegmaier (1968) reported oviposition of 1–12 eggs by females preferentially in the centers of unopened, immature flower heads of *E. strigosus* in Florida.

Larva.—Upon eclosion, first instars tunneled into and fed mainly in floral tubes and ovules of preblossom flower heads. An average of 1.2 ± 0.1 (range, 1–2) first instars was found feeding within 25 closed, preblossom flower heads. The receptacles of

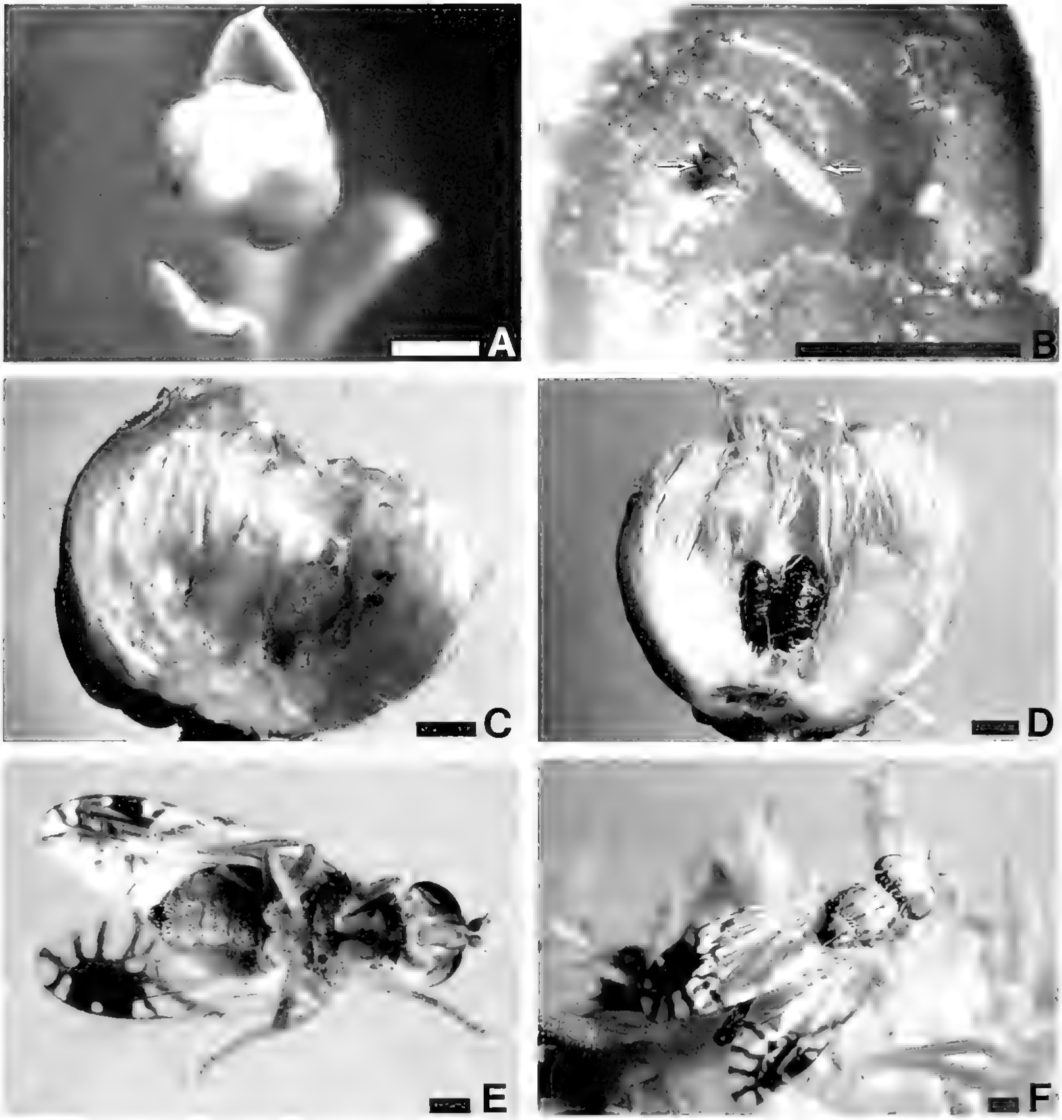

Fig. 6. Life stages of *Trupanea actinobola* in or on *Acamptopappus sphaerocephalus:* (A) immature, preblossom flower head preferred for oviposition; (B) two eggs (arrows), one inserted parallel to, and one perpendicular to, and between florets in closed, preblossom flower head; (C) early third instar tunneling in soft achene; (D) two puparia in center of open flower head; (E) ventral view of adult male displaying abdominal pleural distension; (F) adult female on flower head. Lines = 1 mm

these heads averaged 2.5 ± 0.2 (range, 1.5–5.1) mm in diameter. These heads contained an average of 18 ± 1.3 (range, 14–22) florets, of which an average of 2.2 ± 0.3 (range, 0–6) ovules/floral tubes, or 17% (range, 9–36%), were damaged. No receptacle within these 25 infested flower heads was pitted by first-instar feeding.

Second instars fed mainly on ovules and tunnelled parallel to, but well above, the receptacles of preblossom flower heads. Receptacles of 16 unopen flower heads containing second instars averaged 2.7 ± 0.2 (range, 1.7–4.6) mm in diameter. These flower heads contained an average of 1.1 ± 0.1 (range, 1–2) second instars that had destroyed an average of 2.9 ± 0.4 (range, 1–8) ovules, or 15% (range, 4.2–4.4%) of an average total of 22 ± 1.0 (range, 18–26) ovules per head. Stegmaier (1968) also reported that larvae fed preferentially on ovules and soft achenes.

Third instars fed on soft achenes at the centers, and less commonly towards the margins, of open or postblossom heads (Fig. 6C). Heavily attacked preblossom flower heads never opened. In 14 flower heads averaging 2.9 ± 0.2 (range, 2.2–4.9) mm in diameter and containing an average of 1.4 ± 0.1 (range, 1–2) third instars, an average of 2.9 ± 0.4 (range 1–6) ovules/soft achenes were damaged, or 15% (range, 4–33%). Most third instars fed with their long axes oriented perpendicular to, and mouthparts directed towards, the receptacles, within the upper parts of the soft achenes, and well above the receptacles. Consequently, no receptacles were pitted in the 14 flower heads that contained third instars (Fig. 6C). Upon completing feeding, the larvae oriented with their anterior ends away from the receptacles, retracted their mouthparts, and pupariated.

Pupa.—Flower heads containing puparia (Fig. 6D) reflected the greatest amount of damage that the seed-feeding larvae of *T. actinobola* caused within flower heads sampled. The receptacles of 49 infested, blossom and postblossom flower heads containing puparia averaged 3.7 ± 0.1 (range, 2.2–5.3) mm in diameter and bore an average total of 23.6 ± 1.0 (12–48) soft achenes, of which an average of only 2.4 ± 0.2 (range, 1–8) soft achenes or 11% (range, 4–40%) were damaged. Again, no receptacles were pitted. Stegmaier (1968) reported that one larva destroyed 32 achenes, or about 10% of those in a flower head of *E. strigosus.*

Our sampled heads of *A. sphaerocephalus* contained an average of 1.3 ± 0.1 (range, 1–5) puparia; whereas, Stegmaier (1968) reported from 2–12 puparia in flower heads of *E. strigosus.* Puparia of *T. actinobola* were found alongside of the phyllaries at the margins in 13 flower heads; the remaining heads contained puparia at their centers (Fig. 6D). All puparia had their anterior ends facing away from the receptacles, and their long axes were perpendicular to the receptacles (Fig. 6D).

Adult.—Adults emerged from mature flower heads, and were long-lived under insectary conditions, as 17 unmated males (Fig. 6E) averaged 104 ± 9 (range, 41–150) days, and seven virgin females (Fig. 6F) averaged 128 ± 15 (range, 65–171) days. Like *T. pseudovicina* (Goeden and Teerink 1998), these flies are among the longer average and maximum adult longevities that we have recorded for native species of nonfrugivorous Tephritidae from southern California. Such lengthy longevities are consistent with the aggregative type of life cycle ascribed below to this tephritid.

The premating and mating behaviors of *T. actinobola* were briefly studied in the field, and unlike most congeners that we have studied, a high proportion, i.e. two of three pairs, of adults mated once each in the petri dish arenas found to be so useful with many other noncongeneric, nonfrugivorous species (Headrick and Goeden 1994).

Wing displays: Both sexes displayed asynchronous wing supinations and hamations; the former wing movements were accompanied by swaying and abdominal flexures. Males also displayed synchronous supinations during courtship (Headrick and Goeden 1994).

Courtship: Males displayed abdominal pleural distensions (Fig. 6E) along with synchronous wing supinations and oriented toward females in petri dish arenas during courtship displays. If females remained still, mountings were attempted, but females usually were aggressive toward males and lunged at them with their wings spread open. Only two successful mountings were observed. In both, a male jumped onto the dorsum of a female from behind; she responded by pushing vigorously at him with her hind legs. The male grasped the female with his front legs on top of her abdomen near her thorax, while his middle legs wrapped around the middle of her abdomen and his hind legs pulled upward on her oviscape.

Copulatory induction behavior (CIB): The mounted male held the oviscape of the female upward with his hind legs and drummed his epandrium against its apex. He also rubbed his front legs asynchronously in 1 sec bursts against her abdominal terga. The male of one pair engaged in CIB for more than 10 sec, then dismounted without having successfully gained intromission. The male of a second pair engaged in CIB for ca. 10 sec, when the female exserted her aculeus and intromission was gained.

Copulation: Both adults of the pair that copulated remained quiet for ca. 5 min until the male extended his wings, turned, and stepped down from the female, and walked away while pulling his aedeagus from her aculeus.

Field observations: Females of *T. actinobola* were examined on preblossom and flowering *A. sphaerocephalus* at Snow Creek on 31.iii.1992 and at the mouth of Oriflamme Canyon on 9.iv.1992. No males of *T. actinobola* were observed, as presumably they had mated and died by then.

Daily activity and abundance: By 10:00 h, *T. actinobola* females began to appear on *A. sphaerocephalus* plants at Snow Creek and up to 12 *T. actinobola* females were observed per plant throughout the day (n = 10). The females were actively, rapidly walking, exploring immature flower heads, probing, and displaying asynchronous wing supinations during these activities.

Oviposition: Females touched the ovipositor apex to the side of small flower heads, ca. 1–4 mm diam (n = 3). The apex was traced along the edges of bracts attempting to locate a site to gain purchase for penetration. Females faced away from the center of flower heads during oviposition and curled their ovipositor beneath their bodies. The aculeus tip was inserted into the flower head, after which they paused for ca. 2 min. After oviposition the aculeus was retracted and females walked upon the flower head, or flew to another head.

Seasonal history.—The life cycle of *T. actinobola* in southern California follows an aggregative pattern in which the long-lived adults in reproductive diapause overwinter and aggregate to mate on preblossom host plants in the spring (March–April) (Headrick and Goeden 1994). They reproduce at first on *Acamptopappus* spp. in the Colorado Desert, then on this genus and *Amphipappus fremontii* in the higher-elevation Mojave Desert (Munz 1974, Hickman 1993). A second generation is produced each year on *Gutierrezia* spp. The larger form of *T. actinobola* also is bivoltine on its annually or biannually flowering host plants in southern California.

Natural enemies.—Four species of chalcidoid Hymenoptera were reared from individual puparia and mature flower heads of *A. sphaerocephalus* bearing puparia of *T. actinobola* as solitary, primary, larval-pupal endoparasitoids: *Eurytoma veronia* Bugbee (Eurytomidae), *Halticoptera* sp. (Pteromalidae), *Mesopolobus* sp. (Pteromalidae), *Pteromalus* sp. (Pteromalidae).

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A NEW GENUS AND SPECIES OF ENTEDONINAE (HYMENOPTERA: EULOPHIDAE) FROM THE NEOTROPICAL REGION

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Abstract.—A new genus and species of the subfamily Entedoninae (Hymenoptera: Eulophidae), ***Tropicharis cecivora*** **Hansson** are described based on material from the northern Neotropical Region. The hosts are gallmakers (presumably gallmidges) on host plants of the genera *Amphitecna, Capsicum, Lantana, Neea, Piper, Smilax,* and an unidentified Myrsinaceae.

Key Words: Chalcidoidea, Eulophidae, *Tropicharis,* Neotropical, parasitoid, gallmakers, taxonomy

The Neotropical fauna of Eulophidae is very poorly known. The few recorded species (e.g., De Santis 1979, 1983, 1989, De Santis and Fidalgo 1994) represent only a fraction of the actual number of species. For instance, in Costa Rica new sampling indicates that there may be as many as 1,000 species (LaSalle and Schauff 1995), but so far only about 20 species have been recorded. Needless to say the exploration of Neotropical eulophids is still in its infancy.

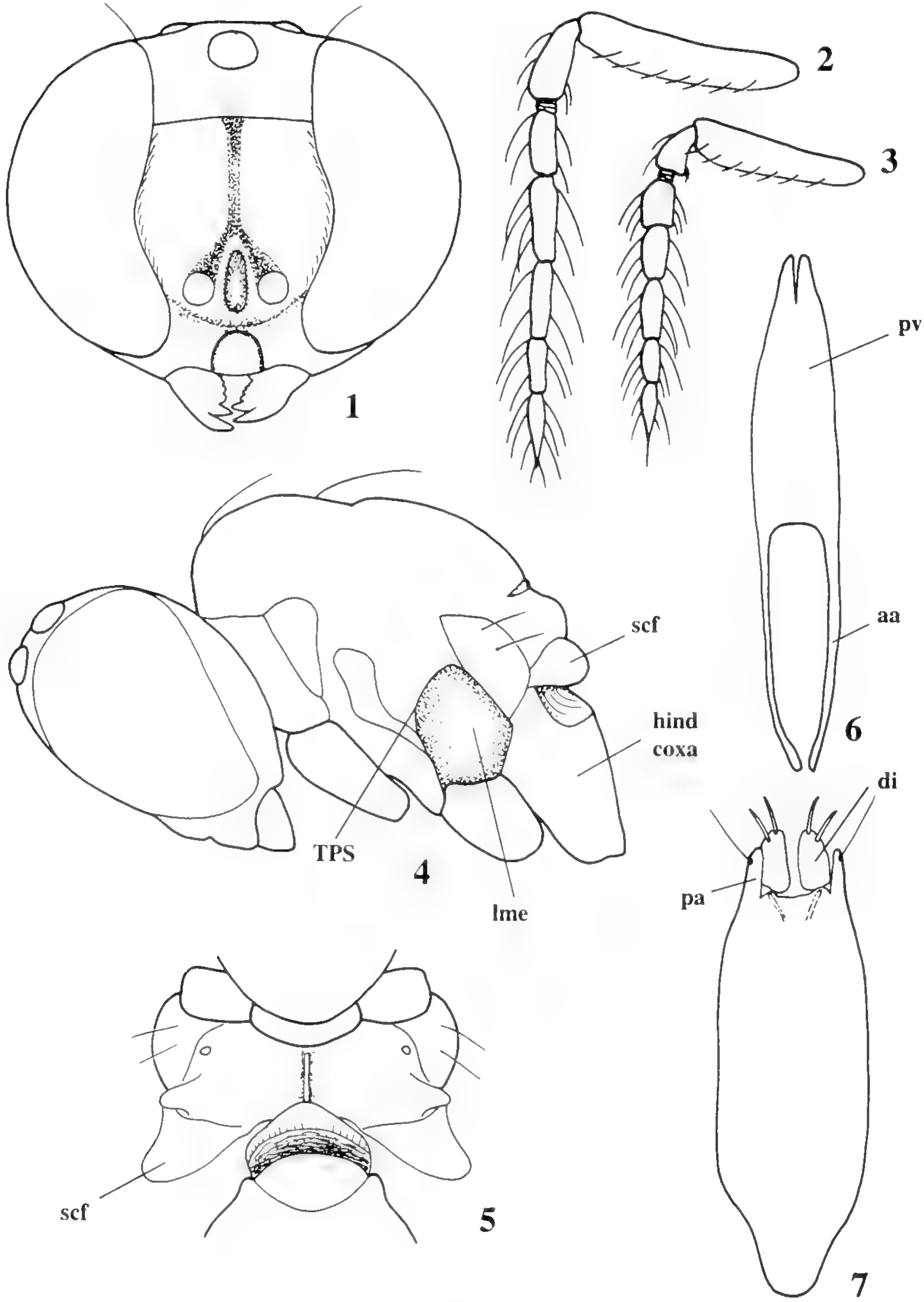
In this paper a new genus and one new species of the subfamily Entedoninae are described. The species has been reared from galls on various plants (see below under "Hosts"), where it develops as a parasitoid on the gall inducers, which are probably gall-midges (Diptera: Cecidomyiidae).

Acronyms of museums used in the text are as follows: BMNH: The Natural History Museum, London; CNC: Canadian National Collection of Insects, Ottawa; EAP: Escuela Agricola Panamericana, Zamorano, Honduras; INBio: Instituto Nacional de Biodiversidad, Costa Rica; LUZM: Lund University Zoology Museum, Sweden; MIUCR: Museo de Insectos, Universidad de Costa Rica; TAMU: Texas A&M University, U.S.A.; USNM: National Museum of Natural History, Smithsonian Institution, Washington, D.C.

Tropicharis Hansson, new genus
(Figs. 1–7)

Type species.—*Tropicharis cecivora* Hansson, new species.

Diagnosis.—Antennal scrobes joining low on frons, far below frontal cross-groove, and with a single median groove running up to frontal cross-groove (Fig. 1); clypeus semicircular and delimited by a distinct groove; eyes large. Pronotum reduced, hardly visible in dorsal view; transepimeral sulcus (TPS) strongly curved (Fig. 4), lower mesepimeron large and convex; part of posterior propodeum over hind coxa (supracoxal flange) enlarged and membranous, and dorsobasal hind coxa with a flattened smooth area to fit the enlarged supracoxal flange; postmarginal vein 2.7–4.2× as long as stigmal vein. Gaster broadly attached to propodeum, petiole short and wide (Fig. 5); female gaster elongate, 1.6–2.3× as long as mesosoma. Male genitalia (Figs. 6, 7): par-



Figs. 1–7. *Tropicharis cecivora.* 1, Female head, front view. 2, Female antenna, lateral view. 3, Male antenna, lateral view. 4, Female head and mesosoma, lateral view. 5, Female propodeum and petiole, dorsal view. 6, Male aedeagus. 7, Male phallobase. Abbreviations: aa = aedeagal apodeme; di = digitus; lme = lower mesepimeron; pa = paramere; pv = penis valves; scf = supracoxal flange; TPS = transepimeral sulcus.

ameres extended, with a single seta close to apex; volsellar setae missing; the two digital spines on each digitus slender, placed with a distance between them, and about equal in size.

Discussion.—Through the large head, large eyes, antennal scrobes joining close to toruli, delimited clypeus, reduced pronotum, ±hidden dorsellum, extended paramere in male genitalia, and hosts (gallmakers), *Tropicharis* is similar to *Eprhopalotus* Girault. *Tropicharis* differs from *Eprhopalotus* in having notauli poorly delimited (notauli deep and complete in *Eprhopalotus*); lower mesepimeron strongly convex and shiny (lower mesepimeron weakly convex and reticulate in *Eprhopalotus*), TPS strongly curved (TPS weakly curved in *Eprhopalotus*); supracoxal flange enlarged and membranous, membrane corresponds to a flattened and shiny surface on dorsobasal hindcoxa (supracoxal flange narrow in *Eprhopalotus*); postmarginal vein 2.7–4.2× as long as stigmal vein (1–1.4× in *Eprhopalotus*); volsellar setae in male genitalia missing (present in *Eprhopalotus*).

In Schauff et al. (1997) *Tropicharis* runs to couplet 117 (*Emersonella*) or 119 (*Entedon*), but differs from both in several characters, e.g., the delimited clypeus. In Bouček (1988) *Tropicharis* runs to couplet 140 (*Zaommomyiella*) or 149 (*Chrysocharis*). *Tropicharis* is similar to *Zaommomyiella* but differs in having frontal cross-groove straight to slightly down-curved laterally (deeply V-shaped in *Zaommomyiella*). The clypeus is distinctly delimited in *Tropicharis*, but undelimited in *Chrysocharis*.

Description.—Flagellum with 5 separated segments; sensilla ampullacea asymmetric and elongate (type III sensu Hansson 1990), present on all segments. Antenna with 3 discoid anelli. Scape narrow in both sexes, ventral sense area in male reaching along major part of scape. Mandibles with 2 larger teeth at apex and with several smaller teeth above them. Clypeus delimited. Antennal scrobes joining close to antennal toruli. Frontal cross-groove straight or slightly down-curved laterally, cross-groove faint or missing in some specimens from Dominica. Occiput without median groove or fold above foramen magnum.

Pronotum reduced and hardly visible in dorsal view. Midlobe of mesoscutum with 2 pair of setae; notauli present as shallow and weakly defined grooves in anterior ¾. Scutellum with 1 pair of setae, situated at equal distance from anterior and posterior edges of scutellum. TPS strongly curved; lower mesepimeron large and convex. Dorsellum partly to completely hidden under scutellum. Propodeum with a complete median carina; propodeal callus with 2 setae; supracoxal flange enlarged and membranous. Dorsobasal hind coxa with a flattened smooth area to fit the enlarged supracoxal flange. Forewing rounded; costal cell narrow, as wide as base of submarginal vein; postmarginal vein 2.7–4.2 as long as stigmal vein; radial cell hairy; without stigmal hairlines.

Petiole short and transverse, with a short, membranous anterodorsal shield that reaches up on posterior propodeum, shield very short or missing in male. Male genitalia: parameres extended, with a single seta close to apex; volsellar setae missing; digitus 1.5× as long as wide, the two digital spines on each digitus slender, placed with a distance between them and about equal in size; aedeagal apodemes about as long as penis valves.

Etymology.—*Tropi* as in tropical—this group is found exclusively in tropical areas in the Americas; *charis* is greek for beauty or splendour, and is a commonly used suffix for entedonines due to their beautiful colors and shiny appearance. The gender is feminine.

Tropicharis cecivora Hansson, new species

(Figs. 1–7)

Description.—Length of body ♀ = 1.0–2.5 mm, ♂ = 0.8–1.7 mm.

Color: Scape whitish with apex infuscate, to completely whitish, remaining antenna dark. Frons below frontal cross-groove golden-green, above cross-groove metallic purple. Vertex metallic purple or bluish-green. Mesoscutum and scutellum golden-red to golden-green. Propodeum golden-green with the enlarged supracoxal flange transparent. Fore coxa pale to dark, mid and hind coxae pale; remaining parts of legs pale. Forewing with an infuscate spot medially, to completely hyaline. Petiole whitish. Gaster golden-green to golden-purple, occasionally with median part pale nonmetallic. Male: Entire antenna dark, or with scape pale. Frons below frontal cross-groove golden-red, above cross-groove metallic purple. Vertex metallic purple. Mesoscutum and scutellum golden-purple to golden-red. Propodeum golden-green. Legs, wings and petiole as in female. Gaster with weak golden-purple tinges.

Head: Antenna as in Figs. 2, 3. Height of eye/malar space/width of mouth ♀: 15.0/1.0/7.0, ♂: 12.8/1.0/4.4. Frons below frontal cross-groove smooth and shiny or with weak smallmeshed reticulation, above cross-groove smooth and shiny; with a protuberance between antennal toruli. Vertex smooth and shiny. Distances between posterior ocelli/one posterior ocellus and the closest eye/one posterior ocellus and occipital margin: 9.0/3.5/1.0. Occipital margin with a sharp edge. Width of head/width of mesosoma just in front of wing base = 1.2.

Mesosoma: Without transverse carina along posterior pronotum. Mesoscutum and scutellum with strong reticulation. Forewing speculum closed below and with 20–25 admarginal setae on underside of membrane; length of wing/length of marginal vein/height of wing: 2.0/1.2/1.0; length of postmarginal vein/length of stigmal vein = 2.7–4.2. Propodeum with a complete and strong median carina, surface otherwise smooth and shiny.

Metasoma: Female gaster lanceolate, strongly sclerotised and not collapsed—not even in specimens dried outside a critical point drier; last tergite varying in length: 1.0–3.7× as long as wide at base; length of mesosoma/length of gaster ♀ = 0.4–0.6, ♂ = 0.6–0.8.

Type material.—Holotype ♀ labelled "Mexico: Oaxaca, 2 mi N Candelaria Loxicha, 17.vii.1985, J. B. Woolley & G. Zolnerowich" (USNM). Paratypes: 6 ♀ 9 ♂ with same label data as holotype (EAP, LUZM, TAMU); 1 ♀ 1 ♂ "Mexico Oaxaca, 4.4 mi NE San Pedro Mixtepec, 16.vii.1985, J. B. Woolley & G. Zolnerowich" (USNM); 1 ♂ "Mexico: Oaxaca, 29.1 mi E Pochutla, 13.vii.1987, 80′, J. B. Woolley & G. Zolnerowich" (TAMU); 1 ♀ "Mexico: Campeche, Chicanna Ruins, 6 mi E Xpujil, 13–14.vii.1983, R. Anderson" (CNC); 1 ♀ "Mexico: Campeche, Chicanna, 10 km W Xpujil, 300 m, 12–14.vii.1983, M. Kaulbars" (CNC); 1 ♀ "Mexico: Campeche, 6 km W Escarcega, El Tormento Research Station, 12.vii.1983, 110 m, M. Kaulbars" (CNC); 1 ♀ "Mexico: Chiapas, 12.1 km S Palenque, 13.viii.1990, 1200′, J. B. Woolley" (LUZM); 1 ♀ "Mexico: Chiapas, Palenque, 80 m, 29.vii.1983, M. Kaulbars" (CNC); 1 ♀ "Mexico: Quintana Roo, 68 km SW Chetumal, Kohunlich, 160 m, 14–17.vii.1983, M. Kaulbars" (CNC); 1 ♀ "Mexico: Tamaulipas, Reserva El Cielo, Alta Cimas, 3100′, 30.vii.1993, J. B. Woolley & K. Wikse" (TAMU); 2 ♂ "Mexico: Tamaulipas, Reserva El Cielo, Gomez Farias, 28.vii.1993, 450 m, J. B. Woolley" (TAMU); 1 ♀ 1 ♂ "Costa Rica: Alajuela, N slope Volcan Cacao, 650 m, 17.iii.1986, C. Hansson" (LUZM); 1 ♂ "Costa Rica: Cartago, Turrialba, CATIE, 100 m, 14–15.iii.1990, J. S. Noyes" (BMNH); 2 ♀ "Costa Rica: Guanacaste, Est. Pitilla, 9 km S Santa Cecilia, 700 m, iii.1995, C. Moraga & P. Rios" (INBio); 4 ♂ "Costa Rica: Guanacaste, P.N. Santa Rosa, x.1996, ex leaf blister gall on Myrsinaceae, V. Solano" (EAP, MIUCR); 1 ♀ "Costa Rica: Heredia, 12 km SO Horquetas, 550 m, 27.ix.1987, P. Hanson, ex leaf gall on *Neea*" (MIUCR); 1 ♀ 1 ♂ "Costa Rica: Heredia, Braulio Carrillo N.P., 500 m, 10.iv.1985, H. Goulet & L. Masner" (CNC); 2 ♀ "Costa Rica: Heredia, Braulio Carrillo N.P., 8 km E HQ, 700 m, 13.ii.1991, J. S. Noyes" (BMNH); 1 ♂ "Costa Rica: Heredia, Chilamate, 75 m, 25.iii.1989, P. Hanson & C. Godoy" (LUZM); 1 ♀ "Costa Rica: Heredia, Volcan Barva, 2400 m, 6.ix.1986, L. Masner" (CNC); 1 ♀ "Costa Rica: Limon, 0.5 km E Braulio Carrillo N.P., San José-Limon road, 400 m, 9.ii.1991, J. S. Noyes" (BMNH); 3 ♂ "Costa Rica: Limon, Hitoy-Cerere BP HQ, 100 m, 14–18.i.1991, J. S. Noyes" (BMNH); 6 ♀ "Costa Rica: Limon, Pococi, Teleferico, 500 m, v.1997, ex cylindrical leaf gall on *Smilax*, P. Hanson" (LUZM, MIUCR); 1 ♀ "Costa Rica: Puntarenas, Golfo Dulce, 5 km W Piedras Blancas, 100 m, iv–v.1991, P. Hanson" (EAP); 1 ♀ from same locality as previous but collected x.1990 (MIUCR); 1 ♀ "Costa Rica: Puntarenas, Golfo Dulce, 24 km W Piedras Blancas, 200 m, xi.1992, P. Hanson" (LUZM); 1 ♀ "Costa Rica: Puntarenas, Golfo Dulce, 3 km SW Rincon, 10 m, vi.1991, P. Hanson" (LUZM); 1 ♀ from same locality as previous but collected vii.1991 (BMNH); 3 ♀ 4 ♂ "Costa Rica: Puntarenas, Manuel Antonio N.P., 23–28. viii.1986, L. Masner" (CNC, LUZM); 1 ♀ "Costa Rica: Puntarenas, P.N. Manuel Antonio, 15.xii.1987, ex leaf vein swelling on *Amphitecna*?, P. Hanson" (MIUCR); 9 ♀ 5 ♂ "Costa Rica: San José, Ciudad Colon, Hacienda Rodea, 800 m, 21.x.1990, P. Hanson, ex vein gall on *Piper*" (LUZM, MIUCR, USNM); 3 ♀ "Dominican Republic: San Cristobal, 20 km NW San Cristobal Manomatuey, 500 m, 23.iii.1991, L. Masner" (BMNH, LUZM); 1 ♀ "Dominican Republic: Pedernales, Sierra de Bahoruca, 1350 m, 22.vii.1990, L. Masner" (BMNH); 2 ♀ 5 ♂ "Dominican Republic: Independencia, 28 km NW La Descubierta, Sierra Nelba, 1400 m, 5.xii.1991, L. Masner" (BMNH, LUZM); 2 ♀ 2 ♂ "Dominican Republic: Barohona, Sierra de Bahoruca, 1400 m, 12.i.1989, L. Masner" (BMNH, CNC); 3 ♀ "Dominican Republic: Prov. Pedernales, 23.5 km N Cabo Rojo, 540 m, vii.1990, L. Masner" (CNC, LUZM); 1 ♀ 1 ♂ "Dominican Republic: Prov. Pedernales, Sta. Bahoruca, Alcoa Rd, 530–750 m, 14.vii.1990, L. Masner" (CNC); 1 ♀ "Ecuador: Pichin, Tinalandia, 800 m, 7.ii.1983, L. Huggert" (LUZM); 1 ♀ "Ecuador: Pichin, Rio Palenque R.S., 200 m, 4.ii.1983, L. Masner & M. Sharkey" (CNC); 1 ♀ "El Salvador: Soyapango, 7.xi.1954, P.A. Berry, on chile pepper" (USNM); 2 ♀ "Guatemala: Petén, 2 km E Tikal, 27.xii.1988, J. LaSalle" (LaSalle); 1 ♀ "Guatemala: Izabal, Dpto, Las Escobas, 15.vii.1986, L. LeSage" (CNC); 3 ♀ "Panama: Chanel Zone, vii.1953, Krauss, stem swelling on *Lantana*" (USNM); 1 ♂ "Panama: Canal Zone, 9°25′N, 80°0′W, 10–12m, 5.v.1973, J. Helava" (CNC); 12 ♀ 4 ♂ "Panama: Barro Colorado Island, 17.i.1924, I. Molino & J. Zetek" (USNM); 1 ♀ "Trinidad: St. George, Arena Reserva, 3.viii.1976" (BMNH); 1 ♀ "Venezuela: Aragua, 24 km N Maracay, Henry Pittier N.P., 1000 m, 24.xii.1985, P. Kovarik & R. Jones" (TAMU).

Distribution.—Costa Rica, Dominican Republic, Ecuador, El Salvador, Guatemala, Mexico, Panama, Trinidad, Venezuela. This indicates a northern Neotropical distribution, including Mexico, Central America, the West Indies and northern South America. However, due to the poor collecting in South America the southern border of distribution is uncertain. No material from the southern U.S. has been found and it is possible that *Tropicharis* is a truly Neotropical group.

Hosts.—Associated with gallmakers on *Amphitecna* sp. (probably *Amphitecna latifolia,* P. Hanson personal correspondance) (Bignoniaceae), *Capsicum* sp. (Solanaceae), *Lantana* sp. (Verbenaceae), *Neea* sp. (Nyctaginaceae), *Piper* sp. (Piperaceae), *Smilax* sp. (Smilacaceae), and an unidentified Myrsinaceae.

Etymology.—*cecivora,* abbreviated latin for "eating cecids," since cecidomyids are the presumed hosts.

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MYELOPSOIDES VENUSTUS, A NEW GENUS AND SPECIES OF PHYCITINAE (LEPIDOPTERA: PYRALIDAE) FROM THE WESTERN UNITED STATES

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Abstract.—***Myelopsoides venustus***, a new genus and species of Phycitinae from California and Idaho, is described and illustrated.

Key Words: Pyralidae, California, Idaho

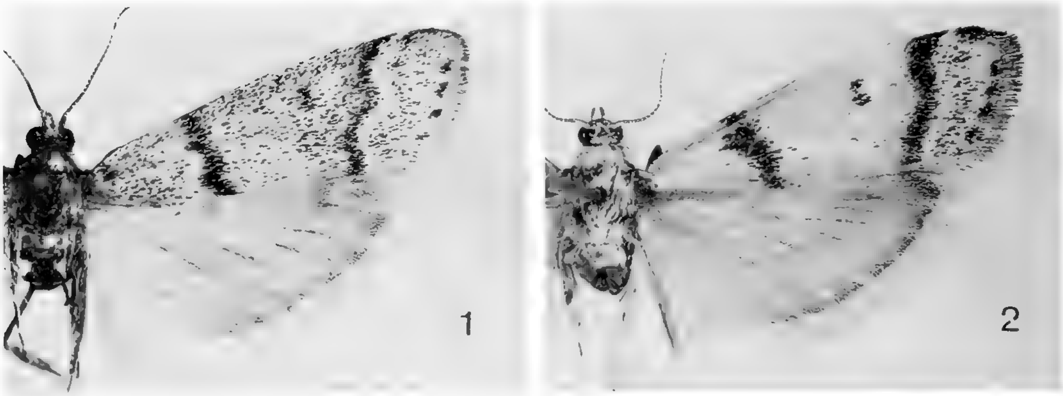
The genus *Myelopsis* Heinrich, and related genera, were treated by Neunzig (1990) in the series "Moths of America north of Mexico." Additional studies of phycitines in the collections of the University of California at Davis (UCDC), and the National Museum of Natural History, Smithsonian Institution, Washington, D.C. (USNM) have revealed a moth, previously overlooked, that appears to be closely related to *Myelopsis*. The new genus and species is represented in the collections by only a few specimens. Label data suggest that the moth occurs at sites with moderate to relatively high elevations (2500′ to 7200′) in the western United States.

Myelopsoides Neunzig, new genus

Type species.—*Myelopsoides venustus* Neunzig

The most obvious diagnostic features distinguishing *Myelopsoides* from other phycitine genera can be seen in the male genitalia. The valva has the base of the costa strongly sclerotized and noticeably concave with a short, setiferous projection at the distal aspect of the concavity, and has a similarly sized, proximally directed, setiferous lobe at its inner base (Fig. 3).

Description.—Antenna simple in both sexes; sensilla trichodea (cilia) of shaft of male moderately abundant, and, at base of shaft about 0.5× as long as basal diameter of shaft. Frons convex, smoothly scaled. Labial palpus of both sexes upcurved. Maxillary palpus of both sexes simple. Haustellum well developed. Ocellus weakly developed. Basal half of costa of forewing of male slightly convex, without costal fold. Forewing (Fig. 6) without raised scales; with 10 veins; R_2 straight; R_{3+4} weakly developed as a short spur of R_5; M_1 rather straight; M_{2+3} and CuA slightly separated at base; CuA_1 from just before lower outer angle of cell; CuA_2 from well before lower outer angle of cell. Hindwing (Fig. 6) with 7 veins (1A, 2A and 3A together treated as 1 vein); Sc + R_1 fused to R_5 for about 0.6× its length from cell; M_1 from upper outer angle of cell; M_{2+3} and CuA_1 adjacent, or M_{2+3} briefly fused with CuA_1 at base; CuA_2 from well before lower outer angle of cell; cell slightly less than 0.5× as long as wing. Abdominal segment 8 of male without scale tufts. Male genitalia (Figs. 3–5) with uncus subtriangular, rounded at apex; apical process of gnathos v-shaped; transtilla a broad, truncated structure composed of well sclerotized, lateral elements weakly joined mesially; distal half of transtilla wrinkled and



Figs. 1–2. *Myelopsoides venustus.* 1, Male, holotype (13.5 mm). 2, Female, paratype (13.0 mm). Length of forewing in parentheses.

minutely spined; juxta broadly v-shaped with short, setiferous, lateral lobes; valva with base of costa strongly sclerotized and concave with short, setiferous projection at distal aspect of concavity, and with similarly sized, proximally directed, setiferous lobe at inner base; vesica of aedoeagus with an elongate, flattened, partially sclerotized element (eversion of vesica (Fig. 5) results in the more heavily sclerotized part of element being directed distally); vinculum slightly longer than greatest width. Female genitalia (Figs. 7–9) with ductus bursae membranous, slender, more than 2× as long as corpus bursae; corpus bursae membranous, somewhat pear-shaped, scobinate, with signum composed of 3, small, fused sclerotized discs; ductus seminalis attached to corpus bursae near junction of ductus bursae and corpus bursae.

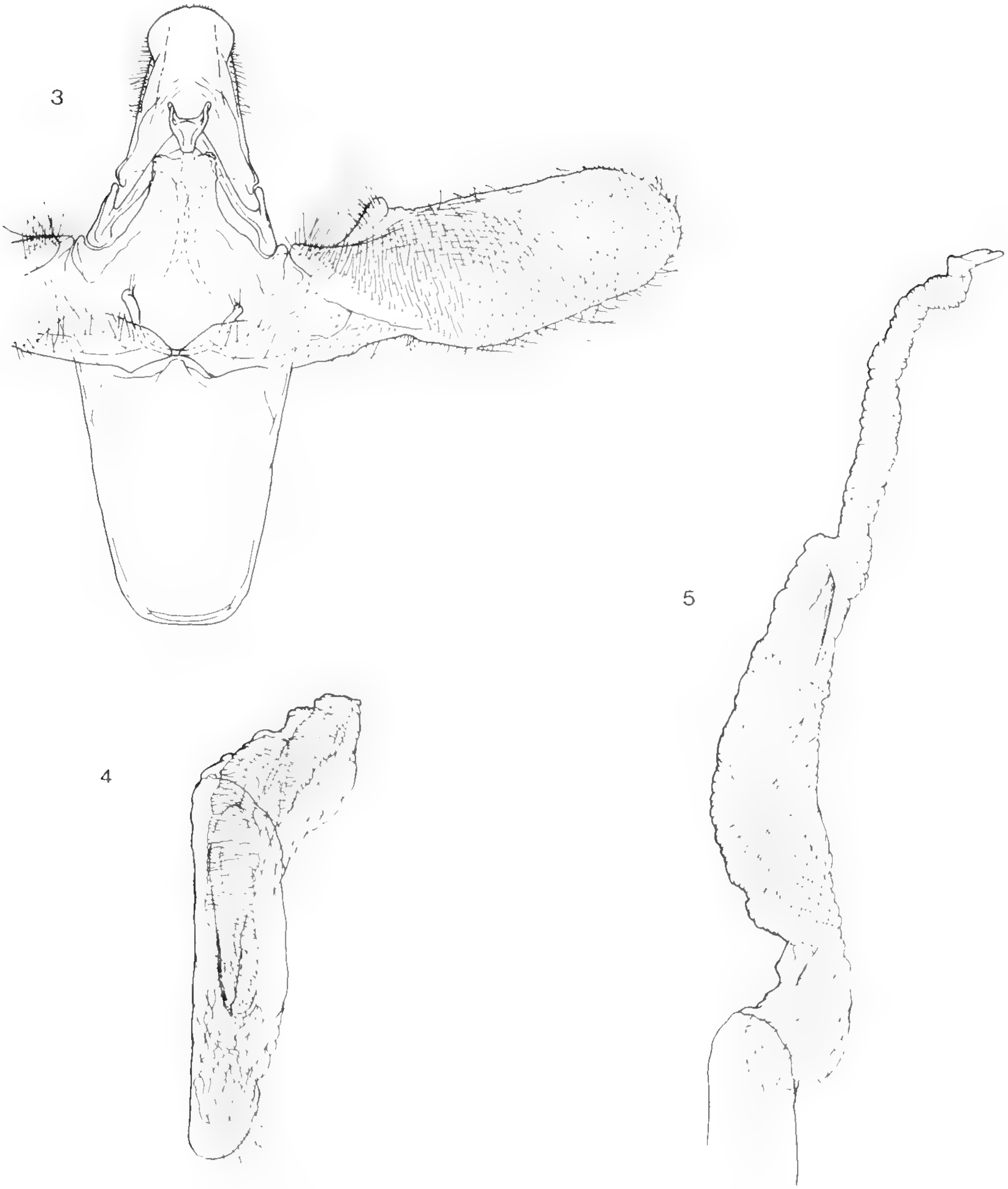
Discussion.—The genus is like *Myelopsis* Heinrich with regard to general habitus, simple antennae in both sexes, forked apical process of the gnathos, a complete transtilla, strong sclerotization of the costa of the valva (at least basally in *Myelopsoides*), and a membranous ductus bursae. The unique appearance of the base of the valva of *Myelopsoides* readily separates the two genera.

Etymology.—The name *Myelopsoides* (gender: masculine) denotes the similarity of *Myelopsoides* and *Myelopsis.*

Myelopsoides venustus **Neunzig, new species**
(Figs. 1–9)

Type locality.—U.S.A.: California, Lee Vining Creek, 6 mi west Mono Lake, 7,200′.

Description.—Forewing length 11.0–13.5 mm. *Head*: frons and vertex white, or grayish white, and fuscous and black; labial palpus with basal segment white, or pale gray (some specimens with a few dark scales), second segment white, or pale gray, with fuscous or black scales, third segment mostly fuscous or black. *Thorax*: collar white (grayish white in some specimens), in male, washed with varying amounts of fuscous or black, in female, entirely white, or pale gray; dorsum of thorax white (pale gray in some specimens), and fuscous or black (in female, almost entirely white or pale gray). Forewing, except for dark transverse bands, mostly white (or gray) sprinkled with varying amounts of fuscous or black (female with forewing, except for dark transverse bands, almost entirely white or pale gray with very few fuscous or black scales); costa with narrow basal streak of fuscous or black; antemedial line white or pale gray (with few fuscous or black scales in some specimens), blending with ground color; distinct fuscous or black band along distal margin of antemedial line; postmedial

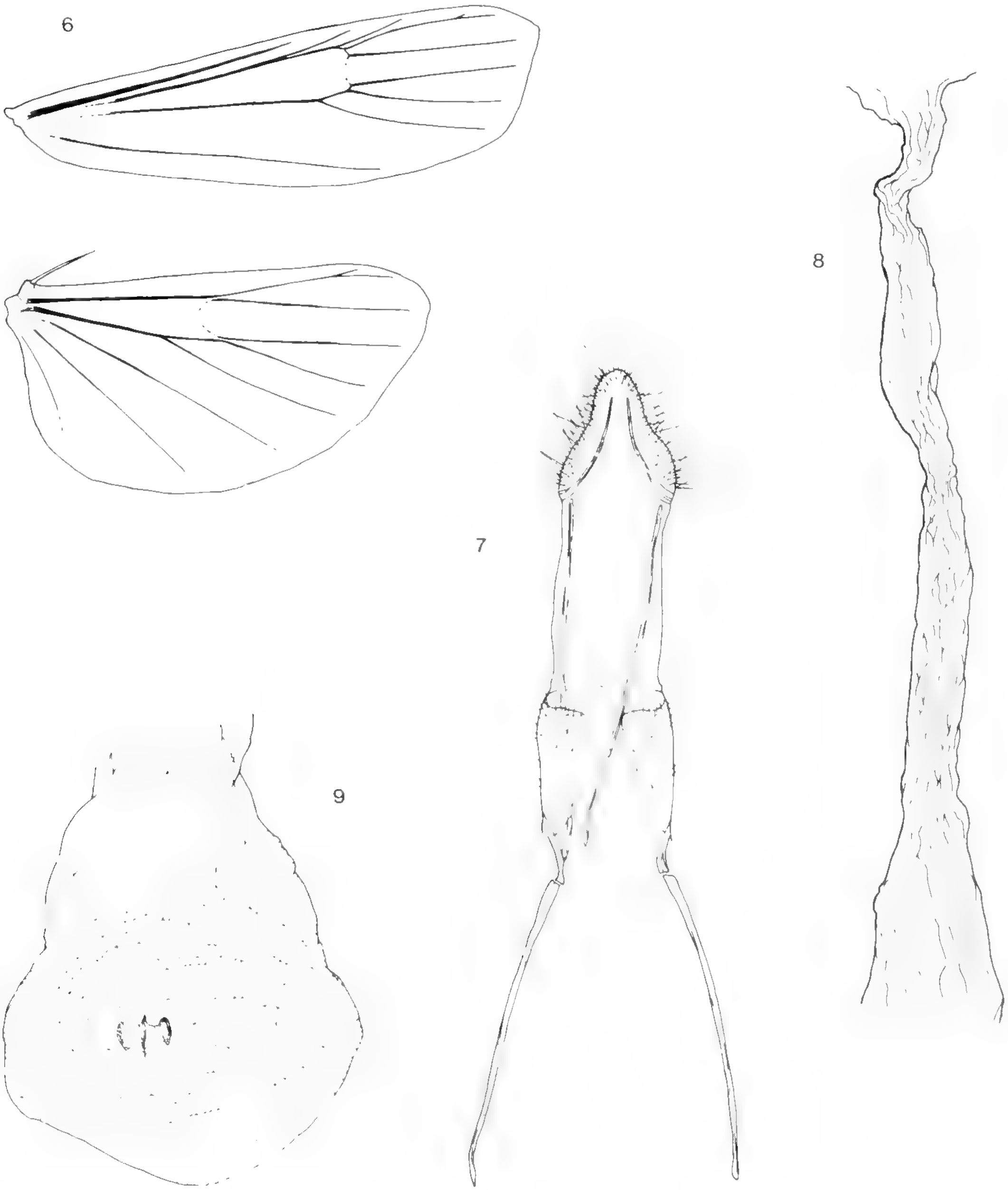


Figs. 3–5. *Myelopsoides venustus*, male genitalia, holotype. 3, Most of genitalia, part of left valva and aedoeagus omitted. 4, Aedoeagus. 5, Part of aedoeagus with vesica everted.

line white to pale gray (with little to moderate amounts of fuscous or black scales in some specimens); distinct fuscous or black band just basad of postmedial line; discal spots fuscous or black, distinct, fused. Hindwing chiefly grayish white with pale brown border, or pale brown with darker brown border. Male and female genitalia (Figs. 3–5, 7–9) as described for genus.

Immature stages.—Unknown.

Types.—Holotype: ♂. California, Lee Vining Creek, 6 mi west Mono Lake, 7,



Figs. 6–9. *Myelopsoides venustus*, male wings and female genitalia, paratype. 6, Right forewing and hindwing. 7, Posterior part of genitalia. 8, Most of ductus bursae. 9, Distal part of ductus bursae, and corpus bursae.

200′, 30-VI-87, D.C. Ferguson, genitalia slide 3977 HHN (USNM). Paratypes 8 ♂, 1 ♀. Same collection data as for holotype, genitalia slide 3978 HHN (1 ♀) (USNM). California, Blodgett For., 13 mi E Georgetown, El Dorado Co., 16-VII-67, P.F. Warner (1 ♂) (UCDC). California, 1 mi west Johnsville, Plumas Co., 18-VII-73, R. A. Belmont, genitalia slide 2003 HHN (1 ♂) (UCDC). California, Mono Co., (East) Monitor Pass, T9N R22E S6, 22-VII-84, Adam H. Porter, genitalia slides 1925 HHN, 4194 HHN, 4218 HHN (5 ♂) (UCDC). Idaho, Priest R. Exp. For., 2, 500′, Bonner Co., 25-VI-79, D. C. Ferguson, genitalia slide 1349 HHN (1 ♂) (NCSU).

Etymology.—The specific epithet *venustus* is Latin for beautiful.

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DESCRIPTIONS OF NYMPHS III AND V OF *DYSDERCUS RUFICOLLIS* (L.) (HETEROPTERA: PYRRHOCORIDAE)

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Abstract.—The third and fifth instars of *Dysdercus ruficollis* (L.) are described. Nymphs of this species have not been described previously. Bolivia is a new country record for *D. ruficollis.*

Key Words: Heteroptera, Pyrrhocoridae, *Dysdercus ruficollis,* nymphs

The genus *Dysdercus,* worldwide in distribution, is represented by 36 species in the New World. Some are serious pests of cotton. According to Loero (1947), species feed principally on *Sida* spp. When they pierce the bolls, they introduce micro-organisms which cause boll rot or a discoloration of the lint, hence their common name "cotton stainers." Many papers have been published on the genus, especially on its economic importance. Taxonomic work for the Neotropical Region are mainly those by Ballou (1906), Lima et al. (1962), and Doesburg (1968).

Among the known species of *Dysdercus,* there are surprisingly few descriptions of the immature stages. Hunter (1912) described *Dysdercus suturellus* (Herrich-Schaeffer).

The purpose of this paper is to describe nymphs III and V of *D. ruficollis* (L.). Specific determination was possible because the material studied was collected with and thus associated with adults. The record from Bolivia represents a new country record for this species.

MATERIALS AND METHODS

The material examined belongs to the following institutions: Museo Argentino de Ciencias Naturales Bernardino Rivadabia (MACN) and Museo de La Plata (MLP).

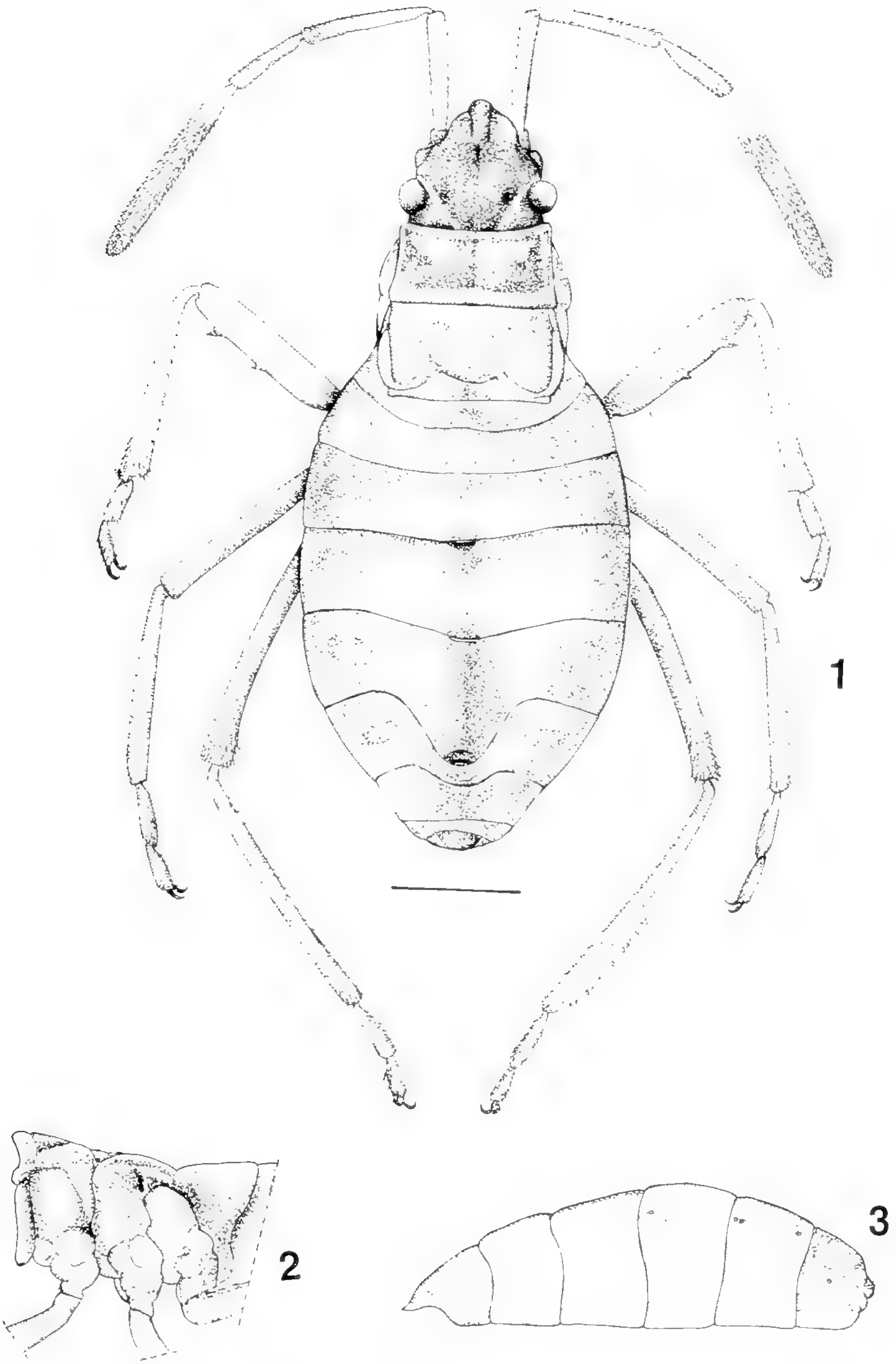
The terminology used for morphology follows Miller (1932). For the descriptions, 15 measurements were taken, and they are expressed in millimeters.

Dysdercus ruficollis (L.)
(Figs. 1–7)

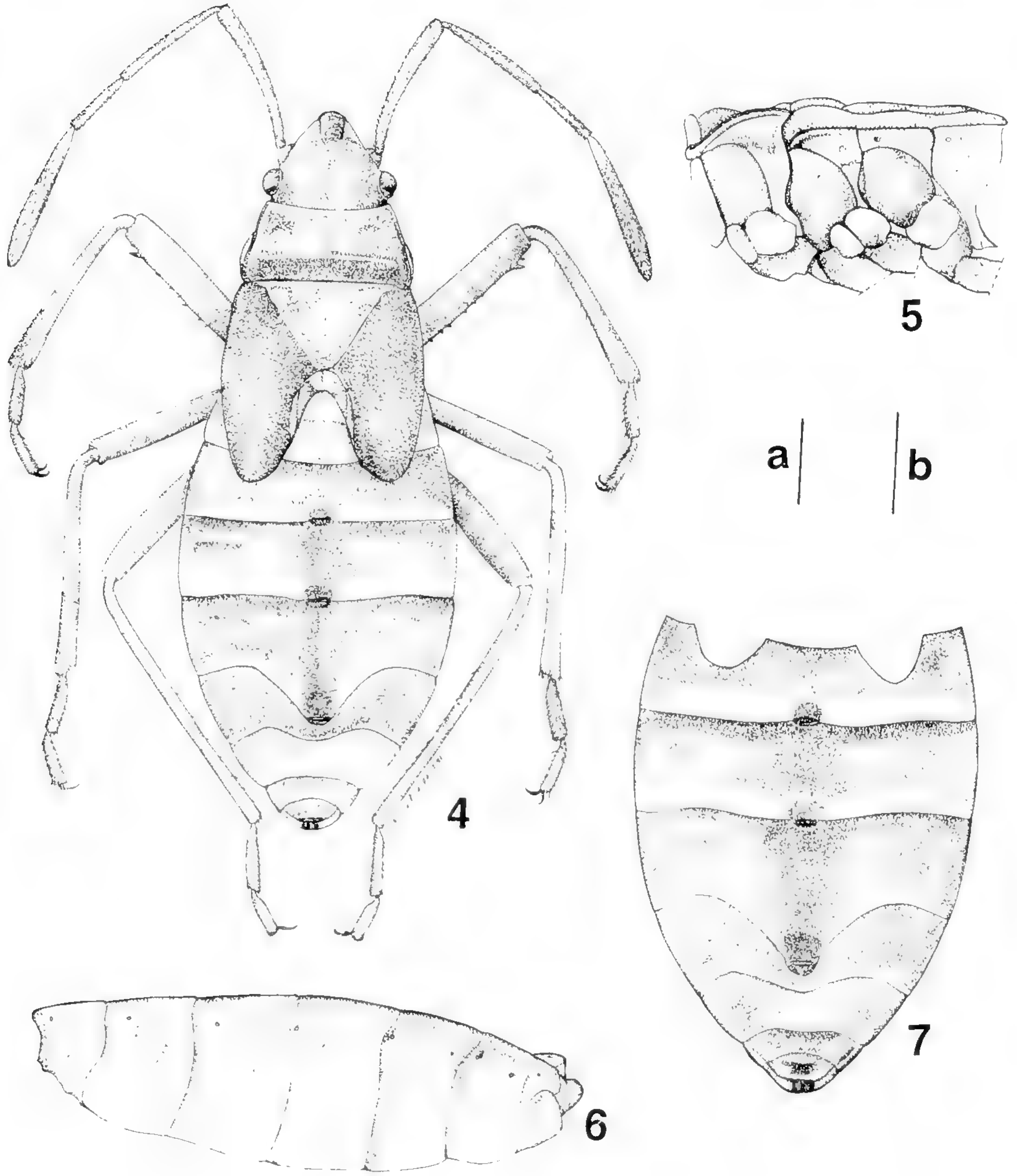
Instar III (Figs. 1–3).—Antenna dark brown; segment IV with a white broad basal ring on upper surface of basal half. Eye white with upper and lower surfaces dark brown. Pronotum anteriorly and medially brown with reddish tone, posteriorly brown. Wing pad brown. Segments 1–3 of abdomen dorsally light red, 4–5 light red with whitish stripe, 6 light red with two whitish dots, 7 red. Area around dorsal plates dark brown. Pleura as in Fig. 2. Abdomen (Figs. 1, 3) anteriorly light red and posteriorly whitish. Legs and rostrum brown. Some specimens with brownish tones instead of reddish.

Body: Length, 6.64–7.84; maximum width, 3.12–3.20.

Head: Length, 0.96–1.52; width, 1.52–1.76; eye width, 0.14–0.19; interocular space, 0.72–0.84. Antennal segment I,



Figs. 1–3. *Dysdercus ruficollis*, instar III. 1, Dorsal view. 2, Pleura, lateral view. 3, Abdomen lateral view. Scale line = 1 mm.



Figs. 4–7. *Dysdercus ruficollis*, instar V. 4, Dorsal view. 5, Pleura, lateral view. 6, Abdomen, lateral view. 7, Abdomen, dorsal view. Scale lines = 1 mm; a, Fig. 4; b, Figs. 5–7.

1.36–1.6; II, 1.20–1.52; III, 0.80–0.96; IV, 1.76–2.16.

Thorax: Length, 0.60–0.67; anterior width, 0.95–1.12; posterior width, 1.12–1.28. Length of wing pads, 0.96–1.20. Abdomen length, 4.16–5.36.

Material studied: ARGENTINA: Misiones, XI-1919, A. Nunez, 1 nymph (MACN); Santa Ana, III-1927, 4 nymphs (MLP).

Instar V (Figs. 4–7).—Antenna light brown; segment IV dark brown with a white longitudinal stripe on upper surface of basal half. Eye dark brown and brown, upper surface dark brown, lower surface paler with a reddish tinge. Pronotum anteriorly white and dark brown, medially brown with reddish tone, posteriorly yellowish and dark brown, edges dark brown or light brown. Wing pad dark brown except light brown medially. Segments 1–6 of abdomen dorsally light red with whitish stripe, 7–8 transparent or not, light red or brown, external margin of connexivum of segments 1–7 light red, 9 light red or brown. Area around dorsal plates dark brown. Pleura as in Fig. 5. Abdomen (Figs. 6, 7) anteriorly light red and posteriorly whitish. Legs and rostrum light brown. Some specimens with brownish tone instead of reddish.

Body: Length, 9.60–11.04; maximum width, 3.44–4.16.

Head: Length, 1.36–1.76; width, 2.00–2.08; eye width, 0.25; interocular space, 0.92–1.04. Antennal segment I, 2.00–2.24; II, 1.68–1.76; III, 0.96–1.12; IV, 2.56–2.80.

Thorax: Length, 0.77–1.02; anterior width, 1.33–1.39; posterior width, 1.97–2.03. Length of wing pad, 2.08–2.32.

Abdomen: Length, 0.92–0.98.

Material studied: ARGENTINA: Missiones, no. 5488, 3 nymphs (MACN); Santa Ana, III-1927, 1 nymph (MLP). BOLIVIA: no. 10324, 1 nymph (MACN). BRAZIL: no. 10346, 1 nymph (MACN).

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A NEW SPECIES OF *PYLA* GROTE AND REDESCRIPTION OF *PYLA AEQUIVOCA* HEINRICH (LEPIDOPTERA: PYRALIDAE: PHYCITINAE)

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Abstract.—A new species of phycitine pyralid, ***Pyla arenaeola,*** is described from sandy habitats in central North America. The female of this new species was previously associated with males of *Pyla aequivoca* Heinrich. *Pyla aequivoca* is redescribed, and *Pyla gaspeensis* McDunnough is placed as a synonym of *Pyla aequivoca* [**new synonymy**]. *Pyla arenaeola* is restricted to loose sandy soils, especially dunes of the Great Lakes shoreline. Its distribution appears to be associated with dunes formed since the last Wisconsin glaciation including fossil dunes on the shores of glacial Lake Agassiz. The larvae feed on bearberry, *Arctostaphylos uva-ursi* (L.) Sprengel (Ericaceae) while concealed in silk-lined sand tubes.

Key Words: Life history, dunes, *Arctostaphylos uva-ursi,* Ericaceae, Great Lakes, Pleistocene, Glacial Lake Agassiz

Heinrich (1956) grouped nine species of *Pyla* Grote based on the color of the forewings in the "Gray" section of the genus. Included were four new taxa described on the basis of well-defined genital characters. Shortly thereafter, McDunnough (1958) described *Pyla gaspeensis* from the Gaspé region of Québec and placed it in the same species group.

Recent collecting on the dunes of the Great Lakes shore has uncovered an additional species described in this paper. Based on distinct male genital characters, it is apparent that this moth is unlike any described *Pyla*. However, a female of this new species was previously described by Heinrich (1956: p.143, Fig. 855) based on a single specimen from Aweme, Manitoba, but incorrectly associated by him with the male type series of *Pyla aequivoca* Heinrich. This left *P. aequivoca* without a recognized female until examination of relevant primary types demonstrated that McDunnough's *P. gaspeensis* (McDunnough) is conspecific with *P. aequivoca.* We believe that when McDunnough described *P. gaspeensis* he was misled by both an incorrectly rendered illustration of the aedeagus of *P. aequivoca* (Heinrich, 1956, Fig. 366a; compare our Figs. 7, 10) and Heinrich's misassociated female. To clarify application of specific names we redescribe *P. aequivoca.*

The larva of the new species belongs to a guild of sand tube constructing Lepidoptera found on dunes and in other very sandy habitats. It feeds on the leaves of bearberry, *Arctostaphylos uva-ursi* (L.) Sprengel (Ericaceae). Despite the widespread distribution of its holarctic host, the new species is apparently restricted to habitats with loose, sandy soils. Documented localities include the dunes of the Great Lakes shoreline and one fossil Pleistocene dune complex in southern Manitoba.

Specimens examined originated from the following institutions and personal collections:

AMNH	American Museum of Natural History, New York, NY (F. H. Rindge)
BGS	B. G. Scholtens, Charleston, SC
CNC	Canadian National Collection, Ottawa, ON, Canada (J.-F. Landry)
EGV	E. G. Voss, Mackinaw City, MI
GJB	G. J. Balogh, Portage, MI
JAB	J. A. Bess, Wanatah, IN
JHW	J. H. Wilterding, East Lansing, MI
JKM	J. K. Morton, Waterloo, Canada
LACM	Los Angeles County Museum, Los Angeles, CA (J. P. Donahue)
LAF	L. A. Ferge, Middleton, WI
MSU	Michigan State University, East Lansing, MI (F. W. Stehr)
NMNH	National Museum of Natural History, Smithsonian Institution, Washington, DC (M. A. Solis)
UCB	University of California, Berkeley, CA (J. A. Powell)
UM	University of Minnesota, St. Paul, MN (P. J. Clausen)
UMDLB	University of Michigan Douglas Lake Biological Station, Pellston, MI (B. G. Scholtens)
UMMZ	University of Michigan Museum of Zoology, Ann Arbor, MI (M. F. O'Brien)
UZMH	Zoologiska Muset, Universitets Helsinki, Helsinki, Finland (J. Jalava, K. Mikkola)

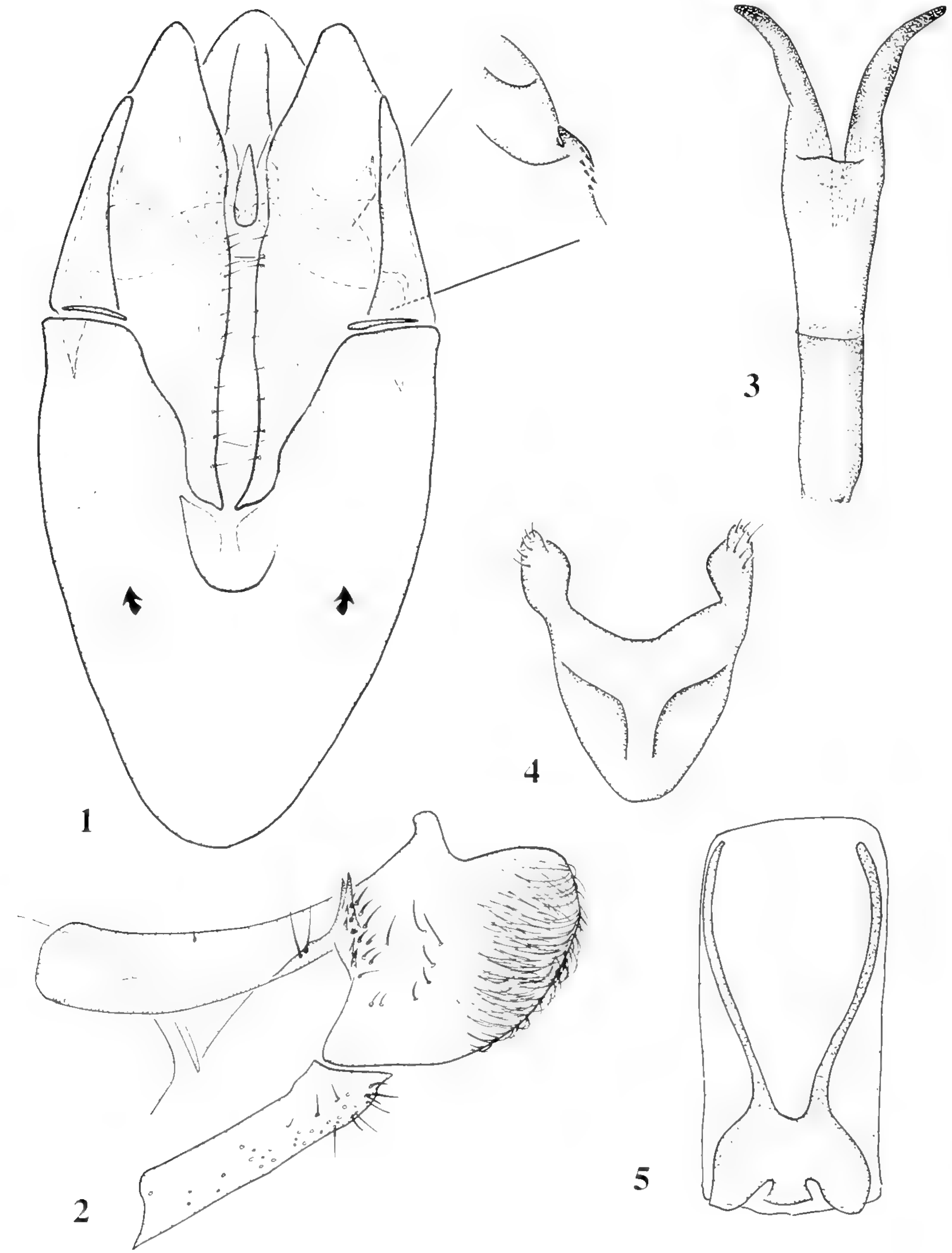
Relevant types in the CNC and NMNH collections were examined during the course of this study.

Pyla arenaeola Balogh and Wilterding, new species

(Figs. 1–5, 11–13, 17, 19–22)

Diagnosis.—Most *Pyla arenaeola* can be distinguished from other *Pyla* species by the broad blue-gray forewings and relative absence of light scaling in the lower outer aspect of the median space (Figs. 19–21). A unique dark morph occurs in both sexes (Fig. 22). However, identification is only confirmed by genital features. The distal costal process of the valva in males (Fig. 2), and the elongate, triangular plates of the ostium bursae in females (Fig. 11) differentiate *Pyla arenaeola* from all other known *Pyla*. In addition, the new species is closely associated with loose sandy soils, especially dunes, and the larval host, bearberry (*Arctostaphylos uva-ursi.*).

Description.—*Alar expanse:* 23.0 to 28.7 mm (Mean = 25.3, n = 23). *Vestiture:* A mixture of dark gray, pale gray, whitish, and pale-tipped gray scales. *Head:* Frons convex, a conical tuft of gray or pale-tipped gray scales dorsally, whitish ventrally; male vertex shallowly concave with appressed central scaling; female vertex flat with loose central scaling; in both sexes anterior and posterior vertex scale tufts of gray or pale-tipped gray scales, midvertex usually paler; ocelli and chaetosemata well developed; labial palpus ascending to level of vertex, 2nd segment longest and broadest, male with medial maxillary palpal groove, 3rd segment thin and very short, less than ¼ length of 2nd, scaled with gray and pale scales, base and mesial aspect often nearly white, 3rd segment darker and sometimes pale at tip; male maxillary palpus extends nearly to ⅓ length 2nd segment labial palpus, 1st segment thin and elongate, 2nd bulbous distally, pale tufts of hairlike and elongate thin scales from 2nd and 3rd segments extend ½ to ⅔ length 2nd segment labial palpus, female maxillary palpus short, 1st segment reduced, scales shorter and broader; tongue well developed, covered proximally with gray and pale scales; antenna laminate, basal 5–6 segments of male flagellum modified forming a mesial sinus, first several segments of sinus may be fused or partially fused, each modified segment with distal spine, spines progressively larger distally, sinus bordered medially and laterally by rows of gray scales, inner row of scales

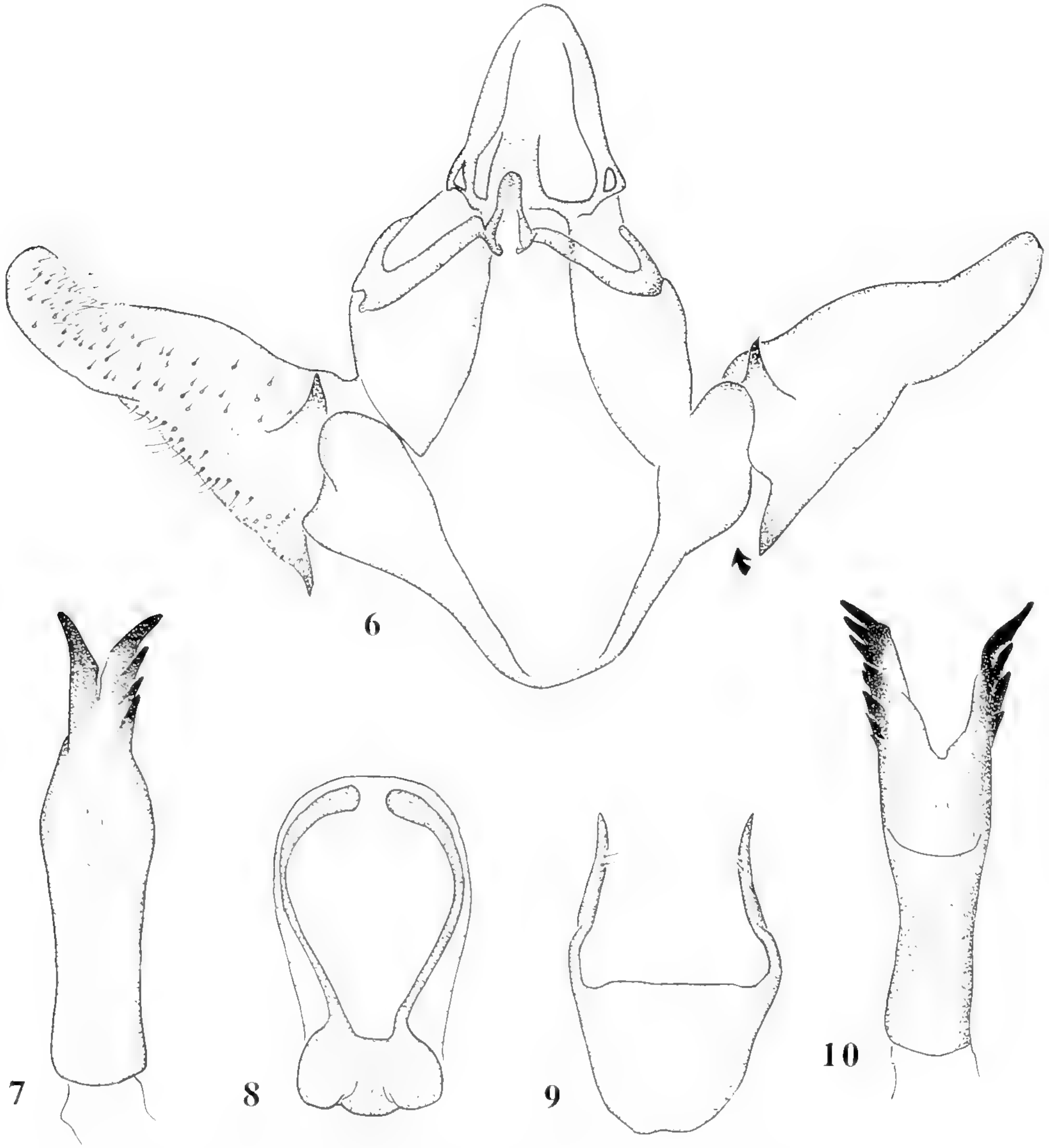


Figs. 1–5. *Pyla arenaeola*, male genitalia. 1, Genital capsule, valves unspread and aedeagus removed, ventral view; telescoped figure illustrates patch of small spines on tegumen near junction with gnathos; arrow heads indicate pouches formed by anellar membrane. 2, Right valva, medial aspect. 3, Aedeagus, ventral view. 4, Juxta, ventral view. 5, 8th sternite, ventral view, without scale tufts.

forming medial border of sinus modified, thick, dark, each with curved central spine-like tooth, base female flagellum unmodified, unmodified segments of flagellum in both sexes scaled with fine bands of gray and pale scales, male scape with a patch or band of pale scales along posteromedial aspect, female scape pale distally. *Thorax:* Dorsum, tegula, and collar of thorax gray, scales sometimes faintly pale-tipped, small white patches on posterolateral aspect of dorsum, lateral and ventral thorax with mixture of gray and whitish scales, predominately white laterally; legs scaled with mixture of gray and whitish scales, white predominates on mesial aspect, mesotibia with dark band at two-thirds, tarsi contrastingly dark, each segment white-tipped distally, protibia with spine-tipped epiphysis from middle extending just distal to first tarsal joint, mesotibia with one and metatibia with two pair of spurs. *Wings* (Figs. 19–21): Forewing gray variably overscaled with white and white-tipped gray scales, in fresh individuals the forewing appears blue-gray; pale scaling fairly evenly distributed in basal and subterminal spaces; median space pale scaling denser in costal half and just distal to antemedial line and making the lower outer aspect of median space appear contrastingly dark; antemedial line white, oblique, indented and most sharply defined in lower third, margined proximally by dark gray band along lower third, and distally by dark band which is widest at costal half; a small white patch of scales often evident near inner margin just distal to antemedial line; postmedial line white, variably sinuate to dentate, often more sharply defined at costa and inner margin, indented opposite cell and in lower third, margined proximally and distally by weakly defined darker banding; terminal line a thin row of dark gray spots; discal spot dark gray, double, usually a thin connection along proximal aspect, lower component elongate along axis of wing; fringe pale gray white-tipped scales; underside gray, contrastingly pale at costal edge and along inner margin, vague indication of pale postmedial and dark terminal lines; hindwing brownish gray, veins slightly darker; a thin slightly darker gray line at outer margin; fringe pale gray, a darker gray band proximal third; underside light gray, slightly darker at costal and outer margins. Dark morph (Fig. 22) occurs in both sexes (8% of material examined); forewing nearly uniform dark slate gray with at most a few scattered white scales; crosslines reduced to a vague, thin antemedial line, most contrasting at inner margin, and a faint white postmedial line which may be evident only at costal and inner margins; darker banding and discal spot often obscure; vague small patches of white scales may be evident along inner margin just distal to antemedial line and distal to position of discal spot. *Abdomen:* Scaled with gray and whitish scales forming lighter bands at posterior margin of segments.

Male genitalia (Figs. 1–5): Uncus subtriangular, slightly constricted near base; gnathos with a stout central hook; valva (Fig. 2) with tooth-like distal costal process, base of costa unmodified; clasper (*sensu* Heinrich) beyond middle of valva at junction of central membranous window and distal sclerotized portion, with setae and small spines; tegumen with weak cluster of small spines near junction with gnathos (see telescoped illustration Fig. 1); juxta (Fig. 4) with ventrally produced blind pockets and paired short blunt lateral processes that have fine distal setae; aedeagus (Fig. 3) divided distally, divisions symmetric, sclerotized, laterally outcurved, pointed, and without additional lateral spines below tips, cornuti absent; anellar membrane (arrows, Fig. 1) extensively developed into distinct membranous pouches extending onto valva; eighth abdominal sternite sclerotized as in Fig. 5 with prominent hair pencils.

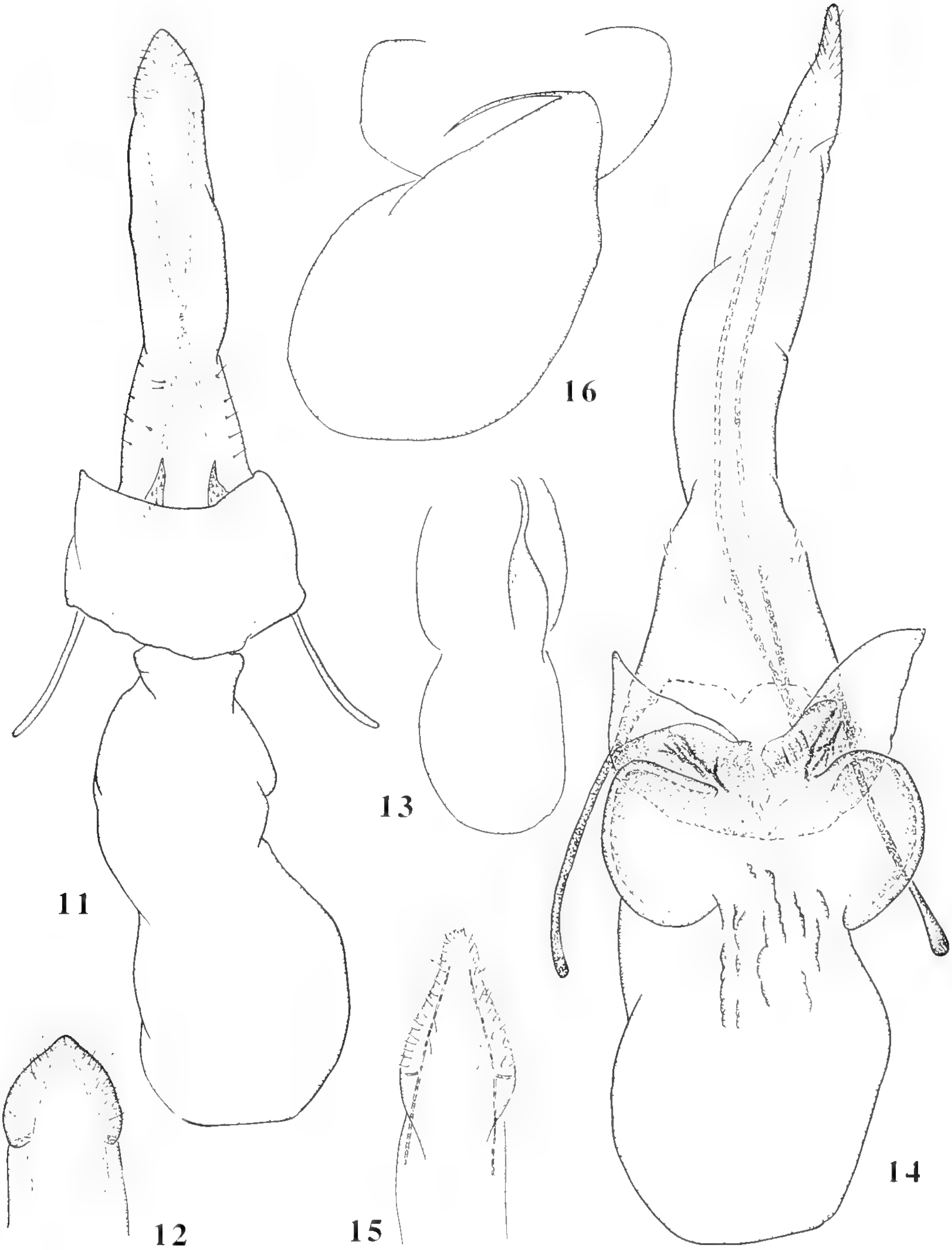
Female genitalia [Figs. 11–13; Heinrich (1956): Fig. 855 (as *aequivoca*)]: Junction of ostium bursae and ductus bursae weakly convoluted, lightly sclerotized; triangular plates of ostium bursae, elongate, sclerotized, with fine spines; ductus bursae broad



Figs. 6–10. *Pyla aequivoca*, male genitalia. 6, Genital capsule, valves spread, aedeagus and juxta removed; note that the valves have partly separated from the vinculum along ventral margin (arrow). 7, Aedeagus, dorsal view (Mackinaw Co., Michigan). 8, 8th sternite, ventral view, without scale tufts. 9, Juxta, ventral view. 10, Aedeagus, ventral view, distal divisions spread out (vic. Schefferville, Québec).

with shallow lateral lobes, nearly continuous with corpus bursae but defined by its thickened membrane, with variably expressed minute median sclerotized patch and weakly developed paired sinuous lines of sclerotization laterally but without broad sclerotized patches or bands; corpus bursae membranous and subrectangular; ductus seminalis dorsal (Fig. 13), arising at posterior margin of corpus bursae, with slight sclerotized collar at junction; ovipositor telescoped, less than half length of genital capsule, ovipositor lobes rounded laterally (Fig. 12).

Holotype.—♂ (Fig. 19), Michigan: Allegan Co., Saugatuck Dunes State Park,



Figs. 11–16. *Pyla arenaeola* and *P. aequivoca,* female genitalia. 11–13, *P. arenaeola.* 11, Genital capsule, ventral view. 12, Ovipositor lobes. 13, Ductus and corpus bursae, dorsal view, illustrating entrance of ductus seminalis. 14–16, *P. aequivoca.* 14, Genital capsule, ventral view. 15, Ovipositor lobes. 16, Ductus and corpus bursae, dorsal view, illustrating entrance of ductus seminalis.

42.39′18″N, 86.12′07″W, 7 August 1992, dunes, G. J. Balogh (NMNH).

Paratypes.—(157 ♂, 92 ♀). UNITED STATES. INDIANA: Porter Co.- 1 ♂, Ogden Dunes, 10 Sep 1996 (Bess)(JAB). MICHIGAN: Allegan Co.—1 ♂, Saugatuck State Park, 8 Aug 1992, dunes (Balogh)(GJB); 3 ♂, 6 ♀, Saugatuck State Park, 3 Jul 1994 (Balogh)(GJB); 4 ♂, 2 ♀, 42.39′18″N, 86.12′07″W, 1 Sep 1995, Saugatuck Dunes State Park, UV (Wilterding)(JHW); 6 ♂, 4 ♀, Saugatuck Dunes SP, 7–8 Aug 1992 (Balogh)(GJB); 1 ♂, 1 ♀, Saugatuck SP, dunes, 29 Jul 1995 (Balogh)(GJB); 12 ♂, 6 ♀, Saugatuck SP, dunes, 26 Aug 1995 (Balogh)(GJB); 1 ♀, Saugatuck SP, dunes, 16 Sep 1995 (Balogh)(GJB); 3 ♂, Saugatuck SP, [larva and pupae in silk/sand tubes under *A. uva-ursi*] collected 15 Jun 1995, em. 24 Jun [pupa], 16 Jul, and 17 Aug 1995 (Balogh)(GJB). Antrim Co.—1 ♀, T32N, R8W, sec 26, 21 Aug 1994 (Stehr)(MSU). Charlevoix Co.—2 ♀, Fisherman's Island State Park, dunes, 13 Aug 1988 (Balogh)(GJB); 1 ♀, High Island, 27 Jul 1923 (Moore)(UMMZ); 1 ♀, Beaver Island, 17 Jul 1925 (Moore) (UMMZ). Cheboygan Co.—6 ♂, T38N, R1W, NE¼ of sec 25, 5–18 Jul 1995 (Scholtens) (BGS); 1 ♂, Douglas Lake, Jul (NMNH); 1 ♂, Douglas Lake (UMMZ). Chippewa Co.—5 ♂, 6 ♀, 0.7 mi S Whitefish Point, Boat Launch, 3 Jul 1988 (Balogh)(GJB); 2 ♂, dunes and wetland on Lake Huron just E of Albany River, 22 Jun 1992 (Balogh)(GJB). Emmet Co.—3 ♂, Wilderness SP, T38N, R5W, sec 8, 22 Jun 1992 (Balogh)(GJB); 1 ♂, Wilderness SP, base of Waugoshance Point, 19 Aug 1990 (Balogh)(GJB). Keweenaw Co.—6 ♂, 2 ♀, Great Sand Bay Dunes, W of Eagle Harbor, 18 Jul 1995 (Balogh)(GJB). Leelanau Co.—1 ♀, T32N, R11W, sec 13, 13 Aug 1988 (Balogh)(GJB). Mackinac Co.—4 ♂, 13 ♀, dunes 1 mi W of Brevoort Rd, 13 Aug 1993 (Balogh)(GJB); 1 ♂, 0.9 miles W of Brevoort Rd, dunes, ex. pupa in sand/silk tube 1–2 inches under surface of sand, coll. 22 Jul 1995, emer. 25 Jul 1995 (Balogh)(GJB); 3 ♂, 2 ♀, Hog Island Point, dunes, 21 Aug 1990 (Balogh)(GJB); 1 ♂, 1 ♀, Pte. Aux Chenes, dunes/wetlands, 13 Aug 1993 (Balogh)(GJB); 3 ♂, Pte. Aux Chenes Bay, 2–3 Aug 1996 (Balogh)(GJB); 1 ♀, T41N, R5W, sec 22, dunes, larvae coll. 23 May 1996, ex. larvae in sand tubes under *A. uva-ursi*, issued 21 Jul 1996 (Balogh)(GJB); 6 ♂, 1 ♀, T41N, R5W, sec 22, 2 Aug 1996 (Balogh)(GJB). Mason Co.—15 ♂, 6 ♀, Ludington State Park, dunes, 26–27 Aug 1994 (Balogh)(GJB); 18 ♂, 15 ♀, Ludington SP, dunes, 11–12 Aug 1995 (Balogh)(GJB); 29 ♂, 10 ♀, Ludington SP, dunes, 26–27 Jul 1996 (Balogh)(GJB). Muskegon Co.—1 ♀, Muskegon SP, dunes, 18 Jun 1988 (Balogh)(GJB). Oceana Co.—1 ♀, Little Point Sable Light House, dunes, 27 Aug 1993 (Balogh)(GJB). Presque Isle Co.—1 ♂, 1 ♀, Hoeft S. P., dunes, coll. 24 May 1996, ex. larvae in sand tubes under *A. uva-ursi*, ♀ issued 28 Jun 1996, ♂ issued 29 Jun to 21 Jul 1996 (Balogh)(GJB). WISCONSIN: Ashland Co.—3 ♂, T49N, R4W, sec 13, Long Island sand dunes, 21 Jul 1995 (Ferge)(LAF); 2 ♀, T49N, R4W, sec 13, Long Island sand dunes, 9 Aug, 1996 (Ferge)(LAF). Manitowoc Co.—3 ♂, T20N, R25E, sec 16, 23 Aug 1992 (Ferge)(LAF). CANADA. MANITOBA: 1 ♀, Aweme, 26 Aug 1921 (Criddle)(CNC). ONTARIO [all localities are on islands in Lake Huron]: 2 ♂, Wagash Bay, Cockburn Is., 9 Jun 1977 (Morton)(JKM); 2 ♂, Carter Bay, Manitoulin Is., 9 Aug 1988 (Morton)(JKM); 1 ♂, 1 ♀, Dean's Bay, Manitoulin Is., 19 Jun 1996 (Morton)(JKM); 3 ♂, Dean's Bay, Manitoulin Is., 8 Jul 1996 (Morton)(JKM); 1 ♂, Dominion Bay, Manitoulin Is., 1 Sep 1990 (Morton)(JKM); 1 ♂, Michael Bay, Manitoulin Is., 13 Jul 1989 (Morton)(JKM); 1 ♀, Providence Bay, Manitoulin Is., 27 Aug 1977 (Morton)(JKM); 1 ♂, Square Bay, Manitoulin Is., 18 Jun 1991 (Morton)(JKM); 2 ♂, 1 ♀, Mississagi Is., North Channel, 7 Aug 1977 (Morton)(JKM); 1 ♂, West Duck Is., 3 Aug 1976 (Morton)(JKM).

Distribution.—(Fig. 17). All recently

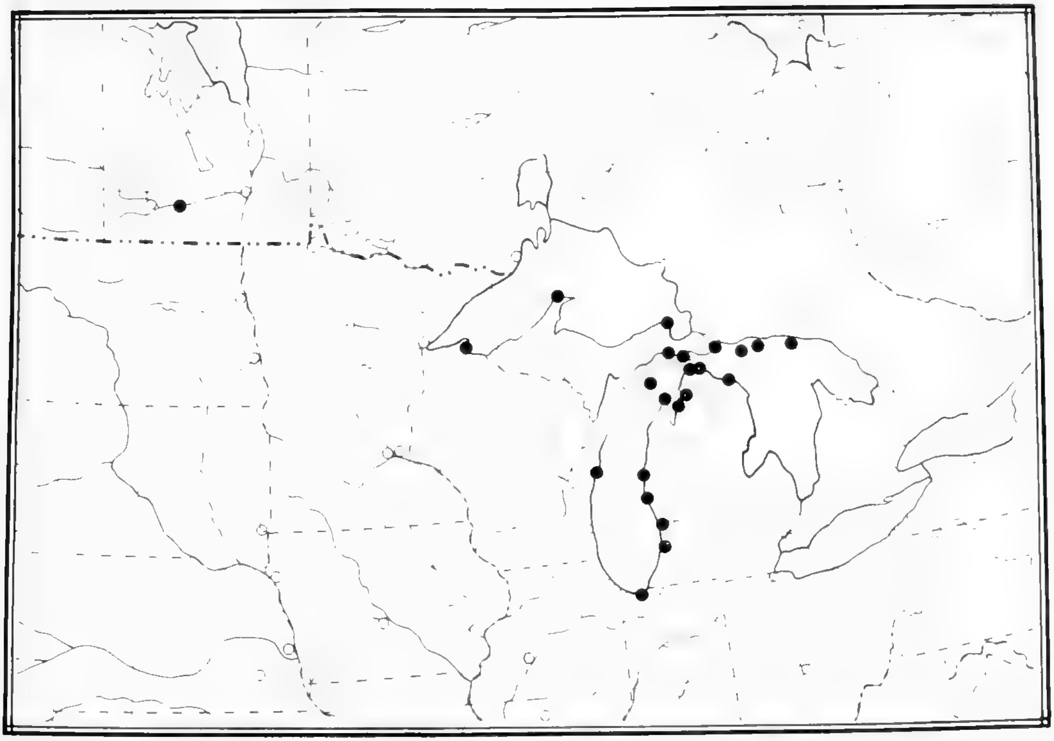


Fig. 17. Known distribution of *Pyla arenaeola* in central North America (because of close proximity not all localities are represented with a dot).

documented localities are from the dunes of the Great Lakes shore extending from the Manitoulin Island region of Lake Huron west to the western portion of Lake Superior and south along the shores of Lake Michigan to northern Indiana. The species may range throughout the Great Lakes basin; appropriate dune habitat is found as far east as the eastern shore of Lake Ontario (J.K. Morton, personal communication, 1996).

Specimens labeled Douglas Lake, Michigan (NMNH, UMMZ) may have originated on the shores of that inland lake approximately ten miles from the nearest Great Lakes shoreline. However, it is possible these specimens are mislabeled since the locality label "Douglas Lake" has been used by students over the years to designate the general vicinity of the University of Michigan Biological Station. Also, there are no recently documented specimens from Douglas Lake despite intense collecting of pyraloids in the region (Scholtens 1996).

The Manitoba record, a single female collected at Aweme (August 26, 1921, Norman Criddle, CNC), is the specimen Heinrich (1956) misidentified as *P. aequivoca.* This is the only known record from outside the Great Lakes basin. The specimen originated from a region of fossil Pleistocene sand dunes which formed at the delta of the Assiniboine River where it entered glacial Lake Agassiz (Dubois 1976, Teller 1984).

Habits and life history (Figs. 29–34).—In the Great Lakes region *P. arenaeola* is often common on foredunes (partially stabilized dunes), dune ridges, and blowouts of the Great Lakes shoreline where the larval host, bearberry, *Artostaphylos uva-ursi,* grows in prostrate creeping mats (Figs. 29, 30). Here it is often in association with beach grass, *Ammophila breviligulata* Fern.; sand reed grass, *Calamovilfa longi-*

folia (Hooker) Scribner var. *magna* Scribner & Merrill; jack pine, *Pinus banksiana* Lamb.; cottonwood, *Populus deltoides* Marshall; and mat-forming plants such as false heather, *Hudsonia tomentosa* Nutt.; common juniper, *Juniperus communis* L.; and creeping juniper, *Juniperus horizontalis* Moench.

Early instar larvae form short, thin tubes of silk and sand particles and skeletonize the lower leaf surfaces of the host (Fig. 32). Young larvae reared from eggs in the absence of sand form tubes of frass and silk (B.G. Scholtens, personal communication, 1996). Later instars form networks of larger tubes on and just beneath the sand surface and attached to the prostrate branches of the host (Fig. 33). Leaves and short branch segments are often incorporated into the tubes, and leaf segments are cut off and transported into the tube shelters where the larvae remain concealed. The sand tubes contain scattered frass, scattered leaf fragments, and occasional groups of leaf fragments which are apparently food caches (Fig. 34). Although the larval tubes of *P. arenaeola* are horizontal at or near the surface, pupation occurs in a vertical tube segment an inch or two under the sand surface.

Last instar larvae are gray green, lighter ventrally, and lack conspicuous longitudinal lines or markings. The head as well as the prothoracic and anal shields are heavily sclerotized, dark brown, and also lack conspicuous markings.

In spring (mid-May) and summer (late July), both early and late instars can be found on the dunes which correlates with the prolonged adult flight (June 9 to October 11—the latest date is not part of the type series). Based on spring collections which often include late instars, the larvae probably overwinter. Most adults were collected during July and August. Adults are nocturnal and strongly attracted to blacklight, but occasionally are flushed from bearberry mats during the day (Fig. 31). It is uncertain if *P. arenaeola* is univoltine with asynchronous development, or perhaps facultatively bivoltine with broadly overlapping broods. In view of relatively prolonged larval development the former is favored.

Comments.—Initial examination of the male genitalia of *Pyla arenaeola* collected on the Great Lakes dunes demonstrated that it was unlike any described species in the genus. Females have characteristic genitalia (Fig. 11) and agree well with a specimen collected at Aweme, Manitoba (Heinrich 1956, Fig. 855) and placed by Heinrich under *Pyla aequivoca.* Although Heinrich incorrectly associated this female with the male type series of *P. aequivoca,* he did so with reservation since he excluded it from the type series of *P. aequivoca.*

While *P. arenaeola* may be confused with a number of other *Pyla* species, the association with dune habitats containing the foodplant is strong evidence that the identity of a moth flying there will be *P. arenaeola.* Other than the widespread and well known *Pyla fusca* (Haworth), *P. arenaeola* is the most commonly encountered *Pyla* in Great Lakes sand dune habitat. Occasionally *Pyla aenigmatica* Heinrich and *Pyla insinuatrix* Heinrich are collected on dunes but they probably stray from other shoreline habitats. Both *P. aenigmatica* and *P. aequivoca* are typically associated with inland sandy habitats, however, *P. insinuatrix* is most often encountered in fens and sedgy wetlands in the Great Lakes region (in coastal bogs in Nova Scotia, D.C. Ferguson, personal communication, 1995).

Besides habitat preferences, subtle superficial characters that are best appreciated in a series of fresh specimens, also support the correct association of sexes for gray *Pyla* of the Great Lakes region. The forewings of *P. fusca* are usually dark gray and perceptibly narrower than other *Pyla* of the region. Great Lakes region *P. aequivoca* (Figs. 23, 24) can be very close to *P. fusca* in color but often the pale forewing scaling is more prominent and the forewings broader in *P. aequivoca.* Fresh *P. insinuatrix* demonstrate dense pale whitish-gray fore-

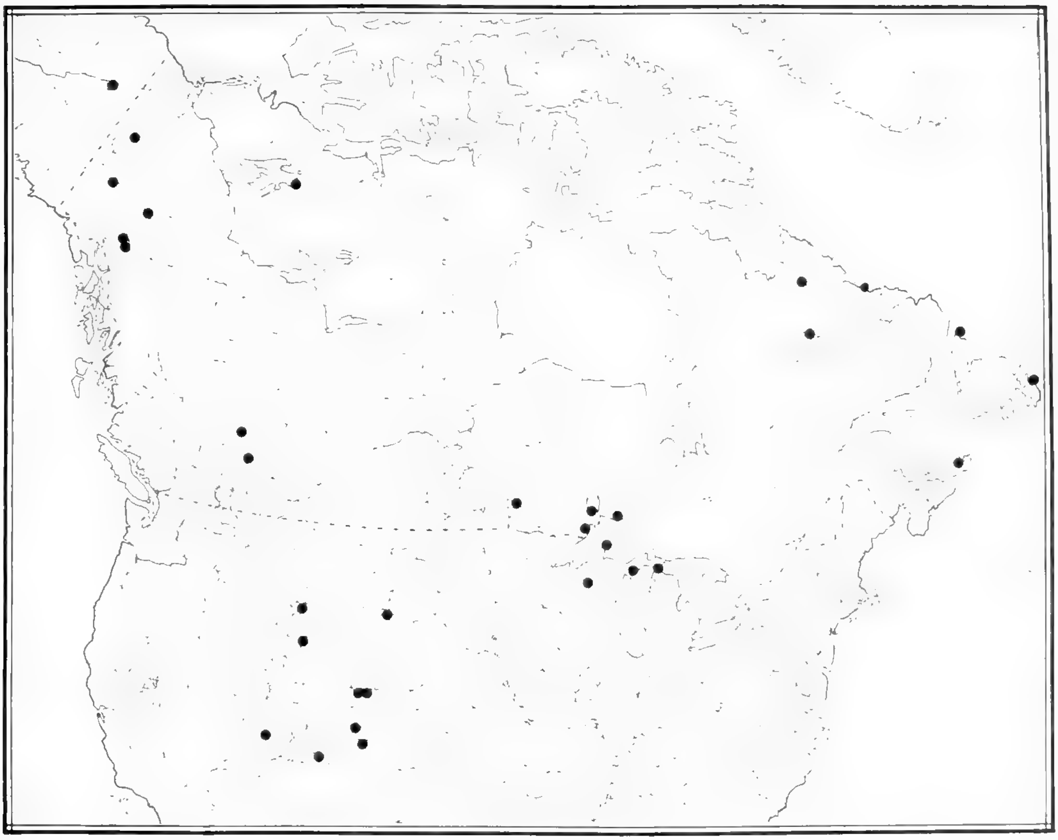


Fig. 18. Known distribution of *Pyla aequivoca* in North America (because of close proximity not all localities are represented with a dot).

wing scaling, with sharply contrasting dark maculation and the forewings of *P. aenigmatica* are medium gray with sharply defined dark maculation. The hindwings of the latter are contrastingly whitish, often lighter than other *Pyla* of the region. Finally, *P. arenaeola* has quite broad forewings, typical fresh individuals (Figs. 19–21) being bluish-gray with the pale scaling less dense in the lower-outer aspect of the medium space than elsewhere on the wing. The dark form, which occurs in both sexes (less than 10 percent of the population), is blackish-gray with pale scaling and maculation much reduced (Fig. 22), a combination not found in other North American *Pyla*.

Pyla arenaeola shows remarkably little variation in genital features; the characteristic triangular plates of the ostium bursae show only minor variation in shape and width.

Etymology.—The specific epithet *arenaeola* is derived from *arena*, L. = sand, and *Aeolus*, L. (*Aiolos*, Gr.) = god of the winds, to designate the sandy wind-blown habitat. The Greek word *aiolos* also means shifting, changeable, or variable (Brown 1956) which describes the nature of dunes and also refers to the dimorphic appearance of the moth.

Pyla aequivoca Heinrich
(Figs. 6–10, 14–16, 18, 23–28)

Pyla aequivoca Heinrich 1956: 143. Holotype ♂, Banff, Alberta, Canada (CNC). Type examined.

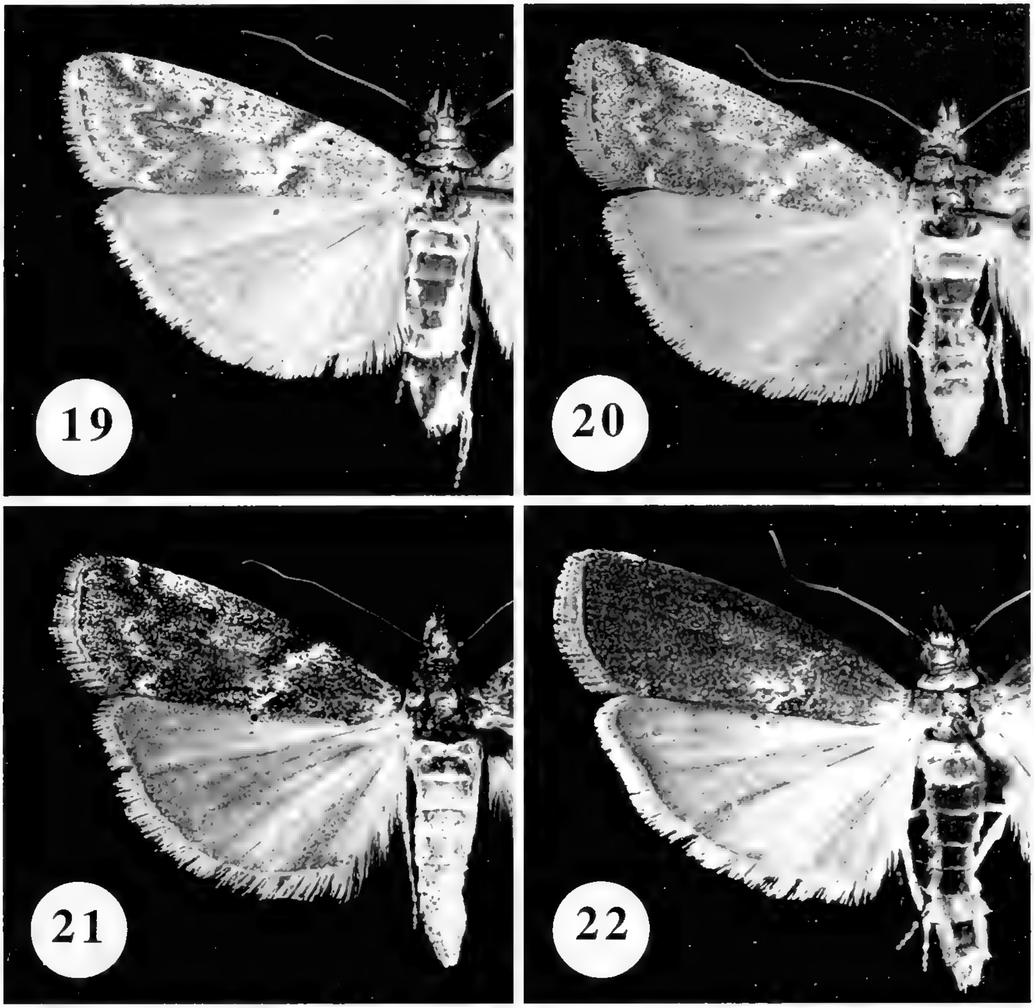
Pyla gaspeensis McDunnough 1958: 5. Holotype ♂, Mile 49, Cascapedia Road, Gaspé, Québec, Canada (CNC). Allotype ♀, Cascapedia Road, near Mt. Albert, Gaspé, Quebec, Canada (NMNH). Types examined. **New synonym.**

Diagnosis.—*Pyla aequivoca* is a variable, broadly ranging species, best distinguished from other *Pyla* based on the following genital features. Aedeagus (Figs. 7, 10) with a variable number of asymmetrically developed stout lateral spine-like processes; valva (Fig. 6) with short clasper (*sensu* Heinrich) near base and lacking costal processes; juxta (Fig. 9) shield-like with a pair of symmetric, elongate and pointed lateral processes. Ostium bursae with lateral, ridged, finely spiculate, sclerotized plates that are roughly rectangular in shape; ductus bursae with distinct lateral outpouchings and lacking well developed sclerotizations at the junction of the ostium and ductus bursae or broad sclerotized patches or bands (Fig. 14).

Description.—*Alar expanse:* 20.5–27.5 mm (Mean = 24.0, n = 26); slightly larger in the southern Rocky Mountain region (UT, WY, CO: Mean = 26.1, n = 10). Vestiture, head, thorax, and abdomen as in *Pyla arenaeola,* except where indicated. *Head:* Anterior and posterior vertex scale tufts gray, pale-tipped, occasionally all vertex scales nearly white and contrasting; labial palpus with 3rd segment about ¼ length of second; male maxillary palpus extends nearly to middle 2nd segment labial palpus and scale tufts extend to end segment labial palpus; scale tufts female maxillary palpus extend to ⅔ length 2nd segment labial palpus; male antenna with sinus bordered by gray, often pale-tipped scales, sinus including modified scales otherwise as in *Pyla arenaeola,* unmodified segments of flagellum in both sexes predominately scaled with gray, scape with a line of pale scales along posteromedial aspect. *Thorax:* Dorsum, tegula, and collar with pale-tipped gray scales, lateral and ventral thorax predominately white. *Wings* (Figs. 23–28): Forewing, individually and geographically variable, dark specimens can be very dark glossy gray with reduced pale scaling (Fig. 25); distribution of light and dark scales sometimes patchy giving the wing a mottled appearance (Fig. 26); in the southern Rocky Mountain region (Colorado, Wyoming) often light gray with more uniform distribution of pale whitish scales (Figs. 27, 28); antemedial line pale, variably sinuate, indented in lower third, margined proximally and distally by darker lines that are broadest and darkest proximally along lower third and distally along costal half of antemedial line; postmedial line pale, dentate, indented opposite cell and in lower third, margined proximally and distally by darker lines; discal spots dark, fused or separate; terminal line a thin row of dark spots; fringe overlapping rows of pale-tipped gray scales; underside gray, pale shade along inner margin and sometimes along costa, faint indication of postmedial and terminal lines; hindwing pale brownish gray, sometimes semitranslucent, darkened along outer margin, veins slightly darker; fringe paler with a gray band proximal third; underside pale gray, darker at costa and outer margin, vague indication of pale subterminal band.

Male genitalia (Figs. 6–10): Uncus hoodlike; gnathos with stout central hook; valva (Fig. 6) widest near basal third, tapering to apex, costa weakly convex centrally and without processes or other modifications; clasper short, angulate, near base of valva, with a variable number of small spines and setae; tegumen without spine clusters; juxta (Fig. 9) shield-like with elongate pointed caudal processes, the processes often with a few setae; aedeagus (Figs. 7, 10) divided distally, the divisions sclerotized laterally and asymmetrically spined, 1 to 8 posterolaterally directed spines on each division, usually more numerous on left, cornuti absent; eighth abdominal sternite sclerotized as in Fig. 8 with prominent hair pencils.

Female genitalia (Figs. 14–16): Junction of ostium and ductus bursae strongly con-

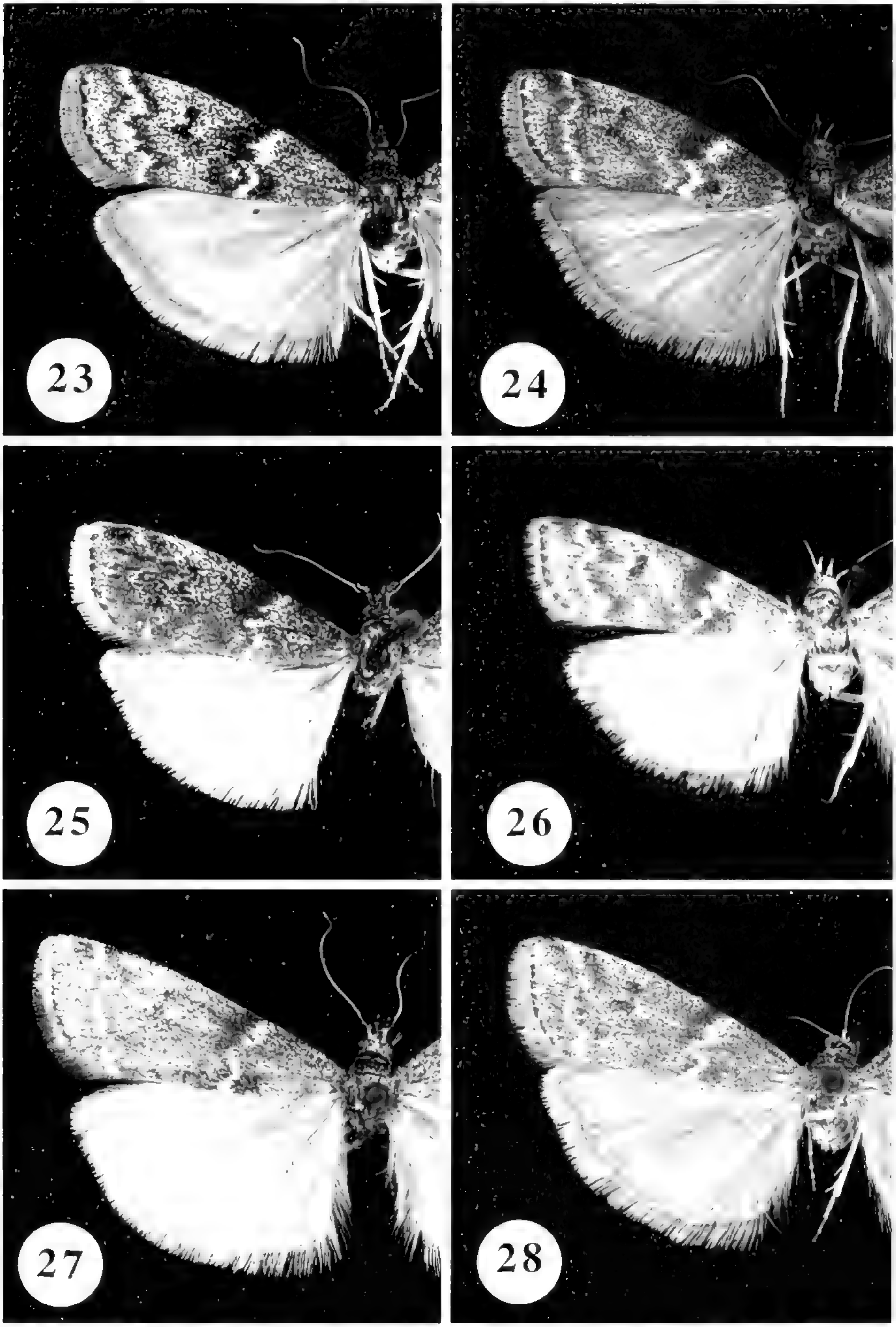


Figs. 19–22. *Pyla arenaeola*, adults. 19, Holotype, male, Saugatuck Dunes State Park, Allegan Co., Michigan. 20, Paratype, female, same locality. 21, Paratype, female, same locality. 22, Paratype, male, dark form, same locality.

voluted, wrinkled, and membranous; paired sclerotized plates of ostium bursae with irregular ridges and furrows, finely spiculate, without caudal extensions; ductus bursae broad with lateral lobe-like, partially sclerotized pouches, variable small sclerotized regions on lateral lobes but ductus bursae without broad strongly sclerotized patches or bands, junction ductus and corpus bursae only slightly constricted; corpus bursae membranous and subrectangular; ductus seminalis (Fig. 16) dorsal, arising on posterior margin of corpus bursa, without sclerotized collar at junction; ovipositor telescoped, about ½ length of entire genital capsule, ovipositor lobes (Fig. 15) taper to nipple-like tip.

Types examined.—*Pyla aequivoca* Heinrich. Holotype (CNC): "Banff, Alta., 30 VI 1922, C.B.D. Garrett, 6000 ft"; "genitalia slide PYR 133" [male symbol][green label]; "[male symbol] Genitalia Slide, 26 June 1937, C.H. #2"; "HOLOTYPE [male symbol] Pyla aequivoca Heinr. No. 7593" [red label].

Pyla gaspeensis McDunnough. Holotype



Figs. 23–28. *Pyla aequivoca* adults. 23, male, Schoolcraft Co., Michigan. 24, male, Oneida Co., Wisconsin. 25, male, vic. Schefferville, Quebec. 26, female, Avalon Peninsula, Newfoundland. 27, male, Chaffee Co., Colorado. 28, female, Alamosa Co., Colorado.

(CNC): "49th Mile, Cascapedia Road, Gaspe, 15.VII.1950, D.C. Ferguson"; "Slide No. Pyla 6167C" [blue-green label]; "Photo No 11" [blue label]; "HoloTYPE Pyla gaspeensis McD No. 6812" [red label]; "Pyla gaspeensis McD Holotype" [red label]. Allotype (NMNH): "nr. Mt. Albert, Cascapedia Road, Gaspe, 13-VII-1950, D.C. Ferguson"; "SLIDE No. Pyla 6167C [female symbol]"; "Pyla gaspiensis [sic, handwritten] McD., Allotype" [red label].

Additional material examined.—(33 ♂, 34 ♀ and including 4 ♂ paratypes) UNITED STATES. ALASKA: 1 ♀, nr Fort Yukon (NMNH). COLORADO: Alamosa Co.—1 ♂, 3 ♀, Great Sand Dunes National Monument, 8200 ft., 22–28 Jun 1982 (Ferguson, Hodges)(NMNH). Chaffee Co.—1 ♂, McGee Gulch, 9100 ft., 5 miles E Buena Vista, 5 Jul 1982, Ponderosa Pine, Pinyon-Juniper, Douglas Fir-Willow (Ferguson)(NMNH). Hinsdale Co.—1 ♀, Lake City, 6 Jul 1957, 8684 ft. (Rindge)(AMNH). Jackson Co.—2 ♂, Gould, 18 Jul 1957, 9000 ft., (Rindge)(AMNH). Larimer Co.—7 ♂, 1 ♀, Rist Canyon, 10 mi W Bellvue, 10 Jul 1957, 7400 ft. (Rindge)(AMNH). San Juan Co.—2 ♀, Silverton, 16–23 (NMNH). MICHIGAN: Emmet Co.—1 ♀, Mackinaw City, 4 Aug 1949 (Voss)(EGV). Keweenaw Co—1 ♂, Ft. Wilkins S. P., 16 Jul 1995 (Balogh)(GJB). Mackinac Co.—1 ♀, 3 Aug 1936 (Dreisbach)(MSU). Schoolcraft Co.—1 ♂, T42N, R16W, sec 11 and 13, 4 Jul 1987 (Balogh) (GJB). UTAH: Garfield Co.—2 ♀, Blue Spruce Camp, 18 mi N Escalante, 30 Jul 1965, 8000 ft. (Rindge)(AMNH). WISCONSIN: Oneida Co.—3 ♂, T38N, R5E, sec 13, 2 Jul 1987 (Ferge)(GJB). WYOMING: Crook Co.—1 ♂, 1 ♀, Reuter Canyon Camp, 5 mi N Sundance, 9 Jul 1962, 5900 ft (Rindge)(AMNH). Park Co.—6 ♀, Lake Creek Camp, 13 mi SE Cooke City MT, 24 Jul 1959 (Rindge)(AMNH). Sublette Co.—2 ♂, Lower Green River Lake, Wind River Range, 6 Aug 1959, 8000 ft. (Rindge)(AMNH). CANADA. ALBERTA: 1 ♂ paratype, "Banff, Alta., 6 VII 1922, C.B.D. GARRETT," "PARATYPE Pyla aequivoca Heinr., No. 7593" [yellow label], "JHW slide 97.1" (CNC); 1 ♂ paratype, "Banff, Alta., 30. VI. 1922, C.B.D. Garrett, 6000 ft.," "[♂ symbol] genitalia on slide 10 Oct. 1950, C.H. #3855," "Genitalia Slide By 101, 092 NMNH" [green label], "PARATYPE" [blue label] (NMNH); 1 ♂ paratype, "Banff, Alta., 21 VI 1922, C. B. D. Garrett," "PARATYPE" [blue label] [specimen not dissected] (NMNH); 1 ♀, Nordegg, 24 Jul 1921 (McDunnough)(CNC); 1 ♀, Eisenhower Junction, 15 mi NW of Banff, 4800 ft, 12 Aug 1973 (Leuschner)(LACM). NEWFOUNDLAND: 1 ♀, Hopedale, Labrador, 23 Jul 1924 (Perrett)(NMNH); 1 ♂, St Anthony, 16 Jul 1951 (Moore)(CNC); 2 ♀, Avalon Peninsula, nr. Topsail, 23 Jul 1954 (Ferguson)(NMNH). NOVA SCOTIA: 1 ♂, Bog, Baddeck, Victoria County, 30 Jul 1970 (Wright)(NMNH); 1 ♂, Middle River, Cape Breton Island, 6 Jul 1968 (Wright)(NMNH). ONTARIO: 1 ♂ paratype, "June 8–15," "Hymers Ont.," "S. triplasiella Dyar comp. with Type Coll., very close, J McD." [red bordered label], "Barnes Collection" [label upside down], "[♂ symbol] genitalia on slide 10 Oct. 1950 C.H. #3861", "Genitalia Slide By 101,091 NMNH" [green label] (NMNH); 1 ♂, 1 ♀, Black Sturgeon Lake, 23–28 Jun 1963 (CNC); 1 ♀, Black Sturgeon Lake, 20 Jul 1963 (CNC); 1 ♂, Neys Prov. Park, 7 Jul 1995 (D. Balogh)(GJB); 1 ♀, Minaki, 8 Jul 1928 (McDunnough)(CNC). QUÉBEC: 1 ♀, Knob Lake, 54.47′ 66.47′, 26 Jul 1948 (Munroe)(CNC); 1 ♂, vic. Schefferville, 55 N centr. Labrador, 23 Jul 1990 (Hensel)(CNC); 1 ♀, 30 km S Mistassini Post, fir/birch slope, at light, 20 Jul 1992 (Mikkola)(UZMH). NORTHWEST TERRITORIES: 1 ♂, Cameron Bay, Great Bear Lake, 8 Jul 1937 (Freeman)(CNC). YUKON TERRITORY: 1 ♂, Ross River, 132.30′ 61.56′, 21 Jun 1960, 3000′ (Martin)(CNC); 1 ♂, km 155, Dempster Hwy., 4 Jul 1985, 950m (Lafontaine)(CNC); 2 ♀, 60.45N, 134.40W, 20 km SE Whitehorse, light trap, 16 Jul 1985 (Mikkola)(UZMH); 1 ♂, 1 ♀, 65.07N, 138.16W, Ogilvie Mtns., 1050 m, Dempster Hwy., km 155, at light, 8 Jul 1985 (Mikkola)(UZMH);

1 ♀, 62.55N, 136.30W, Klondike Hwy km 476, Pelly River bog, 15 Jul 1985 (Mikkola) (UZMH); 1 ♀, S. Yukon, Carcross sand dunes, ad. luc., 12 Jul 1994 (M. Ahola and L. Kalia)(UZMH).

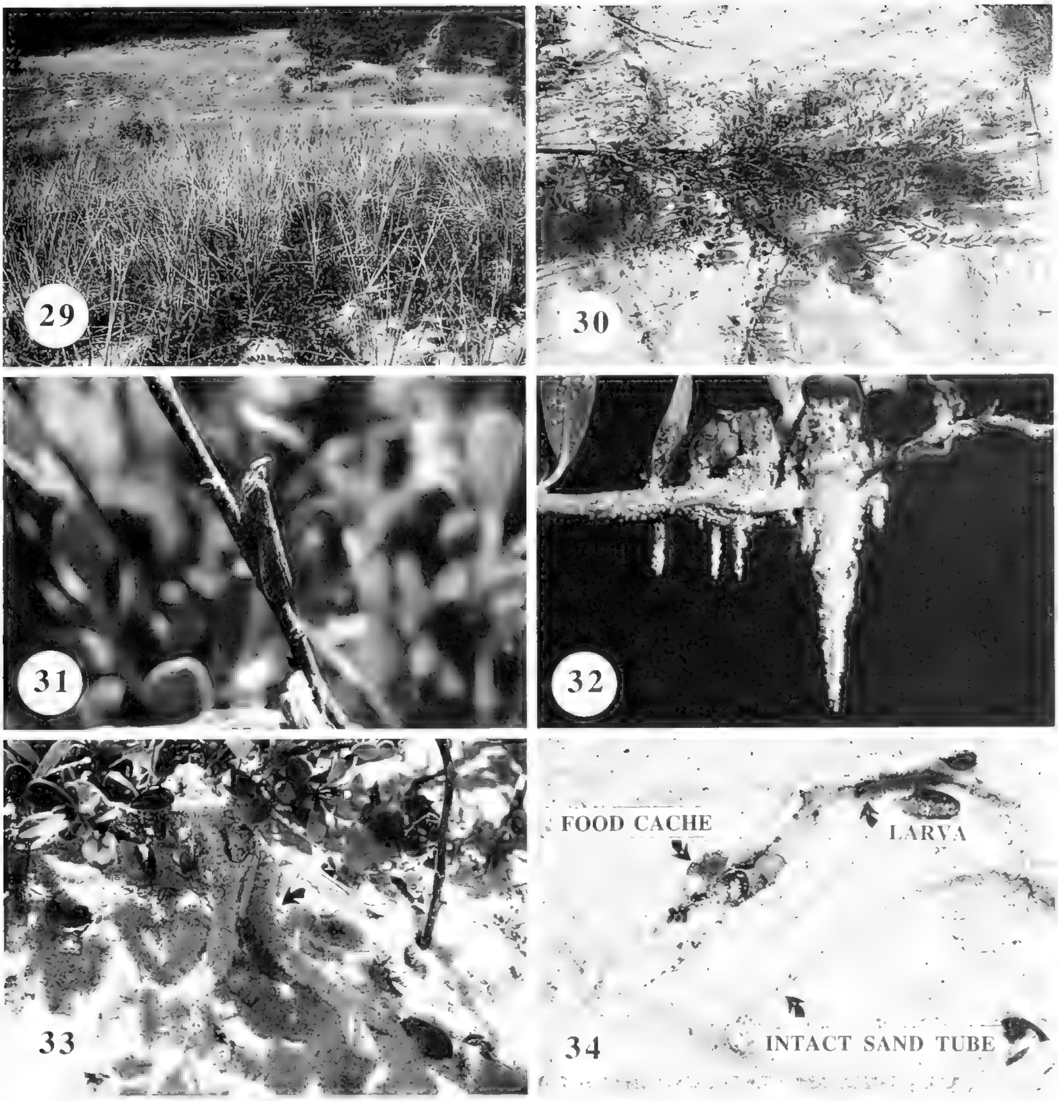
Distribution.—(Fig. 18). *Pyla aequivoca* is known from widely scattered localities across northern North America from the subarctic south to the boreal deciduous border of eastern Canada and the Great Lakes region. In the west, *Pyla aequivoca* ranges south in the Rocky Mountains to southern Colorado. There are also records of this species from the Black Hills region of Wyoming and the mountains of southern Utah.

Habits and life history.—The life history of *P. aequivoca* is unknown but larvae may feed on Ericaceae as do the larvae of *Pyla arenaeola* and *Pyla fusca* (Goater 1986, Palm 1986). The Great Lakes region localities of *P. aequivoca* (Fig. 18) are within the boreal and boreal deciduous border life zones (Danks and Foottit 1989). Specimens have been collected in relatively open, often early successional habitats with sandy or rocky soils including open pine woods and barrens where the ground cover includes bracken fern (*Pteridium aquilinum* (L.) Kuhn), blueberry (*Vaccinium* spp.), bearberry (*Arctostaphylos uva-ursi*), wintergreen (*Gaultheria procumbens* L.), trailing arbutus (*Epigaea repens* L.), and reindeer lichen (*Cladina* spp.). Where the water table is close to the surface such acid soil sites are often accompanied by boggy vegetation dominated by the mat-like growth of many ericads such as leatherleaf (*Chamaedaphne calyculata* (L.) Moench), Labrador tea (*Ledum groenlandicum* Oeder), sheep-laurel, bog-laurel (*Kalmia angustifolia* L. and *K. polifolia* Wangenh.), bog-rosemary (*Andromeda glaucophylla* Link), and blueberry and cranberry (*Vaccinium* spp.). Notable in the Great Lakes region is the apparent absence of *P. aequivoca* on lakeshore dunes and in the Manitoulin Island region of Ontario, the later dominated by calcareous limestone habitats. Both of these habitat types have been actively sampled for phycitines in recent years.

In Newfoundland, *P. aequivoca* has been collected on the Avalon Peninsula (near Topsail), a region of rocky topography with both forest and open heath vegetation including bogs and barrens. Localities in Nova Scotia include a bog (Baddeck), and a stream valley with nearby upland spruce and fir forest (Middle River, Cape Breton Island) (D.C. Ferguson, in litt., 1996). The types of *P. gaspeensis* were collected on the Gaspé Peninsula in boreal forest dominated by spruce (Ferguson and Rupert 1951, D.C. Ferguson, personal communication, 1996). In the far north, both boreal forest and tundra are rich in members of the Ericaceae. One dry tundra locality in the Yukon (km 155, Dempster Highway), as figured and described by Lafontaine and Wood (1988, Fig. 5), includes both rocky tundra and patches of spruce forest (J.D. Lafontaine, personal communication, 1996). Label data for specimens collected in the Yukon and northern Quebec (UZMH) indicates that *P. aequivoca* may be found in a variety of habitats in the far north including fir/birch forest, bog, and sand dunes although it is difficult to assign habitat preferences based on small samples taken at light. In the Rocky Mountain region, *P. aequivoca* has been recorded from 4800 ft. in Alberta to 9100 ft. in Colorado, but insufficient information is available to comment more specifically on habitat requirements.

Pyla aequivoca is apparently univoltine; dates of capture range from June 8 to August 12, but most records are for the month of July in all regions where it has been collected.

Comments.—When McDunnough (1958) described *P. gaspeensis,* he based his diagnosis on comparison with Heinrich's description of *P. aequivoca* and was misled by Heinrich's figure of the aedeagus (Heinrich 1956, Fig. 366a; aedeagus rotated into an off-lateral projection as on holotype slide) and the incorrectly associated female of *P. arenaeola.* Examination of the genitalia of the *P. gaspeensis* male holotype shows that it is conspecific with *P. aequivoca* McDunnough's illustration of the female genitalia of *P. gaspeensis* (McDunnough 1958, Fig. 5) does not



Figs. 29–34. *Pyla arenaeola,* habitat and life history. 29, Dunes at type locality, Saugatuck Dunes State Park, Allegan Co., Michigan; bearberry (*Arctostaphylos uva-ursi*) mats and dune grasses in foreground. 30, Bearberry stems spreading over open sand, same locality. 31, Adult resting posture, same locality. 32, Early instar larval sand tubes dangling from bearberry stem that has been lifted from sand surface, same locality. 33, Late instar larval sand tube attached to bearberry stem that has been slightly elevated from the sand surface, Presque Isle Co., Michigan; arrow head points to the tube. 34, Late instar larval tubes on sand (reared in captivity and host material removed to view tubes); intact tube below; tube above opened exposing larva and food cache

show the lateral pouches of the ductus bursae (our Fig. 14) which are only evident when the genitalia are well inflated and properly stained. Examination of the *P. gaspeensis* allotype slide revealed that the bursa is only weakly stained and not well inflated, but the characteristic sclerotized plates of the ostium bursae are easily seen (as illustrated and described by McDunnough) and in good agreement with other female *P. aequivoca* we have examined.

Superficial distinctions cannot be applied to all *Pyla* specimens, particularly those of *P. aequivoca,* and are totally unreliable for populations outside of the Great Lakes region. Over its wide geographic range, *P. aequivoca* shows considerable individual and geographic variation in color, size, and maculation. Light gray specimens with contrasting maculation (Fig. 26) resemble *P. insinuatrix.* Occasional northern specimens (Fig. 25) are dark glossy gray with reduced pale scaling and somewhat obscured maculation. In the Rocky Mountain region, and especially southward, *P. aequivoca* presents a considerably paler appearance, nearly ashy gray due to an even overlay of fine pale scales and less contrasting maculation (Fig. 27, 28). Specimens from the southern Rocky Mountain region are also slightly larger. In the western mountains, *P. aequivoca* is superficially indistinguishable from sympatric but genitalically distinct *Pyla impostor* Heinrich (Heinrich 1956) and the two species are frequently collected together. Despite superficial variation, genital characters allow identification of *P. aequivoca* in all portions of its range. Variation in number of lateral spines (1–8) on the divisions of the aedeagus (Fig. 7, 10) and in size and shape of the lateral lobes of the ductus bursae (Fig. 14) has been noted but without a detectable geographic pattern.

Etymology.—Four specific epithets applied to *Pyla* species by Heinrich (1956) illustrate the difficulty of relying on superficial characters to determine specimens of the genus. These names, readily linked to commonly used English words, probably came to mind as Heinrich discovered *Pyla's* hidden genitalic riches (or more likely the names were coined to leave a palpable record of frustration due to the inability to depend on maculation to determine specimens). These names include *aenigmatica* (enigma = something obscure, inexplicable, a riddle or mystery), *impostor* (= a person who practices deception under an assumed character, identity, or name), *insinuatrix* (insinuate = to suggest or hint slyly), and *aequivoca* (equivocal = allowing the possibility of several different meanings especially with intent to deceive). Ironically, Heinrich's *Pyla aequivoca* deceived two competent workers, both Heinrich and McDunnough, but allowed us the possibility of recognizing two very distinct *Pyla* species.

DISCUSSION

Biogeography.—All known populations of *P. arenaeola* are found north of the Wisconsin glacial boundary (the Great Lakes shoreline and Manitoba). The Great Lakes developed during the interval 11,000–14,500 BP when repeated glacial retreats and readvances eventually gave way to the present shoreline dunes (Loveless and Hamrick 1988). The only Manitoba specimen examined was collected at Aweme in 1921. This locality is on the western edge of a large fossil sand deposit, the Carberry Sandhills (Carberry Desert or Bald Head Hills), and includes approximately 39 square kilometers of active sand dunes within a larger sand deposit now stabilized by vegetation. The fossil dunes near Aweme Manitoba were formed at the old delta of the Assiniboine River where it entered the southwestern aspect of Glacial Lake Agassiz. At about 10,000 BP this glacial lake that formed at the southern edge of the receding continental ice sheet was the largest lake in North America, extending from the eastern Dakotas and Minnesota well north into Canada. Due to fluctuations in depth and extent of Lake Agassiz during its existence, multiple fossil beaches formed (as many as 55 different lake levels can be identified) and considerable open dune habitat was likely available for colonization by *P. arenaeola* during the glacial and immediate postglacial periods. Coincident with climatic warming and northward spread of prairie grassland to its southern aspect (approximately 9,000 BP), Lake Agassiz drained southeastward into Lake Superior (Teller 1984). The southern shoreline of Lake Agassiz and this drainage corridor may have provided a biogeographic link between the dunes of the Assiniboine delta and those of the Great Lakes shoreline.

Species of the genus *Pyla* share a northern transcontinental and western montane distribution in North America. Almost the entire range of the genus east of the Rocky Mountains (an estimated 8 species of the gray *Pyla* group) lies north of the Wisconsin glacial boundary. There is no known southern relict population or obvious progenitor species to suggest the preglacial origin for *P. arenaeola*. *Pyla arenaeola* could have evolved during the Wisconsin glacial period as a result of vicariant events near the glacial margin. It is also possible that *P. arenaeola* evolved prior to Wisconsin glaciation, survived the Wisconsin period on unglaciated portions of the Atlantic coastal plain or on the pre-Wisconsin sand deposits of the central and western Great Plains, then migrated north with glacial recession. Lafontaine (1982), and Loveless and Hamrick (1988) summarized the relevant biogeographic history of the Wisconsin period and possible scenarios for speciation events. It is of note that the larval host, bearberry, is still extant on the northern Atlantic coast and in the central and western Great Plains (Ferris and Fisher 1973, Great Plains Flora Association 1977). Both regions should be searched for possible relict *Pyla* populations.

Life history.—To the best of our knowledge, *P. arenaeola* is the only species of *Pyla* other than the holarctic *P. fusca*, for which specific life history information is available. In Europe, larvae of *P. fusca* have not been recorded forming sand or soil tubes but construct webs on shoots and leaves of Ericaceae and perhaps other plants. Goater (1986) and Palm (1986) record the following hosts: Heather (*Calluna vulgaris* (L.) Hull), heath (*Erica* spp.), bilberry, blueberry and closely related plants (*Vaccinium* spp. including *V. myrtillus* L.) and perhaps willow (*Salix* spp.) and birch (*Betula* spp.). In Europe the larvae overwinter. Heinrich (1956) was unable to document reliable life history data for *P. fusca* in North America and we have not encountered reared specimens during the course of this study. It should be pointed out that based on genital characters, *P. fusca* may not be closely related to *P. arenaeola* or *P. aequivoca*. Males of *P. fusca* have a thin cornutus in the vesica and females have a simple ostium bursae. Other *Pyla* species (both gray and bronzy-brown species groups, and including *P. arenaeola* and *P. aequivoca*), lack a cornutus, and the females of many species share extensive modifications of the ostium bursae. Perhaps the larvae of most *Pyla*, like those of *P. arenaeola*, feed concealed, accounting for a paucity of life history information. Once better known, the habits and morphology of the immatures should shed further light on the relationships of *Pyla*.

Pyla arenaeola is a member of a guild of sand-tube constructing Lepidoptera which inhabit the Great Lakes dunes and other very sandy habitats. Included in this guild are the pyraloids *Prionapteryx nebulifera* Steph. (host: Sand cherry, *Prunus pumila* L.) (see also Daecke 1905); *Loxocrambus awemensis* McD., *Thaumatopsis* sp., and *Anerastia lotella* (Hbn.) (host: culms of dune grasses); also included are two gelechiids, a *Chionodes* sp. and an undescribed member of the tribe Teleiodini (host: False heather, *Hudsonia tomentosa*) (personal observations). In Florida, Habeck et al. (1995) reported eight species of sand-tube constructing Lepidoptera from Florida scrub habitat, including four pyraloids and four gelechiids. Tube formation from leaves, plant debris, and even soil has been described for other phycitines (Doerksen and Neunzig 1976, Neunzig 1979), and may be more widespread in this subfamily.

The documented distribution of *P. arenaeola* is limited, but recent collecting has shown that it is locally common on the dunes of the western Great Lakes where its future seems secure. Nevertheless, conservationists and land managers should be aware of *P. arenaeola* and other sand-tube Lepidoptera. The pressures of development and the invasion of dune habitat by exotic plants are of ongoing concern. For instance, at the *P. arenaeola* type locality, Saugatuck Dunes State Park, Michigan, a large introduced population of black or Austrian pine (*Pinus nigra* Arnold) is a troublesome invasive tree. Efforts should be made to locate other populations of *P. arenaeola* both outside the Great Lakes basin, such as in southern Manitoba where habitat may be more restricted, as well as on the Great Lakes and especially in regions where the pressures of development, overuse, and habitat degradation are most intense. The moth likely ranges east into the basins of Lakes Erie and Ontario. Additional disjunct populations may persist on dunes associated with the many fossil beaches formed during the existence of glacial Lake Agassiz in central North America (Teller 1984). Adults are easily sampled at blacklight, and with patience, larvae can be located by carefully lifting bearberry stems from the sand and looking for attached tube shelters (Figs. 32, 33). It is noteworthy that a relatively large moth such as *P. arenaeola* (average wing expanse about 2.5 cm) has gone unrecognized for so long. Moreover, other endemic dune Lepidoptera may await discovery; all the more reason to protect and wisely manage the Great Lakes shoreline.

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ON THE GENUS *EUPLOCANIA* ENDERLEIN (PSOCOPTERA: PTILONEURIDAE) WITH DESCRIPTION OF A NEW SPECIES

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Abstract.—The female of *Euplocania cerata* New, and both sexes of ***E. pictaoides*, n. sp.,** are described and illustrated. *Euplocania chulumanensis* Williner is transferred to *Triplocania* (**n. comb.**). New records of *E. badonneli* New and Thornton are provided, as well as a list with distributions and key to the known species of *Euplocania*.

Key Words: *Euplocania*, Ptiloneuridae, new species, Perú, Río Tambopata Reserve

The ptiloneurid genera *Euplocania* Enderlein 1910, and *Triplocania* Roesler 1940, are structurally close, the genital plan of both sexes in both genera being rather similar. As presently known, the two genera differ in wing venation characters only, *Euplocania* having the fore wing M four branched, and *Triplocania* having the fore wing M three branched.

The known species of *Euplocania* are exclusively South American, having been recorded in Brazil, Paraguay, and Amazonian Peru (Table 1). In this paper, I describe a new *Euplocania* from Peru, transfer the Bolivian *E. chulumanensis* to *Triplocania*, describe the female of *E. cerata* New, provide new records of *E. badonneli* New and Thornton, and provide a list of the known species of *Euplocania*. The types of the new species will be deposited in the National Museum of Natural History, Smithsonian Institution, Washington, D.C. (USNM). The standard measurements (FW = fore wing, HW = hind wing, F = femur, T = tibia, IO = minimum distance between compound eyes, D = antero-posterior diameter of compound eye, d = transverse diameter of compound eye, and PO = d/D), are given in microns and were taken on the parts mounted on slides under the compound microscope, with a filar micrometer whose measuring unit is 1.36 microns for wings and 0.53 microns for other parts. The scales of the illustrations are in mm.

Euplocania Enderlein 1910

Type species: *Euplocania amabilis* Enderlein 1910: 69, by original designation

Euplocania badonneli New and Thornton

This species was described from the Río Tambopata Reserved Zone, in Madre de Dios, Peru (New and Thornton 1988). The following are new records: Brazil. Rondônia, 62 km SW Ariquemes, Fzada. Rancho Grande, 12.X.1992, C.W. & L. B. O'Brien, 1 ♀, 1 ♂. 15. XI.1994, UV & mercury vapor light, 1 ♀. 17.XI.1994, UV & mercury vapor light, 1 ♀, same collectors. *Euplocania badonneli* belongs in a group that includes *E. picta* New, and *E. pictaoides*, n. sp. (see below), sharing with them the color pattern of the fore wing, the shape of the pterostigma and of the areola postica, and the structural plan of the male and female genitalia: central piece of the hypandrium bilobed and flanked by sclerites, phallosomes complex and symmetrical, pigment-

Table 1. Species of *Euplocania* and distribution.

E amabilis Enderlein 1910: 69	Paraguay
E. badonneli New and Thornton 1988: 230	Brazil, Peru
E. cerata New 1980: 189	Brazil, Peru
E. greeni New 1972: 489	Brazil
E. maculata New and Thornton 1988: 229	Peru
E. marginata New and Thornton 1988: 226	Peru
E. picta New 1980: 189	Brazil
E. pictaoides Garcia Aldrete	Peru

ed areas of the subgenital plate connected posteriorly by a well defined, slender arch, male paraprocts triangular, with two apical macrosetae, and male epiproct triangular, with marginal setae and five mesal, scattered setae.

Euplocania cerata New
(Figs. 1–6)

This species was described from the Reserva Ducke, Amazonas, Brazil, from two males, the holotype and paratype (New 1980). A female collected in Peru is described here.

Female.—*Color (in 80% alcohol):* Essentially as described for the male.

Morphology: Wings (Fig. 1) same as described for the male. Lacinial apex broad (Fig. 2), inner tyne small, and large, multidenticulate outer lobe. Subgenital plate (Fig. 4), approximately triangular, with pigmented area deeply concave and three marginal apical setae. Ovipositor valvulae (Fig. 6): v1 slender, about half as long as v2; v2 spindle shaped, with elongate, slender, anterior "handle", posterior process stout, almost straight, distally spiculate; v3 a well defined lobe on the outer edge of v2, bearing four setae. Ninth sternum (Fig. 6), large, almost rectangular, with striae as illustrated. Paraprocts (Fig. 5) triangular, with setae as illustrated; each with three stout, apical macrosetae; sensory fields with 16–17 trichobothria on basal rosettes. Epiproct (Fig. 5) triangular, with field of setae on posterior half and three stout, apical macrosetae.

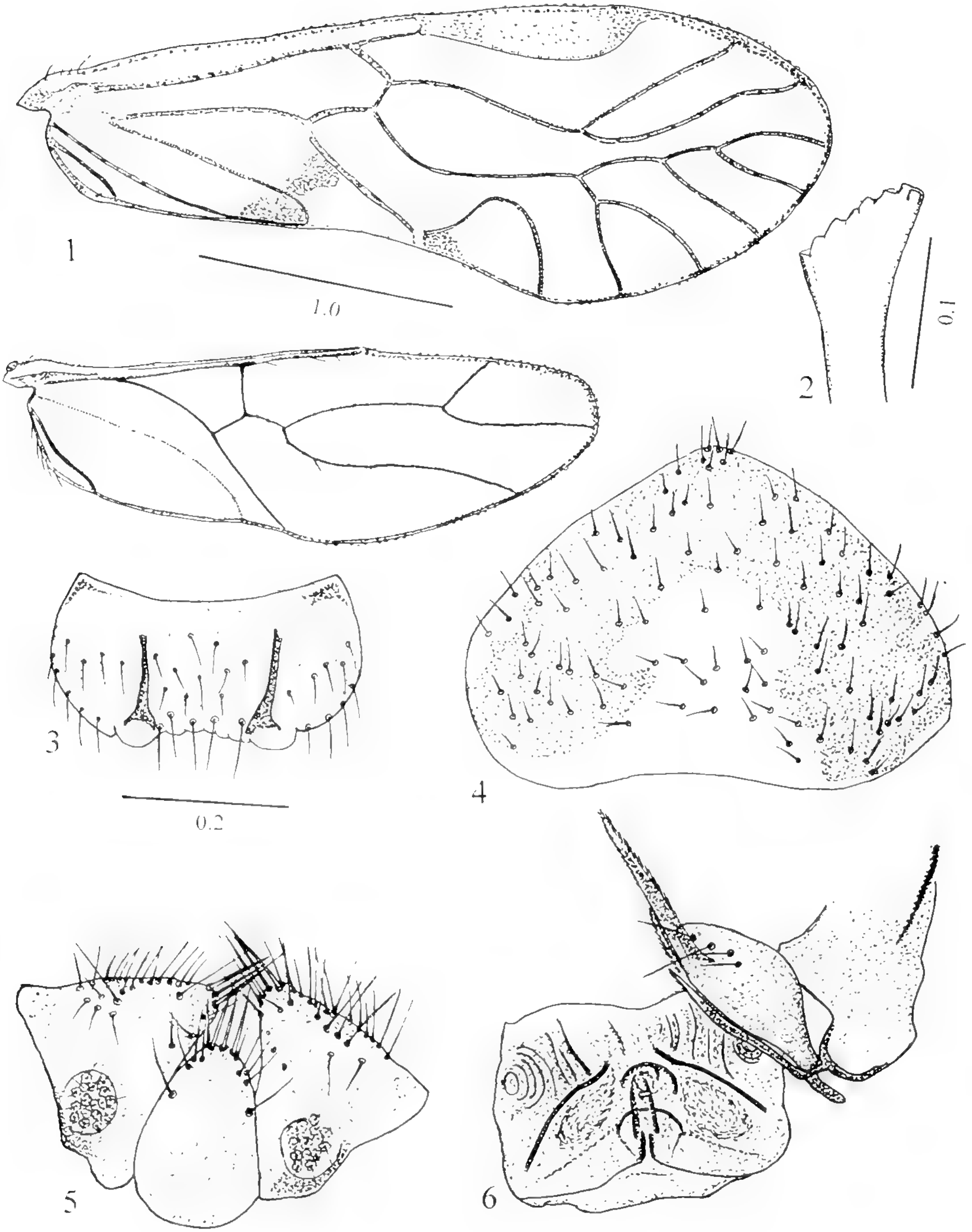
Measurements: FW: 3118, HW: 2178, F: 757, IO:359, D: 330, d: 230, IO/d: 1.08, PO: 0.69.

Locality.—Peru. Madre de Dios, Río Tambopata Reserve, 30 km (air) SW Puerto Maldonado, 12°50′S, 69°20′W. Smithsonian Institution Canopy Fogging Project, T. L. Erwin et al., 14.IX.1984, 01/02/045, 1 ♀, allotype. (USNM).

Comments.—This species is close to *E. maculata* New and Thornton, described from a single female collected also at the locality above indicated. They differ in that both sexes of *E. cerata* lack the radial spots present on the fore wing cells R_5–M_3 of *E. maculata.* That species also shows seven long apical setae on the subgenital plate (three short setae in *E. cerata*); in *E. maculata* the proximal projection of v2 is acuminate and the posterior process is sinuous, thus contrasting with *E. cerata.*

Euplocania chulumanensis Williner

This species was described from Chulumani, south of Yungas, Bolivia. In the original description (Williner 1949) the fore and hind wings were illustrated (Fig. 5, p. 106), the fore wing M_1 being forked near the wing margin; since in all the known species of *Euplocania* and *Triplocania* M_1 and M_2 are about the same length, then the fore wing M is three-branched, although anomalous in having M_1 distally forked, and on that basis I am transfering the species to *Triplocania,* **new combination.**



Figs. 1–6. *Euplocania cerata*, female. 1, Fore and hind wings. 2, Apex of lacinia. 3, Labrum. 4, Subgenital plate. 5, Paraprocts and epiproct. 6, Ninth sternum and left ovipositor valvulae. Scales in mm. Figs. 4–6 to scale of Fig. 3.

Euplocania pictaoides García Aldrete, new species

(Figs. 7–16)

Female.—*Color (in 80% alcohol):* Pale brown, with ochre irregular spots on head (Fig. 7), outer faces of coxae near thoracic pleura, on thoracic pleura and on abdomen. Compound eyes black, ocelli hyaline, each with an ochre centripetal crescent. Maxillary palp pale brown, with Mx4 dark brown. Scape and pedicel dark brown, flagellomeres whitish, with setae ochre, strongly contrasting. Tergal lobes of meso- and metathorax dark brown. Femora and tibiae brown, t_1 brown with ochre apex, t_2 and t_3 dark brown. Fore wing pattern (Fig. 9) as illustrated, pterostigma and marginal band dark brown; dark, triangular spots on distal ends of veins R_{2+3}, R_{4+5}, M_1–M_4, and Cu1a, Hind wing (Fig. 9) hyaline, with a brown band on basal hind margin, and dark spots on ends of R_{4+5}, and M.

Morphology: Lacinial apex (Fig. 8) wide, with small inner tyne and large, multidenticulate outer lobe. Fore wing pterostigma (Fig. 9), basally narrow, wide posteriorly, R_{2+3} and R_{4+5} sinuous, M_1 almost straight and M_2–M_4 sinuous. Areola postica tall, wide based. Hind wing M forming a straight angle with Rs (Fig. 9). Subgenital plate (Fig. 12) broad, setose, narrowing posteriorly to a round apex, with seven marginal setae; lateral pigmented areas connected posteriorly by a slender, pigmented arch. Ovipositor valvulae (Fig. 13): v1 short, slender, v2+3 narrow anteriorly, with five mesal setae as illustrated, posterior process acuminate. Ninth sternum (Fig. 13) broad, coarsely textured. Paraprocts (Fig. 11) elongate, semi-elliptic, sensory fields with 22–23 trichobothria on basal rosettes. Epiproct (Fig. 11) straight anteriorly, rounded posteriorly, with a field of setae next posterior margin.

Measurements: FW, 4379, HW: 2501, F: 1061, T: 1741, t1: 737, t2: 79, t3: 116, ctt1: 22, Mx4: 134, IO: 552, D: 413, d: 240, IO/D: 1.33, PO: 0.58.

Male.—*Color (in 80% alcohol):* Same as female. Fore wing pterostigma with clear area on lower apex (Fig. 10).

Morphology: Hypandrium (Fig. 14), a central body flanked by triangular sclerites; central body setose, deeply cleft in the middle, each half ending in a round, heavily sclerotized spiny apex, with an acuminate projection directed inward. Phallosome (Fig. 16), a broad, central, complex, symmetrical piece as illustrated, and two slender, basal apodemes. Paraprocts (Fig. 15) slender, elongate, triangular, with setae as illustrated, including two stout, apical macrosetae, sensory fields small, each with 15–16 trichobothria issuing from basal rosettes. Epiproct (Fig. 15) slender, triangular, with narrow apex, marginal setae and a mesal field of five setae, as illustrated.

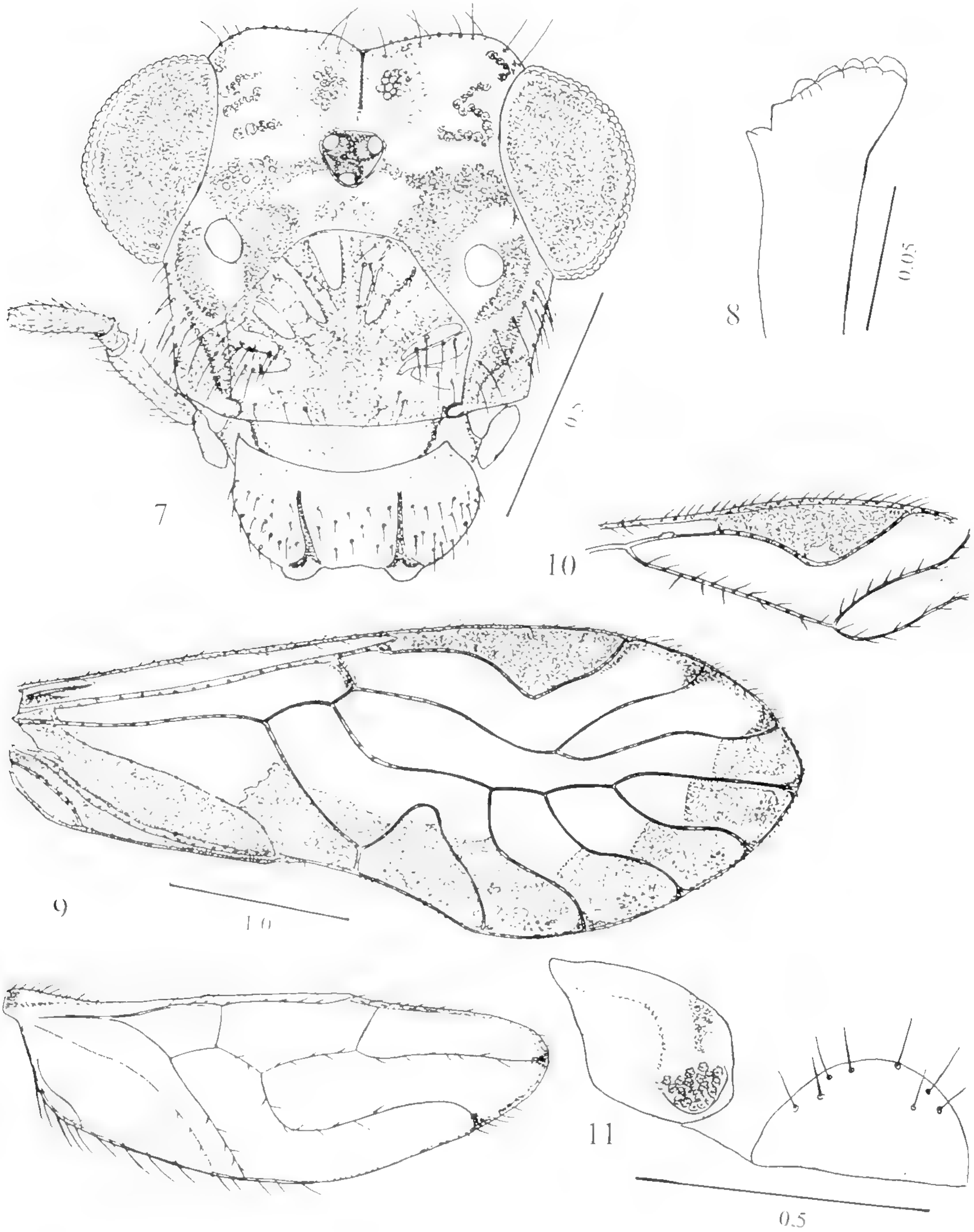
Measurements: FW: 3697, HW: 3017, F: 1101, T: 1807, IO: 534, D: 452, d. 302, IO/D: 1.18, PO: 0.66.

Types.—Peru. Madre de Dios. Río Tambopata Reserved Zone, 30 km (air) SW Puerto Maldonado, 290 m. Smithsonian Institution Canopy Fogging Project, T. L. Erwin et al. Holotype ♂, 8.XI.1983, 04/01/03. Allotype ♀, 7XI.1983, 01/02/072.

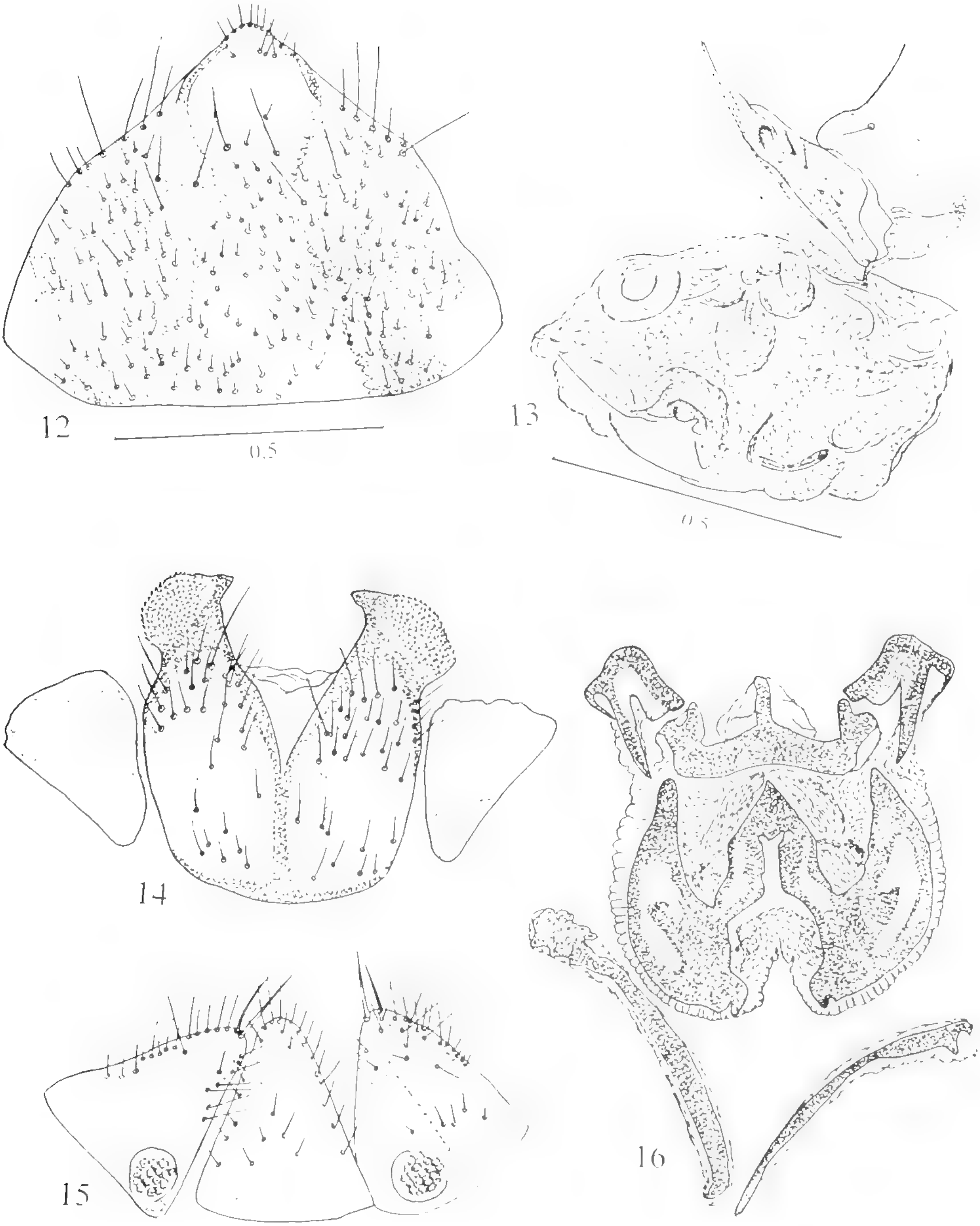
Comments.—This species is very close to *E. picta* New (1980), also described from the Amazonian region, from the Reserva Ducke, near Manaus (03°08′S, 60°02′W), taken in Malaise traps. Both species differ in genital details: the central piece of the hypandrium is more deeply cleft in *E. picta;* the apices of the halves are less spiny and the inner projection is more acuminate in this species. In general, the hypandrium presents the same structural plan in both species, with minor differences between them, but the phallosomes are quite distinct in both (compare Fig. 16 in this paper with Fig. 17 in New 1980, p. 184).

KEY TO THE SPECIES OF *EUPLOCANIA*

1. Fore wings entirely hyaline (Paraguay) . . . . *E. amabilis* Enderlein
– Fore wing marked with brown spots or with a brown band along wing margin 2



Figs. 7–11. *Euplocania pictaoides*. 7, Front view of head, female. 8, Apex of lacinia, female. 9, Fore and hind wings, female. 10, Fore wing pterostigma, male. 11, Epiproct and right paraproct, female. Scales in mm. Fig. 10 to scale of Fig. 9.



Figs. 12–16. *Euplocania pictaoides*. 12, Subgenital plate, female. 13, Ninth sternum and left ovipositor valvulae, female. 14, Hypandrium, male. 15, Epiproct and paraprocts, male. 16, Phallosome, male. Scales in mm. Figs. 14–16 to scale of Fig. 13.

2. Fore wing mostly hyaline, with brown spots on membrane 3

Fore wing with well defined, broad, brown band, along wing margin, posterior to pterostigma 5

3. Fore wing pterostigma spurred, anal region with cross veins, light brown patches distally on cells R_{2+3} to M_4 (Brazil) . . . . . *E. greeni* New

– Fore wing pterostigma not spurred, anal region without crossveins, brown spots in proximal half of wing, near lower margin, with or without radial spots in cells R_{4+5} to M_3 4

4. Fore wing with a brown spot on anterior end of areola postica, one spot between Cu_1 and Cu_2 and a spot in confluence of Cu_2 and 1A (Brazil, Peru) . . . . *E. cerata* New

– Fore wing with a radial series of small brown spots in cells R_{4+5} to M_3, in addition to the spots above indicated for *E. cerata* (Peru) . . . . *E. maculata* New and Thornton

5. A V-shaped, irregularly pigmented area, between vertex and ocellar group, and a slender, irregular pigmented band between ocellar group and postclypeus. Fore wing with almost homogeneous pale brown band along margin, upper border straight, from R_{4+5} to cell Cu_2 (Peru) . . . . *E. marginata* New and Thornton

– Upper border of pigmented band of fore wing sinuous; well defined slender, distal fenestrae, on apices of veins R_{4+5} to Cu1A. Head pattern not as above in two species (head missing in a third species) 6

6. Male epiproct with field of short spines near anterior border (Brazil, Peru) . . . . *E. badonneli* New and Thornton

– Male epiproct without field of short spines near anterior margin 7

7. Male epiproct and paraprocts slender, elongate, triangular; paraprocts with two apical macrosetae (Peru) . . . . . . *E. pictaoides* García Aldrete

– Male epiproct and paraprocts not as above; paraprocts without apical macrosetae (Brazil) . . . . *E. picta* New

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ON THE IDENTITY OF *HOLCOCERA GUILANDINAE* (BUSCK 1900) (LEPIDOPTERA: GELECHIOIDEA: COLEOPHORIDAE: BLASTOBASINAE)

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Abstract.—Adults of *Holcocera guilandinae* (Busck 1900) can be confused with two other species, *H. crassicornella* Dietz 1910, and *H. grenadensis* (Walsingham 1897). A **lectotype** is designated for *Blastobasis grenadensis*, and this species is transferred from *Blastobasis* Zeller 1855 to *Holcocera* Clemens 1863 (**n. comb.**). All three *Holcocera* species are redescribed herein, with complete synonymies given. Photographs of imagos, illustrations of the male and female genitalia and wing venation, and a key to the species are provided.

Key Words: *Holcocera*, Holcocerini, *crassicornella, grenadensis, guilandinae*

The blastobasine moths are probably one of the most frequently collected groups of Gelechioidea in the Americas. Yet, they remain one of the least known to science. Generally, species of Blastobasinae are drab with few diagnostic wing color patterns. This characteristic crosses specific, generic, and even familial boundaries, and makes identification difficult, if not impossible, unless genitalia are examined.

Hypotheses of relationships based primarily upon limited character systems, like wing venation, often result in unnatural or paraphyletic groups. More natural groups or monophyletic groups result when characters of the head, venation, genitalia, and others are incorporated into a phylogenetic analysis. Many genera have come and gone as a result of this change from single character system analysis to a multiple character system analysis.

The 16 genera of Blastobasinae listed by Hodges (1983) were proposed by previous lepidopterists using primarily head and venational characters. A multiple character system for phylogenetic analysis used by Adamski and Brown (1989) recognized this proliferation of artificial taxa and presented a phylogenetic classification that contained only seven genera, including *Holcocera* Clemens 1863.

Holcocera is defined by the following combination of characters: ventrolateral margin of gnathos weakly fused with tegumen, anellus multisetose, and proximal flange of valva with laterally dilated apex. Species of *Holcocera* feed on a variety of hosts that are summarized by Adamski and Brown (1989).

Hodges (1983) listed 57 species and varieties within *Holcocera*. Adamski and Brown (1989) listed 28 species and varieties, and Adamski and Hodges (1996) only eight. The numbers of valid species decreased because of species transfers and synonymy.

The closely similar wing patterns of *Holcocera guilandinae, H. crassicornella*, and *H. grenadensis* have resulted in misidentifications in museum collections as well as confusion with other species. The goals of this study are to clarify the taxonomic re-

Figs. 1–2. Imagos. 1, *Holcocera guilandinae*. 2, *H. crassicornella*.

lationships among these species and to provide efficient means for their identification.

The *Methuen Handbook of Colour* (Kornerup and Wanschner 1983) is used as a color standard for the description of the adult vestiture. Genitalia were dissected following Clarke (1941), except mercurochrome and chlorazol black were used as stains. Pinned specimens and genital preparations were examined with dissecting and compound microscopes. Wing measurements were made using a calibrated ocular

Fig. 3. Imago of *Holcocera grenadensis.*

micrometer. The acronym USNM is used for The National Museum of Natural History, Smithsonian Institution, Washington, D.C.

RESULTS

KEY TO THE SPECIES OF *HOLCOCERA* CONFUSED WITH *H. GUILANDINAE*

1. Male 2
– Female 4
2. Basal area of forewing darker than distal part (Fig. 2); uncus slightly widened basally, abruptly narrowed at $^{3}/_{5}$ length to apex; dorsal margin of gnathos lobelike (Fig. 6) . . . . *crassicornella*
– Basal area of forewing not darker than distal part (Figs. 1, 3); uncus and gnathos not as above 3
3. Uncus stout; dorsal margin of gnathos entire; base of costal lobe of valva slightly arched dorsally; longitidinal notch of anellus shallow; aedeagal cornuti absent (Fig. 5) . . . . . *guilandinae*
– Uncus narrow throughout length; dorsal margin of gnathos notched; base of costal lobe of valva strongly arched dorsally; longitudinal notch of anellus deep; aedeagus with several cornuti (Fig. 7) . . . . *grenadensis*
4. Basal area of forewing darker than distal part (Fig. 2) . . . . *crassicornella*
– Basal area of forewing not darker than distal part (Figs. 1, 3) 5
5. Inception of ductus seminalis near to A-7; inception of ductus seminalis not on enlarged part of ductus bursae; signa not equal in size (Fig. 8) . . . . *guilandinae*
– Inception of ductus seminalis distant to A-7; inception of ductus seminalis on enlarged part of ductus bursae; signa of subequal size (Fig. 10) . . . . *grenadensis*

Holcocera guilandinae Busck 1900
(Figs. 1, 4–5, 8)

Blastobasis guilandinae Busck 1900: 234, pl. 1, Fig. 9; Dyar 1901: 476; Busck 1902: 96; Dyar [1903]: 528; Smith 1903: 115; Barnes and McDunnough 1917: 162; McDunnough 1939: 79; Kimball 1965: 284; Hodges 1983: 14; Becker 1984: 41.

Holcocera guilandinae: Adamski and Brown 1989: 24; Ferguson et al. 1991: 20; Adamski and Hodges 1996: 715.

Diagnosis.—Forewing with dark-brown scales on distal portions of R$_1$-CuA$_1$; dark-brown scales within cells of R$_1$-CuA$_2$ forming an irregular serrate pattern near wing margin; uncus stout, basally widened; dorsal margin of gnathos entire; base of costal lobe of valva slightly arched; longitudinal

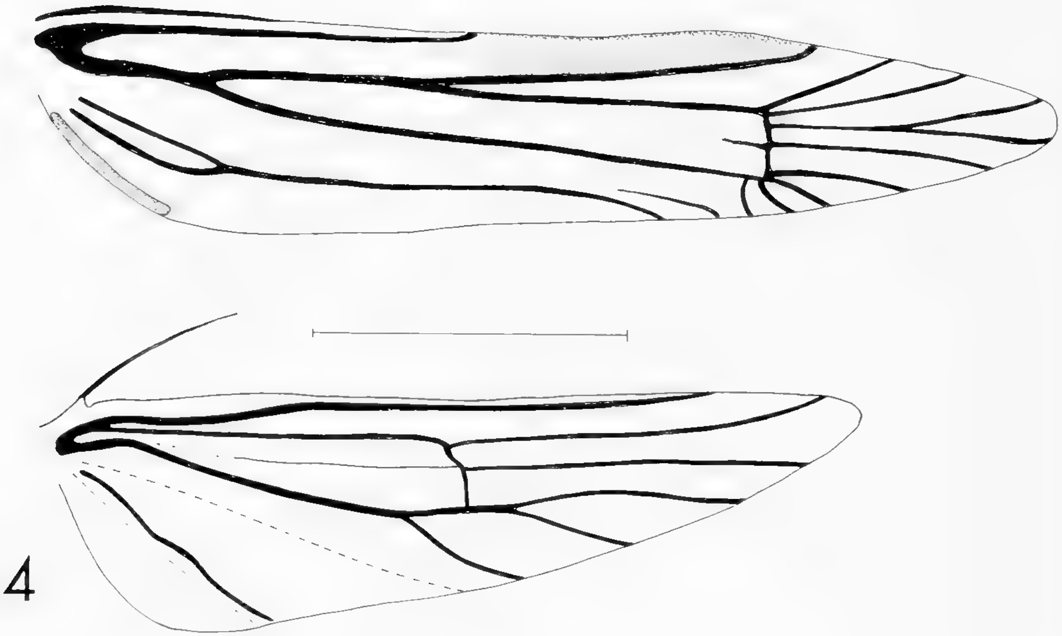
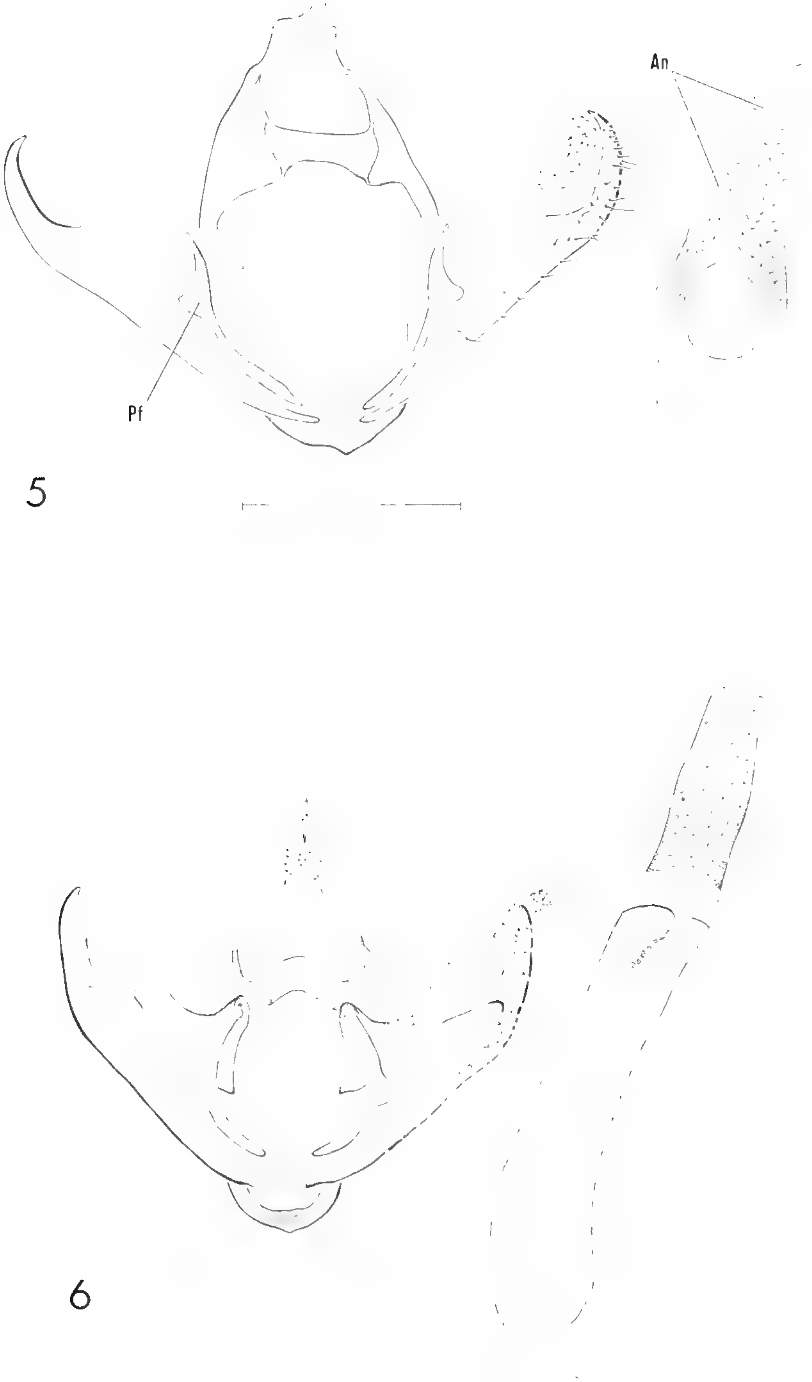


Fig. 4. Wings of *Holcocera guilandinae*. Scale = 1.0 mm.

notch of anellus shallow; cornuti absent; signa unequal in size.

Description.—*Head*: Scales on frontoclypeus and vertex brown or pale brown tipped with white; scape and pedicel with pale-brown scales intermixed with brown scales dorsally, uniformly pale brown ventrally; pecten pale brown; flagellomeres pale brown dorsally, dark brown ventrally; male first flagellomere notched; outer surface of segments 1–2 of labial palpus with dark-brown scales tipped with white intermixed with brown and pale-brown scales tipped with white, inner surface white intermixed with brown and pale-brown scales tipped with white, white apically; terminal segment dark brown intermixed with paler brown scales; proboscis white.

Thorax: Mesonotum pale brown, or pale brown with narrow, transverse brown band on anterior part; tegula pale brown or with pale-brown scales tipped with white. *Legs*: Forecoxa with outer surface pale brown intermixed with brown and pale-brown scales tipped with white; femur, tibia, and tarsomeres dark brown intermixed with brown and pale-brown scales tipped with white, apices of tarsomeres white; midfemur and tibia white basally, dark-brown scales intermixed with pale-brown scales from near midsegment to white apex; hindtibia white; hindtibia similar to midtibia; inner surface of each leg white, except foretibia with basal and subapical areas intermixed with brown and dark-brown scales; all tibial spurs white. *Forewing* (Figs. 1, 4): Length 6.1–9.2 mm (n = 88): Ground color pale brown intermixed with brownish-orange and brown scales; costal margin from base to pterostigma dark brown intermixed with brownish-orange and pale-brown scales; area between anal angle and CuP brown intermixed with pale-brown scales, some specimens with dark-brown scales intermixed with brown and pale-brown scales; dark-brown scales on distal portion of R_1-CuA_1 and dark-brown submarginal scales within cells of R_1-CuA_2 form an irregular serrate pattern near wing margin; discal cell with a brown spot near middle, two dark-brown spots (parallel to the longitudinal body axis) near distal margin of cell; ven-



Figs. 5, 6. Male genitalia. 5, *Holcocera guilandinae*. 6, *H. crassicornella*. Scale = 0.5 mm.

Fig. 7. Male genitalia of *Holcocera grenadensis*. Scale = 0.5 mm.

tral surface mostly brown, except distal portion of wing with brown scales tipped with white or pale-brown scales tipped with white. *Hindwing*: Dorsal and ventral surfaces with pale-brown scales basally, gradually darkening to apex, scales on veins usually darker than ground color; Cubitus 3-branched, M_2 and M_3 fused for entire length (Fig. 4).

Abdomen: Pale gray.

Male genitalia (Fig. 5): Uncus stout, basally widened, slightly extended posteriorly, setose; gnathos weakly fused ventrolaterally with tegumen, dorsal margin entire; vinculum narrow (as in all Holcocerini); costal and saccular parts of valva setose; base of costal lobe of valva slightly arched; proximal flange with a lateral lobelike setose process; anellus setose, with shallow, irregular, transverse grooves, without longitudinal notch at base; aedeagal cornuti absent.

Female genitalia (Fig. 8): Ovipositor telescopic, with three membranous subdivisions posterior to sternum-8 (as in all Holcocerini); anterior margin of sternum-8 emarginate, approximate to ostium; anterior

Figs. 8–9. Female genitalia. 8, *Holcocera guilandinae*. 9, *H. crassicornella*. Scale = 1.0 mm.

apophyses extending slightly beyond posterior margin of segment-8; ductus bursae moderate in length, irregularly spiralled; inception of ductus seminalis arising slightly anterior to A-7; corpus bursae trisignate, larger posteromedian signum at least twice length of other signa.

Types.—Lectotype ♂, [Designated by Adamski and Hodges 1996] "From stem of *Guilandinae bonducella*, iss[ued] Mar[ch] 30, 1900" [hand-written label]; "Palm Beach Fl[orid]a"; "USNM Type no. 4942" [red label]; "*Blastobasis guilandinae* Busck, ♂" [hand-written label]; "USNM ♂ genitalia slide 80980, DA 2410" [green label]. The lectotype is in the USNM. Paralectotype 1 ♀, "From stem of *Guilandinae bonducella*, Palm B[each] Fl[orid]a, iss[ued] Mar[ch] 30, 1900" [hand-written label]; Palm Beach Fl[orid]a"; "USNM Type no. 4942" [red label]; *Blastobasis guilandinae* Busck, Type ♀" [hand-written label]; "USNM ♀ genitalia slide no. 80977, DA 2407" [green label] The paralectotype is in the USNM.

Host.—*Caesalpina* [= *Guilandina*] *bonducella* Linnaeus (Fabaceae); *Garberia heterophylla* (Bartram) (Asteraceae); *Yucca* sp. (Liliaceae).

Distribution.—Southern Florida and Bermuda.

Holcocera crassicornella Dietz 1910
(Figs. 2, 6, 9)

Holcocera crassicornella Dietz 1910: 32; Barnes and McDunnough 1917: 162; McDunnough 1939: 80; Hodges 1983: 15; Adamski and Brown 1989: 24; Adamski and Hodges 1996: 714.

Blastobasis eriobotryae Busck 1915: 85;

Barnes and McDunnough 1917: 162; McDunnough 1939: 80; Kimbal 1965: 284; Hodges 1983: 14; Becker 1984: 41; Adamski and Hodges 1996: 714 (new syn.).

Holcocera eriobotryae: Adamski and Brown 1989: 24.

Diagnosis.—Basal part of forewing brown to near midcell spot; uncus slightly widened at base, abruptly narrowed at ⅗ length to apex; dorsal margin of gnathos lobelike; cornuti subequal in size.

Description.—*Head*: Scales on frontoclypeus and vertex grayish brown tipped with white, darker to vertex; scape and pedicel with pale-brown scales intermixed with darker brown scales, pecten pale brown; flagellomeres in female with pale-brown scales tipped with grayish brown; flagellomeres in male with scales uniformly pale brown; male first flagellomere notched; outer surface of segments 1–2 of labial palpus dark brown intermixed with pale-brown scales, mostly white nearly to apex, inner surface with pale-brown scales intermixed with darker brown scales; terminal segment brown, intermixed with pale-brown scales; proboscis pale brown.

Thorax: Mesonotum pale brown with a narrow transverse brown band on anterior part; tegula brown basally, pale brown apically; legs as in *H. guilandinae. Forewing* (Fig. 2): Length 5.5–7.8 mm (n = 150): Ground color grayish brown intermixed with pale-brown scales and few brown scales; wing base mostly pale brown intermixed with brown scales, brown to near midcell spot; two spots near distal margin; ventral surface pale brown. *Hindwing*: As in *H. guilandinae*.

Abdomen: Pale grayish brown.

Male genitalia (Fig. 6): Uncus slightly widened at base, abruptly narrowed at ⅗ length to apex, slightly extended posteriorly, setose; dorsal margin of gnathos lobelike; costal lobe of valva acutely arched dorsally at base; lobelike process of proximal flange setose; anellus as for *H. guilandinae*, except deeply notched; aedeagus with several subequal cornuti.

Female genitalia (Fig. 9): As for *H. guilandinae* except inception of ductus seminalis on slightly dilated part of ductus bursae, ductus bursae long; corpus bursae with three small, subequal signa.

Types.—Holotype (*Holcocera crassicornella*) ♂, "Florida" [hand-written label]; "Type" [red label]; "*H*[*olcocera*] *crassicornella* Dietz, Type. "Holotype is missing the abdomen; other body parts are within a gelatin capsule on pin. In the USNM.

Lectotype (*Blastobasis eriobotryae*) ♂, [designated by Adamski and Hodges 1996], "From Loquat [*Eriobotrya japonica*], Miami Fl[orid]a, iss[ued]. July 1910" [hand-written label]; "USNM Type no. 19233" [red label], [lectotype not dissected]. The lectotype is in the USNM. Fifteen paralectotypes are in the USNM and two paralectotypes are in The Museum of Comparative Zoology, Harvard University, Cambridge, Massachusetts.

Host.—*Eriobotrya japonica* (Thunberg) Lindberg (Rosaceae); *Acer rubrum* Linnaeus (Aceraceae).

Distribution.—Southern Florida.

Holcocera grenadensis Walsingham 1897, ***new combination***
(Figs. 3, 7, 10)

Blastobasis grenadensis Walsingham 1897: 92; Becker 1984: 41.

Diagnosis.—Forewing veins streaked with pale-brown scales; uncus narrow throughout length; dorsal margin of gnathos notched; cornuti subequal in size.

Description.—*Head*: Frontoclypeus and vertex pale grayish brown; scape and pedicel pale grayish brown intermixed with darker brown scales, flagellum pale grayish brown; pecten pale grayish brown; with first flagellomere notched; outer surface of labial palpus mostly with pale-brown scales intermixed with white and brown scales, inner surface white; proboscis white.

Thorax: Mesonotum brown with a nar-

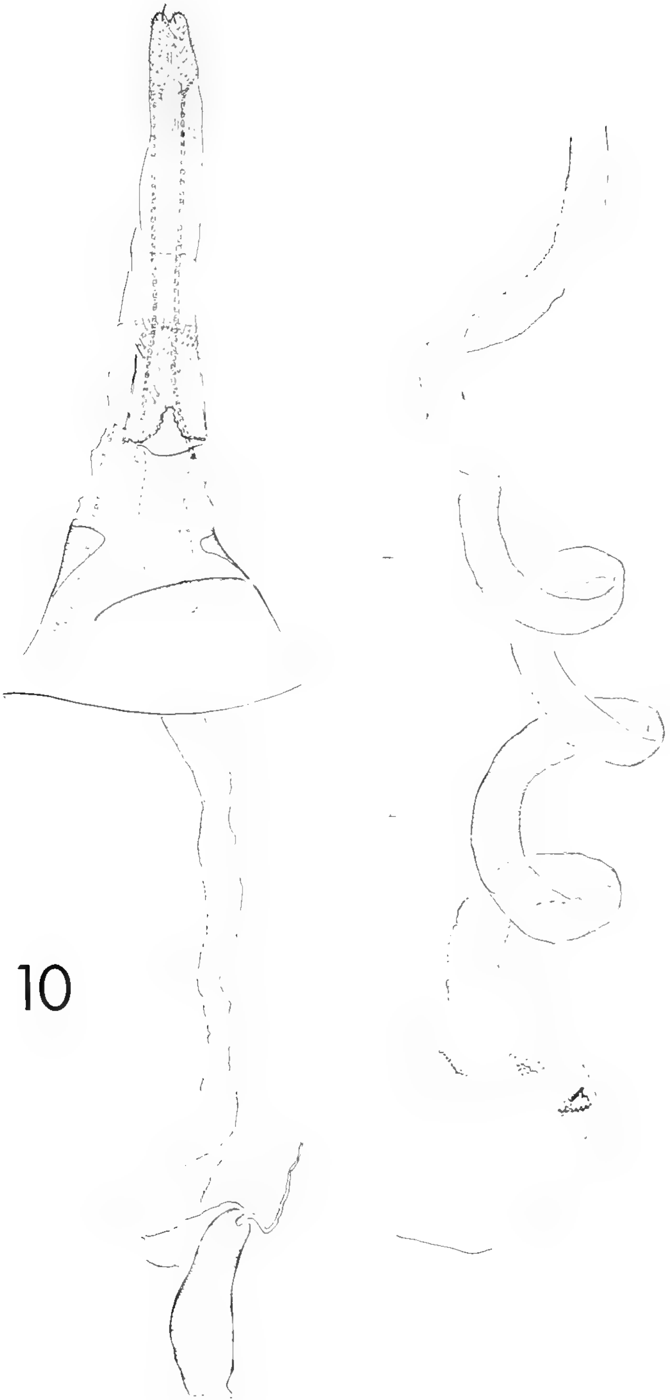


Fig. 10. Female genitalia of *Holcocera grenadensis*. Scale 1.0 mm.

row transverse band of pale-brown scales intermixed with white scales; tegula with pale-brown scales intermixed with white scales basally, brown distally. *Legs*: as for *H. guilandinae*, except banding on tarsomeres is absent in some specimens. *Forewing* (Fig. 3): Length 5.9–6.2 mm (n = 5): Ground color brown intermixed with pale-brown scales, irregularly streaked with pale grayish-brown scales above veins; three discal spots present; ventral surface pale brown. *Hindwing*: Dorsal and ventral surfaces uniformly brownish gray, darkening to outer margin. Venation not studied.

Abdomen: Pale brown.

Male genitalia (Fig. 7): Uncus narrow throughout length, setose; dorsal margin of gnathos notched; valval costa as in *H. crassicornella*; anellus and aedeagus as in *H. crassicornella*.

Female genitalia (Fig. 10): As in *H. crassicornella*.

Types.—Lectotype here designated ♀, "Type" [round label]; "Balthazar, (windward side), Grenada, W.I., H.H. Smith, 4-V"; "Walsingham Collection, 1910-427, 65,285, Type ♀"; "Adamski genitalia slide, BM 26560." Four paralectotypes (1 ♂, 3 ♀) from Mount Gay Estate, (leeward side) and Balthazar (windward side) Grenada, and Dominica. The lectotype and paralectotypes are in The Natural History Museum, London, England.

Host.—Unknown.

Distribution.—Grenada, Dominica.

Remarks.—Female *grenadensis* cannot be distinguished from female *crassicornella*.

DISCUSSION

Holcocera crassicornella and *H. grenadensis* are more closely related to each other than to *H. guilandinae*. Both species share a costal lobe of valva that is acutely arched dorsally at the base, anellus that is deeply notched apically, aedeagal cornuti present, and inception of ductus seminalis on a modified part of the ductus bursae. In addition, female genitalia of *H. crassicornella* cannot be distinguished from the genitalia of *H. grendensis*. This may not only indicate phylogenetic conservatism within a part of *Holcocera*, but a close kinship between these species. Although these three species belong to a monophyletic group (Adamski & Brown 1989), their phylogenetic relationships cannot be determined without further analysis.

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A METHOD FOR REARING PUPAE OF NET-WINGED MIDGES (DIPTERA: BLEPHARICERIDAE) AND OTHER TORRENTICOLOUS FLIES

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Abstract.—A method for obtaining reared adults of net-winged midges (Diptera: Blephariceridae) is presented. Rocks with attached pupae are removed from the stream and placed in a container maintained at high humidity. Survival and emergence rates exceeding 60% were recorded for several species of Nearctic *Blepharicera.* This method is ideal for associating pupae and adults of blephariceridas and other torrenticolous flies.

Key Words: net-winged midges, Blephariceridae, rearing, pupal-adult associations

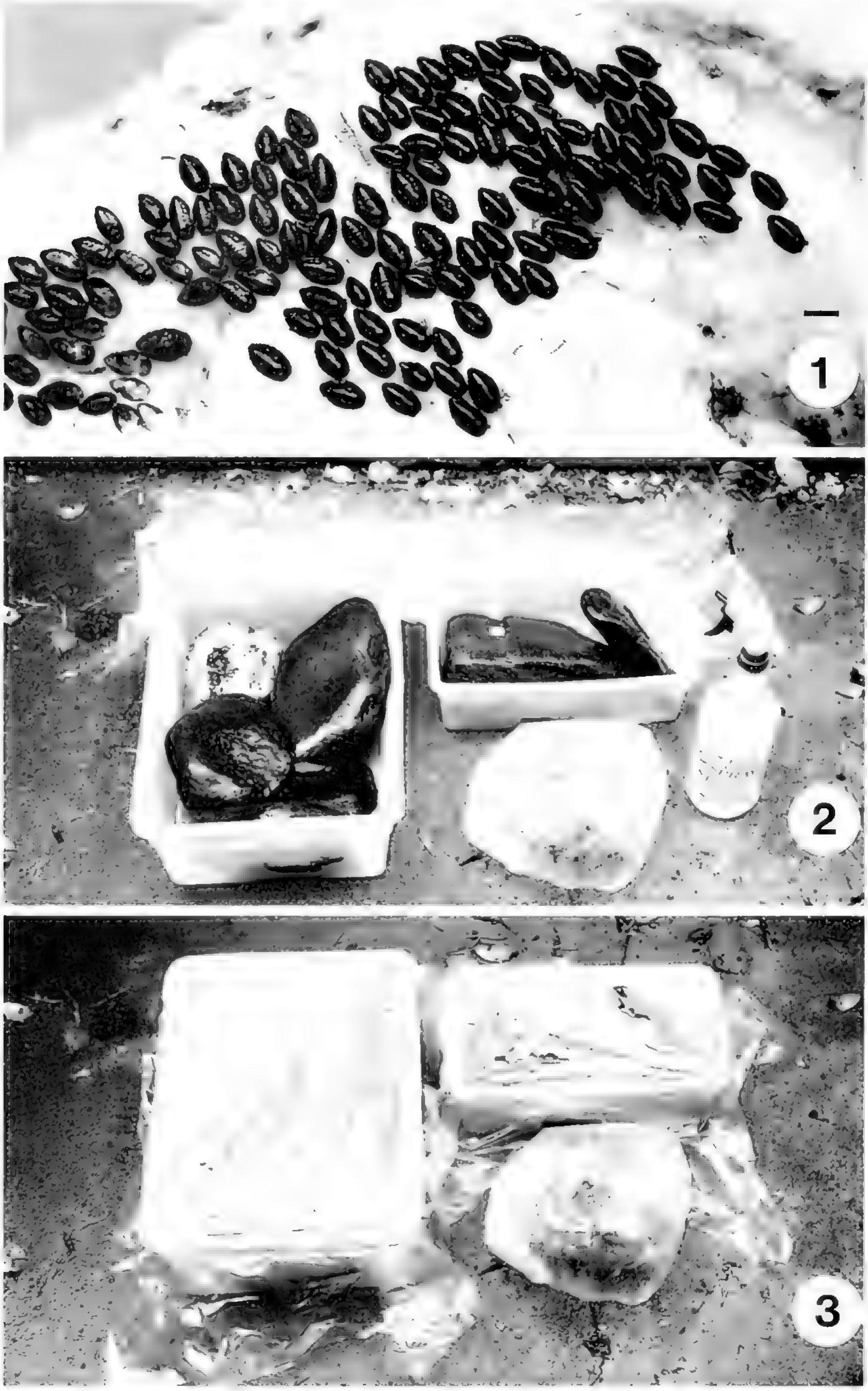
Net-winged midges (Diptera: Blephariceridae) are a distinctive family of nematocerous flies whose immature stages are highly specialized for life in the cascades, rapids and waterfalls of mountain streams. Larvae show many adaptations to a torrenticolous life, including six ventral suckers and a cephalothorax (fused head, thorax, and first abdominal segment). The larvae of all species are grazers, using their highly modified mouthparts to feed on periphyton, the thin film of algae, bacteria, and other organic matter that occurs on current-exposed rocks. Pupae are equally adapted to torrential streams, being streamlined, somewhat dorsoventrally compressed, and attached immovably to rocks by ventrolateral adhesive discs. Adult blephariceridas are slender-bodied, long-legged and show a diversity of habits—some are insect predators, others are nectarivorous or non-feeding; most are short-lived and rarely venture beyond the riparian zone. In spite of these habits, net-winged midges may be a significant component to stream ecosystems (Georgian and Wallace 1983, Anderson 1992, Johns 1996). At many streams, particularly in waterfall habitats, these dipterans are not only the dominant grazer but one of the most abundant insects. The trophic importance of these flies has been under-appreciated, which reflects the paucity of abundance data and the difficulty in identifying larvae and pupae. Identification depends largely on our ability to associate these life stages with the adults. The purpose of this article is to describe an effective method for rearing pupae, thereby permitting association of pupae and adults.

The Blephariceridae contain 26 genera and approximately 300 described species (Hogue and Zwick, in preparation), with representatives on most major continents. *Blepharicera* Macquart is one of the most widespread genera worldwide and in the Nearctic Region is the only group found in both western and eastern North America. Although past studies (e.g., Hogue 1978, Hogue and Georgian 1986) have provided significant insights about the eastern Nearctic fauna, several new species and distinct "morphotypes" of currently recognized species await description. Hogue (1987) provided detailed information about adult character systems, particularly male genitalia; however, the taxonomy of net-winged midges has been hindered by lack of data on larvae and pupae, the stages encountered most often in faunistic and ecological studies and, consequently, the stages for which keys are needed most. A prerequisite for the identification of larvae, pupae, and adults of blephariccrids is the accurate association of all life stages. This is especially true of the eastern Nearctic fauna, which contains eight described species and at least that many undescribed species (Courtney, in progress). Within this complex, the larvae and pupae of three species (*B. capitata* Loew, *B. cherokea* Hogue, *B. diminutiva* Hogue) remain undescribed (Hogue 1987).

Recent studies of the Blephariceridae (Johns 1996, Courtney, in progress) and other stream-inhabiting Diptera (e.g., Courtney 1994) from eastern North America have led to significant new records of net-winged midges. These collections permit definitive association of the larvae, pupae and adults of all described and several new species of *Blepharicera*. Descriptions of and keys to larvae, pupae and adults of all Nearctic species will be provided in a separate paper.

In my studies of Nearctic net-winged midges, association of larvae and pupae has relied on the "ontogenetic" method (Hogue 1989), which involves dissection of a pharate later-instar from an earlier stage. Pupae and adults may be associated in a similar manner and, in some instances (e.g., for species restricted to bedrock habitats), this is the only feasible alternative. Ideally, association of pupae and adults is accomplished by pupal rearings. Detached pupae often survive when placed on damp filter paper in a loosely sealed, chilled container (e.g., petri dish in an ice-filled cooler), but in this state adults cannot emerge successfully—i.e. eclosion requires that the pupa be firmly attached to the substrate. The most effective method of obtaining reared adults involves collection of rocks with attached pupae (Fig. 1). Rocks should be removed from the stream, covered with a damp cloth or paper towels, and placed in an insulated container for transport to the laboratory. On arrival at the laboratory, rocks should be placed in a plastic container that holds a shallow layer of water, sufficiently deep to maintain high humidity but not cover the pupae (Fig. 2). The container is then sealed with a plastic sheet and oversized rubber band (Fig. 3). Alternatively, rocks can be placed in plastic bags. The rearing chamber should be opened 2–3 times per day to check for emerged adults, replenish the air supply, and moisten the pupae (using, for example, a standard spray-bottle for gardening).

Data from 1991–97 collections (Table 1) show survival and emergence rates of >60% for most species. Highest rates of survival occurred in *B. coweetae* Hogue and Georgian (79%) and *B. williamsae* Alexander (74%), species active early in the season, when thermal stress during transportation and rearing was probably less. Lowest rates of survival were in species active during late spring (e.g., *B. cherokea* Hogue) or summer (e.g., *B. similans* Johannsen). Data also indicate differences in male and female survival in some species, notably *B. cherokea,* which showed the lowest values for both males (60%) and females (49%). The basis for these gender differences is unclear. In some species, including *B. cherokea,* females emerge slightly later than males, which may increase the risk of thermal stress. Data in Table 1 are for specimens reared at room temperature (approximately 20°C). Higher rates of survival are expected for material reared at typical stream temperatures (<15°C). In spite of the possibility of some temperature-related mortality, data confirm that this rearing method is an effective means of associating pupae and adults of Appalachian blepharicerids. The same or similar methods have been used to rear pupae of Blephariceridae from Nepal, Thailand, and western North America, and of other torrenticolous Diptera (Courtney 1991).



Figs. 1–3. 1, Rock with attached pupae, mostly *Blepharicera cherokea* [scale bar approximately 3 mm]. 2–3, Rearing systems for Appalachian *Blepharicera*

Table 1. 1991–97 data for pupal rearings of Appalachian *Blepharicera*. (e/d = number that emerged successfully/number that died; % = percent that emerged successfully).

Taxon	Males		Females		Total	
	e/d	%	e/d	%	e/d	%
B. appalachiae Hogue and Georgian	86/48	64	57/32	64	143/80	64
B. cherokea Hogue	137/90	60	44/45	49	181/135	57
B. coweetae Hogue and Georgian	48/11	81	26/9	74	74/20	79
B. similans Johannsen	177/91	66	74/46	62	251/137	65
B. tenuipes (Walker)	152/50	75	128/76	63	280/126	69
B. williamsae Alexander	62/24	72	40/11	78	102/35	74
Total	662/314	68	369/219	63	1141/595	66

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A NEW GENUS, TWO NEW SPECIES, AND SYNONYMICAL NOTES ON THE TRIBE SPATHOPHORINI (HETEROPTERA: COREIDAE: MEROPACHYDINAE), WITH A KEY TO GENERA OF THE TRIBE

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Abstract.—***Himellastella,*** **new genus,** and two **new species** ***H. aploa*** from Brazil, and ***H. conica*** from Brazil, Peru and Bolivia are described in the tribe Spathophorini (Coreidae). Habitus illustrations and drawings of the male and female genitalia, as well as the head, pronotum and metathoracic peritreme are included. *Hoplaphthonia* Schmidt is reduced to a **new junior synonym** under *Acocopus* Stål and *Hoplaphthonia gigantea* Schmidt is transferred to the genus *Acocopus* (**n. comb.**). A key to the Spathophorini genera is given.

Key Words: Insecta, Heteroptera, Coreidae, Meropachydinae, South America

The subfamily Meropachydinae Stål (Heteroptera: Coreidae) restricted to the Western Hemisphere, is a relatively small but diverse group of Heteroptera characterized primarily by having the apex of hind tibia ending beneath in a short projecting spine, hind femur curved and usually strongly incrassate, and hind coxae widely separated. The subfamily includes 15 genera separated into three tribes: Merocorini (1 genus), Meropachyni (7 genera), and Spathophorini (7 genera) (Kormilev 1954, Packauskas 1994).

The new genus belongs to the tribe Spathophorini which are recognizable by the triangular scutellum, flat, shorter than clavus, the hind femora not attaining the apex of the abdomen, antennal segment IV usually slender, and abdominal spiracles elliptical and positioned between the anterior and middle third of the segment. This new genus is unique among members of Spathophorini in having the middle third of the metasternum conspicuously produced into two large conical lobes freely directed downwards, and the parameres bilobated. In the known genera the metasternum is always flat, and the parameres usually elongated and fusiform except in *Paralycambes* Kormilev, a closely related genus.

The following abbreviations are used for the institutions cited in this paper: HNHM (Hungarian Natural History Museum, Budapest); INPA (Instituto de Pesquizas da Amazonia, Manaus); MABR (Museo Argentino de Ciencias Naturales Bernardino Rivadavia, Buenos Aires); MEM (Mississippi Entomological Museum, Mississippi State, Mississippi); NRE (Naturhistoriska Riksmuseet, Stockholm); SMT (Staatliches Museum fur Tierkunde, Dresden); UNAM (Instituto de Biología, Universidad Nacional Autónoma de México, México D.F.).

All measurements are given in millimeters.

KEY TO GENERA OF SPATHOPHORINI

1. Outer and inner apical third of antennal segment III dilated, obovate in outline; inner apical third of antennal segment II dilated . . . . *Spathophora* Amyot and Serville

- Antennal segments II and III cylindrical, never apically dilated 2

2. Middle third of metasternum conspicuously produced into two large conical lobes directed downwards (Figs. 4–5) . . . *Himellastella*, n. gen.

- Metasternum flat, without conical tubercles . . 3

3. Body length greater than 32.0 mm; posterior border of the pronotum lacking triangular process; antenniferous tubercles elevated; space between antenniferous tubercles not filled by tylus; humeral angles remarkably expanded laterally, broad, winglike, with long marginal spines . . . . *Acocopus* Stål

- Body length shorter than 26.3 mm; posterior border of the pronotum with triangular process; antenniferous tubercles not elevated; space between antenniferous tubercles filled by tylus; humeral angles not produced laterally into winglike expansions. 4

4. Hind femur strongly clavate, swollen distally, with proximal half slender; fore and middle femora dorsally granulate from base to apex; hind femur in dorsal view with apical third armed with strong conical plates. . . . . *Allopeza* Bergroth

- Hind femur gradually incrassate from base toward apex; fore and middle femur dorsally smooth; hind femur dorsally smooth or with few small tubercles 5

5. Hind tibia longer than length of hind femur; humeral angles obtusely rounded, or produced laterally into angulate short projection; posterior angles of connexival segments IV to VI each armed with long and acute spines (male) or medium size and broad spines (female); apex of scutellum globose and raised. . . . . *Diariptus* Stål

- Hind tibia shorter than length of hind femur; humeral angles distinctly angulate or produced laterally into sharp spine; posterior angles of connexival segments IV to VI each armed with tiny spine; apex of scutellum acute or subacute 6

6. Mesosternum elevated; humeral angles sharp but hardly produced laterally; posterolateral border of pronotum almost smooth or only with upper half finely nodulose . . *Lycambes* Stål

- Mesosternum flat (Fig. 12); humeral angles produced laterally into medium sized and acute spine; posterolateral border of pronotum abruptly crenate . . . . . . *Paralycambes* Kormilev

Himellastella Brailovsky and Barrera, new genus

Diagnosis.—*Himellastella*, like its closely related genus *Paralycambes* Kormilev, has the space between the antenniferous tubercles filled by tylus, antennal segment IV longest, III shortest, and II shorter than I, ventral surface below and behind the bucculae without tubercle, triangular process of pronotum broad and bifid, mesosternum flat, metathorax not expanded laterally, with metapleura and hind acetabulae not visible dorsally, hind femora attaining abdominal sternite VI with dorsal surface smooth, hind tibiae shorter than hind femora, scutellum longer than wide, triangular, flat and shorter than clavus, and parameres bilobed (Figs. 7–8, 13). *Himellastella* can be recognized from *Paralycambes* by its humeral angles markedly produced laterally into a sharp and large spine (Fig. 3), the middle third of the metasternum conspicuously produced into two large conical lobes freely directed downwards (Figs. 4–5), and metathoracic peritreme with anterior lobe ear-like, and posterior lobe tiny (Fig. 6). In *Paralycambes* the humeral angles are produced laterally into an acute medium-sized angulate triangle (Fig. 11), the middle third of the metasternum is flat (Fig. 12), the metathoracic peritreme is elongate, fusiform, without posterior lobe, and the spermathecal bulb with an elongate digitiform process, absent in *Himellastella* (Figs. 10, 14).

Generic description.—Body medium-sized, oblong-obovate. *Head:* Wider than long, pentagonal, non declivent, dorsally flat; tylus unarmed, apically globose, raised, extending anterior to and higher laterally than juga and antenniferous tubercles; juga unarmed, shorter than tylus; space between antenniferous tubercles filled by tylus, and space between them smaller than width of one tubercle; antenniferous tubercles unarmed, border entire, continuous, almost semicircular, not prominent; side of head anterior to eye unarmed; antennal segment I robust, cylindrical, flat, thickest, slightly curved outward, weakly sulcate, longer than head; segments II and III cylindrical, flat, sulcate; segment IV fusiform; segment IV longest, III shortest, and II shorter than I (Fig. 2); ocelli close to eyes; distance between ocelli 2.2 to 3.6 times diameter of each ocellus; preocellar pit obliquely deep;

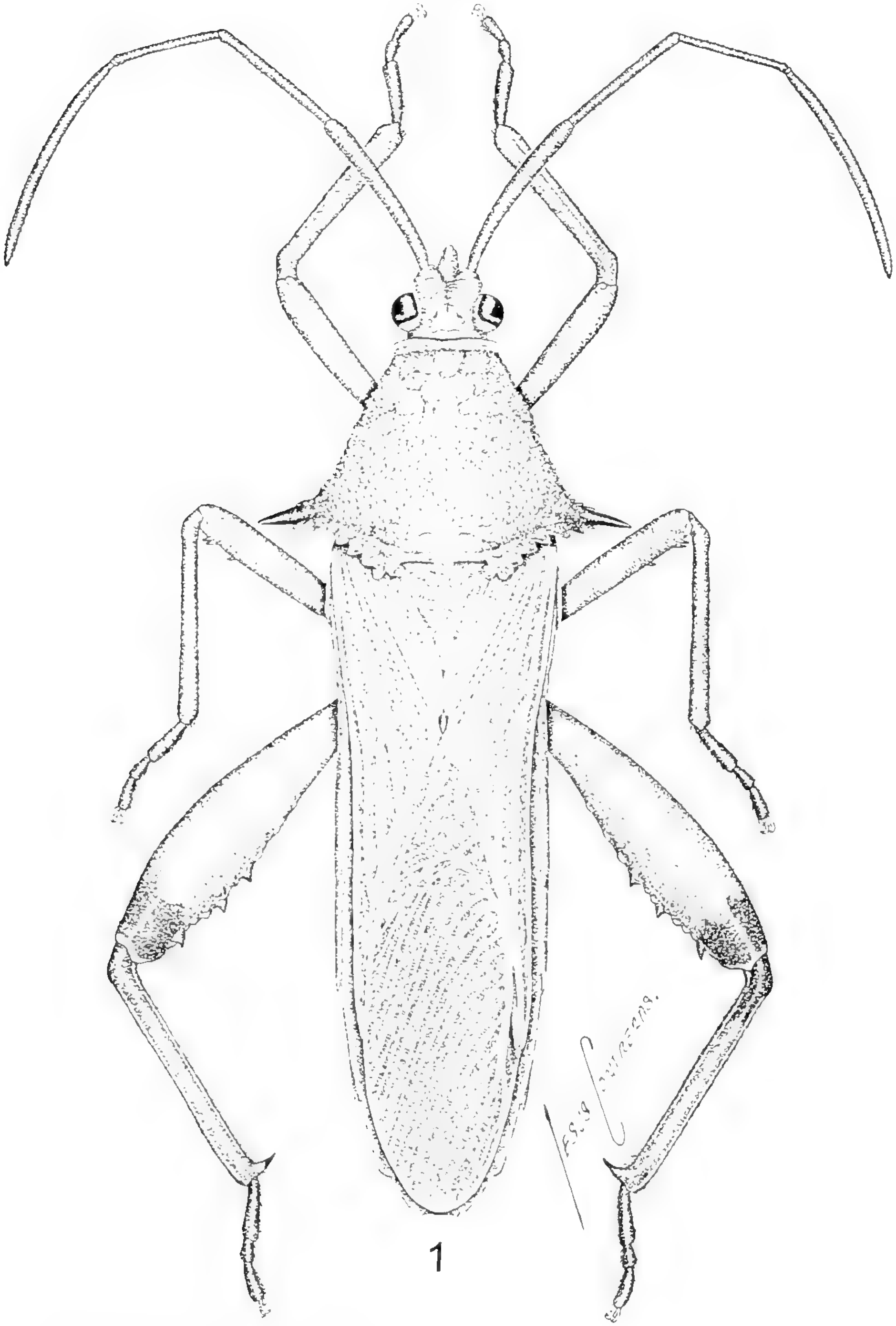

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Fig. 1. Dorsal view of *Himellastella conica.*

eyes globose, slightly protuberant, upper margin located at same level, or above, vertex and frontal area; postocular tubercle absent; mandibular plate absent; buccula squarish, raised, short, entire, not projecting beyond antenniferous tubercle, meeting posteriorly; rostrum reaching middle third of mesosternum; rostral segment III shortest, I longest, and II subequal or shorter than IV; ventral surface below and behind the bucculae without tubercle.

Thorax: Pronotum wider than long, trapeziform, slightly declivent, with posterior border subequal to base of scutellum in width; collar wide; anterolateral angles obtuse; humeral angles markedly produced laterally into sharp and large spine, with medium sized and broad marginal spines and tubercles; calli entire, not elevated separated at midline by short longitudinal furrow; anterior margin smooth and curved; anterolateral margin obliquely straight, uniformly nodulose; posterolateral border abruptly spinate and tuberculate; triangular process broad and bifid; posterior border almost straight, margin with irregular transverse ridge (Fig. 3). Prosternum sunken, posterior third in front of area between fore legs produced into a narrow acute projection; mesosternum flat, anterior third in front of area between fore legs, raised into a broad and blunt keel, posterior third between middle legs raised into a squarish plate, laterally carinate and projected in two slender arms; metasternum broad, rectangular, anterior border slightly bifid, each tubercle small, broad and blunt, close to mesocoxae (Figs. 4, 5); mesosternal arms facing one to one to metasternal anterior tubercles; middle third of metasternum conspicuously produced into two large conical lobes freely directed downwards; posterior border of metasternum straight, lateral angles projected into broad rectangular plate, laying against metacoxae; posterior border of metathorax straight, entire; upper margin of mesopleuron raised; metathorax laterally not expanded, in dorsal view with metapleura and hind acetabula not visible; metathoracic peritreme located near lower margin of metapleuron, with upper third closed; canal elongate, with raised sides; anterior lobe ear-like, and almost fused with tiny posterior lobe; evaporative area poorly developed (Fig. 6).

Legs: Hind coxae separated, distance between them 1.2 to 1.6 times diameter of one coxa, and apically with broad and blunt tubercle located on external surface; fore and middle femora slender, ventrally armed with one or two subdistal spines; hind femur incrassate, attaining posterior third of abdominal sternite VI; dorsal surface smooth, ventrally armed with one row of strong spines and tubercles, running from middle third to apex; fore and middle tibiae unarmed, sulcate, widened distally; hind tibia almost straight, flattened, shorter than length of hind femur, with outer margin sulcate, not expanded, and inner margin not expanded and dimorphic, in male armed with one row of acute spines running from middle third to apex, including a broad and large spine near middle third, and one acute spine at distal third, and in female unarmed, except for the large apical spine.

Scutellum: Longer than wide, triangular, flat, shorter than clavus; disc without triradiate ridge; apex acute, elevated; lateral margins emarginate.

Hemelytra: Macropterous, reaching apex of abdomen; clavus and claval suture not covered by the scutellum; costal margin emarginate; apical margin obliquely straight, with apical angle narrowly, very long, extending beyond middle third of hemelytral membrane.

Abdomen: Gradually narrowed beyond middle; abdominal segment VII of male slightly exposed, on female not expanded; connexival segments scarsely elevated; posterior angle of segments V and VI projected into short and broad spine, segments II to IV and VII entire without spine; abdominal sterna without medial furrow; abdominal spiracles elliptical; abdominal spiracle III closer to anterior border and spiracles IV to VII situated nearer middle third; abdominal sternite II visible, slender, short, rectangular, without tubercle, and with the lateral angles truncate without lateral plate; abdominal sternite III not expanded laterally.

Male genitalia: Genital capsule simple, semiglobose; posteroventral edge with medial broad projection, protruding as a large hemispherical plate, with short median tubercle, laterally with angles rounded and broad (Fig. 9). Parameres: shaft relatively slender, almost parallel-sided, apically bilobate, with proximal lobe short, and distal lobe rather broad and triangular (Figs. 7, 8).

Female genitalia: Abdominal sternite VII with plica and fissura; plica rectangular, narrowed; fissura with inner margin overlapping; gonocoxae I subtriangular, short, exposed, in caudal view closed, in lateral view almost straight, with upper border rounded; paratergite VIII triangular, spiracle visible; paratergite IX squarish, longer than paratergite VIII, in caudal view opened, or almost contiguous. Spermatheca: bulb hemispherical with one elongate and digitiform process, basal duct barely coiled, chamber dilated with small lateral spines, distal duct weakly coiled, and relatively short membraneus duct (Fig. 10).

Integument: Body surface shining, with clavus, corium, prosternum, mesosternum, and metasternum rather dull; included antennal segments and legs sparsely clothed with long to short decumbent to suberect setae; head, prosternum, mesosternum, metasternum, connexival segments, abdominal sterna, and middle third of propleura, mesopleura and metapleura impunctate; pronotum, acetabulae, anterior and posterior margin of propleuron, posterior margin of mesopleuron and metapleuron, clavus and corium, densely to finely punctate; calli smooth; scutellum transversely striate; propleura, mesopleura and metapleura with creamy yellow hardened protuberance; pronotal disc with or without creamy yellow hardened spot.

Etymology.—Named for its similarity to the nematopodini genus *Himella* Dallas; feminine.

Type species.—*Himellastella conica* Brailovsky and Barrera, new species.

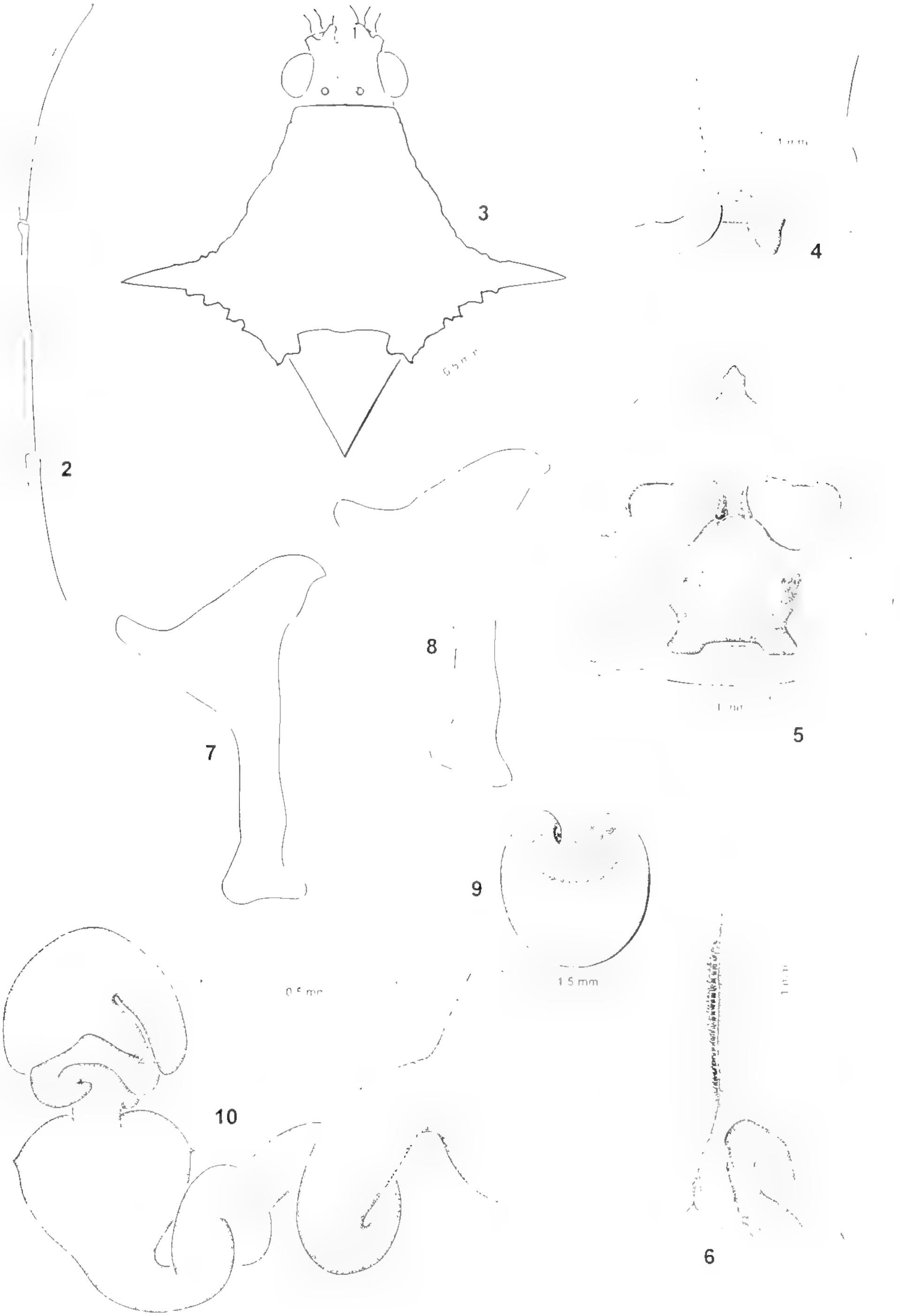
Himellastella conica Brailovsky and Barrera, new species

(Figs. 1–10)

Description.—Measurements: *Male:* Head length in dorsal view 1.52; width across eyes 2.08; interocular space 0.93; preocular distance 0.93; interocellar space 0.40; length antennal segments: I, 3.40; II, 2.56; III, 2.08; IV, 4.72. Pronotum: Length 3.88; width across frontal angles 1.92; width across humeral angles 6.72. Hind leg: Length femur 5.77; length tibia 4.78. Scutellar length 1.80; width 1.48. Body length 16.00.

Female: Head length in dorsal view 1.84; width across eyes 2.20; interocular space 1.08; preocular distance 1.08; interocellar space 0.47; length antennal segments: I, 3.72; II, 2.84; III, 2.20; IV, 4.44. Pronotum: Length 3.92; width across frontal angles 2.02; width across humeral angles 7.20. Hind leg: Length femur 6.68; length tibia 5.39. Scutellar length 2.08; width 1.60. Body length 18.30.

Male: Dorsal coloration: Head bright ochre yellow; ocelli and eye bright red; antennal segments bright orange; pronotum bright ochre yellow, with humeral angles and spines black or dark brown, and two creamy yellow hardened spots located on middle third, one behind calli, other on posterior margin; scutellum bright ochre yellow, with apex creamy yellow; clavus rather dull ochre yellow with punctures orange red, and vein pale yellow; corium rather dull dark red, with costal margin, apical margin and veins pale yellow; hemelytral membrane dark ambarine, with basal angle and veins darker; connexival segments bright yellow; abdominal segments rather dull pale orange yellow with black marks on segment VII. Ventral coloration: Including rostral segments I to IV, legs, and genital capsule bright orange yellow with following areas black: apex of rostral segment



Figs. 2–10. *Himellastella conica.* 2, Antenna. 3, Head, pronotum and scutellum in dorsal view. 4, Metathorax in lateral view. 5, Mesothorax and metathorax in ventral view. 6, Metathoracic peritreme. 7, 8 Parameres. 9. Male genital capsule in caudal view. 10, Spermatheca.

IV, two apical rings on hind femur, basal third of hind tibia, and the space between conical lobes of metasternum; propleuron with small and mesopleuron and metapleuron with large and broad creamy yellow hardened protuberance. Genitalia: Genital capsule: Fig. 9. Paramere: Figs. 7, 8.

Female: Similar to male. Antennal segment I pale orange yellow, and II to IV bright orange; connexival segments VIII and IX bright yellow; abdominal segments VIII and IX rather dull orange yellow; genital plates bright orange yellow. Genitalia: Spermatheca: Fig. 10.

Variation (both sexes).—1, Antennal segments I to IV dark red to pale orange yellow. 2, Hind femur bright yellow to orange yellow with one black ring on the apical joint. 3, Space between conical lobes of metasternum yellow. 4, Abdominal sterna III to VI laterally with or without one or two creamy yellow spots. 5, Punctures orange yellow or red brown.

Type material.—Holotype: ♂, Brasil, Rondônia, vic Caucalandia, 10°32′S 62°48′W, (160–350 m), 30 October 1991, J. MacDonald (MEM). Paratypes: 1 ♂, Brasil, Amazonas, Manaus, Reserva Ducke, May 1968, E. V. Silva and A. Faustino (INPA). 1 ♀, Brasil, Rondônia, 62 km., SW Ariquemes, Fzda. Rcho. Grande, 7 October 1993, C. W. and L. O'Brien (UNAM). 1 ♂, Brasil, Rondônia, Forte Principe da Beira, 19 November 3 December 1967, G. R. Kloss (UNAM). 1 ♀, Peru, Pachitea (without data) (HNHM). 1 ♀, Sud Bolivia, Sta. Cruz, H. Rolle (Berlin SW 11) (HNHM).

Etymology.—Named for the conical projection of the metasternum.

Distribution.—Brazil, Peru, Bolivia.

Himellastella aploa Brailovsky and Barrera, new species

Description.—Measurements: *Female:* Head length in dorsal view 1.72; width across eyes 2.12; interocular space 1.08; preocular distance 1.04; interocellar space 0.52; length antennal segments: I, 2.84; II, 2.24; III, 1.68; IV, 3.76. Pronotum: Length 3.88; width across frontal angles 1.96; width across humeral angles 6.60. Hind leg: Length femur 5.70; length tibia 4.33. Scutellar length 1.80; width 1.48. Body length 15.10.

Female: Coloration: Including antennal segments, rostral segments and legs bright chestnut orange, with following areas black: humeral angles and spines, apex of rostral segment IV, apical joint of hind femur, and basal joint of hind tibia; hemelytral membrane dark ambarine, with basal angles and veins darker; abdominal segments rather dull orange yellow with lateral margins of segments VII to IX black; mesopleuron and metapleuron with large and broad creamy yellow hardened protuberance.

Male: Unknown.

Type material.—Holotype: ♀, Brasil, Amazonas, Manaus, 17 October 1957, Elias and Roppa (UNAM).

Etymology.—From "*aploos*" (Greek adjective meaning simple) refers to the lack of striking characters in this species.

Distribution.—Only known from the type locality.

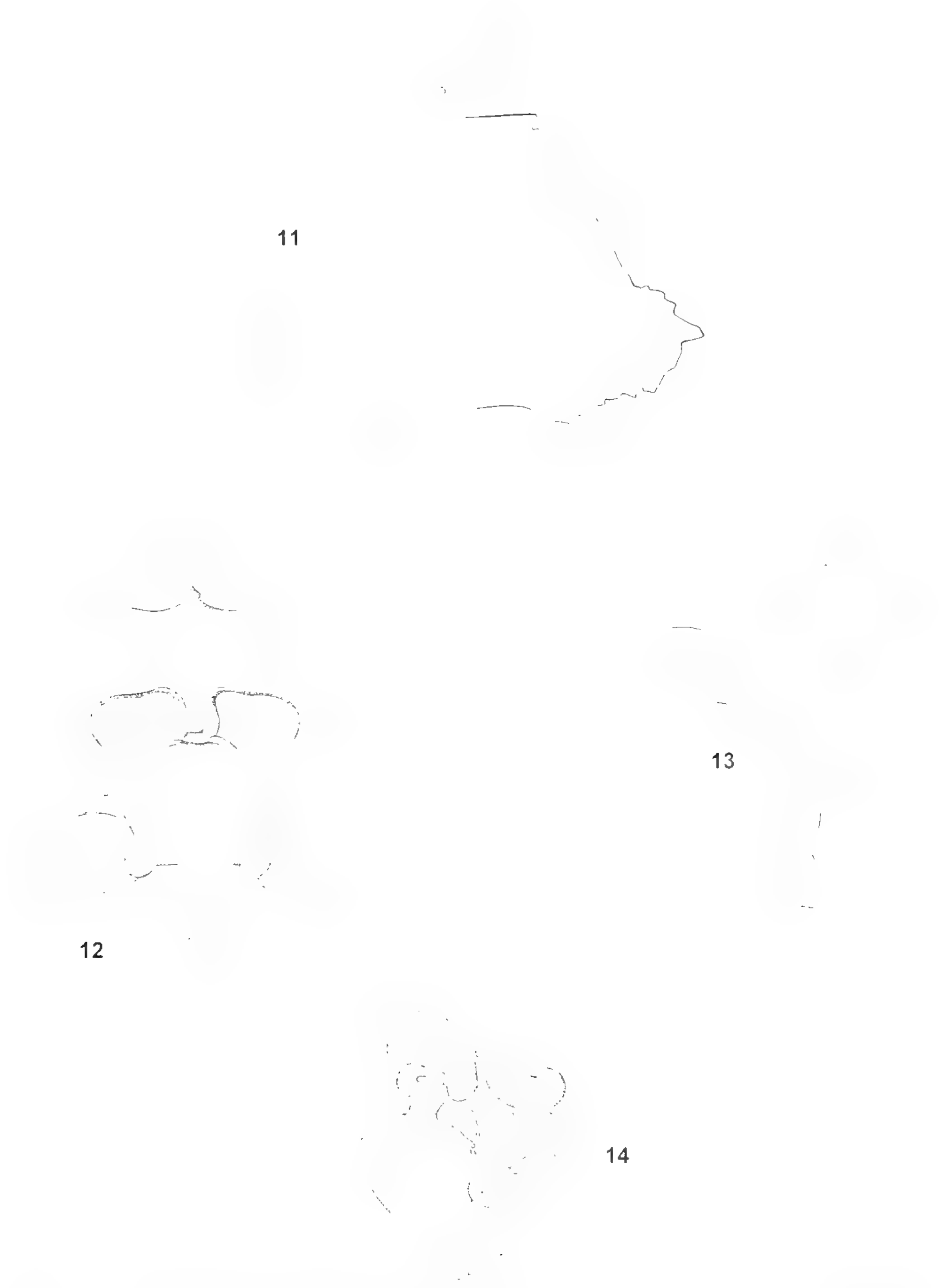
KEY TO SPECIES OF *HIMELLASTELLA*

1. Pronotal disc with two creamy yellow hardened spots; propleuron with a creamy yellow hardened spot; antennal segment I longer than 3.3 mm; antennal segment IV longer than 4.4 mm . . . . *H. conica,* n. sp.
– Pronotal disc without creamy yellow hardened spots; propleuron without creamy yellow hardened spot; antennal segment I shorter than 2.9 mm; antennal segment IV shorter than 3.8 mm . . . . *H. aploa,* n. sp.

Acocopus Stål

Acocopus Stål 1864: 55–56.
Hoplaphthonia Schmidt 1911: 565–566. **New synonym.**

The genus *Acocopus* was erected by Stål (1864) to include one species, *A. verrucifer,* collected in the Amazon (Brazil). Years later Schmidt (1911) described the genus *Hoplaphthonia* and included one species *H. gi-*



Figs. 11–14. *Paralycambes misionensis* Kormilev. 11, Head, pronotum and scutellum. 12, Mesothorax and metathorax in ventral view. 13, Paramere. 14, Spermatheca.

gantea from Bolivia. Examination of the type material deposited in NRE and SMT, respectively, shows that both genera are the same and *Hoplaphthonia* is here synonymized under *Acocopus*. The species *Hoplaphthonia gigantea* Schmidt (1911: 566–567) is transferred to the genus *Acocopus* resulting in the new combination *Acocopus gigantea* (Schmidt).

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HETEROGONY IN *BELONOCNEMA TREATAE* MAYR (HYMENOPTERA: CYNIPIDAE)

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Abstract.—Through experimental rearing we demonstrated that heterogony (the alternation of unisexual and bisexual generations) occurs in the cynipid species *Belonocnema treatae* Mayr 1881. Female *B. treatae* (bisexual generation) induce galls on the leaves of *Quercus fusiformis* Small (Fagaceae), from which unisexual females, previously described as *B. kinseyi* Weld 1921, emerge. Unisexual females induce galls on the roots of *Q. fusiformis.* The name *B. treatae* has priority, so *B. kinseyi* becomes a **new synonym.** The adults of each generation and the galls induced by females of each generation are described. Timing events in the life cycle of both generations are documented as well as hymenopterans associated with both gall types.

Key Words: Heterogony, cynipid gall wasps, *Quercus fusiformis,* parasitoids, synonymy

Phytophagous members of the family Cynipidae induce a spectacular diversity of plant galls that are often complex in structure. Worldwide, approximately 2,000 species of Cynipidae have been described, with 805 occurring in North America (Dreger-Jauffret and Shorthouse 1992). Typically, individual cynipid species induce galls on a single species of host plant or on a series of closely related plant species. In the case of phytophagous cynipids that induce galls on oaks, all host species are typically in the same subgenus. Knowledge of the biology, life cycle, and life history of known cynipid species is largely fragmentary, and there remain many undescribed species (Askew 1984, Meyer 1987, Dreger-Jauffret and Shorthouse 1992).

Cynipid wasps can exhibit an alternation of generations known as heterogony in which an all-female generation alternates with a bisexual generation (Lyon 1963, 1964, Felt 1965, Askew 1984, Rey 1992). The unisexual generation produces eggs parthenogenetically, and those eggs are usually inserted into a specific plant part. At the site of oviposition galls are induced within which a bisexual generation develops and later emerges. Emergent males and females mate, and females in turn initiate galls from which the unisexual generation emerges. Females of the two generations may be morphologically dissimilar and may induce galls that differ greatly morphologically whether oviposition occurs in the same or different plant organs (Felt 1965, Lyon 1969, 1970, Meyer 1987, Rey 1992). Differences in the morphology of both female wasps and galls between generations, coupled with incomplete knowledge of life cycles, has led to considerable taxonomic confusion within the Cynipidae. Alternating generations of numerous species have been described as separate species or even genera

(Dreger-Jauffret and Shorthouse 1992, Rohfritsch 1992).

Here we demonstrate that two cynipid species, *Belonocnema treatae* Mayr 1881 and *B. kinseyi* Weld 1921, that are generally similar in morphology but produce morphologically dissimilar galls on their host plant, plateau live oak, *Quercus fusiformis* Small (formerly *Q. virginiana* var. *fusiformis*) represent alternate generations of a single species. This is the first demonstration of heterogony in North American Cynipidae outside the Pacific Slope region (Lyon 1996). The species name *B. treatae* has priority, thus *B. kinseyi* becomes a synonym, as is *Dryorhizoxenus floridanus* Ashmead 1881 (Ashmead 1886). We also provide a description of the life cycle of the species, a description of the galls induced by unisexual and bisexual females, and a list of the inquilines, parasitoids, and hyperparasitoids associated with galls produced by both generations. The observations and timing of events reported herein describe populations of *B. treatae* from Southwest Texas State University's Freeman Ranch located in Hays County, Texas. The experiments reported herein were conducted using wasps and plants from this same location.

ESTABLISHING SYNONYMY

Mayr (1881) described *B. treatae,* and Weld described *B. kinseyi* in 1921. Weld (1921) speculated that *B. kinseyi* and *B. treatae* could be alternate generations of a single species, but this relationship has only now been demonstrated. *Belonocnema kinseyi* emerges from pea-shaped galls on the leaves of *Quercus fusiformis* from mid-October through early November. No males have been described for this species. *Belonocnema treatae,* described from both male and female specimens, has been obtained from root galls on *Q. fusiformis* from mid-March through early April in both 1996 and 1997.

To link *B. treatae* emerging from root galls with the leaf galls from which *B. kinseyi* emerge, we performed a caging experiment in the field. Observations made in the spring of 1995 and 1996 showed that leaf galls on *Q. fusiformis* developed from oviposition events that occurred during and shortly after bud break. In the spring of 1997, prior to bud break and prior to emergence of *B. treatae,* exclusion cages constructed of fine-mesh, polyester-fiber cloth were placed over eight branches of a *Q. fusiformis* tree that had exhibited a high density of *B. kinseyi* leaf galls during the 1996 growing season. Four additional bags were placed over branches of a second tree that exhibited a moderate density of leaf galls in 1996. Clusters of root galls were then collected from rootlets underneath both trees, returned to the laboratory, and placed in collection traps. Emergent wasps were provided with nectar sources and allowed to mate for 2 days. From 4 to 15 female wasps were then introduced into each of 5 cages on tree # 1, and into each of 2 cages on tree # 2. Five cages (tree #1, $n = 3$; tree #2, $n = 2$) remained sealed as controls. Three months later all bagged branches were harvested and leaves were scored for the presence and number of oviposition scars and developing galls. In total, 2,378 oviposition scars and 207 developing *B. kinseyi* leaf galls were present among 1,356 leaves in cages in which *B. treatae* was introduced. No leaf galls were initiated in the 5 control cages. Thus, on plateau live oak, leaf galls that develop to produce the unisexual generation (i.e., *B. kinseyi*) are initiated by females of the bisexual generation (i.e., *B. treatae*) that emerge from root galls, confirming the synonymy of the two species.

In the laboratory we tested the oviposition preference of *B. treatae* reared from root galls of *Q. fusiformis* using both individual mated females and groups of mated females. Eight mated female *B. treatae* were placed separately in (3.2 × 9.6 cm) vials and presented with one shoot of *Q. fusiformis* and a second shoot from *Q. shumardii* Buckl. (southern red oak) for 24 hours. Four females oviposited exclusively

Figs. 1–4. Galls induced by *Belonocnema treatae*. 1, Unilocular leaf gall induced by bisexual generation (×1). 2, Sectioned leaf gall showing pre-emergent adult of the unisexual generation (×16). 3, Multilocular root gall induced by unisexual generation (×1). 4, Multilocular root gall, bisexual generation pupae exposed by cross section (×10).

on *Q. fusiformis* and four failed to oviposit. Three group cages, each containing 15 male and 15 female *B. treatae*, were established and wasps were provided with one shoot each of *Q. fusiformis, Q. shumardii*, and *Q. macrocarpa* Michx. (bur oak). Leaves were scored for oviposition scars after 3 and then 4.5 hours. In all cages, oviposition scars were evident on *Q. fusiformis* after 3 hours, whereas no oviposition scars were visible on *Q. shumardii* or *Q. macrocarpa* at 4.5 hours. A clear preference for oviposition on *Q. fusiformis* was demonstrated by both individual and groups of *B. treatae* females.

Description of Galls

Leaf galls.—Leaf galls produced by the bisexual generation develop following oviposition on buds and on newly unfurled leaves. Galls develop exclusively on the undersurface of leaves and are unilocular, smooth, and pea shaped. At maturity galls are lignified and range from 3 to 7 mm in diameter (Figs. 1, 2). Unisexual females emerged from lignified galls from mid-October through early November in both 1996 and 1997. No males have been recorded from the 115 wasps that have emerged from leaf galls in the laboratory.

Root galls.—Root galls induced by unisexual females grow in irregularly shaped, multilocular clusters on small rootlets just below the soil surface (Figs. 3, 4). Clusters appear fleshy and yellow and detach easily from the root surface. Sampled galls were composed of from 1 to 28 chambers and measured 5 to 28 mm in length. Developing root galls have been found in early January and at this stage appear yellow-green in color. Mature galls (those from which the bisexual generation has emerged in the laboratory) have been collected in mid-February. In the field, emergence holes in root galls were first observed in mid-March 1997, coincident with the appearance of oviposition scars on leaves of the host plant.

HOST PLANTS

Weld (1921) gave *Quercus virginiana* Miller (Fagaceae) as the host plant for both *B. kinseyi* and *B. treatae* (unisexual and bisexual generations of *B. treatae* respectively). However, *Q. virginiana* has since been split into two species (Muller 1961). *Quercus fusiformis,* (formerly a variety of *Q. virginiana*) is common throughout the Edwards Plateau region of south-central Texas, while *Q. virginiana* (coastal live oak) is distributed from the Atlantic seaboard of the southeastern United States west to eastern Texas. *Quercus virginiana* reaches its western limit in coastal Texas east of the Brazos River (Nixon 1984). In the broad region bounded by the Brazos River and the Edwards Plateau, extensive hybridization between the two parent species has occurred (Nixon 1984). The type locality for *B. treatae* is given as Green Cove, Florida (Mayr 1881), whereas the type locality for *B. kinseyi* is given as Boerne, Texas (Weld 1921). We note that the type locality of *B. kinseyi* (Boerne, Texas) is located within the geographic range of *Q. fusiformis* well to the west of the recognized range of *Q. virginiana.* Thus the host plant species recorded by Weld for *B. kinseyi* should be amended to *Q. fusiformis. Belonocnema kinseyi* is not known outside of the geographic range of *Q. fusiformis.*

Weld (1921) also noted the presence of leaf galls on live oaks in Houston, Wharton, Victoria, Cuero, Austin, Sabinal, and Kerrville, Texas, galls he ascribed to *B. kinseyi* on the basis of morphology. We note that these sites span the entire range of the two parental oak species and their zone of hybridization in Texas. Thus, either the host range of the unisexual generation of *B. treatae* includes both parental oak species and their hybrid, or Weld's site east of the Brazos River, that is, Houston, represents leaf galls induced by a congeneric species, *B. quercusvirens* (Osten Sacken) (Osten Sacken 1861, Burks 1979) (= *B. fossoria* Weld) which is known to induce leaf galls on *Q. virginiana.* At the present time *B. quercusvirens* is known from only Florida and Georgia (E. Grissell and George Melika, pers. comm.). We have not reared *Belonocnema* sp. from either leaf or root galls collected from pure *Q. virginiana* populations located east of the Brazos River in Texas. Thus, on the basis of the available evidence the host plant range of the bisexual generation of *B. treatae* includes, *Q. virginiana,* and *Q. fusiformis* while the host range of the unisexual generation is restricted to *Q. fusiformis.*

ASSOCIATED HYMENOPTERAN SPECIES

Thirteen hymenopteran species belonging to 7 families have been commonly reared from mature leaf galls in addition to the gall former. *Belonocnema treatae* larvae developing within leaf galls are frequently attacked by 3 species of parasitoids: *Acaenacis lausus* (Walker) (Pteromalidae), *Ormyrus labotus* Walker (Ormyridae), and *Torymus tubicola* (Osten Sacken) (Torymidae). Four species described as being inquilines—*Synergus* sp. (Cynipidae), *Sycophila flava* (Ashmead), *Eurytoma furva* Bugbee, and *Eurytoma* sp. (Eurytomidae)—and one hyperparasitoid, *Eurytoma bugbeei* Grissell, have also been reared from leaf galls. The trophic level of 5 other species, *Allorhogas* sp., (Braconidae), *Galeopsomyia* sp., and 3 unidentified *Brasema* (Eulophidae), reared from galls is presently unknown. An additional 10 species have been reared rarely from leaf galls to date and await identification. Root galls held in collection traps in the laboratory yielded several specimens of *Torymus tubicola* (Torymidae) from mid to late April. *Torymus tubicola* is the only species that appears to parasitize larval *B. treatae* in both leaf and root galls.

DESCRIPTION OF ADULTS

Belonocnema treatae Mayr
(Figs. 5–7)

Belonocnema treatae Mayr 1881. Green Cove, Florida. 2 ♀ wasps mounted on a single pin, labeled *syntypes*, Natural History Museum, Vienna.

Dryorhizoxenus floridanus Ashmead 1882 (1881). Jacksonville, Florida. Holotype ♀ #2813 and 5 paratypes, National Museum of Natural History, Smithsonian Institution, Washington, D.C., describes ♂ and galls. Ashmead 1886 acknowledges priority of *Belonocnema* over *Dryorhizoxenus* and places the latter in synonymy.

Belonocnema kinseyi Weld 1921. Holotype ♀ #22832 and 27 paratypes, National Museum of Natural History, Smithsonian Institution, Washington, D.C. Examined by Lyon in 1961. **New synonymy.**

Type data.—Lewis Weld, in 1929, examined the 2 syntype females in the Natural History Museum, Vienna. The distinctive morphology was sketched and drawings were placed in Weld's personal notes now in the possession of R. Lyon. George Melika of the Systematic Parasitoid Laboratory, Hungary, examined the types at the Natural History Museum, Vienna, on April 27, 1998. One female syntype was selected and labeled as the lectotype. The other female was mounted on a separate pin with the label paratype. There were 17 specimens sent to Mayr by Ashmead. These were labeled *D. floridanus* Det. Ashmead and are synonyms of *B. treatae*.

Bisexual Generation
(Figs. 5, 7)

Redescription (Lyon)—*Female:* Uniformly yellow brown, scutellum and propodeum dark brown, almost black; abdomen light brown (Fig. 5E). Length 3.5 to 3.75 mm ($\bar{x}$ = 3.7 mm, *n* = 27 Weld specimens). Head as broad as mesosoma, transverse, coriaceous, gena not broadened behind eyes, malar space (Fig. 5C) 0.33× eye length with groove; frons tumescent; interlocular area broader than high. Antenna 14 segmented, filiform, segment 3 longer than 4, terminal segment 2× as long as 13. Scutum (Fig. 5B) slightly convex but flattened, smooth, shining, as broad as long; notauli percurrent, curving laterally at anterior portion with a few, scattered, setigerous punctures along lateral margins. Scutellum almost circular, nearly two-thirds length of scutum, coarsely rugose, roughly irregular along margin; foveae deep, separated with smooth, shining bottoms. Propodeum with irregular ridges, area between rugose. Mesopleuron bulging, slightly setose on lower portions. Forewing hyaline (Fig. 5A), short ciliate, longer on lower margins, pubescent; veins dark brown, R_{s2} heavy, curving toward wing margin forming a distinct club. Darkened areas around R_{s1} and R_{s2}, radial cell short. Legs bristly; foretibia with a distinctive spur (Fig. 5D), as long as furcula; tarsal claws edentate. Metasoma (Fig. 5E) longer than high with all terga visible along dorsal curvature. Hypopygeal spine short with bristles extending beyond apex.

Male: Similar to female but slightly smaller, length 3.4 to 3.75 mm ($\bar{x}$ = 3.6 mm, *n* = 5) (Fig. 7). Color light brown but blackened along margins of pronotum. Antenna 15 segmented, filiform, 3rd longer than others and deeply excavated, terminal segment equal in length to 14th. Forewing pubescent, ciliated, R_{s2} curving toward wing margin, slender and only slightly enlarged at tip. Foretibial spur much shorter than in female and sometimes not elongated. Tergite 2 oval and occupying most of abdomen, remaining terga visible along dorsal curvature but short.

Unisexual Generation
(Fig. 6)

Redescription (Lyon).—*Female:* Head and metasoma red brown; mesosoma very dark, almost black. Length 2.0 to 3.1 mm ($\bar{x}$ = 2.7 mm, *n* = 62 Weld specimens). Head transverse (Fig. 6B), slightly broader than mesosoma, coriaceous, gena not broadened behind eyes, malar space (Fig. 6E) less than

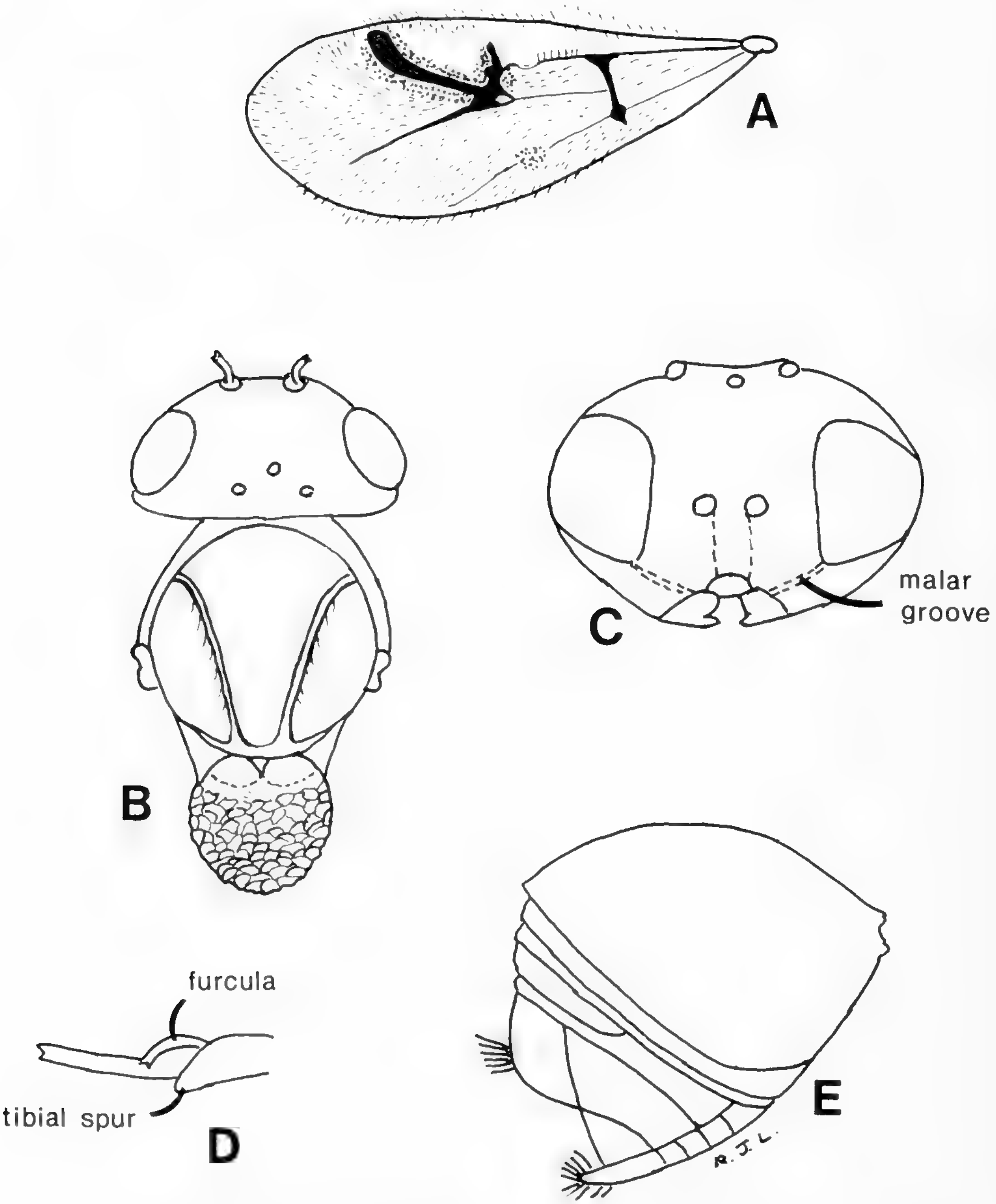

Fig. 5. *Belonocnema treatae* (bisexual female). A, Forewing venation, lateral view (×25). B, Head and mesosoma showing detailed morphology of scutum and scutellum, dorsal view (×40). C, Frontal view of head showing malar furrow (×60). D, Foretibia showing elongated, characteristic spur and furcula. E, Lateral view of metasoma showing shape of abdominal terga (×60).

half length of eye with groove; interocular space broader than high; frons tumescent. Antenna 13 segmented, 3rd nearly 2× length of 4th segment, 4–12 gradually shorter, terminal segment 2× length of preceding one. Scutum (Fig. 6B) slightly convex but flattened, smooth, bare, shining; notauli percurrent, deep, narrow, curving

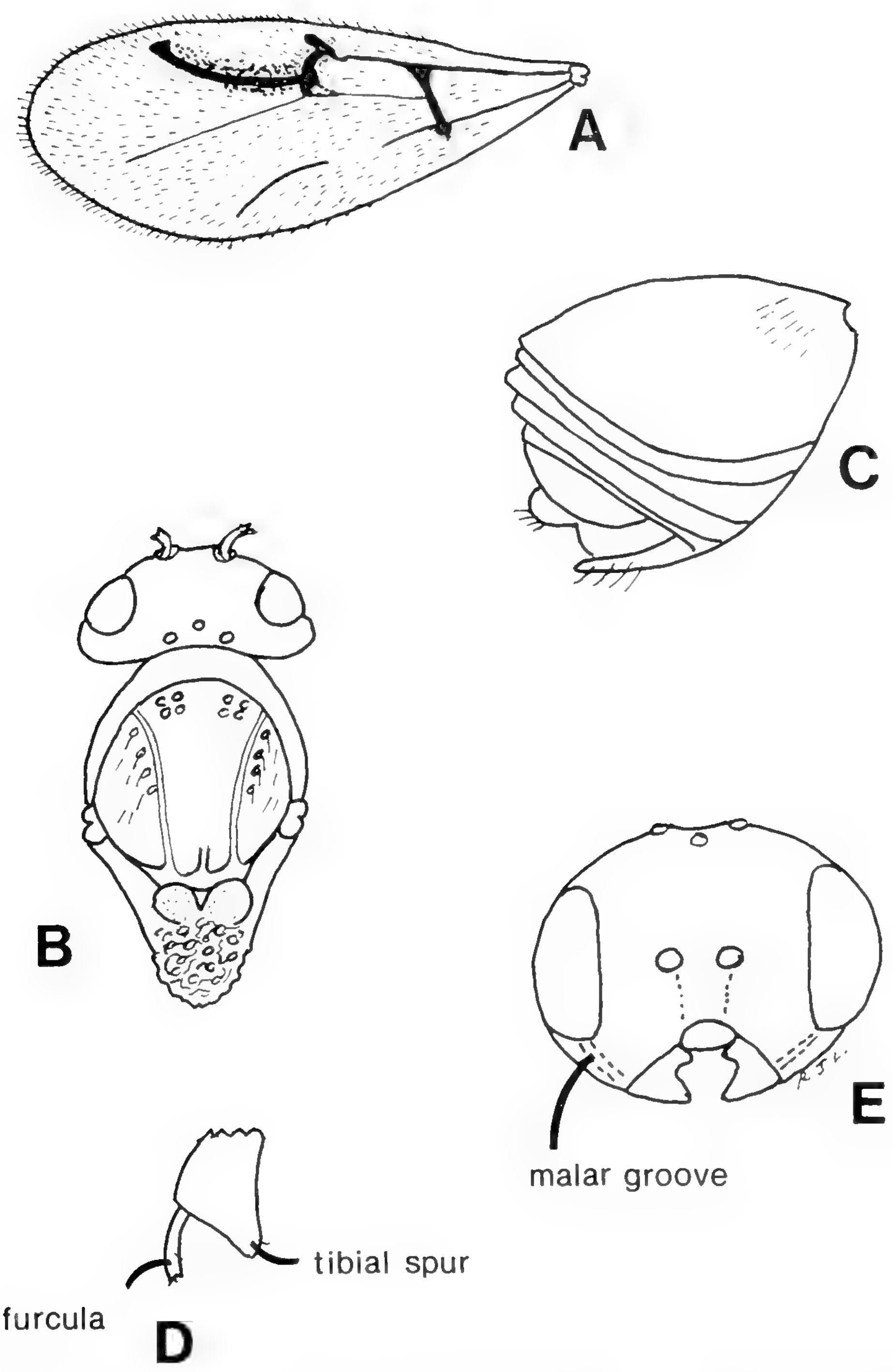

Fig. 6. *Belonocnema treatae* (unisexual generation female = *B. kinseyi*). A, Forewing venation, lateral view (×25). B, Head and mesosoma showing detailed morphology of scutum and scutellum, dorsal view (×40). C, Lateral view of metasoma showing shape of abdominal terga (×40). D, Foretibia showing elongated, characteristic spur and furcula. E, Frontal view of head showing malar furrow (×60).

Fig. 7. *Belonocnema treatae* bisexual generation (×16); male (left), female (right).

slightly along upper lateral margins; a very short median posterior groove in some specimens. Scutellum sloping to a broad, rounded, roughened margin, slightly more than half length of scutum; foveal pits large, deep, separated with smooth, shining bottoms. Propodeum with two curved ridges, area between rugose. Mesopleuron bulging, shiny with setae along lower portion. Forewing hyaline (Fig. 6A), pubescent, short ciliate along anterior margin, longer on posterior margin; veins brown, R_{s1} with dark areas, R_{s2} curving toward wing margin with slightly flattened club at apex; radial cell short, 2× as long as broad. Metasoma (Fig. 6C) longer than high with all terga showing along dorsal margin. Hypopygeal spine with bristles extending beyond apex. Foretibia with an extended spine almost as long as furcula (Fig. 6D).

Comparison of the unisexual and bisexual generation females.—Average bisexual-generation females are larger than unisexual-generation females—3.6 mm versus 2.7 mm. This is unusual; unisexual-generation females are generally larger than those of the bisexual generation (R. Lyon, in litt.). Bisexual females are mostly light yellow brown with a dark scutellum and propodeum. Unisexual females are darker, with the mesosoma almost black and the head and metasoma red brown. The scutellum of bisexual females is broader and more rounded, appearing almost circular in outline, whereas the unisexual females have a narrower scutellum that slopes to a broad, more-rounded point. Bisexual females have 14 segmented antennae, unisexual females have 13 segmented antennae. Bisexual females have wing vein R_{s2} heavier, more sharply curving toward wing margin, and club at tip larger and more rounded than do unisexual females, for which R_{s2} is more slender and less sharply curved and the terminal club is smaller.

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TWO NEW SPECIES OF *ACYTHOPEUS* PASCOE (COLEOPTERA: CURCULIONIDAE: BARIDINAE) FROM *COCCINIA GRANDIS* (L.) VOIGHT (CUCURBITACEAE) IN KENYA

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Abstract.—Two new species of *Acythopeus* Pascoe, ***A. burkhartorum*** and ***A. cocciniae,*** from Kenya are described. These weevils are stem gall makers and leaf miners, respectively. They are considered as potential biological control agents of *Coccinia grandis* (Cucurbitaceae) in Hawaii. These species are described and relevant morphological structures are illustrated. Thirty-two African and Madagascan species, previously placed in *Baris* and *Amictides*, are transferred to *Acythopeus*. AFRICA: *Baris aeniipennis* Hustache, *B. amaniensis* Hustache, *B. behanzii* Hustache, *B. bigibbosa* Hustache, *B. brevisetis* Hustache, *B. conicollis* Marshall, *B. helleri* Hartmann, *B. impolita* Boheman, *B. indigna* Boheman, *B. massaicus* Hustache, *B. naivashensis* Hustache, *B. nodipennis* Hustache, *B. opacus* Boheman, *B. riftensis* Hustache, *B. sculpturata* Hustache, *B. vadonis* Hustache. MADAGASCAR: *Baris allaudi* Hustache, *B. amborobense* Hustache, *B. callosa* Hustache, *B. decorsei* Hustache, *B. distigma* R. Richard, *B. glyptobaroides* Hustache, *B. hovanus* Hustache, *B. laevirostris* Hustache, *B. parvula* R. Richard, *B. perrieri* Fairmaire, *B. pilitarsis* Hustache, *B. rufoapicalis* Hustache, *B. sculpturata* Hustache, *B. vadonis* Hustache; *Amictides similaris* Hustache, and *A. similis* Hustache [**new combinations**].

Key Words: weevils, taxonomy, biological control, ivy gourd, Hawaii

The two species of weevils treated herein are being considered as potential biological control agents against Ivy gourd, *Coccinia grandis,* (L.) Voigt (Cucurbitaceae), an Old World plant native to Africa and the Indo-Malayan region of Asia. The plant was introduced intentionally into Hawaii by immigrants and is widespread on Oahu and on the Kona coast of Hawaii. Previously it was found on Kauai and Maui but has been eradicated there.

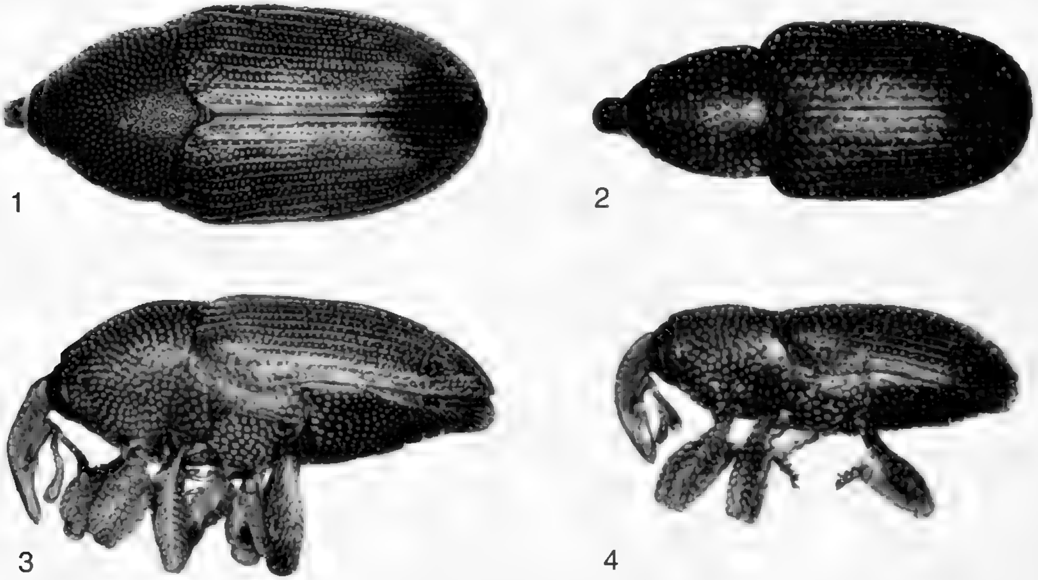
The two species of weevils were collected in Africa during extensive foreign exploration for potential biological control agents of *Coccinia.* Subsequently they were studied in strict quarantine in Hawaii to determine their efficacy as biological control agents and to determine potential host acceptance of other species of native or introduced Cucurbitaceae in Hawaii. Host specificity has been confirmed by feeding and rearing tests demonstrating their suitability as potential biological control agents against this important weed. Publications on the evaluation of two species are in preparation and awaiting the names proposed herein. Species epithets are required for any organisms released for biological control purposes, so the use of these weevils in Hawaii against *C. grandis* also is delayed until such names are available (B. Kumashiro, personal communication.).

The two species of weevils were sent to specialists in three countries for identification, and in each case were identified as unnamed species of *Baris* Germar, a genus with nearly 100 species known from Africa. The senior author was approached for assistance in obtaining names and took specimens to ten major research collections in Europe for comparison with types and other named specimens. Type specimens or authoritatively identified examples of more than 90 species of *Baris* were studied, including all species from East Africa, the origin of the two weevils under study. The descriptions of the few remaining species of African *Baris* were compared with the specimens being studied. None of the descriptions, the types, nor identified species matched the weevils in question. In addition, careful study of the external and internal morphology clearly showed that these two new species belong to the genus *Acythopeus* Pascoe, not *Baris*. Hence, all described African species and 20 of the 25 described Asian species of the genus *Acythopeus* were carefully compared with the two species included herein. Since no match was found, the two species are described herein as new species of the genus *Acythopeus*.

Because *C. grandis* is a member of the family Cucurbitaceae, a plant family with many economically important species, the weevils were tested extensively to determine if they develop and/or feed on a wide spectrum of both cultivated and wild native species of cucurbits. Placement of the two new species in *Acythopeus*, subgenus *Carpobaris*, indicates that they are closely related to the melon weevil, *Acythopeus (Carpobaris) curvirostris* Boheman, an important pest of cultivated melons in Africa, across the Sudan Belt, in the Middle East, Iran and southern India. The taxonomy of the subspecies of this important pest was covered in detail by Thompson (1973). Two other species of *Acythopeus (Carpobaris)* are known to be associated with cucurbits, namely *A. (C.) alcyoneus* (Erichson) from southern Africa, and *A. (C.) cucurbitae* (Marshall) from Kenya, as cited in Thompson (1973). Thompson (1973) describes the distinctive male genitalia of this group of species, which alone distinguishes them readily from *Baris*. In independent research, the senior author also discovered the taxonomic significance of these diagnostic characters.

The two genera can be distinguished by the following characters: *Baris*—rostrum not normally incrassate basally, cylindrical to subcylindrical, not attenuate apically beyond antennal insertion, at most apically flattened; antennal club with article 1 at least half length of club and glabrous; tarsal claws widely separate and free; male median lobe with apodemes directly connected by thick, strongly, scleorotized cuticle; apodemes at most 2× as long as median lobe; flagellum, when present, shorter than or slightly longer than median lobe; *Acythopeus*—rostrum always moderately to strongly incrassate basally, gradually to strongly attenuate beyond antennal insertion; antennal club with article 1 less than half length of club and tomentose to subglabrous; tarsal claws approximate, basally connate; male median lobe with apodemes connected by weakly sclerotized, hyaline connection; apodemes 2.5 to 6.0× as long as median lobe; flagellum *ca* 1.5 to 4.5× as long as median lobe.

The following African and Madagascan species are transferred herein from *Baris* and *Amictides* to *Acythopeus* based on studies by the senior author, mentioned above. AFRICA: *Baris aeniipennis* Hustache, *B. amaniensis* Hustache, *B. behanzii* Hustache, *B. bigibbosa* Hustache, *B. brevisetis* Hustache, *B. conicollis* Marshall, *B. helleri* Hartmann, *B. impolita* Boheman, *B. indigna* Boheman, *B. massaicus* Hustache, *B. naivashensis* Hustache, *B. nodipennis* Hustache, *B. opacus* Boheman, *B. riftensis* Hustache, *B. sculpturata* Hustache, *B. vadonis* Hustache. MADAGASCAR: *Baris allaudi*



Figs. 1–4. *Acythopeus* spp. 1, 3, *A. burkhartorum*. 2, 4, *A. cocciniae*. 1, 2, Habitus, dorsal. 3, 4, Habitus, lateral.

Hustache, *B. amborobense* Hustache, *B. callosa* Hustache, *B. decorsei* Hustache, *B. distigma* R. Richard, *B. glyptobaroides* Hustache, *B. hovanus* Hustache, *B. laevirostris* Hustache, *B. parvula* R. Richard, *B. perrieri* Fairmaire, *B. pilitarsis* Hustache, *B. rufoapicalis* Hustache, *B. sculpturata* Hustache, *B. vadonis* Hustache; *Amictides similaris* Hustache, and *A. similis* Hustache [**new combinations**].

Acythopeus Pascoe
(Figs. 1–12)

Acythopeus Pascoe 1874, p. 61. Type species, *Acythopeus tristis* Pascoe by subsequent designation Heller (1940: 106).

Redescription.—*Rostrum* long, arcuate, with strong transverse impression at base, base moderately to strongly incrassate, apically gradually to strongly attenuate beyond antennal insertion; scrobe lateroventral, deeply grooved; eyes lateroventral. *Antenna* with scape moderately to strongly clavate, short, not quite reaching eye, funicle long, much longer than scape; club small, rounded to oval, subtruncate to acute, article 1 less than half length of club and tomentose to subglabrous. *Prothorax* transverse; apex tubulate, only somewhat produced; base strongly bisinuate. *Scutellum* small, round to oval. *Elytra* slightly to much wider than prothorax, apices apically narrowed to strongly emarginate. *Prosternum* medially, longitudinally, distinctly to moderately sulcate; forecoxae well-separated, by distance *ca* equal to their diameter. *Abdominal sterna* 1 and 2 connate. *Pygidium* exposed. *Legs* with femora unarmed, internally subcanaliculate; tibiae distinctly mucronate; tarsal claws small, approximate, basally connate.

Genitalia and associated structures.—*Median lobe* short to moderate in length, moderately to weakly curved in lateral view; with well-developed flagellum *ca* 1.5 to 4.5× as long as median lobe; apodemes connected to median lobe by weakly sclerotized unpigmented hyaline connection, *ca* 2.5 to 6× as long as median lobe. *Tegmen* (Fig. 7) fused with long "parameres"; with long apodeme. *Spiculum gastrale* (Fig. 8) short, stout, moderately curved and distinctly forked at apex.

Acythopeus burkhartorum O'Brien, new species

(Figs. 1, 3, 7–10)

Description.—Body medium-sized (3.80–4.30 mm); moderately broad-oval; subparallel behind humeri to declivity, there broadly rounded to strongly emarginate apices; cuticle piceous to black, finely to coarsely alutaceous, moderately shining; coarsely strongly punctate, with obvious white straplike setae to oval scales in each puncture, setae or scales all well-separated.

Holotype male.—*Rostrum* 0.81× as long as pronotum; dorsally very strongly, unevenly curved; ventrally weakly, unevenly curved; *ca* basal ⅔ very strongly swollen, with very dense contiguous to cribrate deep punctures; *ca* apical ⅓ moderately attenuate, with basal moderately coarse and moderately dense punctures, becoming finer and sparser apically; with evident ventrally and laterally produced margin at antennal insertion. *Head* smooth, strongly shining, scarcely alutaceous; with fine, shallow, moderately dense punctures; frons moderately strongly transversely impressed, with small deep median fovea; frons 0.44× as wide as head across eyes. *Antennae* inserted just behind apical ⅓ of rostrum (0.35); scape moderately clavate; funicle *ca* 1.14× as long as scape; club *ca* 0.40× as long as scape, weakly oval and subacute; segment 1 of club with sides nearly subparallel, much more than one half length of club, shining and tomentose. *Pronotum* 0.94× as long as broad; sides subparallel in basal ⅓, then unevenly gradually narrowed to weakly tubulate apical 1/12; disc moderately convex, rather evenly covered with dense subcontiguous coarse deep punctures, each with evident recumbent grayish white scale. *Elytra* with angulate, weakly developed, rounded humeri; 1.18× as wide as pronotum; intervals subequal in width, slightly widened basally, only sutural interval narrower, latter scarcely punctate, remainder with coarse subcontiguous moderately shallow punctures; each puncture with recumbent straplike seta or rounded scale; intervals 1–8 flat, intervals 9 and 10 carinately convex producing distinctly margined sides; fused apices of intervals 3–9 forming weak but evident subapical callous; sides subparallel to declivity, there gradually narrowed to broadly rounded, broadly emarginate apices. *Prosternum* distinctly broadly longitudinally sulcate in front of procoxae, side margins of sulcus with evident fine carina from apex to procoxa; longitudinal sulcus deep narrow and transverse at area of subtubulate apex, with deep lateral foveae. *Thoracic sterna* rather evenly densely coarsely punctate, each puncture with recumbent round scale or straplike seta. *Abdominal sterna* more finely and sparsely punctate, slightly coarser and denser laterally, each puncture with recumbent round scale or coarse straplike seta; sternum 1 flattened, very weakly medially longitudinally impressed, with scarcely evident impression extended on sternum 2; sternum 5 with dense coarse setae near apical margin; sternum 5 with median apical narrow quadrate projection. *Pygidium* weakly convex; completely, coarsely, densely punctate. *Legs* densely coarsely punctate, each puncture with recumbent oval to straplike scale or seta; femora unevenly swollen, not distinctly clavate; tibiae with minute apical mucro. *Length,* pronotum and elytron: 3.80 mm.

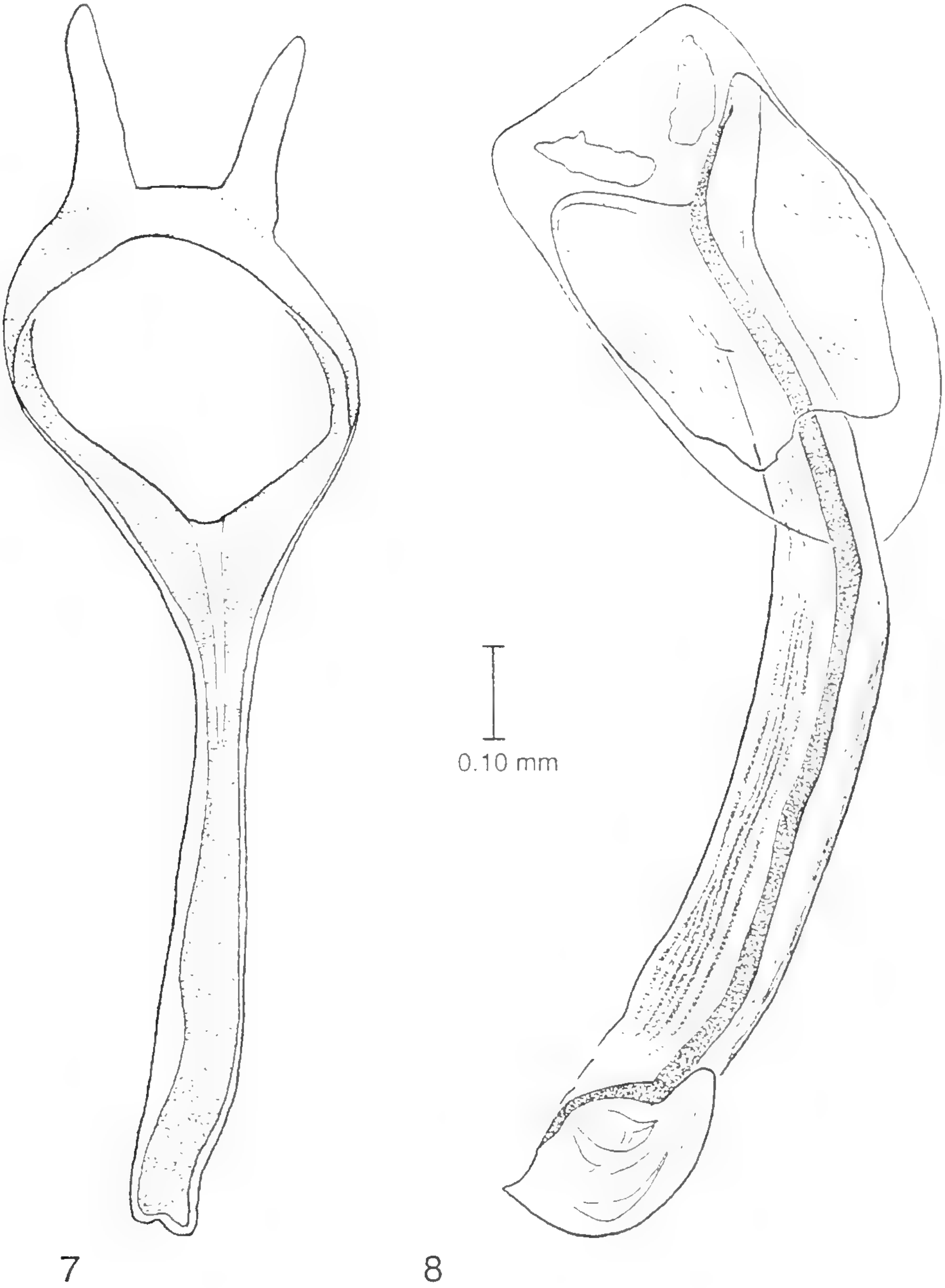
Genitalia and associated structures.—*Median lobe* (Figs. 9, 10) moderate in length; orificial opening triangular-oval, completely visible in dorsal view; moderately slender and weakly curved in lateral view; hyaline connection of apodemes *ca* 0.57× as long as median lobe; apodemes including hyaline connection more than 2× as long as median lobe; flagellum *ca* 1.5× as long as median lobe.

Allotype female.—Same as male except: *Rostrum* longer, 0.91× as long as pronotum; *ca* apical ⅖ strongly attenuate with

Figs. 5–6. 5, *Coccinia grandis* habitat in Hawaii. 6, *C. grandis* habitus.

very fine, sparser punctures. *Antennae* inserted at middle of rostrum (0.51). *Abdominal sterna* with sternum 1 weakly convex medially, with sternum 2 flattened medially, not at all impressed. *Length,* pronotum and elytron: 4.30 mm.

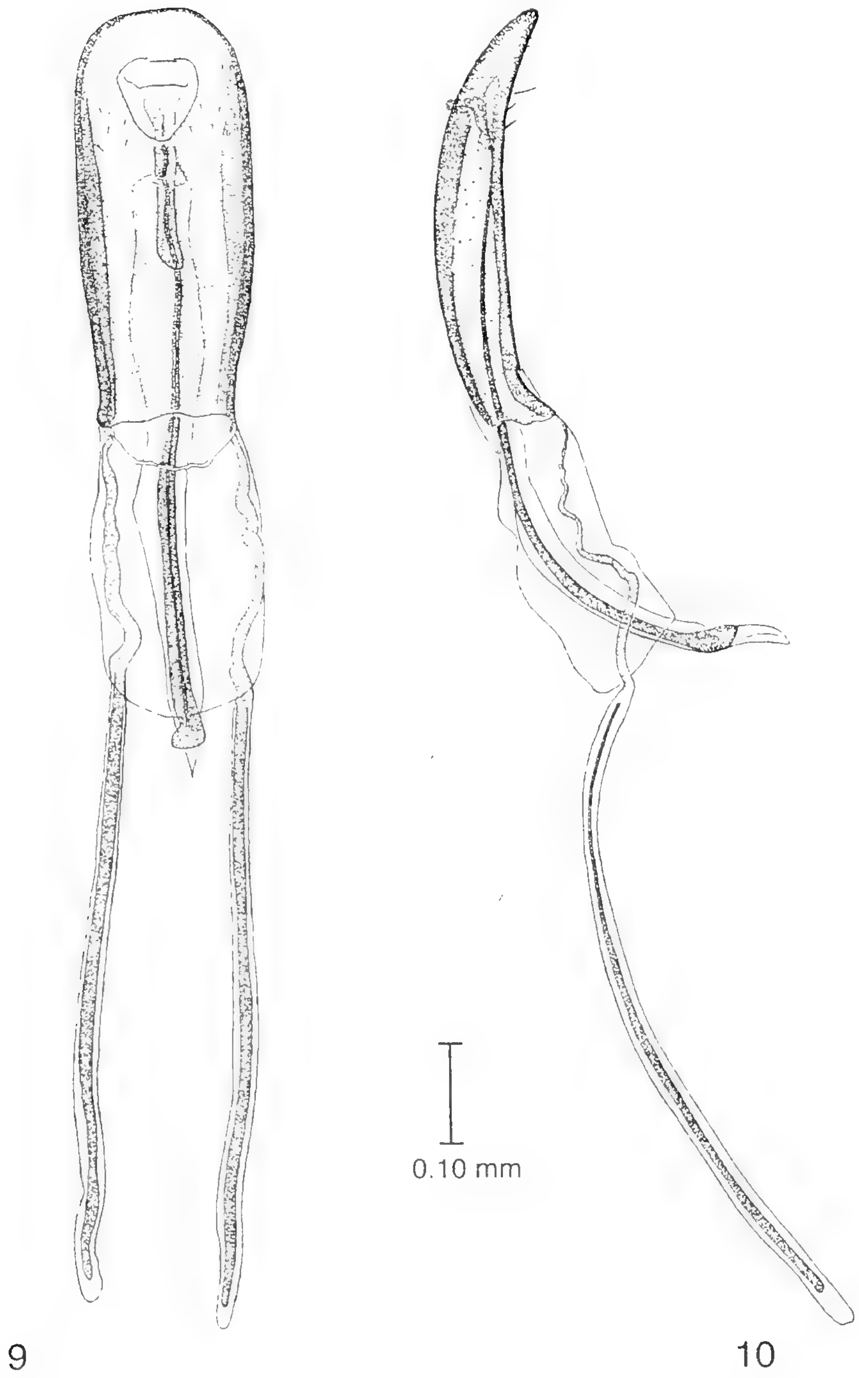
Intraspecific variation.—Although the cuticle is usually black, the elytra, antennae



Figs. 7–8. *Acythopeus burkhartorum.* 7, Tegmen. 8, Spiculum gastrale.

and legs show variable amounts of piceous coloration. The amount of piceous cuticle is increased greatly in teneral specimens, and may be present throughout the body and appendages in occasional specimens.

Etymological note.—This species is named in honor of the collectors, Dr. Robert Burkhart and his wife Lystra, who underwent considerable hardship and struggle to collect the parent population of this and nu-



Figs. 9–10. *Acythopeus burkhartorum.* 9, Median lobe, dorsal. 10, Median lobe, lateral.

merous other species during their years of foreign exploration.

Remarks and comparative notes.—This distinctive species is not likely to be confused with any other species from Africa. It superficially resembles *Acythopeus amaniensis* (Hustache) and *Acythopeus massaicus* (Aurivillius), both of which have much coarser and denser punctation. It also resembles the widespread species, *Acythopeus atrocoerulea* (Boheman), but the latter is metallic blue in color.

Biological notes.—This species develops in stem galls on *Coccinia grandis*. A thorough study of its biology and development is in preparation for publication by researchers of the Hawaii Department of Agriculture (B. Kumashiro, personal communication).

Type locality.—Africa, Kenya, coast between Mombasa and Tanzania.

Notes on type specimen.—Holotype ♂ (not dissected), with the following labels: 1) [rectangular; white; printed in black ink] OAHU I, HAWAII HDOA Quarantine Insectary, xi.1994. 2) [rectangular; white; printed in black ink]. Original colony collected: KENYA: coast btwn. Mombasa and TANZANIA, 29.vi-12.vii.1992, ex *Coccinia grandis,* R. & L. Burkhart. 3) [rectangular; white; printed in black ink. Lab reared on *Coccinia grandis.* M. Chun/94-651. 4) [rectangular; red; printed in black ink]. HOLOTYPE/*Acythopeus/burkhartorum*/O'Brien 1998. Point mounted. Deposited in the National Museum of Natural History, Smithsonian Institution (USNM), Washington, D.C., USA.

Range.—Known only from the type locality. To be introduced in Hawaii, as a potential biological control agent of Ivy gourd, *Coccinia grandis.*

Material examined.—Holotype, allotype and 293 paratypes. HAWAII: OAHU I, HDOA [Hawaii Department of Agriculture] Quarantine Insectary, xi. 1994 Original colony collected KENYA: coast btwn Mombasa & TANZANIA, 29.vi.12.vii.1992, ex *Coccinia grandis,* R.&L. Burkhart Lab reared on *Coccinia grandis* M. Chun 194-651 (holotype, allotype, 13 paratypes); HDQA Quarantine Insectary Lab colony, 3-i-1996 T. Culliney/96-003 Reared ex stems of *Coccinia grandis.* Original collection: KENYA, coast btwn. Mombasa & TANZANIA, 6-7-1992 ex *C. grandis,* R.&L. Burkhart (9, paratypes); same except vi-x-1996, M. Chun/96-470 (270, paratypes). KENYA: Coast btwn. Mombasa & TANZANIA, 29.vi.12.vii.92 ex *Coccinia grandis* stem galls R.&L. Burkhart coll's 94-435/RB. 92.04 (7) (1, paratype)

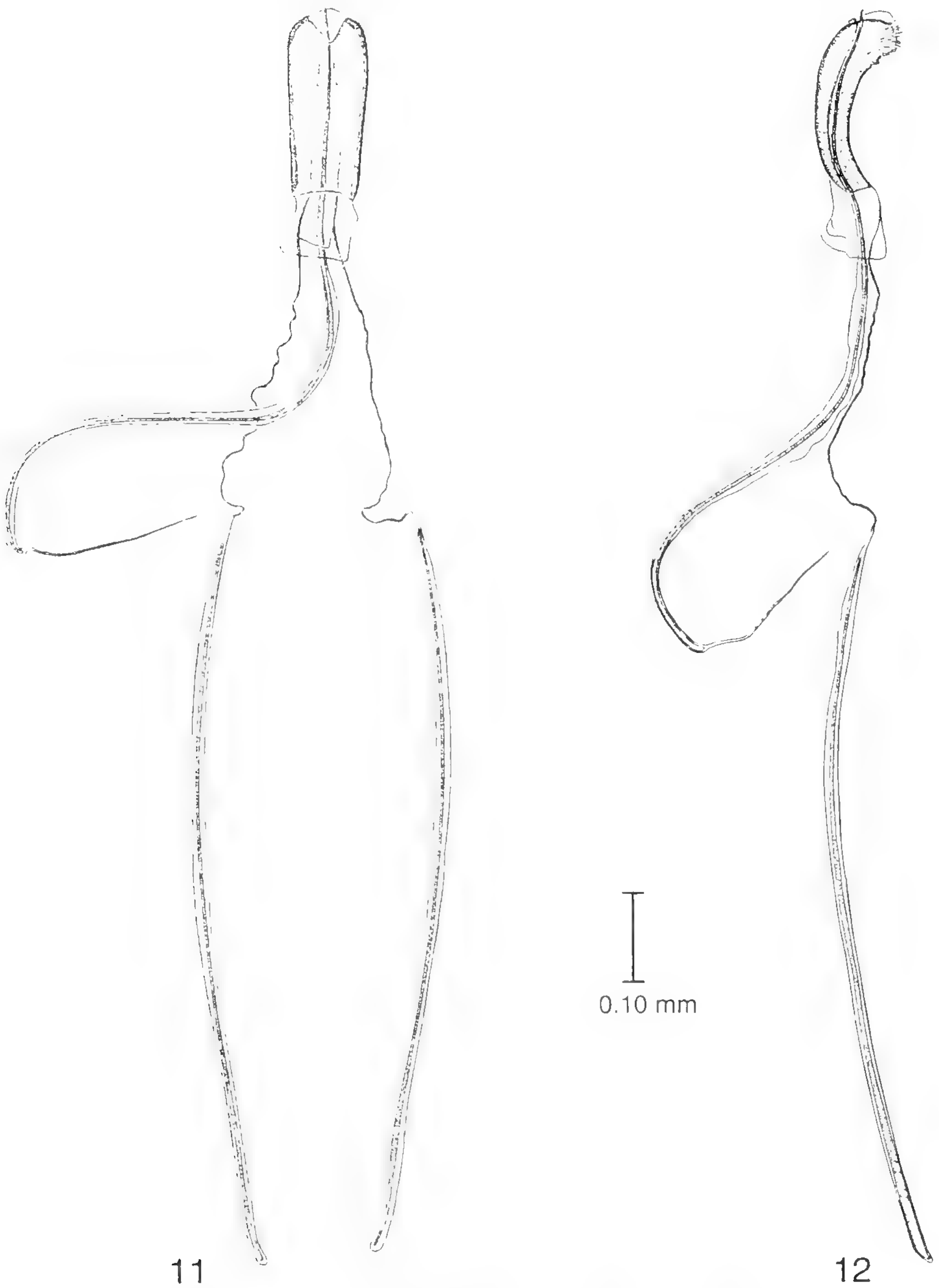
The holotype, allotype, and numerous paratypes are in the USNM. Paratypes are deposited also in ARC, BMNH, BPBM, CASC, CMNC, CWOB, FSCA and MNHP.

Acythopeus cocciniae O'Brien, new species

(Figs. 2, 4, 11, 12)

Description.—Body small (1.40–2.20 mm); moderately slender-oval; sinuately subparallel behind humeri to declivity, there broadly rounded to very weakly emarginate apices; cuticle black or rarely piceous, finely alutaceous, shining; coarsely to finely punctate, with evident white straplike setae to round scales in each puncture, scales often concentrated medially on base of pronotum; and with pearlescent white imbricate scales on dorsal ⅓ of mesepimeron.

Holotype male.—*Rostrum* 0.87× as long as pronotum; dorsally strongly evenly curved; ventrally basally weakly curved and apically straight; *ca* basal ¾ moderately strongly swollen, with dense contiguous moderately deep punctures; *ca* apical ¼ scarcely attenuate, nearly impunctate; lacking evident produced margin at antennal insertion. *Head* not smooth, shining, strongly alutaceous; with coarse to fine, moderately shallow, moderately dense punctures; frons moderately strongly transversely impressed, with large coarse moderately deep median fovea; 0.33× as wide as head across eyes. *Antennae* inserted just in front of middle (0.46); scape clavate; funicle *ca* 1.40× as long as scape; club 0.50× as long as scape;



Figs. 11–12. *Acythopeus cocciniae.* 11, Median lobe, dorsal. 12, Median lobe, lateral.

moderately oval and acute, segment 1 with sides rounded, *ca* ½ length of club, shining and tomentose. *Pronotum* 0.94× as long as broad; sides moderately rounded from base to distinctly tubulate apical 1/6; disc moderately convex, unevenly covered with dense subcontiguous coarse moderately deep punctures, each with evident recumbent grayish white scale. *Elytra* with angulate, very weakly developed, weakly rounded humeri; 1.56× as wide as pronotum; all intervals subequal in width, not distinctly widened basally, with moderately coarse unevenly separated shallow punctures; each punture with relatively fine straplike recumbent seta; intervals flat, intervals 9 and 10 at most weakly convex, not subcarinate, laterally slightly margined only from declivity to apices; fused apices of intervals 3–9 not forming evident callous; sides somewhat sinuately subparallel behind humeri to declivity, there suddenly narrowed to broadly rounded, scarcely emarginate apices; sides below and behind humeri distinctly swollen. *Prosternum* weakly broadly longitudinally sulcate in front of procoxae, side margins of sulcus evident only in area of subtubulate apex, there deeply coarsely transversely sulcate with large deep lateral foveae. *Thoracic sterna* evenly densely coarsely punctate, each puncture with recumbent oval to round scale; *ca* dorsal ⅓ of mesepisternum concealed by coating of broad recumbent imbricate pearlescent white scales (visible laterally and from above). *Abdominal sterna* much more finely though densely punctate, slightly coarser and denser laterally, each puncture with recumbent round scale or straplike seta; sternum 1 broadly medially moderately impressed, with evident narrower impression extended on sternum 2; sternum 5 with dense coarse recumbent straplike setae on apical half; sternum 5 with median apical narrow subacute projection. *Pygidium* strongly convex; completely, coarsely, moderately densely punctate. *Legs* densely coarsely punctate, each puncture usually with pale straplike seta, rarely with few oval to round scales; femora evenly swollen, strongly clavate; tibiae with small apical mucro. *Length,* pronotum and elytron: 2.10 mm.

Genitalia and associated structures.—*Median lobe* (Figs. 11, 12) short; orificial opening broadly triangular-oval, only partially visible in dorsal view; slender and moderately curved in lateral view; hyaline connection of apodemes *ca* 2× as long as median lobe; apodemes including hyaline connection *ca* 4× as long as median lobe; flagellum *ca* 4.70× as long as median lobe.

Allotype female.—Same as male except: *Rostrum* more evenly curved, less coarsely punctate, apical ⅓ distinctly though weakly attenuate. *Antennae* inserted at middle of rostrum (0.51). *Abdominal sterna* 1 and 2 flattened, at most appearing very weakly convex. *Length,* pronotum and elytron: 2.05 mm.

Intraspecific variation.—The scales and straplike setae present in the punctures on the body are often grayish to grayish white and appear relatively nondescript. However there are many specimens on hand which possess very distinct white scales and setae. Frequently there is a distinct white macula at the medial basal margin of the prothorax, but denuded specimens are equally common. The swollen area of the elytral margin just behind and below the humeri is always present but varies greatly in size and convexity. Rarely specimens are piceous rather than black. The dorsal surface of some specimens is very smooth, but an undulate elytral disc is more common.

Etymological note.—This epithet is based on the name of the host plant genus, *Coccinia,* Cucurbitaceae.

Remarks and comparative notes.—This small species is not likely to be confused with any other species from Africa. It superficially resembles the slightly larger *Acythopeus conicollis* (Marshall), but the latter has a distinctive conical shaped pronotum, coarser and denser punctation, and lacks the distinctive pearlescent white patch of imbricate scales on the dorsal ⅓ of the mesepimeron.

Biological notes.—This species develops as a leaf miner in leaves of *Coccinia grandis.* A thorough study of its biology and development is in preparation for publication by researchers of the Hawaii Department of Agriculture (B. Kumashiro, pers. comm.).

Type locality.—Africa, Kenya, coast between Mombasa and Tanzania.

Notes on type specimen.—Holotype (by designation) ♂ (not dissected), with the following labels: 1) [rectangular; white; printed in black ink] KENYA: Coast btwn. Mombasa & TANZANIA, 29.vi-12.vii.92 2) [rectangular; white; printed in black ink] *Coccinia grandis* lvs. R. & L. Burkhart 92-471/RB.92.04(5). 3) [rectangular; red; printed in black ink] HOLOTYPE/*Acythopeus/cocciniae*/O'Brien 1998. Point mounted. Deposited in the National Museum of Natural History, Smithsonian Institution (USNM), Washington, D.C., USA.

Range.—Known only from the type locality. To be introduced in Hawaii, as a potential biological control agent of Ivy gourd, *Coccinia grandis*.

Material examined.—Holotype, allotype and 302 paratypes. [HAWAII:] OAHU I., HI: HDOA [Hawaii Department of Agriculture] Quarantine Insectary Lab colony, 3-i-1996 K.Murai/96-004 Reared ex leaves of *Coccinia grandis* (26, paratypes); same except, vi-x-1996, K Murai/96-470 (276, paratypes). KENYA: Coast btwn. Mombasa & TANZANIA, 29.vi.12.vii.92 *Coccinia grandis* lvs. R. & L. Burkhart coll's 92-471/RB 92.04 (5) (holotype, allotype). The holotype, allotype, and numerous paratypes are in the USNM. Paratypes are deposited also in ARC, BMNH, BPBM, CASC, CMNC, CWOB, FSCA and MNHP.

ACKNOWLEDGMENTS

We thank Bernarr R. Kumashiro of the Hawaii Department of Agriculture who contacted us and presented us with the specimens of the new species described herein. His colleagues at the HDOA supplied us with the basic information on the weevils' biologies. We thank Peter W. Kovarik for his excellent line drawings of the male genitalia and Lisa Roberts for assistance with computer graphics.

Finally we thank the following for their invaluable reviews of this manuscript: Horace R. Burke, Peter W. Kovarik, Alexander S. Konstantinov, Allen L. Norrbom, and Norman E. Woodley.

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The following codens are used to indicate the collections in which specimens are deposited:

ARC	Alexander Riedel Collection, private, Friedberg, Germany.
BMNH	The Natural History Museum, London, England.
BPBM	Bernice Pauahi Bishop Museum, Honolulu, HI.
CASC	California Academy of Sciences, San Francisco, CA.
CMNC	Canadian Museum of Nature Collection, Ottawa, ON, Canada.
CWOB	Charles W. O'Brien Collection, private, Florida A&M University, Tallahassee, FL.
FSCA	Florida State Collection of Arthropods, Division of Plant Industry, Gainesville, FL.
MNHP	Muséum National d'Histoire Naturelle, Paris, France.
USNM	National Museum of Natural History, Smithsonian Institution, Washington, DC.

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RHYSOPHORA LAFFOONI, NEW SPECIES (DIPTERA: EPHYDRIDAE), A SAPROPHAGE ON WATER LETTUCE (*PISTIA STRATIOTES* L.) IN FLORIDA

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Abstract.—In a holistic approach, the adult and immature instars of ***Rhysophora laffooni* Deonier, new species**, are described and illustrated. This species was found in specific association with *Pistia stratiotes* L., or water lettuce, from southern Florida as far north as Polk County. The larvae were found to feed on decay microbes (microsaprophagous), but not on healthy, or undamaged, plant tissue. The basis for this specific plant association and other aspects of the life history and ecology are discussed.

Key Words: *Rhysophora, laffooni, Pistia,* water lettuce, immature stages, ecology

Rhysophora was described by Cresson (1924) as a monotypic genus based on *R. robusta* Cresson. Mathis (1977) revised the genus and added two new species, *R. liropus* Mathis and *R. ardeoceras* Mathis. Rao and Mathis (1995), in the most recent revision of the genus, added the species *R. griseola* Rao and Mathis. Mathis and Zatwarnicki (1995), in their world catalog, placed *Rhysophora* in the tribe Discomyzini, one of two tribes in the subfamily Discomyzinae (one of five subfamilies recognized in the family Ephydridae). Through the efforts of Cresson (1924, 1942, and 1946), Mathis (1977), and Rao and Mathis (1995), *Rhysophora* can be differentiated from other ephydrid genera by the following combination of characters: inner vertical macrochaeta much longer than outer vertical (at least 1.3 × as long in known species); 2–3 fronto-orbital setae, with 1–2 proclinate (anteroclinate) and 1 reclinate (posteroclinate); intrafrontal setae absent; 8–15 dorsal aristal rays; mesonotal discal setae generally small and uniordinal except for pair of prescutellar macrochaetae (displaced dorsocentrals *fide* Rao and Mathis 1995) and sometimes last pair of acrostichals; supra-alars macrochaetous; wing membrane hyaline to slightly fumose; wing vein R_{2+3} nonsetulose basad of crossvein r-m; alula usually well developed but relatively narrow; male metabasitarsomere slightly swollen, with row of pale semihelicoid (torqued) setulae or setae in ventral groove.

Rhysophora robusta Cresson is distributed within the Nearctic from Ontario, Quebec, Maine, Michigan, Ohio and southward along the Atlantic coast to Florida and Texas. The adults are nectarophagous on and the larvae bore in the (mostly unopened) florets of *Pontederia cordata* L. (Deonier, unpublished data). *Rhysophora liropus* Mathis is known only from Buenos Aires Province of Argentina, where it was reared from *Pontederia* sp. and collected as puparia from *Pontederia* sp. and *Eichhornia azurea* (Sw.) Kunth. *Rhysophora ardeoceras* Mathis occurs from Mexico southward through El Salvador and Costa Rica to Colombia and Surinam, and *R. griseola* Rao and Mathis from Mexico southward through Costa Rica to Venezuela and Ecuador.

The purpose of this study is to describe holistically (i.e. the entire life cycle of) *Rhysophora laffooni* Deonier, new species, and to provide data and other information on its life history and ecology.

METHODS

The methods used in this study are the same as those in Deonier (1993). Drawings were made on graph paper with an ocular grid fitted in stereoscopic dissecting and compound microscopes. All scales on drawings are in parts of 1 mm. Specimens for the scanning electron micrographs were prepared by placing them in a critical point dryer before sputter coating them with gold.

The descriptive terminology follows that in McAlpine (1981) and in Rao and Mathis (1995), with the exceptions noted below. The adult description is based on 5 male and 5 female specimens (for some characters as many as 15 specimens). Frequently used measurements, ratios, and indices are defined as follows: *Body length* = Distance between the most prominent part of the face and the posterior end of the abdomen, measured in lateral view and as if head and abdomen were aligned horizontally. *Color* = Descriptions of color apply to views perpendicular to the sclerite concerned unless otherwise stated. Color designations are according to the ISCC-NBS method. *Frons width-to-length ratio* = The frontal width measured at the level of the anterior ocellus divided by the frontal length measured from the anterior margin of the frons to the posterior margin of the posterior ocelli. *Face width-to-height ratio* = The narrowest width between the eyes divided by the height measured vertically from the epistoma to the ptilinal suture (inverse of mesofacial index of Deonier 1971, etc.). *Gena-to-eye ratio* = The genal height measured at the maximum eye height divided by the maximum eye height (inverse of ocular index of Deonier 1971, etc.). *Eye width-to-height ratio* = The eye width divided by the eye height, with both measurements being the greatest distances taken with the eye viewed laterally. *Costal-vein ratio* = The straight-line distance between the apices of R_{2+3} and R_{4+5} divided by the distance between the apices of R_1 and R_{2+3}. *M-vein ratio* = The straight-line distance along M between crossveins dm-cu and r-m divided by the distance apicad of crossvein dm-cu (inverse of M_{1+2} index of Deonier 1971, etc.). *Subcranial index* = The quotient of the subcranial width, or breadth, divided by the width of the anteclypeus (clypeus of some authors).

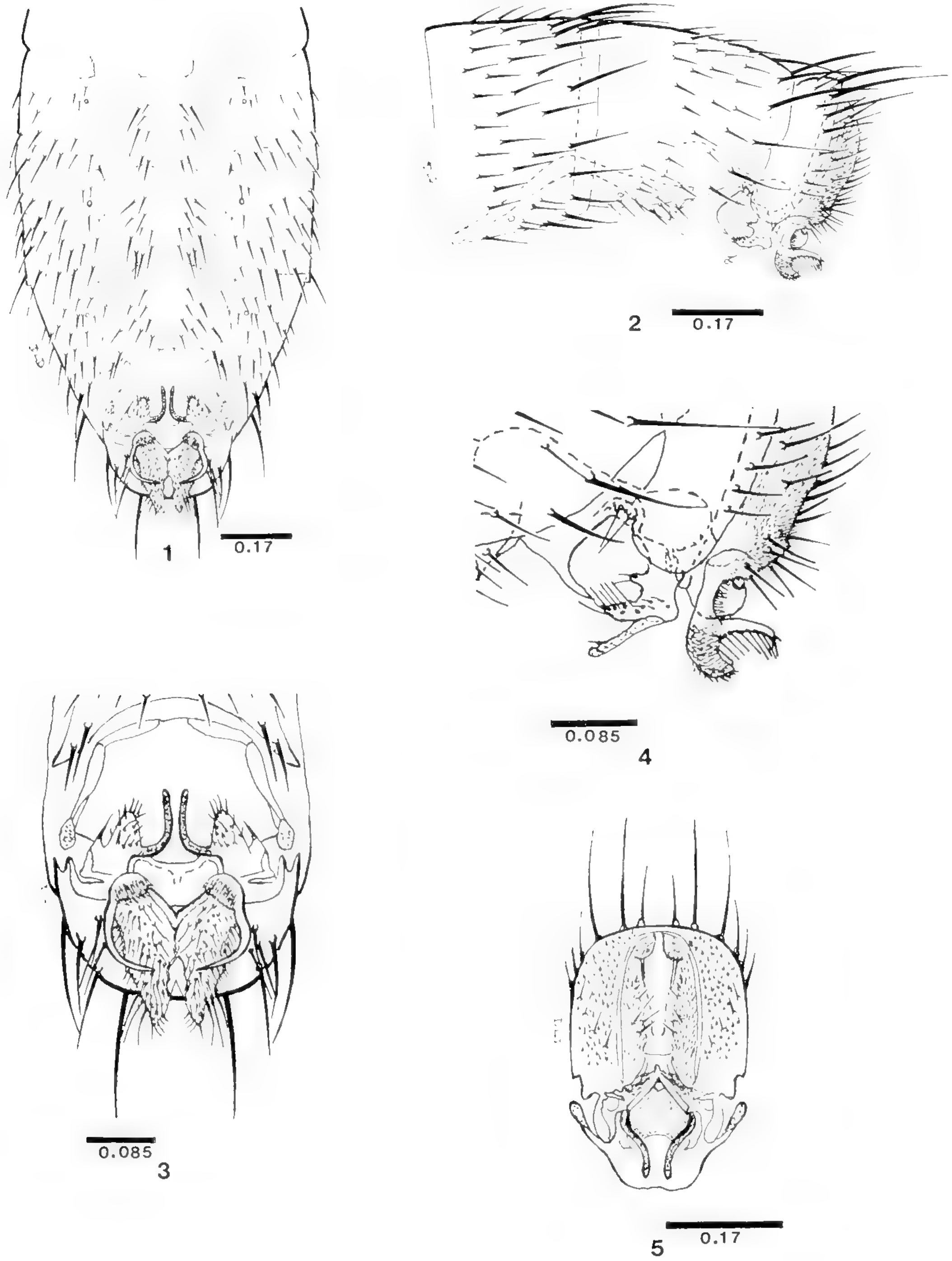
Depositories for the type material are the National Museum of Natural History, Smithsonian Institution (USNM) for the holotype and many paratypes, the Florida State Collection of Arthropods (FSCA), California Academy of Sciences (CAS), and the Deonier Collection (DLD) for the remaining paratypes.

Rhysophora laffooni Deonier, new species

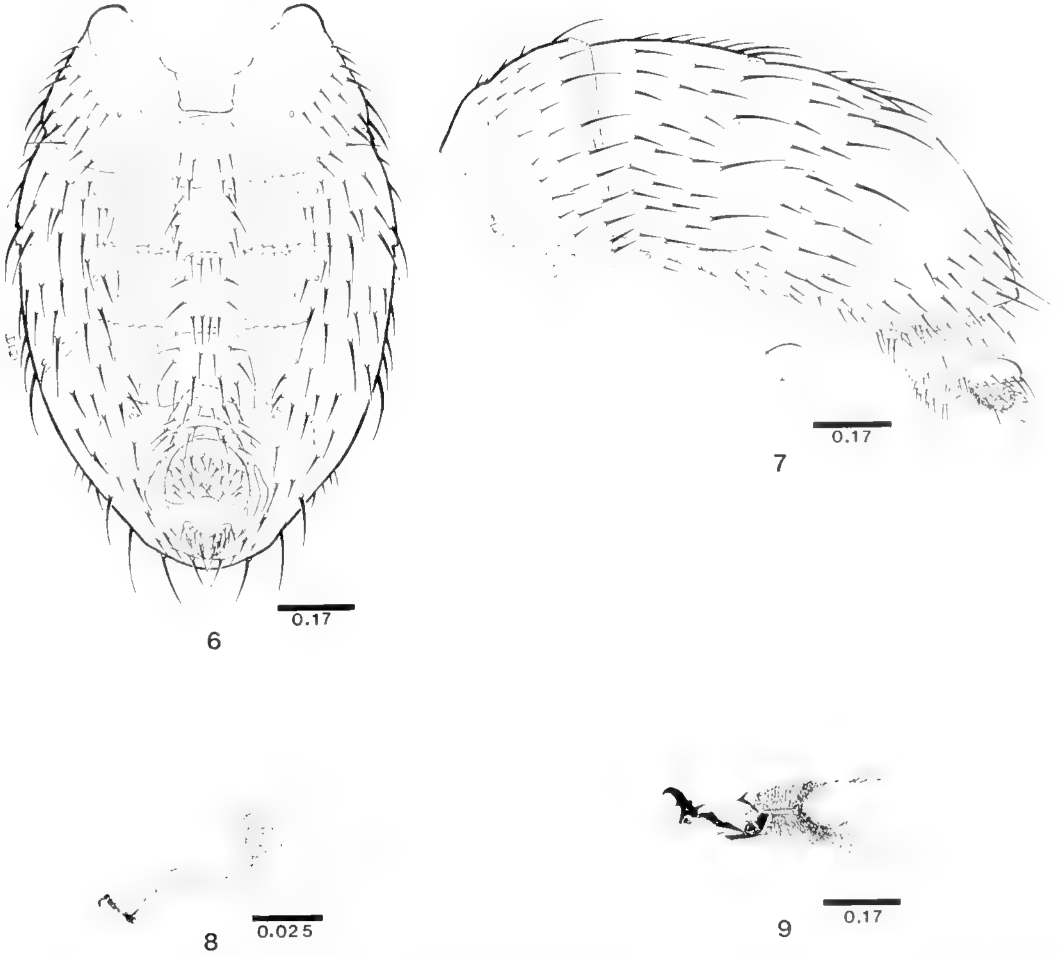
(Figs. 1–28)

Diagnosis.—Frons width-to-length ratio 0.47–0.60; postocellar setae absent (0 setae immediately posterior to ocellar triangle); inner vertical macrochaeta inserted about width of palpus from outer vertical and 2.5–3.0 × as long as outer vertical; inner vertical curving posteriad and among longest of body macrochaetae (subequal to head height and to apical scutellar macrochaeta); 2 fronto-orbital macrochaetae: 1 anterior anteroclinate (proclinate) 0.3–0.5 as long as posterior reclinate (posteroclinate) macrochaeta and 1 small setula inserted lateral to posterior fronto-orbital macrochaeta; antennomere 3 (flagellomere 1) noticeably longer than combined length of 1 and 2, bluntly rounded apically and not noticeably tapered; face width-to-height ratio 0.54–0.64; face, in profile, nearly vertical and only slightly convex; facial carina absent; 2 medioclinate (not cruciate) primary facial macrochaetae and 2 smaller ventral setulae (all on lower 0.3 of face); eye-width-to-height ratio 0.66–0.82; gena-to-eye ratio 0.13–0.16; maxillary palpus curved, spathulate, dark grayish-brown or black and with 3–5 setae (including 1 long, black preapical seta 0.3–0.5 as long as palpus). Anterior notopleural macrochaeta usually 1.3–1.6 × length of posterior macrochaeta and inserted at 0.3–0.5 (usually at 0.5) length of notopleural suture from its anterior end; 1 mesokatepisternal macrochaeta and 6–8 setulae mostly in vertical row just anterior to macrochaeta; legs dark brown except lighter brown coxae and trochanters and mostly moderate yellow meso- and metatarsi; male metabasitarsomere slightly expanded and bearing ventral row of pale semihelicoid setulae; costal-vein ratio 0.60–0.73; M-vein ratio 0.60–0.70. Male abdominal apex (dorsum of epandrium) and margin of tergum 5 each bearing 2–3 pairs of long macrochaetae; surstylus, in lateral view, somewhat falciform, but with medially curving, long, spicate process bearing ventral comb of 10 or more long, fine setulae; distal lobe of surstylus with dense covering of uniformly directed micropubescence. No male sternum with central or medial membranous area; sternum 5 about 1.7 × as wide as 4. Female cercus, in lateral view, obovoid, about 1.6 × as long as wide (shorter than sternum 8 and slightly longer than tergum 8); sternum 8, in ventral view, with slightly concave posteromedial margin, about 0.8 as wide as sternum 5 and subequal to or slightly wider than other sterna. Male length 1.94–2.82 mm; female 2.00–3.30 mm. Male postabdomen as in Figs. 1–5, 10; female abdomen and postabdomen as in Figs. 6–7.

Description.—*Head:* Frons width-to-length ratio 0.47–0.60; mesofrons (frontal vitta), in anterior view, semiglossy to glossy dark grayish brown; parafrons (parafrontalia) velvety dark brown or black; fronto-orbital area with sparse light-gray or light-brown pruinosity (microtomentum of Rao and Mathis 1995); postocellar setae absent (0 setae immediately posterior to ocellar triangle); inner vertical macrochaeta inserted about width of palpus from outer vertical and 2.5–3.0 × as long as outer vertical; inner vertical curving posteriad and among longest of body macrochaetae (subequal to head height and to apical scutellar macrochaeta); 2 fronto-orbital macrochaetae: 1 anterior anteroclinate (proclinate) 0.3–0.5 as long as posterior posteroclinate (reclinate) macrochaeta and 1 small setula inserted lateral to posterior fronto-orbital macrochaeta. Scape (antennomere 1) dark brown or black; pedicel (antennomere 2) dark brown or black with 2 dorsoapical spinoid setae, each about as long as width of antennomere 3: 1 anteroclinate and 1 lateroclinate just posterior with a cluster of 4 setulae near it; 9–12 (usually 10) dorsal aristal rays with longest ray 1.5–2.0 × as long as greatest width of antennomere 3 (flagellomere 1); antennomere 3 noticeably longer than combined length of 1 and 2, bluntly rounded apically and not noticeably tapered, dark brown dorsally with remainder usually light brown and conspicuously micropubescent distally. Face width-to-height ratio 0.54–0.64; face, in profile, nearly vertical and only slightly convex; antennal foveae only slightly apparent on either side of slight central facial elevation (facial carina absent); epistoma shallowly to moderately concave in anterior view; face usually densely light-gray pruinose; lunule usually light gray, but occasionally light-brown pruinose; parafaciale very light yellowish gray (beige) and flaring very gradually ventrad to light-gray or light-brown pruinose gena; 2 medioclinate (not cruciate) primary facial macrochaetae and 2 smaller ventral setulae (all on lower 0.3 of face); 4–5 secondary facial setulae very near upper or central part of parafaciale; 1 genal macrochaeta slightly longer than anterior fronto-orbital and cluster of about 3 setulae just posterior to it; 16–24 postocular setae nearest orbit; eye width-to-height ratio 0.66–0.82; gena-to-eye ratio 0.13–0.16; subcranial index 1.4–2.2; anteclypeus semiglossy dark brown with very slight light-gray pruinosity; maxillary palpus curved, spathulate, dark grayish brown or black, but usually partly infuscated ventrally and with 3–5 setae (including 1 long, black preapical seta



Figs. 1–5. *Rhysophora laffooni.* 1, Male abdomen, ventral view. 2, Male postabdomen, left lateral view. 3, Male postabdomen, enlarged ventral view. 4, Male postabdomen, enlarged left lateral view. 5, Male postabdomen, posteroventral view.



Figs. 6–9. *Rhysophora laffooni*. 6, Female abdomen, ventral view. 7, Female abdomen, left lateral view. 8, Larval feeding apparatus (mouth-hooks + cephalopharyngeal skeleton), first instar, left lateral view. 9, Larval feeding apparatus (mouth-hooks + cephalopharyngeal skeleton), third instar, left lateral view.

0.3–0.5 as long as palpus); prementum dark reddish brown with 2 pairs of distal setulae.

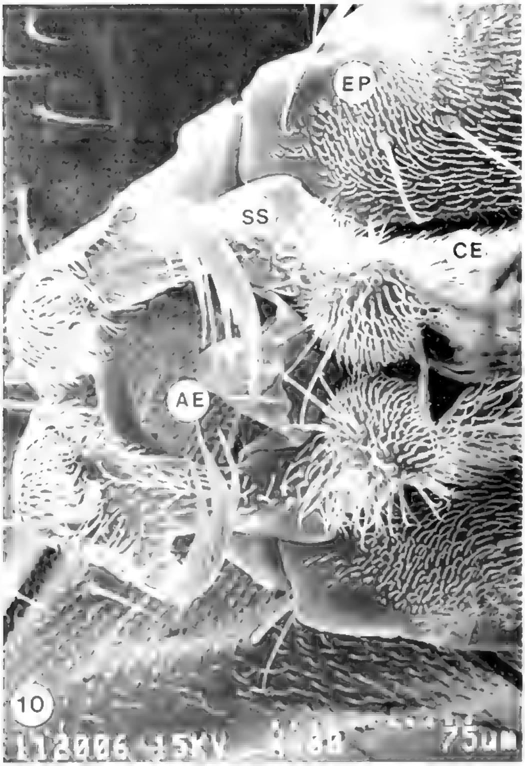
Thorax: Postpronotum dark grayish brown with very slight light-gray pruinosity in dorsolateral view; mesonotum, in dorsolateral view, semiglossy dark grayish brown with slight light-gray or light-brownish pruinosity; notopleuron mostly glossy to semiglossy dark grayish brown (nearly black) in dorsolateral view, but occasionally showing slight light-grayish or light-brownish pruinosity and with anterior notopleural macrochaeta usually 1.3–1.6 × length of posterior macrochaeta and inserted at 0.3–0.5 (usually at 0.5) of length of notopleural suture from its anterior end; notopleuron often with 1 anterodorsal setula near or in anterodorsal notopleural impression; mesoscutum with dorsocentral and acrostichal setae all small (setulous) and subequal; mesoscutal macrochaetae (*fide* Osten Sacken 1881) restricted to: 1 sublateral (dorsal to anterior notopleural), 1 supra-alar (subequal to basal scutellar), 1 postalar (about 0.8 as long as basal scutellar), 2 interalars (posterior subequal to apical scutellar and 4 × as long as anterior), and 1 prescutellar (set between acrostichal and dorsocentral rows just anterior to mesoscutellum) 0.6–0.8 as long as basal scutellar macrochaeta; mesoscutellum colored as mesoscutum except slightly more pruinose in dorsolateral view and with sparse discal setulosity (usually 8–12 setulae). Pleuron mostly with slight light-gray or light-brown pruinosity over dark grayish brown or black except glossy or semiglossy on anterior 0.5 of mesanepisternum and mesokatepisternum; 1 large mesanepisternal macrochaeta subequal to prescutellar (and 2 smaller: 1 about 0.5 size of largest and another about 0.2 size of macrochaeta) near mesopleural suture; 1 mesokatepisternal macrochaeta and 6–8 setulae mostly in vertical row just anterior to macrochaeta; 2 basal coxal setae (1 macrochaetous). Legs dark brown with areas of sparse light-gray or light-brown pruinosity except coxae and trochanters mostly light brown (procoxa with light-gray or light-brown pruinosity) and mostly moderate yellow meso- and metatarsi (these with distal 1–2 tarsomeres dark brown in both sexes, but in addition with metabasitarsomere moderate to dark brown in male); male metabasitarsomere slightly expanded and bearing ventral row of pale semihelicoid setulae; profemur with posteroventral row of 8–10 fine, nearly uniform setae; mesofemur with anteroventral row of 10–12 short setae and 2 anteromedial rows of about 10 somewhat irregular setae, including 1 macrochaeta subequal to anterior notopleural inserted at about 0.6 distance from trochanter to femur apex in lower of 2 rows. Wing length 2.00–2.75 mm; veins light yellow or light yellowish brown; membrane hyaline to slightly fumose; 14–18 dorsal and 12–16 anterior interfractural costal setae with distal 0.3–0.5 of each row denser to large spinoid terminal seta; halter white; costal-vein ratio (section III/II) 0.60–0.73; M-vein ratio (inverse of M_{1+2} index of Deonier 1971) 0.60–0.70.

Abdomen: Terga, in posterodorsal view, semiglossy dark brown with sparse light-brown pruinosity; sides and venter same as terga; male with abdominal apex (dorsum of epandrium) and margin of tergum 5 each bearing 2–3 pairs of macrochaetae as long as, but not as stout as, prescutellar macrochaeta. Male postabdomen: epandrium, in lateral view, slightly widest dorsally, bluntly rounded ventrally, with previously described macrochaetae dorsally and about 5 pairs of smaller setae posteroventrally; cercus about 0.8 of epandrium height, with numerous long marginal setulae and about 6 or more submarginal setulae including 3–4 projecting noticeably beyond posterior margin; surstylus, in lateral view, somewhat falciform, but with medially curving, long spicate process bearing ventral comb of 10 or more long, fine setulae; posterior edge of basal shaft of surstylus with comb of microsetulae; distal lobe of surstylus with dense covering of uniformly directed micropubescence, or microsetulae; surstylus, in ventral view, appearing as microsetulose dipperlike structure with long, tapering handle (pectiniform spicate process) curving posteromediad below cercus; pregonite short papilliform, bearing 2 long, apical setulae and located anterior to ventral lobe of epandrium; postgonite process, or complex (Deonier 1993; clasper of Rao and Mathis 1995), in lateral view, caligiform with long, ventromedially curved styliform lobe (postgonite, *sensu stricto,* Deonier 1971) bearing slightly distinguishable, rounded apical portion (uncus, Deonier 1971) and single preapical microsetula (entire styliform process projects nearly as far ventrad as surstylus); postgonite base complex composed of basal shaft with anterior microtubercle at midlength bearing usually 2 microsetulae and shoelike distal part bearing 6–8 longer, fine setulae on toe, or digit, and 6–8 microsetulae on remainder; phallapodeme moderately convex dorsally; aedeagus (phallus) short, broadly triangular, about as wide as long and with either a mucronate or inversely mucronate (indented) apex. Genital capsule formed above sternum 5; no sterna with central or medial membranous areas; sternum 5 about 1.7 × as wide as 4. Female abdomen: cercus, in lateral view, obovoid, about 1.6 × as long as wide (shorter than sternum and slightly longer than tergum 8) and with about 8 marginal setulae (longest subequal to cercal width) and 6–8 discal setulae (including 1–2 subequal in length to cercus); sternum 8, in lateral view, with 6–8 setulae projecting beyond margin and, in ventral view, with about 3 rows of setulae in addition to numerous rows of microsetulae (or micropubescence); sternum 8, in ventral view, with slightly concave posteromedial margin, about 0.8 as wide as sternum 5 and subequal to or slightly wider than other sterna. Ventral receptacle about as wide as deep (somewhat wider than cercus).

Etymology.—The specific epithet, *laffooni,* honors the late Dr. J. L. Laffoon (1922–1973), highly esteemed mentor and dipterist, in whose character were few inconsistencies. It was while on a museum and collecting tour of the northeastern United States in July 1961 with J. L. Laffoon that I first encountered *Rhysophora* (*R. robusta* Cresson) in a stand of *Pontederia cordata* L. in northern Ohio.

Holotype.—♂, USNM. Florida: Highlands Co: Lake Istokpoga, E. shore (VII-13-1990, D. L. Deonier, on *Pistia*).

Paratypes.—FLORIDA: Same data as holotype, 8 ♂, 2 ♀; Highlands Co: L. Istokpoga, E. shore (VII-13-1990, B. C. Deonier, on *Pistia*), 1 ♀; Highlands Co: L. Istokpoga, E. shore (VII-13-1990, M. Lillpop, on *Pistia*), 2 ♂, 1 ♀; Broward Co: USDA Aquatic Weed Lab. (VI-26-1995, D. L. Deonier, lab culture of *Pistia*) 1 ♂, 9 ♀; USDA Aquatic Weed Lab. (VI-26-1995, B. Maharajh), 1 ♂, 2 ♀; Davie, Ft. Laud. REC (13 Apr 1992, coll. B. Maharajh, reared from *Pistia stratiotes*), 5 ♂, 7 ♀; USDA Aquatic Weed Lab. (VI-26-1995, D. L. Deonier, dead from glove box 1, ex lab culture *Pistia*), 6 ♂, 6 ♀; 2d. Site, Finger Canal at 20-Mile Bend, Everglades Cons. Area 3 (VI-27-1995, D. L. Deonier, on *Pistia*), 20 ♂, 16 ♀; USDA Aquatic Weed Lab. (VI-30-1995, D. L. Deonier, dead in glove box 1, on *Pistia* [lab culture]), 7 ♂, 7 ♀; USDA Aquatic Weed Lab. (VI-29-1995, B. Maharajh, on *Pistia*), 4 ♂, 3 ♀; USDA Aquatic Weed Lab. (VI-30-1995, D. L. Deonier, from glove box 1, ex lab culture *Pistia*), 1 ♀; USDA Aquatic Weed Lab. (adults coll: VI-30-1995, laid eggs VI-30-VII-4-1995, D. L. Deonier, on *Pistia*), 1 ♂, 5 ♀; USDA Aquatic Weed Lab. (adults coll: VI-30-1995, laid eggs VI-30-1995, 1 ♀ dead on VII-4-1995, D. L. Deonier, on *Pistia*), 1 ♂; USDA Aquatic Weed Lab. (adults coll: VI-30-1995, dead VII-3-1995; 4 + eggs laid and started, D. L. Deonier, on *Pistia*), 1 ♂, 1 ♀; USDA Aquatic Weed Lab. (coll: VI-30-1995, 1 adult dead VII-3-1995, laid 3 eggs, D. L. Deonier, on *Pistia*), 1 ♀; USDA Aquatic Weed Lab. (coll. & isol. from lab culture: VI-30-1995, FL-1 = ♀, FL-2 = ♂), 1 ♂, 1 ♀; USDA Aquatic Weed Lab. (adults coll. & isol: VI-30-1995, D. L. Deonier, on *Pistia,* 0 eggs), 16 ♂, 2 ♀; USDA Aquatic Weed Lab. (adults coll. & isol: VI-30-1995; 14 eggs laid; adults dead VII-3-1995, D. L. Deonier, on *Pistia*), 2 ♀; USDA Aquatic Weed Lab. (started VII-3-1995 from 1st instars from eggs laid by adults FL-1 & FL-2 isol. from lab culture VI-30-1995; 3d instars feeding saproph. VII-10-1995; pupar. VII-11; adults emerg: VII-18, D. L. Deonier) 2 ♂, 1 ♀; USDA Aquatic Weed Lab. (Pupar. coll: VI-26-1995, adult emerg: VI-28-1995, B. Maharajh), 1 ♂. Glades Co: Nicodemus Slough, St. Rte. 78 nr. L. Okeechobee (VI-30-1995, D. L. Deonier, on *Pistia*), 1 ♂, 2 ♀; Fisheating Cr. at US Highway 27 (VI-30-1995, D. L. Deonier, on *Pistia*), 5 ♂, 8 ♀. Martin Co: Site 2a (nr Okeechobee Levee) (VI-28-1995, D. L. Deonier, on *Pistia*), 6 ♂, 7 ♀; St. Lucie Canal, Port Mayaca (VI-28-1995, D. L. Deonier, on *Pistia*), 2 ♂, 4 ♀. Palm Beach Co: 2 mi. SE of South Bay (VI-27-1995, D. L. Deonier, on *Pistia*), 24 ♂, 22 ♀; W. Jupiter, nr. SW Fork of Loxahatchie R. (started VII-3-1995 from glove box 2: pupar. coll: VII-9; adult emerg: VII-10, D. L. Deonier, on *Pistia*), 1 ♂; W. Jupiter, nr. SW Fork of Loxahatchie R. (started VII-3-1995 from glove box 2;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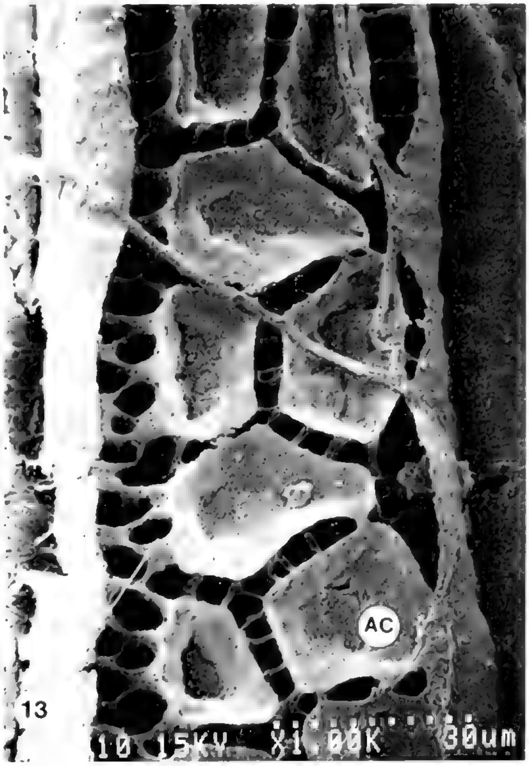
13
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pupar. VII-15; adult emerg: VII-21, D. L. Deonier, on *Pistia*), 1 ♀; W. Jupiter, nr. SW Fork of Loxahatchie R. (started VII-3-1995 from glove box 2; 3d instar VII-13; pupar. VII-14; adult emerg: VII-19, D. L. Deonier, on *Pistia*), 1 ♀; W. Jupiter, Perimeter Canal nr. SW Fork of Loxahatchie R. (VI-28-1995, D. L. Deonier, on *Pistia*, glove box 2), 13 ♂, 10 ♀; W. Jupiter, Perimeter Canal nr. SW Fork of Loxahatchie R. (VI-28-1995, D. L. Deonier, on *Pistia*, adults coll from rearing bag: VII-10), 1 ♂, 2 ♀. Polk Co: Tenoroc Fish Mgmt. Area (VII-17-1995, D. L. Deonier, on *Pistia*), 1 ♂, 11 ♀.

DESCRIPTION OF IMMATURE INSTARS

Egg (Figs. 12–13).—Length 0.47–0.64 mm ($\bar{x}$ = 0.54); maximum width 0.13–0.20 mm ($\bar{x}$ = 0.16). Newly laid egg nearly white, elliptical (except micropylar end more bluntly rounded), noticeably flattened ventrally, transversely convex dorsally; chorion microrugulose, or corrugate, except for ventral aeropyle strip bearing 1–2 irregular rows of irregularly shaped adhesion cups, or plates, on meshwork penetrating to undetermined extent into remainder of chorion. Micropylar process inconspicuous, including short stalk and slightly twisted conical cap, or tip. (Based on 17 specimens).

First-instar larva (Figs. 8, 14–15).—Length 0.68–0.85 mm ($\bar{x}$ = 0.73) maximum width 0.13–0.17 mm ($\bar{x}$ = 0.15). Body grayish white (integument semitransparent). Similar to third instar except in following characters: ends of body somewhat less tapering, spinulosity not as distinct; dorsolateral and lateral abdominal protuberances and ventral creeping welts not as distinct as in third instar; microspinular bands more numerous on most thoracic segments than in third instar, but spinular bands on abdominal segments not as distinct. Antennae appearing 2-segmented with terminal segment ellipsoidal or long ovate, deeply constricted at joint, about 2.0 × as long as wide and 2.0 × as long as preceding segment. Subantennal sensory plate with 6–8 sensilla basiconica apparent. Head-lobe less distinctly bilobate, with feeding-comb microspinules of facial-mask usually with fewer and shorter teeth, sometimes with distal margin apparently only undulate or with 1 long, median tooth; some lateral microspinules with 8 teeth. Prothoracic (anterior) spiracles apparently nonfunctional, represented only by minute pit. Perianal pad swollen globosely and symmetrically on both sides of anus. Posterior tracheospiracular siphons shorter and more tapered than in third instar.

Cephalopharyngeal skeleton (Figs. 8, 14) length (excluding mouth-hook) 0.09 mm. Pharyngeal sclerite much paler than in third instar (only slightly sclerotized at cornual bifurcation and anteriad into fused hypostomal sclerite); mouth-hooks apparently bifid on hook part (as seen in 1 specimen); mouth-hook mostly black with 1–2 pale spots in base part and with 1 ventrolateral tooth basally on hook part; hook and base parts subequal in length; base part apparently closely articulated (or fused) with dental and ligulate sclerites. Hypostomal and pharyngeal sclerites apparently fused; anterior ends of hypostomal sclerite articulated with upturned posterior ends of ligulate sclerites. Dorsal bridge of pharyngeal sclerites entirely hyaline, projecting somewhat acutely anteriad over posterior part of hypostomal sclerite (Fig. 8); dorsal and ventral cornua apparently unforked posteriorly, hyaline and transparent; ventral cor-

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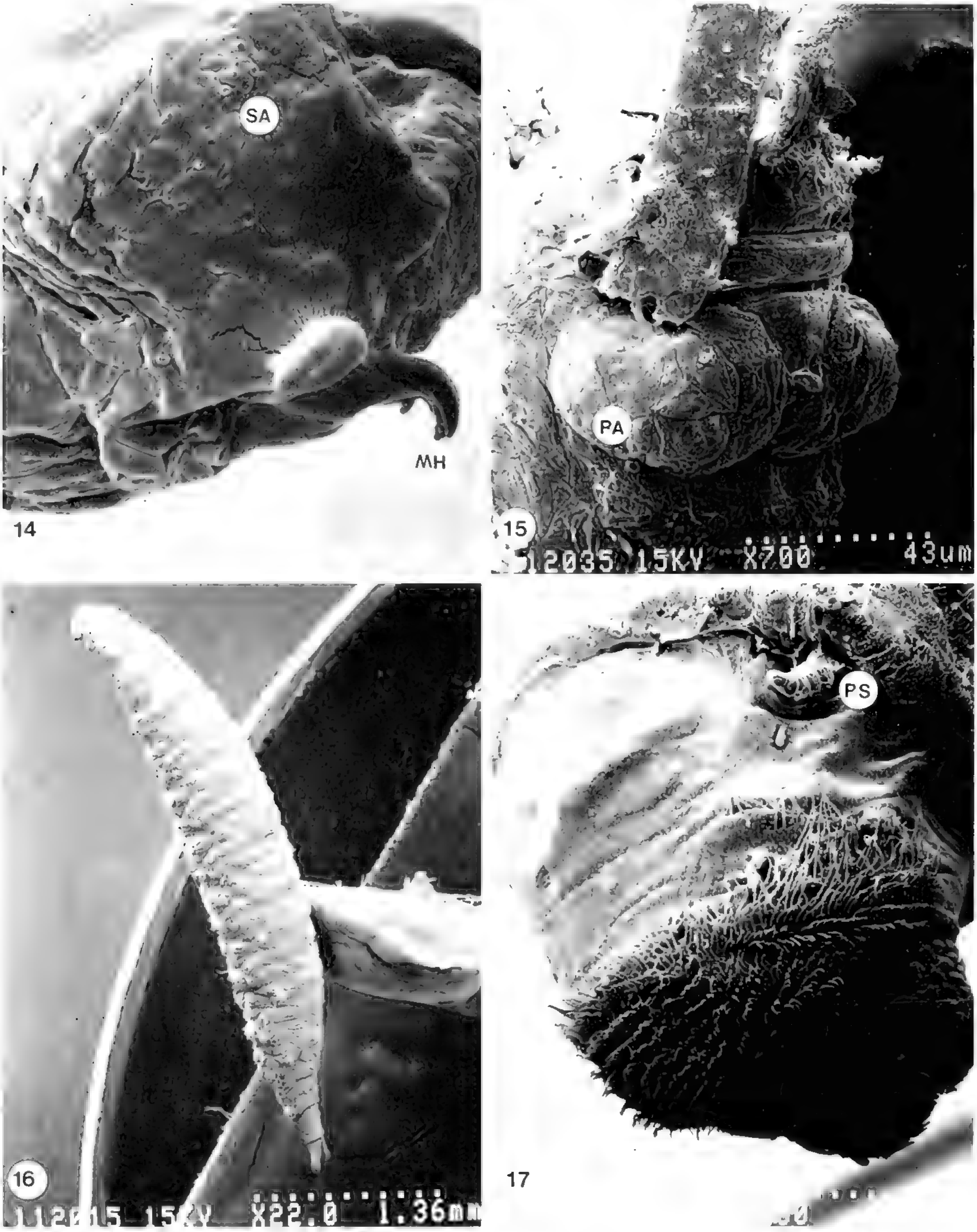
Figs. 10–13. *Rhysophora laffooni*. 10, Male postabdomen, posteroventral view. 11, Male metabasitarsus (partial), ventral view showing part of row of ventral semihelicoid microsetulae. 12, Egg, ventrolateral view showing ventral aeropyle strip. 13, Egg, enlarged ventral view of adhesion cups on aeropyle meshwork. Abbreviations: AC = adhesion cups; AE = aedeagus; CE = cercus; EP = epandrium, MP = micropylar process (protuberance); SS = surstylus.



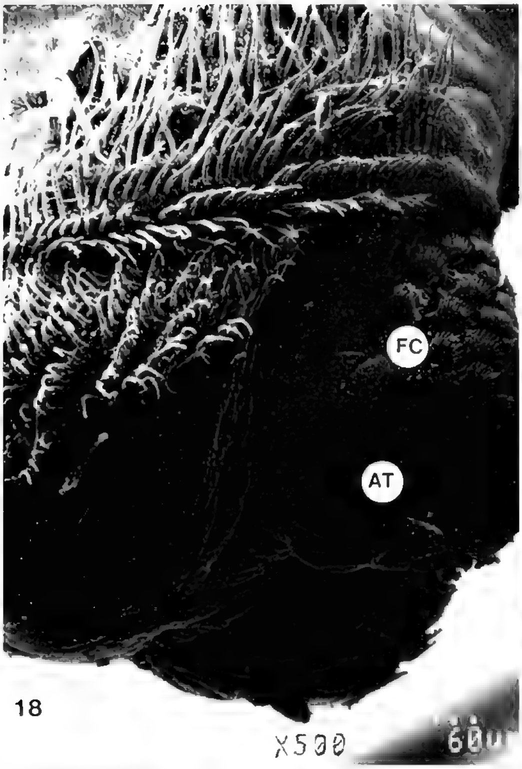
Figs. 14–17. *Rhysophora laffooni*. 14, Head-lobe, first-instar larva, anterolateral view showing bifid mouthhooks. 15, First-instar larva, posteroventral view of posterior tracheospiracular siphons (bases) and perianal pad. 16, Third-instar larva, lateral view showing head-lobe uppermost. 17, Third-instar larva, head-lobe and prothorax, dorsolateral view. Abbreviations: PA = perianal pad; PS = prothoracic spiracle; SA = subantennal sensory plate.

nu 2.0 × as long as dorsal cornu. Ventral length of pharyngeal sclerite about 4.0 × hypostomal length; ventral cornu about 2.5 × hypostomal length. (Based on 4 specimens).

Second-instar larva (Fig. 27).—Length 2.5–2.9 mm (x̄ = 2.7); maximum width 0.44–0.47 mm (x̄ = 0.45). Body grayish white (integument semitransparent). Similar to third instar except in following characters: ends of body somewhat less tapering (difference in maximum prothoracic and maximum abdominal widths less and postanal elongation only about 0.5 as long as in third-instar), spinulosity not quite as distinct; dorsolateral and lateral abdominal protuberances not as well developed or distinct; microspinular bands not as numerous as in third instar. Antennae 3-segmented, very similar to those of third instar except basal annular segment 1 only slightly wider than segment 2. Head-lobe distinctly bilobate, but flatter anteriorly and with fewer feeding-comb microspinules situated laterally and more anteriorly and ventrally.

Cephalopharyngeal skeleton similar to that of third-instar, but not measured or illustrated. (Based on 2 specimens).

Third-instar larva (Figs. 16–19, 24–26).—Length 4.36–4.85 mm (x̄ = 4.68); maximum width 0.58–0.68 mm (x̄ = 0.61). Body white or creamy white except very light-brown posterior spiracular peritremes, subfusiform, tapering gradually from abdominal segment 2 anteriad to head-lobe and posteriad from abdominal segment 6 to posterior tracheospiracular siphons. Head-lobe retractile, bilobate with each lobe, or half, bearing 3-segmented antenna distally and subantennal sensory plate anteroventrally; antennae only about 0.25 as long as mouth-hooks, segment 3 roundly pointed apically, about 2.0 × as long as wide and nearly as long as 1 and 2 together; subantennal sensory plate of nearly same diameter as antennal segment 1. Each half of bilobate head-lobe covered (as part of so-called facial mask) laterally, ventrally, and anteriorly with 60+ feeding-comb microspinules arranged in 10+ longitudinal rows; each comb, or pecten, widely spathulate and bearing 8–12 mostly uniordinal teeth distally about 0.3–0.5 as long as base; anterior part of facial mask with some microspinules bearing only 1–2 teeth and posterior microspinules in each row often with noticeably more sharply acute teeth; labium indistinct. Prothorax (segment 2 of some authors) with 14–16 mostly uniordinal bands (transverse rows) of pilose spinules on anterior 0.25–0.30, remainder posteriad to prothoracic spiracle glabrous; prothoracic spiracle, in anterodorsal view, appearing like lamellate antenna (actually composed of apical polliciform, or thumblike, papilla and 3–4 short anterolateral papillae (on same side), each with fine median longitudinal line; meso- and metathorax each with about 8 bands of microspinules and about 6 bands of slightly larger spinules on anterior 0.3–0.5, followed by mostly glabrous posterior zone. Abdominal segments 1–7 each with numerous bands of microspinules and spinules, some small indistinct glabrous zones (usually near secondary furrows) dorsally and laterally, distinct ventrolateral spinulose protuberance at each end of ventral creeping welt, smaller lateral spinulose protuberances dorsal to and usually 1 anterior to and 1 posterior to larger ventrolateral protuberance; each creeping welt with 4+ bands of curved and slightly hooked types of spinules; 2 transverse secondary furrows (plicae) usually distinct dorsally and laterally on segments 3–6; each furrow separates zone of about 3 or 4 spinular bands each; abdominal segment 8 (anal segment of some authors) with 4 preanal and 6 postanal bands of curved and slightly hooked spinules and, at most, only indistinct creeping welt. Perianal pad with nearly straight anterior and moderately convex, or arched, posterior margin and about as wide as segment 8 (sometimes appearing wider and extending onto sides of segment); posterior limit of segment 8 usually marked by 1 or 2 pairs of ventrolateral postanal tubercles (some of which bear terminal furcate struc-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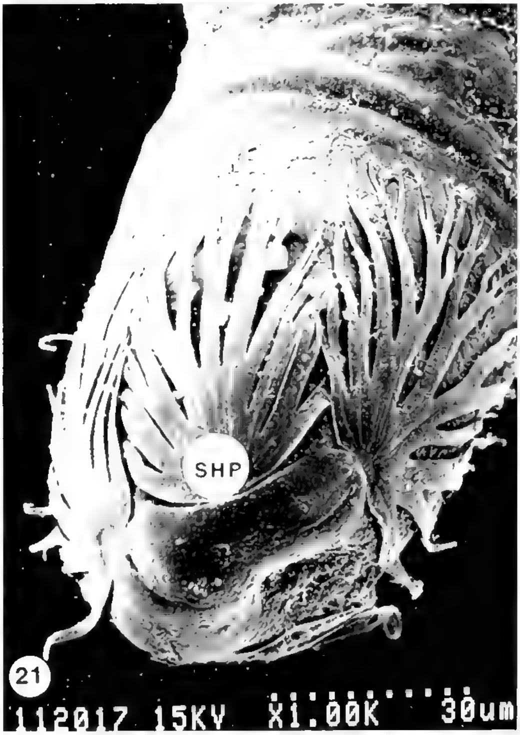
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ture, or rayed sensilla of some authors). Postanal elongation (respiratory, or breathing, tube of some authors) of abdominal segment 8 subequal in length to mesothorax, tapering slightly to posterior tracheospiracular siphons; postanal elongation partially retractile, and glabrous except for 2 basal spinular bands. Posterior tracheospiracular siphons glabrous, partially retractile; posterior spiracular peritreme light brown, roundly pointed apically, about 1.4 × as long as greatest diameter, 0.4–0.5 length of entire siphon, and with medioapical orifice surrounded by 4 symmetrically arranged, dendroid spiracular hydrofuge processes.

Cephalopharyngeal skeleton (Figs. 9, 25–26) length 0.43–0.56 mm (excluding mouth-hook). Pharyngeal sclerite dark brown or black centrally at cornual bifurcation, remainder appearing fiber-streaked hyaline, and lightly sclerotized. Mouthhooks paired, slightly shorter than hypostomal sclerite, with single tooth near midlength, separate basally but apparently fused with basally situated, paired dental sclerites; hook part of mouth-hook black, falciform (smoothly curved and toothless distad of midlength tooth); dental sclerite appearing microfenestrate and articulating closely (or fused) with ventral projection of mouth-hook base; posterodorsal projection of mouth-hook base articulating with anterior arm of hypostomal sclerite. Hypostomal sclerite, in ventral view, with hypostomal bridge hyaline except for dark, narrow posterior margin; posterior arms of hypostomal sclerite acutangular at tips articulating with pharyngeal sclerites; epistomal sclerite apparently articulated closely (or fused) with upper edge of posterodorsal projection of mouth-hook base. Hypostomal and pharyngeal sclerites not fused; dorsal bridge of pharyngeal sclerites, in lateral view, angled at about 45° from horizontal and hyaline except for narrow, heavily sclerotized black strip through middle; dorsal cornu of pharyngeal sclerite ending posteriorly in roundly pointed, digitiform lobe preceded by noticeable expansion; ventral cornu 1.4–1.8 × as long as dorsal cornu, projecting into metathorax, widest posteriorly (2.5–3.0 × dorsal cornu width), and with dorsal margin bearing sclerotized tubercle, or toothlike lobe, near cornual bifurcation; distal, or posterior 0.5 or more of ventral cornu mostly hyaline and somewhat fiber-streaked; cibarial (pharyngeal) grooves visible in ventral view. Ventral length of pharyngeal sclerite 3.8–4.2 × hypostomal length; ventral cornu length 2.3–2.7 × hypostomal length. (Based on 4 specimens).

Puparium (Figs. 20–23).—Length 3.10–4–27 mm ($\bar{x}$ = 3.69); maximum width 0.87–1.06 mm ($\bar{x}$ = 0.95). Empty puparium opaque, moderate to dark brown, scaphiform, sometimes subfusiform, with ventral surface slightly flatter than most of dorsum, and with posterior tracheospiracular siphons and often posterior 0.25–0.30 of body curved steeply dorsad or dorsoanteriad. Prothoracic (anterior) spiracles on prominent respiratory horns borne anterolaterally on dorsocephalic cap (operculum), with single dorsoapical spiracular orifice; dorsocephalic cap with mostly truncated, medially notched anterior and slightly undulate or arched posterior margin; anterior 0.15 of dorsocephalic cap with about 6 interrupted bands of microspinules preceding 3–4 bands of larger spinules, remainder glabrous except for posterior spinulose zone;

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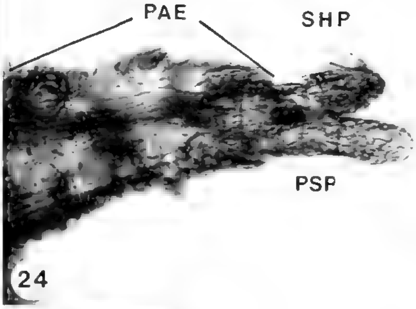
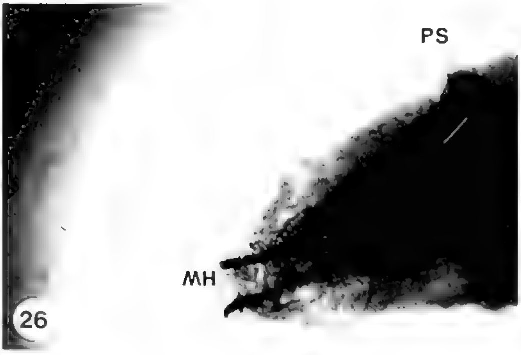
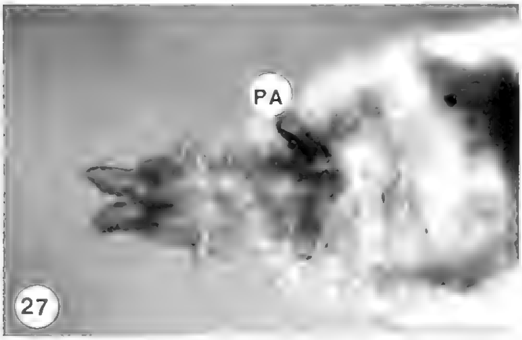
Figs. 18–21. *Rhysophora laffooni.* 18, Head-lobe, third-instar larva, anterolateral view (500×). 19, Head-lobe, third-instar larva, enlarged lateral view showing feeding-comb microspinulae. 20, Puparium, dorsolateral view showing posterior tracheospiracular siphons and postanal extension. 21, Postspiracular peritreme of puparium, left posterodorsolateral view. Abbreviations: AT = antenna; FC = feeding-comb microspinulae; PO = spiracular (peritreme) orifice; PSP = posterior tracheospiracular siphon; PT = posterior spiracular peritreme; SHP = spiracular hydrofuge process.







Figs. 22–28. *Rhysophora laffooni*. 22, Puparium, prothorax and mesothorax, dorsal view showing part of dorsocephalic cap (operculum) and prothoracic respiratory horns. 23, Puparia, left lateral and dorsal views (taken at 10×). 24, Third-instar larva, posterior end, ventrolateral view (taken at 100×). 25, Third-instar larva, anterior end, lateral view showing mouth-hooks (taken at 100×). 26, Third-instar larva, anterior end, ventral view (taken

cap with numerous microfolds (microplicae). Puparium with only slightly elevated or no protuberances and with numerous bands of microspinules and spinules between dorsocephalic cap and postanal elongation. Perianal pad indistinct; abdominal segment 8 with 8–10 spinular bands consisting of both curved and hooked types of spinules; postanal elongation glabrous except for 2 basal spinular bands; posterior spiracular peritreme rounded apically, about 1.4 × as long as greatest diameter and 0.4–0.5 length of entire siphon and with medioapical spiracular orifice equipped with hydrofuge processes as in third instar larva; spiracular remnant (scar) not apparent. (Based on 15 specimens).

Specimens examined.—Broward Co: USDA Aquatic Weed Lab. (started VII-3-1995 from 1st-instar larvae from eggs laid by adults FL-1 & FL-2 isol. from lab *Pistia* culture VI-30-1995; 3d-instar larvae feeding saproph. VII-10-1995; pupar. VII-11; adults emerg: VII-18, D. L. Deonier), 3 puparia; USDA Aquatic Weed Lab. (adults coll. ex Greenhouse *Pistia* culture, ovip: VI-30-1995, D. L. Deonier) 9 eggs (1 full), 4 1st-instar larvae and 2 2d-instar larvae: USDA Aquatic Weed Lab. (pupar. coll: VI-26-1995 ex Greenhouse *Pistia* culture, adult emerg: VI-28-1995, B. Maharajh), 1 puparium; (VII-6-1995, B. Maharajh, ex Greenhouse *Pistia* culture), 19 puparia (empty and full); Martin Co: Site 2a (nr Okeechobee Levee) (VI-28-1995, D. L. Deonier, 3 early 3d-instar larvae isol. VII-12, pupar. VII-14-1995, on *Pistia*), 2 3d-instar larvae + 1 puparium; (VI-28-1995, D. L. Deonier, puparium VII-10–11-1995, on *Pistia*), 1 early puparium; Palm Beach Co: Perimeter Canal nr SW Fork of Loxahatchie R., W. Jupiter (VI-28-1995, D. L. Deonier, on *Pistia*), from 13 ♂, 10 ♀ (isol-in plastic vials with 1+ male): 34 eggs laid VI-29–30-1995 from which were preserved 6 1st-instar larvae, 4 3d-instar larvae, and 7 puparia; unspecified (VI-28–VII-15-1995, D. L. Deonier, on *Pistia*), 1 puparium.

LIFE HISTORY AND ECOLOGY

Adult.—The adults of *Rhysophora laffooni* are small, black flies, which in sufficient numbers are conspicuous on the leaves of *Pistia*. They have a patchlike distribution in areas of *Pistia* concentration, with occasional high density locally (estimated 1 adult per plant in one 5 m^2 area). Whether this patchy within-habitat distribution is correlated with infestations of larval *Spodoptera* (Lepidoptera: Noctuidae) has not been determined. Also, the existence of aggregation pheromones, as in *Rhysophora robusta* Cresson (unpublished experimental data), is a possibility. Close observations of feeding in the laboratory and in the field indicate that the adults feed on microbes (and perhaps some plant cells) on the decaying, damaged edges of *Pistia* leaves, especially ones fed upon by *Spodoptera* caterpillars. This contrasts with the nectar feeding observed in adults of *R. robusta*.

Courtship and copulation were not observed. Females oviposited only on *Pistia* leaves (sometimes on both surfaces, in the laboratory) and mostly centrally and basally on the adaxial surface. The females moved slowly and intermittently over the *Pistia* plants while they laid eggs singly or in scattered groups (seldom of sufficiently close spacing to constitute an egg mass). Although maximum number of eggs per female was not measured, one female laid 16 eggs in one day. Adults appear to spend

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at 100×). 27, Second-instar larva, posterior end, ventral view (taken at 100×). 28, Adult male, left lateral view (taken at 12.5×). Abbreviations: MH = mouth-hook(s); OP = operculum (dorsocephalic cap); PA = perianal pad; PAE = postanal extension; PS = prothoracic respiratory horn or prothoracic spiracle; PSP = posterior tracheospiracular siphon; SHP = spiracular hydrofuge process.

much of the daylight period resting in shaded areas where leaves of adjacent plants overlap. In one observation made on about 30 adults in a glove box with a red light at 11:00 p.m., most had their wings elevated (as was first observed in *Hydrellia discursa* Deonier by Deonier, in press).

Egg.—The incubation period ranged from 1 to 3 days for 14 eggs at 18–24°C. On one occasion eggs laid within the previous 2-hour period could be readily moved with a needle probe, but older eggs adhered to the leaf. It is possible that the adhesion cups in the ventral aeropyle strip are coated with an adhesive at oviposition which requires some time to dry. Applying interpretations from Hinton (1981 and earlier), the ventral aeropyle strip facilitates air entrapment and thus automatic plastron formation during inundation of the ovisite or simply when droplets of water cover the egg.

Larva.—The stadia were not measured. The time required from oviposition to adult emergence was 17 and 18 days for 2 specimens; egg eclosion (hatching) to adult emergence was 8, 12, and 16 days for 3 specimens; and eclosion to pupariation was 9 and 11 days for 2 specimens. Search of over 100 *Pistia* plants from the field and laboratory, or greenhouse, cultures did not reveal any mining larvae. However, observation of second- and third-instar larvae reared in the laboratory showed them feeding on microbial material in decayed tissue, especially at the base of the rosette. Guts packed throughout with black material were observed in several second- and third-instar larvae. Since the larvae, especially the second- and third-instar like those of *Notiphila aenigma* Cresson, *N. carinata* Loew, *N. solita* Walker, *N. (Dichaeta) caudata* Fallén, and *Cirrula austrina* (Coquillett) [as illustrated and described by Busaca and Foote (1978), Deonier et al. (1979), Eastin and Foote (1971), and Simpson (1979)] all have comblike components in the facial mask, it seems very probable that all are microphagous filter-feeders and that microbes and other particles are collected by the feeding-comb (pecten) microspinules and transferred into the cibarium during the rapid partial head-lobe involution and retraction. The mouth-hooks retain their primary locomotory function and possibly work in an ancillary way by breaking loose microbes and particles from clumps, or aggregations. Although they did not illustrate the facial mask, it seems appropriate to point out that Steinly and Runyan (1979) observed that the larvae of *Leptopsilopa atrimana* (Loew), another member of the subfamily Discomyzinae, ingested decay microbes from grass clippings and had guts packed with black material.

The role of any specific microsaprophagy in the overall specific association of this fly species with *Pistia* is yet to be determined by a few laboratory feeding experiments.

Puparium.—The time from pupariation to adult emergence was measured as 5, 6, and 7 days for 3 specimens. Although most puparia were found in the air cavities in leaves damaged by *Spodoptera* larvae, this species sometimes uses undamaged leaves for pupariation, as evidenced by the discovery of adult flies in 2 of 5 *Pistia* cultures collected 3 days previously and held in screened tanks. All leaves therein appeared healthy.

The posterior spiracular peritremes are rounded, not pointed apically and are, along with the remainder of both posterior tracheospiracular siphons, upturned and often curled anteriad. Puparia occasionally found on the undamaged leaf surface are fairly readily moved and, therefore, any stability gained is probably via cuticular spinules interlacing with the velvety leaf pubescence.

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REVIEW OF THE GENUS *HEMERODROMIA* MEIGEN (DIPTERA: EMPIDIDAE; HEMERODROMIINAE) OF AMERICA NORTH OF MEXICO

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Abstract.—The genus *Hemerodromia* is reviewed for America north of Mexico. A general diagnosis and a modified description are presented for the genus and each of the 13 previously described species. Nine **new species** are described from America north of Mexico: ***Hemerodromia burdicki, H. chelata, H. flexiformis, H. glabella, H. ligata, H. loba, H. reclinata, H. sinclairi,*** and ***H. subchelata.*** Designation of **neotypes** are made for *Hemerodromia empiformis* (Say) and *H. superstitiosa* Say. Designation of **lectotypes** are made for the following: *H. captus* Coquillett; *H. coleophora* Melander; *H. haruspex* Melander; *H. jugulator* Melander; *H. melanosoma* Melander; *H. stellaris* Melander; *H. vates* Melander; and, *H. vittata* Loew. *Hemerodromia haruspex* Melander 1947 is shown to be a **new synonym** of *H. melanosoma* Melander 1947, *H. rogatoris* Coquillett 1895 a **new synonym** of *H. superstitiosa* Say 1824, and *H. vittata* Loew 1862 a **new synonym** of *H. superstitiosa* Say 1824. Previously known only from the Palearctic Region, *H. oratoria* (Fallén) was found to be widely distributed in North America. Separate keys to male and female adults, illustrations of male terminalia, and known distributions are provided.

Key Words. Diptera, Empididae, Hemerodromiinae, *Hemerodromia,* dance flies

Adult flies of the genus *Hemerodromia* Meigen (Empididae, Hemerodromiinae), like those of other genera in the subfamily, are very small (ca. 2–4 mm), elongate, and possess raptorial forelegs. Their wings lack an anal lobe. Nearctic genera of Hemerodromiinae have been reviewed by Melander (1902, 1928, 1947), MacDonald (1988, 1989, 1993, 1994), and MacDonald and Turner (1993). Species fitting the present concept of *Hemerodromia* are found in North America (Melander 1947), Europe (Chvala and Wagner 1989), China (Yang and Yang 1990), India and Indonesia (Melander 1928), Nepal (Smith 1965), South Africa (Smith 1969), and South America (Collin 1933, Smith 1967).

Larvae and pupae of *Hemerodromia* species are aquatic (Smith 1969), and larvae are reported to prey on black fly larvae (Peterson 1960). Labels accompanying adults of Nearctic *Hemerodromia* suggest that they commonly are swept from riparian vegetation and also taken in Malaise traps. Harper (1980) collected males and females of several species in emergence traps placed over streams in Quebec, Canada.

The present study is limited to *Hemerodromia* species of America north of Mexico. Included are a general diagnosis and a modified description for the genus and each of the 13 previously described species, descriptions of nine new species, separate keys to male and female adults, and known distributions.

Materials and Methods

The present study was facilitated by the existence of large number of Nearctic specimens added to collections since Melander's (1947) revision. The following institutions loaned the material upon which this work is based: American Museum of Natural History, New York (AMNH); California Academy of Sciences, San Francisco (CAS); Canadian National Collection, Agriculture Canada, Ottawa (CNC); Cornell University, Ithaca (CU); Clemson University, South Carolina (CUSC); Florida State Collection of Arthropods, Gainesville (FSCA); James Entomological Collection, Washington State University (WSU); Illinois Natural History Survey (INHS); Los Angeles County Museum (LACM); Museum of Comparative Zoology, Harvard University (MCZ); Purdue University Entomological Research Collection (PERC); Snow Museum, University of Kansas, Lawrence (UKL); National Museum of Natural History, Smithsonian Institution, Washington D. C. (USNM); University of California, Riverside (UCR); University of Minnesota, St. Paul (UMSP); Universite de Montreal (UMC); University of New Hampshire (UNH); and, Utah State University, Logan (USU). Specimens also came from the author's collection (MAC) and a series from Hawaii sent by D. E. Hardy.

The methods employed in this study were reported in a review of the genus *Chelipoda* Macquart (MacDonald 1993), including details of specimen preparation as presented by Cumming (1992). Terminology pertaining to vestiture is based on McAlpine (1981), but interpretation of male terminalia follows Cumming and Sinclair (1990).

Genus *Hemerodromia* Meigen

Hemerodromia Meigen 1822: 61. Type species: *Tachydromia oratoria* Fallén 1816 (des. Rondani 1856: 148).

Microdromia Bigot 1857: 557, 563 (as *Microdromya,* later regarded as erroneous). Type species: *Tachydromia oratoria* Fallén 1816 (des. Coquillett 1902: 1).

Diagnosis.—Adults of the genus *Hemerodromia* are distinguished from those of other genera of Hemerodromiinae in the Nearctic Region primarily by reduced venation, including the following: anal cell lacking; crossveins h and bm-cu lacking; and, cells bm and dm confluent and ending in the basal third of wing.

Description.—*Hemerodromia* species treated in this paper agree in general with the generic description of Collin (1961), with the following additions and modifications. Body length exclusive of antennae and including terminalia 2.0 to 4.0 mm. Fore femur and fore tibia with 2 median rows of 14–20 black setulae ventrally; those of fore femur flanked by row of 5–8 light brown bristles; those of fore tibia weaker, more sharply pointed, and lacking flanking bristles. Fore tibia with strong apical bristle. Prominent vestiture lacking on mid and hind leg. Male terminalia including hypandrium, pair of epandrial lobes of differing shape and vestiture, pair of cerci of differing shape and vestiture; phallus of differing shape and vestiture. Female "ovipositor" of differing degrees of development, formed from cerci and abdominal segments 8 and 9.

Informal species groups.—Most Nearctic species treated here are placed in four informal species groups, the *H. empiformis* (Say) group, the *H. captus* Coquillett group, the *H. melanosoma* Melander group, and the *H. superstitiosa* Say group. No phylogenetic analysis has demonstrated the monophyly of these groups, but their use herein facilitates presentations of species' diagnoses and descriptions.

Males of the *H. empiformis* group are characterized by distinctive epandrial lobes. Each is slender and straight basally, and then abruptly enlarged at or slightly beyond the apical third. A row of about five to eight (one species possesses only two) strong setulae exist along the medial surface of each epandrial lobe about midway and an another series of strong setulae exists along the inner, dorsal surface. Differences in the general shape of the cerci, especially the apex, distinguish member species. Females possess a well-developed ovipositor. The group includes eight species in America north of Mexico, *H. brevifrons* Melander, *H. coleophora* Melander, *H. empiformis, H. sufflexa* Melander, and four new species described below.

Males of the *H. superstitiosa* group share a prominent basoventral process on each fore femur, which bears an apical spine (Fig. 7). Immediately distal to this process is an indentation for reception of an apical bristle of a corresponding fore tibia. Females possess a well-developed ovipositor. The group includes *H. oratoria* (Fallén), *H. superstitiosa,* and a new species described below. The degree of development of the basoventral process of the fore femur varies among males of *H. oratoria,* being most strongly developed on specimens from northwestern North America. This structure is weakly developed or lacking on females of *H. oratoria.*

Males of the *H. captus* group possess cerci that are deeply excavated apically, resulting in a very long dorsal and a correspondingly long ventral fork. Females possess a well-developed ovipositor, but it is relatively shorter than that on females of the *H. empiformis* group. The *H. captus* group treated here includes *H. captus, H. fibrina* Landry and Harper, and two new species described below.

Adults of the *H. melanosoma* group are very small and nearly concolorous reddish black to black. Male terminalia include cerci and epandrial lobes that are relatively very slender. The degree of development of the female ovipositor varies among included species. The group as treated here includes *H. chillcotti* Harper, *H. melanosoma,* and one new species described below; *H. jugulator* Melander also appears to belong to this group.

Three species are not placed in any of the informal species groups. Adults of *H. stellaris* Melander and *H. vates* Melander most resemble those of the *H. empiformis* group in size and coloration, but male terminalia lack the distinctive epandrial lobe. *Hemerodromia sinclairi,* newly described below, is distinct from all other species.

Remarks.—Species of *Hemerodromia* are founded largely on terminalia characters of males and identification may require maceration of specimens. Preparation of "good" specimens is difficult because macerating with lactic acid may not always produce enough clearing of pigment to facilitate study and clearing with 10% sodium hydroxide must be done very carefully to prevent the disappearance of certain characters. Storage of adequately cleared terminalia in glycerin may result in additional clearing so that the preparation virtually "disappears" in the microvial. Finally, discerning certain characters associated with terminalia, including vestiture and form of the phallus, often is complicated because their appearance may change substantially with minor rotation of terminalia placed in on microscope slides. For these reasons, the key to male adults is based on coloration and attributes of terminalia visible on intact specimens when possible.

Development of a key to female adults was accomplished only by employing coloration, relative body length from front of head (excluding antennae) to tip of ovipositor, and geographical distribution; females of certain sympatric species appear to be indistinguishable. Two descriptive terms, weakly developed and well developed, are applied to ovipositors in the discussion below and in the diagnosis and description of each species. A well-developed ovipositor, found on the majority of species, involves elongation and sclerotization of abdominal segments eight and nine; it is shiny and usually about twice as long as its diameter. A weakly developed ovipositor, found on two species, involves little elongation and almost no sclerotization of abdominal segments eight and nine.

Key to Male Adults of *Hemerodromia* Meigen of America North of Mexico

1. Thoracic pleura concolorous yellow to yellowish gold, contrasting strongly with black scutum; terminalia as in Fig. 1 . . . . *H. jugulator* Melander

– Thoracic pleura and lateral scutum concolorous brown, reddish brown, reddish black or black 2

2. Legs light reddish black (except coxae and femora bases yellow); terminalia as in Fig. 2 . . . . *H. sinclairi,* n. sp.

– Legs yellow (except distal 2 tarsomeres dark brown on two species) 3

3. Cercus deeply excavated apically (Figs. 3–6), ventral and dorsal lobes visible on unmacerated specimens 4

– Cercus not excavated apically 7

4. Thorax nearly concolorous reddish black or black 5

– Thorax brown or golden brown with areas of darker brown pigmentation 6

5. Scutum with broad median stripe changing in pattern with rotation of specimens during examination under illumination; terminalia as in Fig. 3 . . . . *H. subchelata,* n. sp.

– Scutum lacking median stripe, dorsum not changing pattern with rotation of specimens during examination under illumination; terminalia as in Fig. 4 . . . . . . *H. captus* Coquillett

6. Mesopleuron and scutum nearly concolorous brown (scutum may have thin darker stripe medially); terminalia as in Fig. 5 . . . . *H. chelata,* n. sp.

– Mesopleuron and scutum not concolorous; mesopleuron golden brown ventrally with dark brown stripe below notopleural suture; scutum mostly dark brown; terminalia as in Fig. 6 . . . . *H. fibrina* Landry and Harper

7. Epandrial lobe not abruptly broadened apically in lateral view (Figs. 9–16) 8

– Epandrial lobe abruptly broadened at or beyond apical third in lateral view (Figs. 17–24) 15

8. Distal 2 tarsomeres of mid and hind leg dark brown, contrasting strongly with basal tarsomeres; basoventral process on fore femur well developed as a pointed projection, with deep indentation for reception of apical bristle of fore tibia (Fig. 7) 9

– Tarsomeres nearly concolorous yellow, distal 2 not contrasting strongly with basal tarsomeres; basoventral process on fore femur not developed (except on some specimens of *H. oratoria*), with weakly developed indentation on fore femur for reception of apical bristle of fore tibia (Fig. 8) 10

9. Cercus and epandrial lobe forming interlocking unit, with ventral process of cercus fitting into dorsal groove on epandrial lobe (Fig. 9) . . . . *H. ligata,* n.sp.

– Cercus and epandrial lobe not forming interlocking unit; cercus and epandrial lobe entire, each ending in slender, in-turned process (Fig. 10) . . . . *H. superstitiosa* Say

10. Thorax concolorous reddish black or black (shiny reddish brown on teneral specimens) 11

– Thorax brown with darker brown median stripe on scutum or nearly concolorous light brown 13

11. Abdominal tergum 7 yellow; cercus ending in down-turned, lobe (Fig. 11) . . *H. chillcotti* Harper

Abdominal tergum 7 brown to dark brown; cercus lacking down-turned lobe . . . 12

12. Scutum and mesopleuron pruinose, except for prominent denuded spot above mesocoxa; apical half of cercus narrowed; epandrial lobe weakly concave dorsally in lateral view (Fig. 12) . . . . *H. glabella* n. sp.

– Scutum shiny; mesopleuron pruinose, lacking denuded spot above mesocoxa; cercus entire, not narrowed apically; epandrial lobe strongly concave dorsally in lateral view (Fig. 13) . . . . *H. melanosoma* Melander

13. Cercus and epandrial lobe subequal in size and shape in lateral view; apex of cercus lined with 5–6 minute pointed processes (Fig. 14) . . . . *H. stellaris* Melander

– Cercus and epandrial lobe differing in size and shape in lateral view; apex of cercus lacking minute pointed processes (Figs. 15, 16) 14

14. Epandrial lobe broadly rectangular in lateral view, except for apicoventral lobe; cercus broadened and shallowly excavated apically in lateral view (Fig. 15) . . *H. oratoria* (Fallén)

Epandrial lobe strap-like in lateral view, ending in 2, twisted apical processes; cercus narrowed apically and convoluted along dorsal margin in lateral view (Fig. 16) . . . . *H. vates* Melander

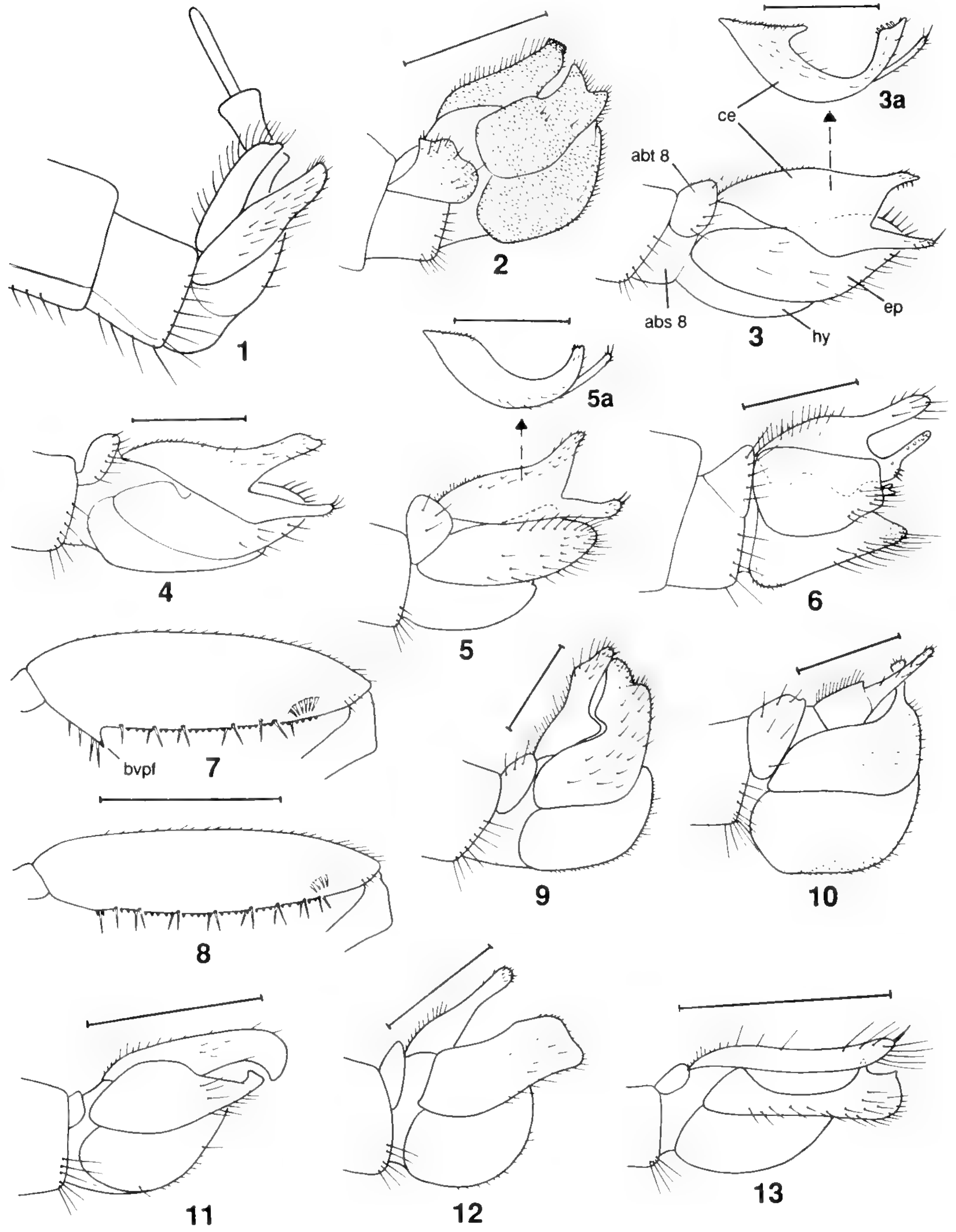
15. Cercus bearing apicodorsal, prong-like process that turns inward (Figs. 17, 18), usually discernible on unmacerated specimens in dorsolateral view 16

– Cercus lacking apicodorsal, prong-like process 17

16. Apical setae on cercus long, projecting at least to apex of epandrial lobe; distal prong on cercus ca. ¼ length of cercus and somewhat jagged along ventromedial surface (Fig. 17) . . . . *H. coleophora* Melander

Distal setae on cercus short, not projecting to apex of epandrial lobe; distal prong on cercus ca. ⅓ length of cercus and smooth along ventromedian surface (Fig. 18) . . . . *H. loba,* n. sp.

17. Cercus more or less quadrate in lateral view, apical margin nearly straight (Fig. 19) . . . . *H. sufflexa* Melander



Figs. 1–13. *Hemerodromia* spp. 1–6, 9–13, male terminalia. 7–8, male fore femur. 1, *H. jugulator.* 2, *H. sinclairi.* 3, 3a, *H. subchelata.* 4, *H. captus.* 5, 5a, *H. chelata.* 6, *H. fibrina.* 7, *H. superstitiosa.* 8, *H. empiformis.* 9, *H. ligata.* 10, *H. superstitiosa.* 11, *H. chillcotti.* 12, *H. glabella.* 13, *H. melanosoma.* Abbreviations: abs 8 = abdominal sternum eight; abt 8 = abdominal tergum eight; bvpf = basoventral process of fore femur; ce = cercus; ep = epandrial lobe; hy = hypandrium. Scale bars = 0.25 mm, except 0.5 for Figs. 7–8. Phallus omitted, except for Fig. 1. Figures of all terminalia except Fig. 1 based on macerated specimens. Fig. 1 based on intact male holotype.

– Cercus more or less triangular or rectangular in lateral view, apical margin broadly pointed . . . 18

18\. Cercus broadly triangular in lateral view (Figs. 20–22) . . . 19

– Cercus more or less rectangular over basal ½ in lateral view (Figs. 23, 24) . . . 21

19\. Body length ca. 2.3 mm; epandrial lobe with 2 setulae on medial surface (Fig. 20) (visible only on macerated terminalia) . . . *H. brevifrons* Melander

– Body length 2.8–4.0 mm; epandrial lobe with row of 5–8 setulae on medial surface (visible only on macerated terminalia . . . 20

20\. Epandrial lobe with pointed, anterodorsal projection (Fig. 21) . . . *H. reclinata,* n. sp.

– Epandrial lobe lacking anterodorsal projection (Fig. 22) . . . *H. empiformis* Say

21\. Cercus ending in short apicodorsal process, less than $\frac{1}{10}$ length of cercus (Fig. 23) (clearly visible on macerated terminalia) . . . *H. burdicki,* n sp.

– Cercus ending in long apicodorsal process, about $\frac{1}{5}$ length of cercus (Fig. 24) (clearly visible on macerated terminalia) . . . *H. flexiformis,* n. sp.

KEY TO FEMALE ADULTS OF *HEMERODROMIA* MEIGEN OF AMERICA NORTH OF MEXICO

1\. Scutum concolorous black or shiny reddish brown to reddish black . . . 2

– Scutum brown with darker median stripe or concolorous brown . . . 7

2\. Legs pale reddish black; body length including ovipositor 3.5–4.2 mm . . *H. sinclairi,* n. sp.

– Legs yellow; body length including ovipositor 2.4–2.8 mm . . . 3

3\. Thoracic pleura yellowish gold, contrasting strongly with black scutum . . . *H. jugulator* Melander

– Thoracic pleura and scutum concolorous black or shiny reddish brown to reddish black . . . 4

4\. Mesopleuron with denuded spot above mesocoxa . . . *H. glabella,* n. sp.

– Mesopleuron lacking denuded spot above mesocoxa . . . 5

5\. Scutum and thoracic pleura heavily pollinose . . . *H. captus* Coquillett

– Scutum shiny, contrasting strongly with pollinose thoracic pleura . . . 6

6\. Abdominal tergum 7 yellow, contrasting with brown abdominal tergum 6 . . . *H. chillcotti* Harper

Abdominal tergum 7 and abdominal tergum 6 concolorous brown . . *H. melanosoma* Melander

7\. Distal 2 tarsomeres dark brown, contrasting strongly with yellow basal tarsomeres . . . 8

– Distal 2 tarsomeres light brown or yellow, not contrasting strongly with yellow basal tarsomeres . . . 9

8\. Distributed in southern Texas and northern Mexico . . . *H. ligata,* n. sp.

– Distributed in eastern United States and southeastern Canada . . . *H. superstitiosa* Say

9\. Color pattern of scutum changing in intensity with rotation under illumination . . . *H. subchelata,* n. sp.

– Color pattern of scutum constant, not changing in intensity with rotation under illumination . . . 10

10\. Mesopleuron golden brown with dark brown stripe below notopleural suture . . . *H. fibrina* Landry and Harper

– Mesopleuron concolorous light brown to brown, lacking darker stripe below notopleural suture . . . 11

11\. Distributed east of the Mississippi River . . 12

– Distributed west of the Mississippi River . . . 13

12\. Body length including ovipositor 2.6–2.8 mm . . . *H. oratoria* (Fallén); *H. vates* Melander

– Body length including ovipositor 3.2–3.5 mm . . . *H. empiformis* Say; *H. sufflexa* Melander

13\. Body length including ovipositor 2.8–3.4 mm . . . *H. burdicki,* n. sp., *H. chelata,* n. sp., *H. coleophora* Melander, *H. flexiformis,* n. sp., *H. loba,* n. sp., *H. reclinata,* n. sp., *H. sufflexa* Melander

Body length including ovipositor 2.4–2.8 mm 14

14\. Scutum concolorous brown, occasionally with thin, darker stripe along median . . . *H. oratoria* (Fallén)

– Scutum brown laterally with broad, darker stripe along median . . . 15

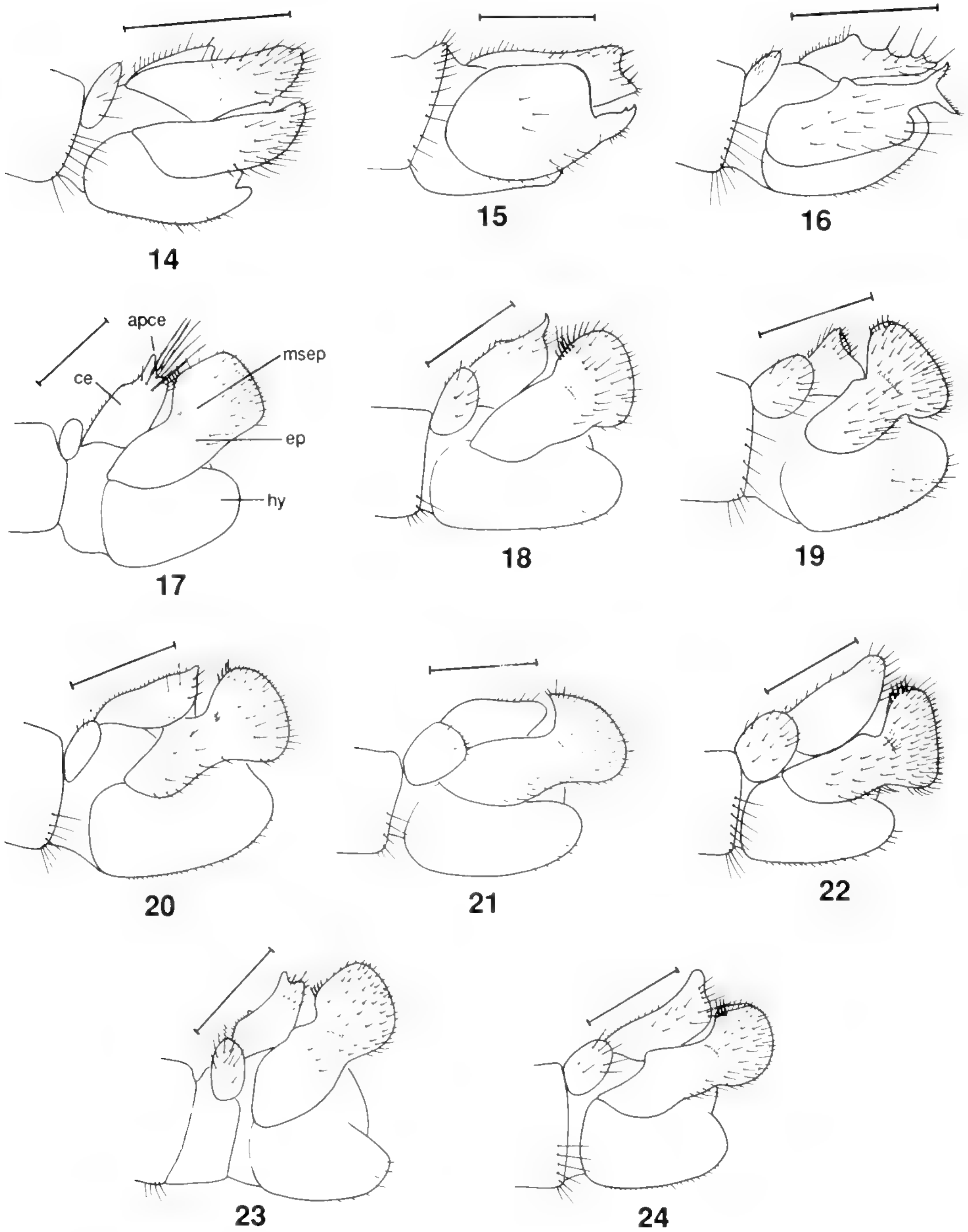
15\. Scutal stripe gradually broadening over apical ⅓; distributed in southern Texas . . . *H. stellaris* Melander

Scutal stripe thin anteriorly, then abruptly broadened and uniform in width over posterior ⅘; distributed from eastern California south into northern Mexico and southwestern Texas . . . *H. brevifrons* Melander

Hemerodromia brevifrons Melander
(Figs. 20, 29)

Hemerodromia empiformis var. *brevifrons* Melander 1947: 248.

Diagnosis.—This species belongs to the *H. empiformis* group. Existence of only two setulae on the inner surface of each epandrial lobe past its midpoint is diagnostic for males of *H. brevifrons,* but they are discernible only on macerated terminalia. Adults are smaller in size compared to



Figs. 14–24. *Hemerodromia* spp., male terminalia. 14, *H. stellaris.* 15, *H. oratoria.* 16, *H. vates.* 17, *H. coleophora.* 18, *H. loba.* 19, *H. sufflexa.* 20, *H. brevifrons.* 21, *H. reclinata.* 22, *H. empiformis.* 23, *H. burdicki.* 24, *H. flexiformis.* Abbreviations: apce = apicodorsal process of cercus; ce = cercus; ep = epandrial lobe; hy = hypandrium; msep = medial setulae of epandrium lobe. Scale bars = 0.25 mm. Figures based on macerated specimens.

those of most species in the *H. empiformis* group, resembling those of *H. stellaris* and *H. vates* in size and coloration. Males of these three small, brownish species are distinguished by their terminalia, but females appear to be inseparable.

Description.—Length including terminalia of male ca. 2.3 mm, of female 2.4–2.5 mm. General body color brown. *Head*: black; antenna yellow. *Thorax*: pruinose; scutum golden brown with dark brown median stripe; scutellum brown laterally, dark brown in center; postnotum dark brown; pleura golden brown. Fore femur lacking prominent basoventral process (see Fig. 8). *Abdomen*: terga 1 and 7 yellow, remainder brown, sterna light brown. Male terminalia (Fig. 20) dark brown; cercus smoothly triangular in lateral view; epandrial lobe abruptly expanded over apical ⅓, two setulae on inner surface near midpoint. Female similar to male; ovipositor well developed.

Type material examined.—Holotype ♂, labeled "San Diego Co/Desert Edge/Cal. Apr 14 '15/M C VanDuzee" (USNM). The specimen is damaged, but the macerated terminalia are intact and preserved in glycerin in a microvial attached to the specimen pin. The type locality in San Diego county could not be established.

Other specimens examined.—MEXICO. Chihuahua: 1 ♂, Camargo, May (CNC). UNITED STATES. California: 17 ♂, 19 ♀, Riverside Co., 1000 Palms and Willis Palms Oasis, Feb–Apr; 1 ♂, Victorville, May (CNC); 3 ♂, 1 ♀, 1000 Palms, Mar (LACM); 10 ♂, 9 ♀, Mono Co., Fish Slough, Jul (UCR). Texas: 7 ♂, 7 ♀, Big Bend Nat. Prk., May (CNC).

Distribution.—Males are known from eastern and southeastern California, Big Bend National Park, Texas, and northern Mexico (Fig. 29).

Remarks.—Distinctive male terminalia support treatment as a separate species in the *H. empiformis* group. Variation exists in the coloration of males possessing identical terminalia, with the central scutum, lower aspects of thoracic pleura, and the central area of the fore coxa ranging from partially brown to completely black on some specimens in concurrently collected series.

***Hemerodromia burdicki* MacDonald, new species**

(Figs. 23, 30)

Diagnosis.—This species belongs to the *H. empiformis* group. Males of *H. burdicki* closely resemble those of *H. flexiformis*, newly described below, with separation of most specimens dependent on macerated terminalia. The cercus on males of *H. burdicki* possesses a very short apicodorsal process. In contrast, the cercus on males of *H. flexiformis* possesses a much longer apicodorsal process.

Description.—*Male:* Length including terminalia ca. 2.8 mm. General body color brown. *Head*: black; antenna yellow. *Thorax*: pruinose; scutum and scutellum golden brown with dark brown median stripe; humeral area, scutellum and postnotum dark brown; pleura brown. Fore femur lacking prominent basoventral process (see Fig. 8). *Abdomen*: terga 1 and 7 yellow, remainder brown, sterna light brown. *Terminalia* (Fig. 23): dark brown; cercus elongate in lateral view, ending in a blunt process ca. ⅕ or less the length of cercus; epandrial lobe abruptly expanded over apical ⅓, with row of 4–6 setulae on inner surface past midpoint.

Female: Similar to male, except length including terminalia ca. 3.3 mm; ovipositor well developed.

Type material.—HOLOTYPE ♂, labeled "USA: UT; WAYNE CO./CAPITOL REEF NAT. P.; PLEASANT CREEK/AUGUST 2–7, 1993/J. F. MACDONALD" (USNM). The specimen is in excellent condition and some of the diagnostic features of terminalia are visible without maceration. The type locality is in Capitol Reef National Park in south-central Utah. Allotype, same data as holotype (USNM). Paratypes. UNITED STATES. Arizona: 14 ♂, 25 ♀, Cochise Co., SW Research Sta., W. Portal, May–Jul (UCR, USNM); 1 ♂, Nogales, Jun; 13 ♂, 2 ♀ (1 pair in copula) Patagonia, Jun (USNM). California: 12 ♂, 25 ♀, Fresno Co., Tollhouse, Sep; 7 ♂, 7 ♀, Tulare Co., Three Rivers, Jul–Aug; 1 ♂, Tulare Co., Farmersville, Jul (CNC, MAC); 2 ♂, 1 ♀, Sierra Nat. For., El Portal, Apr (CNC); 8 ♂, 4 ♀, Stanislaus Co., Frank Raines Prk., Sep (CAS); 3 ♂, Riverside Co., Cottonwood Cyn., Jul (UCR). Idaho: 1 ♂, Franklin, Jul (USU). Utah: 30 ♂, 23 ♀, Wayne Co., Capitol Reef Nat. Prk., Aug (MAC, USNM, USU); 4 ♂, 28 ♀, Washington Co., Beaver Dam Wash, Jun–Jul; 1 ♂, Templeton, Jun (USU); 55 ♂, 56 ♀, Washington Co., Leeds Cyn., Jul–Sep. (USU).

Distribution.—Males of this species are known from southeastern Arizona, central and southern California, southern Utah and southeastern Idaho (Fig. 30).

Etymology.—This species is named after Donald Burdick, my undergraduate mentor, to whom I owe my interest in insects and who facilitated my early career in entomology.

Remarks.—Males and females of this species have been collected in Malaise traps and aspirated from leaves of trees associated with permanent streams in Capitol Reef National Park in early August, and large series were collected in Malaise traps set by W. Hanson (Utah State University) in riparian zones in southwestern Utah from July into September.

Hemerodromia captus Coquillett
(Figs. 4, 25)

Hemerodromia captus Coquillett 1895: 391.

Diagnosis.—Adults of *H. captus* are characterized by their uniformly blackish body coloration together with dense pruinescence, resulting in a matte thorax. The latter attribute helps to distinguish *H. captus* from *H. chillcotti* and *H. melanosoma,* the adults of which have a denuded scutum. Adults of *H. captus* lack the denuded, shiny spot on the mesopleuron that exists on those of *H. glabella,* newly described below.

Description.—Length including terminalia of male ca. 2.4 mm, of female ca. 2.7 mm. General body color concolorous dark reddish black or black. *Head*: black; antenna yellow. *Thorax*: densely pruinose; scutum, scutellum, postnotum and pleura dark reddish black or black. Legs yellow, contrasting with thoracic pleura. Fore femur lacking prominent basoventral process (see Fig. 8). *Abdomen*: tergum 7 yellow, terga 1–6 brown; sterna yellowish. Male terminalia (Fig. 4): brownish black; cercus slender, deeply excavated apically, ventral fork more slender than dorsal fork. Female similar to male; ovipositor well developed.

Type material examined.—Lectotype female, here designated, labeled "4327/ Demster/N.Y." (USNM; type no. 3151). The label is difficult to read, with one word being either "Demster" or perhaps "Demester"; if the former, the locality is New York, Oswego County, about 50 kilometers north of the city of Syracuse. The specimen is in excellent condition. A lectotype is designated because it is not possible to identify a specific specimen as "type" from the publication alone.

Other specimens examined.—CANADA. Ontario: 2 ♂, 2 ♀, Brockville, Aug; 1 ♀, Orillia, Aug; 4 ♀, Ottawa, Jun–Jul; 2 ♀, St. Lawrence I. Prk., Aug (CNC); 26 ♂, 12 ♀, Orillia, Jul (USNM). Quebec: 1 ♂, Gatineau Prk., Jul (CNC). UNITED STATES. Connecticut: 7 ♂, 5 ♀, Waubamich, Jul (USNM). Indiana: 2 ♂, Lafayette, Jul (USNM). Maine: 1 ♂, 2 ♀, Kennebec Co., Wayne, Aug (MAC). Maryland: 4 ♂, 8 ♀, Washington D. C. area, May–Sep (USNM). Michigan: 3 ♂, 3 ♀, Beulah, Jul; 1 ♀, Brevport, Aug; 1 ♂, Cheboygan Co., Jul; 1 male, Monroe Co., May (USNM); 13 ♀, Emmett Co., Jul (UKL). New York: 2 ♀, Demester; 2 ♂, 1 ♀, Oswego, Jul–Aug (USNM); 1 ♂, Oswego, Jul (INHS). Virginia: 3 ♂, 1 ♀, Great Falls, Jun–July (USNM).

Distribution.—This species is known from the Great Lakes region east to the mid-Atlantic seaboard and New England (Fig. 25).

Fig. 25. Distribution of *Hemerodromia captus*, *H. chelata*, *H. fibrina*, *H. subchelata*.

Remarks.—Males of *H. captus* possess terminalia that resemble those of *H. bifurcata* Collin, described from Bikin in extreme eastern Russia. However, the shape of the cercus appears to be distinct, based solely on the figure in Collin 1941 since the type was not examined. The two species also appear to differ in coloration, with the thorax of *H. captus* being reddish black to black while that of *H. bifurcata* is described as "yellowish."

Hemerodromia chelata MacDonald, new species

(Figs. 5, 25)

Diagnosis.—This species belongs to the *H. captus* group. Terminalia of males of *H. chelata* closely resemble those of *H. subchelata,* newly described below, but maceration reveals the absence of a basomedial process on the cercus of males of *H. chelata* that is present on males of *H. subchelata.* Males and females of these two species differ in thoracic coloration, with those of *H. chelata* having a nearly concolorous golden brown thorax and those of *H. subchelata* a reddish black scutum with a black median stripe that changes in intensity as specimens are rotated during examination under illumination.

Description.—*Male:* Length including terminalia ca. 2.8 mm. *Head*: black; antenna yellow. *Thorax*: pruinose; scutum golden brown, usually with brown median stripe ranging from thin to broad; humeral area paler than surrounding scutum; pleura, scutellum and lateral aspects of scutum golden brown. Fore femur lacking prominent basoventral process (see Fig. 8). *Abdomen*: terga grayish brown, darker than background thoracic coloration, except tergum 1 yellowish brown and tergum 7 nearly yellow; sterna yellowish brown. *Terminalia* (Fig. 5): brownish black; cercus deeply excavated apically into 2 forks of nearly equal size, with apex of dorsal fork smooth; basomedial process lacking on cercus.

Female: Similar to male, except length including terminalia 2.8–3.0 mm; ovipositor well developed.

Type material.—HOLOTYPE ♂, labeled "UTAH Garfield Co/Capitol Reef NP/Sulfur Creek/26–28 Jun 1978/Lindahl Mal. tr." (USNM). The specimen, which was collected in a Malaise trap, is in good condition; most of the diagnostic features of terminalia are visible without maceration. The type locality is Capitol Reef National Park in southcentral Utah, but the county of record probably is Wayne County, not Garfield County (Two Sulphur Creeks are named in the area, but only one occurs in the National Park and it is in Wayne County.) Allotype, same data as holotype, except date was 28 Jul (USNM). Paratypes. UNITED STATES. Utah: 10 ♂, 8 ♀, same collecting site as holotype, Jun–Aug (USU, USNM); 5 ♂, Washington Co., Beaver Dam Wash, Jun–Sep; 2 ♂, Washington Co., Leeds, Apr (USU).

Distribution.—This species is known only from the type series from Capitol Reef National Park in southcentral Utah and several specimens from extreme southwestern Utah (Fig. 25).

Etymology.—The specific epithet is from the Latin word "chela," in reference to the deeply excavated cercus of this species, which resembles the claw-like anterior appendage of a decapod crustacean.

Remarks.—Males of *H. chelata* resemble those of Palearctic *H. raptoria* Meigen, based solely on a figure in Vallaint (1981: 388. Fig. 10) since the type was not examined. The former lack peg-like setulae on the epandrial lobe and also lack a basal process on the inner surface of the cercus that is present on males of *H. raptoria.*

Variation in coloration exists among males of *H. chelata* based on a small series of males collected near Leeds, Utah, all of which share terminalia that are identical to the holotype and macerated paratype males. One male in the series resembles males in the type series, but five other males have varying degrees of black pigmentation involving the foreleg and the scutum. For example, the fore coxae are black on four males, the fore femora are black on three males, and the scutum is grayish black on four males while being yellowish brown laterally and grayish black dorsally on the remaining male.

Hemerodromia chillcotti Harper

(Figs. 11, 27)

Hemerodromia chillcotti Harper 1974: 295.

Diagnosis.—This species belongs to the *H. melanosoma* group. Terminalia of males, with a down-turned process apically on each cercus, are distinct from those of *H. glabella* and *H. melanosoma*. Females of *H. chillcotti* have a long ovipositor and thus are readily distinguished from those of *H. melanosoma* on which the ovipositor is very weakly developed. Both species lack the distinct shiny spot on the mesopleuron immediately above the mesocoxa that is diagnostic for *H. glabella*.

Description.—Length including terminalia of male ca. 2.3 mm, of female ca. 2.5 mm. General body color reddish black to black. *Head*: black; antenna yellow. *Thorax*: lightly pruinose on shiny background, scutellum more pruinose; scutum reddish black to black; pleura, scutum, scutellum and postnotum reddish black to black. Fore femur lacking prominent basoventral process (see Fig. 8). *Abdomen*: terga 1 and 7 yellow, remainder brown; sterna yellowish. Male terminalia (Fig. 11): dark brown; cercus slender, with down-turned, rounded lobe apically in lateral view; epandrial lobe strongly narrowed and in-turned apically. Female similar to male; ovipositor well developed.

Type material.—Holotype ♂ (not examined), deposited in the Collection entomologique Ouellet-Robert, Universite de Montreal (UMC). The type locality is St-Hippolyte de Kilkenny, comte de Terrebonne, north of Montreal, Quebec. Paratypes. CANADA. Quebec: 6 ♂, 12 ♀, same locality as holotype, Jun–Aug (CNC, UMC); 1 ♂, 1 ♀, Wakefield, Jul (CNC). UNITED STATES. North Carolina: 1 ♂, Wayah Bald, Jul (CNC).

Other specimens examined.—CANADA. Quebec: 1 ♀, Lac Phillippe, Jul; 3 ♂, Old Chelsea, Jul (CNC). UNITED STATES. Alabama: 9 ♂, 7 ♀, Conecuh Co., Apr (CNC). Connecticut: 1 ♂, 2 ♀, Redding, Jul (USNM). Florida: 2 ♂, Liberty Co., Apr (CNC). Georgia: 6 ♂, 10 ♀, Athens, Apr–Jun (MAC); 1 ♀, Rabun Co., Jul (CNC). Maryland: 1 ♂, Cabin John, Jul (USNM). Massachusetts: 1 ♂, 1 ♀, Petersham, Jul (USNM). New Hampshire: 1 ♂, White Mts., Stinson Lk., Jul (USNM). New York: 1 ♂, Lk. Placid, Jul (CNC). North Carolina: 1 ♀, Cherokee, Jul (CNC); 2 ♂, Graham Co., Robbinsville, Jun (USC). Pennsylvania: 18 ♂, 9 ♀, Fulton Co., Jul (CAS). South Carolina: 1 ♀, Black Falls, Jul (USNM); 1 ♂, Senaca, Aug (CNC). Tennessee: 1 ♀, Gatlingburg, Aug–Sep (INHS); 1 ♀, Van Buren Co., Jun (CNC). Virginia: 1 ♀, Alexandria, Jun (USNM).

Distribution.—This is an eastern species, found from southeastern Canada and New England south into southern Alabama and northwestern Florida (Fig. 27).

Remarks.—Adults have been collected at lights at night, and I have collected specimens in Malaise traps set across a small stream under dense hardwood canopy near Athens, Georgia.

Hemerodromia coleophora Melander
(Figs. 17, 29)

Hemerodromia empiformis coleophora Melander 1928: 256.

Hemerodromia coleophora Melander 1965: 470.

Diagnosis.—This species belongs to the *H. empiformis* group. It is one of two species whose males have a prong-like, apical process on the cercus. Males of *H. coleophora* are distinct from those of *H. loba,* newly described below, but maceration of terminalia of specimens may be required to reveal the features. The apical setae of the cercus of *H. coleophora,* which extend at least to the apex of the corresponding epandrial lobe, are longer and the terminal prong of the cercus is shorter and slightly jagged along the ventromedial surface. Corresponding features of the cercus of *H. loba* include shorter apical setae, which do not extend to the apex of the epandrial lobe, and a longer terminal prong that is entirely smooth.

Description.—Length including terminalia of male ca. 3.0 mm, of female ca. 3.0

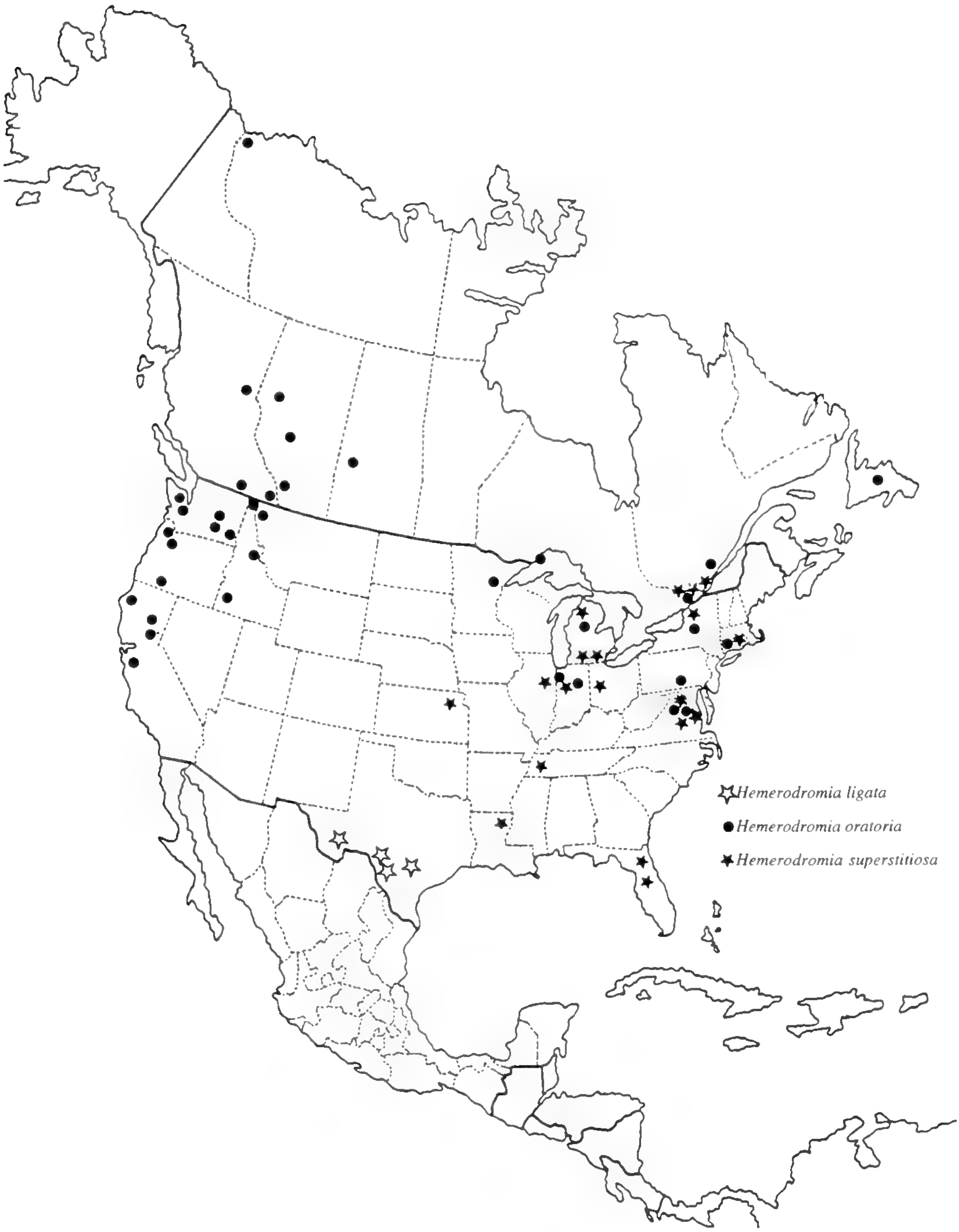


Fig. 26. Distribution of *Hemerodromia ligata, H. oratoria, H. superstitiosa.*

mm. General body color brown. *Head*: black; antenna yellow. *Thorax*: pruinose; scutum and scutellum brown with dark brown median stripe; humeral area, scutellum and postnotum dark brown; pleura brown. Fore femur lacking prominent basoventral process (see Fig. 8). *Abdomen*: terga 1 and 7 yellow, remainder brown; sterna lighter brown. Terminalia (Fig. 17): brownish black; cercus with prong-like apical process, ca. ¼ the length of remainder of cercus and slightly jagged along ventromedial margin; lateral setae of cercus extending at least to apex of epandrial lobe; epandrial lobe abruptly expanded over apical ¼, with row of 4–6 setulae on inner surface near midpoint. Female similar to male; ovipositor well developed.

Type material examined.—Lectotype ♂, here designated, labeled "Yellowst Park/4 Aug 1918/A. L. Melander" (USNM). The specimen is in excellent condition and most of the diagnostic features of terminalia are visible without maceration. The lectotype locality is in Yellowstone National Park of northwestern Wyoming. Paralectotypes. Washington: 1 ♂, 2 ♀, Central Ferry, Aug; 3 ♂, Mt. Rainier, Summerland, Aug (USNM). Wyoming: 12 ♂, 14 ♀, Yellowstone Nat. Prk., Aug (USNM).

Other specimens examined.—UNITED STATES. Arizona: 1 ♂, Santa Cruz Co., 8 mi SE Patagonia, Jun (WSU). California: 2 ♂, 4 ♀, Los Angeles Co., Angeles Nat. For., Windy Sprs., Jun (CAS); 1 ♂, Los Angeles Co., Big Tujunga Cyn., July (LACM). Montana: 1 ♂, Great Falls, Jul (USNM); 1 ♂, 1 ♀, Lewis & Clark Co., Missouri R., Aug (CAS). New Mexico: 6 ♂, 3 ♀, Catron Co., 5 mi E. Glenwood, Jun; 6 ♂, 4 ♀, Taos Co., Rio Grande R., Jul (USNM). Oregon: 5 ♂, 3 ♀, Deschutes R. nr. Redmond, Jul (WSU, USNM); 1 ♂, Wheeler Co., 2 mi W. Spray, Jun (WSU). Utah: 1 ♂, Garfield Co., Capitol Reef Nat. Prk., Aug (USU). Washington: 2 ♂, Kittitas Co., 8 mi S. Ellensburg, Jul (CAS); 1 ♂, Benton Co., W. Richland, Jun; 2 ♂, Whitman Co., 8 mi SW Pullman, Jun (WSU). Wyoming: 1 ♂, 1 ♀, Yellowstone Nat. Pk., Riverside, Aug (CNC).

Distribution.—This species is widely distributed in the western United States (Fig. 29).

Hemerodromia empiformis (Say)
(Figs. 8, 22, 30)

Ochthera empiformis Say 1823: 99.
Hemerodromia empiformis (Say): Melander 1902: 236.

Diagnosis.—Adults closely resemble those of *H. sufflexa* and maceration of male terminalia is necessary to identify most specimens. Males of *H. empiformis* are distinguished by the shape of the cercus, which is smoothly triangular in a posterodorsal plane in lateral view. The cercus on males of *H. sufflexa* is not smoothly triangular in a posterodorsal plane, instead, it is more or less quadrate with the posterior margin nearly straight in lateral view.

Description.—Length including terminalia of male 3.0–3.5 mm, of female 3.3–3.7 mm. General body color brown. *Head*: black; antenna yellow. *Thorax*: pruinose; scutum and pleura golden brown, scutum usually with darker median stripe. Fore femur lacking prominent basoventral process (Fig. 8). *Abdomen*: tergum 7 yellow, terga 1–6 brown; sterna paler. Male terminalia (Fig. 22): dark brown; cercus smoothly triangular in a posterodorsal plane in lateral view; epandrial lobe abruptly expanded at apical ⅓, with row of 4–6 setulae on inner surface past midpoint. Female similar to male; ovipositor well developed.

Type material.—Neotype ♂ of *H. empiformis,* here designated, labeled "IN: WHITE CO./TIPPE. RIVER/5 MI E. BROOKSTON/JULY 5, 1988/J. F. MACDONALD" (USNM). The specimen is in excellent condition and most of the diagnostic features of terminalia are visible without maceration. A neotype is necessary because it is not possible to characterize *H. empiformis* on the basis of Say's description alone.

Specimens examined.—CANADA. Ontario: 1 ♂, Algonguin Prk., Jun (USNM); 2 ♂, 2 ♀, Grand Bend, Jul; 1 ♂, Marmora, Jul (CNC); 1 ♂, Milton I., Aug (CNC); 2 ♂, 2 ♀, Ottawa, Jul (CAS, CNC); 1 ♂, Ridgeway, Jul (CAS); 1 ♂, Rainy Lk., Jun; 1 ♂, Simcoe, Jun; 1 ♂, St. Lawrence Is. Nat. Prk., Aug (CNC). Quebec: 1 ♂, 2 ♀, Berthierville, Jul (FSCA). UNITED STATES. Alabama: 1 ♂, 1 ♀, Jefferson Co., Apr (MAC). Georgia: 3 ♂, 2 ♀, Athens, Jun (MAC). Indiana: 7 ♂, 8 ♀, White Co., 5 mi E. Brookston, Jul; 4 ♂, 9 ♀, W. Lafayette, Jun–Sep (MAC; PERC). Maine: 1 ♂, Orono, Aug (USNM). Maryland: 1 ♂, Plummer, May (USNM). Minnesota: 1 ♂, Houston Co., Jun; 2 ♂, Olmstad Co., Sep; 3 ♂, 1 ♀, Pine Co., May (UMSP). New York: 1 ♂, 1 ♀, Chautaugua Lk., Jun (CAS); 1 ♂, Ithaca, Aug (CU). Virginia: 1 ♂, 3 ♀, May (CAS). Wisconsin: 1 ♂, 3 ♀, Polk Co., Jul (LAC).

Distribution.—Males of this species are widely distributed in the eastern United States and southeastern Canada (Fig. 30).

Remarks.—Described on the basis of a female by Say (1823), *H. empiformis* is one of two species of the *H. empiformis* group found in eastern North America. The other species is *H. sufflexa,* which was described on the basis of male terminalia as a variety of *H. empiformis* by Melander (1947) and was listed, without explanation, as *H. sufflexa* by Melander (1965). Since females of these two species are indistinguishable, Say's description of *H. empiformis* could apply equally to *H. sufflexa.* However, the concepts of these two species presented and supported with figures of male terminalia in Melander (1947) are adopted here.

I have aspirated male and female adults of *H. empiformis,* together with those of *H. superstitiosa,* from the undersides of heavily shaded leaves overhanging a very small, spring-fed stream that runs into the Tippecanoe River northeast of Lafayette, Indiana. Two females of *H. empiformis* were observed with prey impaled on their mouthparts and subsquently aspirated; prey were determined to be immature leafhoppers (Cicadellidae).

Hemerodromia fibrina Landry and Harper
(Figs. 6, 25)

Hemerodromia fibrina Landry and Harper 1985: 1384.

Diagnosis.—This species belongs to the *H. captus* group. Among North American species, adults possess distinctive pigmentation patterns on the thorax, described below. Terminalia of males include a deeply excavated cercus with prominent vestiture, including rows of black, peg-like setulae on the lower fork.

Description.—Length including terminalia of male ca. 3.0 mm, of female ca. 3.0 mm. General body color brown, with areas of darker pigmentation on thorax. *Head*: black; antenna yellow. *Thorax*: pruinose; scutum mostly dark brown; humeral area and scutellum golden brown to brown; pleura golden brown, except dark brown below notopleural suture; postnotum dark brown. Fore femur lacking prominent basoventral process (see Fig. 8). *Abdomen*: male terga reddish brown, sterna light reddish brown. Male terminalia (Fig. 6): reddish brown; cercus deeply excavated apically, lower fork lined by black, peg-like setulae; epandrial lobe nearly rectangular. Female coloration similar to male, except abdominal terga 1 and 7 light reddish brown; ovipositor well developed.

Type material.—Holotype ♂ (not examined), deposited in the Collection entomologique Ouellet-Robert, Université de Montreal UMC). The type locality is Lac Helene on the Rivière du Castor drainage (53°25′N, 77°30′W), south of La Grande-Riviere inland from the eastern shore of James Bay, Quebec, Canada.

Specimens examined.—CANADA. Quebec: 1 ♂, 2 ♀, July (MAC); Northwest Territories: 1 ♂, Norman Wells, Hodgeson Lk., Jul; 1 ♂, 2 ♀, Wholdaia Lk., Jul (CNC). UNITED STATES. Alaska: 1 ♂, Nenana, Jun (USNM).

Distribution.—This species is known from central Alaska east to west-central Quebec (Fig. 25).

Remarks.—Adults of *H. fibrina* resemble those of Palearctic *H. raptoria* Meigen, but terminalia of males of the former (Fig. 6) differ from those of the latter, based on figure 303 in Collin (1961). The most prominent difference is in the structure and vestiture of the cercus and epandrial lobe. Labels on some specimens of *H. fibrina* revealed their collection along edges of peat bogs, and Landry and Harper (1985) found this species to be one of the few lacustrine Hemerodromiinae during their study.

Hemerodromia flexiformis **MacDonald, new species**

(Figs. 24, 30)

Diagnosis.—This species belongs to the *H. empiformis* group. Adults closely resemble those of *H. burdicki,* newly described above, and maceration of male terminalia may be necessary to distinguish them. The cercus on males of *H. flexiformis* possesses a much longer apical process that is smoothly rounded at its apex. The cercus on males of *H. burdicki* processes a very short apical process that is more pointed at its apex.

Description.—*Male:* Length including terminalia ca. 2.8 mm. General body color brown. *Head*: black; antenna yellow. *Thorax*: pruinose; scutum and scutellum golden brown, usually with darker median stripe; humeral area, scutellum and postnotum dark brown; pleura golden brown. Fore femur lacking prominent basoventral process (see Fig. 8). *Abdomen*: terga 1 and 7 yellow, remainder brown, sterna lighter brown. *Terminalia* (Fig. 24): brownish black; cercus rectangular basally in lateral view, sharply narrowed and in-turned apically; epandrial lobe abruptly expanded over apical ⅓, with row of 4–6 setulae on inner surface past midway.

Female: Similar to male; body length including terminalia ca. 3.3 mm; ovipositor well developed.

Type material.—HOLOTYPE ♂, labeled "WASHINGTON: Steptoe/Cyn., 10 mi. SW/Colton, Whitman Co./900 ft., 29-VII-1976/W. J. Turner" (USNM). The specimen is in excellent condition and most of the diagnostic features of terminalia are visible without maceration. The type locality is in southeastern Washington State. Allotype, same data as holotype (USNM). Paratypes. UNITED STATES. California: 2 ♂, Tulare Co., Farmersville, Jul–Aug; 3 ♂, Tulare Co., Three Rivers, Jun (MAC). Oregon: 1 ♂, 2 ♀, Deschutes Co., Cline Falls St. Prk., Jul; 1 ♂, Umatilla Co., 27 km E. Ukiah, Jul (CAS). Washington: 1 ♂, Kittitas Co., Yakima R., 8 mi S. Ellensburg, Jul (CAS); 7 ♂, 1 ♀, Asotin Co., Asotin Crk., 6 mi W. Asotin, Aug; Whitman Co., 32 ♂, 17 ♀, Steptoe Cyn., 10 mi SW Colton, Jul; 2 ♂, 8 mi SW Pullman, Aug; 1 ♂, Big Almota Cyn., Jul (USNM, WSU).

Distribution.—Males of this species are known from central California, central Oregon and southeastern Washington (Fig. 30).

Etymology.—The specific epithet is an arbitrary combination of letters incorporating "flexa" and "formis," Latin for shape or figure, alluding to the structural similarity between the new species and *H. sufflexa.*

Hemerodromia glabella **MacDonald, new species**

(Figs. 12, 27)

Diagnosis.—This species belongs to the *H. melanosoma* group. The shiny, denuded spot on the mesopleuron just above the mesocoxa distinguishes this species from *H. chillcotti* and *H. melanosoma,* the other two Nearctic species with relatively small and shiny reddish black to black adults.

Description.—*Male:* Length including terminalia ca. 2.2 mm. General body coloration reddish black. *Head*: black; antenna yellow. *Thorax*: slightly pruinose on shiny background; scutum, scutellum, postnotum and pleura reddish black to black; mesopleuron with denuded spot just above mesocoxa. Fore femur lacking prominent ba-

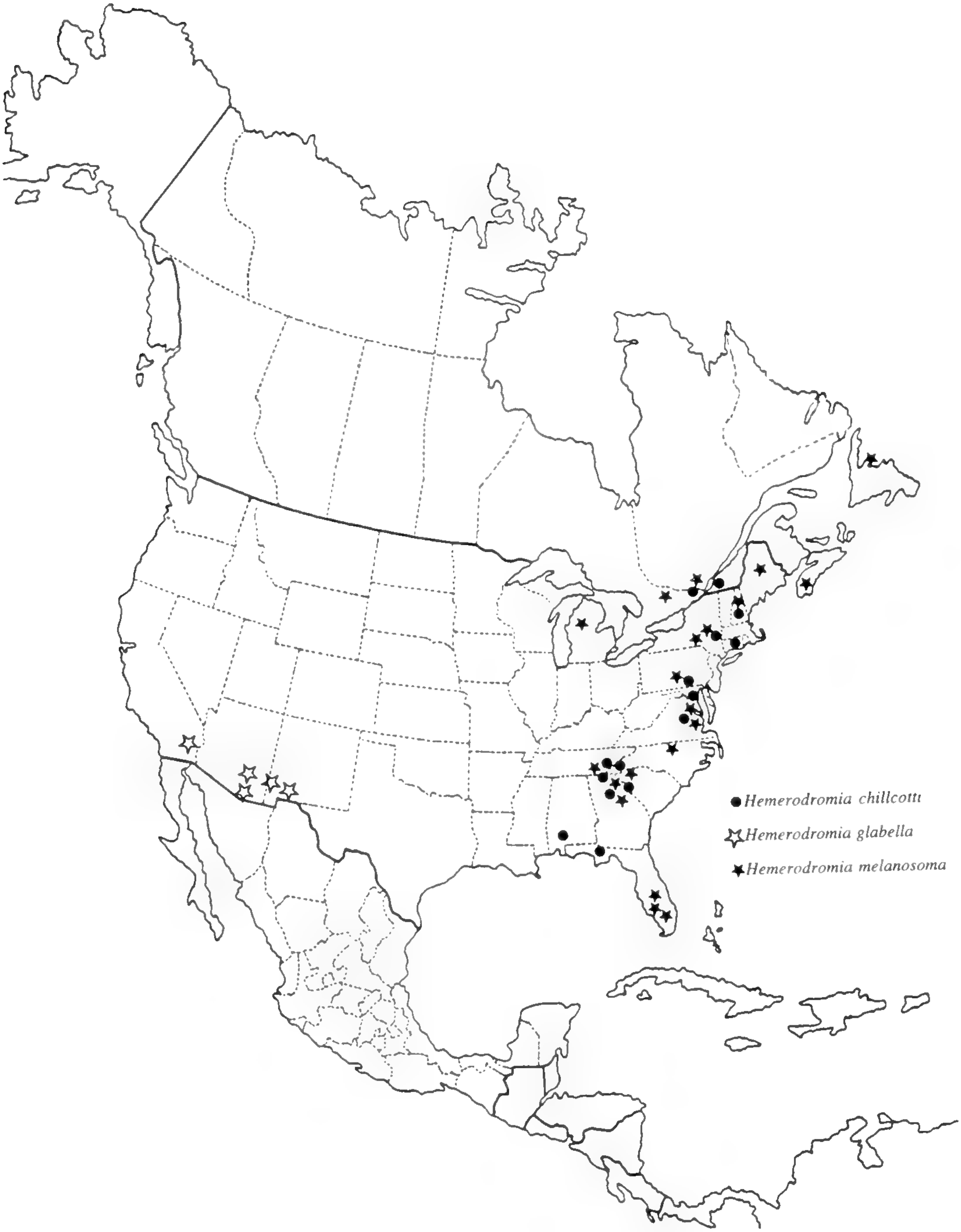


Fig. 27. Distribution of *Hemerodromia chillcotti, H. glabella, H. melanosoma.*

soventral process (see Fig. 8). *Abdomen*: terga dark brown, sterna lighter brown. *Terminalia* (Fig. 12): reddish black; cercus straight, apical half narrowed; epandrial lobe straight, broadening apically.

Female: Similar to male, except length including terminalia 2.3–2.7 mm; ovipositor well developed.

Type material.—HOLOTYPE ♂, labeled "ARIZONA Gila Co/Jones Water C. G./30 Jul 1885/W. J. Hanson" (USNM). The specimen is in excellent condition and some of the diagnostic features of terminalia are visible without maceration. The type locality is in Gila County, about 30 kilometers northeast of Globe, Arizona. Allotype, same collecting data as holotype (USNM). Paratypes. UNITED STATES. Arizona: 5 ♂, 10 ♀, Southwest Research Station, Cochise Co., May–Sep (UCR, CAS, USNM); 7 ♂, 5 ♀, same collecting data as holotype (USU). California: 1 ♂, Andreas Cyn., Oct (USNM); 1 ♂, Blythe, May (CNC). New Mexico: 1 ♂, Catron Co., 5 mi E. Glenwood, Jun (USNM); 1 ♂, Dona Ana Co., 17 mi NE Las Cruces, May (UCR); 1 ♂, 1 ♀, Pinos Altos, Cherry Crk., Jun (USNM).

Distribution.—This is a southwestern species, known from southeastern California east into south-central New Mexico (Fig. 27).

Etymology.—The specific epithet is from the Latin word "glabella," for hairless or bald, in reference to the small, denuded spot on the mesopleuron just above the mesocoxa.

Remarks.—Males of *H. glabella* closely resemble those of Neotropical *H. extispex* Melander (type examined), but the latter possess a patch of long setae distally on the hypandrium that is lacking on males of *H. glabella*.

Hemerodromia jugulator Melander

(Figs. 1, 28)

Hemerodromia jugulator Melander 1928: 256.

Diagnosis.—Adults of this species are characterized by concolorous yellowish to yellowish gold thoracic pleura that contrast strongly with the shiny black scutum.

Description.—Length including terminalia of male ca. 2.8 mm, of female ca. 3.0 mm. *Head*: black; antenna yellow. *Thorax*: slightly pruinose with shiny background; scutum reddish black to black; pleura and humeral area yellowish to yellowish gold. Fore femur lacking prominent basoventral process (see Fig. 8). *Abdomen*: terga 1 and 7 yellow, remainder dark brown; sterna yellowish. Male terminalia (Fig. 1): dark brown; cercus and epandrial lobe straight, slender; phallus strongly developed and projecting dorsally beyond cercus; exposed phallus and cercus subequal in length. Female similar to male; ovipositor well developed.

Type material examined.—Lectotype ♂, here designated, labeled "Cld. Sp. Harb./L. I. July" (USNM). The specimen is in excellent condition and the terminalia are not macerated. The type locality is New York, Suffolk County, Cold Spring Harbor, on the north shore of Long Island. Paralectotypes. New York: 3 ♀, Cold Spr. Harbor, Jul (USNM).

Other specimens examined.—UNITED STATES. Georgia: 1 ♀, Athens, Jun (MAC). New York: 1 ♀, Cold Spr. Harbor, July (AMNH). North Carolina: 1 ♀, Pisgah Nat. For., Looking Glass Prk., Jul (CNC). Washington D.C.: 1 ♀, Jun (USNM).

Distribution.—This species is known from Long Island, New York and south into Georgia (Fig. 28).

Remarks.—The female I collected near Athens, Georgia, was taken in a Malaise trap set across a small stream under a dense hardwood canopy.

***Hemerodromia ligata* MacDonald, new species**

(Figs. 9, 26)

Diagnosis.—This species belongs to the *H. superstitiosa* group. Terminalia of males, which have a ventral process on each cercus that fits into a dorsal groove on the corre-

Fig. 28. Distribution of *Hemerodromia jugulator, H. sinclairi, H. stellaris, H. vates.*

sponding epandrial lobe, are distinct from those of *H. superstitiosa.* Darkened distal tarsomeres on mid and hind legs distinguish adults of both sexes from those of *H. oratoria.*

Description.—*Male*: Length including terminalia 3.2–3.4 mm. General body color brown. *Head*: black; antenna yellow. *Thorax*: pruinose; scutum golden brown with dark brown median stripe; scutellum brown, lighter brown laterally; postnotum dark brown; pleura golden brown. *Legs*: fore femur basally bearing prominent ventral process ending in 1 or 2 strong, black setulae, with associated indentation on ventral surface for reception of apical bristle of fore tibia (see Fig. 7); distal 2 tarsomeres on mid and hind leg brown to dark brown. *Abdomen*: tergum 1 light brown, tergum 7 yellow, remainder dark brown. *Terminalia* (Fig. 9): dark brown; cercus with ventral process fitting into dorsal indentation of epandrial lobe.

Female: Similar to male except abdominal tergum 1 light brown, remainder brown; length including terminalia 3.5–3.7 mm; ovipositor well developed.

Type material.—HOLOTYPE ♂, labeled "Devil's River/Del Rio, TEXAS/April 28 1959/J. F. McAlpine" (CNC, holotype number 21335). The specimen is in excellent condition and most of the diagnostic features of terminalia are visible without maceration. The type locality is Val Verde County, near the town of Del Rio in southwestern Texas. Allotype, same collecting data as holotype (CNC). Paratypes. UNITED STATES. Texas: 2 ♂, 4 ♀, same data as holotype; 1 ♂, 1 ♀, Big Bend Nat. Prk., Oak Spr., May; 1 ♂, 1 ♀, Kerrville, Apr (CNC); 2 ♂, 3 ♀, Devil's River, Apr–May (USNM).

Distribution.—This species is known only from southwestern and southcentral Texas (Fig. 26).

Etymology.—The specific epithet is from the Latin word "ligatus," for tie or fasten, in reference to the cercus and corresponding epandrial lobe that fit together to form an interlocking unit.

Hemerodromia loba MacDonald, new species

(Figs. 18, 29)

Diagnosis.—This species belongs to the *H. empiformis* group. Males resemble those of *H. coleophora,* but are characterized by their longer and entirely smooth, prong-like apical process on the cercus which usually is evident on unmacerated specimens. The corresponding structure on *H. coleophora* is shorter (ca. ¼ length of cercus compared to ca. ⅓ for males of *H. loba*) and more difficult to discern on unmacerated specimens.

Description.—*Male:* Length including terminalia 3.0–3.4 mm. General body color brown. *Head*: black; antenna yellow. *Thorax*: pruinose; scutum and scutellum brown with darker median stripe; humeral area and postnotum dark brown; pleura brown with darker brown areas above meso-and metacoxa. Fore femur lacking prominent basoventral process (see Fig. 8). *Abdomen*: terga 1 and 7 yellow, remainder brown; sterna light brown. *Terminalia* (Fig. 18): brownish black; cercus with prong-like apical process, ca. ⅓ length of remainder of cercus, which is entirely smooth; epandrial lobe abruptly expanded over apical ¼, with row of 4–6 setulae on inner surface past midpoint.

Female: Similar to male, except length including terminalia 3.2–3.5 mm; ovipositor well developed.

Type material.—HOLOTYPE ♂, labeled "Truckee, CALIF./6000′ Tahoe Co./14. vii. 1961/B. H. Poole" (CNC, holotype no. 21336). The specimen is in excellent condition and most of the diagnostic features of terminalia are visible without maceration. The type locality cannot be established from the holotype label since there is no "Tahoe County"; however, based on elevation data on the label, the specimen probably was collected near the town of Truckee, northwest of Lake Tahoe in extreme eastern California. Allotype, same collecting data as holotype (CNC). Paratypes. UNITED STATES. California: 2 ♂, 4 ♀, same collecting data as holotype (CNC). Nevada: 4 ♂, 4 ♀, Pershing Co., Rye Patch Dam, Jul (CAS). Washington: 1 ♂, Kittitas Co., 8 mi S. Ellensburg, Jul (CAS); 1 ♂, 1 ♀, Spokane, Aug (USNM).

Distribution.—Males of this species are known only from east-central California and adjacent Nevada, and the eastern half of Washington (Fig. 29).

Etymology.—The specific epithet is from the Latin word "lobus," for elongated projection or protuberance, in reference to the prominent lobe that arises from the dorsal surface near the apex of each cercus.

Hemerodromia melanosoma Melander
(Figs. 13, 27)

Hemerodromia melanosoma Melander 1947: 250.

Hemerodromia haruspex Melander 1947: 249. **New synonymy.**

Diagnosis.—Adults are distinguished from those of other members of the *H. melanosoma* group by their nearly denuded scutum that contrasts strongly with the pruinose thoracic pleura.

Description.—Length including terminalia of male 2.2–2.4 mm, of female ca. 2.3 mm. General body color reddish black or black. *Head*: black; antenna yellow. *Thorax*: background shiny; scutum denuded, contrasting strongly with more pruinose pleura; scutum, scutellum, postnotum and pleura reddish black to black (tan or brown on teneral specimens). Fore femur lacking prominent basoventral process (see Fig. 8). *Abdomen*: tergum 1 yellow, terga 2–7 brown; sterna yellowish. Male terminalia (Fig. 13): reddish black; cercus strap-like in lateral view; epandrial lobe slender and concave dorsally. Female similar to male; ovipositor weakly developed.

Type material examined.—Lectotype ♂ of *H. melanosoma,* here designated, labeled "Petawawa CAN/4 July '1938/A. L. Melander" (USNM). The specimen is in excellent condition and most of the diagnostic features of terminalia are visible without maceration. The type locality is ca. 150 km west-northwest of Ottawa, along the Ottawa River. Lectotype ♂ of *H. haruspex,* here designated, labeled "Orlando Fla/26 Apr. '30/A. L. Melander" (USNM). The specimen is in very good condition and most of the diagnostic features of terminalia are visible without maceration.

Other specimens examined.—CANADA. Newfoundland: 1 ♀, Indian R., Jul (USNM). Nova Scotia: 4 ♂, 6 ♀, Shelbourne, Aug (CNC). Ontario: 1 ♂, Algonquin Prk., Jun (CNC); 5 ♀, Petawawa, Jul (USNM). Quebec: 8 ♂, 4 ♀, Old Chelsea, Jul; 2 ♀, Parc de Mauricie, Aug; 8 ♂, 24 ♀, Wakefield, Jun–Jul (CNC). UNITED STATES. Connecticut: 2 ♀, Redding, Jul–Aug; 1 ♂, Terryville, Jun; 1 ♂, 1 ♀, Waubamich, Jun (USNM). Florida: 1 ♂, Gulf Hammock, Apr (CNC); 5 ♀, Orlando, Apr; 1 ♀, Sebring, Apr (USNM). Georgia: 1 ♀, Athens, Jun (MAC); 1 ♂, Rabun Bald, Jul (CNC); 2 ♂, 1 ♀, Rabun Co., May–Jun (CNC). Maine: 1 ♀, Kennebec Co., Wayne, Aug (MAC); 2 ♂, Old Town, Lk. Pushan, Aug (USNM). Maryland: 1 ♂, 1 ♀, Beltsville, May; 2 ♂, 2 ♀, Cabin John, Jun (USNM). Massachusetts: 1 ♀, E. Falmouth, Jul (USNM). Michigan: 1 ♂, Marquette Co., Big Bay, Jun (MAC); 1 ♂, Missaukee Co., Jun (CNC); 1 ♀, Schoolcraft Co., Aug (USNM). New Hampshire: 5 ♂, 4 ♀, Dixville, Jul (UNH). New York: 3 ♀, Lk. Placid, Jul (CNC); 2 ♂, 2 ♀, Milford Center, Jul (USNM). North Carolina: 1 ♂, 1 ♀, Durham Co., May (USNM). Pennsylvania: 1 ♂, 3 ♀, State College , Jul (CAS). South Carolina: 1 ♂, 1 ♀, Oconee Co., Jun (CNC). Tennessee: 1 ♂, 1 ♀, East Ridge, Chapin Sanctuary, May (CNC). Virginia: 1 ♀, Alexandria, Jun; 1 ♂, Big Mdws., Jun (USNM).

Distribution.—This species is known from the Great Lakes region east to Newfoundland, along the southern Appalachian

Fig. 29. Distribution of *Hemerodromia brevifrons, H. coleophora, H. loba, H. reclinata, H. sufflexa.*

Mountains and south into south-central Florida (Fig. 27).

Remarks.—Melander (1947) distinguished *H. melanosoma* and *H. haruspex* on the basis of thoracic coloration, with adults of *H. haruspex* described as shiny tan to brown and those of *H. melanosoma* described as shiny black. These color descriptions are true of Melander's "type" of *H. melanosoma* and his "type" of *H. haruspex,* but examination of both revealed identical terminalia. In addition, several shiny tan to shiny brownish to shiny black males examined from museum series collected in Maryland, New England and southern Canada have identical terminalia. Based on identical male terminalia, *H. melanosoma* (Melander 1947: 250) and *H. haruspex* (Melander 1947: 249) are considered synonyms. The former available name is retained because it applies to fully sclerotized adults and is better known; the latter rarely has been cited in the literature.

Hemerodromia oratoria (Fallén)
(Figs. 15, 26)

Tachydromia oratoria Fallén 1816: 34.

Diagnosis.—This species appears to belong to the *H. superstitiosa* group, but both the basoventral process and associated indentation for the reception of the fore tibial bristle vary in development among males and are virtually lacking on females. Male terminalia are distinct, as described below, but females are difficult to separate from those of other species that are concolorous golden brown and have a well-developed ovipositor.

Description.—Length including terminalia of male 2.4–3.2 mm, of female 2.4–3.4 mm. General body color of male light reddish brown, of female darker. *Head*: black; antenna yellow. *Thorax*: pruinose; male scutum, scutellum, postnotum and pleura light reddish brown, scutum occasionally with darker median stripe. Male fore femur usually with well-developed basoventral process and associated indentation on ventral surface for reception of apical bristle of fore tibia (see Fig. 7). *Abdomen*: male tergum 7 yellow and tergum 6 mostly yellow, darker laterally on most specimens; remaining terga brown. Male terminalia (Fig. 15): dark brown; cercus nearly rectangular, with broadly excised apex; epandrial lobe rectangular, except for in-turned, apicoventral lobe. Female similar to male except basoventral process of fore femur and associated indentation lacking, scutum usually with broad median stripe, and abdominal terga 1–7 brown; ovipositor well developed.

Type material.—Lectotype ♀ (not examined), deposited in Fallén collection in Stockholm, Sweden. Collin (1961: 719) discusses the circumstances surrounding the correct association of *H. oratoria* males in the collections of Zetterstedt and Lundbeck.

Specimens examined.—CANADA. Alberta: 1 ♂, 20 mi W. Calgary, Jul; 1 ♂, 1 ♀, Edmonton, Jun (CNC); 1 ♂, 8 ♀, Slave Lk., Aug (CAS). British Columbia: 1 ♂, Big Beaver Crk., Aug; 1 ♂, 2 ♀, Chase, Aug; 2 ♂, 1 ♀, Moyie Lk., Jul; 14 ♀, Taylor Landing, Aug (CAS); 1 ♂, Robson, Aug (CNC); 4 ♂, Carbonate, Jul (CU, USNM). Newfoundland: 8 ♂, 2 ♀, Jul–Aug (USNM). Northwest Territories: 8 ♂, 9 ♀, Aklavik, Jul–Aug (CAS). Ontario: 1 ♂, Ottawa , Jul (CNC); 9 ♂, 12 ♀, Waubamik, Jun–Jul (USNM). Quebec: 1 ♂, Berthierville, Jul (FSCA). Saskatchewan: 2 ♂, 3 ♀, Saskatoon, Aug (USNM). UNITED STATES. California: 1 ♂, Shasta Co., Boundary Cmpgr., Jul; 2 ♂, 4 ♀, Santa Cruz Co., Felton, Jul (CAS); 3 ♂, 3 ♀, Humboldt Co., Jun (CU); 1 ♂, Butte Co., Madrone Lk., Jul (UCR); 1 ♂, 2 ♀, Humboldt Co., Blue Lk. (USNM). Connecticut: 1 ♂, Canaan, Aug; 5 ♂, 2 ♀, Redding, Jun–Jul; 1 ♀, Storrs, Jun (USNM). Georgia: 3 ♂, 2 ♀, Rabun Co., May (CNC, MAC); 1 ♂, 1 ♀, Clayton, May (USNM). Idaho: 1 ♂, 1 ♀, Horseshoe Bend; 1 ♂, 3 ♀, Priest Lk., Aug (USNM); 3 ♂, 1 ♀, 10 mi E. Lowell, Lochsa R., Jul (WSU). Indiana: 1 ♂, W. Lafayette, May; 1 ♂, Fulton Co., Aug (MAC). Michigan: 3 ♂, Isle Royale, Aug; 2 ♂, Marquette Co., Aug; 1 ♂, Waxford Co., Jul (USNM). Minnesota: 2 ♂, St. Louis Co., Aug (UMSP). Montana: 1 ♂, Gillame, Jul (AMNH); 1 ♂, 1 ♀, Troy, Aug (USNM). New York: 1 ♂, Long Is., Jul (AMNH); 4 ♂, Rome, Jun (USNM). North Carolina: 1 ♂, Black Mt., N. Frk. Swannanoa R. (USNM). Oregon: 2 ♂, 1 ♀, Jackson Co., Rogue R., Jul; 2 ♂, 1 ♀, Minam, Jul (CAS); 3 ♂, 1 ♀, Corvallis, Jun; 1 ♂, Forest Grove, Jun; 1 ♂, Salem, Jul (USNM). Pennsylvania: 1 ♂, State College, Jun (CAS). South Carolina: 1 ♂, Pickens Co., Apr (CUSC). Virginia: 3 ♂, Alexandria, May–Jun; 1 ♂, Luray, Jun (USNM). Washington: 24 ♂, 22 ♀, Asotin Co., 6 mi W. Asotin, Jun–Jul; 3 ♂, 2 ♀, Jefferson Co., Cottonwood Cmpgr., Jul; 1 ♂, Lewis Co., Rainbow Falls St. Prk., July (WSU); 1 ♂, Entiat, Jul; 11 ♂, 3 ♀, Zilliah, Jun (USNM).

Distribution.—This Holarctic species is widely distributed in the Nearctic Region, occurring in eastern North America and westward across southern Canada to the Pacific Coast and south into central California (Fig. 26).

Remarks.—Examination of males of *H. oratoria* from Europe (deposited in USNM) revealed identical fore leg structure and terminalia between them and males of a taxon that is widely distributed in the Nearctic Region. This Nearctic taxon heretofore has been known as *H. rogatoris* Coquillett, but examination of the holotype male (USNM type no. # 3152) revealed that it is a male of *H. superstitiosa*. This new synonymy is reported below under the treatment of *H. superstitiosa*.

Hemerodromia reclinata MacDonald, new species

(Figs. 21, 29)

Diagnosis.—This species belongs to the *H. empiformis* group. Adults resemble those of *H. empiformis* in size and coloration, but male terminalia are distinct. The main difference involves the structure of the epandrial lobe, which is strongly expanded anteriodorsally on males of *H. reclinata*.

Description.—*Male:* Length including terminalia ca. 2.6 mm. General body color brown. *Head*: black; antenna yellow. *Thorax*: pruinose; scutum and scutellum golden brown with darker median stripe; humeral area dark brown; pleura golden brown. Fore femur lacking prominent basoventral process (see Fig. 8). *Abdomen*: terga 1 and 7 yellow, remainder brown; sterna lighter brown. *Terminalia* (Fig. 21): brownish black; cercus broadly triangular in lateral view; epandrial lobe abruptly expanded over apical ¼, with strongly developed anterodorsal projection lined by row of setulae; inner surface of epandrial lobe with 4–6 setulae past midpoint.

Female: Similar to male except length including ovipositor 2.8–3.0 mm; ovipositor well developed.

Type material.—HOLOTYPE ♂: upper label "ARIZONA Oak/CrkCn Sedona/29 June 1953" and lower label "WW Wirth/ collector" (USNM). The intact specimen is in excellent condition and at least some of the diagnostic features of terminalia are discernible without maceration. The type locality is about 30 km south of Flagstaff in central Arizona. Allotype, same data and labels as holotype (USNM). Paratypes. UNITED STATES. Arizona: 1 ♂ (lacking head; macerated terminalia in glycerin microvial attached to pin have become overcleared and are difficult to see), 5 ♀, same collecting data as holotype (USNM).

Distribution.—This species is known only from the type locality (Fig. 29).

Etymology.—The specific epithet comes from the Latin word "reclinis," for leaning back, in reference to the distinctive anterodorsal projection of the expanded portion of the epandrial lobe.

Hemerodromia sinclairi MacDonald, new species

(Figs. 2, 28)

Diagnosis.—Adults of this species are characterized by a unique combination of

Fig. 30. Distribution of *Hemerodromia burdicki*, *H. empiformis*, *H. flexiformis*.

features, including relatively large size, greater development of macrotrichiae, grayish black coloration, and gray wings.

Description.—*Male:* Length including terminalia 3.3–3.5 mm. General body color grayish black. *Head*: black, except white hair fringe on gena; antennal scape and pedicel reddish brown, flagellum and stylus dark reddish brown; mouthparts reddish brown; palps whitish. *Macrotrichiae*: black, reclinate, including pair of ocellar bristles and 5 pairs of parafrontal bristles. *Thorax*: densely prinose, matte; concolorous grayish black; scutal pruinescence golden yellow; pruinescence on lower half of mesopleuron whitish. *Macrotrichiae*: black, erect, including several pronotal setae, pair of notopleural bristles, uniserial acrostichal hairs, and 2 rows of scutellar setae including 10–12 dorsally and 6–8 apically. *Legs*: mostly light reddish black; coxae and trochanters yellow; femora yellowish basally, becoming light reddish black distally (darker on lateral surface); tibiae and tarsi light reddish black. Fore femur ventrally with 2 rows of black, bluntly pointed setulae; each row flanked by row of bristles, inner row with 7 black bristles and outer row with 3 black bristles distally and 3–4 light reddish brown setae basally; lacking prominent basoventral process (see Fig. 8). Fore tibia ventrally with 2 rows of black, sharply pointed setulae, each flanked by rows of blackish setae. *Wings*: gray with darker veins; stigma lacking. *Abdomen*: terga grayish black; sterna light gray. *Terminalia* (Fig. 2): nearly black; cercus crescent shaped in lateral view, in-turned aspically; epandrial lobe rectangular basally, narrower and truncate apically in lateral view, apex up-turned and excavated.

Female: Similar to male, except body length including terminalia 3.5–4.2 mm and fore femur ventrally with 6 black bristles in outer row; ovipositor weakly developed.

Type material.—HOLOTYPE ♂, labeled "USA:NM: Grant Co./Gila Nat. For./29. VI. 1991/E. Fork Gila River/BJ Sinclair BS9101" (CNC). The specimen is in excellent condition and the terminalia are not macerated. The type locality is in Grant County, Gila National Forest, north of Silver City, New Mexico. Allotype, same collecting data as holotype (CNC). Paratypes. UNITED STATES. New Mexico: 5 males (2 with macerated terminalia in microvial attached to respective pins); 2 females, same collecting data as holotype (CNC).

Distribution.—This species is known from the type series from southwestern New Mexico (Fig. 28).

Etymology.—This species is named after Brad Sinclair who aspirated the type series off rocks in the east fork of the Gila River, has collected numerous representatives of other species of Hemerodromiinae, and has contributed greatly to our understanding of Diptera larvae and adult terminalia.

Hemerodromia stellaris Melander
(Figs. 14, 28)

Hemerodromia stellaris Melander 1947: 251.

Diagnosis.—Terminalia of males of *H. stellaris* are distinct. Each cercus and corresponding epandrial lobe are subequal in shape and size, and there are 5–6 minute pointed processes along the apical margin of the cercus (best seen on macerated terminalia). Lack of an expanded epandrial lobe distinguishes males from those of *H. brevifrons*, but females of these two species appear to be separable only by subtle differences in the development of the median stripe on the scutum. Relatively small size and lack of a basoventral process on the fore femur distinguish adults of *H. stellaris* from those of *H. ligata*, newly described above and which also may be collected in Texas.

Description.—Length including terminalia of male ca. 2.3 mm, of female 2.6–2.8 mm. General body color brown. *Head*: black; antenna yellow. *Thorax*: thinly pruinose; scutum and pleura golden brown, scutum with dark brown median stripe expanding over apical ⅓ to width of similarly darkened scutellum and postnotum. Fore femur lacking prominent basoventral process (see Fig. 8). *Abdomen*: tergum 7 yellow, remainder dark brown. Male terminalia (Fig. 14): dark brown; cercus and epandrial lobe straight and relatively slender, nearly equal in size and shape; apex of cercus lined by 5–6 tiny pointed processes. Female similar to male; ovipositor well developed.

Type material examined.—Lectotype ♂, here designated, labeled "Comal River/24-3-42 Tex/A. L. Melander" (USNM). The specimen is in excellent condition and most of the diagnostic features of terminalia are visible without maceration. The type locality is immediately north-northeast of San Antonio, Texas. Paralectotypes. UNITED STATES. Texas: 6 ♂, 6 ♀, same collecting data as holotype; 1 ♂, Del Rio, May (USNM).

Other specimens examined.—MEXICO. Sonora: 2 ♂, Ciudad Obregon, May (CNC). UNITED STATES. Texas: 15 ♂, 10 ♀, Devil's R. nr. Juno, Jun (USNM).

Distribution.—This species is known from southcentral Texas and northwestern Mexico (Fig. 28).

Remarks.—A series of specimens collected in Hawaii (Oahu Island, Makiki Valley) by D. E. Hardy are identical to specimens in Melander's type series of *H. stellaris* with regard to size, coloration, and all the details of male terminalia. Symmorphy of male terminalia between the Hawaiian specimens and specimens from the continental United States is evidence for conspecificity since convergence in such genitalic details is highly unlikely.

Hemerodromia subchelata MacDonald, new species

(Figs. 3, 25)

Diagnosis.—This species belongs to the *H. captus* group. Terminalia of males closely resemble those of *H. chelata,* newly described above. The distinction involves subtle differences in the shape of the cercus, revealed only upon maceration. The cercus on males of *H. subchelata* has a median lobe basally that is lacking on males of *H. chelata,* and the dorsal fork of the cercus is somewhat lobed apically in contrast to the corresponding area being smooth on males of *H. chelata.* Adults of these two species differ in coloration, as described above under *H. chelata.*

Description.—*Male:* Length including terminalia 2.8–3.0 mm. General body color reddish black. *Head*: black; antenna yellow. *Thorax*: pruinose; scutum mostly reddish black with black median stripe changing intensity with rotation of specimens; humeral area golden brown; scutellum grayish black; pleura reddish black, usually edged with golden brown dorsally. Fore femur lacking prominent basoventral process (see Fig. 8). *Abdomen*: terga dark brown, except tergum 7 yellow; sterna yellowish brown. *Terminalia* (Fig. 3): dark brown; cercus with prominent basomedian process, deeply excavated apically into 2 forks of nearly equal size; apex of dorsal fork somewhat lobed.

Female: Similar to male, except length including terminalia 2.8–3.0 mm, median stripe on scutum less developed, and abdominal tergum 7 light yellow; ovipositor well developed.

Type material.—HOLOTYPE ♂, labeled "Kerrville, TEX./April 14 (handwritten) 1959/J. F. McAlpine" (CNC, holotype no. 21337). The specimen is in excellent condition and most of the diagnostic features of terminalia are visible without maceration. The type locality is in Kerr County, about 100 kilometers northwest of San Antonio, Texas. Allotype, same collecting data as holotype (CNC). Paratypes. UNITED STATES. Texas: 7 ♂, 12 ♀, same collecting data as holotype (CNC); 3 ♂, Llano Co., Enchanted Rock, Jun (USNM).

Distribution.—This species is known only from southcentral Texas (Fig. 25).

Etymology.—The specific epithet is an arbitrary combination of letters incorporating "sub," Latin for from or somewhat, and "chelata," alluding to the structural similarity between this species and *H. chelata.*

Remarks.—Males of *H. subchelata* resemble those of Palearctic *H. raptoria* Meigen, based solely on Vallaint 1981 (388; Fig. 10) since the type was not examined. However, the former lack peg-like setulae on the epandrial lobe, instead possessing a row of sharp setulae. Unlike males of *H. chelata,* those of *H. subchelata* share with *H. raptoria* the existence of a median basal process on the inner surface of the cercus.

Hemerodromia sufflexa Melander
(Figs. 19, 29)

Hemerodromia empiformis var. *sufflexa* Melander 1947: 248.

Hemerodromia sufflexa: Melander 1965: 470.

Diagnosis.—This species belongs to the *H. empiformis* group. As discussed under *H. empiformis,* males of *H. sufflexa* are distinguished by the shape of the cercus, which is nearly quadrate in lateral view and relatively straight along the apical margin, in contrast to the smoothly triangular cercus on males of *H. empiformis.* Females of the two species are indistinguishable.

Description.—Length including terminalia of male 3.0–3.4 mm. General body color brown. *Head*: black; antenna yellow. *Thorax*: pruinose; scutum and pleura golden brown, scutum with darker median stripe. Fore femur lacking prominent basoventral process (see Fig. 8). *Abdomen*: tergum 7 yellow, remainder brown. Male terminalia (Fig. 19): dark brown; cercus nearly quadrate, apical margin nearly straight; epandrial lobe abruptly expanded at apical ⅓, with row of 4–6 setulae on inner surface past midpoint. Female similar to male; ovipositor well developed.

Type material examined.—Holotype ♂, upper label "Chatcolet/Aug '15 Ida/AL Melander" and lower label "type male" (USNM). The specimen is damaged, but the macerated terminalia are in a glycerin microvial attached to a pin. The type locality is in Benewha County, at the southern tip of Coeur d'Alene Lake, north of the town of St. Maries, Idaho. One ♀ with same data as holotype was labeled "type ♀" (USNM). Syntypes. Idaho: 5 ♂, 11 ♀, Chatcolet, Aug; 2 ♂, 2 ♀, Priest Lk., Aug–Sep (USNM). Washington: 1 ♀, Knightmere, Aug (USNM).

Other specimens examined.—CANADA. British Columbia: 1 ♂, Laird R. Hot Sprs., Aug (CNC). Ontario: 1 ♂, Grand Bend, July; 2 ♂, St. Lawrence Is. Nat. Prk., Aug; 3 ♂, Ottawa, Jun–Jul (CNC); 1 ♂, Orillia, Jul (USNM). Quebec: 1 ♂, Lac Phillippe, Jul (CNC). UNITED STATES. Idaho: 38 ♂, 61 ♀, Kootenai Co., 10 m. N. Harrison, Jul–Aug (WSU). Illinois: 1 ♂, Kankakee St. Prk., Jun; 6 ♂, Muncie, May (INHS). Indiana: 1 ♂, Lafayette, Jul (USNM). Nebraska: 2 ♂, 2 ♀, Cherry Co., Valentine, Jun (USNM). New York: 1 ♂, Ithaca, Sep (USNM). Washington: 2 ♂, Stevens Co., 2 mi SE Deer Lk., Jul (WSU); 1 ♂, Oroville, Aug (CNC).

Distribution.—Males of this species have been collected across the northern United States and southern Canada (Fig. 29).

Hemerodromia superstitiosa Say
(Figs. 7, 10, 26)

Hemerodromia superstitiosa Say 1824: 376.

Hemerodromia vittata Loew 1862: 210. **New synonymy.**

Hemerodromia rogatoris Coquillet 1895: 392. **New synonymy.**

Diagnosis.—Distinctive terminalia separate males from those of *H. ligata,* but females of these two species appear to be indistinguishable. Darkened distal tarsomeres on mid and hind legs separate adults of both of these species from those of *H. oratoria.*

Description.—Length including terminalia of male 3.3–3.5 mm, of female 3.4–4.0 mm. General body color brown. *Head*: black; antenna yellow. *Thorax*: pruinose; male scutum and pleura golden brown, occasionally with either 1 or 2 thin stripes medially on scutum; female scutum and pleura golden brown, with broad, dark brown stripe on scutum medially; scutellum and postnotum of both sexes dark brown. Fore femur (Fig. 7) bearing prominent basoventral process with associated indentation on ventral surface for reception of apical bristle of fore tibia; distal 2 tarsomeres on mid and hind leg brown to dark brown. *Abdomen*: terga 1 and 7 of male yellow, remainder brown; abdominal terga 1 of female yellow, remainder brown. Male terminalia (Fig. 10): dark brown; cercus quadrate basally, ending in narrow process that is inturned at tip; epandrial lobe oval basally, strongly narrowed apicodorsally, in-turned at tip. Female similar to male, except for coloration as noted above; ovipositor well developed.

Type material.—Neotype ♂ of *H. superstitiosa,* here designated, labeled "Kilbourne/La. 10 v 47/W. W. Wirth" (USNM). The specimen is in excellent condition and most of the diagnostic features of terminalia are visible without maceration. A neotype is designated because it is not possible to identify *H. superstitiosa* on the basis of Say's description alone. Lectotype ♂ of *H. vittata,* here designated: top label "type 1645"; next label "D. C."; next label "Loew coll."; and, bottom label "vittata n." (MCZ). The specimen is in poor condition, with a collapsed head, no wings, no middle legs, and no hind legs, but the macerated terminalia are intact and preserved in a glycerin microvial attached to the specimen pin. The male designated as Coquillett's type (# 3152) of *H. rogatoris* is in excellent condition, with the following labels: top label "N. Carolina"; next label "Morrison"; next label "collection"; and bottom label "CV Riley".

Specimens examined.—CANADA. Nova Scotia: 1 ♂, Truro, Aug (CU). Ontario: 3 ♂, 5 ♀, Ottawa, Jun–Sep. (CNC, USNM); 1 ♀, Petawawa, Jul (USNM). Quebec: 2 ♀, Farnham, Jul; 1 ♂, Old Chelsea, Aug (CNC). UNITED STATES. Connecticut: 1 ♂, 1 ♀, Redding, Jun–Aug (USNM). Florida: 104 ♀, Columbia Co., Sante Fe R., Jan (FSCA); 1 ♂, Crescent City, Jun (USNM). Illinois: 1 ♂, Kempsville, Jun (INHS); 2 ♂, 2 ♀, 15 mi SSW Joliet, Jun (UKL). Indiana: 6 ♂, 3 ♀, W. Lafayette, Jun–Sep (MAC, USNM); 37 ♂, 21 ♀, White Co., 5 mi E. Brookston, Jul (MAC). Kansas: 1 ♀, Manhattan, Jul (USNM). Maryland: 10 ♂, 19 ♀, Wash. D. C. area, Sep (CNC, USNM). Michigan: 1 ♂, Osceola Co., Jun (CNC); 5 ♂, 3 ♀, Brevort, Aug; 1 ♂, E. Lansing, Sep; 1 ♂, Monroe, May (USNM). New York: 1 ♀, Erie Co., 1 ♀, Ithaca, Aug; 1 ♂, 3 ♀, Niagara, Jul (USNM). Ohio: 2 ♂, Maumee, Jul (USNM). Pennsylvania: 2 ♂, Benvenue, Jun (CAS). Tennessee: 1 ♂, Memphis, Jul (USNM). Virginia: 3 ♂, 6 ♀, Great Falls, Jun; 1 ♀, Stubblefield Fall, Jul (USNM); Wisconsin: 1 ♀, Milwaukee Co. (USNM).

Distribution.—This species is distributed in the eastern United States and southeastern Canada (Fig. 26).

Remarks.—This species was described on the basis of a female by Say (1824). The concept of the male of *H. superstitiosa* first appeared with an illustration of terminalia in Melander (1947), and Melander's concept of *H. superstitiosa* is adopted here, although Say's original female description could apply to both *H. empiformis* and *H. sufflexa.*

Loew (1862) described *H. vittata* on the basis of a male, with the first illustration of terminalia appearing in Melander (1947; Figs. 17, 18). Examination of Loew's intact type male (MCZ type no. 1645) revealed initial similarly to Melander's (1947) concept of the male of *H. superstitiosa* in terms of both terminalia and the foreleg. Subsequent maceration of Loew's male type revealed terminalia identical to those of *H. superstitiosa* (sensu Melander 1947), including the missing tip of the right epandrial lobe, which explains the structure shown in figs. 17 and 18 of Melander (1947). Melander apparently examined and illustrated the terminalia of Loew's type, but did not recognize it as being identical to his concept of *H. superstitiosa.* Based on identical male terminalia, *H. vittata* of

Loew (1862) is considered a junior synonym of *H. superstitiosa.*

Coquillett described *H. rogatoris* in 1895, but, as mentioned above under *H. oratoria,* his holotype has terminalia that match exactly those of *H. superstitiosa.* Coquillett (1895) and Melander (1947) had before them males of *H. oratoria,* at least based on their descriptions and figures of terminalia, but the former apparently mislabeled his holotype (USNM type number 3152) and the latter apparently did not examine the specimen.

Labels on specimens in collections report adults of *H. superstitiosa* emerging from streams, on floating vegetation, or in swarms above streams. I have aspirated males and females, together with adults of *H. empiformis,* from the undersides of leaves of small trees overhanging a meter wide, spring-fed stream near Lafayette, Indiana.

Hemerodromia vates Melander
(Figs. 16, 28)

Hemerodromia vates Melander 1947: 252.

Diagnosis.—Males possess distinctive terminalia, including a pair of corkscrew-shaped processes that arise from each epandrial lobe, which are only partially discernible without maceration. Otherwise, males and females are similar to several species of *Hemerodromia* with adults that are relatively small and golden brown.

Description.—Length including terminalia of male ca. 2.4 mm, of female 2.8–3.0 mm. General body color brown. *Head*: black; antenna yellow. *Thorax*: slightly pruinose; scutum and pleura golden brown, scutum with faint to light brown median stripe. Fore femur lacking prominent basoventral process (see Fig. 8). *Abdomen*: tergum 7 yellow, tergum 1 light brown; remainder brown. Male terminalia (Fig. 16): brown; cercus with distal half strongly narrowed, with series of small projections along dorsal margin; epandrial lobe bearing 2 narrow processes apically, each assuming corkscrew appearance in lateral view. Female similar to male; ovipositor well developed.

Type material examined.—Lectotype ♂, here designated, labeled "Kent Conn/16 July '38/A. L. Melander" (USNM). Except for lacking the left wing, the specimen is in good condition and most of the diagnostic features of terminalia are visible without maceration. The type locality is in Litchfield County in extreme west-central Connecticut. Paralectotype. Connecticut: 1 ♂, same collecting data as holotype (USNM).

Other specimens examined.—UNITED STATES. Georgia: 1 ♂, Blackshear, May (CU). Indiana: 1 ♂, Lafayette, Aug (USNM). Louisiana: 1 ♂, Kilbourne, May (USNM). Virginia: 3 ♂, 1 ♀, Great Falls, Jun (USNM).

Distribution.—This species is widely distributed in the eastern United States (Fig. 28).

Remarks.—Males of *H. vates* have terminalia that in part resemble those of *H. acuminata* Collin, described from Bikin in extreme eastern Russia. However, the cercus of males of *H. vates* differs in lacking an apical process, based on figure in Collin (1941) since the type was not examined, and the epandrial lobe is distinct.

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DESCRIPTION OF A PARALECTOTYPE FEMALE OF *AEDES (FINLAYA) NIVEUS* (LUDLOW) (DIPTERA: CULICIDAE)

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Abstract.—A paralectotype female of *Aedes (Finlaya) niveus* (Ludlow) from Oras, Samar, Philippine Islands is described and illustrated.

Key Words: Description, paralectotype, Culicidae, mosquitoes, *Aedes niveus,* vector, filaria, Philippines

The species concept of *Aedes niveus* (Ludlow) 1903 has been confused in the Oriental Region, for example, the so-called "*niveus*" from India (Tewari and Hiriyan 1995) is not conspecific with the type specimens from the Philippines. Ludlow (1903: 139) originally described this species from females collected in Oras, Samar, Philippines, and placed the species in the genus *Stegomyia* Theobald. Ludlow also sent a specimen along with her description of this species to Theobald to be included in his Monograph (Theobald 1903: 139). Edwards (1932: 154) placed this species in the subgenus *Finlaya,* genus *Aedes* Meigen. In a note, Theobald (1903: 140) stated that "A specimen of this very distinct species has been presented to the Museum by the describer.—F.V.T." Barraud (1934: 208) reported this same female specimen in the British Museum as the type and the other females in the National Museum of Natural History, Smithsonian Institution (USNM) as "paratypes or cotypes." Ludlow (1903) in her original description did not designate a holotype and did not mention the exact number of specimens. Knight (1946: 278) reported "Female lectotype in Brit. Mus.; lectoparatypes (all females) in U.S. Nat. Mus." In a taxonomic discussion, however, Knight (1946: 278) stated that "This specimen was designated as type (lectotype) by Barraud (1934). A series of three females bearing red type labels (Type No. 27792) exist[s] in the U.S. National Museum."

We have examined the lectotype female of *Ae. niveus* (Ludlow). This specimen (Oras, Samar, Philippine Is., Cat. Ludlow/ Stegomyia nivea, Type, Ludlow/LECTOTYPE (small circular white label with a blue border), in The Natural History Museum (NHM), London, unfortunately is in a very bad condition: antenna missing; scutum broken; postpronotum badly damaged; foreleg (right side) missing, foreleg (left side) with tarsomeres 2–5 missing; midleg (right side) missing, midleg (left side) with tibia and tarsomeres 1–5 missing; hindleg (right side) with tarsomeres 2–5 missing, hindleg (left side) missing.

While preparing a computerized key to the vector species of mosquitoes in the Oriental Region, we found among specimens from the Philippines in the USNM a female bearing the labels: (1). Type No. 27792, U.S.N.M. [red type label] and (2). Stegomyia nivea Ludlow, Oras, Samar, P. I., May–June, C S L., Type (handwritten). This female, the paralectotype of *niveus* (Ludlow) 1903 from Oras, Samar, Philippine Islands, is one of the three females bearing red type labels (Type No. 27792) that exists in the USNM as reported by Knight (1946). Presently, three females are in the USNM; each bears the red type label "Type No. 27792, U.S.N.M.", and one of these bears the additional label "Stegomyia nivea Ludlow, Oras, Samar, P.I., May–June, C S L., Type (handwritten). This female is in rather good condition. Based on a detailed morphological and comparative study of the lectotype and paralectotype, this female specimen (paralectotype) is conspecific with the lectotype female. Neither the lectotype nor the paralectotype of this species has been described in detail. For example, Ludlow (1903) wrote in her original description of *Stegomyia nivea* regarding the type specimens, "Thorax: . . . ; pleurae dark brown, with silvery spots." Moreover, the lectotype female was badly damaged particularly on the pleuron of thorax which possesses some rather important diagnostic characters. It is thus desirable to give a full description of the paralectotype female so that the identity of Ludlow's *niveus* will no longer remain in doubt.

The terminology follows Harbach and Knight (1980, 1982), with the exception of "tarsal claws," which is retained for "ungues." The venational terms follow those of Belkin (1962).

Aedes (*Finlaya*) *niveus* (Ludlow)
(Fig. 1)

Stegomyia nivea Ludlow 1903: 139 (F). Type locality: Oras, Samar, Philippine Islands, May–June, 1902.

Paralectotype female/Type No. 27792, U.S.N.M. (red type label)/Stegomyia nivea Ludlow, Oras, Samar, P. I. May–June, C S L., Type (handwritten). Deposited in the USNM.

Female.—*Head:* Proboscis dark-scaled, without pale scales on ventral surface, longer than forefemur; maxillary palpus 0.21 length of proboscis, dark; pedicel with few fine, short, hair-like setae on mesal side; antenna missing; clypeus bare; occiput with few erect forked scales; row of broad white scales around eye margins; vertex with all broad, flat, dark scales. *Thorax* (Figs. 1A, B): Scutum with narrow white (silvery) scales, from anterior promontory, reaching to level of wing root, on anterior two-thirds of scutum, with narrow dark scales on posterior one-thirds of scutum (some of these scales were rubbed off); no white scales present around prescutellar area; acrostichal and dorsocentral setae absent; scutellum with broad dark scales on all lobes; antepronotum with broad white scales; postpronotum with broad dark scales along upper margin of postpronotum (lectotype female has 3 broad dark scales on upper posterior corner and 1 broad dark scale on upper middle area of postpronotum, most of scales apparently rubbed off); paratergite without scales; postspiracular setae present; hypostigmal area and subspiracular area without scales; postprocoxal membrane without scales; patches of broad white scales on propleuron, lower prealar area, upper and lower portions of mesokatepisternum, and on mesepimeron; upper mesokatepisternal scale patch reaching to anterior corner of mesokatepisternum; upper mesepimeral scale patch connected with lower mesepimeral scale patch; lower mesepimeron without setae; metameron and mesopostnotum bare. *Wing:* With dark scales on all veins; cell R_2 1.30–1.34 length of vein R_{2+3}. *Halter:* With dark scales. *Legs* (Fig. 1C): Coxae with patches of white scales; forefemur anteriorly dark without a narrow white longitudinal stripe on ventral surface in basal area; midfemur anteriorly dark without a large, median white spot; hindfemur anteriorly with a broad, white longitudinal stripe in basal 0.82; fore-, mid- and hindtibiae all dark; forelegs with tarsomeres 1–4 all dark, tarsomere 5 missing; midleg (right side) with tarsomeres 1–5 all

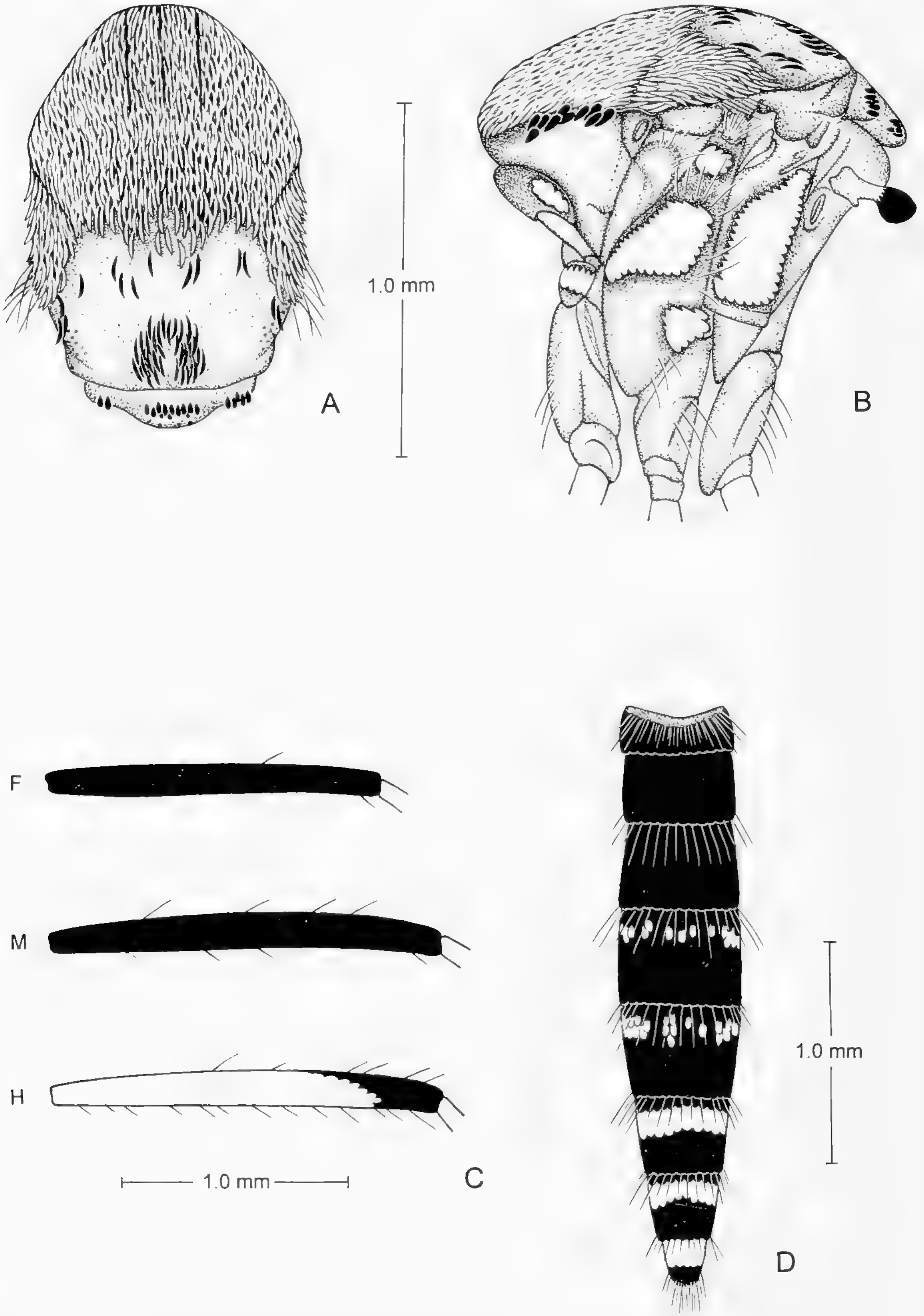

Fig. 1. *Aedes* (*Finlaya*) *niveus*, paralectotype female. A, Dorsal aspect of thorax. B, Lateral aspect of thorax. C, Anterior surface of legs (fore-, mid- and hindfemora). D, Dorsal aspect of abdomen.

dark, midleg (left side) with tarsomeres 2–5 missing; hindleg (right side) with tarsomeres 2–5 missing, hindleg (left side) missing; fore-, mid- and hindtarsal claws missing. *Abdomen* (Fig. 1D): Tergum I with white scales on laterotergite; terga II, III with basolateral white spots only; terga IV, V with incomplete subbasal white band and basolateral white spots; terga VI, VII with complete subbasal white band and basolateral white spots which connect with the subbasal white band; tergum VIII with broad basal white band; sternum VIII without scales and strongly compressed laterally.

Remarks.—*Aedes niveus* is presently known from the Philippines. Other records of so-called "*niveus*" will require confirmation. Rozeboom and Cabrera (1964: 18) reported that *Aedes* (*Finlaya*) *niveus* (Ludlow) is probably a vector of *Wucherria bancrofti* (Cobbold) filaria in the Philippines.

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NOTE

Brachystegus decoratus (Turner) (Hymenoptera: Sphecidae), an Indian wasp new to Sri Lanka

In my revision of the Sri Lankan Nyssoninae (1985. Smithsonian Contributions to Zoology 414, 43 pp.) I reported that the Indian *B. dubitatus* (Turner) and *B. basalis* (Smith) occurred in Sri Lanka and suggested that other Indian species might be found subsequently.

While in Sri Lanka during 1997 I had an opportunity to examine the Hymenoptera collected in paddy fields by Channa Bambaradeniya. He is working on his doctorate in the University of Peradeniya and is studying the biodiversity in a paddy field ecosystem.

Among his hymenopterans was a female of *Brachystegus decoratus* (Turner), a species described in *Nysson* from a pair collected in Coimbatore, Madras State, India (1914. Annals and Magazine of Natural History (8)14: 254). Bambaradeniya collected the Sri Lankan specimen at Batalagoda, Kurunegala District on 20 June 1996. He was using a sweep net to collect insects from the bund covered with weeds during the period when the paddy field was flooded and the plants were in the early reproductive stage. He did not note any wasps digging in the soil of the bund, but at other times had seen wasps entering holes or crevices in the soil.

Brachystegus decoratus runs to couplet 6 in my key to species (1985) which separated *B. dubitatus* and *B. basalis*. The following modified key will separate the three species.

6a. Basal two-thirds of second abdominal tergum with much of surface covered with small punctures separated by half a puncture diameter among which are interspersed larger punctures separated by more than a puncture diameter; paired pale posterolateral spots on abdominal terga 1–4 (and 5 in ♂) white to creamy yellow and separated from each other by the width of the spot or more .... *B. basalis* (Smith)

– Basal two-thirds of second abdominal tergum with most of surface covered by small, subcontiguous punctures and only a few scattered, larger punctures; paired pale posterolateral spots on abdominal terga 1–5 bright yellow and separated from each other by less than the width of the spot 6b

6b. Wings infuscated; integument black except a pair of small yellow spots behind ocelli and paired yellow spots on abdominal terga 1–5, markings on terga laterally covering most of dorsum of terga 1 and 2; base of dorsal surface of abdominal tergum 1 densely silvery tomentose .... *B. decoratus* (Turner)

– Wings hyaline except apex of forewing narrowly and anterior third of marginal cell infumated; legs and base of first abdominal segment light red; paired yellow markings on abdominal terga 1–5 more separated and narrower, covering only half or less of dorsum; base of dorsal surface of abdominal tergum 1 with thin silvery tomentum .. .. *B. dubitatus* (Turner)

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NOTE

Alveotingis grossocerata Osborn and Drake (Hemiptera: Tingidae): First Host Records of a Rarely Collected Lace Bug

Lace bugs most familiar to entomologists tend to be species that feed on the lower surfaces of tree and shrub leaves, often causing substantial chlorosis. Members of the well-known genus *Corythucha* Stål feed in this manner. Not all North American lace bugs, however, have such habits. Exceptions include the mainly stem-feeding and infrequently collected *Melanorhopala clavata* (Stål) on goldenrod (*Solidago* spp.) (personal observation) and *M. froeschneri* Henry and Wheeler on trumpet-creeper (*Campsis radicans* (L.) Seem. ex Bureau (Henry and Wheeler 1986. Journal of the New York Entomological Society 94: 235–244). Certain herb-associated lace bugs, such as *Hesperotingis illinoiensis* Drake on *Penstemon* spp., feed primarily on basal leaves that can be obscured by other vegetation or by litter (Wheeler 1994. Proceedings of the Entomological Society of Washington 96: 533–536); such species, and any chlorosis they cause, are not readily noticed on their hosts. McAtee (1923. Proceedings of the Entomological Society of Washington 25: 143–151) noted that rarely collected tingids afford collectors the opportunity to discover host-plant relationships and to add other new biological information.

Alveotingis grossocerata is a seldom-collected, poorly known lace bug of distinctive habitus. This broadly oval, or ovoid, strongly convex species is grayish or dark brown, with the hemelytra a shining brown or black, the antennae stout or swollen, and the areolae whitish; the long, clavate third antennomere is covered with coarse, black setae. Both macropterous (3.4 mm long) and brachypterous (about 2.8 mm) forms are known, the coleopteroid, short-winged form being more often collected (Blatchley 1926. Heteroptera of Eastern North America, Nature Publishing, Indianapolis. 1116 pp.; Torre-Bueno 1931. Bulletin of the Brooklyn Entomological Society 26: 149). The coleopteroid form is illustrated by Drake and Davis (1960. Entomologica Americana 39: 1–200).

Described from a specimen collected in Maine in 1913 (Osborn and Drake 1916. Ohio Biological Survey Bulletin 8(Vol.2,No.4): 217–251), *A. grossocerata* has since been reported from Connecticut, Kansas, Massachusetts, New Hampshire, New York, and Pennsylvania (Froeschner 1988. pp. 708–733. *In* Henry, T.J. and R.C. Froeschner, eds., Catalog of the Heteroptera, or True Bugs, of Canada and the Continental United States. Brill, Leiden). The Iowa record of Slater and Baranowski (1978. How to Know the True Bugs. W.C. Brown, Dubuque, Iowa, 256 pp.) likely pertains to *A. brevicornis* Osborn and Drake or to *A. minor* Osborn and Drake, both of which were described from that state (Osborn and Drake 1917. Ohio Journal of Science 17: 295–307). The only available information on the bionomics of this tingid consists of its collection from a rock on a Massachusetts lake shore, from a thistle in New York, and from grass by sweeping in Connecticut (Bailey 1951. Entomologica Americana 31: 1–140).

I became aware of *A. grossocerata* in 1994 during fieldwork with T.J. Henry and I.M. Kerzhner in Rockingham Co., Virginia. The latter heteropterist found an adult on the ground near a colony of pussytoes (*Antennaria* sp.; Asteraceae) on a dry shale slope. Our immediate search of *Antennaria* at this site yielded eight additional adults and two nymphs, and I collected additional specimens there later that year. To determine if other populations of this lace bug use *Antennaria* spp. as hosts, I sampled pussytoes in five other mid-Appalachian shale barrens and shale outcrops, with the following positive results.

Collection records.—MARYLAND: Washington Co., Sideling Hill Wildlife Management Area, Boy Scout shale barren, E. of Little Orleans, 12 June & 2 July 1994, AGW (2 adults). VIRGINIA: Rockingham Co., George Washington National Forest, For. Service Rd. 87 W. of Fulks Run, 11 June, 25 June, & 6 Aug. 1994, AGW (16 adults, 3 nymphs); Shenandoah Co., Short Mountain shale barren, SE of Mount Jackson, 7 Aug. 1994, AGW (2 adults).

Maryland and Virginia are new state records for *A. grossocerata*. Voucher specimens are deposited in the National Museum of Natural History, Smithsonian Institution, Washington, D.C.

All adults found at the three sites were brachypters. Nymphs and most adults were collected on shale barren pussytoes (*Antennaria virginica* Stebbins) at the Rockingham Co., Va., site; several adults might have been on foliage of co-occurring plantain pussytoes (*A. plantaginifolia* (L.) Richardson). *Antennaria virginica* was the host at the other two sites. Only slight chlorosis was seen on upper surfaces of infested leaves. The presence of last-instar nymphs on 11 June and 6 August suggests that this lace bug is bivoltine.

Alveotingis grossocerata might be restricted to developing on *Antennaria* spp. or other genera of the composite tribe Inuleae. Although it is a wide-ranging species that has been found in nonshale habitats, this tingid seems characteristic of mid-Appalachian shale barrens. Discovery of its host plants should facilitate the accumulation of additional biological information. Yet even with the knowledge that *Antennaria* spp. serve as hosts, *A. grossocerata* is difficult to collect or observe in colonies of these stoloniferous, mat-forming herbs with spreading, rather than erect, basal leaves.

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BOOK REVIEW

Contributions to a Manual of Palaearctic Diptera (with special reference to flies of economic importance), Vol 2, Nematocera and Lower Brachycera. László Papp and Béla Darvas, eds. Science Herald, Budapest. 1997. 592 pp. ISBN 963 04 8837 X (Volume 2).

This book contains generic keys to 38 families of Nematocera and lower Brachycera by 23 authors. It is the first volume to appear of a projected three-volume work. Volume 1, scheduled for 1999, will contain chapters on general and applied Dipterology, and volume 3, expected in 1998, the higher Brachycera. In the introduction to the present volume, the editors relate a sad history of the enterprise. Originally conceived in 1992 as a project similar to that of the *Manual of Nearctic Diptera* (1981–1989, Vols. 1–3, Research Branch, Agriculture Canada Monographs Nos. 27, 28, and 32), the project was stalled by various financial problems and author delay or unresponsiveness. At the beginning of 1997, it was thought best to publish what could be made available for the projected volume 2, evidently the reason for the addition of "Contributions to a" in the title.

The 38 chapters represent most of the smaller families of Nematocera and lower Brachycera. Notable for their absence are some large families, Tipulidae, Mycetophilidae (old sense, now considered as five separate families), and Chironomidae. The chapters appear well illustrated. Family treatments range from 6 to 134 pages with Cecidomyiidae by far the longest, the next longest being the Stratiomyidae and Bombyliidae, each with 26 pages.

The family chapters were originally meant to treat the following topics: general remarks; adult, larval, and pupal descriptions; biology and behaviour; classification and distribution; keys to genera of adults and larvae; species of economic importance; morphology and life habits; and references. The authors were allowed to determine the contents and emphasis of their chapters, so, as the editors acknowledge, the chapters are not as uniform or well-balanced as the *Manual of Nearctic Diptera.*

I have had experience with three of the families treated here, so will confine my further comments to those, the Scatopsidae, Sciaridae, and Cecidomyiidae.

The chapter on Scatopsidae is authored by Jean-Paul Haenni. The introductory sections are well written and authoritative. His descriptions use the terminology employed consistently throughout the *Manual of Nearctic Diptera* and generally used at least in North America as a lingua franca for dipterology. An exception is his use in the key of segments when numbering flagellomeres. The chapter structure conforms closely to the format listed above and the discussions are thorough and informative. The key to adults is fine, and a partial key to larvae is also provided. Below each generic name is given the number of species, the range of the genus, and the best reference or references. Many of the figures are redrawn from the article by E.F. Cook in the *Manual of Nearctic Diptera* and are so attributed.

Frank Menzel and Werner Mohrig authored the Sciaridae chapter. Here these flies are called black midges: in North America we call them black fungus gnats. This is a remarkably well known group in the Palaearctic Region. The 782 known species are grouped into only 25 genera (the largest genus, *Bradysia,* has 245 species), and these species make up 60% of the known world fauna. The authors use anatomical terminology peculiar to sciarid workers and occasionally give equivalents used in the *Manual of Nearctic Diptera,* but they regard flagellomeres as segments. Their description of classification is a masterful, up-to-date review. The key, to adults only, works well, but we are not told why four genera that are listed under the first half of couplet 16 are not distinguished further. The individual generic names are followed by the number of Palaearctic species and the type species, but this is not as helpful as the information given in the Haenni chapter. The accompanying figures are effective. When figures are borrowed from other works, attribution is given. The chapter does not have a section on economic importance.

The Cecidomyiidae chapter is authored by Marcela Skuhravá. This family is the largest treated in the book, with some 300 genera for possibly 3000 species that are still for the most part not well known. Unlike the Scatopsidae and Sciaridae chapters, this chapter is of poor quality. It appears not even to have received the benefit of review. The introductory sections are unhelpful and, although the book has "economic importance" in its title, the opportunity for a discussion on that topic is not taken here. The key, to adults only, works poorly and is incomplete and retrograde. Superimposed over it is an outdated classification that ignores important literature of the last 30 years. Many of the 297 figures are recognizable from other works but not attributed, and at least some are redrawn inexactly. This is a lost opportunity for a workable, modern key to the Palaearctic genera of Cecidomyiidae.

Anatomical terminology is inconsistent and the descriptions imprecise. The terms flagellomeres, flagellar segments, and antennal segments are all used. In the introductory section the author states that larvae "usually [have] three, but also four or even five larval instars," but I know of no reliable report of more than three larval instars in cecidomyiids. Examples of error or imprecision in the general discussion are that Cecidomyiidae categorically have "normal or produced" mouthparts, "very short" pulvilli, "usually long" ovipositors, a pair of "short, broad" wings, and "usually a pupa of the mummiform type."

The keys are poorly expressed, simplistic, and confusing. Couplet pairs are often not mutually exclusive. While one operative character may be given in one half of a couplet, the other half may have several not necessarily exclusive characters. Other couplets feature such choices as, "palpi 2 segmented" versus "palpi 1 or 2 segmented" (couplet 21, p. 136), or "R5 almost straight, joining costa almost before wing apex" versus "R5 straight, joining costa at wing apex" (couplet 14, p. 142). Much use is made of superficial characters such as the foregoing and peculiarities of the antennae, but none made of the more diagnostic nongenitalic abdominal characters used in other recent keys (cf. *Manual of Nearctic Diptera*) or even host data.

The key is not comprehensive or up-to-date. None of Z.A. Fedotova's 36 genera described from Kazakhstan and Turkestan from 1984 to 1997 is present. In a note at the top of p. 121, Skuhravá dismisses Möhn's exemplary work leading to the synonymy of 6 genera of Lasiopterini (Möhn 1971, Cecidomyiidae (Itonididae). Vol. 2(2), part 6. L: 201–248. In E. Lindner (ed.), *Die Fliegen der Palaearktischen Region*. Schweizerbart'sche Verlagsbuchhandlung, Stuttgart). Möhn effectively used larval characters to make sense of a monophyletic group of Old World species that occur on Chenopodiaceae and that had been distinguished chiefly by their bizarre female cerci. Skuhravá resurrects those genera, which will break down as soon as one goes beyond their type species. None of the innovations in supertribal and tribal classification in Gagné (1994, *The Gall Midges of the Neotropical Region*. Cornell University Press, Ithaca, New York. xv and 352 pp.) is used or even mentioned, even though they bear directly on this key. In her introduction, Skuhravá states, "I use a practical concept of system with categories of earlier authors . . .," and "such grouping is not necessarily in accordance with phylogenetic consideration but seems very useful for the purpose." An artificial key is fine if effective, but it is not correct to superimpose a classification on the results. Her tribes Monodiplosini, Coquillettomyiini, and Polystephini are not natural groups. *Endaphis,* a lestodiplosine, keys with the Cecidomyiini without comment, *Mikiola* with the Brachineurini, and *Trotteria* with the Lasiopterini. Buried and unlamented junior synonyms are resurrected without explanation: *Spaniocera, Lasiopteryx,* even *Therodiplosis,* which she distinguishes from *Feltiella* even though the two share the same type species (cf. Gagné 1995, Ann. Entomol. Soc. Am. 88: 16–30). *Allocontarinia* is considered a genus even though its senior subjective synonym is subsumed in this key under *Contarinia.*

In contrast to the other chapters that offer consistent generic information, here, in addition to the number of species, major area of distribution, and best references, we are in many cases additionally given the name of one or more species, sometimes their host(s), a more specific area of distribution, even synonyms of species and genera. These data add to the interest, but two genera ending in the same couplet may be treated dissimilarly.

I point out here for the taxonomic record that the author proposes new names for two preoccupied generic names: *Harmandiola* for *Harmandia* (p. 166; preoccupied by Rochebrune (Mollusca)), and *Silvestriola* for *Silvestrina* (p. 170; preoccupied by Prewer (Protozoa)).

It would appear that the editors were too rushed in the production of this volume to insure a consistently high standard of quality. It is to be hoped that in the volumes that follow, the editors will become sufficiently personally involved with each chapter to submit it to outside review for both content and English and take a heavier hand in planning and setting the standards for the contents.

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SOCIETY MEETINGS

1025th Regular Meeting—January 8, 1998

With three quick but powerful strokes of the gavel, the 1025th regular meeting of the Entomological Society of Washington (ESW) was called to order at exactly 7:30 pm, not a second before, not a second after, by President Warren Steiner, in the lovely-as-always Waldo Schmidt Room of the National Museum of Natural History, Washington, D.C. Thirteen members and 5 guests sat in eager anticipation of the evening's entertainment . . . and refreshments. Any hope of an early exit were immediately dashed by John Brown's laborious reading of the minutes—what probably was 7–8 minutes seemed like an hour. Before their final approval, the minutes received the disapproval of Chris Thompson, who indicated that there was no need to include the reports of the committees, so on and so forth. After a brief discussion, the minutes were approved with minor modification.

President Steiner asked for reports from the committees. John Brown, Membership Chair, read the names of 5 new applicants for membership in ESW: Bohdan Bilyj, Brian Rayburn, Cristiane Vieira de Assis Pujol-Luz, Jose Roberto Pujol-Luz, and Eric Metzler. The only new member present, Eric Metzler, stood up and was identified (*Homo sapiens,* I believe). Eric will be the guest speaker at the February meeting.

President Steiner announced that all surplus publications of ESW will be moved from the museum to Beltsville on 13 January, where they will be sorted for various means of disposal or disposition. Steiner's solicitation for volunteer assistance appeared to fall on deaf ears.

On a more serious note, President Steiner reported the tragic death of 27-year old Virginia Crouch, a local botanist and vice-president elect of the Botanical Society of Washington. He indicated that a research fund has been established in her name, administered by The Nature Conservancy, and suggested that ESW make a contribution. There was no further discussion.

The show-and-tell portion of the meeting included 2 books on dead dipterists brought in by Chris Thompson; 2 entomological calendars and an ESA tee-shirt shared by David Furth; and a lovely rendition of the ever popular tune "Lepidoptera" from the newly released cassette entitled "Mothrock! The Soundtrack of Mothra! The Rock Musical," contributed by Gabriella Chavarría.

In his inimitable style, David Furth punned his way through an introduction of Dr. M. Alma Solis, our immediate past president and the speaker for the evening. Dr. Solis' multimedia talk touched on a variety of topics related to the lepidopterous superfamily Pyraloidea—species richness, morphological diversity, phylogeny, biogeography, and field work in Mexico. Her talk addressed two intriguing scientific questions: 1) What is a pyraloid moss (= moth); and 2) How did she become interested in these little buggers. Her presentation concluded with 2 videos, one a newsy report focused on outdoor, hands-on education being conducted at a research station in Tamaulipas, Mexico, and the other a video produced for the O. Orkin Insect Zoo, starring that famous Smithsonian entomologist Jonathan Coddington. The latter is available to teachers free-of-charge, the video, that is.

Two visitors were introduced: Gene Rosenberg, a botanist with SI, and Andrew Mitchell, a graduate student at the University of Maryland. Refreshments were provided by Jil Swearingen, and David Furth volunteered to provide refreshments for the February meeting.

The meeting was adjourned at 8:51, without incident.

Irreverently submitted,
John W. Brown,
acting Recording Secretary

1026th Regular Meeting—February 5, 1998

The 1026th regular meeting of the Entomological Society of Washington (ESW) was called to order at 7:37 pm by President Warren Steiner, in the Waldo Schmidt Room of the National Museum of Natural History, Washington, D.C. Eleven members and one guest attended. John Brown's brief and entertaining minutes from the 1025th Regular Meeting were read by Stuart McKamey and approved with minor modification.

President Steiner asked for reports from the committees. John Brown, Membership Chair, read the name of the single new applicant for membership in ESW: Nayeem Hoq. There were no new members. Ronald Ochoa was introduced as a guest.

In miscellaneous business, President Steiner described the January 13th culling day for ESW publications as a great success. Eight volunteers compiled 20 complete sets of back issues, whittling down a roomful of ancient publications to a couple of cabinets' worth. He extended special thanks to all participants. President Steiner then announced that Andy Jensen and Gary Miller are calling for a meeting to discuss archiving of back issues onto CD ROM, as the earlier issues are flaking from acidity and brittleness.

Several books were exhibited by David Furth: a 1997, 2-volume set on the insects of the Three Gorge Reservoir, Yangtze River, constituting a survey in this area destined for flooding; two new books in Spanish from Venezuela, one on exoskeletal morphology of insects and the other a guide to Venezuelan scorpions; and a monograph of Noctuinae of Europe. Furth also announced the availability of 10–12 handsome custom cabinets from the Smithsonian, remaining after the accession of over 41 such cabinets of butterflies. Manya Stoetzel passed around two newspaper clippings that appeared from January 29th to February 1st that describe the exploits of Ralph Eckerlin, a past president of ESW. Ed Saugstad passed around a Phoenician silver coin dating 130 BC and bearing the image of a bee. M. Alma Solis exhibited the book "Caterpillars of Eastern Forests," a new publication freely available from the USDA.

David Furth introduced the speaker of the evening, Eric Metzler, co-founder of the Ohio Lepidopterists Society. True to the talk title, Eric gave an account of the "Activities of the Ohio Lepidopterists Society." The Society, with 360 members nationwide, was founded in 1979. Since then, they have developed into a standard for similar societies to follow, though they are too humble to suggest that themselves. For the members, they sell entomology books and supplies wholesale, organize collecting trips, and have Identification Days, when everybody brings their unknowns and shares their own expertise with others. The Ohio Lepidopterists Society has achieved a synergism of lepidopterists, effective outreach to the public and liaisons with government and private businesses, and established accountability through concrete scientific contributions for basic research and conservation, including two monographic publications to date: "Butterflies and Skippers of Ohio" and "The Owlet Moths of Ohio." They are currently working on a number of additional publications, for example an annotated state list of Lepidoptera, drawn in large part from their extensive collecting around the state. Their database contains over 100,000 records and shows regional patterns not otherwise apparent, yet relevant to conservation management. The keys to their success are patience and accountability; the rewards include permission and funds to conduct research on endangered Lepidoptera, conservation and restoration of Lepidoptera-producing meadows, and a burgeoning population of immature, though wise for their age, Ohio lepidopterists.

The meeting was adjourned at 8:35. Refreshments were provided by David Furth and enjoyed by the rest of us.

Respectfully submitted,
Stuart H. McKamey,
Recording Secretary

1027th Regular Meeting—March 5, 1998

With the familiar sound of gavel striking podium, the resonating thump of wood to wood, quieting the restless crowd, the 1027th regular meeting of the Entomological Society of Washington (ESW) was called to order at 7:38 pm by President Warren Steiner, uncharacteristically clad in closed-toed shoes—it must be winter. As usual, the meeting was held in the Waldo Schmidt Room of the National Museum of Natural History, Washington, D.C. A good turn-out, including 15 members and 11 guests, was in attendance. Stu McKamey's minutes of the February meeting were read by John Brown. They received no comments, motions, or need for approval.

President Steiner asked for reports from the committees. John Brown, Membership Chair, read the name of one new applicant for membership received in February: Dr. Ronald Ochoa, a new acarologist with SEL shamed into joining at the last meeting. President Steiner announced that the annual banquet of the ESW will be held 11 June 1998 at the same location as last year's (Bethesda, MD). The speaker will be John Acorn, the entertaining host of a Canadian television program featuring natural history. Steiner also announced a vacancy in the position of Honorary President of the Society, owing to the death of Kurt Sabrosky, and solicited nominations for the position.

The notes-and-exhibits part of the show featured Don Davis, sharing a specimen of a non-descript species of *Harmaclona,* along with a reprint of his recent monographic treatment of the Harmacloninae. Alma Solis, determined to fill the void of Furth's absence, shared four books: 1) The Microlepidoptera of Europe—Pterophoridae; 2) The Microlepidoptera of Europe—Scythrididae; 3) Afrotropical Tiger Moths; and 4) Living Butterflies of Southern Africa. Harold Harlan shared a series of small scarab beetles that live in the galleries of termites; Steiner provided brief additional comments on the beetle.

In Furth's conspicuous absence, President Steiner introduced the speaker for the evening, Dr. James Liebher, a professor in the Department of Entomology at Cornell University. The advertised title of Dr. Liebher's talk, "Diversity and Distribution of Hawaiian Insects," was clearly a ruse to attract a large audience—he actually talked about nothing but carabid beetles. Jim showed photographs of apparently inaccessible localities and described "helicopter collecting." His talk focused on a single tribe of carabid beetles that includes about 130 species, all of which are endemic to Hawaii, another remarkable case of monophyletic radiation on the islands. He presented a cladistic analysis of the group based primarily on male and female genitalia, followed by analyses of biogeography (including one-way dispersal patterns), cladistic patterns of brachyptery, patterns of rarity, and patterns of habitat breadth, most of which could be explained by phylogenetic relationships among taxa. Questions were asked until the audience grew quiet from exhaustion.

Three visitors introduced themselves. President Steiner asked for a volunteer to provide refreshments for next month's meeting—there were no offers.

The meeting was adjourned at 9:07. Refreshments were provided by Gabriela Chavarría.

Respectfully submitted,
John W. Brown,
acting Recording Secretary

1028th Regular Meeting—April 2, 1998

The 1028th regular meeting of the Entomological Society of Washington (ESW) was called to order at 7:34 pm by President

Warren Steiner, in the Waldo Schmidt Room of the National Museum of Natural History, Washington, D.C. Thirteen members and three guests attended. John Brown's ever-entertaining minutes from the 1027th Regular Meeting were read by Stuart McKamey and approved without modification.

President Steiner asked for reports from the committees. John Brown, Membership Chair, read the name of two new applicants for membership in ESW: Dr. Bradley A. Mullens, an entomology professor at UC Riverside, and Dr. Volker Hollman-Schirrmacher, a Smithsonian postdoc beginning work on ephydrids. There were no new members. Nate Erwin, SI insect zoo manager, and Gene Rosenberg, SI president of the Botanical Society of Washington, were introduced as guests.

President Steiner reminded members of the June 11th banquet featuring nature nut John Acorn. Gene Rosenberg welcomed participation on upcoming botanical society field trips near (Potomac River) and far (Ice Mountain, West Virginia).

Dave Furth exhibited the March 1998 issue of National Geographic with a beautiful spread on beetles, and presented a candidate for consideration for the SI Insect Zoo: a showy cetoniine flower scarab from Israel, rare in the Golan Heights but easily being reared for their own Insect Zoo. Jil Swearingen endeared us to a 0.5 m stuffed ant available at IKEA. President Steiner noted that flying tenebrionids and other fliers are already showing up, corresponding to the early spring.

David Furth introduced Dr. Diane Calabrese, an entomologist-cum-writer/columnist based in Silver Spring, MD. She presented some of her work on Insects in Literature. The tone was more personal than usual for ESW meetings, with Dr. Calabrese asking us to reflect during the hour on which writers reach us, and why. Do these writers incorporate insects? The point being that emotional contact is often evoked from a match in context between writers and readers. Dr. Calabrese proceeded to discuss and recite insect-related selections of various writers of the early 1800's, including Shakespeare and most notably the English poet-Parliamentarian Yeats. It was quite common to incorporate insects, more as aspects of peaceful nature than as pestilence, or to refer to them indirectly as in Yeats metaphor "Wisdom is a butterfly." To an entomologist reading Yeats, his close observation and love of insects is apparent as a source of inspiration. The literary evening was nicely rounded off by a joint recitation by Nate Erwin and Alma Solis of a poem in which a pair of silly conniving gerrid water striders coax naive children into trying to walk on water.

The meeting was adjourned at 8:45. Harold Harlon provided copious refreshments.

Respectfully submitted,
Stuart H. McKamey,
Recording Secretary

1029th Regular Meeting—May 7, 1998

The 1029th regular meeting of the Entomological Society of Washington (ESW) was called to order at 7:30 pm by President Warren Steiner, in the Log Lodge (ARS National Visitor Center) of the Beltsville Agricultural Research Center in Beltsville, MD. Fourteen members and guests attended.

President Steiner announced next month's ESW annual banquet. Mike Schauff had tickets available for sale.

Suzanne Batra exhibited Himalayan bee specimens, and Gabriela Chavarría exhibited jewelry depicting bees. David Furth exhibited the new book on behavioral evolution, "The Handicapped Principal," by Amotz Zahazi.

David Furth introduced Dr. Suzanne W. Batra, of the USDA Agricultural Research Center's Bee Research Laboratory at Beltsville, MD. Her presentation was entitled "Bees of the Garhwal Himalaya." Meeting attendants were given a tour of the cultural and beekeeping practices of that region, where a number of wild *Apis* bee species occur, and discussed her trials while traveling there to study the honey-producing and pollinating bees. The talk was received well.

The meeting was adjourned at 8:40 pm.

Respectfully submitted,
Stuart H. McKamey,
Recording Secretary

1030th Regular Meeting—June 11, 1998

The Annual Banquet of the Entomological Society of Washington (ESW), held jointly with the Entomological Society of Maryland (ESM), was held in the Uniformed Services University of Health Sciences in Bethesda, MD, at 7:00 pm. There were approximately 100 members and guests from the two organizations. After a social hour and delicious meal, the meeting began with introductory remarks by ESW president elect Michael Schauff, ESW president Warren Steiner, and ESM president Fred Paras. The rest of the meeting consisted of the presentation by Canadian TV personality John Acorn (his real name), host of The Nature Nut series. John entertained the audience with his anecdotes from the show's humble beginnings to its current globe-trotting themes, its hits and flops, and fan mail. About one third of his shows focus on insects. His presentation ended with some lively insect-related singing and ukulele playing.

Respectfully submitted,
Stuart H. McKamey,
Recording Secretary

PROC. ENTOMOL. SOC. WASH.
100(4), 1998, pp. 838

OBITUARY
Nicholas A. Kormilev
1901–1998

Nicholas A. Kormilev, born January 29, 1901, in Yalta in the Crimea, died April 22, 1998, in St. Petersburg, Florida.

His early life, due to political unrest and wars and his father's varying military assignments, was rather unsettled. But in 1926 he graduated from the School of Agriculture at the University of Zagreb in Yugoslavia and published his first paper in 1929; in 1947 he moved to Argentina where he was employed by the Museo Argentino de Ciencias Naturales "Bernardino Rivadavia" and the Instituto Nacional de Investigacion de las Ciencias Naturales Museum; in 1957 he came to the United States and worked at an electric corporation in New York in quality control and production of silver-zinc batteries. He retired in 1968 but continued his studies of true bugs.

He published 232 papers containing proposals of nine family-group names, 105 genus-group names, and 1,182 species-group names.

Lists of his publications and proposed taxa can be found in (1) Froeschner, R.C. 1995, Nicholas A. Kormilev: A List of His Entomological Publications and Proposed Taxa. Proceedings of the Entomological Society of Washington, 97: 515–547, and in (2) Polhemus, J.T. 1996, An Overlooked Paper on Heteroptera by N. A. Kormilev. Proceedings of the Entomological Society of Washington, 98: 376.

Richard C. Froeschner, *Department of Entomology, MRC-105, Smithsonian Institution, Washington, D.C. 20560, U.S.A.*

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1998

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PUBLICATIONS FOR SALE BY THE ENTOMOLOGICAL SOCIETY OF WASHINGTON

Miscellaneous Publications

A Handbook of the Families of Nearctic Chalcidoidea (Hymenoptera), by E. Eric Grissell and Michael E. Schauff. 85 pp. 1990	$10.00
A Handbook of the Families of Nearctic Chalcidoidea (Hymenoptera): Second Edition, Revised, by E. Eric Grissell and Michael E. Schauff. 87 pp. 1997	15.00

Memoirs of the Entomological Society of Washington

Memoirs 2, 3, 7, 9, 10, 11, and 13 are no longer available.

No. 1.	The North American Bees of the Genus *Osmia*, by Grace Sandhouse. 167 pp. 1939	$15.00
No. 4.	A Manual of the Chiggers, by G. W. Wharton and H. S. Fuller. 185 pp. 1952	15.00
No. 5.	A Classification of the Siphonaptera of South America, by Phyllis T. Johnson. 298 pp. 1957	15.00
No. 6.	The Female Tabanidae of Japan, Korea and Manchuria, by Wallace P. Murdoch and Hirosi Takahasi. 230 pp. 1969	15.00
No. 8.	The North American Predaceous Midges of the Genus *Palpomyia* Meigen (Diptera: Ceratopogonidae), by W. L. Grogan, Jr. and W. W. Wirth. 125 pp. 1979	12.00
No. 12.	The Holarctic Genera of Mymaridae (Hymenoptera: Chalcidoidae), by Michael E. Schauff. 67 pp. 1984	5.00
No. 14.	Biology and Phylogeny of Curculionoidea, edited by R. S. Anderson and C. H. C. Lyal. 174 pp. 1995	25.00
No. 15.	A Revision of the Genus *Ceratopogon* Meigen (Diptera: Ceratopogonidae), by A. Borkent and W. L. Grogan, Jr. 198 pp. 1995	25.00
No. 16.	The Genera of Beridinae (Diptera: Stratiomyidae), by Norman E. Woodley. 231 pp. 1995	25.00
No. 17.	Contributions on Hymenoptera and Associated Insects, Dedicated to Karl V. Krombein, edited by B. B. Norden and A. S. Menke. 216 pp. 1996	25.00
No. 18.	Contributions on Diptera, Dedicated to Willis W. Wirth, edited by Wayne N. Mathis and William L. Grogan, Jr. 297 pp. 1997	25.00
No. 19.	Monograph of the Stilt Bugs, or Berytidae (Heteroptera), of the Western Hemisphere, by Thomas J. Henry. 149 pp. 1997	18.00
No. 20.	The Genera of Elaphidiini Thomson 1864 (Coleoptera: Cerambycidae), by Steven W. Lingafelter. 118 pp. 1998	12.00
No. 21.	New World *Blepharida* Chevrolat 1836 (Coleoptera: Chrysomelidae: Alticinae), by David G. Furth. 110 pp. 1998	12.00

Back issues of the Proceedings of the Entomological Society of Washington are available at $60.00 per volume to non-members and $25.00 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, MRC 168, Smithsonian Institution, Washington, D.C. 20560.

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