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NOTES ON THE GENUS *CYAMOPS* MELANDER (DIPTERA: PERISCELIDIDAE), INCLUDING DESCRIPTION OF TEN NEW SPECIES

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Abstract.—The species of *Cyamops* Melander are reviewed for five regional faunas, including the description of 10 new species as follows: ***C. funkae*** (Guyana), ***C. nigeriensis*** (Nigeria), ***C. freidbergi*** (Madagascar), ***C. micronesicus*** (Yap), ***C. fiji*** (Fiji), ***C. samoensis*** (American Samoa), ***C. femoratus*** (Philippine Islands), ***C. laos*** (Laos), ***C. banvaneue*** (Laos), ***C. kaplanae*** (Thailand). *Cyamops pectinatus* Khoo is reported from Tasmania. Regional keys are provided for the New World, Afrotropical, Australasian/Oceanian, and Oriental faunas.

Key Words: Diptera, Periscelididae, *Cyamops,* New World, Afrotropical, Australasian/Oceanian, Oriental, Palearctic

The genus *Cyamops* Melander includes 14 valid species: three in the Nearctic Region, five in the Neotropical Region (Baptista and Mathis 1994, 1996), and six in the Australasian Region (Khoo 1985). Since revising the New World species of *Cyamops* (Baptista and Mathis 1994), we (Baptista and Mathis 1996) have described one additional species, *C. sabroskyi,* from specimens collected in Rio de Janeiro, Brazil. When we published our revision of New World species, several new species from localities elsewhere in the world were then known to us, and some of these species had previously been reported (Hennig 1969, Sabrosky 1980). The purpose of this paper is to describe most of the new species and update the existent keys to facilitate identification of all known species of *Cyamops.* The new species that we studied and that are not described in this paper are represented by poorly preserved specimens, frequently a single male.

Methods.—The descriptive terminology, with the exceptions noted in Baptista and Mathis (1994), is that published in the Manual of Nearctic Diptera (McAlpine 1981). As we recently published a complete description for the genus *Cyamops,* the generic characters are not repeated here. The format for species' description likewise adheres to Baptista and Mathis (1994), with the following modifications:

Facial shape: In addition to being sexually dimorphic, two basic facial shapes occur among males of *Cyamops:* 1. Face constricted medially by the anteroventral margin of the eyes, expanding into a triangular region ventrally below the level of the pseudovibrissae and bearing a median ridge that was called the "facial carina" in our first paper. The corresponding female face is trapezoidal below the level of the pseudovibrissa, with a central, large, more elevated area. 2. Face not constricted medially, without a median ridge. The corresponding female face is equally large but has no central, elevated area. These shapes will be cited simply as "face of male narrowed" or "not narrowed."

The structure we called the "hypandrial projection" in our revision will not be used in species descriptions herein, as this structure is apparently unique to the following Neotropical species: *C. halteratus* Sabrosky, *C. nebulosus* Melander, *C. buenorum* Baptista and Mathis, and *C. faciatus* Baptista and Mathis. This structure is mentioned in the revised key, however, as it distinguishes the Neotropical species just noted.

The "Key for the Australasian and Oceanian species of *Cyamops*" was generated using DELTA (Dallwitz et al. 1998). The character states for the Australian species, described by Khoo (1985) and Hennig (1969), were taken from their publications.

Species represented by poorly preserved specimens are noted and are included in an appropriate regional key. Our purpose in providing information on undescribed species is to call attention to character variation and distributional data for future studies on *Cyamops*.

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 were borrowed from and will be deposited in the Bernice P. Bishop Museum (BPBM).

NEOTROPICAL REGION

The new species treated in this section all key to *C. americus* Baptista and Mathis in our "Key to the New World species of *Cyamops* Melander" (Baptista and Mathis 1994) and form a species group that is characterized by the following combination of characters: face of male constricted medially; crossvein bm-cu present, separating cell bm from cell dc. To help identify the new American species discovered since our revision, we have furnished a revised key to the New World species. Species of the genus *Cyamops* that have large geographic distributions, however, demonstrate some variation in the extent of microtomentum and coloration of the legs and wings. Thus, study of characters of the male terminalia is still advisable to determine a species' identity accurately.

KEY TO NEW WORLD SPECIES OF *CYAMOPS*

1\. Anepisternum bare along posterior margin . . . 2
– Anepisternum setose along posterior margin, usually bearing 1 seta and a few setulae . . . 6
2\. Only apical scutellar seta present (United States) . . . . *C. imitatus* Sturtevant
– Apical and basal scutellar setae present 3
3\. Wing hyaline (Canada, United States) . . . . *C. halteratus* Sabrosky
– Wing at least partially infuscate 4
4\. Vein R$_{2+3}$ sinuous; mid- and hindtibiae mostly yellow; scutellar disc slightly convex (eastern Canada and United States) . . . . *C. nebulosus* Melander
– Vein R$_{2+3}$ straight or nearly so; mid- and hindtibiae lightly infuscate to brown; scutellar disc flat 5
5\. Male right surstylus as narrow as left; hypandrial projection large and exposed; 7th and 8th sternites reduced (Brazil) . . . . *C. fasciatus* Baptista and Mathis
– Male right surstylus much broader than left; hypandrial projection of normal length, not large, usually hidden beneath right surstylus; 7th and 8th sternites well developed, fused to 5th sternite (Mexico) . . . . *C. buenorum* Baptista and Mathis
6\. Face of ♂ and ♀ angulate in profile, sloped anteroventrally from base of antenna to vibrissal angle; facial carina lacking in ♂; ♂ frons entirely depressed below insertion of fronto-orbital setae; eye densely microsetulose (Colombia) . . . . *C. colombianus* Baptista and Mathis
– Face of ♂ shallowly and vertically arched, never angulate; facial carina present in ♂; ♂ frons depressed only medially; eye microsetulae sparse, difficult to discern 7
7\. Wing cell R$_{4+5}$ usually completely infuscate, dividing subapical white spot (pale specimens with only traces of brown on the veins around cell R$_{4+5}$); mid- and hindfemora mostly yellow 8
– Wing cell R$_{4+5}$ with a conspicuous, undivided subapical white spot; mid- and hindfemora mostly dark 11
8\. Basal rays of arista not bifurcate; middle portion of hindtibia darkened; postpronotum shiny to subshiny, microtomentose 9

- Basal 3–4 rays of arista bifurcate; hindtibia completely yellow; postpronotum shiny, lacking microtomentum (Costa Rica, Mexico) . . . . *C. americus* Baptista and Mathis

9\. Forefemur brownish dorsally; vertex with a large, shiny spot; surstylus as in Fig. 1 (Guyana) . . . . *C. funkae*, new species

- Forefemur mostly yellow dorsally; vertex entirely subshiny microtomentose or with a tiny shiny spot adjacent to posterior ocellus; surstylus otherwise 10

10\. Hindfemur infuscate on apical 1/6; surstyli very elongate, apical portion concealed below 6th–7th sternite; right surstylus boot-shaped; produced portion of male face ¾ width of 1st flagellomere . . . . *C.* sp. 1

- Hindfemur infuscate on apical ⅓; surstyli not elongate, apex of right surstylus only partially concealed below 6th–7th sternite; right surstylus as in Fig. 7; male face only slightly produced, produced portion of face ¼ width of 1st flagellomere . . . . *C.* sp. 2

11\. Right surstylus with apical margin deeply concave in middle, having a hook-shaped appearance; aedeagal apodeme length equal to length of combined 6th and pregenital tergites (Baptista and Mathis 1996:246, Fig. 1) (Brazil) . . . . *C. sabroskyi* Baptista and Mathis

- Right surstylus with apical margin convoluted, irregular (Baptista and Mathis 1994:24, Fig. 58); aedeagal apodeme very large, length equal to combined length of 5th, 6th, and pregenital tergites (Brazil, Costa Rica, Peru) . . . . *C. neotropicus* Hennig

Cyamops funkae Baptista and Mathis, new species

(Figs. 1–4, 32)

Baptista and Mathis 1996: 247 [misidentified as *C. americus* Baptista and Mathis].

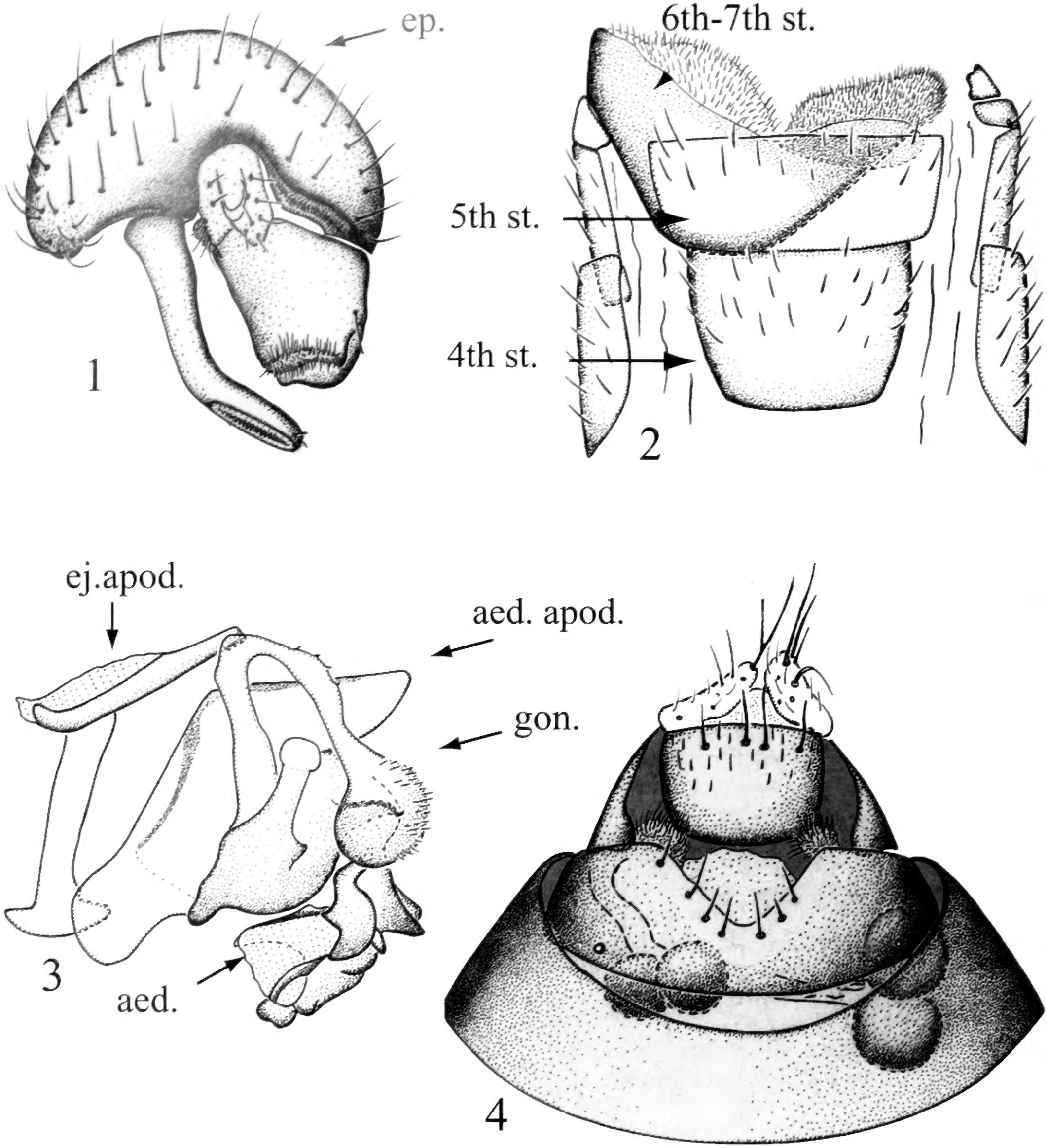
Description.—Adult ♂ length 2.5–2.6 mm; wing length 2.1–2.4 mm; wing width 0.8 mm. Adult ♀ length 3.0 mm; wing length 3.5 mm; wing width 1.0 mm.

Head: Ocellar tubercle polished; vertex with a large shiny spot; remaining frons subshiny, microtomentose, velvet at deepest portion; antenna mostly yellow, infuscate at dorsal margin; facial region intensely whitish microtomentose, brownish dorsally; palpus and labellum mostly white; face in profile sloped ventrally from base of antenna to vibrissal angle, then slightly receded to oral margin, produced portion of face same width as medial portion of 1st flagellomere; eye sparsely microsetulose; arista bearing about 10–12 dorsal, 3 ventral rays, none clearly bifurcate. Chaetotaxy: Inner fronto-orbital setae slightly divergent, almost same length as outer vertical seta; pseudovibrissae divergent, curved dorsally; peristomal setae 7–10, intercalated by a few setulae.

Thorax: Postpronotum sparsely microtomentose; halter mostly white, brown at base; scutellum trapezoidal, orientation of scutellum slightly more elevated than scutum, disc flattened. Chaetotaxy: Dorsocentral setae 0+1, same length as basal scutellar seta; some setulae between dorsocentral and acrostichal rows; setulae of mesonotum short and numerous; scutellar setae 2, basal seta about ⅔ length of apical seta; anepisternum with 2–3 posterior setae. Legs: Mostly yellow; forecoxa pale yellow, whitish microtomentose; midcoxa strongly microtomentose; forefemur mostly brown dorsally; apical ¼ of hindfemur, apical and sometimes subapical tarsomere of each leg brown; hindtibia darkened on central portion; spinelike setulae 5–7, weakly differentiated and difficult to discern. Wing (Fig. 32): Partially hyaline, mostly with dark pattern; cell R_{4+5} usually entirely infuscate, dividing subapical white spot; 1st costal ratio: 1.2–1.37 (wing not slide-mounted); 2nd costal ratio 2.97–3.33 (wing not slide-mounted); wing ratio 2.7–3.5.

Abdomen (Figs. 1–3): All segments subshiny microtomentose; 7th tergite as wide as 6th; 6th–7th sternite as in Fig. 2, setulose along postarior portion. Terminalia (Figs. 1, 3): Left surstylus long, slightly inclinate at apical ⅔, posteroapical portion apparently excavated, although without a true concavity; right surstylus shorter and broader than left; ejaculatory apodeme (Fig. 3) small, almost equal to length of 5th tergite (a little longer than combined 6th and pregenital tergites), in lateral view hatchet shaped, extended process parallel sided, in dorsal view somewhat triangular in shape.

Female: *Head:* First flagellomere with dorsal half and apex brown; mesofacialia



Figs. 1–4. *Cyamops funkae.* 1, Epandrium, cerci, and surstyli, ventral view. 2, Male abdominal segments 4–7, ventral view. 3, Internal male terminalia, lateral view. 4, Female abdomen, segments 6–9, ventral view. Abbreviations: aed. = aedeagus; aed. apod. = aedeagal apodeme; ej. apod. = ejaculatory apodeme; ep. = epandrium; gon. = gonite; st. = sternite.

dark brown, shiny medially; gena light brown to brown in ground color; palpus brown; produced portion of face longer than 1st flagellomere medially; arista bearing 14 dorsal rays.

Thorax: Dorsocentral setulae typically more developed than in males. Legs with base of forecoxa sometimes mostly black.

Abdomen (Fig. 4): Width of 7th tergite about ⅓ that of 6th tergite; 8th sternite apparently fused to 7th sternite, as in Fig. 4, not completely conspicuous, represented by a pair of lateral setulose lobes and a central membranous lobe; 4 spermathecae, rounded, 1 pair slightly smaller than others.

Type material.—The holotype ♂ is labeled "GUYANA. CEIBA (ca.40 km S Georgetown) 06°29.9′N, 58°13.1′W[,] 21 April 1995[,] Wayne N. Mathis/USNM ENT 00134287 [plastic bar code label]/HOLOTYPE ♂ Cyamops funkae Baptista & W.N.Mathis USNM [red; species name, gender symbol, and "Baptista &" handwritten]. The holotype is double mounted (minuten in a block of plastic), is in excellent condition, and is deposited in the USNM. Paratypes are as follows: Same label data as the holotype (2 ♂; USNM; 1 ♂ with abdomen dissected, structures in an attached microvial); same label data as the holotype but with the following changes in dates: 13 Apr 1994 (1 ♀ USNM; abdomen dissected, structures in an attached microvial); 28 Aug 1997 (3 ♂; 1 ♀; USNM).

Distribution.—*Cyamops funkae* is known only from the type locality, CEIBA (06°29.9′N, 58°13.1′W), in Guyana.

Etymology.—The species epithet, *funkae,* is a patronym to honor, recognize, and express appreciation to Dr. Vicki A. Funk, Director of the Biodiversity of the Guianas Program, who supported and encouraged our field work in Guyana.

Remarks.—In our last paper on *Cyamops* (Baptista and Mathis 1996), we misidentified *C. funkae* as *C. americus* and reported Guyana as a new locality for the latter species. The two species are very similar, and care must be taken to distinguish between them. Although the dorsal aristal branches of *C. funkae* are not bifurcate, which seems to be a consistent character, we relied on the structures of the male terminalia to distinguish this species.

The female of *C. funkae* can easily be distinguished from that of *C. americus* by the shape of the 8th sternite, which is apparently reduced to a pair of lateral setose lobes and a well-defined median lobe. Females of *C. americus* have lateral plates without setulae and a membranous median lobe that is less conspicuous. The 7th tergite of the female abdomen is very narrow in *C. americus,* approximately ¼ the width of the preceding tergite, and the spermathecae are elongate, not rounded as in this species. The shape of the 6th-7th sternite and of the surstyli is unique to this species.

Cyamops sp. 1
(Figs. 5–6)

A specimen from Trinidad, representing an undescribed species, can be distinguished from other Neotropical species of *Cyamops* by the characters given in the key. Although we are not naming this species here because the only available specimen is in poor condition, we are providing an illustration of the male terminalia (Figs. 5–6). This species is similar to *C.* sp. 2 (see below) but can be distinguished from it by the characters given in the key. The shape of the right surstylus is boot-shaped and that of the 6th–7th sternite is quite distinctive and apparently unique among species of the genus.

Material examined.—The specimen is labeled "Trinidad 20 Jun [date handwritten] WI/Aug. Busck Collector" (1 ♂; USNM).

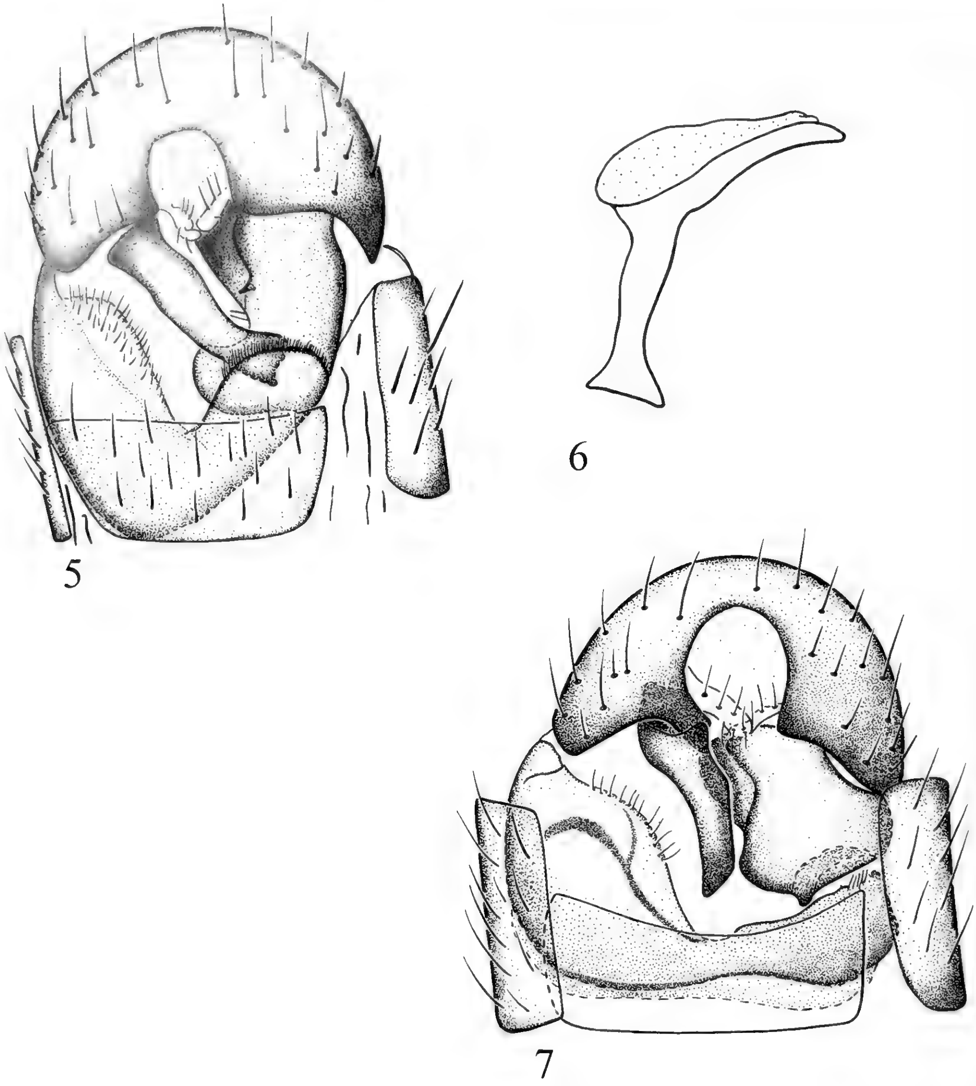
Cyamops sp. 2
(Fig. 7)

This unique male from Panama apparently represents a new species. We defer formal description for the same reasons just noted (see *Cyamops* sp. 1). An illustration of the male terminalia is provided, however (Fig. 7). This species is most similar to *C.* sp. 1, described above, but can be easily distinguished from that species by the characters given in the key. The shape of the right surstylus and of the 6th-7th sternite is unique for this species.

Material examined.—The specimen is labeled "LaJollaPan[ama] 29 IV 1952 [29 Apr 1952]/FSBlanton Collector" (1 ♂; USNM).

AFROTROPICAL REGION

Until now, no species had been described from this region, although Sabrosky (1980)



Figs. 5–7. *Cyamops* sp. 1 (Trinidad). 5, Segments 5–7, epandrium, cerci, and surstyli, ventral view. 6, Ejaculatory apodeme, lateral view. *Cyamops* sp. 2 (Panama). 7, Segments 5–7, epandrium, cerci, and surstyli, ventral view.

listed a "sp." from Nigeria and Khoo (1985) mentioned an "undescribed species" from Africa.

Both of the Afrotropical species described below are characterized by the following combination of characters: Face of male constricted medially; crossvein bm-cu present, separating cell bm from cell dc; anepisternum not setulose posteriorly.

KEY TO AFROTROPICAL SPECIES OF *CYAMOPS*

1. Scutellar setae 1 pair; dorsocentral setae 0 + 2; hindfemur mostly yellow, infuscate apically; wing mostly brown with 2 conspicuous white spots along anterior margin and 2 white spots along posterior margin; right surstylus subrectangular, not claw shaped in appearance (Nigeria) . . . . *C. nigeriensis,* new species
– Scutellar setae 2 pairs; dorsocentral seta 0 + 1; hindfemur brown on apical ¾; wing hyaline;

right surstylus with apical margin deeply concave in middle, claw shaped in appearance (Madagascar) . . . . *C. freidbergi*, new species

Cyamops nigeriensis Baptista and Mathis, new species
(Figs. 8–10, 33)

Description.—Adult ♂ length 1.6–2.0 mm; wing length 1.6–1.7; wing width 0.5–0.6 mm. Adult ♀ length 1.8–2.0 mm; wing length 1.9 mm; wing width 0.6–0.7 mm.

Head: Vertex shiny, ocellar tubercle and surrounding area almost polished; depressed region of frons deep black; antenna yellow, some specimens with dorsal margin slightly infuscate; facial region mostly yellow, sparsely microtomentose medially; labellum and palpus pale yellow; face shallowly and vertically arched, not angulate, slightly produced, produced portion about ¾ width of 1st flagellomere. Chaetotaxy: Inner fronto-orbital setae nearly parallel to slightly divergent, ½–¾ length of outer vertical seta; arista bearing 9–10 dorsal, 3 ventral rays, 6–7 basal rays clearly bifurcate; pseudovibrissae slightly converging, oriented dorsally; peristomal setae 3–4, some setulae intercalated between them.

Thorax: Halter mostly white; scutellum more or less trapezoidal, apex rounded, orientation of scutellum slightly more elevated than scutum, disk slightly convex; postpronotum narrow and shiny; anepisternum shiny; anepimeron polished. Chaetotaxy: Dorsocentral setae 0 + 2, posterior seta subequal in length to scutellar seta, anterior dorsocentral seta slightly shorter and thinner; mesonotal setulae very thin and sparse; scutellar seta 1. Legs mostly yellow; mid- and hindfemora infuscate, becoming darker brown apically; apical tarsomere of each leg brown; spinelike setulae not differentiated. Wing (Fig. 33): Mostly with dark pattern; cell R_1 mostly hyaline; cell R_{2+3} with a basal and subapical oblique spot; cell R_{4+5} completely brown; cell M with a medioblique spot; posterior margin of wing with 2 well-defined, hyaline spots (some specimens with an additional hyaline spot at anal angle); vein R_{2+3} strongly sinuous about midlength; 1st costal ratio: 1.3–2.22 (slide-mounted wing 1.42); 2nd costal ratio 3.84–5.0 (slide-mounted wing 5.0); wing ratio 2.42–2.57 (slide-mounted wing 2.5).

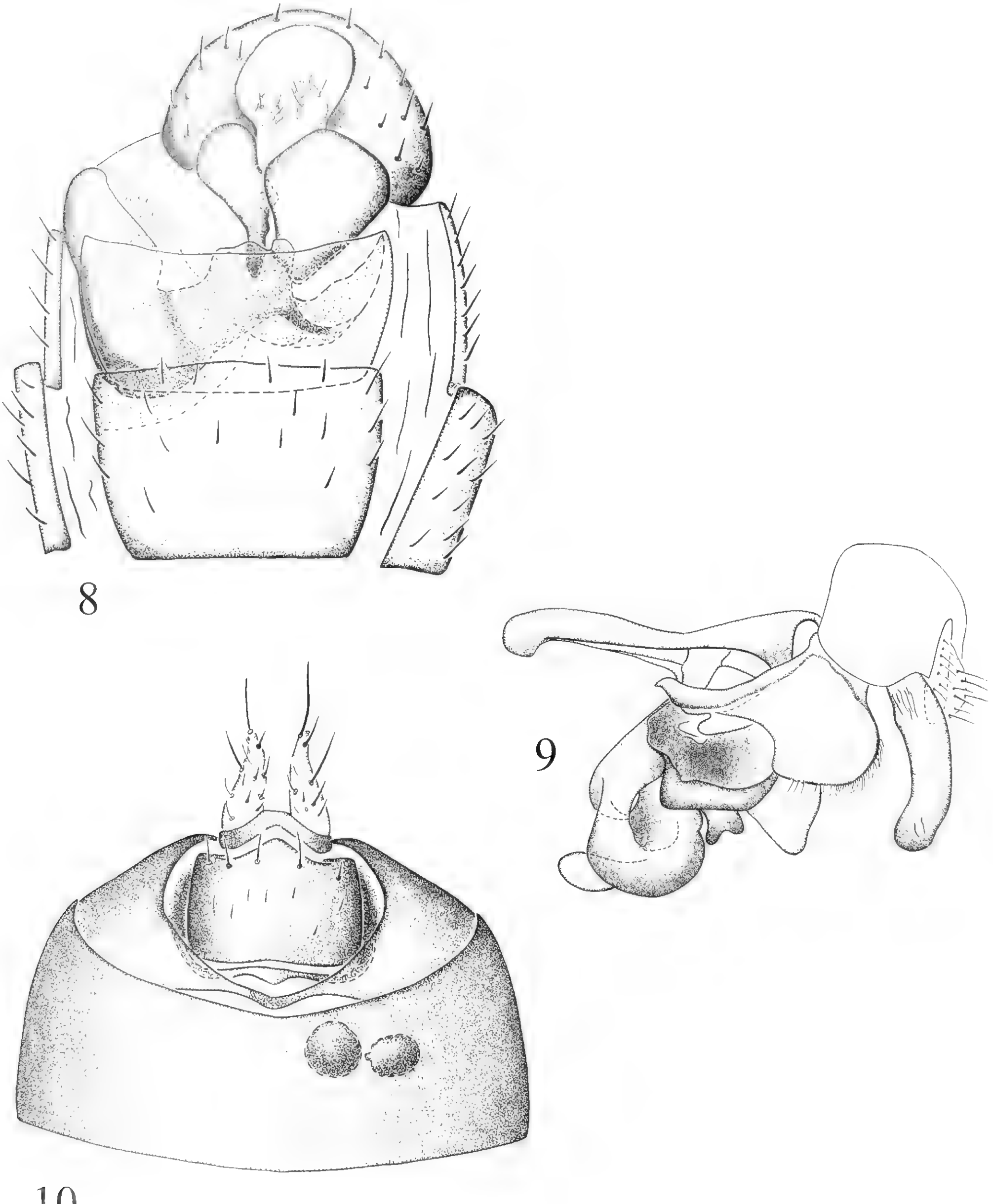
Abdomen (Figs. 8–9): Abdominal segments subshiny; 6th–7th sternite as in Fig. 8. Male terminalia (Figs. 8–9): Right surstylus large, slightly longer than wide, almost same length as left; left surstylus narrow, gradually tapered to point, internal margin slightly sinuous, approximately boot-shaped; ejaculatory apodeme subequal in length to 5th tergite, in lateral view hatchet shaped, extended process parallel sided, in dorsal view somewhat tear drop in shape.

Female: *Head:* Mesofacialia and gena dark brown, strongly microtomentose, medial portion of face and clypeus shiny; palpus brown; antenna dorsally infuscate; face in profile sloped anteroventrally from base of antenna to vibrissal angle, thereafter slightly receded to oral margin.

Thorax: Setae and setulae of mesonotum typically better developed and longer than in male. Legs with foretarsi brown; apical ¼–½ of midfemur brown; apical ¼–½ of hindfemur brown.

Abdomen (Fig. 10): 7th tergite and sternite forming a complete ring as in American species, widened ventrally with posterior margin slightly pointed, very thin dorsally, not well delimited and concealed beneath 6th tergite; 2 spermathecae, apical portion of spermathecal duct apparently unsclerotized.

Type material.—The holotype ♂ is labeled "Nigeria Badeggi Rice Res. Sta., NW state12-22-68 [22 Dec 1968]/J.T.Medler Collector/HOLOTYPE ♂ Cyamops nigeriensis Baptista & W.N.Mathis [red; species name, gender symbol, and "Baptista &" handwritten]." The holotype is double mounted (glued to a point), is in relatively good condition (setae of face and thorax half broken, following tarsi missing; fore right, mid right, hind left), and is deposited in the USNM. Paratypes are as follows:



Figs. 8–10. *Cyamops nigeriensis.* 8, Segments 4–7, epandrium, cerci, and surstyli, ventral view. 9, Epandrium, internal male terminalia, lateral view. 10, Female abdomen, segments 5–9, dorsal view.

Same locality label as the holotype (4 ♂, 8 ♀; none in good condition; 1 ♂, 1 ♀ with abdomen dissected, structures in an attached microvial; USNM).

Other material examined.—Nigeria. Zaria, Samaru, 23 Jun 1966, J. C. Deeming (2 ♀; USNM).

Distribution.—*Cyamops nigeriensis* is known only from Nigeria.

Etymology.—The species epithet, *nigeriensis,* refers to the country where the type locality is located.

Remarks.—A character that distinguishes this species from *C. freidbergi,* the presence of a single pair of scutellar setae, also occurs in *C. imitatus* Sturtevant (North America). The narrowed postpronotum is apparently unique to *C. nigeriensis.*

Cyamops freidbergi Baptista and Mathis, new species
(Figs. 11–13)

Description.—Holotype ♂ length 1.9 mm; wing length 1.74; wing width 3.2 mm.

Head: Vertex almost completely polished; ocellar tubercle shiny; depressed region of frons deep black; antenna yellow, pedicel infuscate dorsally; facial region yellow, sparsely microtomentose medially; palpus and labellum pale yellow; face shallowly and vertically arched, not angulate, only slightly produced, produced portion almost width of 1st flagellomere. Chaetotaxy: Inner fronto-orbital setae nearly parallel to slightly divergent, about half length of outer vertical seta; arista bearing 10 dorsal, 3 ventral rays, 6 dorsobasal rays clearly bifurcate; pseudovibrissae slightly convergent, oriented dorsally; peristomal setae 9, with longest seta about half length of pseudovibrissal seta.

Thorax: Halter pale yellow; scutellum trapezoidal, orientation of scutellum slightly more elevated than scutum, disk flat; postpronotum shiny, slightly microtomentose. Chaetotaxy: Dorsocentral setae 0+1; mesonotal setulae very thin and sparse, mostly restricted to dorsocentral and acrostichal rows; scutellar setae 2, basal pair about ½ length of apical seta. Legs mostly yellow; hindfemur brown on apical ⅔; apical and subapical tarsomere of each leg brown; spinelike setulae weakly differentiated, brown, 5. Wing: Hyaline, central portion very slightly infuscate with brown; 1st costal ratio 1.2 (slide-mounted wing); 2nd costal ratio 3.75 (slide-mounted wing); wing ratio 4.16 (slide-mounted wing).

Abdomen (Figs. 11–13): 6th tergite as large as 7th tergite dorsally. Male terminalia (Figs. 11, 13): Right surstylus short, almost as long as wide, about a half length of left surstylus, apical margin deeply concave in middle, hook-shaped in appearance; left surstylus narrow, gradually tapered to point, margins slightly sinuous, basally slightly expanded to left; ejaculatory apodeme in lateral view hatchet shaped, extended process parallel sided, in dorsal view somewhat tear drop in shape.

Female: Unknown.

Type material.—The holotype ♂ is labeled "MADAGASCAR NW[,] NosyBe, Forest SE[,] Lakobe Res[,] 5.IV.1991 [5 Apr 1991] A. FREIDBERG & FINI KAPLAN/PERISCELIDIDAE Cyamops sp. D.K. McAlpine det. 1991 [handwritten except for "D. McAlpine Det."]/Dissected by A.Baptista 97 [black border]/HOLOTYPE ♂ Cyamops freidbergi Baptista & W.N.Mathis [red; species name, gender symbol, and "Baptista &" handwritten]." The holotype is double mounted (minuten in a block of plastic), is in relatively good condition (abdomen removed, dissected, structures in an attached microvial), and is deposited in the USNM.

Distribution.—This species is known thus far only from the type locality on Madagascar.

Etymology.—The species epithet, *freidbergi,* is a genitive patronym to honor and recognize Dr. Amnon Freidberg, who collected this species and many other interesting acalyptrate Diptera on Madagascar.

Remarks.—The presence of a single dorsocentral seta, a character that distinguished this species from *C. nigeriensis,* also occurs in New World species of *Cyamops.* The shape of the male surstylus (Fig. 11) distinguishes this species from other congeners.

AUSTRALASIAN/OCEANIAN REGION

The Australasian/Oceanian fauna demonstrates variation in characters that are constant in American and Afrotropical species, i.e., sexual dimorphism in the shape of the face (absent in *C. micronesicus* and an undescribed species from Ponape) and presence of crossvein bm-cu. All species, however, have two dorsocentral setae, and the anepisternum lacks setae along the posterior margin.

KEY TO AUSTRALIAN/OCEANIAN SPECIES OF *CYAMOPS*

1. Basal aristal rays not bifurcate 2
– Basal aristal rays bifurcate 5
2. Mesofacialia bearing a ridge (male) or a wide elevated portion (female); face of male narrow, constricted medially; 1st costal ratio 2.3 or greater (Fiji) . . . . *C. fiji,* new species
– Mesofacialia flat throughout; face of male wide, not constricted medially; 1st costal ratio 1.0–1.8 3
3. Pseudovibrissa aligned with other peristomal setae; basal scutellar seta about ½ length of apical seta 4
– Pseudovibrissa placed externally to the row of peristomal setae; basal scutellar seta about ¾ or more length of apical seta (Micronesia) . . . . "Ponape" species complex
4. Mesofacial plate without setae; tibia and tarsus of foreleg mostly brown to dark-brown; ocellar tubercle shiny; vertex shiny (Yap) . . . . *C. micronesicus,* new species
– Mesofacial plate setose between upper peristomal setae; tibia and tarsus of foreleg mostly yellow; ocellar tubercle dull microtomentose; vertex dull microtomentose (Ponape) . . . . *C.* sp. 3
5. 1st costal ratio 1.0–1.8 6
– 1st costal ratio 2.3 or more 10
6. Comb on ventral margin of midcoxa absent 7
– Comb on ventral margin of midcoxa present (Australia) . . . . *C. pectinatus* Khoo
7. Peristomal setae on mesofacial plate (Australia) . . . . *C. claudiensis* Khoo
– Peristomal setae on genal suture 8
8. Basal scutellar seta about ¾ or more length of apical seta; tibia and tarsus of foreleg mostly yellow to yellowish brown 9
– Basal scutellar seta at most ⅓ length of apical seta; tibia and tarsus of foreleg mostly brown to dark-brown (New Guinea) . . . . *C. papuensis,* new species
9. Wing hyaline (Australia) . . . *C. truncatus* Khoo
– Wing with a conspicuous brown pattern (Australia) . . . . *C. dayi* Khoo
10. 5th sternite of male abdomen entire 11
– 5th sternite of male abdomen divided medially (American Samoa) . . . . *C. samoensis,* new species
11. Legs mostly yellowish; midfemur yellow; wing hyaline (Australia) *C. australicus* Hennig
– Legs mostly yellowish brown to black; midfemur brown apically; wing with a conspicuous brown pattern (Australia) . . *C. delta* Khoo

Cyamops micronesicus Baptista and Mathis, new species

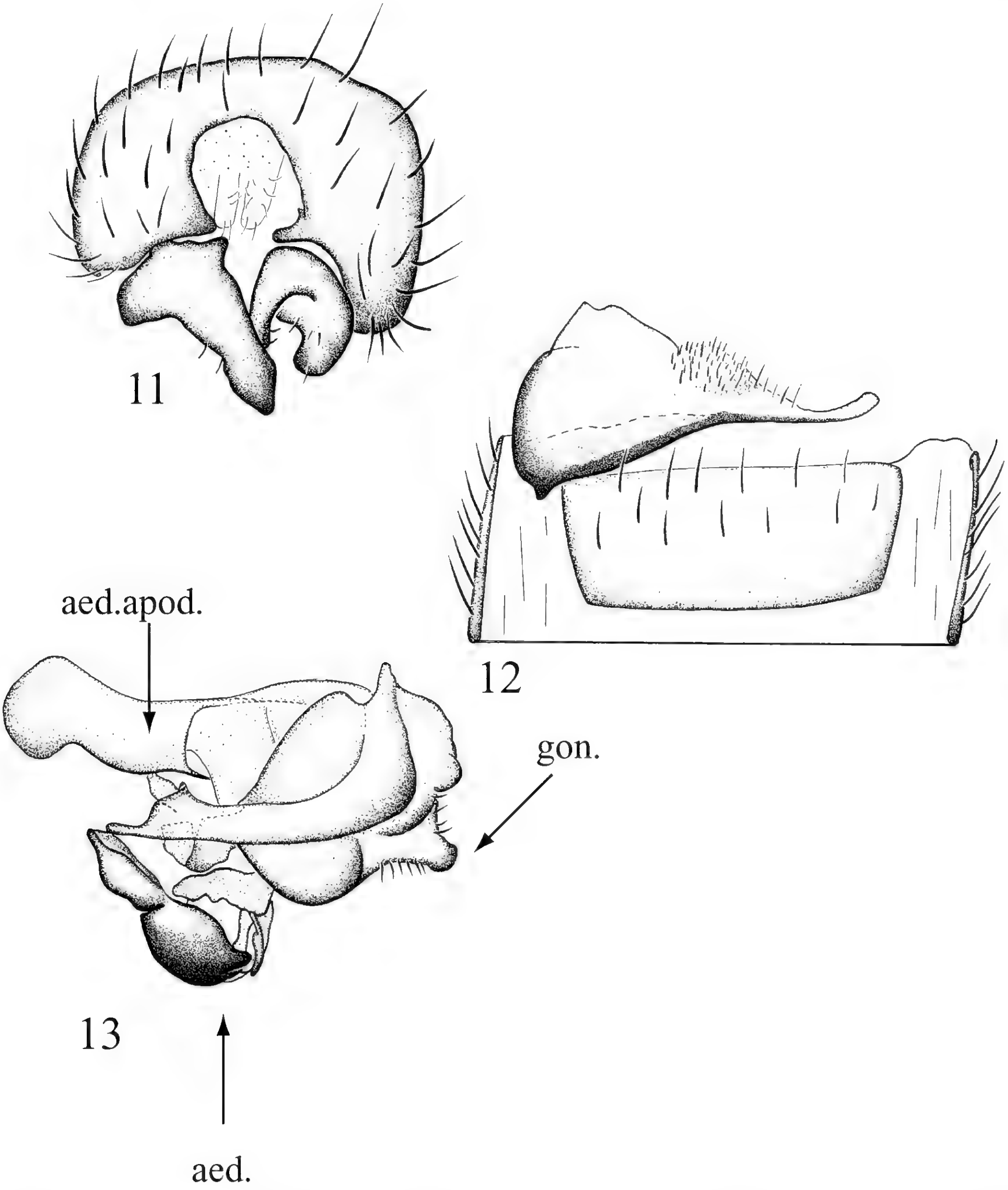
(Figs. 14–16)

Description.—Adult ♂ length 2.0 mm; wing length 1.8 mm; wing width 0.6 mm. Adult ♀ length 1.8–2.07 mm; wing length 1.97–2 mm; wing width 0.67–0.72 mm.

Head: Vertex and ocellar tubercle bright shiny, depressed region of frons subshiny; antenna yellow; facial region yellow in ground color, gray microtomentose; clypeus and palpus yellow; face shallowly and vertically arched, not angulate, nor constricted medially. Chaetotaxy: Inner fronto-orbital setae nearly parallel to slightly divergent, slightly smaller than outer vertical seta; arista bearing 9–10 dorsal, 3 ventral rays, none clearly bifurcate; pseudovibrissae slightly divergent, pointing dorsally; peristomal setae 6–7.

Thorax: Halter mostly pale yellow; scutellum trapezoidal, orientation of scutellum very slightly more elevated than scutum, disk slightly convex; postpronotum and upper margin of notopleuron shiny. Chaetotaxy: Dorsocentral setae 0+2, posterior seta subequal in length to apical scutellar seta but thinner, anterior dorsocentral seta slightly shorter and thinner; mesonotal setulae very thin and sparse; scutellar setae 2, basal seta about ¾ of apical seta. Legs mostly yellow (foretibia and foretarsi of holotype missing); apical ¼–⅓ of hindfemur, apical and subapical tarsomere of each leg brown; spinelike setulae not differentiated. Wing: Partially hyaline; cell R_{4+5} mostly brown, subdividing subapical spot; cell M and somewhat cell CuA_1 mostly lightly infuscate to hyaline; vein R_{2+3} only slightly sinuous at midlength; cells bm and dm confluent; 1st costal ratio 1.15–1.4 (slide-mounted wing); 2nd costal ratio 2.2–3.8 (slide-mounted wing); wing ratio 2.88–2.96 (slide-mounted wing).

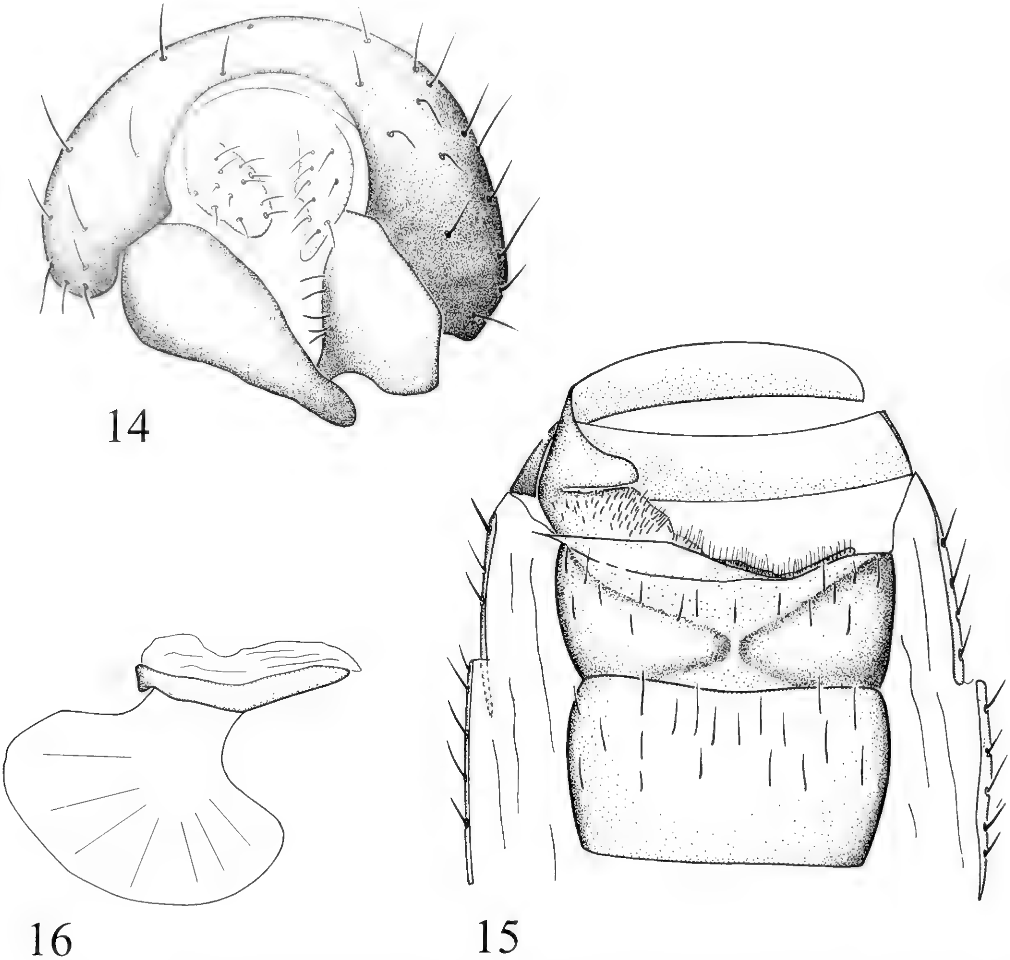
Abdomen (Figs. 14–16): 6th tergite subequal in width to 7th tergite. Male terminalia (Figs. 14–15): Left surstylus narrow, gradually tapered to a point, about 1.5 times



Figs. 11–13. *Cyamops freidbergi.* 11, Epandrium, cerci, and surstyli, ventral view. 12, Male abdominal segments 5–7, ventral view. 13, Internal male terminalia, lateral view. Abbreviations: aed. = aedeagus; aed. apod. = aedeagal apodeme; gon. = gonite; st. = sternite.

longer than right; right surstylus slightly longer than wide, anterior margin slightly receded, forming a nipplelike projection on inner corner; ejaculatory apodeme in dorsal view as long as 6th tergite, with extended process greatly expanded toward apex, fanlike (Fig. 16).

Female: *Head:* Mesofacialia and gena



Figs. 14–16. *Cyamops micronesicus*. 14, Epandrium, cerci, and surstyli, ventral view. 15, Male abdominal segments 4–7, ventral view. 16, Ejaculatory apodeme, lateral view.

brown in ground color, strongly invested with grayish microtomentum; inner margin of pedicel dorsally infuscate.

Thorax: Setae and setulae of mesonotum typically better developed and longer than in male; postpronotum almost lacking microtomentum; tibia and tarsus of foreleg brown to dark brown. Wing: pattern generally darker than in male.

Abdomen: 7th tergite and sternite forming a complete ring, wide ventrally, dorsally about half that of 6th tergite; 2 subequal spermathecae.

Type material.—The holotype ♂ is labeled "YaptownYap VII-13 -46 [13 Jul 1946]/HKTownes No 1090 [number handwritten]/HOLOTYPE Cyamops micronesicus Baptista & W.N.Mathis USNM [red; species name, gender symbol, and "Baptista &" handwritten]." The holotype is double mounted (glued to a point on ventral, right side), is in fair condition (foretibiae and tarsi missing, left wing detached and slide-mounted; abdomen removed, dissected, structures in an attached microvial), and is deposited in the USNM. Paratypes are as follows: Same locality label as the holotype but with different dates: 12, 14 Jul 1946 (3 ♀; USNM).

Distribution.—This species is known only from the type locality in Micronesia.

Etymology.—The species epithet, *micronesicus,* refers to the island group in the South Pacific where this species was collected.

Remarks.—This species is similar to the other Micronesian species, the underscribed species from the "Ponape" complex, and to *C.* sp. 3. It is easily distinguished from these species by having the pseudovibrissae aligned with the other peristomal setae and in lacking setae on the mesofacialia.

Cyamops fiji Baptista and Mathis, new species

(Figs. 17–19, 34)

Description.—Adult ♂ length 1.54–1.7 mm; wing length 1.6–1.68 mm; wing width 0.5–0.6 mm. Adult ♀ length 1.8–1.86 mm; wing length 1.9 mm; wing width 0.7–0.74 mm.

Head: Vertex and ocellar tubercle microtomentose, except for a small shiny dot adjacent to posterior ocellus; depressed region of frons subshiny; antenna yellow; facial region yellow in ground color, whitish microtomentose; clypeus and palpus yellow. Chaetotaxy: Inner fronto-orbital setae slightly divergent, slightly smaller than outer vertical seta; arista bearing 7 dorsal, 3 ventral rays, none clearly bifurcate; pseudovibrissae oriented dorsally; peristomal setae 5–7.

Thorax: Halter mostly dark brown; postpronotum microtomentose, subshiny; scutellum trapezoidal, orientation of scutellum very slightly more elevated than scutum, disk slightly convex. Chaetotaxy: Dorsocentral setae 0+1 (some specimens with an elongate but thin setula anterior of dorsocentral seta); mesonotal setulae well developed; scutellar setae 2. Legs mostly yellow; forefemur a little infuscate dorsally, mostly on apical portion; apical ⅓–½ of hindfemur brown; apical and sometimes subapical tarsomere of each leg brown; spinelike setulae not differentiated. Wing (Fig. 34): Hyaline to faintly brown with slight traces of brown around veins and in cell R_1; vein R_{2+3} very slightly sinuous at midlength; cells bm and dm separated; 1st costal ratio 2.35–2.8 (slide-mounted wing); 2nd costal ratio 2.1–2.5 (slide-mounted wing); wing ratio 2.4–3.2 (slide-mounted wing).

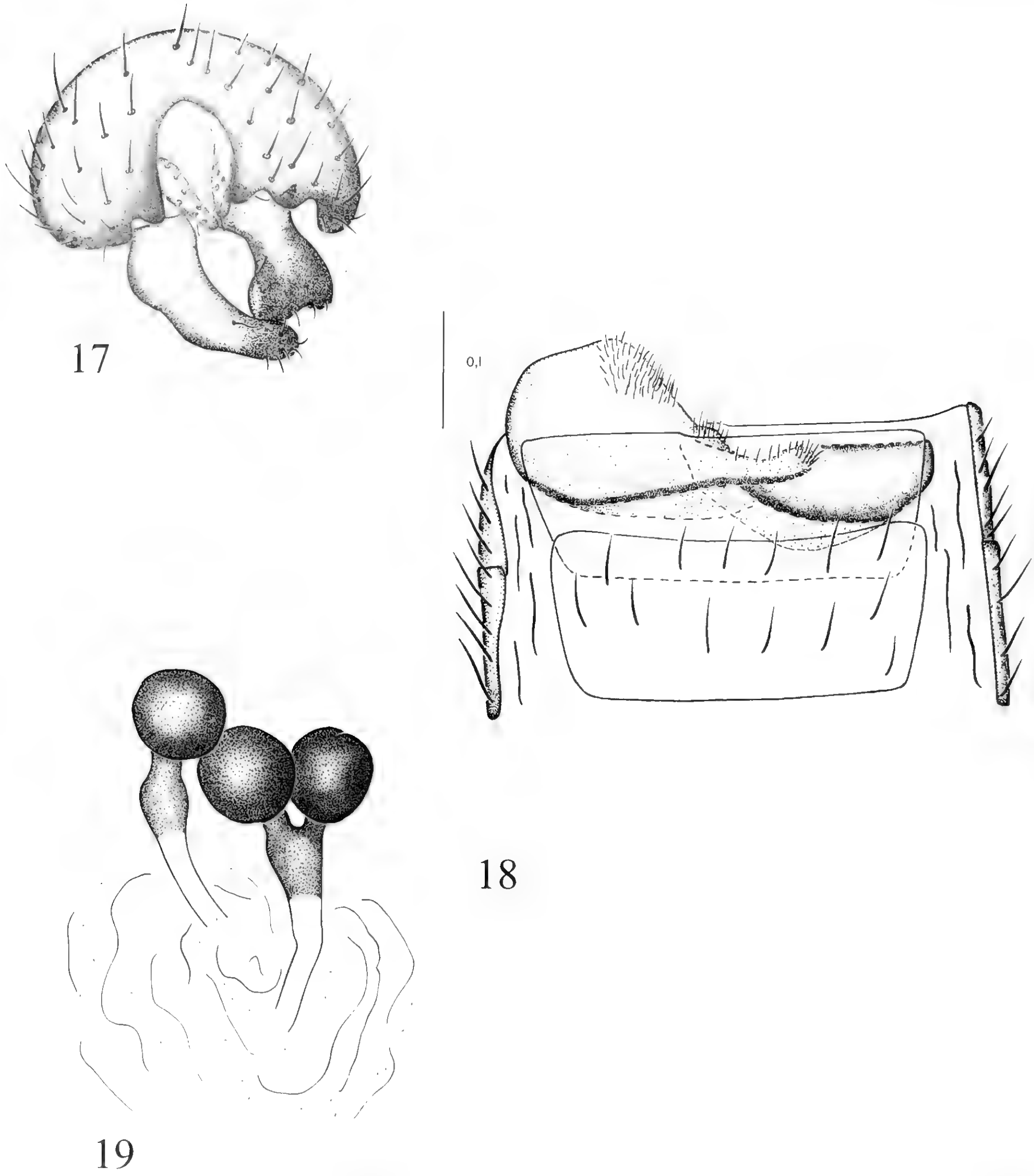
Abdomen (Figs. 17–18): 6th sternite apparently not completely fused with 7th sternite. Male terminalia (Fig. 17): Right surstylus large, slightly longer than wide, expanded and convolted apically; left surstylus narrow, gradually tapered to rounded apex, slightly bent inward, a little longer than right surstylus; aedeagal apodeme with a ventral projection joining hypandrium posteriorly; ejaculatory apodeme small, slightly longer than 7th tergite, in lateral view hatchet shaped, extended process parallel sided and slightly expanded at apical portion, in dorsal view somewhat subrectangular in shape with margins slightly converging toward apex.

Female: *Head:* Mesofacialia and gena brown, strongly microtomentose, silver except on lower central portion of mesofacialia, where microtomentum is thin; inner margin of pedicel dorsally infuscate.

Thorax: Setae and setulae of mesonotum typically better developed and longer than in male. Legs with midfemur a little infuscate dorsoapically; hindfemur usually infuscate on apical half or slightly more. Wing: Cells R_1 and in some specimens R_{2+3} infuscate, brown.

Abdomen (Figs. 19): 7th tergite and sternite forming a complete ring, wide ventrally, dorsally about ¾ of 6th tergite; 3 subequal spermathecae (Fig. 19); sclerotized portion of spermathecal duct about same length as spermatheca.

Type material.—The holotype ♂ is labeled "FIJI: Viti Levu I: Lami, 0–200 m, III.1981/N.L.H. Krauss, Coll. BISHOP Museum Acc. #1981.131/HOLOTYPE ♂ Cyamops fiji Baptista & W.N.Mathis [red; species name, gender symbol, and "Baptista



Figs. 17–19. *Cyamops fiji.* 17, Epandrium, cerci, and surstyli, ventral view. 18, Male abdominal segments 4–7, ventral view. 19, Spermathecae, ventral view.

&" handwritten]." The holotype is double mounted (glued to a point on the right side), is in relatively good condition (mesonotal setae broken), and is deposited in the BPBM. Paratypes are as follows: Same label data as the holotype (17 ♂, 18 ♀; BPBM, USNM).

Etymology.—The species epithet, *fiji,* is the name of the country where the type locality is located and is a noun in apposition.

Remarks.—This species has the 6th and 7th sternites incompletely fused, a character shared with *C. samoensis.* Both species, however, can be easily distinguished by the characters in the key. The shape of the right surstylus is unique to *C. fiji.*

Cyamops papuensis Baptista and Mathis, new species

(Fig. 20)

Description.—Adult ♂ length 1.7–1.8 mm; wing length 1.6 mm; wing width 1.6–2 mm. Adult ♀ length 1.8–2.0 mm; wing length 1.8–2.0 mm; wing width 2.5 mm.

Head: Ocellar tubercle polished; shiny spot on vertex large and distinct, extended from ocellus ⅔ distance to eye margin; depressed region of frons deep, velvet; pedicel on upper half, 1st flagellomere yellow, infuscate dorsally; facial region yellow in ground color, strongly microtomentose; labellum and palpus pale yellow; face produced and slightly angulate. Chaetotaxy: Inner fronto-orbital setae slightly divergent, slightly smaller than outer vertical seta; arista bearing 9 dorsal, 3 ventral rays, 6 basal rays bifurcate; pseudovibrissae oriented dorsally; peristomal setae 7.

Thorax: Halter brown; scutellum trapezoidal, orientation of scutellum moderately more elevated than scutum, disk a little convex; postpronotum polished. Chaetotaxy: Dorsocentral setae 0+2, posterior seta slightly longer than anterior seta; mesonotal setulae moderately well-developed; scutellar setae 2, basal seta ⅓ length of apical seta. Legs mostly yellow; femora brown infuscate at apical ½–⅔ tibiae very slightly infuscate; apical and subapical tarsomere of each leg brown; spinelike setulae about 6, weakly differentiated. Wing: Hyaline, slightly fuscous; cells bm and dm separated; 1st costal ratio 1.28–1.5 (slide-mounted wing); 2nd costal ratio 3.5–4.0 (slide-mounted wing); wing ratio 0.8–1.0 (slide-mounted wing).

Abdomen (Fig. 20): 6th tergite about same width as dorsal portion of 7th tergite, both sclerites almost without setae; 4th and 5th sternites with well-developed lateral setae and a row of setae along posterior margin, 5th sternite slightly reduced in length, posterior margin somewhat receded. Male terminalia: right surstylus almost globular, posteromedial margin deeply excavated, forming a fingerlike projection on left portion of surstylus, left surstylus at least 4× longer than wide.

Female: *Head:* Mesofacialia and gena brown, strongly microtomentose, silver except on facial carina where microtomentum is thin; 1st flagellomere infuscate dorsally.

Thorax: Legs with femora mostly brown.

Abdomen: 7th tergite and sternite separate; 7th tergite about ¾ length of 6th tergite; 2 subequal, spherical spermathecae; sclerotized portion of spermathecal duct about 1⁄5 length of spermatheca.

Type material.—The holotype ♂ is labeled "NEW GUINEA: NE Morobe District Mindik, 1,200–1,600 m, IX.1968 [Sep 1968]/N.L.H. Krauss Collector BISHOP MUSEUM/HOLOTYPE ♂ Cyamops papuensis Baptista & W.N. Mathis [red; species name, gender symbol, and "Baptista &" handwritten]." The holotype is double mounted (glued to a paper point), is in good condition (right wing missing), and is deposited in the BPBM. Paratypes are as follows: NEW GUINEA. NE. Morobe District, Mt. Kaindi (N Peak; 2,350 m), 1–14 Sep 1966 (1 ♂; USNM).

Other material examined.—Papua New Guinea. NE. Wau, Hospital Creek (1,200 m; Malaise trap), 6 Apr 1965, J. Sedlasec (1 ♀; BPBM); Amok (165 m), 6 Jan 1960, T. C. Maa (1 ♀; BPBM). SE. Western District. Oriomo River (3 ♂; light trap), 4 Aug 1964, H. Clissold (1 ♂; BPBM).

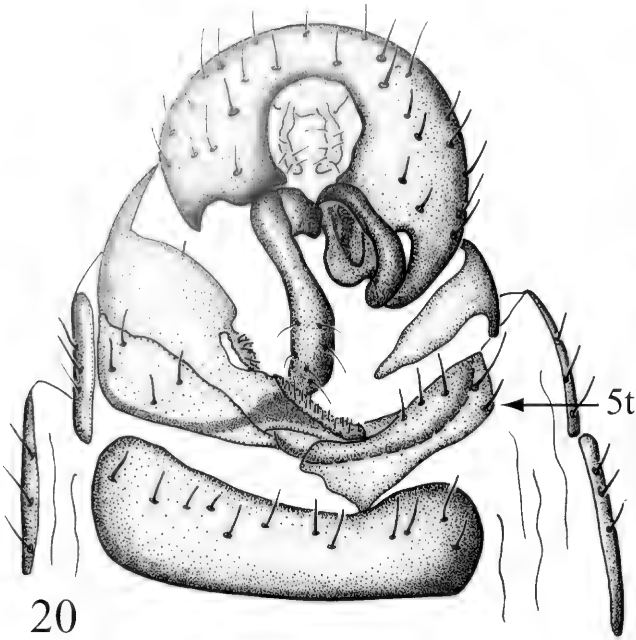
Etymology.—The species epithet, *papuensis,* refers to Papua New Guinea, the country where the type locality is located.

Remarks.—The reduced 5th sternite, the presence of well-developed setae laterally on the 4th and 5th sternites, and the shape of the 6th-7th sternites and surstylus distinguish this species.

Cyamops samoensis Baptista and Mathis, new species

(Figs. 21–22)

Description.—Holotype ♂ length 1.8 mm; wing length 1.7 mm; wing width 0.6 mm.



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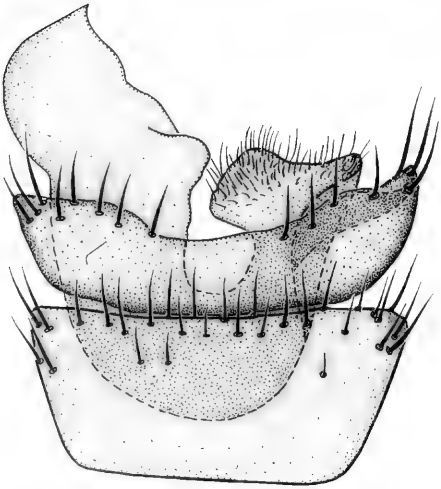

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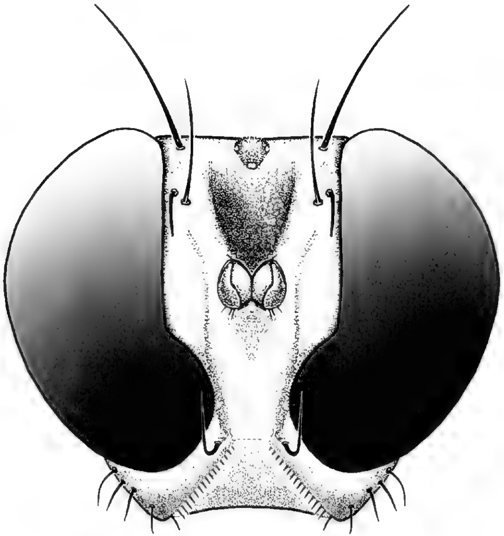

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Figs. 20–23. *Cyamops papuensis.* 20, Segments 4–7, epandrium, cerci, and surstyli, ventral view. *Cyamops sampensis.* 21, Epandrium, cerci, and surstyli, ventral view. 22, 4th–7th sternites, ventral view. *Cyamops* sp. ("Ponape" species complex). 23, Head, anterior view. Abbreviations: st. = sternite.

Head: Ocellar tubercle microtomentose; a shiny spot on vertex large and distinct, extended from ocellus ⅔ distance to eye margin; depressed region of frons deep velvet; pedicel brown, 1st flagellomere yellow; facial region yellow in ground color, strongly microtomentose; labellum and palpus yellow; face slightly produced, constricted medially. Chaetotaxy: Inner fronto-orbital setae slightly divergent, slightly smaller than outer vertical seta; fronto-orbits with setulae that run beyond limits of silver-microtomentose portion; arista bearing 9 dorsal, 3 ventral rays, 6 basal rays bifurcate; pseudovibrissae parallel, oriented dorsally; peristomal setae 7.

Thorax: Halter mostly white, dark brown at base; scutellum trapezoidal, orientation of scutellum moderately more elevated than scutum, disk flat; postpronotum microtomentose. Chaetotaxy: Dorsocentral setae 0+2, posterior seta slightly longer than anterior seta; mesonotal setulae moderately well developed; scutellar setae 2, basal seta ¾ of apical seta. Legs mostly yellow; hindfemur apically weakly infuscate; apical and subapical tarsomere of each leg brown; spinelike setulae about 6, weakly differentiated. Wing: Hyaline to faintly brownish infuscate; cells bm and dm separated; 1st costal ratio 3.0; 2nd costal ratio 2.4, wing ratio 2.8.

Abdomen (Figs. 21–22): 6th tergite about same width as 7th tergite, both tergites almost without setae (in a dry specimen, only 6 abdominal segments are seen); 5th sternite asymmetrical, divided in 2 parts; 6th sternite apparently incompletely fused with 7th sternite. Male terminalia: Right surstylus large, slightly longer than wide, complicated in shape, convoluted; left surstylus narrow, a little enlarged posteriorly, twice length of right surstylus; ejaculatory apodeme triangular when viewed dorsally, posterior process in lateral view parallel-sided, not longer than body of apodeme.

Type material.—The holotype ♂ is labeled "Amer[ican]. Samoa Tutuila Is. Leone Area/July 27-Aug 5 MR Wheeler 1962 [date handwritten]/HOLOTYPE ♂ Cyamops samoensis Baptista & W.N. Mathis USNM [red; species name, gender symbol, and "Baptista &" handwritten]." The holotype is in good condition (glued to a point; abdomen removed and in an attached microvial) and is deposited in the USNM. Paratype is as follows: SAMOA. Tulia, Naval station, 24 Aug 1940, Sand Zimmerman (1 ♂; BPBM).

Etymology.—The species epithet, *samoensis,* refers to the country where the type locality is located.

Remarks.—The shape of the medially divided, symmetrical 5th sternite and of the right surstylus are typical for this species. The separated 6th and 7th sternites is a character shared with *C. fiji.* Males of *C. femoratus* also have the 5th sternite divided medially.

Cyamops pectinatus Khoo

Cyamops pectinatus Khoo 1985: 528–530.—Khoo and Sabrosky 1989: 551 [Australasian/Oceanian catalog].

Specimens examined.—AUSTRALIA. Tasmania: Stoneyford Creek (N of Lagoons), 11 Nov 1979, H. B. Williams (1 ♂; USNM).

Distribution.—North Queensland to the southern coast of New South Wales and inland to Narrabri and the Australian Capital Territory (Khoo 1985). Tasmania is a new state record for this species.

"Ponape" species complex
(Fig. 23)

Seven specimens from Ponape, all in poor condition, share a distinctive character: Pseudovibrissae are placed external to the row of peristomal setae (Fig. 23). In addition, these species can be easily distinguished from other species from Ponape by the absence of mesofacial setae. The male, like *C.* sp. 3, has a wide face. Having peristomal setae that are modified differently in the male and the female, along with differences in the coloration of the legs and wings, lead us to suspect that the male and female might belong to different species. Because the wings of available specimens are in poor condition, it was impossible to determine whether crossvein bm-cu is present or not. Some of the specimens we examined came from different localities and we are unsure of the number of species represented in this series. We hope that study of additional and well preserved specimens from this region will resolve these problems.

Material examined.—Ponape: Mt. Tamatamnsakis (180 m), 17 Jan 1953 (1 ♂, USNM); E. Caroline Is. Pac. Sci. Bd. J. L. Gressitt (2 ♀, USNM); (N.); SE. Nampnmal (70 m; light trap), 12 Jan 1953, J. L. Gressitt" (1 ♀, USNM); Mt Do Lenmankap (1,800 ft), 2 Aug 1946 (1 ♀; USNM); (2,000 ft), 13 Aug 1996 (2 ♀; USNM).

Cyamops sp. 3

A unique male specimen, also from Ponape (see above), is distinguished by having long pseudovibrissae (longer than outer vertical seta) and by having mesofacial setae between the uppermost peristomal setae. The face is wide, the pseudovibrissae are aligned with the peristomal setal row, and crossvein bm-cu is present. This is the only species of *Cyamops* known to have mesofacial setae. Although this species is distinct from the other species occurring on Ponape, the specimen is in poor condition and we are not formally describing it.

Material examined.—MICRONESIA. Ponape: Mt. Do Lenmankap (1800 ft), 2 Aug 1946 (1 ♂; USNM).

ORIENTAL REGION

KEY TO ORIENTAL SPECIES OF *CYAMOPS*

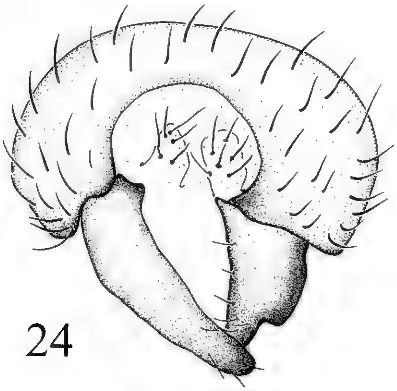
1. Face of male wide, not constricted medially; male and female facialia gray microtomentose, bearing a polished triangular region on lower, protruded portion (inconspicuous in some ♂ specimens); forefemur of male with a long basal ventral seta (Philippines. Negros) . . . . *C. femoratus,* new species
– Face of male narrow, constricted medially, facialia of male and female without a polished, anterior triangle; forefemur without a basal ventral seta 2
2. Basal scutellar seta very thin, about ⅓ that of apical seta (Thailand) *C. kaplanae,* new species
– Basal scutellar seta well developed, about ½–¾ of apical seta 3
3. Hindfemur of male brown at apical ½; femora of female mostly brown; cell R_{2+3} of wing usually hyaline on anterior basal portion, otherwise brown; right surstylus subrectangular, much smaller than left surstylus (Fig. 17) (Laos) . . . . *C. banvaneue,* new species
– Hindfemur of male brown at apical ¼ femora of female mostly yellow; cell R_{2+3} of wing usually mostly infuscate dividing subapical white spot; right surstylus as in Fig. 26 (Laos) . . . . *C. laos,* new species

Cyamops femoratus Baptista and Mathis, new species
(Figs. 24–25, 35)

Description.—Adult ♂ length 2.3–2.4 mm; wing length 2.2–2.4 mm; wing width 0.6–0.7 mm. Adult ♀ length 2.4–2.7 mm; wing length 2.5–2.6 mm; wing width 0.8–0.9 mm.

Head: Vertex bright shiny, mostly polished; ocellar tubercle and depressed region of frons subshiny; pedicel brown, 1st flagellomere yellow; facial region brown in ground color, gray microtomentose, anteriorly with a polished triangular region; palpus and labellum yellow; face shallowly and vertically arched below level of pseudovibrissae, in lateral view as large as widest portion of 1st flagellomere. Chaetotaxy: Inner fronto-orbital setae nearly parallel to slightly divergent, slightly smaller than outer vertical seta; arista bearing 12–14 dorsal, 3–4 ventral rays, none clearly bifurcate; pseudovibrissae oriented anteriorly and curved laterad; peristomal setae 6–7, 3rd and 4th setae better developed and strongly inclinate.

Thorax: Halter mostly brown, base pale yellow; scutellum trapezoidal, orientation of scutellum very slightly more elevated than scutum, disk flat to slightly convex; pleural region shiny; postpronotum glossy. Chaetotaxy: Dorsocentral setae 0+2, posterior seta subequal in length to apical scutellar seta, anterior dorsocentral seta slightly shorter and thinner; mesonotal setulae very thin and sparse; scutellar setae 2. Legs with femora long, almost same length as abdomen; legs mostly yellow; forefemur slightly infuscate apically; apical 1/10–1/5 of hindfemur brown; apical and subapical tarso-



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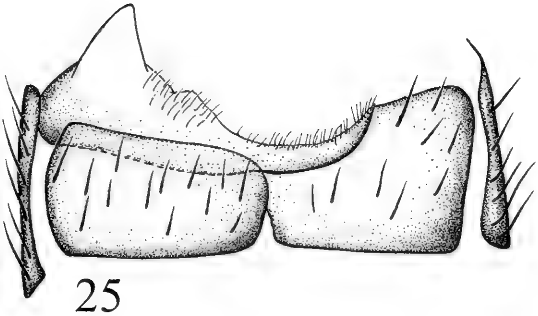

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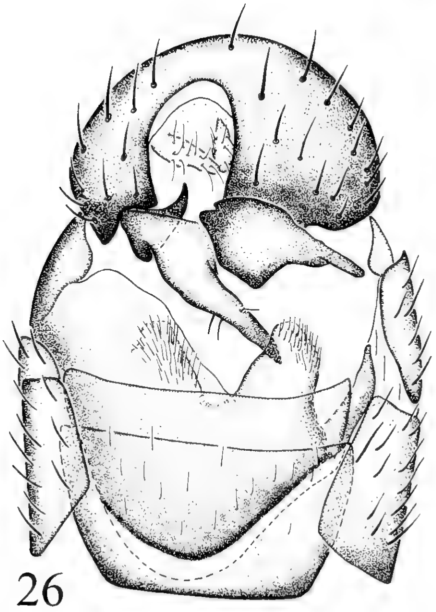

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Figs. 24–26. *Cyamops femoratus.* 24, Epandrium, cerci, and surstyli, ventral view. 25, Male 5th–7th sternites, ventral view. *Cyamops laos.* 26, Segments 4–7, epandrium, cerci, and surstyli, ventral view.

mere of each leg brown; spinelike setulae about 4, basalmost seta long, forefemur bearing an additional long seta basally. Wing (Fig. 35): Mostly hyaline; cells R_1 and R_{2+3} mostly hyaline; posterior margin and apex of cell R_{2+3} dark; posterior portion of cell M and cell CuA_1 with hyaline area (pale specimens with wing mostly hyaline and pattern rather faint); vein R_{2+3} sinuous, narrowing cell R_{2+3} at midlength; cells bm and dm only partially separated; 1st costal ratio 1.3–1.5 (slide-mounted wing); 2nd costal ratio 4.3–4.8 (slide-mounted wing); wing ratio 2.8–3.6 (slide-mounted wing).

Abdomen (Figs. 24–25): 5th sternite divided in middle, slightly asymmetrical; 6th tergite almost same width as 7th tergite; 6th–7th sternites simple, reduced in comparison to other species. Male terminalia (Fig. 24): Right surstylus large, slightly longer than wide; left surstylus much longer than wide, slightly tapered to point; aedeagal apodeme joined to hypandrium posteriorly; length of ejaculatory apodeme in dorsal view same as 6th tergite, with extended process greatly expanded toward apex, fanlike.

Female: *Head:* Face silver microtomentose, lower portion with a polished spot.

Thorax: Setae and setulae of mesonotum typically better developed and longer than in male; notopleuron polished dorsad of level of setae. Legs with forefemur infuscate brown.

Abdomen: 7th tergite and sternite forming a complete ring, wide ventrally, dorsally about half width of 6th tergite; 2 subequal spermathecae; sclerotized portion of spermathecal duct subequal to length of spermatheca.

Type material.—The holotype ♂ is labeled "P[hilippine]. I[slands]., NEGROS OR. L. Balinsasayao 6-X-1959 [number "6" handwritten over the top of a printed number] /C.M. Yashimoto Collector BISHOP MUSEUM/HOLOTYPE ♂ Cyamops femoratus Baptista & W.N. Mathis [red; species name, gender symbol, and "Baptista &" handwritten]." The specimen is double mounted (glued to a paper point), is in good condition (left vertical seta missing), and is deposited in the BPBM. Paratypes are as follows: Same label data as the holotype (one ♀ with abdomen and wing dissected and in an attached microvial) but with different dates as follows: 6 Oct 1959 (2 ♂, 4 ♀; BPBM, USNM); 1–7 Oct 1959 (3 ♂, 4 ♀; BPBM).

Etymology.—The species epithet, *femoratus,* refers to the characteristic seta on the forefemur.

Remarks.—The presence of a basoventral seta on the male forefemur is an autapomorphy for this species. The wing pattern of *C. femoratus* resembles that of *C. banvaneue,* and a sinuous vein R_{2+3} is shared with *C. laos* and *C. nebulosus* from North America. The shape of the hypandrium, aedeagal apodeme, and 6th–7th sternite of the male abdomen somewhat resembles the same structures in *C. micronesicus.* Like the latter species, males of *C. samoensis* also have a medially divided 5th sternite.

Cyamops laos Baptista and Mathis, new species

(Fig. 26, 36)

Description.—Adult ♂ length 1.7–1.9 mm; wing length 1.9–2.0 mm; wing width 0.64–0.66 mm. Adult ♀ length 2.2–2.6 mm; wing length 2.5–2.8 mm; wing width 0.86–0.9 mm.

Head: Ocellar tubercle and vertex almost polished; depressed region of frons deep, velvet; antenna yellow; face pale yellow, strongly microtomentose; labellum and palpus yellow; face shallowly and vertically arched, not angulate, only lower portion slightly produced. Chaetotaxy: Inner fronto-orbital setae slightly divergent, slightly smaller than outer vertical seta; arista bearing 7–8 dorsal, 3 ventral rays, 6–7 basal rays bifurcate; pseudovibrissae slightly divergent, oriented dorsally; peristomal setae 6–8.

Thorax: Halter brown; scutellum trapezoidal, orientation of scutellum moderately more elevated than scutum, disk flat; postpronotum polished. Chaetotaxy: Posterior dorsocentral seta slightly longer than anterior seta; mesonotal setulae weakly developed; scutellar setae 2, basal seta ⅔ length of apical seta. Legs mostly yellow, only hindfemur brown at apical 1⁄6; apical and subapical tarsomere of each leg brown; spinelike setulae about 8, weakly differentiated. Wing (Fig. 36) mostly slightly infuscate; cell R_1 mostly hyaline; cell R_{2+3} mostly infuscate with subapical white spot; posterior portion of cell M and somewhat of cell CuA_1 with hyaline area (wing only slightly infuscate around veins in some specimens); vein R_{2+3} sinuous, narrowing cell R_{2+3} at midlength; 1st costal ratio: 1.37–1.61 (slide-mounted wing), 1st costal ratio: 3.25–4.14 (slide-mounted wing), wing ratio 2.9–3.1 (slide-mounted wing).

Abdomen (Fig. 26): 6th tergite about same width as 7th, both tergites almost without setae; 6th–7th sternite as in Fig. 26. Male terminalia (Fig. 26): Right surstylus large, longer than wide, gradually tapered laterally toward right side; left surstylus about 4× longer than wide, much longer than right, narrowed toward apex; ejaculatory apodeme short in dorsal view ⅔ as

Female: *Head:* Mesofacialia and gena dark brown, strongly microtomentose, silver except for facial carina which is shiny and almost polished on posterior half; pedicel mostly brown; palpus brown to dark brown; face angulate, strongly produced, produced portion about same width as 1st flagellomere.

Thorax: Wing (Fig. 36): Pattern darker; cell R_{2+3} mostly brown except for a hyaline median spot.

Abdomen: 7th tergite and sternite forming a complete ring, wide ventrally, dorsally ranging ⅔ of 6th tergite; 2 spermathecae, one slightly larger than the other; sclerotized portion of spermathecal duct about half length of spermatheca.

Type material.—The holotype ♂ is labeled "LAOS: Vientiane Prov. Ban Van Eue 15.IX.1967 [15 Sep 1967]/Native Collector BISHOP [Museum]/HOLOTYPE ♂ Cyamops laos Baptista & W.N. Mathis [red; species name, gender symbol, and "Baptista &" handwritten]." The holotype is double mounted (glued to a paper point), is in fair condition (facial setae, right 1st flagellomere, thoracic setae, right hindleg missing), and is deposited in the BPBM. Paratypes are as follows: Same locality label as the holotype, but with different dates as follows: 15 May 1966 (2 ♀; BPBM), 8 Aug 1966 (1 ♀; BPBM), 15 Aug 1966 (2 ♀; BPBM), 15 May 1967 (1 ♂, 1 ♀; BPBM, USNM), 30 Jun 1967 (2 ♂, 1 ♀; BPBM, USNM), 15, 30 Aug 1967 (1 ♀; BPBM), 15 Sep 1967 (1 ♂, 1 ♀; BPBM). One ♂ paratype has been dissected (the structures are in an attached microvial).

Etymology.—The species epithet, *laos*, refers to the country of the type locality and is a noun in apposition.

Remarks.—This species is similar to *C. banvaneue* but can be easily distinguished by the characters cited in the key (also see comments under *C. banvaneue*).

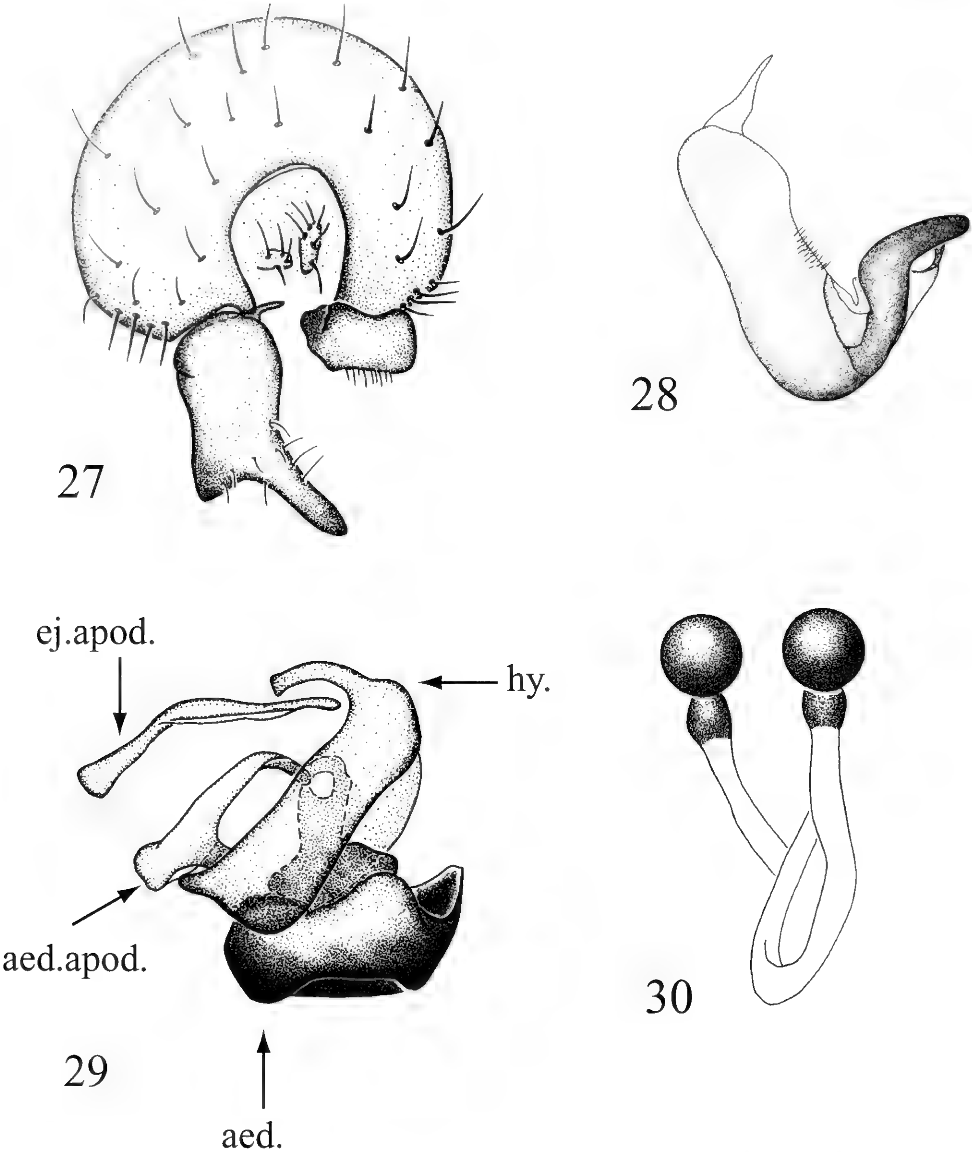
Cyamops banvaneue **Baptista and Mathis, new species**

(Figs. 27–30, 37)

Description.—Adult ♂ length 1.5–2.5 mm; wing length 1.6 mm; wing width 0.56 mm. Adult ♀ length 1.8–2.1-mm; wing length 1.6–2.1 mm; wing width 0.6–0.7 mm.

Head: Ocellar tubercle and vertex slightly microtomentose to polished, bright shiny; depressed region of frons dull; antenna yellow, pedicel slightly infuscate on dorsal margin; face pale yellow, strongly microtomentose; labellum and palpus yellow; face shallowly and vertically arched, not angulate, only slightly produced, produced portion of face about same length as width of 1st flagellomere. Chaetotaxy: Inner fronto-orbital setae slightly divergent, slightly smaller than outer vertical seta; arista bearing 9–10 dorsal, 2 ventral rays, 6 basal rays bifurcate; pseudovibrissae oriented dorsally; peristomal setae 7–9.

Thorax: Halter brown; scutellum trapezoidal, orientation of scutellum slightly more elevated than scutum, disk flat to slightly convex; postpronotum sparsely microtomentose to polished. Chaetotaxy: Posterior dorsocentral seta slightly longer than anterior seta; scutellar setae 2, basal seta ⅔–¾ length of apical seta. Legs mostly yellow, only hindfemur brown at apical half; apical and subapical tarsomere of each leg brown; forefemur slightly infuscate dorsally; spine-like setulae slightly differentiated, 2–3, black. Wing (Fig. 37): Mostly infuscate; cells R_1 completely and R_{2+3} mostly hyaline; posterior margin and apex of cell R_{2+3} dark, posterior portion of cell M and somewhat cell CuA_1 with hyaline areas; cells bm and dm separated; 1st costal ratio 1.2–1.3



Figs. 27–30. *Cyamops banvaneue*. 27, Epandrium, cerci, and surstyli, ventral view. 28, Male 6th–7th sternites, ventral view. 29, Internal male terminalia, lateral view. 30, Spermathecae, ventral view. Abbreviations: aed. = aedeagus; aed. apod. = aedeagal apodeme; ej. apod. = ejaculatory apodeme; hy. = hypandrium.

(slide-mounted wing); 2nd costal ratio 3.7–3.8 (slide-mounted wing); wing ratio 2.3–2.8 (slide-mounted wing).

Abdomen (Figs. 27–29): 6th tergite about same width as 7th tergite, both tergites almost without setae; 6th–7th sternite as in Fig. 28. Male terminalia (Figs. 27, 29): Right surstylus large, slightly wider than long, subrectangular; left surstylus slightly longer than wide, with a fingerlike process on apicomesal inner corner about ⅔ of length of surstylus; aedeagal apodeme joined to hypandrium posteriorly; ejaculatory apodeme short in dorsal view at most

⅓ as long as 7th tergite, extended process thin, with margins subparallel, in dorsal view subrectangular in shape.

Female: *Head:* Mesofacialia and gena dark brown, strongly microtomentose, silver except for facial carina which is shiny and almost polished on posterior ⅔; pedicel mostly brown; palpus brown to dark brown; femora dark except for yellow basal ring.

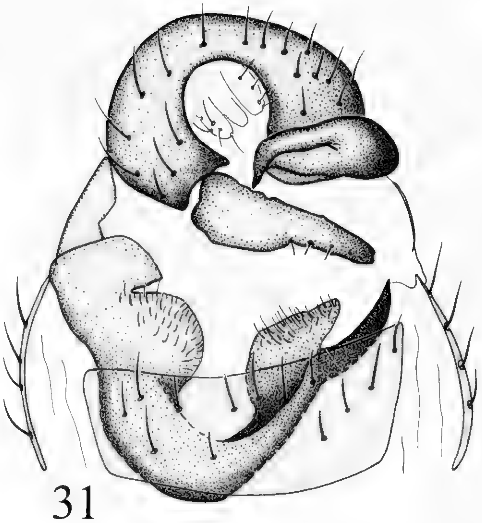
Thorax: Wing: Pattern darker, cell R_{2+3} mostly brown except for a hyaline median spot.

Abdomen (Fig. 30): 7th tergite and sternite forming a complete ring, wide ventrally, dorsally ranging ⅔ of 6th tergite; 2 spherical subequal spermathecae (Fig. 30); length of sclerotized portion of spermathecal duct about ½ diameter spermatheca.

Type material.—The holotype ♂ is labeled "LAOS: Vientiane Prov. Ban Van Eue 30.VI.1967 [30 Jun 1967] /Native collector BISHOP [Museum] /HOLOTYPE ♂ Cyamops banvaneue Baptista & W.N. Mathis [red; species name, gender symbol, and "Baptista &" handwritten]." The holotype is double mounted (glued to a paper point), is in fair condition (setae of head broken, both 1st flagellomeres and many thoracic setae missing), and is deposited in the BPBM. Paratypes are as follows: Same locality data as the holotype except for dates, which are as follows: 15–31 May 1965 (1 ♀; BPBM); 15 May 1966 (1 ♀; BPBM); 15 Aug 1966 (1 ♀; BPBM); 30 Jun 1967 (1 ♂; BPBM); 15 Aug 1967 (2 ♀; BPBM, USNM); 15 Sep 1967 (1 ♀; BPBM). One ♂ has been dissected (the structures are in an attached microvial).

Etymology.—The species epithet, *banvaneue,* refers to the type locality in Laos and is a noun in apposition.

Remarks.—This species is sympatric with *C. laos* but the two species are easily distinguished by the wing patterns. The wing of *C. banvaneue* has cell R_{2+3} mostly hyaline with only the apical third dark, whereas in *C. laos* this cell is mostly dark with a subapical hyaline spot. A second difference is the shape of vein R_{2+3}, which is straight in *C. banvaneue* and sinuous in *C. laos.*



31

Fig. 31. *Cyamops kaplanae.* 20, Segments 5–7, epandrium, cerci, and surstyli, ventral view.

Cyamops kaplanae Baptista and Mathis, new species
(Fig. 31)

Description.—Adult ♂ length 2.1 mm; wing length 1.86 mm; wing width 0.6 mm. Adult ♀ length 2.1 mm; wing length 2.2 mm; wing width 0.8 mm.

Head: Ocellar tubercle and vertex mostly polished; depressed region of frons deep black; antenna yellow, slightly infuscate on dorsal margin; face pale yellow, strongly microtomentose; labellum and palpus yellow; face in profile angulate, sloped anteroventrally from base of antenna to vibrissal angle, thereafter slightly receded to oral margin, produced portion about ¾ width of 1st flagellomere. Chaetotaxy: Inner fronto-orbital setae slightly divergent, about half length of outer vertical seta; arista bearing 10 dorsal, 3 ventral rays, 7 basalmost rays bifurcate; pseudovibrissae slightly divergent and curved dorsally; peristomal setae 7.

Thorax: Halter mostly brown, base pale yellow; scutellum trapezoidal, orientation of scutellum moderately more elevated than scutum, disk flat; postpronotum and central portion of anepimeron polished. Chaetotaxy: Posterior dorsocentral seta almost 3 times longer than anterior seta; mesonotal setulae moderately developed; scutellar setae 2, basal seta ⅓ length of apical seta, thinner. Legs mostly yellow, only hindfemur brown on apical 1/5; apical and subapical tarsomere of each leg brown; spinelike setulae 4, weakly differentiated. Wing mostly hyaline, with brownish area on central portion over cells dm, vein R_{4+5} and upper portion of cell br, and apex of cell R_{2+3}; cells bm and dm separate; 1st costal ratio 1.4; 2nd costal ratio 4.5; wing ratio 2.75.

Abdomen (Fig. 31): 6th tergite about same width as 7th tergite, both tergites almost without setae; 6th–7th sternite with posterior process as in Fig. 31. Male terminalia (Fig. 31): Right surstylus large, subrectangular, complex in shape; left surstylus slender, length about 2× that of right surstylus; ejaculatory apodeme short, as long as 5th tergite dorsally, extended process thin and short, with margins subparallel.

Female: *Head:* Antenna dark, median portion of 1st flagellomere microtomentose, with silver dust; produced portion of face larger than width of 1st flagellomere; mesofacialia and gena dark brown, strongly microtomentose, central portion shiny; palpus brown to dark brown; femora dark except for yellow basal portion.

Thorax: Wing: Hyaline

Abdomen (abdomen not dissected): 7th tergite and sternite separate.

Type material.—The holotype ♂ is labeled "THAILAND: S. KhaoSokNatPar. Rt. 401, 22.X.1993 [22 Oct 1993], F. KAPLAN & A. FREIDBERG/Dissected by A. Baptista97 [type written]/HOLOTYPE ♂ Cyampos kaplanae Baptista & W.N. Mathis USNM [red; species name, gender symbol, and "Baptista &" handwritten]." The holotype is double mounted (glued to a paper triangle), is in excellent condition (abdomen removed and dissected, structure in an attached microvial), and is deposited in the USNM. The paratype ♀ bears the same locality data as the holotype (1 ♀; USNM).

Etymology.—The species epithet, *kaplanae,* is a genitive patronym to recognize the collecting efforts of Ms. Fini Kaplan, who collected the type series of this species and many other specimens of interesting acalyptrate Diptera.

Remarks.—The 7th tergite and sternite of the female abdomen are separate. Having a suture between the 7th tergite and the 6th–8th sternites is apparently a plesiomorphic feature. Female specimens from the Australasian Region also have the tergite and sternite of the 7th segment separate.

PALEARCTIC REGION

No species of *Cyamops* has been described from this zoogeographic region.

Cyamops sp. 4

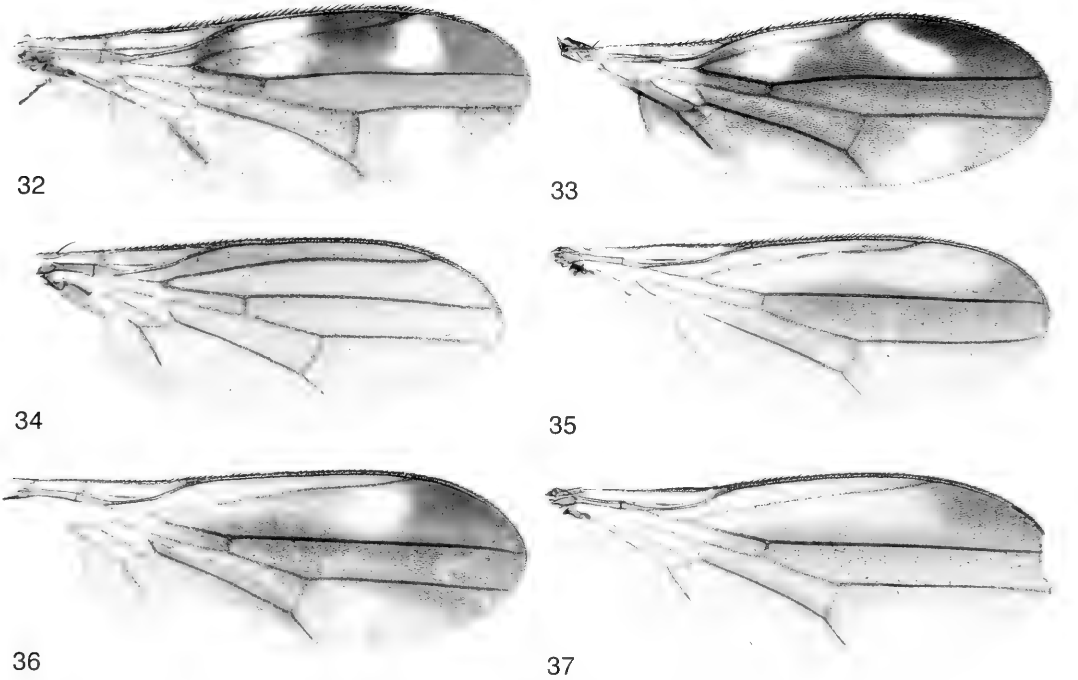
One specimen from Japan (Kyushu Beppa, 21 Jun 1952, P. W. Oman; USNM) has the following combination of characters: Face constricted medially; lacking mesofacial setae; pseudovibrissae aligned with peristomal setae; dorsocentral setae 2.

The only available specimen is in poor condition, and we defer describing this species until better preserved specimens become available.

PHYLOGENETIC CONSIDERATIONS

At the time of our revision we followed D. McAlpine (1989) and classified *Cyamops* in the family Periscelididae. Roháček (1998) has questioned the placement of *Stenomicra* and *Cyamops* ("Stenomicridae") with the other Periscelididae as unnatural, based on the "different types of male postabdomen and hypopygium" for each group. Moreover, he tentatively included the anthomyzid genus *Echidnocephalodes* Sabrosky in Periscelididae.

We agree with Roháček that the supporting evidence for the monophyly of Periscelididae is weak and needs further investigation. That both groups have different types of postabdomens, however, does not



Figs. 32–37. Wings. 32, *Cyamops funkae*. 33, *C. nigeriensis*. 34, *C. fiji*. 35, *C. femoratus*. 36, *C. laos*. 37, *C. banvaneue*.

preclude the hypothesis of monophyly. The "naturalness" of a group does not rely wholly on characters of the male terminalia or on any one character suite in particular. Our study of structures of the male terminalia of many Periscelididae reveals that these features are often so highly modified and derived that they obscure hypotheses of primary homology.

The caplike pedicel also occurs in the family Neurochaetidae, and it is possible that Periscelididae and Neurochaetidae are sister groups or one family.

ACKNOWLEDGMENTS

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THE BIOLOGY OF *DOA AMPLA* (GROTE) (LEPIDOPTERA: DOIDAE) ON ITS HOST PLANT *STILLINGIA TEXANA* (EUPHORBIACEAE)

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Abstract.—We confirm *Stillingia texana* L. (Euphorbiaceae) as a primary host plant of *Doa ampla* Grote (Lepidoptera: Doidae), document aspects of the biology, ecology, and behavior of larval and adult *D. ampla* on *S. texana*, and provide initial geographic distribution data for *D. ampla* in central Texas.

Key Words: gregarious behavior, aposematic coloration, group defense

Doa ampla (Grote) is one of five species in the genus *Doa* (Neumoegen and Dyar 1894). The familial placement of this group has a checkered history (Donahue and Brown 1987). The genus *Doa* has at times been placed in the Lymantriidae (Dyar 1903, Holland 1903, Barnes and McDunnough 1917, Bryk 1934), Hypsidae (Walton 1912), Pericopidae (Schaus 1927, McDunnough 1938, Peterson 1948), Dioptidae (Brues and Melander 1954), and Arctiidae (Franclemont 1983). The genera *Doa* and *Leuculodes* (which contains two species) currently are placed in the family Doidae within the superfamily Noctuoidea (Donahue and Brown 1987). According to Donahue and Brown, elevation of doid months to the family level represents an interim solution; however, Miller (1991) strongly supported family status.

All known host plants of *D. ampla* are in the family Euphorbiaceae. *Doa ampla* previously has been reared on *Euphorbia robusta* (Engelmann) in Colorado (Cockerell 1911), *E. incisa* Engelmann and *E. lurida* Engelmann in Arizona, and *Stillingia texana* L. in Texas (Donahue and Brown 1987). *Doa ampla* occurs from Colorado east to Texas, southward to Durango and Nuevo León, Mexico, and west to Arizona (Donahue and Brown 1987). Aside from limited information on geographic distribution and host plant range, nothing is known of the biology and ecology of *D. ampla*. Here we confirm *S. texana* as a primary host plant of *D. ampla* in Texas, document aspects of the biology, ecology, and behavior of larval and adult stages, and provide distribution data for *D. ampla* in central Texas.

METHODS

Here we present the findings of field and laboratory studies conducted during the summers of 1996 and 1997. To confirm *S. texana* as a host plant of *D. ampla* (as evidenced by acceptance of *S. texana* for oviposition and the ability of *D. ampla* larvae to complete development successfully) we searched *S. texana* plants for ovipositing females, egg clusters, and larvae at three field sites. These field sites were located at Honey Creek State Natural Area (Comal Co., Texas), Pollard Refuge (Southwest Texas State University, Hays Co., Texas), and a privately owned site along Devils Backbone (Comal Co., Texas). We censused daily egg clusters located in the field to estimate timing events in the life cycle, describe larval behavior, and document natural enemies. In addition, we collected females from *S. texana* patches and introduced them onto potted *S. texana* plants in the laboratory to monitor oviposition. We subsequently monitored egg clusters daily to estimate rates of development for each instar at 21–23°C.

We gathered initial distribution and abundance data for *D. ampla* in south-central Texas by surveying *S. texana* populations in seven adjacent counties located along the eastern edge of the Edwards Plateau. Primary state roads were used to establish multiple transects across each county. All *S. texana* populations on each transect that were accessible through a public right-of-way were searched for *D. ampla* egg clusters and larvae. We recorded the location (latitude, longitude, and elevation) of sites containing *D. ampla* by use of a Magellan GPS unit to provide site records for this apparently uncommon species (see below). We recorded site characteristics of occupied and unoccupied plant populations to describe the habitat affinities of this herbivore.

Initial field observations indicated that groups of larvae are often capable of defoliating the host plant and thus must travel between host plants to complete development. To determine at which instar larvae are capable of dispersing to adjacent plants we field-tested the dispersal capabilities of first- through fourth-instar larvae. Five field-collected larvae of each instar were marked with fluorescent dye powder and placed on the ground in the center of a 1-m-diameter circular area bordered by a ring of *S. texana* plants. All trials were initiated in full sun between 1500 and 1600 to mimic the conditions under which late-instar larvae had been observed to move between plants. We then counted the number of larvae that successfully traversed the 0.5-m distance to a *S. texana* stalk after nightfall, using a UV lamp, and again at 24 hours. In total, 20 larvae of each instar were tested.

To describe the pattern of movement of feeding groups within plants and the movement of individual larvae within the natal plant as feeding aggregations fragmented we marked all second-instar larvae in feeding aggregations on selected plants at the Honey Creek field site using fluorescent dye. For the duration of the second and third instar we then relocated these larvae daily during both day and night. Using *D. ampla* clutches located on a second set of focal plants, we then estimated the rate of dispersal (%) and dispersal distance of third-instar or older larvae from natal plants. On each focal plant we counted and marked all larvae present with a color of dye unique to that plant just prior to the onset of dispersal (i.e., immediately after the molt into the third instar). We then censused each focal plant and all other *S. texana* plants within 20 m of each focal plant for marked larvae daily during both day and night until larvae molted into the fifth instar. Relocated larvae were re-marked after each molt to maintain unique marks. We calculated percent dispersal as the ratio of the number of third-, fourth-, and fifth-instar larvae relocated on adjacent plants to the original number of third-instar larvae on each focal plant. The distribution of distances moved from natal plants was used to construct a dispersal profile for late-instar larvae. We then compared the distribution of larval dispersal distances to the distribution of near-neighbor interplant distances to gauge the ability of dispersing larvae to locate neighboring host plants. To determine if dispersal from the natal host plant is related to resource depletion, we recorded the percent of leaves remaining on each focal plant at the time that larvae began to disperse and then used regression techniques to test for the dependency of dispersal rate on resource availability per plant.

RESULTS AND DISCUSSION

Host plant confirmation.—At our field sites we observed female *D. ampla* in residence with newly deposited egg clusters on *S. texana,* and caged females readily oviposited on the leaves of *S. texana* in the lab. Following oviposition on *S. texana* in the laboratory, we subsequently reared 48 *D. ampla* larvae to pupae and reared 12 of those to adults. Voucher specimens are deposited in the Southwest Texas State University Entomology Collection. These observations confirm *S. texana* as a primary host of *D. ampla* in central Texas.

During our field studies we observed third- and fourth-instar *D. ampla* larvae rarely feeding on *Chamaesyce acuta* Engelmann (Euphorbiaceae). No egg masses were observed on *C. acuta*, however, and no larvae found on *C. acuta* were relocated the following day on the same plant. Thus, this feeding appears to occur only when late-instar larvae are in transit between *S. texana* plants (see below). In addition to *S. texana*, two other species of *Stillingia*, *S. sylvatica* I. M. Johnst. and *S. treculiana* (Muell. Arg.) I. M. Johnst., occur in Texas. The distribution of *S. sylvatica* overlaps the eastern and northern edges of the geographic range of *S. texana*, whereas *S. treculiana* overlaps along the southwestern edge of *S. texana*'s range. We were unable to locate either species within the seven counties we surveyed. Hence, whether these species serve as additional hosts for *D. ampla* in regions of overlap with *S. texana*, as bridges to other known euphorb host plants whose geographic distributions occur west of Texas, or as both, remains unknown.

Distribution of *D. ampla* in central Texas.—We collected *D. ampla* larvae feeding on *S. texana* in six of seven counties surveyed. Representative GPS latitude—longitude—elevation coordinates of collection sites within each county are Bandera (29°43.42N, 99°7.47W, 555 m); Comal (29°55.46N, 98°9.10W, 326 m); Gillespie (30°10.42N, 98°44.65W, 639 m); Hays (29°56.13N, 98°7.24W, 393 m); Real (29°42.67N, 99°43.82W, 543 m); and Uvalde (29°45.50N, 99°31.15W, 682 m) (Fig. 1). In addition, *D. ampla* has been collected in Blanco County, Texas, by R. Kendall (Pedemales Falls State Park; collection date, 1973; personal communication).

Habitat affinities.—The host plant, *S. texana*, is a common though patchily distributed perennial that ranges from Oklahoma to Coahuila, Mexico. In Texas, the species is restricted to the dry calcareous soils of the Edwards Plateau region of south-central Texas, west to Val Verde Co., and north to Wise and Collin counties (Fig. 1). Within south-central Texas, we found *S. texana* to occur in two markedly different ecological contexts: (1) dense contiguous patches covering up to several hectares in heavily grazed lowlands and (2) sparse, patchily distributed small populations typically located in Hill Country uplands associated with moderate to steep slopes (20–45°). In upland areas, *S. texana* is characteristically smaller and has fewer and shorter flowering stalks per root system (mean number stalks per plant [± SE] upland = 4.2 ± 0.41, $n = 30$; lowland = 25.6 ± 1.9, $n = 30$; $t = 11.4$, $P < 0.01$; mean height tallest stalk per plant [± SE] upland = 30.0 cm ± 1.4, $n = 30$; lowland = 37.6 ± 1.9, $n = 30$; $t = 3.2$, $P < 0.01$).

We searched extensively for *D. ampla* on *S. texana* in both lowland and upland settings. However, we never found *D. ampla* in lowland sites and only found it in a small percent of upland sites examined. Moreover, within upland habitats where *D. ampla* was present, we rarely encountered larvae. For example, at the Honey Creek site (a primary study site based on the availability of *D. ampla*) we found eggs or larvae on fewer than 1% of the 1,042 plants censused. Nighttime black light surveys conduced at each of our three field sites known to be occupied by *D. ampla* failed to attract adults during the oviposition period. Thus, *D. ampla* is relatively rare in our study region, appears to be a habitat spe-

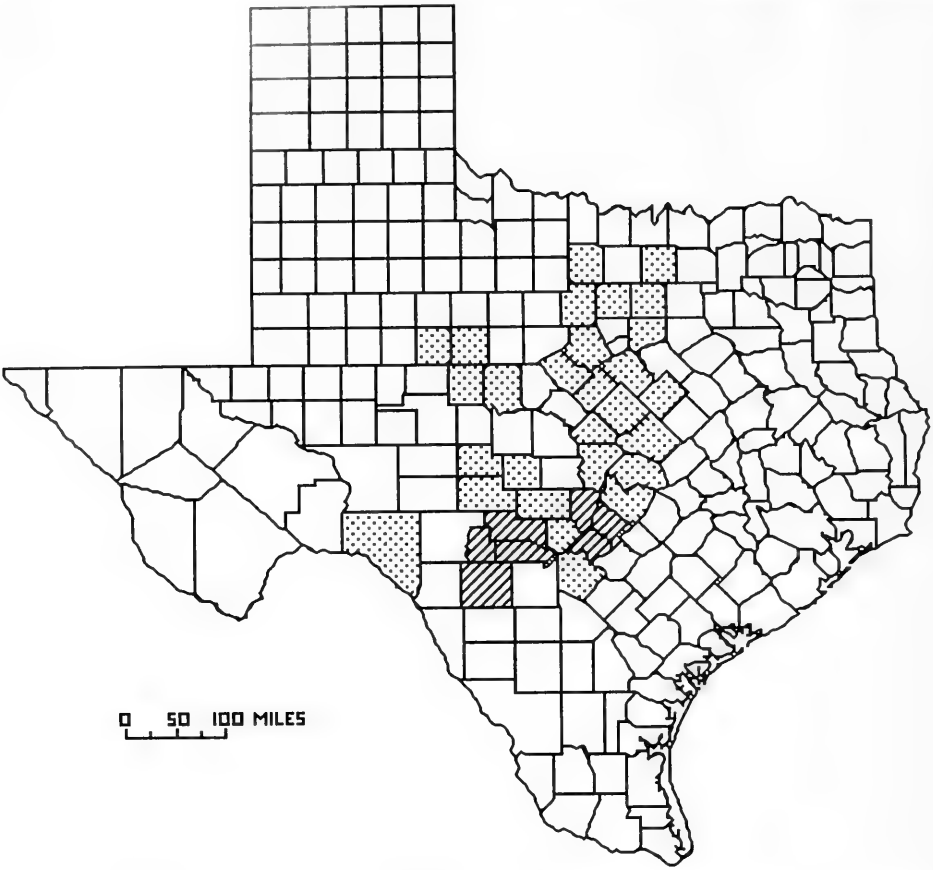


Fig. 1. The known geographic distribution of *Stillingia texana* (light stippling) and *Doa ampla* (cross-hatched) in Texas.

cialist, and is rarely encountered even within its preferred habitat. Restriction of *D. ampla* to small, sparse upland plants is enigmatic in that the majority of larvae in all but very small groups must leave the natal host at some point during development and travel to a new host plant due to resource limitation (Braswell 1998). Therefore, the absence of *D. ampla* in lowland settings, where plants are larger (i.e., more resources per plant and therefore reduced need for between-plant travel) and more dense (i.e., reduced risk associated with interplant travel) is counterintuitive.

Life cycle.—*Doa ampla* is bivoltine in central Texas, exhibiting two narrowly overlapping generations per year. Oviposition occurs in early to mid-May and again in mid-July. Eggs are laid in clusters of 7 to 231 eggs ($\bar{x} = 78.5 \pm 7.97$; $n = 44$) in parallel rows (Fig. 2). Egg clusters are placed on the underside of leaves on the upper one-fourth to one-third of the host plant. Occasionally, females covered a single leaf with eggs and moved to a second leaf to complete oviposition. Although field observations of females were rare and only a single female has been observed moving to a second leaf, the large discrepancy between the number of eggs on the first and second leaf suggests that the second group of eggs resulted from spillover of one clutch and not from a second female. Therefore, including spillover eggs, the mean number of eggs per clutch is 111.5 ± 11.51; $n = 31$. The larvae from different egg clusters generally developed as independent groups. These egg cluster sizes are much larger than the 15 to 35 eggs per cluster reported for *D. ampla* on host plants in Arizona by Donahue and Brown (1987).

First- and second-instar *D. ampla* are gregarious (Fig. 3). As in *D. dora* Neumoegen and Dyar (Brown 1990) and *D. raspa* Druce (Dyar 1911), all instars of *D. ampla* are boldy colored and patterned, presumably an aposematic display associated with the toxicity of the host plant (Fig. 4). *Doa ampla* larvae complete five instars before pupation (Fig. 5). In the laboratory at 21–23°C, mean development time from egg hatch to pupation on cuttings of *S. texana* was 35.8 d ($n = 48$) and from pupation to adult emergence was 16.25 d ($n = 12$). In the field, mean larval development time (for the first generation) from first to fifth instar was 32.6 days; larvae spent 9.9 d ($n = 8$ groups) as first instars, 8.1 d ($n = 13$ groups) as second instars, 7.0 d ($n = 9$ groups) as third instars, and 7.6 d ($n = 10$ groups) as fourth instars. In both the laboratory and field, fifth-instar larvae leave the host plant to pupate. Pupation sites in the field are unknown. In the laboratory *D. ampla* fifth-instar larvae spun cocoons on the bottom, sides, or top of their nylon screen cages. In contrast, *D. dora* is know to pupate in the debris at the base of its host plant (Brown 1990). The cocoon of *D. ampla* described by Dyar (1912) is similar to that produced by *D. dora* (Brown 1990) and *D. raspa* (Dyar 1911). Individual larval groups followed in the field underwent ecdysis relatively synchronously (all larvae in each group completed ecdysis within 2 days). In early May, fifth-instar larvae appeared on new growth of the host plant prior to appearance of eggs, indicating that second-generation *D. ampla* overwinter as late instar larvae, pupae, or both.

Larval feeding behavior.—First- and second-instar larvae feed inside a communal nest loosely constructed of sparse silk threads (Fig. 3) and feed preferentially in the upper one-third of the host plant. These early-instar larvae feed by scraping the upper and lower surfaces of leaves leaving behind skeletonized leaf material. The leaves of *S. texana* are defended by a well-developed laticifer system that exudes latex when cut. Dussourd and Eisner (1987) demonstrated the defensive properties of laticer systems against herbivorous insects by showing that when drained of latex, formerly unpalatable leaves become palatable. Numerous insect feeding behaviors have been shown to represent adaptations designed to deactivate latificer-based host plant defenses (Dussourd and Denno 1991). Latex exudate is not visible when first- and second-instar *D. ampla* larvae feed on *S. texana*. Thus the mode of feeding of early-instar larvae may either allow them to avoid the laticifer system completely or scraping may result in small nicks that depressurize the laticifer system and diminish latex flow. If scraping depressurizes the system, individual larvae in groups may avoid ingesting large amounts of latex via the cumulative effect of the group on latex flow. We hypothesize that the behaviors of leaf scraping and gregarious feeding of early instars function as adaptations to diminish the functionality of or circumvent the host plant's laticifer system (Braswell 1998).

Beginning with the third instar, feeding aggregations dissolve and larval feeding behavior changes. Larvae continue to feed preferentially on the uppermost leaves of the host plant; however, third- through fifth-instar larvae bite through the entire leaf blade, often leaving behind only the main rib of the leaf. At this stage larvae are exposed directly to the latex exudate produced by the plant. On host plants with multiple stalks, larvae move to new stalks before feeding on the lower leaves of any stalk. Paradoxically, latex flow from injured leaves is highest in the uppermost portions of the host plant (Braswell 1998).

Larval dispersal capabilities.—When larval density is high, early-instar larvae quickly consume the preferred feeding area and, on small plants, begin to defoliate the

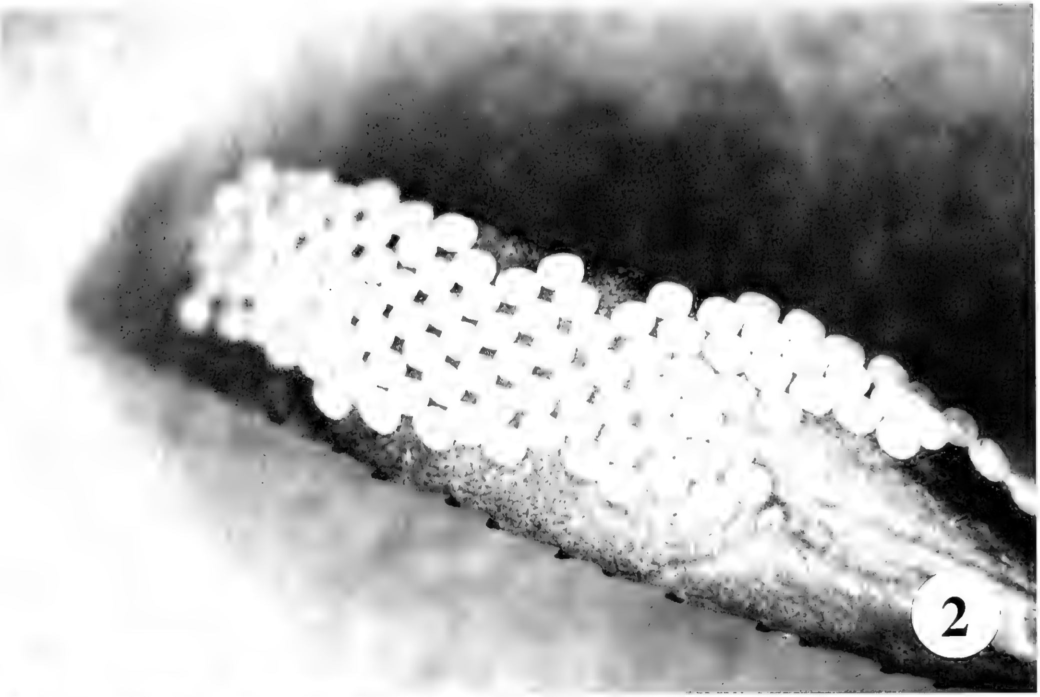


Fig. 2–3. 2, *Doa ampla* egg clusters on the underside of *Stillingia texana* leaves. 3, Second-instar *D. ampla* larvae exhibiting gregarious feeding behavior within a loose communal nest.

Fig. 4. Fifth-instar *Doa ampla* larvae exhibiting the aposematic color pattern typical of all instars (bright yellow background color with longitudinal black bands).

entire plant. Because larvae typically avoid lower leaves of the plant, they must travel from the natal plant to another plant to continue feeding. We observed first- and second-instar larvae only on host plants with evidence of prior gregarious feeding (i.e., skeletonized leaves), suggesting that early instars do not disperse from the natal plant. Third- through fifth-instar larvae, however, were found on host plants lacking evidence of prior gregarious feeding, suggesting that these instars do disperse.

The results of our dispersal capability experiment confirmed these field observations. First- and second-instar larvae were incapable of traveling between host plants: none of 40 first- and second-instar larvae managed to move the 0.5-m linear distance required to reach a host plant, and all died within 24 h without traveling. However, 100% (40/40) of the third- and fourth-instar larvae tested traveled to a new host plant and initiated feeding within 8 h. Marking and monitoring second-instar larvae in feeding aggregations showed that beginning with the third instar, concomitant with the switch in feeding mode, aggregations disintegrate and larvae independently move to new feeding positions on a plant, migrate to new host plants, or both.

An average of 82% of dye-marked third-instar larvae left their natal plants prior to completing development. Most larvae settled on near-neighbor plants, and no larvae traveled more than 5 m from the natal plant (Fig. 6). Mean dispersal distance of third-instar or older larvae (3.6 m ± 1.9, n = 126) did not differ from the mean distance between nearest-neighbor plants (1.6 m ± 7.6, n = 73) in the field population of *S. texana* we examined (t-test of means with unequal sample sizes and unequal variances, $P > 0.05$). These data suggest that whereas dispersing larvae may not always find the nearest-neighbor plant in relation to

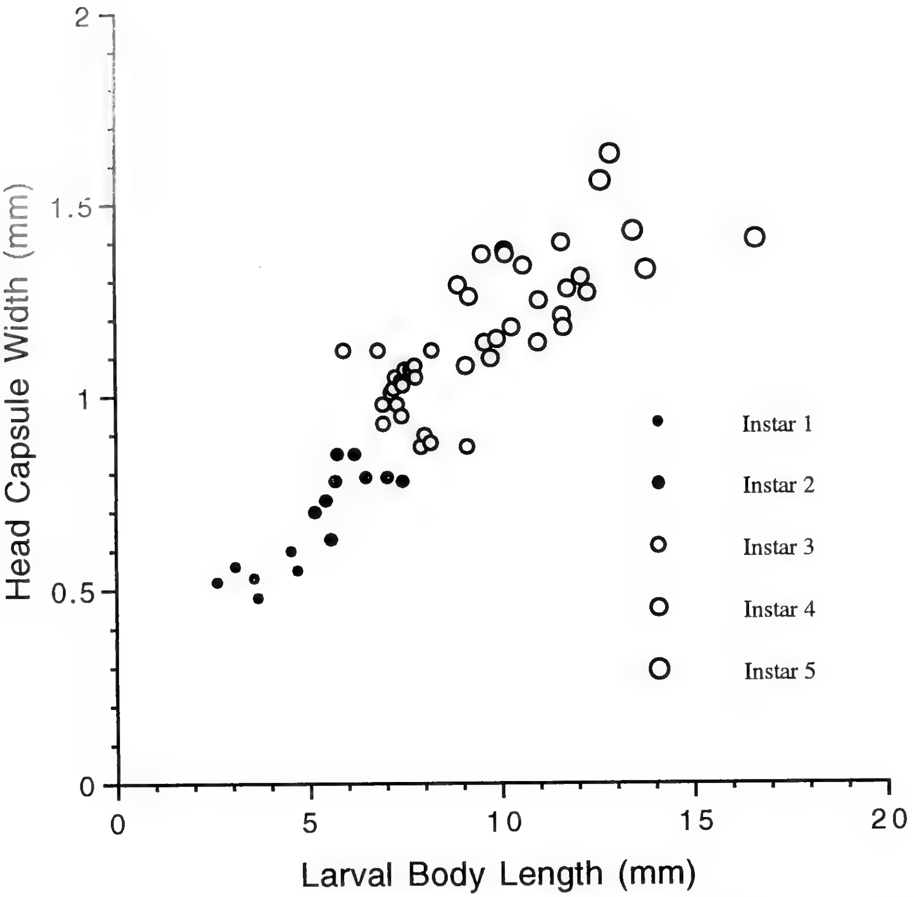


Fig. 5. The relationship between head capsule width and body length for *Doa ampla* larvae, illustrating the five instars. Instars are represented by increasing-sized symbols. Instars exhibiting gregarious behavior are depicted with shaded symbols.

their natal plant, they are relatively adept at locating near-neighbor host plants.

Third-instar larvae can markedly reduce the number of leaves per plant prior to the onset of dispersal. The percent of leaves remaining per plant was inversely and nonlinearly related to the number of third-instar larvae per group ($R^2 = 0.41$, $P < 0.05$; Fig. 7). Moreover, the percent of larvae that dispersed was negatively related to the percent of leaves remaining on the host plant ($R^2 = 0.38$, $P < 0.05$; Fig. 8). Therefore, dispersal rate appears to be influenced by resource availability as mediated by the interaction of larval group size and plant size.

Larval defensive behavior.—First and second instars when disturbed exhibit a head-flicking display. In this display, larvae rear up on the abdominal prolegs and thrash the head from side to side. The display occurs synchronously within the aggregation, and communication between larvae appears to be facilitated by the silk of the nest. Following continued disturbance, larvae drop from the host on silken threads. In later instars the head-flicking behavior decreases and larvae are more likely to drop to the ground when disturbed.

Predators and parasitoids.—Through two field seasons we observed relatively few

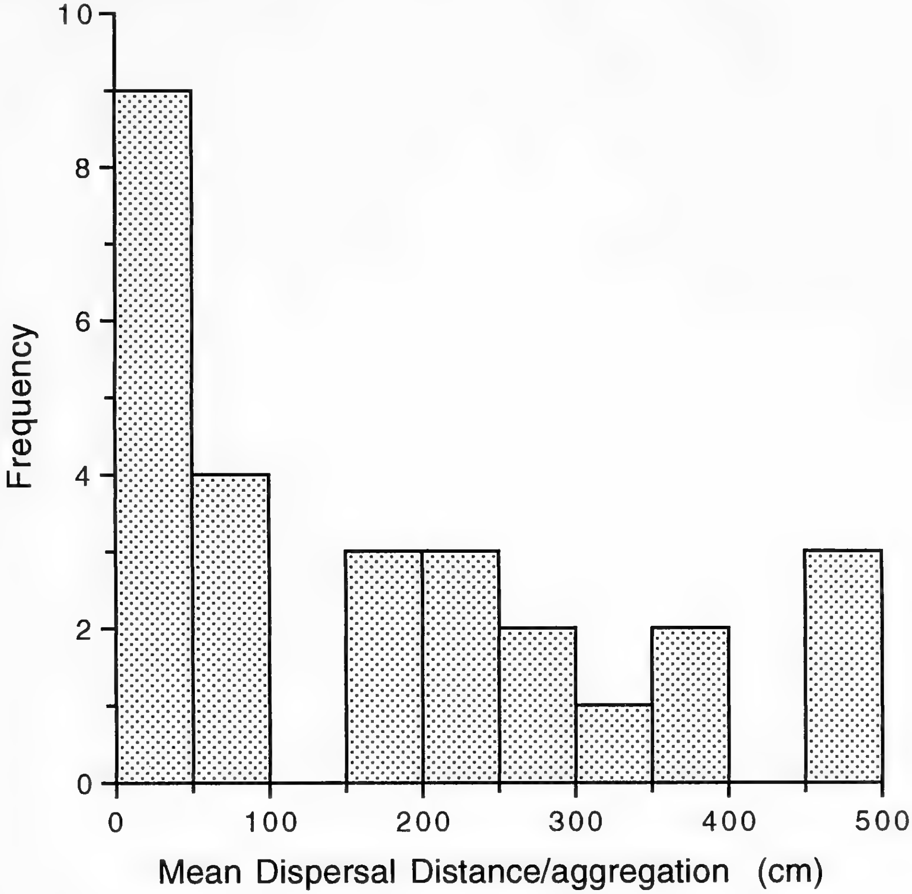
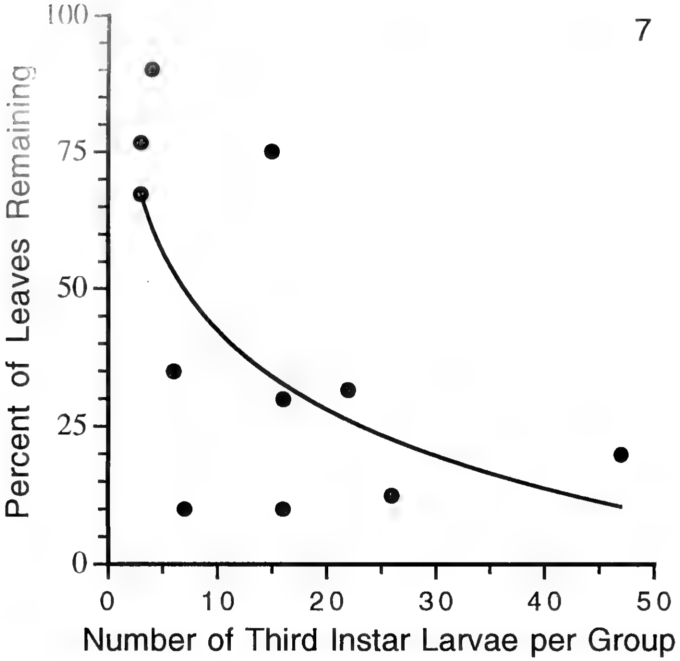


Fig. 6. Mean dispersal distances/group for each of 25 groups of later-instar *D. ampla* larvae from their natal host plants under field conditions.

acts of larval predation and no acts of larval parasitism. No predation or parasitism of eggs was observed. The only successful acts of predation occurred on early-instar larvae by ants, which collectively attacked and removed single larvae. The only other act of predation we observed was an attack by a lynx spider (*Peucetia viricans* Hentz) on a third-instar larva. The spider bit and killed the larva but never returned to consume it. We collected later-instar larvae from both generations that appeared to have been parasitized as evidenced by their sluggish, unresponsive behavior. These animals did not feed and remained alive for months before dehydrating. No parasitoids emerged from these larvae.

SUMMARY

Stillingia texana is a host plant for *Doa ampla* in central Texas. Although this host plant is common throughout the eastern edge of the Edwards Plateau, often occurring in large, contiguously distributed populations, *D. ampla* is rarely encountered and is restricted to small, low-density patches of host plant occupying upland regions of moderate to steep slope. *Doa ampla* is bivoltine in central Texas and overwinters as late-instar larvae, pupae, or both. First- and second-instar larvae feed gregariously on leaf tissue by scraping the epidermal layer. This mode of feeding circumvents or reduces contact with the plant's la-



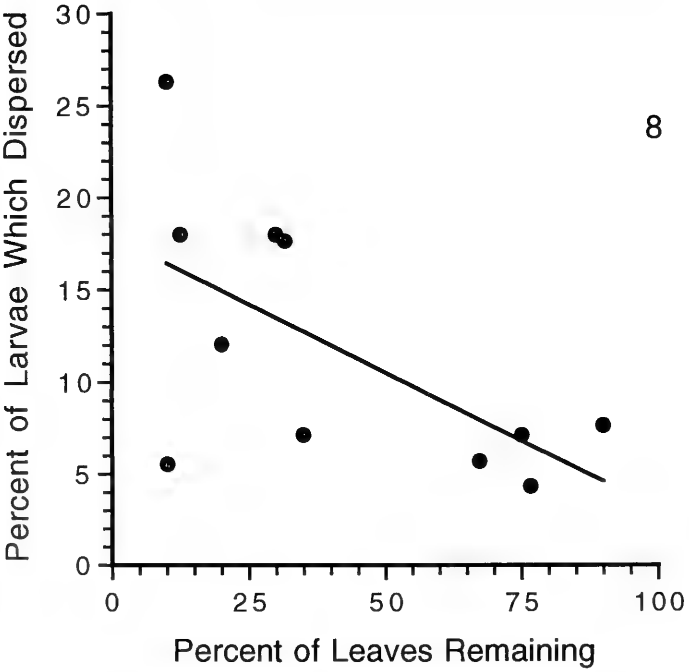


Fig. 7–8. 7, The relationship between the number of third-instar larvae per group at the onset of dispersal and the percent of leaves remaining per plant ($y = 90.1 - 47.6(x)$; $R^2 = 0.41$, $P < 0.05$). 8, The relationship between resource availability (percent of leaves remaining at the onset of dispersal) and the percent of larvae that disperse from their natal plant ($y = 17.9 - 0.15(x)$; $R^2 = 0.38$, $P < 0.05$).

ticifer system. Beginning at the third instar, the mode of feeding switches to leaf chewing, and feeding aggregations dissolve. Later-instar larvae continue to feed on the natal plant or disperse to adjacent plants. Only third-instar or later larvae are capable of dispersal, and dispersing larvae are adept at locating near-neighbor host plants. Dispersal rate from natal plants may be governed by resource availability during the third larval instar, which may be mediated by feeding group size in relation to plant size. The ecological factors underlying dispersal from natal plants deserve further attention as there seems to be a fundamental conflict between the clutch size deposited by females on plants and the amount of resources required to support development of the clutch. First- and second-instar larvae exhibit group defense, and all instars are brightly patterned with contrasting colors. The apparent lack of natural enemies, along with the gregarious nature, defensive behaviors, apparent aposematic coloration, and the chemical composition of the host plant suggest that *D. ampla* larvae are noxious to natural enemies and that the larval color pattern may function as warning coloration used to deter predation. Based on these initial observations *D. ampla* populations may be controlled by factors other than natural enemies.

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LIFE HISTORY AND DESCRIPTION OF IMMATURE STAGES OF *NEASPILOTA APPENDICULATA* FREIDBERG AND MATHIS (DIPTERA: TEPHRITIDAE) ON *MACHAERANTHERA CANESCENS* (PURSH) A. GRAY (ASTERACEAE) IN SOUTHERN CALIFORNIA

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Abstract.—*Neaspilota appendiculata* Freidberg and Mathis is a univoltine, monophagous fruit fly (Diptera: Tephritidae) developing solely in the flower heads of *Machaeranthera canescens* (Pursh) A. Gray (Asteraceae) belonging to the subtribe Solidagininae of the tribe Astereae in southern California. The egg, first-, second-, and third-instar larvae, and puparium are described and figured. The pedicel of the egg is completely circumscribed apically by different sized, semicircular to elliptical aeropyles arranged singly and in rows of two to three parallel to the long axis of the egg. The dorsal sensory organ of the first instar is well defined, but flattened, not dome-shaped, and the single integumental petal and stomal sense organ are fused in this instar. The lateral stelex sensilla are ringed basally with three, irregular, poorly developed acanthae. The anterior thoracic spiracle of the second instar uniquely bears eight, cuboidal papillae, reduced to two or three, oblong papillae in the third instar. The ventrally-toothed oral ridges number seven in the third instar, which compares to seven or eight in one congener, and six in three other congeners examined to date. The ventrally toothed appearance and arrangement in a vertical series of these oral ridges appears to be a generic character. The puparium is reniform in shape. The larvae feed mainly on the ovules and soft achenes as first and second instars; however, as third instars, they usually extend their feeding into the receptacle and additionally feed on sap that collects in the shallow scars. The nonfeeding prepuparium overwinters in a protective cell that occupies much of the excavated flower head and is formed of floret, pappus, ovule and achene fragments impregnated with excess sap and liquid feces that harden when dry. A few prepuparia pupate and emerge from their cells in the late summer and fall and probably overwinter as adults, but most pupariate during the next year in late-winter to early spring, and emerge as adults that aggregate in summer on preblossom host plants to mate and subsequently oviposit. *Pteromalus* sp. (Hymenoptera: Pteromalidae) was reared as a solitary, larval-pupal endoparasitoid, and an unidentified Eulophidae (Hymenoptera) was reared as a gregrarious endoparasitoid from puparia of *N. appendiculata*.

Key Words: Insecta, *Neaspilota, Machaeranthera*, Asteraceae, nonfrugivorous Tephritidae, biology, taxonomy of immature stages, flower-head feeding, monophagy, seed predation, parasitoids

Revision of the genus *Neaspilota* (Diptera: Tephritidae) by Freidberg and Mathis (1986) facilitated determination of specimens reared from California Asteraceae

(Goeden 1989) and stimulated several life-history studies, including those on *N. viridescens* Quisenberry (Goeden and Headrick 1992), *N. wilsoni* Blanc and Foote (Goeden and Headrick 1999), *N. signifera* (Coquillett) (Goeden 2000a), and *N. aenigma* Freidberg and Mathis (Goeden 2000b). This paper describes the immature stages and life history of a fifth species from California, *N. appendiculata* Freidberg and Mathis.

MATERIALS AND METHODS

The present study was based in large part on dissections of flower heads of *Machaeranthera canescens* (Pursh) A. Gray collected discontinuously during 1988–1997 mainly from the following three locations in the northern section of the San Bernardino Nat. Forest, SW San Bernardino Co.: Onyx Peak at 2700-m elevation, Caribou Creek along Van Duzen Canyon Road at 2120 m, and N shore Big Bear Lake at 2020 m. 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, six first-, 12 second-, and 13 third-instar larvae, and five puparia dissected from flower heads were preserved in 70% EtOH for scanning electron microscopy (SEM). Additional prepuparia and 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 hexamethyldisilazane (HMDS), mounted on stubs, sputter-coated with a gold-palladium alloy, and studied and photographed with a Philips XL-30 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 studies of longevity and sexual maturation in the insectary of the Department of Entomology, University of California, Riverside, at 25 ± 1°C, and 14/10 (L/D) photoperiod. Six pairs of virgin males and females obtained from emergence cages also were held in each of six separate, clear-plastic, petri dishes provisioned with a flattened, water-moistened pad of absorbant cotton spotted with honey (Headrick and Goeden 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 Goeden (2000a, b), Goeden et al. (1998), Goeden and Headrick (1992, 1999), Goeden and Teerink (1997; 1998; 1999a, b), Teerink and Goeden (1999), and our earlier works cited therein. Means ± SE are used throughout this paper. Voucher specimens of *N. appendiculata* immature stages, adults, and parasitoids reside in my research collections.

RESULTS AND DISCUSSION

Taxonomy

Adult.—*Neaspilota appendiculata* was described by Freidberg and Mathis (1986, p. 37–39), who pictured the unpatterned wing (p. 72), along with drawings (p. 38) of the lateral aspect of the head, male right foretarsus, epandrium, distiphallus, epandrium and cerci, aculeus and its apex enlarged, and spermatheca.

Immature stages.—The egg, first-, second-, and third-instar larvae, and puparium

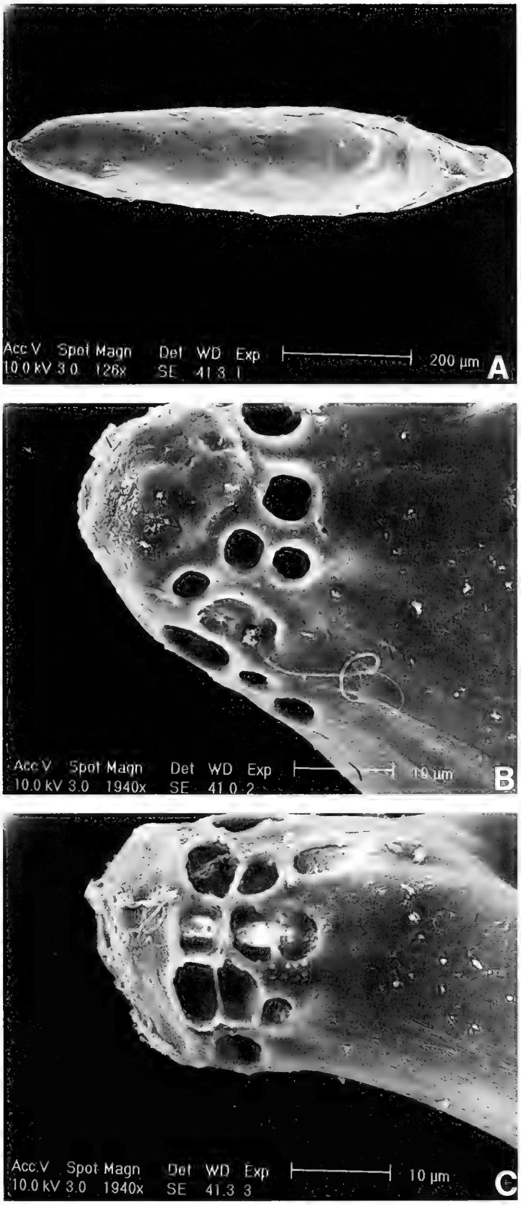

Fig. 1. Egg of *Neaspilota appendiculata:* (A) habitus, anterior end to left; (B) pedicel showing pattern of aeropyles; (C) pedicel of a different egg with its aeropyles.

heretofore have not been described or figured.

Egg: Thirty-three eggs dissected from field-collected flower heads were white, opaque, smooth, elongate-ellipsoidal, 0.71 ± 0.017 (range, 0.62–0.96) mm long, 0.175 ± 0.003 (range, 0.16–0.22) mm wide, smoothly rounded at tapered basal end (Fig. 1A); pedicel button-like, 0.02 mm long, completely circumscribed apically by different-sized, semicircular to elliptical, shallow aeropyles, through which the spongy inner layers of the chorion are readily visible; aeropyles arranged singly and in rows of two to three, parallel to the long axis of the egg (Fig. 1B, C).

The egg of *N. appendiculata* is similar in shape to those of *N. viridescens* (Goeden and Headrick 1992) and *N. wilsoni* (Goeden and Headrick 1999), but about 20% longer on average than that of *N. viridescens*, and 24% shorter and 27% wider on average than that of *N. wilsoni* (Goeden and Headrick 1999). Moreover, *N. appendiculata* has more aeropyles that are more regularly and densely spaced around the pedicel apex than *N. viridescens* (Goeden and Headrick 1992), but fewer aeropyles than *N. wilsoni*, which essentially cover the conical pedicel (Goeden and Headrick 1999). The eggs of 12 species of *Trupanea* from California mainly differ from eggs of the three *Neaspilota* spp. studied to date by having pedicels circumscribed by only one or two rows of aeropyles (Goeden and Teerink 1999b and references therein).

First instar: White, elongate-cylindrical, bluntly rounded anteriorly and posteriorly (Fig. 2A); body segments well defined, nearly free of minute acanthae; gnathocephalon smooth, lacking oral ridges, with pair of prominent integumental petals dorsad of mouth hooks (Fig. 2B-1); dorsal sensory organ well-defined, dome-shaped papilla (Fig. 2C-1), pit sensillum at base of dorsal sensory organ; anterior sensory lobe (Fig. 2B-2, C-2) bears terminal sensory organ (Fig. 2C-3); lateral sensory organ (Fig. 2C-4), supralateral sensory organ (Fig. 2C-5), and pit sensory organ (Fig. 2C-6); stomal sense organ ventrolateral of anterior sensory lobe (Fig. 2B-3, C-7), integumental petal (Fig. 2B-1) fused laterally with stomal sense organ (Fig. 2B-3); mouthhook bidentate (Fig. 2B-4, C-8); median oral lobe lat-

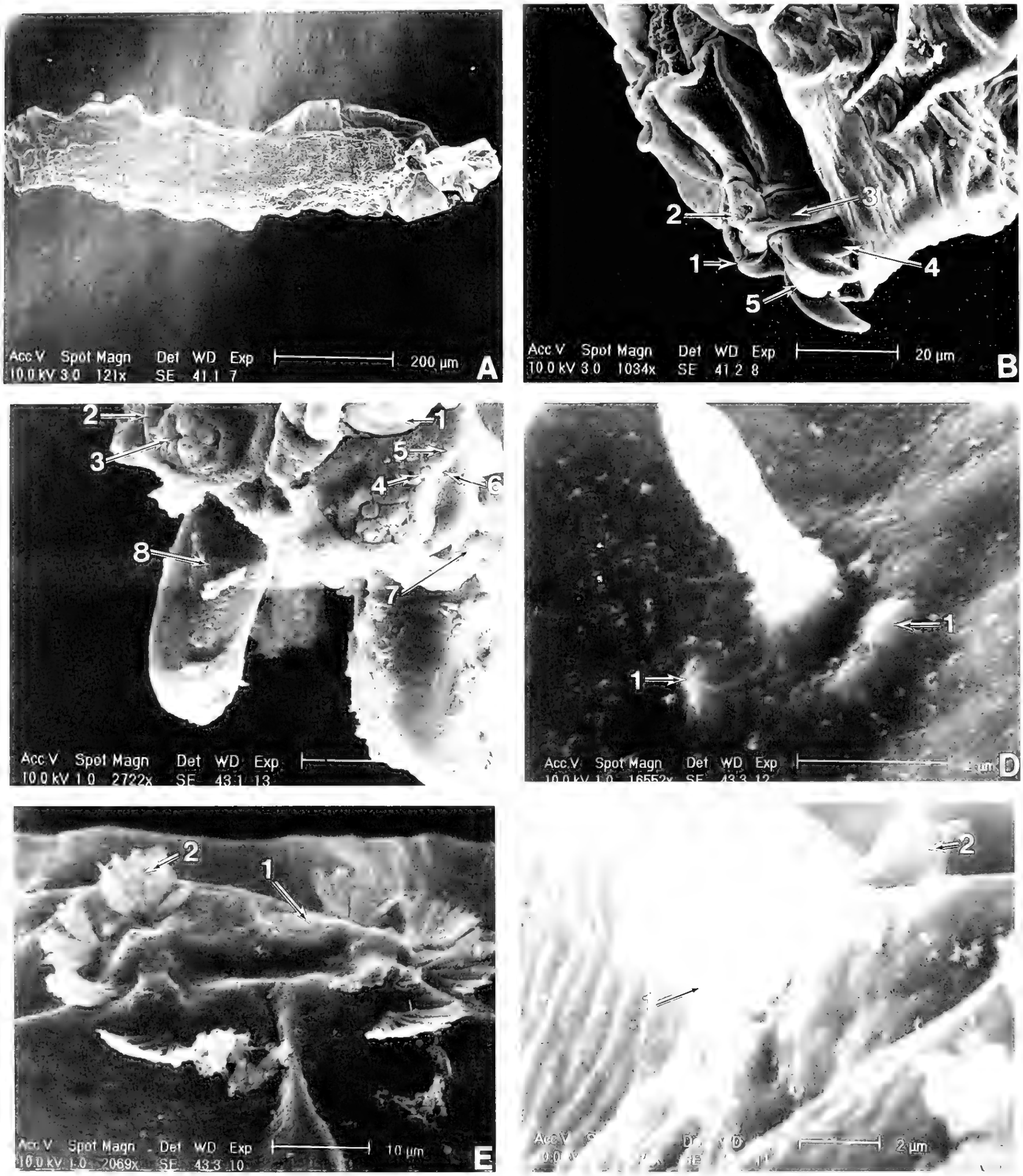

Fig. 2. First instar of *Neaspilota appendiculata:* (A) habitus, anterior to left; (B) gnathocephalon, ventrolateral view, 1-integumental petal, 2-anterior sensory lobe, 3-stomal sense organ, 4-mouth hook, 5-median oral lobe; (C) gnathocephalon, frontal view, 1-dorsal sensory organ, 2-anterior sensory lobe, 3-terminal sensory organ, 4-lateral sensory organ, 5-supralateral sensory organ, 6-pit sensory organ, 7-stomal sense organ, 8-mouthhook; (D) ventrolateral stellex sensillum, 1-basal acanthae; (E) anal segment, 1-rima, 2-interspiracular process; (F) intermediate sensory complex, 1-stelex sensillum, 2-medusoid sensillum.

erally flattened (Fig. 2B-5); meso- and metathoracic and abdominal lateral spiracular complexes not seen; caudal segment with two stelex sensilla, dorso- and ventrolateral of posterior spiracular plate, each stelex sensillum (Fig. 2D) basally ringed with three, irregular, poorly developed acanthae (Fig. 2D-1); posterior spiracular plate bears two ovoid rimae, ca. 0.008 mm in length (Fig. 2E-1), and four interspiracular processes, each with two to four branches, longest measuring ca. 0.01 mm (Fig. 2E-2); intermediate sensory complex with one stelex sensillum (Fig. 2F-1) and one medusoid sensillum (Fig. 2F-2).

The first instar is similar in general habitus to that of *N. viridescens* (Goeden and Headrick 1992), *N. wilsoni* (Goeden and Headrick 1999), *N. signifera* (Goeden 2000a), and *N. aenigma* (Goeden 2000b). However, unlike *N. viridescens*, but like *N. wilsoni* and *N. aenigma*, the dorsal sensory organ of the first instar of *N. appendiculata* is well defined (Fig. 2C-1), as is the anterior sensory lobe (Fig. 2B-2, C-2) and integumental petal (Fig. 2B-1). Also, the pit sensory organ (fig. 2C-6), not seen in *N. viridescens* (Goeden and Headrick 1992) and presumably hidden in specimens viewed of *N. signifera* (Goeden 2000a), is present in *N. appendiculata*, as it is in *N. wilsoni* (Goeden and Headrick 1999) and *N. aenigma* (Goeden 2000b). A fused integumental petal and stomal sense organ also was reported in first instars of *N. wilsoni* (Goeden and Headrick 1999), *N. signifera* (Goeden 2000a), and *N. aenigma* (Goeden 2000b) as well as *Trupanea vicina* (Wulp) (Goeden and Teerink 1999b), but these structures were separated in *N. viridescens* (Goeden and Headrick 1992)

Having two stelex sensilla dorso- and ventrolaterad of each posterior spiracular plate in the first instar of *N. appendiculata* (Fig. 2D) and *N. aenigma* (Goeden 2000b) agreed with the four such sensilla reported to ring the caudal segment of *N. wilsoni* (Goeden and Headrick 1999), but not the 10 sensilla reported to ring the caudal segment of *N. viridescens* (Goeden and Headrick 1992). The last number is probably erroneous, as discussed by Goeden (2000b). Lateral stelex sensilla on the caudal segment that are basally ringed with acanthae (Fig. 2D-1) first were reported in *N. wilsoni* (Goeden and Headrick 1999), where the upright acanthae among them number one to three and are pointed, and in *N. aenigma* (Goeden 2000b), where the upright acanthus is solitary and rounded apically.

Second instar: White, elongate-cylindrical, rounded anteriorly, truncated dorsoposteriorly (Fig 3A), body segments well defined, circumscribed by only a few minute acanthae; dorsal sensory organ well-defined (Fig. 3B-1, C-1), with basally associated pore sensilla (Fig. 3C-2); anterior sensory lobe (Fig. 3B-2, C-3) with terminal sensory organ (Fig. 3B-3, C-4), lateral sensory organ (Fig. 3C-5), supralateral sensory organ (Fig. 3C-6), and pit sensory organ (Fig. 3C-7); stomal sense organ ventrolaterad of anterior sensory lobe (Fig. 3B-4, C-8); mouthhook bidentate (Fig. 3B-5); median oral lobe laterally compressed (Fig. 3B-6), ventrally transversely divided (not shown); seven papilliform, integumental petals dorsal to each mouthhook (Fig. 3B-7, C-9); six oral ridges toothed ventrally, lateral to oral cavity (Fig. 3B-8); pore sensilla circumscribe gnathocephalon posterior to oral ridges (Fig. 3B-9); prothorax circumscribed anteriorly by minute acanthae (Fig. 3B-10); anterior thoracic spiracle with eight cuboidal papillae (Fig. 3D); lateral spiracular complexes not seen; caudal segment with two stelex sensilla dorsolaterad and ventrolaterad of posterior spiracular plate (not shown); posterior spiracular plate bears three ovoid rimae, ca. 0.02 mm long, and four interspiracular processes, each with four, simple or forked branches, longest measuring 0.012 mm; intermediate sensory complex with a stelex sensillum and a medusoid sensillum.

The habitus of the second instar of *N. appendiculata* (Fig. 3A) is more like *N. wilsoni* (Goeden and Headrick 1999), *N. signifera* (Goeden 1999a), and *N. aenigma* (Goeden 2000b) than the barrel-shaped second instar of *N. viridescens* (Goeden and Headrick 1992). The dorsal sensory organ of *N. appendiculata* is well defined in the second instar (Fig. 3C-1), as with *N. signifera* (Goeden 1999a), but is not well defined in *N. viridescens* (Goeden and Head-

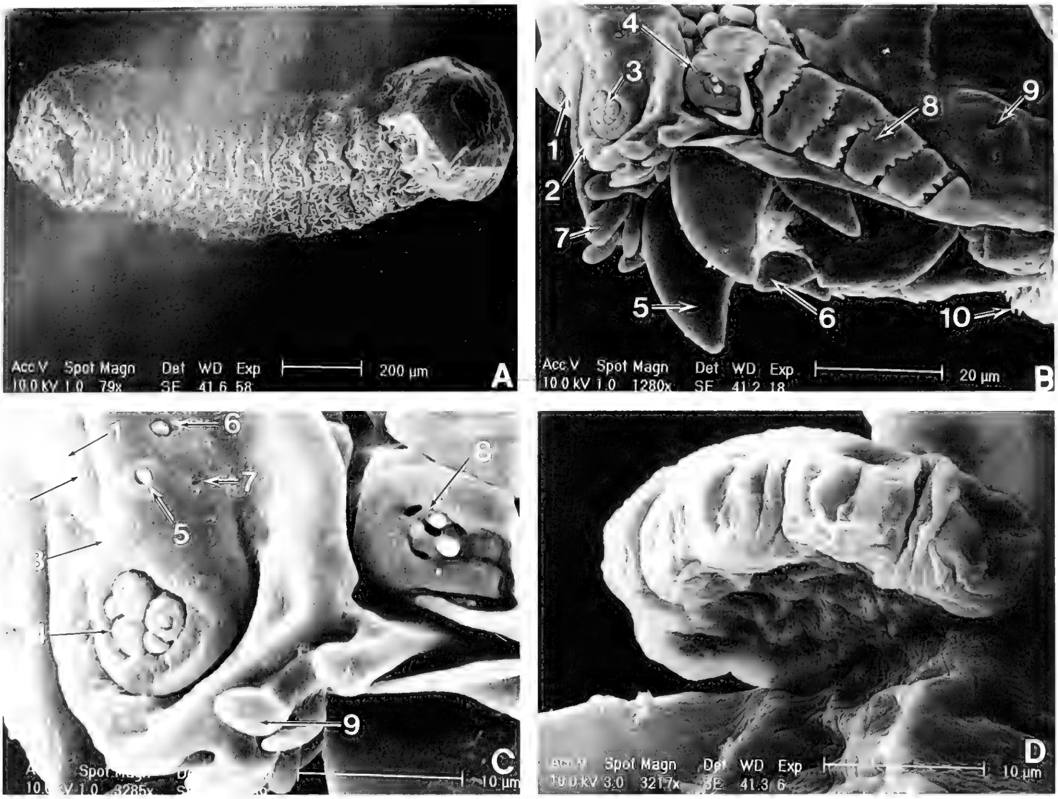

Fig. 3. Second instar of *Neaspilota appendiculata:* (A) habitus, anterior to left; (B) gnathocephalon, ventrolateral view, 1-dorsal sensory organ, 2-anterior sensory lobe, 3-terminal sensory organ, 4-stomal sense organ, 5-mouthhook, 6-median oral lobe, 7-integumental petal, 8-oral ridge, 9-pore sensillum, 10-minute acanthae; (C) anterior sensory lobe, 1-dorsal sensory organ, 2-basilateral, pore sensillum, 3-anterior sensory lobe, 4-terminal sensory organ, 5-lateral sensory organ, 6-supralateral sensory organ, 7-pit sensory organ, 8-stomal sense organ, 9-integumental petal; (D) anterior spiracle.

rick 1992), *N. wilsoni* (Goeden and Headrick 1999), or *N. aenigma* (Goeden 2000b). The integumental petals of the second instars of all five species are papilliform and seven in number above each mouthhook in *N. appendiculata* (Fig. 3B-7), but four occur in *N. signifera* (Goeden 2000a), six in *N. viridescens* (Goeden and Headrick 1992), seven in *N. wilsoni* (Goeden and Headrick 1999), and eight occur in *N. aenigma* (Goeden 2000b); whereas, in the first instars of all five congeners examined these structures are broad, flattened, and paired (Fig. 2B-1; Goeden and Headrick 1992, 1999; Goeden 2000a, b). A clear difference in *N. appendiculata* is the eight papillae on the anterior spiracle of the second instar (Fig. 3D), compared to three to four papillae in second instars of *N. viridescens* (Goeden and Headrick 1992), *N. wilsoni* (Goeden and Headrick 1999), *N. signifera* (Goeden 2000a), and *N. aenigma* (Goeden 2000b). Only the third-instar of *Paracantha gentilis* Hering with seven to eight papillae on the anterior spiracle (Headrick and Goeden 1990) approached this number among the 34 species of tephritid larvae that we have described in similar detail to date. Finally, the interspiracular processes each bear four branches, not one to four branches like *N. aenigma* (Goeden 2000b), nor two to four branches like *N. signifera* (Goeden 1999a), nor five to nine branches like those of *N. viridescens* (Goeden and Headrick

1992), nor two to six branches like those of *N. wilsoni* (Goeden and Headrick 1999).

Third instar: Pale yellow, with posterior spiracular plate dark brown to black, elongate-cylindrical, tapering anteriorly; posterior spiracular plate on caudal segment flattened and upturned dorsally ca. 60° (Fig. 4A), minute acanthae circumscribe anterior thirds of thoracic and abdominal segments (Fig. 4B-1, C-1, D-1); gnathocephalon conical (Fig. 4B); dorsal sensory organ a well-defined, circular, flattened pad (Fig. 4B-2); anterior sensory lobe (Fig. 4B-3) bears terminal sensory organ (Fig. 4B-4), lateral sensory organ (Fig. 4B-5), supralateral sensory organ (Fig. 4B-6), and pit sensory organ (not shown); six, papilliform, integumental petals above each mouthhook (Fig. 4B-7); seven oral ridges toothed ventrally lateral to oral cavity (Fig. 4B-8); stomal sense organ ventrolateral of anterior sensory lobe (Fig. 4B-9); mouthhook tridentate (Fig. 4B-10); median oral lobe laterally flattened (Fig. 4B-11); prothorax circumscribed by minute acanthae (Fig. 4B-1); verruciform sensilla circumscribe prothorax posteriorad of minute acanthae (Fig. 4B-12); anterior thoracic spiracle on posterior margin of prothorax bears two or three oblong papillae; mesothoracic lateral spiracular complex consisting of spiracle (Fig. 4C-2) and five verruciform sensilla (Fig. 4C-3), two above and three below the spiracle; metathoracic lateral spiracular complex consisting of five verruciform sensilla (Fig. 4C-4), one above and four below the spiracle (Fig. 4C-5); abdominal lateral spiracular complex consists of a spiracle (Fig. 4D-1) anterior to a verruciform sensillum (Fig. 4D-2), and two or three other verruciform sensilla, one above (not shown in Fig. 4D) and one (Fig. 4D-2) or two (unpublished data) below the spiracle; caudal segment circumscribed by minute acanthae (Fig. 4E-1); each posterior spiracular plate bears three ovoid rimae, ca. 0.03 mm in length (Fig. 4E-2), and three-four interspiracular processes (Fig. 4E-3), each with four, simple, pointed or forked branches, longest branch measuring 0.015 mm; stelex sensilla (Fig. 4F) dorsolaterad, laterad, and ventrolaterad of posterior spiracular plate (Fig. 4E); each of the eight stelex sensilla surrounding the posterior spiracular plate in turn ringed by four to six, conical minute acanthae (4F-1); intermediate sensory complex with a medusoid sensillum and a stelex sensillum.

The habitus of the third instar of *N. appendiculata* generally is like that reported for *N. viridescens* (Goeden and Headrick 1992), *N. wilsoni* (Goeden and Headrick 1999), *N. signifera* (Goeden 2000a), and *N. aenigma* (Goeden 2000b). Like *N. signifera* (Goeden 2000a), the anterior part of each body segment of *N. appendiculata* is circumscribed by minute acanthae. Whereas, in *N. aenigma* the anteriors, pleura, and posteriors of each segment are thus circumscribed (Goeden 2000b); in *N. wilsoni*, all intersegmental areas and all abdominal segments except the pleura are so circumscribed (Goeden and Headrick 1999); and in *N. viridescens*, the intersegmental areas are free of acanthae (Goeden and Headrick 1992). Unlike *N. viridescens* (Goeden and Headrick 1992) and *N. wilsoni* (Goeden and Headrick 1999), but like *N. signifera* (Goeden 2000a) and *N. aenigma* (Goeden 2000b), the dorsal sensory organ is well defined, but flattened and not dome-shaped in the third instar of *N. appendiculata* (Fig. 4B-2). In the second instar of *N. wilsoni* (Goeden and Headrick 1999), *N. signifera* (Goeden 2000a), and *N. appendiculata* (Fig. 3B-2), the dorsal sensory organ is both prominent and dome-shaped, as it is in the first instar of all congeners except *N. signifera*, where it was hidden in my specimens and could not be examined for comparison (Goeden 2000a).

Additional similarities involved the integumental petals in the third instars of all five congeners examined to date, all of which are papilliform and arranged in a double row above each mouth hook (Goeden and Headrick 1992, 1999; Goeden 2000a, b; Fig. 4B-7). The stomal sense or-

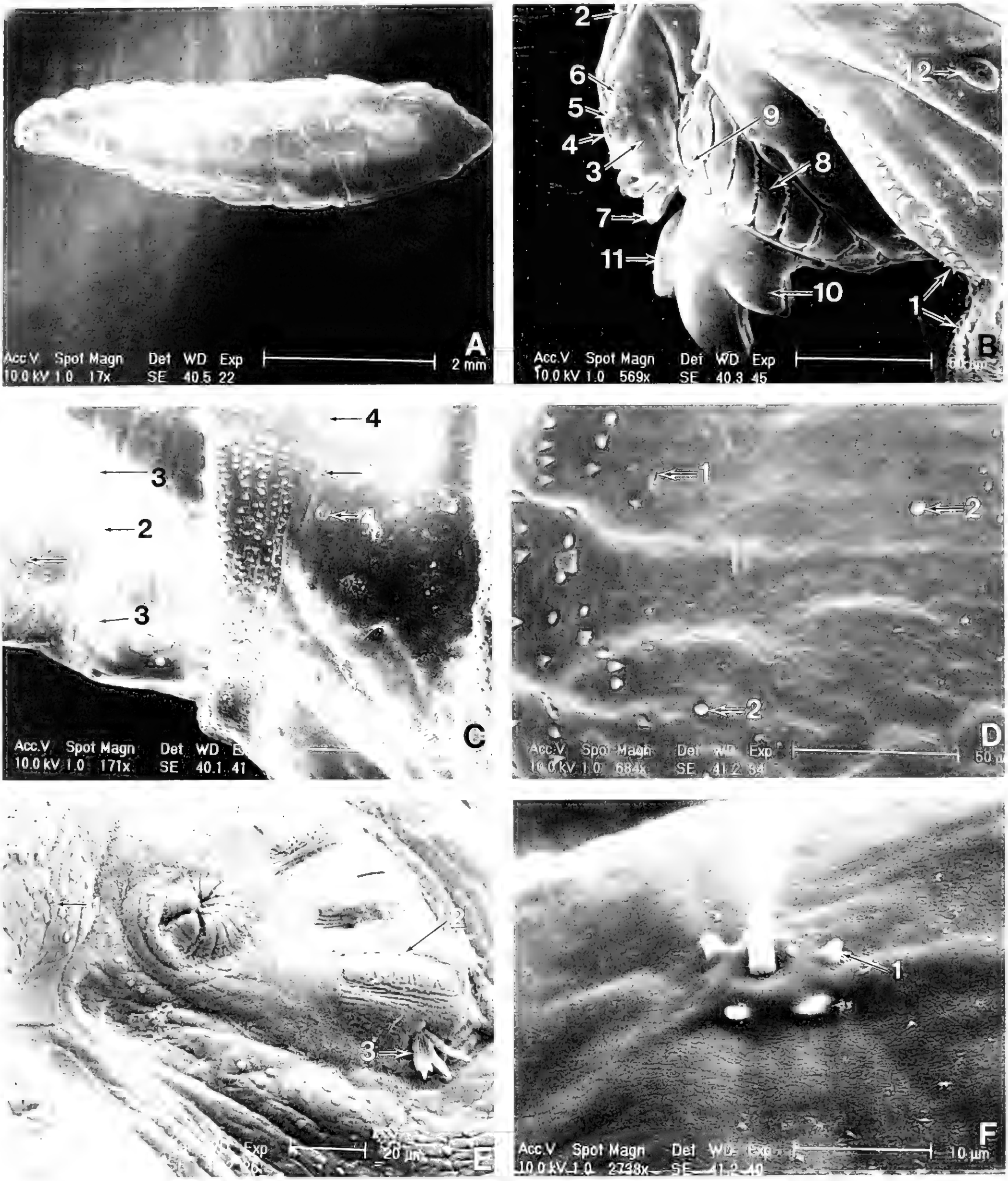

Fig. 4. Third instar of *Neaspilota appendiculata:* (A) habitus, anterior to left; (B) gnathocephalon, lateral view, 1-minute acanthae, 2-dorsal sensory organ, 3-anterior sensory lobe, 4-terminal sensory organ, 5-lateral sensory organ, 6-supralateral sensory organ, 7-integumental petal, 8-oral ridge, 9-stomal sense organ, 10-mouthhook, 11-median oral lobe, 12-verruciform sensillum; (C) meso- (left) and metathoracic (right), lateral spiracular complexes; 1-minute acanthae, 2-spiracle on mesothorax, 3-verruciform sensillum of mesothorax, 4-verruciform sensillum on metathorax, 5-spiracle on metathorax; (D) abdominal lateral spiracular complex; 1-spiracle, 2-verruciform sensillum; (E) posterior spiracular plate; 1-minute acanthae, 2-rima, 3-interspiracular process; (F) stelex sensillum; 1 basal, conical, minute acanthus.

gan of the third instar of *N. appendiculata* (Fig. 4B-9) was not seen clearly enough to allow comparison with other species; however, the third instars of all five species of *Neaspilota* examined to date have oral ridges with dentate ventral margins characteristically arranged in vertical series ventrolaterad of the dorsal sensory organ and laterad of the oral cavity. Similar oral ridges also were described in the second instars of *N. viridescens* (Goeden and Headrick 1992), *N. wilsoni* (Goeden and Headrick 1999), and *N. signifera* (Goeden 2000a). The oral ridges number seven or eight in the third instar of *N. aenigma* (Goeden 2000b), seven in *N. appendiculata* (Fig. 4B-8), but six in the second and third instars of the other three congeners examined to date. The appearance and arrangement of these oral ridge appears to be a generic character; however, the present study confirms that the oral ridges vary in number among *Neaspilota* species. The third instars of *Trupanea imperfecta* (Coquillett), *T. jonesi* Curran, *T. nigricornis* (Coquillett), *T. pseudovicina* (Hering), *T. signata* Foote, and *T. wheeleri* Curran also bear serrated oral ridges (Goeden and Teerink 1997, 1998, 1999a; Goeden et al. 1998; Knio et al. 1996; Teerink and Goeden 1999), but these oral ridges appear to be fewer in number, and are not arranged in a more or less regular, vertical row laterad to the oral cavity, as in *Neaspilota*.

The mouth hooks of the third instars of *N. appendiculata*, *N. aenigma*, *N. signifera*, and *N. viridescens* are tridentate (Goeden and Headrick 1992; Goeden 2000a, b); whereas, those of the third instar of *N. wilsoni* are bidentate (Goeden and Headrick 1999). Such interspecific differences in dentation are supported by our findings that the mouth hooks of third-instar *Trupanea vicina* are bidentate; whereas, those of 12 other congeners examined from California are tridentate (Goeden and Teerink 2000b and citations therein).

The number and appearance of the stelex sensilla surrounding the posterior spiracular plate differ among the *Neaspilota* species examined to date. These number only four in the first instars of *N. wilsoni* (Goeden and Headrick 1999). *N. aenigma* (Goeden 2000b), and *N. appendiculata*, but unfortunately were not observed with *N. signifera* (Goeden 2000a). This count of stelex sensilla remains at four in the second instars of *N. aenigma* (Goeden 2000b) and *N. appendiculata*, but increases to six in third instars of *N. wilsoni* (Goeden and Headrick 1999), *N. aenigma* (Goeden 2000b), and *N. appendiculata*. These stelex sensilla also show inter-instar (intraspecific) and interspecific differences in the incidence and appearance of the minute acanthae that ring them basally, but this was not recognized, studied or recorded by my coworkers and me until recently (Goeden 2000b and above description).

Puparium: Mostly pale yellow, with posterior two-three segments grayish to blackened, reniform, and smoothly rounded at both ends (Fig. 5A); anterior end bears the invagination scar (Fig. 5B-1) and anterior thoracic spiracles (Fig. 5B-2); caudal segment circumscribed by minute acanthae; three stelex sensilla, dorsolaterad, laterad, and ventrolaterad of posterior spiracular plates; posterior spiracular plate bears three broadly elliptical rimae (Fig. 5C-1), and four interspiracular processes, each with three to four branches (Fig. 5C-2); intermediate sensory complex with a medusoid sensillum and a stelex sensillum. Eleven puparia averaged 3.5 ± 0.08 (range, 3.13–3.84) mm in length; 1.51 ± 0.03 (range, 1.42–1.71) mm in width.

DISTRIBUTION AND HOSTS

Freidberg and Mathis (1986) described the distribution of *N. appendiculata* as, "Widespread in western United States between 32° and 46° north latitude and between 104° and 118° west longitude." Foote et al. (1993) mapped the distribution to include two or more collection records each from Arizona, Nevada, New Mexico, Utah, and Wyoming, along with additional single

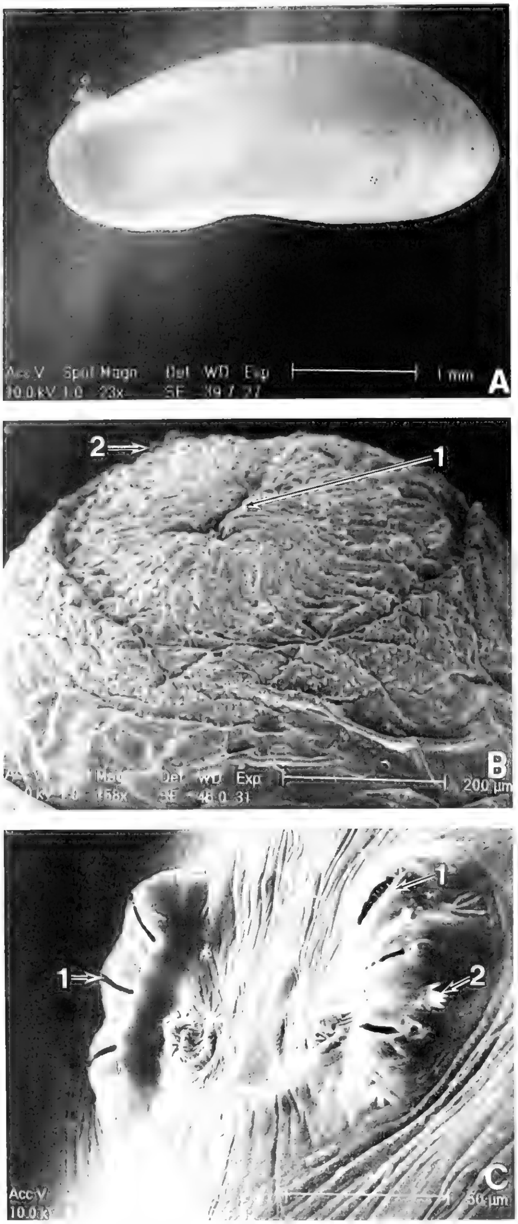

Fig. 5. Puparium of *Neaspilota appendiculata:* (A) habitus, anterior to left; (B) anterior end, 1-invagination scar, 2-anterior thoracic spiracle; (C) caudal segment, 1-rima, 2-interspiracular process.

collection records from California and Idaho, and a "state record only" from Colorado. Besides our three study sites, two other collection sites in California were along Pine Creek Road at 1774-m elevation, Inyo Nat. Forest, Inyo Co., 10.x.1990, and Mountain Pass, S of Interstate Highway I-15 at 1369 m, E. San Bernardino Co., 6.11.1998.

The only reported and confirmed host plant of *N. appendiculata* is *Machaeranthera canescens* (Goeden 1989), belonging to the subtribe Solidagininae of the tribe Astereae in the family Asteraceae (Bremer 1994). This herbaceous, annual to short-lived perennial, host-plant species has at least five distinct varieties and itself is widely distributed in many habitats throughout western United States and into adjacent Canada and Mexico (Hickman 1993, Shreve and Wiggens 1964). Therefore, *N. appendiculata* provides still another apparent example of a true monophage reported among the nonfrugivorous Tephritidae (Headrick and Goeden 1998).

BIOLOGY

Egg.—In 16, mostly closed, preblossom, immature flower heads of *M. canescens*, 35 eggs were inserted pedicel-last, six (17%) with their long axis at a slight angle to the receptacle, and 29 (83%) with their long axis perpendicular to the receptacle. These 16 flower heads each contained an average of 2.2 ± 0.4 (range, 1–7) eggs. Three (9%) eggs were inserted between the phyllaries and outer ovules and 32 (91%) within single florets; 12 (34%) of the 35 eggs were inserted into corollas of peripheral florets and 20 (66%) into corollas of central florets. The diameters of the receptacles of these flower heads containing eggs averaged 2.4 ± 0.14 (range, 1.58–3.7) mm.

Larva.—Upon eclosion, the first instars usually tunneled into an ovule, or into a corolla before entering the ovule to which it was basally attached. Single first instars were found feeding within each of six, closed, preblossom or open flower heads. The receptacles of these flower heads averaged 2.4 ± 0.2 (range, 1.6–2.9) mm in diameter. An average of 3.3 ± 1.0 (range, 2–8) ovules of soft achenes was damaged in these six heads as the first instar tunnelled into the layer of ovules or soft

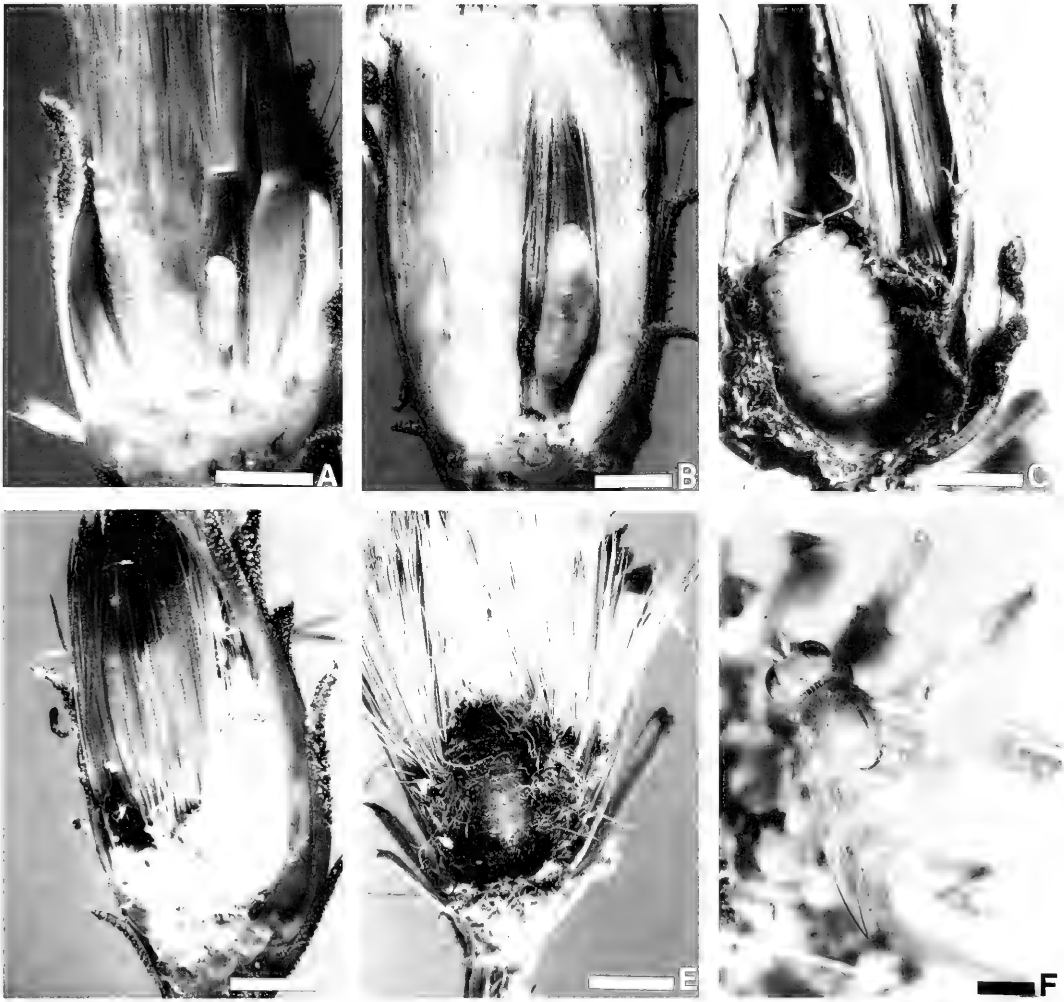

Fig. 6. Life stages of *Neaspilota appendiculata* in *Machaeranthera canescens:* (A) second instar feeding on soft achenes in open flower head, (B) third instar feeding on soft achenes in open flower head, (C) prepuparium in center of flower head, (D) puparium of nondiapausing individual formed in flower head in summer, (E) puparium formed in spring by overwintered prepuparium in flower head, (F) adult male. Lines = 1 mm.

achenes and parallel to and above the receptacle. No receptacles within these six infested flower heads were abraded or pitted by feeding. Based on 54 (range, 20–75) as the average total number of ovules and achenes, respectively, counted in 29 preblossom to postblossom flower heads, about 6% (range, 4–15%) of the ovules in the six infested, preblossom flower heads were damaged by first instars.

Second instars continued feeding on ovules in preblossom flower heads or in soft achenes in open, blossom and post blossom, flower heads (Fig. 6A). All fed within a series of adjacent ovules/soft achenes with their bodies horizontal to and their mouthparts directed towards the receptacles, but always well above the receptacles. Receptacles of 14 flower heads containing second instars were not fed upon and averaged 2.94 ± 0.29 (range, 1.99–5.7) mm in diameter. These flower heads each contained an average of 1.2 ± 0.2 (range, 1–3) larvae that had destroyed an average of 10.3 ± 2.1

(range, 2–31) ovules/soft achenes, or as calculated for the preceding instar, about 19% (range, 4–57%) of the average total of 54 ovules/soft achenes per flower head.

Third instars initially continued to feed mainly on soft achenes in post blossom flower heads; however, prior to pupariation, and usually before all the achenes were damaged, they proceeded to tunnel into the center of the receptacle (Fig. 6B). Sixty-five flower heads that averaged 3.09 ± 0.14 (range, 1.71–7.19) mm in diameter each contained a single third instar, so intraspecific mortality occurs in heads containing more than one larva. An average of 51 ± 7.1 (range, 24–63) of the soft achenes therein were damaged, or about 94% (range, 44–100%) of the average total of 54 ovules/soft achenes per flower head. These percentages of seed predation per larva per flower head are on the high side among florivorous tephritids studied by us to date (Headrick and Goeden 1998); this seed predation was exceeded only by gregarious florivorous species like *Trupanea conjuncta* (Adams) (Goeden 1987) and *T. pseudovicina* Hering (Goeden and Teerink 1998) or by species with large larvae that develop in immature or small flower heads like *Paracantha cultaris* (Coquillett) (Cavender and Goeden 1984) and *Xenochaeta dichromata* Snow (Goeden and Teerink 1997).

Third instars in flower heads fed with their long axes oriented perpendicular to and mouthparts directed towards the receptacles (Fig. 6B). Ninety percent of the third instars in the 65 infested heads scored or pitted the receptacles and thus presummably supplemented their diet with sap. Goeden and Headrick (1992, 1999) described and discussed this similar type of feeding by *N. viridescens* and *N. wilsoni*. And, as also reported for both of these congeners (Goeden and Headrick 1992, 1999), most third instars became surrounded for about 90% their lengths by cells, which occupied most of the interior of the flower heads and consisted of ovule-, achene-, chaff-, pappus-, and corolla-fragments cemented together by liquid feces and sap that hardened when dry (Fig. 6C). These protective cells were slightly larger than the mature larva, externally incorporated the outer walls of achenes and the few uneaten achenes, and were blackened and smooth inside. Upon completing feeding and cell construction, the third instars oriented with their anterior ends towards the receptacles, retracted their mouthparts, and formed prepuparia (Headrick and Goeden 1998). Most individuals overwintered in diapause as prepuparia (Fig. 6C) (Goeden and Headrick 1992, 1999; Headrick and Goeden 1998), but a few individuals pupariated early and emerged in late-summer and fall (August–September) (Fig. 6D). Prior to pupariation the prepuparia reversed their orientation within their cells and turned 180° such that their heads were directed away from the receptacles (Fig. 6D, E).

Pupa.—The receptacles of 11, overwintered, postblossom flower heads, each also containing a single puparium (Fig. 6E), averaged 3.50 ± 0.08 (range, 3.13–3.84) mm in diameter.

Adult.—Adults emerged from overwintered, mature flower heads, and were long-lived under insectary conditions, as 24 unmated males (Fig. 6F) averaged 64 ± 9 (range, 10–177) days, and 14 virgin females averaged 73 ± 12 (range, 10–133) days. Such lengthy longevities compare favorably with average adult longevities reported for adults of *N. viridescens* (Goeden and Headrick 1992), *N. wilsoni* (Goeden and Headrick 1999), *N. signifera* (Goeden 1999a), and *N. aenigma* (Goeden 1999b).

The premating and mating behaviors of *N. appendiculata* were not studied in the field, but were observed in petri dish arenas found to be so useful with many other nonfrugivorous tephritid species (Headrick and Goeden 1994). Premating behaviors observed with paired *N. appendiculata* (n) were brief “kissings” (n = 2), side-stepping by males while tracking females (n = 4) (Headrick and Goeden 1994), and rapid wing hamation, sometimes combined with lofting about 20° by both sexes (n = 6) (Headrick and Goeden 1994). Two matings were observed that began during late afternoon in twilight involving different pairs of flies that lasted 225 and 345 min. These compared to average durations of 190 min reported for *N. aenigma* (Goeden 2000b), 235 min. reported for *N. wilsoni* (Goeden and Headrick 1999), 238 min. reported for *N. signifera* (Goeden 2000a), and 5.3 h reported for *N. viridescens* (Goeden and Headrick 1992). No post-copulatory behavior reminescent of the mate guarding observed with *N. signifera* (Goeden 2000a), *Dioxyna sororcula* (Wiedemann) (Headrick et al. 1996), and *Euaresta stigmatica* Coquillett (Headrick et al. 1995) was observed with *N. appendiculata*. Postcopulatory behavior by *N. appendiculata* mainly consisted of storing of genitalia by males and cleaning and grooming by both sexes (Headrick and Goeden 1994)

Seasonal history.—The life cycle of *N. appendiculata* in southern California follows an aggregative pattern (Headrick and Goeden 1994, 1998) in which the prepuparium is the principal overwintering stage. Come late spring (April–May), overwintered prepuparia reverse their orientation in their cells in flower heads on shoots of dead host plants and pupariate. Adults emerge during May and June and aggregate on preblossom shoots of *M. canescens* to mate. Females oviposit in the small, newly-formed, closed, preblossom flower heads in June and July and larvae feed until fully grown, then enter diapause in the late summer and early fall (August–October). There is a single generation per year on their sole host plant, although as mentioned above, a few adults emerge in August–September, perhaps to produce a partial generation on late-flowering plants, or to overwinter as long-lived adults.

Natural enemies.—Two males and two females of *Pteromalus* sp. (Hymenoptera: Pteromalidae) were reared from separate puparia of *N. appendiculata* as solitary, larval-pupal endoparasitoids. Seven, 15, and 17 individuals of an unidentified Eulophidae (Hymenoptera) respectively were reared from three puparia as gregarious endoparasitoids.

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MORPHOMETRIC VARIATION AMONG POPULATIONS OF *AMBRYSUS MORMON* MONTANDON (HETEROPTERA: NAUCORIDAE)

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Abstract.—Morphometric variation with respect to 15 mensural characters was assessed for adult specimens from 13 populations of *Ambrysus mormon* Montandon in the United States. This provides a context from which to assess the degree of divergence of an isolated population (Ash Warm Springs, Nevada), which possesses discrete-state characteristics that differ markedly from those of other populations of the species. A multivariate analysis of variance revealed that interpopulational differences were dependent on sex, a finding corroborated by the univariate perspective provided by Bonferroni's sequential adjustment that additionally identified lengths of body, protibia, and protarsus as contributing to the interaction between population and sex. Moreover, all pairwise comparisons of the 13 populations were significant for males as well as for females (*F*-tests from discriminant function analysis). Indeed, the pattern of morphometric variation among populations was similar in males and females but was not a consequence of differentiation by geographic distance (Mantel analyses). Interindividual variation primarily was due to differences in size, as the first axis from principal components analysis accounted for 92.2% of the total variation. Three additional axes represented shape, and each accounted for at least 10% for the remaining variation among individuals. The population from Ash Warm Springs differed markedly (larger protarsus relative to meso- and metatarsi, and smaller pro-, meso-, and metatarsi relative to body length and synthlipsis) from the other populations, suggesting the need for systematic revision of its subspecific affiliation. In contrast, populations of *A. m. heidemanni* Montandon and *A. m. minor* La Rivers were similar to the other populations of the nominate subspecies, suggesting their subspecific recognition is questionable. The distinctiveness of the population from Ash Warm Springs as an isolated remnant of the historically connected pluvial White River intimates that it may be a taxon in the process of specific differentiation.

Key Words: Naucoridae, *Ambrysus mormon,* morphometrics, phenetics, shape

Ambrysus mormon Montandon is the most widespread species of the genus in the United States, ranging from Oregon and Idaho east to South Dakota, and south through Arizona and New Mexico into Mexico. Throughout its range, *A. mormon* occurs in diverse habitats ranging from cold montane streams to thermal spring effluents. Typically, it is found in slow water near margins of gravel-bottomed streams

(Usinger 1946). Four subspecies currently are recognized (La Rivers 1971): *A. m. australis* La Rivers in Mexico, southern Texas, and New Mexico; *A. m. heidemanni* Montandon in thermal runoffs in Yellowstone National Park; *A. m. minor* La Rivers in a thermal spring in Idaho; and the nominate subspecies throughout the remainder of the range in the United States from Idaho and South Dakota south to Arizona and New Mexico.

Because of their aquatic habitat requirements, occurrence in otherwise arid landscapes, and limited dispersal abilities, naucorids in the southwestern United States are characterized by a high level of endemism. For example, *A. relictus* Polhemus and Polhemus and *A. amargosus* La Rivers, which is listed as a federally endangered species, occur only in several fragile streams in a western Nevada desert oasis; *A. funebris* La Rivers occurs only in Death Valley; and *Limnocoris moapensis* (La Rivers) occurs only in the vicinity of Moapa, Nevada.

An isolated population of *A. mormon* at Ash Warm Springs, Nevada, possesses discrete morphological characteristics that differ from those of other populations of the species. As a parallel study to an analysis of discrete characters (J. T. Polhemus, in litt.), we present an analysis of shape-related variation in *A. mormon* to determine the degree of divergence of the Ash Warm Springs population from other populations of the nominate subspecies, as well as from *A. m. minor* and *A. m. heidemanni.*

MATERIALS AND METHODS

A suite of 15 external mensural characters (body length and width; head length and width; synthlipsis; pronotal length; lengths of pro-, meso-, and metathoracic femur, tibia, and tarsus), previously determined to be effective in discriminating among naucorid taxa (Sites and Willig 1994a, b), was measured for adult specimens of 13 populations of *A. mormon* (Table 1, Fig. 1). Body length was measured from the tip of the labrum to tip of the abdomen; body width, head length, head width, and all leg segments were longest distances; pronotal length was measured along the midline. Meso- and metanotal lengths were not included because it is difficult to obtain accurate measurements without dissection of specimens. Each of these nota subducts below the preceding notum, and the visible length is variable and dependent on the degree of thoracic flexion. Generally, 10 specimens of each sex from each population were measured; however, for four populations, fewer than 10 specimens were available (Eel River, Hot Creek Falls, Utah, and Yellowstone). All data were transformed to natural logarithms to evaluate more effectively the contribution of shape (see Sites and Willig 1994a, b) to interpopulational differences. Statistical analyses were executed using SPSS (1990). Voucher specimens are deposited in the Enns Entomology Museum, University of Missouri-Columbia, and the John T. Polhemus Collection.

Data from labels of 18 of the 19 specimens of *A. m. minor* provided insufficient detail concerning site of collection (Table 1, HCF) to ascribe individuals to the type locality for the subspecies with certainty. More specifically, a single specimen from the type locality of Hot Creek Falls is included in the analysis, along with a series of 18 specimens labeled "nr. Bruneau." Therefore, the morphometric affinities of these specimens with that of the known topotypic specimen were determined using discriminant function analysis with groups defined by combinations of sex and population.

Two-way multivariate analysis of variance (MANOVA) evaluated differences among populations and between sexes based on mensural characters. Univariate, two-way analyses of variance (ANOVAs) were performed to assess the contribution of each particular character to multivariate group differences. To minimize the likelihood of overestimating the significance of individual characters that compose a large

Table 1. Acronyms and collection data for populations of *Ambrysus mormon*. Numbers of measured male and female specimens, respectively, appear parenthetically below each acronym.

AWS (10,10)	NEVADA: Lincoln Co. Ash Warm Springs 3750 ft. elev.; 36°C 21 July 1992; CL 2711 J. T. and D. A. Polhemus
COL (10,10)	COLORADO: Pueblo Co. Burnt Mill Creek CL2683; 19-V-1992 J. T. Polhemus
EEL (8,10)	CALIFORNIA: Mendocino Co. Eel River at Bell glen nr. Leggett 62°F; 2-VII-1959 R. K. Allen
HCF (0,1)	IDAHO: Owyhee Co. (1) Hot Cr. Falls 9-IX-1965 E. J. Allen
HCF (10,8)	IDAHO: Owhyee Co. (18) nr. Bruneau 10-X-1975 A. D. Allen
IDA (10,10)	IDAHO: Owyhee Co. Bruneau Riv. ca. 7 mi SSE Bruneau T7S R6E sect. 26 22 Sept. 1988 R. S. Zack, coll.
INY (10,10)	CALIFORNIA: Inyo Co. Shoshone Hot Spring CL 2904 coll: J. T. and D. A. Polhemus
MOA (10,10)	NEVADA: Clark Co. Warm Springs; 32°C 27 August 1989 coll: J. A. Back
NMX (10,10)	NEW MEXICO: Lincoln Co. Rio Hondo 2 mi E Hondo 23 Sept. 1988; 12°C coll: R. W. Sites veg. in flow at margin
NYE (10,10)	NEVADA: Nye Co. Hot Creek Spring 7 mi. W. Hwy 93 30°C; CL2898 coll: J. T. and D. A. Polhemus
SDA (10,10)	SOUTH DAKOTA: Fall River Co. Hot Springs; 2 mi NW Hot Water 22 June 1940; H. C. Severin
SHA (10,10)	CALIFORNIA: Shasta Co. Rt. 44; Cow Ck nr Palo Cedro 28 Aug 1991; R. S. Zack and M. A. Valenti, collrs.
UTA (10,8)	UTAH: Washington Co. North Creek nr. Virgin 16-X-1982 D. A. Polhemus
YST (9,10)	WYOMING: Yellowstone Nat. Pk. CL 556; 15-VIII-1972 J. T. Polhemus

suite of attributes (Holm 1979, Rice 1989), the Bonferroni sequential adjustment was applied to each morphometric character before ascribing statistical significance to univariate analyses. Discriminant function analysis (DFA) simultaneously maximized intergroup differences and minimized intragroup variation among individuals by adjusting the linear combination of variables in each of a number of orthogonal axes. Pairwise *F*-tests associated with DFA determined which populations differed significantly from each of the other populations. The subsequent classification phase of DFA then assigned each specimen to a population based on the linear combination of variables from each discriminant function axis. Percent of correct assignments was used as a separate measure of morphometric distinction among populations. Because DFA reconstitutes variables to maximize differences among groups, natural relationships can become distorted in multidimensional space. In contrast, principal components analysis (PCA) was used as a data reduction technique to retain natural distance relations

Fig. 1. Range (shaded) of *Ambrysus mormon* in the United States and localities (black circles) represented in analyses.

among individuals in multidimensional space and to view differences among populations with regard to shape and size for males and females separately. If the magnitude of differences in shape among populations is a consequence of the degree of isolation derived from geographic distance, then a correlation should exist between a matrix of pairwise linear distances between sites and a matrix of pairwise morphometric distances based on population centroids (PC2 through 4). We tested this hypothesis of differentiation by distance separately for males and females using Mantel correlation analysis (Fortin and Gurevitch 1993, Manly 1994, Sokal and Rohlf 1995). Via a separate Mantel analysis, we evaluated the degree to which interpopulational differences in shape between males and females were similar, regardless of geographic correlates.

RESULTS

The 18 specimens labeled "nr. Bruneau" of uncertain subspecific association likely represent *A. m. minor* because they formed a well-defined cluster in morphometric

Table 2. Significance levels (P)[a] of the character suite (MANOVA) and each character separately (ANOVA) in distinguishing between sexes and among 13 populations of *Ambrysus mormon.*

	Population	Sex	Pop × Sex
MANOVA	<0.001	<0.001	<0.001
ANOVA			
Body length	<0.001	<0.001	0.001
Body width	<0.001	<0.001	0.180 ns
Head length	<0.001	<0.001	0.908 ns
Head width	0.001	<0.001	0.922 ns
Synthlipsis	<0.001	<0.001	0.121 ns
Pronotum	<0.001	<0.001	0.418 ns
Profemur	<0.001	<0.001	0.099 ns
Protibia	<0.001	<0.001	<0.001
Protarsus	<0.001	<0.001	0.003
Mesofemur	<0.001	<0.001	0.427 ns
Mesotibia	0.001	<0.001	0.353 ns
Mesotarsus	<0.001	<0.001	0.099 ns
Metafemur	<0.001	<0.001	0.018 ns
Metatibia	<0.001	<0.001	0.009 ns
Metatarsus	<0.001	<0.001	0.437 ns

[a] Bonferroni sequential adjustments within a column for the 15 univariate characters corroborated significant ($\alpha \leq 0.05$) group differences in all situations except those marked ns.

space that was distinct from that of specimens representing the population of *A. m. mormon* in the Bruneau River (IDA). In addition, each specimen was assigned to the correct population in the classification phase of DFA, further substantiating the morphometric distinction of these specimens. All 19 specimens match discrete characteristics listed for the subspecies by La Rivers (1963) and are small; this is typical of naucorids that develop in high environmental temperatures (Sites et al. 1996). Differences among populations (Table 2) depended on sex (MANOVA, Population by Sex interaction, $P \leq 0.001$). Three characters (lengths of body, protibia, and protarsus) contributed significantly ($P \leq 0.05$) to the interaction (Table 2). All other characters contributed significantly to differences ($P \leq 0.001$) among populations or between sexes in a consistent fashion.

Pairwise *F*-tests revealed very highly significant morphometric differences ($P \leq 0.001$) between each possible pair of populations (78 pairwise contrasts per sex). The classification phase of DFA assigned all but two (98.43%) male specimens and all but one (99.21%) female specimen to the correct population. Clearly, intrapopulational morphometric variation was considerably less than interpopulational differences.

Principal components analysis effectively disassociated aspects of size (PC 1) and shape (other axes) from morphological variation among individuals. The loading coefficient of each character was positive on PC 1 (Table 3) and accounted for 92.2% of the interindividual variation. Three additional axes each accounted for at least 10.0% of the shape-related variation. Of these shape axes, PC2, PC3, and PC4 accounted for 33.5%, 20.5%, and 10.4% of the shape-related variation among individuals, respectively. Males and females show correlated patterns of interpopulational variation in shape (Mantel analysis; $P = 0.015$). This is reinforced by results from PCA in which the interpopulational dispersion with respect to shape is similar in males and females (Fig. 2). The main difference between the sexes is captured by PC2 (lengths of meso- and metatarsi relative to protarsus): females from a particular population have larger scores on PC2 than do corresponding males. Nonetheless, the degree of differentiation in shape was unrelated to geographic distance between populations for males (Mantel analysis; $P = 0.604$) and females (Mantel analysis; $P = 0.278$). Factors other than distance, per se, must be affecting interpopulational variation in shape in this species.

Regardless of sex, the attribute of shape that distinguishes the Ash Warm Springs population from the other populations of *A. mormon* is its relatively elongate protarsi compared to meso- or metatarsi (PC2). To a lesser degree, this same attribute of shape distinguished populations of MOA and NYE from the remainder of populations, especially when considering females. Addi-

Table 3. Principal component loadings (correlations) for axes representing size (PC1) and appreciable attributes of shape (PC2 through 4).

Character	PC1	PC2	PC3	PC4
Body length	0.964	−0.031	−0.143	−0.168
Body width	0.986	−0.006	−0.057	−0.113
Head length	0.978	−0.019	−0.074	−0.024
Head width	0.977	−0.006	−0.058	−0.006
Synthlipsis	0.925	0.164	−0.246	0.109
Pronotum length	0.964	−0.098	−0.108	−0.006
Profemur length	0.973	−0.054	−0.011	0.175
Protibia length	0.970	−0.099	0.014	0.174
Protarsus length	0.883	−0.338	0.258	−0.002
Mesofemur length	0.992	−0.014	−0.007	0.002
Mesotibia length	0.986	−0.068	0.046	−0.006
Mesotarsus length	0.880	0.398	0.203	0.020
Metafemur length	0.992	−0.016	0.009	−0.044
Metatibia length	0.985	−0.037	0.065	−0.063
Metatarsus length	0.936	0.250	0.144	−0.040
Eigenvalue	13.826	0.393	0.240	0.122
% variance (total)	0.922	0.026	0.016	0.008
% variance (shape)	—	0.335	0.205	0.104

tional shape variation that distinguishes all populations (PC3) is related to length of tarsi relative to body size and synthlipsis. In particular, the relative lengths of tarsi in the three populations from White River (AWS, MOA, and NYE) are smaller than those in the other populations.

DISCUSSION

Recently, Sites and Willig (1994a, b) demonstrated that the above character suite was effective at discriminating among genera and species of naucorids. This character suite is not only diacritical in distinguishing among taxa but discriminates among conspecific populations of *A. mormon.* Nonetheless, the particular components of shape that distinguished 22 species of *Ambrysus* (Sites and Willig 1994a) are different than those that distinguished populations of *A. mormon.* The positions of populations of *A. mormon* in multidimensional morphometric space do not reflect currently established subspecific designations within the species. More specifically, *A. m. heidemanni* (YST) and *A. m. minor* (HCF) occur in close morphometric proximity to members of the nominate subspecies (all other populations), and occur within the range of shape variability encompassed by the nominate subspecies (Fig. 2). Moreover, populations of the nominate subspecies from Ash Warm Springs, Moapa, and New Mexico (AWS, MOA, NMX) are considerably more divergent based on shape-related variation (Fig. 2) than either of the two other currently recognized subspecies included in this analysis (*A. m. heidemanni,* YST; *A. m. minor,* HCF). Further, discrete characters defining *A. m. heidemanni,* which occurs in the warm waters of the Yellowstone geyser basins, may be expressed in other warm water populations of nominate *A. mormon,* which led La Rivers (1951) to question the subspecific affiliation of this population. Because shape-related variation among populations does not reflect the currently accepted intraspecific taxonomy of *A. mormon,* and discrete characters offer only equivocal support, re-evaluation of subspecific status is warranted for those populations.

Populations from Utah, Yellowstone, Colorado, and South Dakota; as well as those from Idaho and New Mexico (Sites et al. 1996), reflect a wide range of envi-

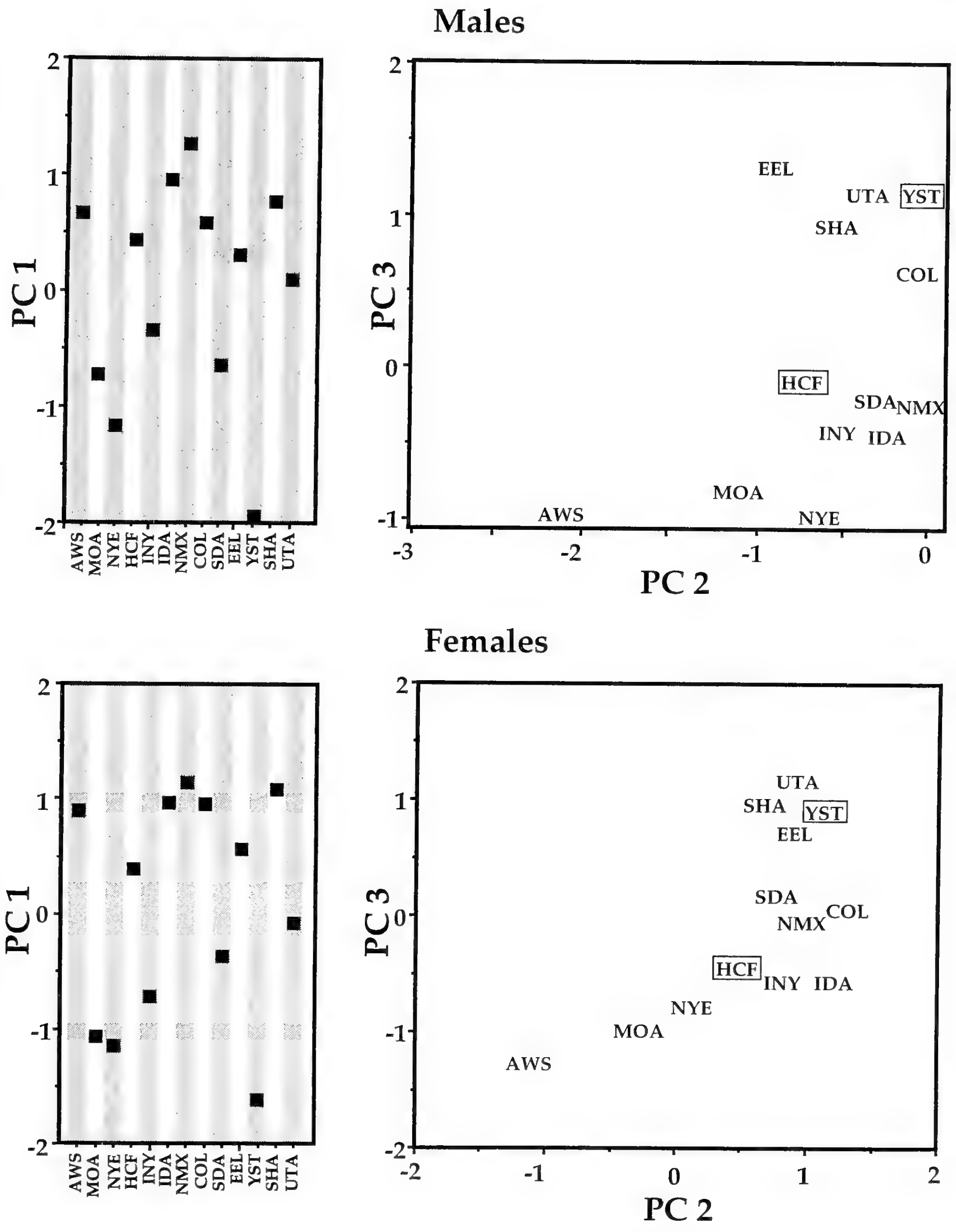

Fig. 2. Plots of 13 population centroids, derived from a principal components analysis of 15 mensural characters, illustrate intraspecific size (PC1) and shape (PC 2 and 3) variation for male and for female *A. mormon.* Eleven populations represent nominate *A. mormon,* whereas HCF and YST populations (in boxes) represent *A. m. minor* and *A. m. heidemanni,* respectively.

ronmental temperatures during development, yet the positions of group centroids (Fig. 2) indicate that these populations share similar attributes of shape. Although thermal environment does influence allometric relationships during ontogeny (Sites et al. 1996), the greatest degree of shape-related variation in *A. mormon* has been achieved independently of thermal environment during ontogeny.

The population of *A. m. minor* (HCF) exhibits morphometric attributes distinct from those of the nearby population of nominate *A. mormon* in the Bruneau River (IDA), based on a pairwise *F*-test from DFA. Despite the close proximity of Hot Creek Falls to Bruneau River (≈1 km), distinct morphologies characterize the populations of the two sites. A series of unnamed hot springs occurs along the Bruneau River, and *A. mormon* may occur in them. Because of local irrigation demands, the water table has declined recently, resulting in a concomitant reduction in the size of the springs. During the last known visit to these springs (1991), the pool at the base of Hot Creek Falls, known as Indian Bathtub, was reduced tremendously in size (≈1.0 m diam × 0.3 m depth) and persisted only because a piece of plastic had been placed on the downstream side of the pool, probably to allow bathing; the actual falls no longer exists (R. S. Zack, personal communication). Continued reduction in the water table may threaten *A. m. minor* to the point that it may soon become extinct.

The White River system in eastern Nevada extends from the White Pine Mountains near Ely south to the Moapa River near Lake Mead. The lower end of the White River near Moapa is known as the Muddy River. The White River system is of hydrographic and faunistic interest because of its recently restricted watercourse and isolated fish populations. In the Pliocene and at least the early Pleistocene epochs, the pluvial White River was continuous throughout its length to an isolated lake, now represented by the Moapa River (Gilbert 1893, Carpenter 1915), which persists as a tributary of the Colorado River. Since that time, extensive desertification of the Great Basin has occurred (King 1958), significantly reducing the extent of the White River. As a result, ≈200 miles of dry river bed now cross the parched desert, isolating the Recent White River (north) from the Moapa River (south). Despite drastic reductions in surface water, sporadically distributed springs and effluent fragments of the pluvial White River persist.

The fish fauna of the White River is distinct and includes an endemic cyprinid genus, an endemic species of *Crenichthys,* and several indigenous species and subspecies (Hubbs and Miller 1948). Subspecific affinities of isolated fish populations in these springs and effluents strongly suggest that these habitats were continuous in the past. *Ambrysus mormon* also occurs in many of these aquatic fragments, a result of its almost certain occurrence in the pluvial White River and subsequent isolation following landscape wide desertification. Three populations included in our morphometric assessment represent White River isolates [AWS, MOA, and NYE (see Table 1)]. Specimens of the Ash Warm Springs population exhibit structural features that are divergent from "typical" *A. mormon,* including reduction in posterolateral connexival spines, narrow embolium, and differences in genitalic features.

Evaluation of discrete-state characters of the isolated Ash Warm Springs population, combined with the attributes of shape of other members of the species, suggests that this population may warrant taxonomic recognition, at least at the subspecific level. Although the length of time that it has been separated from the parent population from White River is uncertain, clear differences in phenotype, including shape, have accumulated in isolation. Even if speciation is not yet complete, the population likely will continue to diverge from the other populations of *A. mormon* because of the effects of drift and natural selection in environmental isolation. If divergence has not progressed to the point at which reproductive incompatibility exists between the Ash Warm Springs population and the remainder of *A. mormon,* then we are witnessing speciation in action in this remnant population of *A. mormon.* Although the Nye Co. and Moapa populations also represent isolates along the White River system, these populations have not diverged from typical morphometric form of *A. mormon* as radically as has the population at Ash Warm Springs (Fig. 2). Further studies involving discrete state characters are needed to resolve the intraspecific taxonomic status of these populations of *A. mormon.*

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NOTES ON NEOTROPICAL SPECIES OF *TETHINA* HALIDAY (DIPTERA: TETHINIDAE)

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Abstract.—Neotropical beach-fly species (Diptera: Tethinidae) not included in a previous faunal revision of the Caribbean, Gulf of Mexico, and Bermuda are reviewed, including description of the following new species (type locality in parenthesis): ***Tethina robusta*** (Chile. Osorno: Puchatrihue). Two **new synonyms** are also proposed (junior synonyms cited first): *Rhicnoessa sonorensis* Melander = *Tethina albula* Loew and *Tethina setulosa* Malloch = *Tethina spinulosa* Cole. A revised key to the Neotropical species of *Tethina* and a diagnosis for the senior synonyms are provided.

Key Words: Diptera, Tethinidae, *Tethina*, neotropics

Since revising the Tethinidae from the Caribbean, Gulf of Mexico, and Bermuda (Foster and Mathis 1998), we have studied additional Neotropical specimens that have revealed a striking new species from Chile and two synonyms of widespread species. This paper reports these discoveries. Herein, we present a revised key to the Neotropical species of *Tethina* and diagnoses for the species for which synonyms have been discovered. This paper is written within the context of our recent revision (Foster and Mathis 1998), and further details are found in that reference.

The discovery of the two new synonyms reported herein re-emphasizes our previous observation (Foster and Mathis 1998) that most coastal marine species of Tethinidae have widespread distributions. Although we studied most species of *Tethina* that were known to occur in the New World for our Caribbean study, we did not examine two species, *T. spinulosa* Cole and *T. sonorensis* (Melander), as both were reported to occur only in western North America and our study concerned the Caribbean and adjacent areas. Our study of these two species reveals that they too are conspecific with other, widespread species as we document below.

Methods.—The descriptive terminology, with the exceptions noted in Mathis and Munari (1996), follows that of McAlpine (1981). 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. 2–4. The description of the new species is based primarily on its holotype.

States of Mexico are abbreviated as follows: Baja California Norte (BCN), Quintana Roo (QNR), Sonora (SON), and Tabasco (TAB).

KEY TO NEOTROPICAL SPECIES OF *TETHINA*

1. Gena high, at least 0.5 eye height 7
– 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* Foster and Mathis

– Mid- and hindtibiae yellow; first 3 tarsomeres yellow 4

4. Hindfemur of ♂ not particularly swollen . . . 5

– Hindfemur of ♂ distinctly swollen 6

5. Center of gena with elongate, shiny area apparently free of microtomentum (fig. 24 in Foster and Mathis 1998); surstylus armed with many short, well-developed, thick toothlike setulae . . . . *T. texana* (Melander)

– Gena uniformly microtomentose (♂ unknown) . . . . *T. insulans* Curran

6. Surstylus curved anteriorly, ending in an acute point, densely setulose with well-developed setae over most of surface . . . . *T. cohiba* Foster and Mathis

– Surstylus paddle shaped, with well-developed setae along margin only . . . . *T. spinulosa* Cole

7. Body distinctly gray to grayish brown 8

– Body whitish 9

8. Tibiae yellow . . . . *T. willistoni* (Melander)

– Tibiae gray, microtomentose . . . . *T. robusta*, **new species**

9. Surstylus in lateral view curved anteriorly . . . . *T. albula* Loew

– Surstylus in lateral view straight 10

10. Surstylus in posterior view with median margin curved and rounded, sparsely setulose . . . . *T. lisae* Foster and Mathis

– Surstylus in posterior view with median margin straight, bearing dense row of setulae . . . . *T. bermudaensis* (Melander)

Tethina insulans Curran

Tethina insulans Curran 1932: 358.—Foster 1976b: 2 [Neotropical catalog].—Mathis and Munari 1996: 17 [world catalog].

Diagnosis.—Body length 3 mm, generally gray, microtomentose; setae and setulae black. Gena moderately high, slightly less than 0.5 eye height. Presutural acrostichal setae 4; scutellum uniformly gray, lacking a dorsal spot. Femora gray, microtomentose; hindfemur of male similar to or only slightly more swollen than fore- and midfemora; tibiae yellow. Male terminalia unknown.

Distribution—*Neotropical:* Ecuador (Galápagos Islands).

Remarks.—We studied the apparent allotype female and only known specimen of *T. insulans,* which is deposited in the AMNH. The holotype male was originally deposited in the Zoological Museum, University of Oslo, Oslo, Norway [type locality: Ecuador. Galápagos Islands: Floreana, Post Office Bay (seaside)], and may now be lost.

Curran's original description characterizes the allotype well and is not repeated here. The allotype, which is covered with white particles, is in poor condition (head partially collapsed, glue covering mouthparts, thorax very greasy, and abdomen is wrinkled and partially collapsed), making it difficult to study.

This species is apparently related to *T. milichioides,* as Curran noted in the original description (Curran 1932:359): "[This species] In Melander's key to *Rhicnoessa (Tethina),* traces to *milichiodes* [sic] Melander but differs in having reddish antennae, etc." *Tethina milichioides* is known from western United States (Mathis and Munari 1996). Although the setae are not as short as in *T. milichioides,* this species shares many of characters of the *milichioides* group (Foster 1976a). We are satisfied that *T. insulans* is not conspecific with any known Neotropical species.

Tethina albula (Loew)

(Figs. 8–10, 13 in Foster and Mathis 1998)

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].—Foster and Mathis 1998: 609–611 [revision].

Rhicnoessa sonorensis Melander 1952: 207.—Cole 1969: 387 [distribution, diagnosis].—Foster 1976b: 2 [lectotype designation]. New **synonym.**

Tethina sonorensis: Foster 1976b: 2 [generic combination, Neotropical 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 in Foster and Mathis 1998), 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 in Foster and Mathis 1998) 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 male (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.

The lectotype male of *Rhicnoessa sonorensis* (designated by Foster, 1976b:2) is labeled "SonoraMEXICO RockyP[oin]t Marsh 21 April '47 [1947] A.L. Melander/ ALMelander Collection 1961 [stippled green band on right side of leabel]/Lectotype Tethina sonorensis (Melander) George A. RFoster 1974 [handwritten; black submarginal border]." The lectotype is double mounted (minuten in a rectangular card), is in excellent condition (abdomen removed and dissected, the structures in an attached microvial), and is deposited in the USNM.

Other specimens examined.—MEXICO. Sonora: Pt. Penasco, 21 Apr 1948, A. L. Melander (1 ♂, 3 ♀; USNM); Rocky Point Marsh, 21 Apr 1947, A. L. Melander (6 ♂, 10 ♀; USNM).

Distribution.—*Nearctic:* USA (DE, FL, MA, MD, NC, NY, SC, RI, VA). *Neotropical:* Bahamas, Belize, Guyana, Mexico (QNR, SON), Trinidad, Turks and Caicos, West Indies (Grand Cayman).

Remarks.—This is the first record of *T. albula* from the West Coast of the New World; we anticipate that it will be found to be more widespread.

Tethina spinulosa Cole
(Figs. 26, 28–29 in Foster and Mathis 1998)

Tethina spinulosa Cole 1923: 478.—Hendel 1934: 41 [citation].—Vockeroth 1965: 728 [Nearctic catalog].—Foster 1976b: 2 [Neotropical catalog].—Mathis and Munari 1996: 18 [world catalog].

Rhicnoessa spinulosa: Melander 1952: 202, 208 [key, generic combination, citation].

Tethina setulosa Malloch 1934: 454.—Foster 1976b: 2 [Neotropical catalog].—Mathis and Munari 1996: 18 [world catalog].—Foster and Mathis 1998: 624 [revision]. **New synonym.**

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 in Foster and Mathis 1998), length about equal to width, median margin bearing dense patch of robust setulae along entire length (Fig. 29 in Foster and Mathis 1998); surstylus in lateroblique view (Fig. 28 in Foster and Mathis 1998) broadly rounded, constricted anteriorly, external surface bearing numerous setulae; aedeagus thin, ribbonlike.

Type material.—The holotype male of *Tethina spinulosa* is labeled "[MEXICO. Baja California Norte:] Las Animas Bay[,] Gulf Cal. May 8 1921/EPVan Duzee Collector/HOLOTYPE spinulosa/ALLOTYPE spinulosa/Tethina spinulosa Type and allotype [two specimens on separate points; type data taken from Arnaud 1979:345]." The holotype and allotype are double mounted (glued to separate paper points on same pin) and are deposited in the CAS (1356). We examined 30 paratypes, including 18 from the type locality, as follows: Mexico. Baja California Norte: Las Animas Bay, 8 May 1921, E. P. Van Duzee (4 ♂, 14 ♀; USNM); Loreto, 19 May 1921, E. P. Van Duzee (8 ♂, 4 ♀; USNM).

The holotype male 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).

Other specimens examined.—ECUADOR. Galápagos: Isla Santa Cruz: Academy Bay, Darwin Research Station (beach and coastal rocks), 24 Jan 1964, D. Q. Cavagnaro, R. O. Schuster (7 ♂, 6 ♀; USNM).

MEXICO. Sonora: Guaymas (40 mi N), 24 Nov 1951, J. J. Teas (3 ♂, 4 ♀; USNM); Pto. de Lobos, 18–19 Mar 1974, W. Brown, V. Roth (5 ♂, 3 ♀; USNM); "Marsh," 21 Apr 947, A. L. Melander (1 ♂; USNM).

UNITED STATES. California. Orange: Balboa, 13 Jul 1940 (2 ♂; USNM); Corona del Mar, 25 Jul–19 Nov, 1942–1949, A. L. Melander (5 ♂, 9 ♀; USNM); Doheny Park, 12 Oct 1951, A. L. Melander (3 ♂, 7 ♀; USNM); Laguna Beach, 18 Jul-12-20 Oct 1943, 1951, A. L. Melander (15 ♂, 9 ♀; USNM); San Clemente, 13 Oct 1950, A. L. Melander (3 ♂, 4 ♀; USNM); Seal Beach, 26 Jul 1942, A. L. Melander (2 ♂, 1 ♀; USNM). Los Angeles: Palos Verdes, 15 Oct 1944, A. L. Melander (4 ♂, 7 ♀; USNM). San Diego: Scripps, 8 Oct 1972, L. Chang (4 ♂, 2 ♀; USNM).

Clipperton Island (10°17′N, 109°13′W; a French possession off the Pacific Coast of Mexico), 22 Aug 1958, C. F. Harbison (15 ♂, 6 ♀; USNM).

Distribution.—Widespread, primarily on the west coast of the New World. *Nearctic:* United States (CA). *Neotropical:* Chile (Tarapaea to Antofagasta), Clipperton Island, Ecuador (Galápagos), Mexico (BCN, SON, TAB).

Remarks.—Although this species was known previously from Chile (Malloch 1934) and later from the Caribbean coast of Mexico (TAB; Foster and Mathis 1998), we have identified numerous other specimens from the West Coast of the New World as noted above. The specimens from Clipperton Island, a French possession in the north

Pacific, approximately 1,100 km from the west coast of Mexico, are of note.

Tethina robusta Foster and Mathis, new species
(Figs. 1–4)

Diagnosis.—This species is distinguished from congeners by the following combination of characters: Body with gray microtomentum, thorax entirely gray; setae black; gena high, 0.62–0.75 eye height; 4 irregular rows of acrostichal setulae; scutellum uniformly gray, lacking yellowish to reddish spot; femora distinctly gray; fore- and hindfemora of male distinctly swollen, distinctly larger than midfemora, with hindfemora distinctly larger than forefemora; tibiae black; basal 3 tarsomeres yellow, appearing velvety ventrally on fore- and hindleg; surstylus broadly spatulate and broadly attached to epandrium posteriorly, bearing 2 rows of short setae along medial margin and scattered setae on posterior surface; epandrium with a large, triangular, ventral lobe nearly as long as surstylus, sparsely setulose on medial surface, bearing a row of short setae along posterior margin; aedeagus very thin, ribbonlike.

Description.—Body length 2.65–2.85 mm; body with gray microtomentum; setae black.

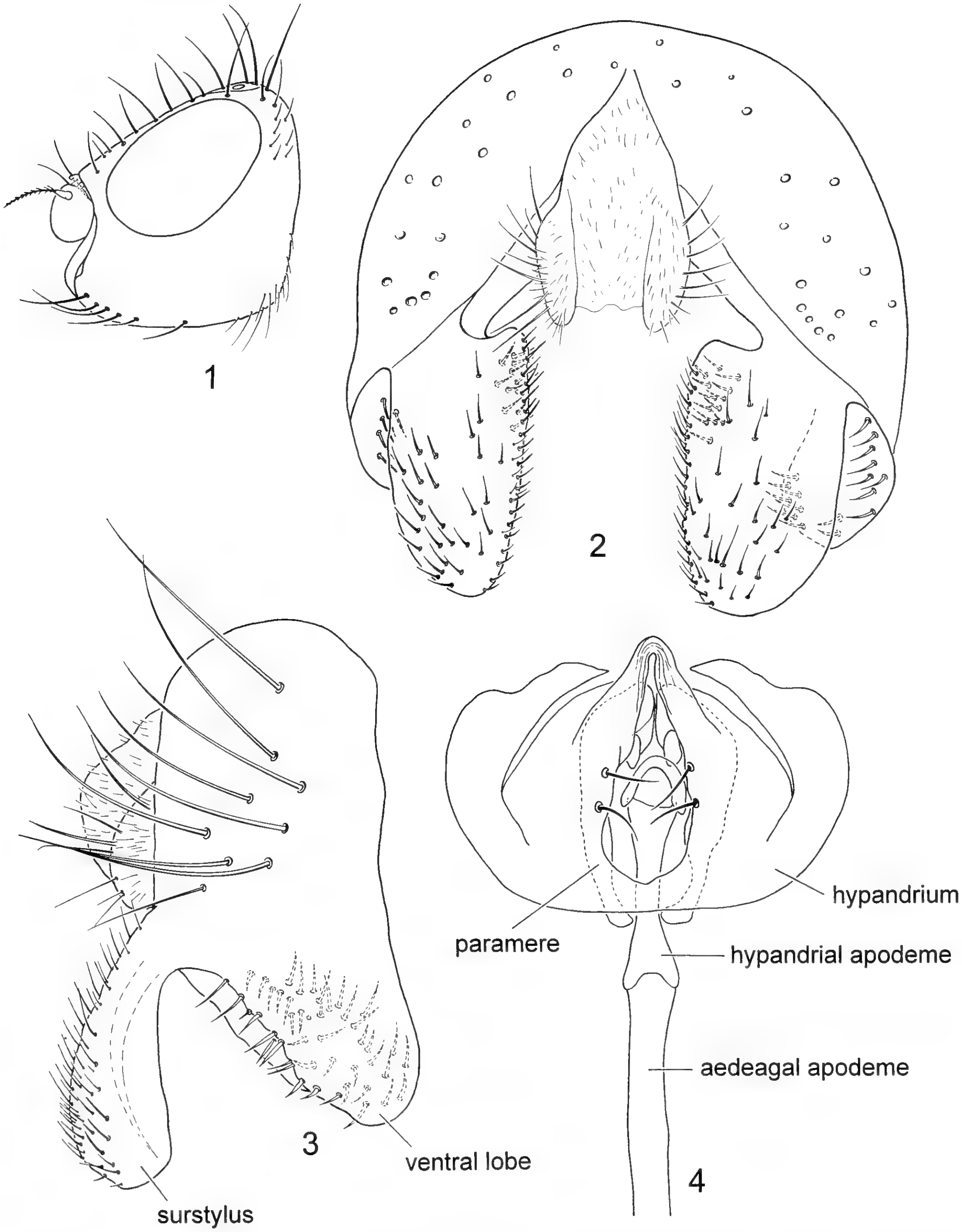
Head (Fig. 1): Setae black. Vertex gray, microtomentose; ocellar tubercle bearing 2 ocellar setae and 1 shorter setula directly in middle; postocellar seta well developed; frons yellowish medially, grayish laterally, microtomentose; interfrontal setae 3, anterior pair proclinate, posterior 2 setae convergent; fronto-orbital setae as 3 convergent, proclinate inner setae and 4 divergent, outer setae; bearing 2 additional pairs of dorsally directed setae near base of antennae. Antenna dark brown except basal ½ of 1st flagellomere reddish brown; arista dark brown, sparsely pubescent. Face white microtomentose; facial tubercle yellow, dorsad of anteriormost seta; peristomal setae bearing 4 dorsally directed setae, 5th directly anteriorly. Gena high, 0.62–0.75 eye height, white, microtomentose; postgena gray bearing pale setulae. Palpus yellow; labellum long, brown.

Thorax: Entirely gray microtomentose; scutellum uniformly gray, lacking yellowish to reddish spot. Acrostichal setulae in 4 irregular rows; dorsocentral setae 5 (2+3); proepisternum and proepimeron each bearing 1 seta. Wing with veins brown to yellow except center of crossveins distinctly whitish; costa continuing strongly to vein M; vein R_{2+3} and R_{4+5} divergent; veins R_{4+5} and M parallel apically. Midtibia ventrally bearing several strong black setae in addition to long apical seta; hindtibia bearing 1 well-developed seta in addition to apical seta; coxae gray to brownish gray, bearing mostly pale setulae; femora entirely gray microtomentose, swollen, especially hindfemur, which is distinctly more swollen than fore- and midfemora; tibiae gray microtomentose; basal 3 tarsomeres yellow, apical tarsomeres black.

Abdomen: Setae and setulae black; distal margins of segments yellow, remainder concolorous with thorax. Male terminalia (Figs. 2–4): Surstylus broadly spatulate and broadly attached to epandrium posteriorly, bearing 2 rows of short setae along medial margin and scattered setae on posterior surface; epandrium with a large, triangular, ventral lobe nearly as long as surstylus, sparsely setulose on medial surface, bearing a row of short setae along posterior margin; aedeagus very thin, ribbonlike.

Type material.—The holotype ♂ is labeled "CHILE: Osorno Pr[ovince]: Pucatrihue, 27–30 January 1978 WNMathis/ HOLOTYPE Tethina robusta ♂ Foster & W.N.Mathis USNM [red; species name and "♂ & Foster" handwritten]." The holotype is double mounted (minuten in a block of plastic), is in excellent condition (a few setae with apices broken), and is deposited in the USNM. Three paratypes, all males, bear the same locality label data as the holotype.

Distribution.—*Neotropical:* Chile. Osorno: Pucatrihue.



Figs. 1–4. *Tethina robusta:* 1, Head, lateral view. 2, External male terminalia, posterior view (Chile. Orsono: Puchatrihue). 3, Same, lateral view. 4, Internal structures of male terminalia (aedeagus excluded), ventral view.

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LIFE HISTORY OF THE PUTNAM SCALE, *DIASPIDIOTUS ANCYLUS* (PUTNAM) (HEMIPTERA: COCCOIDEA: DIASPIDIDAE) ON BLUEBERRIES (*VACCINIUM CORYMBOSUM,* ERICACEAE) IN NEW JERSEY, WITH A WORLD LIST OF SCALE INSECTS ON BLUEBERRIES

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Abstract.—Life history of the Putnam scale was investigated during 1997 and 1998 on highbush blueberries in the pine barrens of southern New Jersey. Putnam scale has two generations each year. Crawler emergences in the first and second generations peaked during late May and early to mid-August, respectively. This species overwinters as second instar nymphs, primarily under the bark (cork cambium) of the host. Adult females that occur on or under the bark of blueberries differ morphologically from those on the leaves and fruit. Descriptions of both forms are provided. Nine species of parasitoids were reared from canes containing Putnam scale infestations and peak emergence times of the parasitoids coincided with the transition between the adult females and crawlers.

Key Words: scale insect, life history, armored scale, Putnam scale, blueberry, pest, parasitoids, lady beetles, *Diaspidiotus ancylus*

Scale insects are frequently cited as pests of blueberries (Marucci 1966, Milholland and Meyer 1984, Antonelli et al. 1992), but there often is considerable misinformation about the species that are causing problems. Examples of erroneous statements from the literature include: terrapin scale, *Mesolecanium nigrofasciatum* (Pergande) secretes a rigid cover over its body (Milholland and Meyer 1984); Putnam scale overwinters as fully developed adults (Antonelli et al. 1992); all scale insects on blueberries have a single generation each year (Milholland and Meyer 1984); Putnam scale secretes honeydew which covers leaves and fruit and interrupts normal plant growth (Marucci 1966). In fact, terrapin scale does not secrete a cover, but the hard, banded structure that is evident on the host plant is the body of the adult female; Putnam scale is only known to overwinter as second-instar males and females (Tinker 1957, Stimmel 1976); Putnam scale is reported to have two generations each year in Delaware (Bray 1974); armored scales do not secrete honeydew but concentrate the anal secretion and incorporate it into the scale cover (Foldi 1989).

The purpose of this paper is to provide definitive information on the life history of Putnam scale on blueberries in the pine barrens of southern New Jersey, to provide detailed illustrations of the leaf and stem forms of the species, to give information on natural enemies reared during life-history studies, and to provide a list of the scale-insect species that occur on blueberries and other *Vaccinium* hosts. Phenological information on Putnam scale will enable the development of effective management strategies timed to coincide with the occurrence of susceptible stages. Data on natural enemies should assist pest management specialists in the development of IPM programs that do not affect natural-enemy populations. The list of scale-insect species on blueberries provides general information on the distribution of species and heightens awareness of the diverse scale fauna that could become pests of blueberries.

The pest status of Putnam scale is variable. Large populations are reported to reduce plant vigor (Antonelli et al. 1992). It also is an aesthetic pest; the fruit can be deformed because of depressions formed under aggregated females, and the scale covers appear as white spots on the berries. Feeding on leaves and green stems causes red areas around the feeding site. Regular pruning to remove older canes appears to keep Putnam scale populations from becoming a serious problem (Weiss and Beckwith 1945, Marucci 1966). Application of dormant oil before the plant blossoms also is an effective control method (Marucci 1966).

Putnam scale life history and identification is complicated by the presence of different morphs on different parts of the bush. Host-position dimorphism was first discovered on maple by Stannard (1965). He provided evidence that the bark form was typical of *Aspidiotus* (= *Diaspidiotus*) *ancylus,* but when bark females produced crawlers that settled on leaves the resulting leaf adults were typical of *Aspidiotus howardi* Cockerell or *A. comstocki* Johnson. Stannard (1965) stated that more than 90% of the leaf population dispersed back to the twigs in late summer as crawlers and implied that a significant proportion of the summer-generation crawlers settled on the leaves of the host. The bark form (Fig. 3) was characterized by having the second pair of pygidial lobes either absent or greatly reduced, and by having the interlobular plates with only small fimbriations. The leaf form (Fig. 4) has large second lobes and the plates have conspicuous fimbriations. These differences are so significant that the bark form was placed in the genus *Diaspidiotus* (Borchsenius 1966) and the leaf form was put in *Abgrallaspis* (Balachowsky 1953).

A summary of the literature on the life history of Putnam scale is as follows. This species has one generation each year in northern areas (e.g., Iowa, parts of New Jersey, Ohio, and Pennsylvania) and two generations in southern areas (e.g., southern Illinois and Delaware). Crawlers are reported in late spring or early summer in Iowa (Putnam 1880), in May and July in Delaware (Bray 1974), before midsummer in Ohio (Houser 1918), in May or June and midsummer in Illinois (Stannard 1965). Stimmel (1976) states that crawlers are present in Pennsylvania (a one generation per year area) for 4–5 weeks and are active through late July. In Illinois, Tinker (1957) reports crawler peaks in the third week of June and again in the second week of August. The species overwinters as second instars on the bark of twigs in both single-generation (Stimmel 1976) and two-generation areas (Tinker 1957). In Illinois, Tinker (1957) reported that females lay an average of 49 eggs at a rate of 2–3 eggs each day; eggs hatch in about 16 hours. Adults appear in May and July in Illinois (Tinker 1957) and in April in Pennsylvania (Stimmel 1976).

The known parasitoids of the Putnam scale are as follows: Aphelinidae: *Coccobius* (= *Phycus*) *varicornis* (Howard); *Encarsia* (= *Prospaltella*) *aurantii* (Howard); *E.* (= *Aspidiotiphagus*) *citrinus* (Craw) (Gordh 1979). Tinker (1957) reared six "eulophid" species from this scale in Illinois, but the identity (and family assignment) of these species is unknown.

METHODS

Monitoring the life history of Putnam scale was undertaken using two methods.

Crawler emergence was monitored using sticky-tape traps (Scotch™ poster tape #109, 3M Company, St. Paul, MN) wrapped around infested canes as described by Dreistadt et al. (1994). The sticky-tape traps were placed on at least seven different plants in two different locations (near Browns Mills, Burlington County, New Jersey, and Rutgers Blueberry and Cranberry Research Center, Chatsworth, Burlington County, New Jersey). At the Browns Mills location 'Bluecrop' blueberries were sampled and at Chatsworth the field contained a mixture of mid-season varieties. Some plants contained two sticky-tape traps and each location had 10 to 12 sampling sites. The sticky-tape traps were replaced at about weekly intervals and were examined using a Nikon SMZ-U stereo microscope at 30–40× magnification. The total number of crawlers on each sticky-tape trap was counted and recorded for each sampling interval.

The second method of life-history monitoring was undertaken by examining woody canes (and the leaves and fruit at their apex) that were pruned from plants at the Rutgers Blueberry and Cranberry Research Center, Chatsworth. Two sites were sampled; one from the northern part of the blueberry breeding plot near the area sampled using sticky tapes, and one from a southern area of the same breeding plot. Five canes were taken from each location and were examined in the laboratory using a Wild Photomakroskop M400 stereomicroscope at 30–60× magnification. From each location the sex and life-history stage of the first 50 specimens encountered were recorded; observations on parasite emergence, predator activity, and scale behavior were made during the counting process. Samples were taken approximately once each month.

The following technique was used to collect the parasitoids in the samples. After completing the counting process, heavily infested pieces of blueberry cane were placed in clean 2 lb. 7 oz. coffee cans that were covered by tissue paper and held in place by plastic lids with the centers cut out. Each can contained an average of 10 twigs, five inches long, between ½ and 1 inch in diameter. All parasitoids that emerged in the cans were collected in alcohol and submitted for identification.

Search of the literature for species of scale insects on *Vaccinium* was not exhaustive, but included the majority of the species on this host genus. Primary sources of information were: ScaleNet which is part of the database system within the Systematic Entomology Laboratory's web site (http://www.sel.barc.usda.gov), Borchsenius (1966), Dekle (1976), Hamon and Williams (1984), Kozár (1998), Howell and Kosztarab (1972), Lambdin and Kosztarab (1977).

RESULTS

Putnam scale life history.—The Putnam scale has two generations each year in the blueberry growing areas of the pine barrens of southern New Jersey (Fig. 1). Peak crawler emergences were in late May and early June for the first generation, and early to mid-August for the second (Figs. 2a, b). Second-instar males and females were the overwintering stages, and they were predominant under the bark of old canes.

Spring activity began in early February when second-instar males began to molt to third instars. By the end of March most second-instar females had transformed into adults (3rd instar) and males had matured to pupae (4th instar) and adults (5th instar) (Tables 1–2). In late April most of the population was in the adult-female stage indicating that adult males had emerged, mated, and died. Crawlers (1st instars) began to appear in mid-May and were present for the rest of the growing season into October. However, there were two distinct peaks in crawler abundance coinciding with the beginning of the two annual generations (Figs. 2a, b). In early to mid-July, the number of crawlers taken on the sticky-tape traps decreased significantly and signaled the transition between generations. In most instances, the sticky-tape traps at this time of year

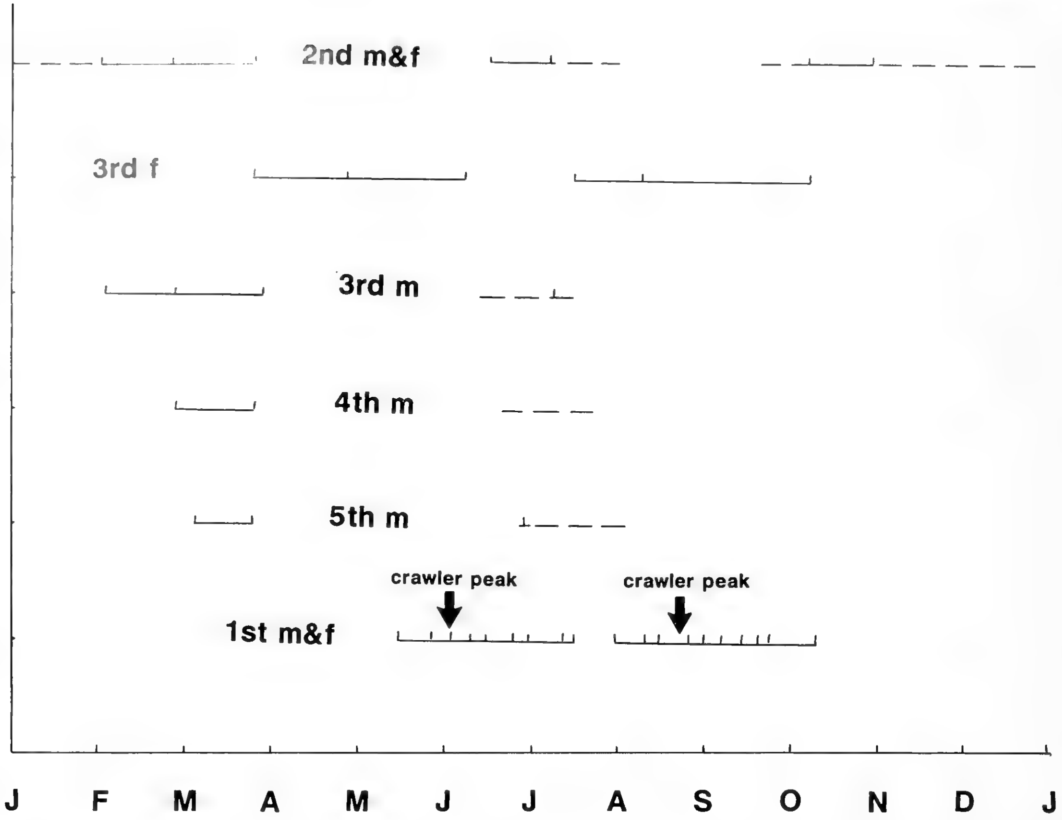

Fig. 1. Seasonal occurrence and duration of various instars of *Diaspidiotus ancylus* through the 1998 growing season at Rutgers Blueberry and Cranberry Research Center, Chatsworth, NJ. Points on the life-history bars are actual observations. Doted lines are given when direct observations of a particular instar were not made, but they are surmised to be present based on indirect evidence (m = male; f = female).

were without crawlers, but a few contained a small number (Figs. 2a, b). Crawlers seemed to prefer settling under the flaky bark on older canes, but small numbers also settled on the undersides of leaves and fruit. As the crawlers mature, the tan cork cambium of the bark grows over the scale cover, and the only evidence that a scale insect is present is a rounded swelling on the bark. Peak emergence of crawlers at Browns Mills occurred a few days after peak emergence at Chatsworth, most likely because of slightly lower temperatures at Browns Mills.

Second instars were first collected in mid June and were apparently present until mid-July (Tables 1–2). Second-instar males began to elongate their scales in late June and became distinguishable from the round scales of the second-instar females at that time. We did not find sufficient numbers of males in the second generation to make good observations on their developmental time frame. Many empty male scale covers were found in samples from July 9 suggesting that adult males had already emerged. We found a few adult males on the sticky-tape traps from June 26. Adult females were first detected in mid-June, but scale covers were not enlarged until mid-July. Observations from the August 11 sample indicate that about half of the adult females had eggs under their scale covers. The remaining females had not yet begun to lay eggs. Crawlers of the second generation began to appear in late July; peak

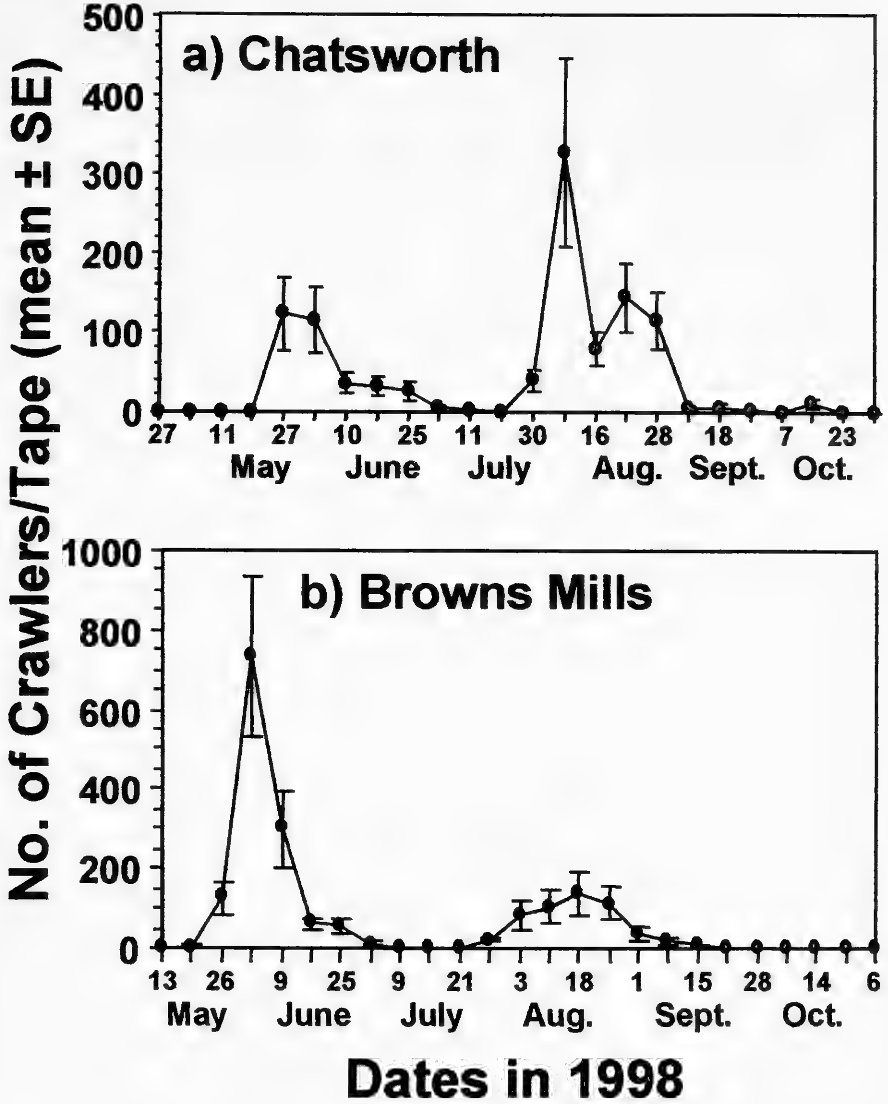

Fig. 2. Crawler abundance (mean number per sticky-tape trap ± SE) of *Diaspidiotus ancylus* at Rutgers Blueberry and Cranberry Research Center, Chatsworth, NJ, (a) and at Browns Mills, NJ (b) during 1998 growing season.

numbers were found on the sticky-tape traps in early August at the Blueberry and Cranberry Research Center and slightly later at the Browns Mills location (Figs. 2a, b). Second instars first appeared in early September and by late October were the only stage present. In the October 30 sample, second-instar males had begun to elongate their scale covers and were distinguishable from second-instar females at that time.

Host-position dimorphism.—Studies were undertaken to examine morphological differences induced by settling site locations. Specimens collected on the stems and even leaf petioles showed the morphology typical of the ancylus form (Fig. 3) that have the second lobes absent or reduced to

Table 1. Percent of *Diaspidiotus ancylus* populations in each instar during the 1998 growing season at the north side of the blueberry breeding plot at the Rutgers Blueberry and Cranberry Research Center, Chatsworth, NJ. A total of 50 specimens were examined on each sampling date. Abbreviations are m = male; f = female.

	Percent of Population in each Instar Dates in 1998								
Instars	2/2	2/26	3/26	4/30	6/18	7/9	8/11	10/9	10/30
Settled 1st					30		36	4	
Active 1st					8		22		
2nd m or f?					56				100
2nd f	54	60	6					92	
2nd m	12	2				2			
3rd f			56	100	6	96	42	4	
3rd m	34	8	6			2			
4th m		30	16						
5th m			16						

small points (Fig. 3A), the plates between the median and second lobes have small fimbriations (Fig. 3B) (compared to the howardi-comstocki form), with 18–48(31) macroducts on each side of the pygidium (Fig. 3C), 9–22(15) perivulvar pores on each side of the pygidium (Fig. 3D), and many microducts near the dorsomarginal area of the thorax and head (Fig. 3E). Specimens collected on fruit and leaves showed the morphology typical of the howardi or comstocki forms (Fig. 4) that have well-developed second lobes (Fig. 4A), the plates between the median and second lobes have large fimbriations (Fig. 4B), (compared to the ancylus form), with 12–22(17) macroducts on each side of the pygidium (Fig. 4C), 8–10(9) perivulvar pores on each side of the pygidium (Fig. 4D), and few or no microducts near the dorsomarginal area of the thorax and head (Fig. 4E). In some cases intermediate forms are collected particularly on green stems and leaf petioles.

Table 2. Percent of *Diaspidiotus ancylus* populations in each instar during the 1998 growing season at the south side of the blueberry breeding plot at the Rutgers Blueberry and Cranberry Research Center, Chatsworth, NJ. A total of 50 specimens were examined on each sampling date. Abbreviations are m = male; f = female.

	Percent of Population in each Instar Dates in 1998						
Instars	3/26	4/30	6/18	7/10	8/11	10/9	10/30
Settled 1st			22		34	22	
Active 1st			22		34		
2nd m or f?			54			78	100
2nd f	60						
2nd m							
3rd f		100	2	100	32		
3rd m	4						
4th m	36						
5th m							

There also is a striking difference in the appearance of the scale cover between the leaf-fruit form and the bark form. The howardi-comstocki form on the fruit has a conspicuously white scale cover with a slight grayish tinge and is never under the outer cell layer of the host. The ancylus form on the bark has the scale cover dark gray and is usually hidden under the host cork cambium.

Information on natural enemies.—Based on parasitoid rearing data, there were two occurrence peaks of adult parasitoids. The sample from April 30 had an emergence of more than 50 adult parasitoids. This time frame coincided with the predominance of adult females just before the first crawlers appeared. The sample from August 11 had an emergence of about 100 adult parasitoids. The scale population at this time was near the end of the first generation, with adult females predominantly laying eggs and with crawlers of the second generation the most abundant life stage. The parasitoids that were collected are as follows:

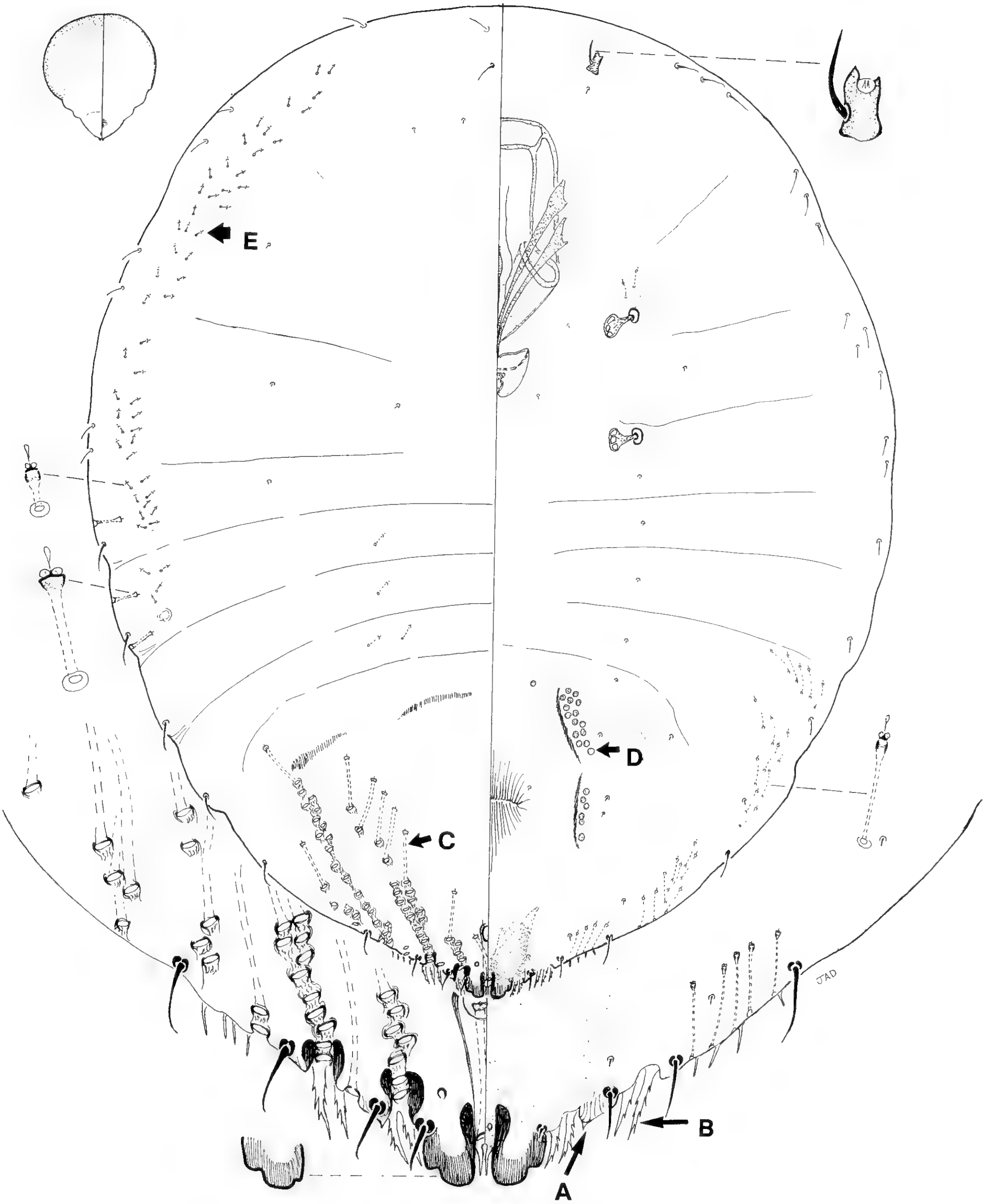

Fig. 3. Bark form (ancylus form), adult female *Diaspidiotus ancylus.* A, Second lobe; B, Interlobular plates; C, Macroducts; D, Perivulvar pores; E, Microducts.

Aphelinidae: *Ablerus clisiocampae* (Ashmead); *Coccobius varicornis* (Howard); *Coccophagoides* sp. #1; *Coccophagoides* sp. # 2; *Encarsia* sp.; *Encarsia aurantii* (Howard); *Marietta carnesi* (Howard). Encyrtidae: *Epitetracnemus intersectus* (Fonscolombe). Signiphoridae: *Signiphora* sp. The most abundant parasitoids were *Able-*

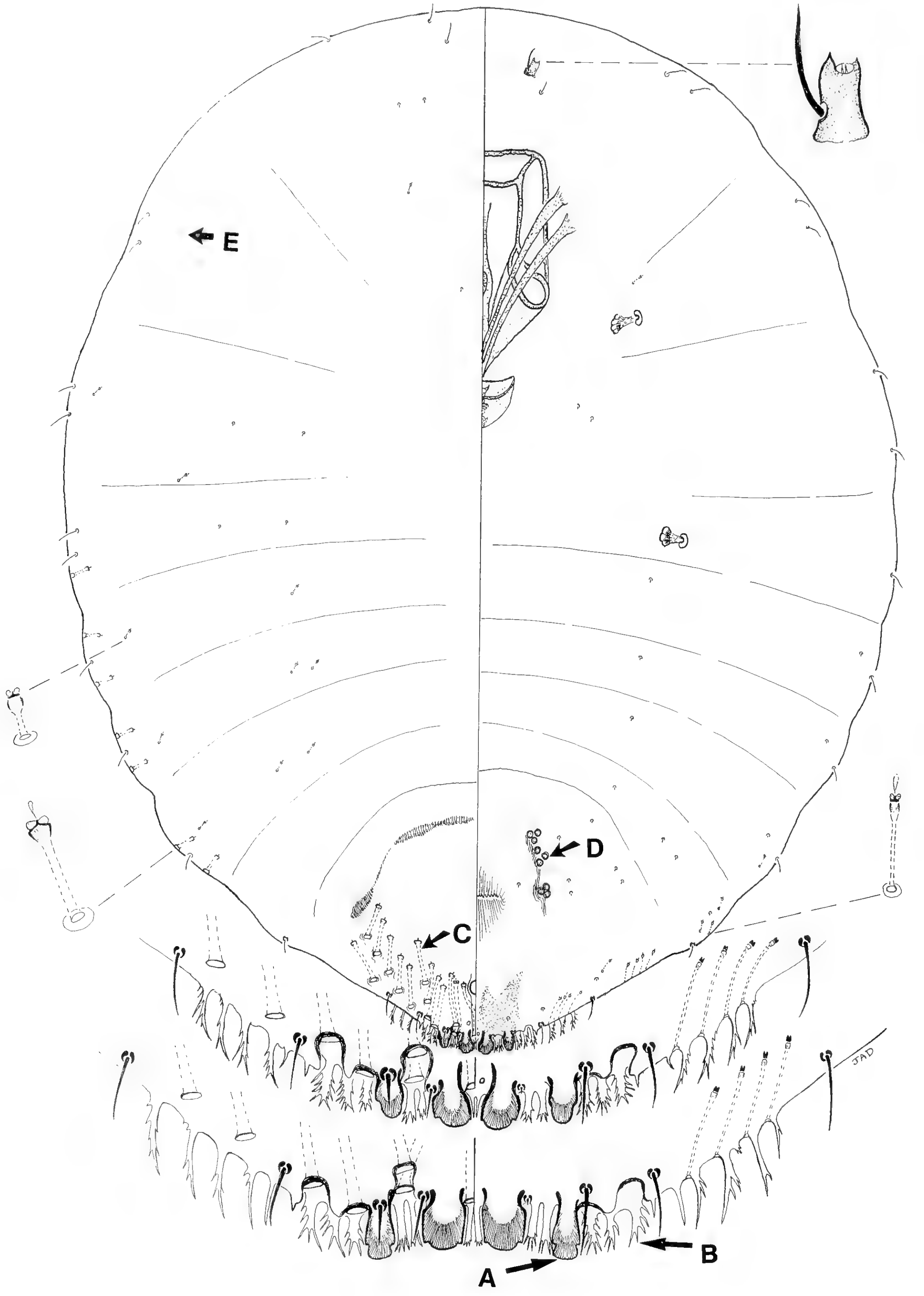

Fig. 4. Leaf and fruit form (howardi-comstocki form), adult female *Diaspidiotus ancylus* (Putnam). A, Second lobe; B, Interlobular plates; C, Macroducts; D, Perivulvar pores; E, Microducts.

rus clisiocampe and *Marietta carnesi* (Howard).; *Coccophagoides* sp. #1; *Coccophagoides* sp. # 2; and *Coccobius varicornis* were next most numerous, and the remainder were uncommon.

The lady beetle (Coccinellidae) *Microwesia misella* (LeConte) was commonly encountered during the warm parts of the year, as was an occasional *Chilocorus* specimen. Adults were found in the samples collected February 2 and April 30, and larvae were seen in the March 26 and August 11 samples. The predatory mite (Hemisarcoptidae), *Hemisarcoptes malus* (Shimer) was noticeably abundant in the August 11 sample.

Survey results.—We found the following scale species in 1997 and 1998 in commercial blueberry fields in New Jersey: Coccidae: European fruit lecanium—*Parthenolecanium corni* (Bouché) (4 locations); Cottony hydrangea scale—*Pulvinaria hydrangeae* Steinweden (2 locations); Cottony maple scale—*Pulvinaria innumerabilis* (Rathvon) (3 locations). Diaspididae: Putnam scale—*Diaspidiotus ancylus* (6 locations). Pseudococcidae: Blueberry mealybug—*Dysmicoccus vaccini* Miller and Polavarapu (7 locations).

We collected additional species in native blueberries near commercial fields in NJ as follows: Coccidae: Cottony azalea scale—*Pulvinaria ericicola* McConnell (8 locations). Pseudococcidae: Myrmecophile mealybug—*Peliococcus flaveolus* (Cockerell) (7 locations).

Other species known to occur on *Vaccinium* in the Northeastern US are: Cerococcidae: *Cerococcus kalmiae* Ferris (Eastern US, Kansas, Texas). Coccidae: Thorn scale—*Eulecanium tiliae* (Linnaeus) (US and Europe); Terrapin scale—*Mesolecanium nigrofasciatum* (Pergande) (eastern US); Cottony camellia scale—*Pulvinaria floccifera* (Westwood) (Cosmopolitan). Diaspididae: Cranberry scale—*Abgrallaspis oxycoccus* (Woglum) (Eastern US); Oystershell scale—*Lepidosaphes ulmi* (Linnaeus) (Cosmopolitan); San Jose scale—*Quadraspidiotus perniciosus* (Comstock) (Cosmopolitan); Dearness scale—*Rhizaspidiotus dearnessi* (Cockerell) (US and Mexico). Eriococcidae: Azalea bark scale—*Eriococcus azaleae* (Comstock) (US); Oak felt scale—*Eriococcus quercus* (Comstock) (US). Lecanodiaspididae: Common false pit scale—*Lecanodiaspis prosopidis* (Maskell) (US and Mexico). Pseudococcidae: *Heliococcus osborni* (Sanders) (Eastern US and Colorado); False puto mealybug—*Phenacoccus rubivorus* Cockerell (Eastern US and New Mexico); Kellogg mealybug—*Radicoccus kelloggi* (Ehrhorn and Cockerell) (US).

Other species known to occur on *Vaccinium* in parts of the US other than the Northeast are: Coccidae: Barnacle scale—*Ceroplastes cirripediformis* Comstock (Cosmopolitan); Indian wax scale—*Ceroplastes ceriferus* (Fabricius) (Cosmopolitan); Florida wax scale—*Ceroplastes floridensis* Comstock (Cosmopolitan); Chinese wax scale—*Ceroplastes sinensis* Del Guercio (Cosmopolitan); Brown soft scale—*Coccus hesperidum* Linnaeus (Cosmopolitan); Pyriform scale—*Protopulvinaria pyriformis* (Cockerell) (Tropical areas); Cottony maple leaf scale—*Pulvinaria acericola* (Walsh and Riley) (Eastern US); (Southern US, Pacific Islands, Caribbean Islands, Galapagos Islands, Israel) Urbicola soft scale—*Pulvinaria urbicola* Cockerell (Southern US, Pacific Islands, Caribbean Islands, Galapagos Islands, Israel); Hemispherical scale—*Saissetia oleae* (Olivier) (Cosmopolitan). Diaspididae: Cyanophyllum scale—*Abgrallaspis cyanophylli* (Signoret) (Cosmopolitan); Red bay scale—*Acutaspis perseae* (Comstock) (New World and Europe); Oleander scale—*Aspidiotus nerii* (Bouché) (Cosmopolitan); Spinose scale—*Aspidiotus spinosus* Comstock (Cosmopolitan); Camellia mining scale—*Duplaspidiotus clavigera* (Cockerell) (Florida, Tropical areas); Tesserate scale—*Duplaspidiotus tesseratus* (Grandpré and Charmoy) (Tropical areas); Latania scale—*Hemiberlesia lataniae* (Signoret); Mimosa scale—*Melanaspis mimo-*

sae (Comstock) (Mexico, Arizona, California, and Florida); Harper scale—*Neopinnaspis harperi* McKenzie (California, Florida, Georgia, Hawaii, Japan, Taiwan); Camphor scale—*Pseudaonidia duplex* (Cockerell); White peach scale—*Pseudaulacaspis pentagona* (Targioni-Tozzetti) (Cosmopolitan); False parlatoria scale—*Pseudoparlatoria parlatoriodes* (Comstock) (Tropical areas); Dentate scale—*Velataspis dentata* (Hoke) (Southeastern US, Panama). Eriococcidae: Texas eriococcin—*Eriococcus texanus* (King) (Western US). Pseudococcidae: Bilberry mealybug—*Cucullococcus vaccinii* Ferris (California). Putoidae: Pacific mealybug—*Puto pacificus* McKenzie (California).

Scale species known to occur on *Vaccinium* outside of the US: Coccidae: *Eulecanium distinguendum* (Douglas) (England); *Eulecanium franconicum* (Lindinger) (Europe and Former Soviet Union); *Parthenolecanium rufulum* (Cockerell) (Europe and Former Soviet Union); *Phyllostroma myrtilli* (Kaltenbach) (Europe and Former Soviet Union); *Pulvinaria peregrina* (Borchsenius) (Azerbaijan and Georgia). Conchaspididae: *Conchaspis vaccinii* Khoo (Malaysia). Diaspididae: *Aulacaspis ericacearum* Takagi (Japan); *Chionaspis salicis* (Linnaeus) (Europe, Asia, N. Africa); *Niveaspis vulcania* Ferris (Panama); *Pseudaulacaspis ericacea* (Ferris) (China); *Quadraspidiotus bavaricus* (Lindinger) (Europe); *Quadraspidiotus ostreaeformis* (Curtis) (temperate areas); *Quadraspidiotus zonatus* (Frauenfeld) (Europe, Middle East, and Africa). Eriococcidae: *Eriococcus baldonensis* (Rasina) (Finland, Latvia, Ukraine, and Russia); *Eriococcus costaricensis* (Cockerell and Robinson) (Costa Rica); *Eriococcus devoniensis* (Green) (Europe); *Eriococcus uvaeursi* (Linnaeus) (Europe). Ortheziidae: *Arctorthezia cataphracta* (Olafsen) (Europe); *Newsteadia floccosa* De Geer (Europe). Pseudococcidae: *Atrococcus bejbienkoi* Kozár and Danzig (Hungary and Former Soviet Union); *Atrococcus cracens* Williams (Europe); *Indococcus acanthodes* (Wang) (China); *Phenacoccus insularis* Danzig (Russia); *Phenacoccus vaccinii* (Danzig) (Russia); *Spinococcus calluneti* (Lindinger) (Europe). Putoidae: *Puto janetscheki* Balachowsky (France and Czechoslovakia); *Puto tubulifer* Danzig (Mongolia and Russia); *Puto vaccinii* (Coquillett) (Russia).

Discussion

It is now clear that references to the Putnam scale having only a single generation in the commercial blueberries areas near the pine barrens of New Jersey are incorrect. It also is incorrect that the overwintering stage is the adult female. Quite clearly, there are two generations each year, and the overwintering stage is the second-instar male and female.

Although we did not make a detailed comparison of the relative abundance of Putnam scale on the bark versus the leaves and fruit, it is obvious that only a very small proportion of the population is found on plant parts other than the roughened bark. The reasons for this are not clear, but there are at least two possibilities. 1) It is feasible that the preferred feeding site is under the bark, and only when this habitat is crowded will crawlers settle on sites that are less than optimal. 2) It also is possible that a large proportion of the population actually settles on exposed parts of the host but is killed by pesticides used to control other blueberry pests. Our current thinking favors hypothesis 1 since we see no evidence of massive pesticide kills of crawlers on exposed parts of the plants, and it appears that crawlers settle on host areas other than the bark only in situations where the bark is already encrusted with heavy populations of the scale. Hypothesis 1 supports the long-held belief that removal of old woody canes will prevent the Putnam scale from becoming a serious pest. Without the roughened bark of older canes to settle under, their preferred habitat is lacking, and the scales that settle on the smooth areas of the host may be more susceptible to natural enemies. Our observations suggest that there is a much higher rate of parasitism on individuals that are exposed on the fruit, leaves, or smooth bark than on those hidden under rough bark. It is interesting that every blueberry farm that we examined for Putnam scale had populations of the scale under the bark of the older canes. This suggests that these residual populations could build to pest levels if conditions encouraging their build up were to occur.

Adult parasitoids seem to be most abundant when adult females and crawlers are most prevalent. This situation is problematic because pesticide applications (other than horticultural oil sprays) are most effective against the scales during these same periods, i.e., when the crawlers are wandering on the host searching for settling sites and have yet to form a scale cover. If chemical applications are required at these times, it would probably be best to use horticultural oils at summer rates without combinations of pesticides, since residues from the latter can kill parasitoids for one or more weeks after application.

A broad diversity of scale insects has been reported to feed on *Vaccinium* hosts including highbush blueberries. At present we know of 54 species of scale insects that feed on species of *Vaccinium.* In the Northeastern U.S. there are 21 different species. In other parts of the U.S. there are seven additional species. In areas outside of the U. S. there are 26 more species. Of these 26 species, 11 have limited host ranges: *Aulacaspis ericacearum*–Ericaceae only; *Eriococcus baldonensis*–Ericaceae and one other family; *E. costaricensis–Vaccinium* only; *Eulecanium distinguendum–Vaccinium* only; *E. franconicum*–Ericaceae only; *Indococcus acanthodes–Vaccinium* only; *Niveaspis vulcania–Vaccinium* only; *Phenacoccus vaccinii*–Ericaceae only; *Phyllostroma myrtilli*–Ericaceae only; *Puto tubulifer–Vaccinium* only; *Puto vaccinii–Vaccinium* only. If any of these species were accidentally introduced into the blueberry growing areas of the U.S. there could be serious consequences.

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REVISION OF THE *MEXICANA*-GROUP OF THE CYCLOTELINE GENUS *OZODICEROMYIA* BIGOT (DIPTERA: THEREVIDAE)

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Abstract.—The *mexicana*-group of the cycloteline genus *Ozodiceromyia* Bigot (Diptera: Therevidae) is treated. The two previously described species of the group, *Ozodiceromyia mexicana* Bigot (the type species) and *Ozodiceromyia argentifera* (Kröber), are redescribed, and two new species, ***Ozodiceromyia livdahli*** and ***Ozodiceromyia parargentifera,*** are described. In addition, a neotype is designated for *Phycus argentifer* Kröber, and a lectotype is designated for *Euphycus setosus* Kröber, a junior subjective synonym of *Ozodiceromyia mexicana.* A phylogenetic hypothesis is discussed for the relationships among these taxa, characters and their evolution are discussed, a key to species is provided, and each species is diagnosed.

Key Words: phylogeny, revision, morphology, cladistics

The genus *Ozodiceromyia* Bigot (Diptera: Therevidae) is distributed throughout North and Central America, into northern South America, being most speciose in the dry regions of the southwestern United States, California, and northern Mexico. The genus was treated by Gaimari (1998) from the standpoint of hypothesizing relationships among described species. As a result of cladistic phylogenetic analysis, a well characterized "*mexicana*-group," including *Ozodiceromyia mexicana* Bigot and *Ozodiceromyia argentifera* (Kröber), was demonstrated.

The concept of *Ozodiceromyia* was introduced by Bigot (1890), for the single species *Ozodiceromyia mexicana,* and the genus remained monotypic until *Phycus argentifer* Kröber was included by Cole (1965). Irwin and Lyneborg (1981a) were the first to recognize the diversity of *Ozodiceromyia,* transferring 34 species into the genus, mostly from *Psilocephala* Zetterstedt and *Thereva* Latreille. The list was modified by Gaimari and Irwin (2000) to reflect current opinions on synonymy and to add several new combinations, leaving the genus with 27 valid species. The current revision treats the nominal *mexicana*-species group, seeking to clarify the identities of the two described species within the group, which have often been confused, and to add two new species, both of which can be confused with the described species.

METHODS

Specimens were examined using a Wild/Leica MZ8 binocular dissecting microscope with a range of magnification between 6.3 and 50×. For phylogenetic analyses, a minimum of four male and four female specimens were examined for each species, with the exception of *Ozodiceromyia parargentifera,* which is known from only the holotype male and three female paratypes.

For each species, at least one male ab-

Table 1. Data matrix used in analysis of the *Ozodiceromyia mexicana*-group.

Ozodiceromyia signatipennis	00000 00000 00000 00000 00000 00000 00000 00000 0
Ozodiceromyia costalis	01010 00001 10000 00000 10000 00010 11001 00000 0
Ozodiceromyia argentifera	11111 11101 01101 10001 11100 10101 11110 00011 1
Ozodiceromyia livdahli	11111 11101 01101 10001 11100 00101 11110 00011 1
Ozodiceromyia mexicana	11011 11111 10011 11001 10111 01010 11111 11010 0
Ozodiceromyia parargentifera	11111 11101 00000 10111 11000 10101 11110 00111 1

domen and one female abdomen were macerated and dissected per the procedure outlined in Gaimari and Irwin (2000). Illustrations (carbon dust on clayboard) were made with a camera lucida attached to a Leica MZ12 binocular dissecting microscope with a range of magnification between 8 and 100×. Morphological terminology follows that of Gaimari and Irwin (2000).

Each specimen has been assigned a unique 6-digit number with the prefix "MEI." This number is printed on a yellow label (THEREVIDAE/M. E. Irwin/Specimen #), which is attached to each pinned specimen. This unique number for each specimen facilitates entry and manipulation of data in a specimen-level database of world Therevidae. These numbers are referred to throughout the text, illustrations, and in the "Materials examined" list for each species.

Cladistic analysis.—Phylogenetic analyses follow the cladistic philosophy of parsimony promoted by Hennig (1966) and later by other workers (e.g., Wiley 1981; Farris 1983). The same basic principles, philosophies, and specific methods are followed as outlined in Gaimari and Irwin (2000).

Character polarities were determined using outgroups (Watrous and Wheeler 1981; Farris 1982; Maddison et al. 1984; Nixon and Carpenter 1993) chosen within the context of the phylogeny of the described species of the genus proposed by Gaimari (1998). Cladistic analyses were performed using the exhaustive search option in PAUP (Swofford 1993, version 3.1.1) using the data matrix presented in Table 1. The cladogram figure displaying character state changes was prepared using WINCLADA (Nixon 1999, currently in version 0.9.9 *beta*) under ACCTRAN character optimization (Swofford and Maddison 1987), following the same reasoning as Gaimari and Irwin (2000).

Terminal taxa.—Very few specific hypotheses exist for relationships within *Ozodiceromyia,* and only Gaimari (1998) considered the genus in the broader context of phylogeny. Nonetheless, many undescribed species can be assigned to species-groups based on putative synapomorphies. Gaimari (1998) suggested a close relationship between *Ozodiceromyia argentifera* and *Ozodiceromyia mexicana* based upon the following synapomorphic characteristics: antenna longer than head; setae covering more than the basal half of first flagellomere; first flagellomere fully surrounded by setae equally on all sides; antennal style subapical and not extending beyond tip of first flagellomere; halter yellow (although this state appears in other members of the genus); distal part of ventral lobe of male genitalia with a pilose distal secondary lobe. Based upon these synapomorphic states, two new species have been recognized as members of this group and are described herein, along with redescriptions of the previously described species, and a phylogenetic hypothesis is proposed for the relationships among these taxa.

The two outgroup taxa, *Ozodiceromyia costalis* (Loew, 1869) (MEI 033251, 037735, 037741, 041847, 044821, 044990, 050648, 075851) and *Ozodiceromyia signatipennis* (Cole 1923) (MEI 035882, 041854, 041855, 043837, 044750, 056972, 056973, 071403), were chosen on the basis of relationships within this genus hypothesized by Gaimari (1998). *Ozodiceromyia costalis* is hypothesized to be closely related to the *mexicana*-group based upon the following synapomorphic characteristics: medial surface of scape setose; medial surface of pedicel setose; setae of male frons in patches or absent, not scattered; face directly below antenna shiny black, with little or no pruinescence (however, *Ozodiceromyia argentifera* displays the state of having silver pruinescence, and so this state is only synapomorphic under accelarated transformation character optimization); presence of projection on gonocoxal apodeme of male genitalia for articulation with aedeagus. *Ozodiceromyia signatipennis* is hypothesized to be a more distant part of this larger clade, based upon the following synapomorphic characteristics: median occipital sclerite of male entirely shiny black, lacking pruinescence; ventral gonocoxal process of male genitalia present as a small fold of the edge.

DESCRIPTIONS AND REDESCRIPTIONS OF SPECIES

The recognized species of the *Ozodiceromyia mexicana*-group are described or redescribed herein, and a dichotomous key is included. An exhaustive list of references for the two previously described taxa is provided by Gaimari (1998), but only taxonomically relevant references are listed herein. Within species descriptions, values in [ ] represent the values taken from paratypes or additional specimens of the same sex. Abbreviations for repositories follow Arnett et al. (1993), and are listed in Table 2.

Ozodiceromyia Bigot

Ozodiceromyia Bigot 1890: 323. Type species: *Ozodiceromyia mexicana* Bigot, by original designation. Sabrosky 1978: 143 (formally fixed spelling as "first reviser"); Gaimari and Irwin 2000 (in phylogeny, key ref., lit. list, list spp., biogeogr.).

Ozodiceromya (incorrect original spelling): Bigot 1890: 321 (orig. descr.); Irwin and Lyneborg 1981a: 203 (key ref.), 254 (redescr.), 1981b: 522 (key ref.).

Ozodiceronyma (misspelling): Godman 1901: 378 (listing).

Phycus Walker 1850, in part: Becker 1912: 294 (prop. *Ozodiceromyia* as junior syn.).

Psilocephala "*haemorrhoidalis*-group": Cole 1923: 34–37 (key ref.), 37 (descr.).

Ozodiceromyia mexicana-group

The small, easily recognized *mexicana*-group is characterized by an elongated antennal scape and first flagellomere, as well as the slightly elongated, barrel-shaped pedicel. In total, the antenna is longer than the head, and is densely setose, including setae on the median surface. This surface is bare in nearly all other members of the genus. Setae cover all but the distal third of the first flagellomere. The stylus is inserted subapically in a ventral pit slightly behind the apex of the first flagellomere. In the wings, the veins are orange, at least in the basal two-thirds; the distal third is often darkened and smoky, with correspondingly darker veins. In the male genitalia, the gonostylus is distinctly expanded ventrally into a large lobe, which is densely covered with fine, pale or orange setae. The sclerotized portions of the ventral lobes are completely separated, and each has a small, secondary lobe distally, covered with fine, short pile. When present, the ventral gonocoxal process is flattened and elongated (the ventral gonocoxal process is absent in *Ozodiceromyia mexicana*). The outer gonocoxal process is flattened and elongated. In the female terminalia, the furca lacks an anterior, sclerotized transverse bar. The common spermathecal duct originates on the furcal membrane within an indented cavity on the posterior part of the furcal bulla.

Synapomorphies.—Antenna longer than head (character 1), setae of first flagellomere covering more than basal half (character 5), setae fully surrounding first flagellomere (character 6), antennal style distinctly subapical (character 7), first stylar segment reduced to flattened ring (character 8), wing

Table 2. List of codons used for repositories of specimens.

AMNH	American Museum of Natural History, New York, New York.
ANIC	Australian National Insect Collection, CSIRO, Canberra, ACT, Australia.
ANSP	Academy of Natural Sciences, Philadelphia, Pennsylvania.
ASUT	Frank M. Hasbrouk Insect Collection, Arizona State University, Tempe, Arizona.
BMNH	The Natural History Museum, London, United Kingdom.
BPBM	Bernice P. Bishop Museum, Honolulu, Hawaii.
BYUC	Monte L. Bean Life Science Museum, Brigham Young University, Provo, Utah.
CASC	California Academy of Sciences, San Francisco, California.
CDFA	California State Collection of Arthropods, California Department of Food and Agriculture, Sacramento, California.
CICESE	Centro de Investicación Cientifica y de Educación Superior de Ensenada, Baja California Norte, Mexico.
CMNH	Carnegie Museum of Natural History, Pittsburgh, Pennsylvania.
CNCI	Canadian National Collection of Insects, Ottawa, Ontario, Canada.
CSUC	C. P. Gillette Arthropod Biodiversity Museum, Colorado State University, Fort Collins, Colorado.
CUIC	Cornell University Insect Collection, Ithaca, New York.
DEIC	Deutsches Entomologisches Institut, Eberswalde, Germany.
DENH	Entomological Museum, University of New Hampshire, Durham, New Hampshire.
EBCC	Estacion de Biologia Chamela, Universidade Nacional Autónoma de México, Jalisco, México.
EMEC	Essig Museum of Entomology, University of California, Berkeley, California.
EMUS	Entomological Museum, Utah State University, Logan, Utah.
ESUW	Rocky Mountain Systematic Entomology Laboratory, University of Wyoming, Laramie, Wyoming.
FMNH	Field Museum of Natural History, Chicago, Illinois.
FSCA	Florida State Collection of Arthropods, Gainesville, Florida.
IEXA	Instituto de Ecología, Xalapa, Vera Cruz, Mexico.
INBC	Instituto Nacional de Biodiversidad, Santo Domingo, Heredia, Costa Rica.
INHS	Illinois Natural History Survey, Champaign, Illinois.
IZAS	Institute of Zoology, Academica Sinica, Beijing, China.
IZAV	Instituto de Zoologia Agricola, Universidad Central de Venezuela, Maracay, Venezuela.
KSUC	Kansas State University Insect Collection, Manhattan, Kansas.
KUIC	Kagoshima University Insect Collection, Kagoshima, Japan.
LACM	Los Angeles County Museum of Natural History, Los Angeles, California.
MCZC	Museum of Comparative Zoology, Harvard University, Cambridge, Massachusetts.
MEIC	Michael E. Irwin private collection, for eventual deposit in CASC.
MEUC	Museo Entomologico, Universidad de Chile, Santiago, Chile.
MHNG	Muséum d'Histoire Naturelle, Genève, Switzerland.
MNHN	Muséum National d'Histoire Naturelle, Paris, France.
MRSN	Spinola Collection, Museu Regionale di Scienze Naturali, Torino (= Turin), Italy.
MTEC	Montana State University Entomological Collection, Bozeman, Montana.
MUSM	Museo de Historia Natural, Universidad Nacional Mayor de San Marcos, Lima, Peru.
MZSP	Museu de Zoologia, Universidade de São Paulo, São Paulo, Brazil.
NHMW	Naturhistorisches Museum Wien, Wien (= Vienna), Austria.
NHRM	Naturhistoriska Riksmuseet, Stockholm, Sweden.
NMSA	Natal Museum, Peitermaritzburg, Natal, South Africa.
NMSU	Insect Collection, New Mexico State University, Las Cruces, New Mexico.
NVDA	Nevada State Department of Agriculture, Reno, Nevada.
NYSM	New York State Museum, Albany, New York.
OSEC	K. C. Emerson Museum, Oklahoma State University, Stillwater, Oklahoma.
OSUC	Museum of Biological Diversity, Ohio State University, Columbus, Ohio.
PMNH	Peabody Museum of Natural History, Yale University, New Haven, Connecticut.
QCAZ	Quito Catholic Zoology Museum, Universidad Catolica del Ecuador, Quito, Ecuador.
SDGC	Stephen D. Gaimari private collection.

Table 2. Continued.

SDMC	San Diego Natural History Museum, San Diego, California.
SEMC	Snow Entomological Collection, University of Kansas, Lawrence, Kansas.
SWRS	Southwestern Research Station of the American Museum of Natural History, Portal, Arizona.
TAMU	Texas A&M University Insect Collection, College Station, Texas.
TAUI	Zoological Museum, Tel Aviv University, Tel Aviv, Israel.
UAIC	University of Arizona Insect Collection, Tucson, Arizona.
UCDC	Bohart Museum of Entomology, University of California, Davis, California.
UCMC	University of Colorado Museum, Boulder, Colorado.
UCRC	UCR Entomological Research and Teaching Collection, University of California, Riverside, California.
UGCA	Museum of Natural History, University of Georgia, Athens, Georgia.
UMRM	W. R. Enns Entomology Museum, University of Missouri, Columbia, Missouri.
UNAM	Colección Nacional de Insectos, Universidad Nacional Autónoma de México, México, Distrito Federal, México.
UNSM	University of Nebraska State Museum, Lincoln, Nebraska.
USNM	National Museum of Natural History, Smithsonian Institution, Washington, District of Columbia.
WFBM	W. F. Barr Entomological Collection, University of Idaho, Moscow, Idaho.
WSUC	Maurice T. James Entomological Collection, Washington State University, Pullman, Washington.
ZMAS	Zoological Institute, Russian Academy of Sciences, St. Petersburg, Russia.
ZMHB	Museum für Naturkunke, Humboldt Universtitat, Berlin, Germany.
ZMUC	Zoological Museum, University of Copenhagen, Copenhagen, Denmark.

cloudy yellow or orange and darkened distally (character 16), distiphallus longer than dorsal apodemes (character 20), distiphallus recurved before apex, becoming parallel with dorsal apodemes (character 23; with subsequent change to perpendicular in *Ozodiceromyia parargentifera*), secondary distal lobe present at tip of ventral lobe (character 33), ventral part of gonostylus expanded into large lobe (character 34), anterior margin of furcal bulla indented as a cavity to house the common spermathecal duct (character 39). Synapomorphies for *Ozodiceromyia parargentifera* + *Ozodiceromyia argentifera* + *Ozodiceromyia livdahli*: setae of scape shorter than or subequal to setae of first flagellomere (character 3), basal portion of distiphallus swollen (character 22), gonocoxal setae all black (character 26; with subsequent change to pale setae in *Ozodiceromyia livdahli*), ventral gonocoxal process present, elongated, and flanged (character 28), setae of outer gonocoxal process present (character 30), subapical spur of gonostylus absent (character 35), basal part of common spermathecal duct distinctly widened, tapering quickly (character 40), spermathecal ducts originate from common spermathecal duct (character 41). Synapomorphies for *Ozodiceromyia argentifera* + *Ozodiceromyia livdahli*: ♂ notum with thick, decumbent pile (character 12), fine, erect setae of ♂ notum entirely pale or gold (character 13).

Ozodiceromyia argentifera (Kröber)
(Figs. 7–8, 13, 14–15, 17–19, 26–27, 32–33, 39)

Phycus argentifer Kröber 1929: 418. Type locality: Oaxaca, Mexico. Type: NT♂ (designated herein) in ZHMB. Kröber 1929: 418 (comment on affinity with *Ozodiceromyia,* illust.: antenna).

Ozodiceromyia argentifera: Cole 1965: 349 (comb. change, cat. cit.); Gaimari 1998: 117 (lit. list), 157–159 (in phylogeny), 188–267 (illust.: ♂ and ♀ heads, lat. thorax, wing base, ♂ and ♀ pregenit. segs. and genit.); Gaimari and Irwin 2000 (in phylogeny; illust.: ♂ and ♀ heads, lat.

thorax, wing base, ♂ and ♀ pregenit. segs. and genit.).

Ozodiceromya (sic) *argentifera*: Irwin and Lyneborg 1981a: 257 (listing).

Male.—*Body length:* 8.5 mm.

Head (Fig. 7): 1.2 mm long, 2.2 mm wide, 1.7 mm high. Distance between eyes at antennal level 0.50 mm; at genal level 0.78 mm. Antenna brown, except basal half of scape orange. Scape 1.11 mm long, 0.15 mm wide; with short, fine, black setae, evenly distributed over entire scape (including median surface), and few larger setae in basal half. Pedicel 0.24 mm long, barrel-shaped, setose (including median surface). First flagellomere 1.02 mm long, 0.17 mm wide; with short setae covering basal two-thirds. Stylus 0.09 mm long, inserted subapically in ventral pit. Antennal base to nearest edge of eye 0.18 mm. Frons bulging 0.09 mm beyond eye in lateral view. Face below antenna with silver pruinescence. Parafacial lacking pile, with silver pruinescence extending to antennal base and dorsally along eye margin halfway up frons. Frons otherwise shiny black; with few, short, fine, black setae (0.15 mm long) dorsolateral to antennal base; remainder of frons bare. Genal pile short, darkened. Palpal pile white basally, dark brown distally. Postgenal and occipital pile white; occiput with silver pruinescence only along edge of eye, and with several black setae. Median occipital sclerite flattened; glabrous, shiny black; upper edge not rounded. Postocular setae black, arranged in single, transverse row. Ocellar tubercle with silver pruinescence, and fine, forward-directed, black setae.

Thorax (Fig. 14): Scutum and scutellum with appressed and semi-appressed gold pile. Scutum 2.6 mm long, 1.7 mm wide; ground color black; with silver-blue pruinescence dorsally, lacking pruinescence laterally; median vitta diffuse bronze; dc vittae absent; 1 pair [or lacking] dc setae. Scutellum with silver pruinescence, reduced pruinescence anteriorly. Halter yellow, except base of stalk brown. Katatergite with dense, long, white pile. Anepimeron, katepimeron, and meron lacking pile, and with reduced silver pruinescence, appearing as vertical brown stripe from wing base to between second and third coxae. Anepisternum with silver pruinescence, and with white pile. Katepisternum with silver pruinescence, with white pile only on vertical crest along middle of pleurite. Prepimeron with silver pruinescence, lacking pile.

Legs: Coxae with silver pruinescence, posterior surfaces less so. Posterior surface of hindcoxa lacking pile (Fig. 14). Femora dark brown; with appressed, scale-like brown and white pile dorsally. Fore- and midfemora also with erect and recumbent brown and white pile. Tibiae with short, erect, black setae; proximal, dorsal surface with sparser setal covering. Foretibia orange on basal half, becoming dark brown distally; clavate distally. Midtibia orange, becoming darkened distally. Hindtibia orange. Foretarsus dark brown. Mid- and hindtarsi dark brown except for basal two tarsomeres mostly orange.

Wing: 6.5 mm long. Basal costal lobe with setae arranged in line along outer edge, extending into outer row of costal setae; second line of setae along base of basal costal lobe, extending into inner row of costal setae (Fig. 15). Entire membrane slightly darkened; veins and membrane orange basally, brown distally.

Abdomen: Tergites with erect and recumbent, white pile, except tergite 1 with recumbent brown pile mediodorsally; dorsally, with silver pruinescence; laterally, lacking pruinescence (showing dark brown ground color), except tergite 1 and posterior edges of basal tergites with silver pruinescence. Sternites with silver pruinescence only along anterior edge of sternite 2.

Terminalia: (MEI 037789). Sternite 8 (Fig. 17) with black setae restricted to posterior edge, which is emarginate medially. Tergite 8 (Fig. 18) dumbell-shaped, with black setae restricted to posterior edge. Epandrium (Fig. 23) 0.24 mm long, 0.72

mm wide at widest point; orange; emarginate anteriorly; dorsal surface with black setae on posterior half; lateral edges parallel; posterolateral corners extended posteriorly. Subepandrial plate (Fig. 23) attached to posterolateral and posterior edges; sclerotized portion V-shaped posteriorly. Sclerotized portion of cerci 0.24 mm long; extending posteriorly beyond posterolateral corners of epandrium; subequal in length to ventral epandrial sclerite. Gonocoxites (Figs. 26–27) 0.83 mm wide; orange; with black setae, up to 0.45 mm long; fusion 0.39 mm long at midline, lacking suture. Inner gonocoxal process flanged; knob with several black setae. Outer gonocoxal process flange-like, 0.38 mm long; with small patch of short, fine setae dorsodistally. Gonocoxal apodeme entirely within anterior edge of gonocoxite; lacking sclerotized bridge to parameral sheath of phallus. Ventral gonocoxal process 0.26 mm long, tapering distally; bare. Ventral lobes distinct, fused basally by thin, transparent membrane. Gonostylus (Fig. 19) expanded ventrally into large lobe; with dorsobasal lobe; with subapical, lateral spur. Dorsal apodemes (Fig. 32) of aedeagus parallel; subequal in length to ventral apodeme; parameral sheath smooth dorsally. Ventral apodeme uniformly wide; lacking ventral keel. Ejaculatory apodeme 0.38 mm long; stick-like, slightly expanded distally. Lateral ejaculatory process a complete ring dorsally, but notched; set into aedeagus; lightly sclerotized. Distiphallus swollen basally, long, recurved; distally parallel with ventral apodeme (Fig. 33).

Female.—Similar to ♂ except as follows: body length 10.0 mm.

Head (Fig. 8): 1.4 mm long, 2.5 mm wide, 1.6 mm high. Distance between eyes at level of anterior ocellus 0.53 mm; at antennal level 1.01 mm; at genal level 1.13 mm. Scape 1.35 mm long, 0.18 mm wide. First flagellomere 1.19 mm long, 0.18 mm wide. Antennal base to nearest edge of eye 0.35 mm. Frons bulging 0.17 mm beyond eye in lateral view. Parafacial pruinescence ends at antennal level. Frons shiny black; lower frons bulging to antennal base; upper frons bulging, distinct from lower frons, with short, black setae (up to 0.18 mm long) in patch between edge of eye and midline. Median occipital sclerite and upper edge rounded; transverse row of black setae across median occipital sclerite in addition to row of postocular setae.

Thorax: Scutum and scutellum with short, recumbent, black and gold pile. Scutum 2.8 mm long, 2.1 mm wide. Pile of anepisternum and katepisternum short, white.

Wing: 7.4 mm long.

Abdomen: Tergites and sternites lacking pruinescence (showing dark brown ground color), except posterolateral edges of tergites 2 and 3 with silver pruinescence. Tergites covered with short, fine, appressed gold pile.

Terminalia (Fig. 39): Furca 0.53 mm long, 0.33 mm wide; anterior edge not sclerotized; anterolateral prongs dorsoventrally flattened, separation subequal to greatest width of furca. Furcal bulla not sclerotized; posteriorly with indented cavity. Gonopore basal to furcal bulla, originating within posterior cavity. Common spermathecal duct basally 0.11 mm wide, tapering to 0.05 mm within 0.33 mm distance from gonopore; 0.68 mm long. Spermathecal ducts originate from clean trifurcation with central sac duct; central sac duct wider in basal diameter than spermathecal ducts. Central sac duct 0.45 mm long. Central sac 0.69 mm long, 0.39 mm wide. Spermatheca 0.18 mm in diameter; rounded, but basal edge slightly flattened.

Type material.—NEOTYPE (here designated): pinned ♂ (MEI 027042) with the following labels: 10 mi. NE Haujuapan de Leon, Oax.(aca), Mex.(ico), VI-27-1965, Burke, Meyer, Schaffner/Neotypus ♂, Phycus argentifer Kröber, designated in 1998 by SD Gaimari et ME Irwin (red label)/ Ozodiceromyia argentifera (Kröber), det. S. D. Gaimari, 1997. This pinned specimen is in excellent condition, and is deposited in ZMHB (with permission of TAMU).

The designation of a neotype in this circumstance is warranted under article 75.3 of the *International Code of Zoological Nomenclature,* Fourth Edition, for the following reasons: 75.3.1) designation of this neotype is done for the express purpose of fixing the identity of a species where three similar species occur, two of which are new to science; 75.3.2) the characters that differentiate this taxon from other taxa are contained in both the species diagnosis and key in the present work; 75.3.4) the holotype was confirmed lost in the postal system (the package was shipped from Berlin by post, and a broken (likely crushed open or deliberately slit open along the box's edge) box half full with packing material arrived in Illinois; staff in Berlin and in Illinois made inquiries with the postal services, confirming that the specimen was lost); 75.3.5) the original type locality (Veracruz, Mexico) allows only for certain possible identities, all of which are excluded except the current species due to morphological characteristics in the original description (e.g., area under antennae is silver-white excludes *Ozodiceromyia mexicana,* and the yellow halter excludes *Ozodiceromyia parargentifera*); the original description fully matches the holotype description; 75.3.6) Oaxaca, Mexico is as close to Veracruz as any of the known specimens.

Materials examined.—MEXICO: *Chihuahua,* Cuiteco, T. A. Sears, P. C. Gardner, C. S. Glaser, 29-VII-1969 (1 ♂, MEI 052225, UCDC); *Durango,* 19.3 km W of Dolores Hidalgo, E. M. Fisher, J. L. Fisher, 7-IX-1970 (1 ♂, MEI 037789, SDGC); 8.1 km W of Durango, 1981.2 m, J. F. McAlpine, 23-VII-1964 (1 ♀, MEI 052215, CNCI); 11.3 km W of Durango, 2,133.6 m, W. C. McGuffin, 26-VII-1964 (1 ♀, MEI 052230, SDGC), W. R. M. Mason, 11-VIII-1964 (1 ♀, MEI 052210, CNCI), 22-VII-1964 (1 ♀, MEI 052214, CNCI; 1 ♀, MEI 052217, ZMHB), 2,286 m, W. R. M. Mason, 14-VII-1964 (1 ♂, MEI 052213, BMNH); 17.7 km W of Durango, 2,133.6 m, J. F. McAlpine, 29-VII-1964 (1 ♀, MEI 052218, CNCI), L. A. Kelton, 2-VII-1964 (1 ♂, MEI 038785, CNCI); 28.98 km W of Durango, 2,194.56 m, J. A. Chemsak, 31-VII-1964 (1 ♂, MEI 045406, CASC); 32.2 km W of Durango, 2,133.6 m, Rio Chico, J. F. McAlpine, 10-VIII-1964 (1 ♀, MEI 052208, CNCI), 22-VII-1964 (1 ♂, MEI 052212, 1 ♀, MEI 052216, ZMUC; 1 ♂, MEI 052219, CNCI; 1 ♀, MEI 052211, BMNH; 1 ♀, MEI 052209, MEIC), 2,194.56 m, L. A. Kelton, 23-VII-1964 (1 ♂, MEI 052207, MEIC); *Jalisco,* 13 km. N Autlan [de Navarro], Carn. Mina San Francisco, F. A. Noguera, A. Rodriguez, 29-VI-1995 (1 ♀, MEI 103438, UNAM); 13 km NE San Gabriel, A. Rodriguez, F. A. Noguera, 8-X-1994 (1 ♂, MEI 051278, 1 ♀, MEI 051277, UNAM; 1 ♀, MEI 051276, MEIC); 16 km N of Autlan [de Navarro], Carroll, Friedlander, J. C. Schaffner, 7-VII-1984 (1 ♀, MEI 027077, TAMU); 40.3 km SE of Atotonilco, J. W. MacSwain, 23-VII-1952 (1 ♂, MEI 038789, ♂ & ♀ *in copula,* MEI 052171, 052172, EMEC; 1 ♂, MEI 038790, SDGC; 1 ♀, MEI 038788, AMNH); [Estacion de] Biol.[ogia] Chamela, E. Ramírez, 8-VII-1988 (1 ♀, MEI 051279, EBCC); Estacion de Biologia Chamela, E. Ramírez, 17-VII-1981 (1 ♂, MEI 051280, EBCC); Guadalajara, McConnell, 1909 (1 ♀, MEI 078359, CMNH); *Michoacán,* 29 km NW of Quiroga, 2,072.64 m, R. H. Painter, E. M. Painter, 22-VIII-1962 (1 ♀, MEI 052183, KSUC); *Morelos,* 7.1 km E of Cuernavaca, Clark, Murray, Ashe, J. C. Schaffner, 6-VII-1974 to 7-VII-1974, at light, (1 ♀, MEI 026699, TAMU); 38 km W Iguala Gro. [probably referring to Iguala de la Indepencia, near the Morelos border in Guerrero], J. Chemsak, A. Michelbacher, M. Michelbacher, 23-VII-1983 (1 ♀, MEI 081501, USNM); *Nayarit,* Ahuacatlan, P. D. Hurd, 18-VII-1951 to 22-VII-1951, on fl[ower]s. of *Donnellsmithia hintonii* (1 ♂, MEI 038786, AMNH); *Oaxaca,* 16.1 km NE of Huajuapan de León, Burke, Meyer, J. C. Schaffner, 27-VI-1965 (1 ♀, MEI

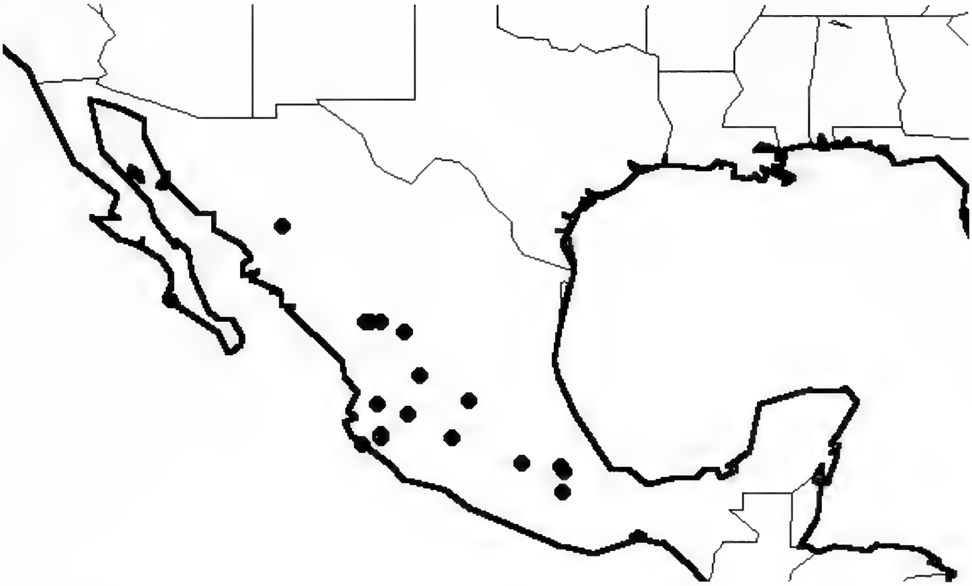


Fig. 1. Known distribution for *Ozodiceromyia argentifera.*

027043, SDGC); *Puebla,* 6.4 km NW Tepanco de Lopez, 2-VII-1952, Univ. Kans. Mex. Expedition (1 ♀, MEI 052179, SEMC); 8 km S of Tecomachalco, 2103.12 m, M. E. Irwin, 10-VIII-1967, flight trap, narrow canyon (1 ♂, MEI 052195, UCRC); *Zacatecas,* 15 km E of Sombrerete, P. D. Hurd, 28-VII-1951 to 31-VII-1951 (1 ♀, MEI 038783, EMEC).

Diagnosis.—The scape in this species is setose, but most of the setae are short, with few longer ones. The lower frons bulges only slightly, with silver pruinescence laterally, extending down along parafacial. The face below the antenna also has silver pruinescence. In males, the notum is densely covered with erect and appressed gold pile. In females, the gold pile on the notum and abdominal tergites is short, fine, and appressed. In the male genitalia, the setae of the epandrium and gonocoxites are black. The subepandrial plate is attached to the epandrium at the posterolateral corners, and the sclerotized portion of the subepandrial plate is V-shaped posteriorly. The gonocoxites lack a suture along the midline separating the two lateral halves. The outer gonocoxal process is widened distally, with a small patch of setae on the dorsolateral surface. The ventral gonocoxal process of the gonocoxites is present, elongated and flattened; there are no clumped setae at its base. The base of the ventral lobes is U-shaped and broad between the two halves. The parameral sheath of the aedeagus is smooth dorsally. The ventral apodeme lacks a ventral keel. The distiphallus is swollen basally, and is recurved and parallel with the ventral apodeme at the tip. In the female terminalia, the furca is not notched posteriorly, and lacks a posterolateral peg. The anterolateral furcal prongs are separated by a distance subequal to the greatest width of the furca. The common spermathecal duct is broad basally, at half the width of the entire furca; the duct tapers quickly.

Autapomorphies.—No character states in the current analysis appear to be autapomorphic for this species. Despite this, the gold (as opposed to pale) coloration of the decumbent pile on the male notum may be autapomorphic.

Distribution.—The known distribution for this species is found in Fig. 1. Nearly all specimens were collected near 2,000 m elevation, with the exceptions of 1 ♂ and 1

♀ collected under 500 m in Chamela, Jalisco. The distribution encompasses parts of the following biogeographical regions: the Provincia Xerófila Mexicana, the Provincia Mesoamericana de Montaña, and the Provincia Pacifica.

Biology.—This species appears to be most abundant in the month of July, with a period of activity from late June to early October. One ♂ was collected at a flower of *Donnellsmithia hintonii* Mathias and Constance (Asteraceae).

Ozodiceromyia livdahli Gaimari and Irwin, new species

(Figs. 24, 28)

Male.—*Body length:* 7.6 mm.

Head: 1.11 mm long, 2.12 mm wide, 1.23 mm high. Distance between eyes at antennal level 0.60 mm; at genal level 0.98 mm. Antenna brown, except basal half of scape orange. Scape 1.02 mm long, 0.12 mm wide; with short, fine, black setae, evenly distributed over entire scape (including median surface), and few larger setae. Pedicel 0.23 mm long, barrel-shaped, setose (including median surface). First flagellomere 0.92 mm long, 0.15 mm wide; with short setae covering basal two-thirds. Stylus 0.11 mm long, inserted subapically. Antennal base to nearest edge of eye 0.15 mm. Frons bulging 0.12 mm beyond eye in lateral view. Face below antenna with silver pruinescence. Parafacial lacking pile, with silver pruinescence extending to antennal base and dorsally along eye margin halfway up frons. Frons otherwise shiny black; with few, short, fine, black setae (0.14 mm long) dorsolateral to antennal base; remainder of frons bare. Genal pile short, darkened. Palpal pile white basally, dark brown distally. Postgenal and occipital pile white; occiput with silver pruinescence only along edge of eye, and with several black setae. Median occipital sclerite flattened; glabrous, shiny black; upper edge not rounded. Postocular setae black, arranged in single, transverse row. Ocellar tubercle with silver pruinescence, and fine, forward-directed, black setae.

Thorax: Scutum and scutellum with appressed, flattened, pale [or gold] pile, and erect, pale [or gold] pile. Scutum 2.30 mm long, 1.80 mm wide; ground color black; with silver-grey pruinescence dorsally, lacking pruinescence laterally; median vitta diffuse bronze; dc vittae faintly present only as lines of reduced pruinescence; dc setae absent [or 1 pair present]. Scutellum with silver pruinescence, reduced pruinescence anteriorly. Halter yellow, except base of stalk brown. Katatergite with dense, long, white pile. Anepimeron, katepimeron, and meron lacking pile, and with reduced silver pruinescence, appearing as vertical brown stripe from wing base to between second and third coxae. Anepisternum with silver pruinescence, and with white pile. Katepisternum with silver pruinescence, with white pile only on vertical crest along middle of pleurite. Prepimeron with silver pruinescence, lacking pile.

Legs: Coxae with silver pruinescence, posterior surfaces less so. Posterior surface of hindcoxa lacking pile. Femora dark brown; with appressed, scale-like white and brown pile dorsally. Fore- and midfemora with erect and long, recumbent, white pile. Tibiae with short, erect, black setae; proximal, dorsal surfaces with sparser setal covering, or nearly bare. Foretibia orange basally, becoming dark brown distally; clavate distally. Midtibia orange, becoming darkened distally. Hindtibia orange. Foretarsus dark brown. Mid- and hindtarsi dark brown except basal two tarsomeres mostly orange.

Wing: 6.18 mm long. Basal costal lobe with setae arranged in line along outer edge, extending into outer row of costal setae; second line of setae along base of basal costal lobe, extending into inner row of costal setae. Entire membrane slightly darkened; veins and membrane orange basally, brown distally.

Abdomen: Tergites with erect and recumbent, white pile, except tergite 1 with recumbent brown pile medioposteriorly;

dorsally, with silver pruinescence; laterally, lacking pruinescence (showing dark brown ground color), except tergite 1 and posterior edges of basal tergites with silver pruinescence. Sternites with silver pruinescence only along anterior edge of sternite 2.

Terminalia (paratype, MEI 038822): Sternite 8 with fine black setae restricted to posterior edge, which is emarginate medially. Tergite 8 dumbell-shaped, with fine black setae restricted to posterior edge. Epandrium 0.23 mm long, 0.66 mm wide at widest point; orange; emarginate anteriorly; dorsal surface with white setae on posterior half (Fig. 24); lateral edges parallel; posterolateral corners extended posteriorly. Subepandrial plate attached to posterolateral and posterior edges; sclerotized portion V-shaped posteriorly. Sclerotized portion of cerci 0.23 mm long; extending posteriorly slightly beyond posterolateral corners of epandrium; subequal in length to ventral epandrial sclerite. Gonocoxites 0.80 mm wide; orange; with white setae (Fig. 28), up to 0.45 mm long; fusion 0.36 mm long at midline, lacking suture. Inner gonocoxal process flanged; knob with several white setae. Outer gonocoxal process flange-like, 0.38 mm long; with small patch of short, fine setae dorsodistally. Gonocoxal apodeme entirely within anterior edge of gonocoxite; lacking sclerotized bridge to parameral sheath of phallus. Ventral gonocoxal process 0.23 mm long, tapering distally; bare. Ventral lobes distinct, fused basally by thin, transparent membrane. Gonostylus expanded ventrally into large lobe; with dorsobasal lobe; with subapical, lateral spur. Dorsal apodemes of aedeagus parallel; subequal in length to ventral apodeme; parameral sheath smooth dorsally. Ventral apodeme uniformly wide; lacking ventral keel. Ejaculatory apodeme 0.30 mm long; stick-like, slightly expanded distally. Lateral ejaculatory process a complete ring dorsally, but notched; set into aedeagus; lightly sclerotized. Distiphallus swollen basally, long, recurved; distally parallel with ventral apodeme.

Female.—Similar to ♂ except as follows: body length 10.1 mm.

Head: 1.25 mm long, 2.30 mm wide, 1.65 mm high. Distance between eyes at level of anterior ocellus 0.51 mm; at antennal level 0.96 mm; at genal level 1.04 mm. Scape 1.29 mm long, 0.17 mm wide. First flagellomere 1.04 mm long, 0.17 mm wide. Antennal base to nearest edge of eye 0.30 mm. Frons bulging 0.15 mm beyond eye in lateral view. Frons shiny black; lower frons with short (up to 0.09 mm long) setae dorsolateral to antennal base; upper frons distinctly bulging and distinct from lower frons, with small patch of setae (up to 0.09 mm long) between edge of eye and midline. Median occipital sclerite and upper edge rounded; transverse row of black setae across median occipital sclerite in addition to row of postocular setae.

Thorax: Scutum and scutellum with appressed and semi-appressed white pile. Scutum 2.75 mm long, 1.95 mm wide. Pile of anepisternum and katepisternum short, white.

Wing: 7.26 mm long.

Abdomen: Tergites and sternites mostly lacking pruinescence; tergites with short, fine appressed brown and white pile.

Terminalia: Furca 0.54 mm long, 0.32 mm wide; anterior edge not sclerotized; anterolateral prongs dorsoventrally flattened, separation subequal to greatest width of furca. Furcal bulla not sclerotized; posteriorly with indented cavity. Gonopore basal to furcal bulla, originating within posterior cavity. Common spermathecal duct basally 0.11 mm wide, tapering to 0.05 mm within 0.33 mm distance from gonopore; 0.93 mm long. Spermathecal ducts originate from clean trifurcation with central sac duct; central sac duct wider in basal diameter than spermathecal ducts. Central sac duct 0.45 mm long. Central sac 0.68 mm long, 0.39 mm wide. Spermatheca 0.18 mm in diameter; rounded, but basal edge slightly flattened.

Type materials.—HOLOTYPE ♂ (MEI 038101) with the following labels: 5 mi. E

Fort Apache, ARIZ[ona]., VIII-28–1964, E. I. Schlinger. This pinned specimen is in excellent condition, and is deposited in CASC.

Materials examined.—PARATYPES. MEXICO: *Chihuahua,* D. J. Knull, J. N. Knull, 22-VII-1961 (1 ♀, MEI 038853, SDGC), 29-VII-1955 (1 ♀, MEI 038858, SDGC) ; J. N. Knull, 18-VIII-1936 (1 ♂, MEI 038854, OSUC); 2,072.64 m, J. A. Chemsak, 14-VII-1964 (2 ♂, MEI 038817, 038818, EMEC), J. A. Chemsak, J. A. Powell, 14-VII-1964, black and white lights (1 ♂, MEI 038837, EMEC), J. A. Powell, 15-VII-1964 (1 ♂, MEI 038815, EMEC); 2,011.68 m, D. Rockefeller, Gertsch Exp., 21-VII-1947 (1 ♀, MEI 038791, AMNH); 8.1 km W of Parrita, Santa Clara Canyon, D. D. Linsdale, 3-IX-1956 (1 ♀, MEI 052154, USNM), J. W. MacSwain, 3-IX-1956 (1 ♂, MEI 052159, USNM; 1 ♂, MEI 038874, 2 ♀, MEI 038873, 038875, EMEC; 1 ♀, MEI 052158, SDGC); 20.9 km E of Cuauhtemoe, 2,011.68 m, J. A. Chemsak, 11-VII-1964 (1 ♀, MEI 038780, EMEC); La Bufa, Sierra Madre Mountains, 900 m, D. D. Giuliani, 7-VII-1972 (1 ♂, MEI 052246, SDGC); *Sinaloa,* bet.[ween] NW of Culiacan & Las Mochis, D. Spencer, R. Ryckman, J. Ryckman, A. Ryckman, 21-VII-1957 (1 ♂, MEI 038787, UNAM); ca. 100 km NW of Culiacan, D. Spencer, R. Ryckman, J. Ryckman, A. Ryckman, 21-VII-1957 (1 ♂, MEI 038779, UNAM).

UNITED STATES: *Arizona, Cochise County,* L. D. Anderson, 21-VIII-1966, at light (1 ♀, MEI 040761, SDGC) ; M. Statham, 19-VIII-1959 (1 ♀, MEI 053688, AMNH); Mina Canyon, 20-VII-1925 (1 ♂, MEI 041774, DENH); Chiricahua Mts., J. K. Robertson, 1-VIII-1965 to 2-VIII-1965 (2 ♀, MEI 030930, 030931, LACM); K. W. Brown, 7-VIII-1965, UV light (1 ♂, MEI 038868, INBC; 1 ♀, MEI 038865, ZMAS); R. M. Bohart, 6-VIII-1958 (1 ♂, MEI 038915, NHMW); 1.6 km S of Portal, E. G. Linsley, J. M. Linsley, 16-VIII-1966 (1 ♀, MEI 038870, EMEC) ; 1.6 km SW of Portal, J. A. Powell, 11-VII-1972 to 18-VII-1972 (1 ♂, MEI 038825, ZMAS; 1 ♂, MEI 038826, NMSA; 1 ♂, MEI 038827, INHS; 1 ♂, MEI 038828, ASUT; 1 ♂, MEI 038829, BMNH; 1 ♂, MEI 038830, MEIC); 1.61 km E, 8.05 km N of Portal, 2-IX-1959, at light (1 ♂, MEI 043432, UMSP) ; 2.7 km W of Portal, S. I. Frommer, S. L. Frommer, 22-VIII-1975, dry stream bed (1 ♂, MEI 052194, UCRC); 3.2 km NE Portal, 1645.92 m, J. Wilcox, 20-IX-1962 (1 ♂, MEI 038878, MEIC); 4.8 km S of Paradise, A. B. Patterson, 9-VIII-1966, malaise trap (1 ♂, MEI 038813, SDGC); 4.8 km W of Portal, D. P. Levin, 28-VIII-1971, black light (1 ♀, MEI 034099, DENH); 8.1 km W of Portal, C. G. Moore, 8-VIII-1958 (1 ♀, MEI 038912, MNHN), G. B. Pitman, 19-VIII-1958 (1 ♂, MEI 038904, IZAS; 1 ♂, MEI 038916, BYUC), P. M. Marsh, 13-VIII-1958 (1 ♂, MEI 029552, SDGC), P. Opler, 11-VIII-1958 (1 ♀, MEI 056915, EMEC), 1,645.92 m, V. D. Roth, 9-VIII-1965 (1 ♂, MEI 038903, UNAM); 9.7 km N of Portal, L. D. Anderson, M. D. Anderson, 20-VIII-1970 (1 ♀, MEI 038848, SDGC); Cave Creek Canyon, 5,000′, D. R. Corr, 7-VIII-1986, malaise trap (1 ♂, MEI 110058, MTEC), 6.4 km SSW of Portal, R. Davidson, 24-VIII-1981, malaise trap (1 ♂, MEI 052169, CMNH); Cave Creek Ranch, G. R. Ballmer, 15-VIII-1965, UV light (1 ♀, MEI 038861, FMNH), R. Silberglied, 16-VIII-1966, black light (1 ♀, MEI 038866, CUIC), 1524 m, K. W. Brown, 10-VIII-1965 (1 ♀, MEI 038863, ESUW), M. E. Irwin, 13-VIII-1965 (1 ♀, MEI 038893, MHNG), Portal, E. G. Linsley, 1-VIII-1972 to 3-VIII-1972 (1 ♀, MEI 038809, EMEC), J. A. Powell, 2-VII-1972 to 4-VII-1972 (1 ♂, MEI 038831, BPBM; 2 ♂, MEI 038832, 038833, 2 ♀, MEI 038834, 038835, EMEC; 1 ♀, MEI 038836, ASUT), 3-VII-1972 to 4-VII-1972 (1 ♂, MEI 038822, MEIC; 1 ♂, MEI 038823, CSUC; 1 ♂, MEI 038824, TAMU; 1 ♂, MEI 038821, 2 ♀, MEI 029554, 038820, EMEC; 1 ♀, MEI 038819, MUSM), R. Silberglied, 21-VIII-1966, black light—UV (1 ♂, MEI 038869, CUIC), 1.6 km S of Portal, 21-VIII-1969 to 26-VIII-1969 (1 ♂, MEI 038843, NMSU), E. G. Linsley, J. M. Linsley, 15-VIII-1970 to 20-VIII-1970 (1 ♂, MEI 038844, EBCC; 1 ♂, MEI 038842, 1 ♀, MEI 038845, MEIC; 1 ♀, MEI 038846, CICESE; 1 ♀, MEI 038847, EMEC; 1 ♀, MEI 038839, UCMC; 1 ♀, MEI 038840, IZAV; 1 ♀, MEI 038841, MZSP); Chiricahua National Monument, L. M. Martin, 23-VIII-1951 (1 ♀, MEI 030937, LACM); Paradise, G. R. Ballmer, 6-VIII-1966, malaise trap (1 ♂, MEI 038889, ZMHB; 1 ♂, MEI 038890, MZSP; 1 ♂, MEI 038891, MRSN; 1 ♀, MEI 038909, CASC; 1 ♀, MEI 038910, TAMU; 1 ♀, MEI 038911, UNAM); Portal, E. I. Schlinger, 11-VIII-1967 (1 ♀, MEI 038849, SDGC; 1 ♀, MEI 038850, MEIC), J. A. Powell, 2-VII-1972 to 4-VII-1972, at light (1 ♂, MEI 038792, EMEC), R. M. Bohart, 15-VIII-1958 (1 ♀, MEI 029555, SDGC), 1524 m, H. E. Evans, 9-VIII-1959 (1 ♀, MEI 038812, ZMUC); Rucker Canyon, R. M. Bohart, 24-VIII-1979 (1 ♂, MEI 052226, UCDC); Southwestern Research Station, 8.1 km W of Portal, P. D. Hurd, 3-VIII-1958 (1 ♀, MEI 038872, NMSU), 11-VIII-1958 (1 ♀, MEI 038871, EMEC), South Fork Cave Creek, P. H. Arnaud, 5-IX-1959 (1 ♂, MEI 052249, 1 ♀, MEI 052248, CASC), 1645.92 m, 14-VIII-1970 (1 ♀, MEI 038838, MEIC), H. E. Evans, 18-VIII-1959 (1 ♀, MEI 038811, UNAM), M. Statham, 26-VII-1957 (1 ♂, MEI 052232, AMNH), 27-VII-1959 (1 ♀, MEI 052233, AMNH), M. S. Wasbauer, 8-VIII-1978 to 9-VIII-1978, malaise trap (1 ♂, MEI 071419, CNCI; 1 ♂, MEI 071420, 1 ♀, MEI 071440, CDFA), 10-VIII-1978 to 11-VIII-1978, malaise trap (1 ♀, MEI 071426, CDFA), 14-VIII-1978 to 15-VIII-1978, malaise trap (1 ♂, MEI 071421, WSUC; 1 ♂, MEI 071422, SDGC; 2 ♀, MEI 071424, 071425, CDFA), 16-VIII-1978 to 17-VIII-1978, malaise trap (1 ♂, MEI 071448, CDFA), V. D. Roth, 9-IX-1979 (2 ♀, MEI 026953, 026954, SWRS), 15-VIII-1965 to 20-VIII-1965 (1 ♂, MEI 026986, SWRS); Sulphur Draw, G. R. Ballmer, 7-VIII-1965, UV light (1 ♂, MEI 038862, NVDA); Sunny Flat, 6.4 km W of Portal, C. W. Melton, 27-VIII-1979, black light (1 ♀, MEI 071409, CDFA; 1 ♀, MEI 070409, CSUC); Tex Canyon, F. G. Andrews, 6-VIII-1967 (1 ♂, MEI 038851, DEIC); Dragoon Mountains, Cochise Stronghold, R. J. Shaw, 12-VIII-1970 to 16-VIII-1970, UV light (1 ♀, MEI 076933, ANIC); Huachuca Mountains, D. J. Knull, J. N. Knull, 20-VII-1937 (1 ♀, MEI 052160, USNM), J. S. Hine, 28-VII-1907 (1 ♀, MEI 052222, OSUC), R. L. Westcott, 16-VIII-1966 (1 ♀, MEI 079534, WFBM); 13 km SE of Sunnyside, 1,813.56 m, R. R. Snelling, 23-VIII-1971 (1 ♂, MEI 030927, 1 ♀, MEI 030932, LACM); Ash Canyon, N. McFarland, 15-IX-1983 (1 ♂, MEI 052161, 1 ♀, MEI 052162, USNM), 1554.48 m, N. McFarland, 13-VIII-1982, UV light (1 ♀, MEI 052170, SDMC), 1676.4 m, R. R. Snelling, 20-VIII-1971 (2 ♂, MEI 030928, 030940, LACM); Carr Canyon, E. P. Van Duzee, 5-VIII-1924 (1 ♂, MEI 029553, MCZC), J. O. Martin, 6-VIII-1924 (1 ♀, MEI 038816, MCZC), 1,645.92 m, C. W. O'Brien, 7-IX-1995, black light (1 ♂, MEI 038782, EMEC), H. B. Leech, J. W. Green, 8-VIII-1952 to 9-VIII-1952, floor of Carr Canyon (1 ♂, MEI 052234, CASC); Copper Canyon, W. F. Barr, 5-VIII-1990, beat. *Quercus* (1 ♂, MEI 079905, 1 ♀, MEI 079904, WFBM), at Rd. 61, Sec. 10, T23S, R29E, W. F. Barr, 31-VII-1979 (1 ♀, MEI 079468, NYSM), 1,828.8 m, Y. F. Hsu, J. Powell, M. Prentice, 3-VIII-1989, black light—UV (1 ♂, MEI 081462, EMEC); Miller Canyon, G. E. Wallace, 24-VIII-1965, UV light (1 ♂, MEI 038855, NYSM; 1 ♀, MEI 038852, OSUC); Ramsey Canyon, L. D. Anderson, 21-VIII-1969 (1 ♀, MEI 038888, ANSP); Stump Canyon, Olson, 31-VII-1979, UV light (1 ♂, MEI 076939, UAIC); *Gila County,* Pinal Mountains, Sixshooter Canyon, 1,524 m (1 ♀, MEI 052156, USNM); *Graham County,* Graham Mountain, Noon Creek, F. G. Werner, 28-VII-1954, at light (1 ♂, MEI 038905, MEIC), G. D. Butler, 1-VIII-1957 (1 ♀, MEI 038913, SDGC); Noon Creek Camp, L. G. Bezark, G. M. Nishida, C. Kitayama, B. Tilden, 29-VIII-1975, UV light (1 ♂, MEI 041767, UCMC), Highway 266, L. G. Bezark, G. M. Nishida, C. Kitayama, B. Tilden, 29-VIII-1975 to 30-VIII-1975, UV light (1 ♀, MEI 041771, MEIC; 1 ♀, MEI 041772, NVDA); Pinaleño Mts., Hospital Flats, Mt. Graham, G. D. Butler, 15-VIII-1953 (1 ♀, MEI 076943, EMEC; 1 ♀, MEI 076928, KSUC); *Maricopa County,* 3.22 km W of Tortilla Flat, 505.968 m, Canyon Lake, J. LaSalle, S. Y. H. Lin, 22-VIII-1982, black light (1 ♀, MEI 043088, UCRC) ; *Pima County,* Baboquivari Mountains, Brown Canyon, F. G. Werner, W. Nutting, 4-VIII-1961, UV light (1 ♂, MEI 038884, UAIC; 1 ♀, MEI 038877, SDGC; 1 ♀, MEI 038879, DEIC); Santa Catalina Mountains, S. L. Wood, J. B. Karen, 9-VIII-1962, black light (1 ♀, MEI 037668, BYUC), Bear Canyon, 19.32 km HK Highway, F. G. Werner, W. Nutting, 26-VII-1961, light trap (1 ♀, MEI 038899, UAIC) , Molino Basin, 1,402.08 m, C. W. O'Brien, L. B. O'Brien, 4-IX-1965, black light (1 ♀, MEI 038814, SDGC), Sabino Basin, C. H. Townsend, 20-VIII (1 ♂, MEI 052157, USNM); Santa Rita Mountains, Box Canyon, R. F. Denno, 16-VIII-1970 (1 ♀, MEI 052224, UCDC), Madera Canyon, L. G. Bezark, G. M. Nishida, C. Kitayama, B. Tilden, 31-VIII-1975 (1 ♂, MEI 041769, ESUW), W. J. Hanson, 4-IX-1968 (1 ♂, MEI 070469, EMUS; 1 ♂, MEI 071469, CDFA), 1569.72 m, J. M. Sheppard, 8-VIII-1969, black light, oaks (1 ♀, MEI 052193, OSEC), N End Rosemont Area, 31°48–53′N, 110°42–47′W, 4,400–6,175′ El (6,000′), Anamax Mine Inventory 1975–1976, Wasp Cn. Sec. 31, J. Busacca and C. Olson, 8-28-1975, U V light (1 ♀, MEI 076921, UAIC); Santa Rita Res. Range, D. K. Faulkner, 5-VIII-1980 (1 ♂, MEI 052164, 1 ♀, MEI 052166, SDMC); *Pima and Santa Cruz Counties,* Santa Rita Mountains, E. L. Todd, 1-VIII-1941 (1 ♀, MEI 052221, SEMC), F. H. Parker, 12-VIII-1935 (1 ♀, MEI 052155, USNM), S. L. Szerlip, J. A. Powell, 13-VIII-1974, at light (1 ♂, MEI 052175, KSUC); *Santa Cruz County,* K. Roever, 3-VIII-1959, black light trap (1 ♀, MEI 038886, UAIC; 1 ♀, MEI 038887, IZAS); Canelo, G. D. Butler, 3-VIII-1965 (1 ♀, MEI 038901, BPBM); Canelo Hills, Parker Cyn, R. L. Westcott, 30-VII-1979 (1 ♂, MEI 079463, CNCI); Pena Blanca, Werner, Olson, 11-VIII-1983 (1 ♀, MEI 076929, UAIC); Sycamore Canyon, near Ruby, K. Roever, 2-VIII-1959, light trap (1 ♀, MEI 038876, UNAM; 1 ♀, MEI 038885, INBC; 1 ♀, MEI 038900, UNSM) V. L. Versterby, 6-IX-1963 (1 ♀, MEI 038880, MEIC); Patagonia Mountains, F. G. Werner, G. D. Butler, 8-VIII-1955, western slope (1 ♂, MEI 038867, SDGC), 9-VIII-1966, western slope (1 ♀, MEI 038918, MEIC), G. D. Butler, F. G. Werner, 9-VIII-1955, western slope (1 ♂, MEI 038906, QCAZ; 1 ♂, MEI 038907, ANSP; 1 ♂, MEI 038908, SDGC; 1 ♂, MEI 038914, UAIC; 1 ♂, MEI 038917, UNSM), Mount Washington, 1676.4 m, L. G. Bezark, R. A. Cunningham, D. E. Russell, 12-VIII-1991 to 13-VIII-1991, Hg vapor and UV blacklight (1 ♀, MEI 038115, WSUC); Pajarito Mountains, R. H. Arnett Jr., E. VanTassell, 6-VIII-1961 (1 ♀, MEI 038784, FSCA); Santa Rita Mountains, Madera Canyon, 3-VIII-1977 (1 ♂, MEI 052167, SDGC), A. J. Gilbert, N. J. Smith, 11-VIII-1981 (1 ♀, MEI 038119, SDGC; 1 ♀, MEI 038120, MEUC), D. K. Faulkner, 9-VIII-1978 to 20-VIII-1978 (1 ♀, MEI 052168, ZMAS), D. J. Knull, J. N. Knull, 1-VIII-1972 (1 ♀, MEI 052223, TAUI), D. K. Faulkner, 20-VIII-1979 (1 ♀, MEI 052165, BMNH), E. M. Fisher, 7-VIII-1962 to 9-VIII-1962 (1 ♀, MEI 030943, CMNH; 1 ♀, MEI 030929, CNCI; 1 ♀, MEI 031008, EMUS; 1 ♂, MEI 030942, KUIC), G. R. Ballmer, K. Brown, 31-VII-1965 (1 ♂, MEI 038860, 1 ♀, MEI 038859, MEIC; 1 ♀, MEI 038808, NHRM), L. G. Bezark, G. M. Nishida, C. Kitayama, B. Tilden, 24-VIII-1975, UV light (1 ♂, MEI 041768, NHRM; 1 ♂, MEI 041773, UMRM; 1 ♀, MEI 041770, MEIC), L. M. Martin, 14-VIII-

1949 (1 ♀, MEI 030936, MRSN), 15-VIII-1949 (1 ♂, MEI 030934, LACM; 1 ♀, MEI 030933, CNCI; 1 ♀, MEI 030935, UMSP), 16-VIII-1949 (1 ♂, MEI 030941, LACM), 31-VII-1947 (1 ♀, MEI 030939, INHS), M. A. Cazier, R. Schrammel, C. Vaurie, P. Vaurie, 13-VIII-1952 (1 ♀, MEI 038781, AMNH), P. H. Sullivan, 31-VIII-1970 (1 ♀, MEI 038856, KUIC), R. L. Westcott, 13-VIII-1964 (1 ♂, MEI 079570, WFBM; 1 ♀, MEI 079569, FSCA), W. A. McDonald, 17-VIII-1955 to 20-VIII-1955 (1 ♀, MEI 038902, LACM), 1,402.08 to 1,706.88 m, 4-VIII-1975 (1 ♂, MEI 076916, CICESE; 1 ♂, MEI 076918, FMNH; 2 ♂, MEI 076919, 076915, 1 ♀, MEI 076920, UAIC; 1 ♀, MEI 076940, ZMHB; 1 ♀, MEI 076917, EBCC; 1 ♀, MEI 076914, NHMW), 1,487.424 m, J. G. Franclemont, 20-VII-1959 (1 ♀, MEI 038810, CUIC), L. M. Martin, 20-VIII-1946 to 29-VIII-1946 (1 ♀, MEI 031062, EMEC; 1 ♀, MEI 030938, CNCI), V. L. Versterby, 8-IX-1963 (1 ♀, MEI 038894, QCAZ; 1 ♀, MEI 038895, MEIC), 12-VIII-1963 (1 ♂, MEI 038896, MUSM; 1 ♂, MEI 038897, ANIC; 1 ♂, MEI 038898, IZAV), 21-VII-1963 (1 ♂, MEI 038881, MHNG), 22-IX-1963 (1 ♀, MEI 038883, UMRM), 31-VII-1963 (1 ♂, MEI 038882, MEUC), 1,524 m, K. W. Brown, P. Petrulis, 3-IX-1971, UV light (1 ♂, MEI 033978, 1 ♀, MEI 033979, PMNH), 1,554.48 m, D. R. Davis, 10-VII-1964 to 26-VII-1964 (1 ♂, MEI 052152, SEMC; 1 ♀, MEI 052153, NMSA), Bog Springs, 1,706.88 m, E. Lindquist, 6-VIII-1973 (1 ♂, MEI 052231, CNCI); *County unknown,* Floricera, Sta Rita Mts., Olson, Burme, Frank, 30-VII-1980 (1 ♀, MEI 076938, UAIC); Garces, N. Banks, VIII (1 ♀, MEI 038864, MCZC) ; *New Mexico, Hidalgo County,* 1,645.92 m, Skeleton Canyon, G. R. Ballmer, 12-VIII-1965 (1 ♂, MEI 038892, USNM); 56.35 km E of Douglas, Arizona, C. W. Sabrosky, 22-IX-1965 (1 ♀, MEI 038857, USNM); Coronado National Forest, Peloncillo Mountains, 1.4 km W National Forest Boundary, Black C.C.C. Dam Road, NFR63, 1661.16 m, M. A. Metz, 28-VI-1997, malaise trap (2 ♂, MEI 103430, 103426, SDGC; 2 ♂, MEI 103431, 103432, MEIC; 1 ♂, MEI 103433, OSEC; 1 ♂, MEI 103427, ZMUC), 4.0 km W National Forest Boundary Black C.C.C. Dam Road, NFR63, 1,682.496 m, M. A. Metz, 28-VI-1997, malaise, 9 m Fock's (1 ♂, MEI 103428, INHS; 1 ♂, MEI 103429, ZMAS; 1 ♂, MEI 103424, TAUI; 1 ♂, MEI 103425, MNHN).

Diagnosis.—The scape in this species is setose, but most of the setae are short, with few longer ones. The lower frons bulges only slightly, with silver pruinescence laterally, extending down along parafacial. The face below the antenna also has silver pruinescence. In males, the notum is densely covered with erect and appressed pale or gold pile. In females, the notum and abdominal tergites are covered with short, fine, appressed brown and white pile. In the male genitalia, the setae of the epandrium and gonocoxites are orange. The subepandrial plate is attached to the epandrium at the posterolateral corners, and the sclerotized portion of the subepandrial plate is V-shaped posteriorly. The gonocoxites lack a suture along the midline separating the two lateral halves. The outer gonocoxal process is widened distally, with a small patch of setae on the dorsolateral surface. The ventral gonocoxal process of the gonocoxites is present, elongated and flattened; there are no clumped setae at its base. The base of the ventral lobes is U-shaped and broad between the two halves. The parameral sheath of the aedeagus is smooth dorsally. The ventral apodeme lacks a ventral keel. The distiphallus is swollen basally, and is recurved and parallel with the ventral apodeme at the tip. In the female terminalia, the furca is not notched posteriorly, and lacks a posterolateral peg. The anterolateral furcal prongs are separated by a distance subequal to the greatest width of the furca. The common spermathecal duct is broad basally, at half the width of the entire furca; the duct tapers quickly.

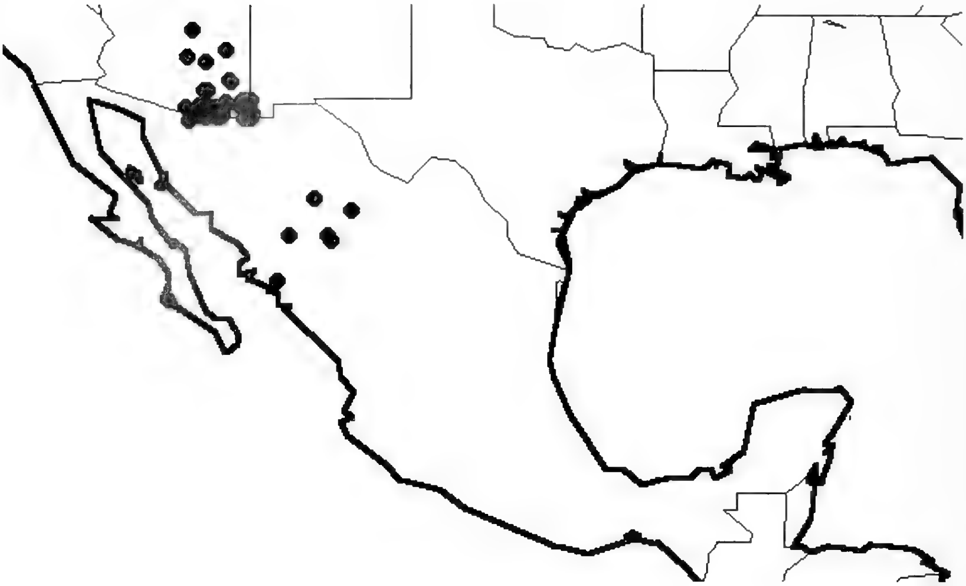


Fig. 2. Known distribution for *Ozodiceromyia livdahli.*

Autapomorphy.—Gonocoxal setae pale (character 26, state 0).

Distribution.—The known distribution for this species is found in Fig. 2. Most of the localities fall within an elevational range of 1,000–2,000 m, although 1 ♀ was collected near 500 m. The distribution encompasses parts of the following biogeographical regions: the Provincia Xerófila Mexicana, the northern part of the Provincia Mesoamericana de Montaña, and the montane regions of the southeastern quarter of Arizona and southwestern New Mexico.

Etymology.—Patronym for Todd P. Livdahl, professor of Biology at Clark University, Worcester, Massachusetts, *alma mater* of SDG; to be treated as a noun in apposition.

Biology.—This species is most active in July and August, with a range from the end of June (4 ♂♂) through September. This species seems to be commonly collected at UV and other light sources at night.

Ozodiceromyia mexicana Bigot
(Figs. 9–10, 16, 21, 25, 30–31, 34–35, 41)

Ozodiceromyia mexicana Bigot 1890: 321. Type locality: Mexico. Type: HT♀ in BMNH. Bigot 1890: 323 (key ref.); Kröber 1912: 211 (repr. orig. descr.), 1913: 8 (cat. cit.); Cole 1923: 19–20 (annot. listing); Gaimari 1998: 124–125 (lit. list), 157–159 (in phylogeny).

Ozodiceromya (sic) *mexicana*: Bigot 1890: 321 (orig. descr.); Irwin and Lyneborg 1981a: 196 (illust.: coxa), 199 (illust.: antenna), 254 (illust.: ♂ genit.), 257 (listing).

Ozodiceronyma (sic) *mexicana*: Godman 1901: 378 (listing).

Euphycus setosus Kröber 1912: 211. Type locality: Mexico. Type: LT♂ (designated herein) in NHMW. Irwin and Lyneborg 1981a: 257 (prop. syn.).

Ozodiceromya (sic) *setosa*: Irwin and Lyneborg 1981a: 257 (comb. change).

Female holotype.—The HT♀ is in poor condition, i.e., the abdomen and thorax are completely covered with orange fungus. Fortunately, the head is mounted separately and is fungus-free. The head is distinct enough to associate this specimen with a recognizable species. The following description deals only with the characteristics that can be seen in the specimen. Following this, the full redescription of the recognized species comes from the LT♂ of the junior synonym, *Euphycus setosus* Kröber.

Body length: 7.1 mm.

Head: 1.13 mm long, 1.73 mm wide, 1.28 mm high. Distance between eyes at level of anterior ocellus 0.33 mm; at antennal level 1.01 mm; at genal level 0.96 mm. Scape 0.59 mm long, 0.12 mm wide; with long, fine and thick, black setae, evenly distributed over entire scape (including median surface). Pedicel 0.18 mm long, barrel-shaped, setose (including median surface). Antennal base to nearest edge of eye 0.20 mm. Frons bulging 0.17 mm beyond eye in lateral view. Parafacial lacking pile; silver pruinescence in thin line along edge of eye; face and parafacial otherwise glabrous, shiny black. Frons shiny black; lower frons globose and bulging to antennal insertion; upper frons distinct from lower frons, bulging. Genal pile short and black.

Legs: Foreleg dark brown, except foretibia paler and lacking setae on proximal, dorsal surface. Midleg dark brown, except midtibia orange basally.

Wing: 5.85 mm long.

Male.—Lectotype of *Euphycus setosus* Kröber, to represent the species *Ozodiceromyia mexicana.*

Body length: 6.9 mm.

Head (Fig. 9): 0.90 mm long, 1.59 mm wide, 1.35 mm high. Distance between eyes at antennal level 0.83 mm; at genal level 1.01 mm. Antenna dark brown. Scape 0.71 mm long, 0.18 mm wide; with long, fine and thick, black setae, evenly distributed over entire scape (including median surface). Pedicel 0.20 mm long, barrel-shaped, setose (including median surface). First flagellomere 0.60 mm long, 0.15 mm wide; with short setae covering basal two-thirds. Stylus 0.09 mm long, inserted subapically. Antennal base to nearest edge of eye 0.26 mm. Frons globose, bulging 0.18 mm beyond eye in lateral view. Parafacial lacking pile, with silver pruinescence only along eye edge; pruinescence extends dorsally in thin line along eye margin halfway up frons; face and parafacial otherwise glabrous, shiny black. Frons otherwise shiny black; with long, fine, black setae (up to 0.38 mm long); upper frons bare. Genal pile short, darkened. Palpal pile white basally, dark brown distally. Postgenal pile white; occipital pile black; occiput with silver pruinescence only along edge of eye, and with several black setae. Median occipital sclerite flattened; glabrous, shiny black; upper edge not rounded. Postocular setae black, arranged in single, transverse row. Ocellar tubercle shiny black, with fine, forward-directed, black setae.

Thorax: Scutum and scutellum with erect black pile sparsely interspersed with appressed gold pile. Scutum 2.08 mm long, 1.70 mm wide; ground color black; with silver-grey pruinescence dorsally, lacking pruinescence laterally; median vitta diffuse bronze; dc vittae absent; dc setae absent [or 1 pair present]. Scutellum with silver pruinescence, reduced pruinescence anteriorly. Halter yellow. Katatergite with dense, long, orange pile. Anepimeron, katepimeron, and meron lacking pile, and with reduced silver pruinescence, appearing as vertical brown stripe from wing base to between second and third coxae. Anepisternum with silver pruinescence, and with white pile. Katepisternum with silver pruinescence, with white pile only on vertical crest along middle of pleurite. Prepimeron with silver pruinescence, lacking pile.

Legs: Coxae with silver pruinescence, posterior surfaces less so. Posterior surface of hindcoxa with long, white pile (Fig. 16). Femora dark brown. Fore- and midfemora with appressed, scale-like, white pile, and with long, erect, recumbent, white and black pile. Hindfemur with appressed, scale-like brown and white pile. Tibiae with short, erect, black setae; proximal, dorsal surfaces with sparser setal covering, or nearly bare. Foretibia orange basally, becoming dark brown distally; clavate distally. Midtibia orange, becoming darkened at distal tip. Hindtibia orange basally, becoming dark brown distally. Foretarsus dark brown. Mid- and hindtarsi dark brown except for basal two tarsomeres orange at their bases.

Wing: 6.24 mm long. Basal costal lobe with setae arranged in line along outer edge, extending into outer row of costal setae; second line of setae along base of basal costal lobe, extending into inner row of costal setae. Entire membrane slightly darkened; veins and membrane orange basally, brown distally.

Abdomen: Tergite 1 with erect and recumbent gold pile, except dark brown medioposteriorly; remaining tergites with erect and recumbent, white pile; dorsally, with silver pruinescence; laterally, lacking pruinescence (showing dark brown ground color), except tergite 1 and posterior edge of tergite 2 with silver pruinescence. Sternites with silver pruinescence only along anterior edge of sternite 2.

Terminalia (MEI 052240): Sternite 8 with black setae along posterior edge, which is emarginate medially. Tergite 8 dumbell-shaped, with black setae along posterior edge. Epandrium (Fig. 25) 0.24 mm long, 0.63 mm wide at widest point; orange; emarginate anteriorly; dorsal surface with white setae on posterior two-thirds; lateral edges parallel; posterolateral corners extended posteriorly. Subepandrial plate (Fig. 25) unattached to epandrium; sclerotized portion reduced, divided into two small plates. Sclerotized portion of cerci 0.23 mm long; extending posteriorly beyond posterolateral corners of epandrium; subequal in length to ventral epandrial sclerite. Gonocoxites (Figs. 30–31) 0.77 mm wide; orange; with white setae, up to 0.50 mm long; fusion 0.35 mm long at midline, with suture. Inner gonocoxal process flanged, knob with several white setae. Outer gonocoxal process flange-like, 0.23 mm long; bare. Gonocoxal apodeme entirely within anterior edge of gonocoxite; lacking sclerotized bridge to parameral sheath of phallus. Ventral gonocoxal process absent, lateral part of corresponding edge with dense patch of fine orange setae, up to 0.30 mm long. Ventral lobes distinct, fused basally by thin, transparent membrane. Gonostylus expanded ventrally into large lobe; with dorsobasal lobe; lacking subapical, lateral spur. Dorsal apodemes (Fig. 34) of aedeagus parallel; subequal in length to ventral apodeme; parameral sheath with distinct transverse wrinkles dorsally. Ventral apodeme thin, of uniform width; lacking ventral keel. Ejaculatory apodeme 0.35 mm long; stick-like, slightly expanded distally. Lateral ejaculatory process a complete ring dorsally, but notched; set into aedeagus; lightly sclerotized. Distiphallus long, recurved; distally parallel with ventral apodeme (Fig. 35).

Female (MEI 052163).—Similar to ♂ except as follows: body length 8.6 mm.

Head (Fig. 10): 1.10 mm long, 1.76 mm wide, 1.28 mm high. Distance between eyes at level of anterior ocellus 0.32 mm; at antennal level 0.83 mm; at genal level 0.95 mm. Scape 0.81 mm long, 0.15 mm wide. First flagellomere 0.71 mm long, 0.15 mm wide. Antennal base to nearest edge of eye 0.32 mm. Frons shiny black; lower frons globose and bulging to antennal insertion, with fine, black setae (up to 0.12 mm long) in patch above antennal base; upper frons bulging and distinct from lower frons.

Thorax: Scutum and scutellum with recumbent black pile and appressed gold pile. Scutum 2.08 mm long, 1.80 mm wide. Anepisternum with reduced silver pruinescence; pile of anepisternum and katepisternum sparse, short, white.

Wing: 6.12 mm long.

Abdomen: Tergites and sternites lacking pruinescence (showing dark brown ground color); tergites with appressed and semi-appressed gold pile.

Terminalia (paratype, MEI 070426) (Fig. 41): Furca 0.53 mm long, 0.38 mm wide; anterior edge not sclerotized; anterolateral prongs dorsoventrally flattened, separation subequal to greatest width of furca; posterolaterally with small, ventromedially oriented peg; posterior edge notched. Furcal bulla not sclerotized; posteriorly with indented cavity. Gonopore basal to furcal bulla, originating within posterior cavity. Common spermathecal duct 1.14 mm long. Spermathecal ducts originate from clean trifurcation at base of central sac duct; central sac duct absent. Central sac 0.89 mm long, 0.30 mm wide. Spermatheca 0.15 mm long, 0.15 mm wide; rounded distally, but basal edge flattened.

Type materials.—HOLOTYPE ♀: (MEI 103180) top label: Mexic[o]; with the following handwritten, second label (note, this is a standard provisional label of Bigot which he never updated): n. genus, Ozodiceromyia, J. Bigot, O. mexicana ♀, n. sp. Inedict. [= unedited, unpublished], Quincy 9b, 1888 J. Bigot, Mexique. This specimen, which is from BMNH, is in poor condition and is entirely covered with orange fungus, except for the head, which is mounted separately on the same pin.

LECTOTYPE ♂ (here designated to fix the current interpretation of this name and to ensure stability and uniformity in its future interpretation) of *Euphycus setosus*: (MEI 084117) with the following labels: Bilimek, Mexico, 1871, Guadalupe/Cotype (pink label)/Phycus setosus Kröb., det. Kröber 1911/Lectotypus ♂, Euphycus setosus Kröber, designated in 1998 by SD Gaimari et ME Irwin (red label). This pinned specimen is in very good condition, and is deposited in NHMW. PARALECTOTYPES: Bilimek, Mexico, 1871/Type (pink label)/Phycus setosus Kröb., det. Kröber 1911/Paralectotypus ♀, Euphycus setosus Kröber, designated in 1998 by SD Gaimari et ME Irwin (red label) (pinned ♀, MEI 084118, NHMW); Mexico/Cotype (pink label)/Phycus setosus Kröb., det. Kröber 1911/Paralectotypus ♂, Euphycus setosus Kröber, designated in 1998 by SD Gaimari et ME Irwin (red label) (2 pinned ♂♂, MEI 084115, 084116, NHMW); Type (pink label)/Mexico, Sta. Fe, 1871/Type No. 24183, U.S.N.M. (red label)/Euphycus setosus Kröb., Kröber det. 1911/Paratype only, det. WWirth/Ozodiceromyia mexicana Bigot, det WWirth/Paralectotypus ♂, Euphycus setosus Kröber, designated in 1998 by SD Gaimari et ME Irwin (red label) (pinned ♂, MEI 032957, USNM).

Materials examined.—MEXICO: *Coahuila,* 30.6 km SE of Saltillo, Highway 57, 2,194.56 m, C. O'Brien, L. O'Brien, G. Wibmer, 12-IX-1982 (1 ♀, MEI 052245, MCZC); *Distrito Federal,* IX-1898 (2 ♀, MEI 032959, 032960, USNM); Mexico City, R. Muller (1 ♂, MEI 032958, USNM), W. G. Downs, 14-X-1951 (♂ and ♀, MEI 038775, 038774, AMNH); Pedregal de San Angel, H. Perez, 27-IX-1969 (1 ♀, MEI 084201, KSUC); Tizapan (1 ♀, MEI 052178, AMNH; 2 ♂, MEI 084194, 084195, UNAM); *Guerrero,* 12.9 km E of Taxco, 1,828.8 m, R. H. Painter, E. M. Painter, 15-IX-1963 (1 ♂, MEI 052188, UAIC); 22 km NE Telolopan, 1,530 m, J. A. Powell, J. A. Chemsak, 16-IX-1982 (1 ♀, MEI 081567, EMEC); *Hidalgo,* 16.1 km S of Zimapán, 1,889.76 m, J. A. Powell, 28-IX-1975 (1 ♂, MEI 052247, SDGC); Tepeapulco, G. E. Bohart, W. J. Hanson, 18-IX-1974 (1 ♂, MEI 007797, EMUS; 1 ♂, MEI 007795, FSCA; 1 ♂, MEI 007796, UAIC; 1 ♀, MEI 007798, EBCC); *Jalisco,* 6.4 km W Mazamilta, 2,072.64 m, R. F. Smith, 16-X-1950 (1 ♀, MEI 052182, ZMHB); *Mexico,* C. W. Johnson coll. (1 ♂, MEI 032961, USNM; 1 ♂, MEI 052180, MCZC); Amecameca, R. Dreisbach, K. Dreisbach, 25-IX-1957 (1 ♂, MEI 052192, MEIC; 1 ♀, MEI 052181, INHS); 45.1 km SE of San Juan del Rio, G. E. Bohart, W. J. Hanson, 31-VIII-1974 (1 ♂, MEI 007800, EMUS); *Michoacán,* 4.8 km W of Morelia, 1,859.28 m, R. H. Painter, E. M. Painter, 21-X-1963 (1 ♂, MEI 052185, KUIC), 1,950.72 m, R. H. Painter, E. M. Painter, 20-IX-1963 (1 ♂, MEI 052190, KUIC; 1 ♂, MEI 052191, FSCA; 1 ♀, MEI 090233, SDGC); 6 km S of Ocampo, Lag.[una] Verde, A. L. Norrbom, 6-X-1991, observed waving forelegs acting like a wasp (1 ♀, MEI 052163, USNM); 11.3 km E of Quiroga, 2,346.96 m, R. H. Painter, E. M. Painter, 21-IX-1963 (1 ♂, MEI 052176, KSUC); 14.5 km W of Ciudad Hidalgo, 2,194.56 m, R. H. Painter, E. M. Painter,

19-IX-1963 (1 ♀, MEI 052177, KSUC); 14.5 km W of Morelia, 2,072.64 m, J. A. Powell, J. A. Chemsak, T. Eichlin, T. P. Friedlander, 9-X-1975 (3 ♂, MEI 052236, 052238, 052239, CASC; 1 ♂, MEI 052237, ZMAS); 20.9 km N of Morelia, 1,981.2 m,, R. H. Painter, E. M. Painter, 22-IX-1963 (1 ♀, MEI 107043, MEIC); N of Patzcuaro, 3 km E of Zintzuntzan, 2,100 m, T. Griswold, 26-X-1987 (1 ♀, MEI 052229, EMUS); SW of Patzcuaro, 3 km E of Zirahuén, 2,000 m, T. Griswold, 27-X-1987 (1 ♂, MEI 052227, WFBM; 1 ♀, MEI 052228, EMUS); *Morelos,* 19 km E Cuernavaca, Canyon del Lobo, E. M. Fisher, 15-X-1986 (6 ♂, MEI 070420, 070421, 070423, 070424, 070425, 070427, 1 ♀, MEI 070419, CDFA; 1 ♂, MEI 070422, 1 ♀, MEI 070428, SDGC; 1 ♂, MEI 070429, ZMUC; 1 ♂, MEI 070430, MNHN; 1 ♂, MEI 070431, INHS; 1 ♀, MEI 070426, MEIC; 1 ♀, MEI 070432, CNCI); Cañón del Lobos, M. Rodriguez, 19-X-1985 (1 ♂, MEI 084184, CICESE); Tepoztlán, 1,700 m, C. D. Michener, R. Murillo, J. M. Labougle, 13-XI-1980 (1 ♂, MEI 052220, SEMC); *Nuevo León,* 4.8 km E of Galeana Jct., 1,828.8 m, J. A. Chemsak, J. Powell, A. Michelbacher, M. M. Michelbacher, 15-IX-1976 (1 ♂, MEI 081532, EMEC; 1 ♀, MEI 081530, NHMW; 1 ♀, MEI 081531, SDGC); 6.4 km W Iturbide, 1,676.4 m, J. A. Chemsak, 22-IX-1976, at light (1 ♂, MEI 052240, MEIC; 1 ♀, MEI 052241, CASC), J. A. Chemsak, J. A. Powell, 13-IX-1976 to 14-IX-1976, at light (1 ♂, MEI 052197, EMEC); 8.1 km E of Galeana Jct., J. A. Powell, J. A. Chemsak, 16-IX-1976 to 17-IX-1976 (1 ♂, MEI 052202, MNHN; 1 ♂, MEI 052204, AMNH; 1 ♂, MEI 052205, SEMC; 1 ♂, MEI 052206, BMNH), J. A. Powell, J. A. Chemsak, A. E. Michelbacher, M. M. Michelbacher, 16-IX-1976 to 17-IX-1976 (10 ♂, MEI 052196, 052199, 052200, 081551, 081550, 081549, 081548, 081547, 081538, 081537, 1 ♀, MEI 081539, EMEC; 1 ♂, MEI 052201, UCRC; 1 ♂, MEI 052198, EBCC; 1 ♀, MEI 081536, ZMUC); 11.3 km W of Iturbe, 1,767.84 m, R. H. Painter, E. M. Painter, 25-IX-1963 (1 ♂, MEI 052187, KSUC); 14.5 km S of junction 60 to Dr. Arroyo, R. Turnbow, 22-X-1979 (1 ♂, MEI 052174, UGCA); 16.1 km E of San Roberto, 2,133.6 m, 15-IX-1976 (1 ♂, MEI 052203, MZSP); 16.1 km NW Provedencia, 1828.8 m, J. A. Chemsak, J. Powell, A. Michelbacher, M. Michelbacher, 27-IX-1976 (♂ and ♀ *in copula,* MEI 081553, 081552, EMEC); 16.1 km N Provedencia, J. Powell, J. A. Chemsak, A. Michelbacher, M. M. Michelbacher, 25-IX-1976 (1 ♂, MEI 081534, EMEC); 22.5 km N San Juanito, 2,194.56 m, J. A. Chemsak, J. Powell, A. Michelbacher, M. M. Michelbacher, 22-IX-1976 (2 ♂, MEI 081528, 081529, EMEC); 66 km S of Saltillo, 1,889.76 m, 7-IX-1962, U. Kans. Mex. Exped., on flowers of *Encelia farinosa* (2 ♂, MEI 052184, 052186, KSUC); 66 km SE of Saltillo, 1,889.76 m, N. Marston, 7-IX-1962 (1 ♂, MEI 052184, KSUC); 70.8 km SE of Saltillo, G. E. Bohart, W. J. Hanson, 30-VIII-1974 (1 ♂, MEI 007803, EMUS); *probably Nuevo León,* Guadalupe, [D.] Bilimek, 1871 (1 ♂, 109316, NHMW); *Oaxaca,* 11.3 km SE of Nochixtlan, 2,133.6 m, J. A. Powell, J. A. Chemsak, T. Eichlin, T. P. Friedlander, 7-X-1975 (2 ♂, MEI 052242, 052243, CASC; 1 ♂, MEI 052244, DEIC; 1 ♀, MEI 052235, MZSP); 14.5 km NE San Jose del Estado, 2,590.8 m, R. F. Smith, 25-X-1966 (1 ♂, MEI 081533, EMEC); *San Luis Potosi,* 31 km SE San Luis Potosi, 2,250 m, E. Ramírez, 17-X-1996 (1 ♂, MEI 103423, NHMW; 1 ♂, MEI 103422, EBCC; 1 ♂, MEI 103420, ZMHB; 1 ♂, MEI 103419, UCRC), 18-X-1996 (1 ♂, MEI 103403, SDGC; 1 ♂, MEI 103421, CNCI); *Veracruz,* Perote, San Juan del Monte, A. Cordoba, 14-X-1989 to 15-X-1989 (1 ♂, MEI 080258, 1 ♀, MEI 080259, IEXA; 1 ♀, MEI 080260, BMNH); *Zacatecas,* 3.2 km S of Luis Moya, 1,920.24 m, R. H. Painter, E. M. Painter, 3-IX-1962 (1 ♂, MEI 052189, INBC); (*unknown state*), Carr. la para cuautla km 2; 15 Nov. 1978, coll: E. Olvara (1 ♂, MEI 084199, UCDC;

1 ♂, MEI 084202, UNAM), 19 Nov. 1978 (1 ♂, MEI 084200, DEIC); Cuamauaca moz, km 57.5 Autopista, 15 Nov. 1978, J. C. Medina (1 ♂, MEI 084188, UCDC); San Lucas PUZ., Matorrol espinoso [= spiny bush], 21-IX-89, A. Exuihua M. (1 ♀, MEI 079915, UNAM).

Diagnosis.—The scape in this species is densely setose, with long setae. The lower frons is globose and distinctly bulging, is shiny black, lacking pruinescence, and has only a thin line of silver pruinescence along the eye margin extending down along the parafacial. The face below the antenna is shiny black, lacking pruinescence. In males, the notum is covered with erect black pile interspersed with appressed gold pile. In females, the notum and abdominal tergites are covered with short, fine, appressed gold pile. In the male genitalia, the setae of the epandrium and gonocoxites are orange. The subepandrial plate is attached to the epandrium only through a thinly membranous connection laterally. The sclerotized portion of the subepandrial plate is not V-shaped posteriorly, but is reduced to two smaller lateral plates. The gonocoxites have a suture along the midline separating the two lateral halves. The outer gonocoxal process tapers evenly towards apex and is bare of setae. The ventral gonocoxal process of the gonocoxites is absent; there is a distinct, dense clump of orange setae on the posteroventral edge of the gonocoxite. The base of the ventral lobes is V-shaped and narrow between the two halves. The parameral sheath of the aedeagus has distinct, transverse wrinkles dorsally. The ventral apodeme lacks a ventral keel. The distiphallus is evenly tapered to apex, lacking any swelling, and is recurved and parallel with the ventral apodeme at the tip. In the female terminalia, the furca is notched posteriorly, and ventromedially oriented pegs are present on the posterolateral portion of furca. The anterolateral furcal prongs are separated by a distance subequal to the greatest width of the furca. The common spermathecal duct is not widened basally, and tapers normally.

Autapomorphies.—Lower frons globose and bulging to antennal insertion (character 9), posterolateral surface of hindcoxa pilose (character 14), parameral sheath with transverse wrinkless dorsally (character 17), subepandrial plate attached to epandrium laterally only (character 24), posterolateral corners of epandrium held by separate, sclerotized membrane, (character 25), presence of distinct internal keel where gonocoxites fused (character 27), posterior edge of furca with distinct notch (character 36), medially directed peg present on posterolateral furcal margin (character 37).

Distribution.—The known distribution for this species is found in Fig. 3. Nearly all of the specimens were collected at elevations ranging from 1,500–2,600 m. The distribution encompasses parts of the following biogeographical regions: the Provincia Xerófila Mexicana, and the Provincia Mesoamericana de Montaña.

Biology.—This species is most active in September and October, with several specimens collected in late August and in the middle of November. Two males were collected on flowers of *Encelia farinosa* A. Gray (Asteraceae), and one female was observed in life waving her forelegs in apparent mimicry of the antennae of a sphecoid wasp.

***Ozodiceromyia parargentifera* Gaimari and Irwin, new species**

(Figs. 36–37, 40)

Male.—*Body length:* 7.0 mm.

Head: 1.04 mm long, 2.00 mm wide, 1.58 mm high. Distance between eyes at antennal level 0.62 mm; at genal level 0.83 mm. Antenna brown, except basal half of scape orange. Scape 0.95 mm long, 0.15 mm wide; with short, fine, black setae, evenly distributed over entire scape (including median surface), and few larger setae. Pedicel 0.18 mm long, barrel-shaped, setose (including median surface). First flagellomere 0.96 mm long, 0.15 mm wide; with

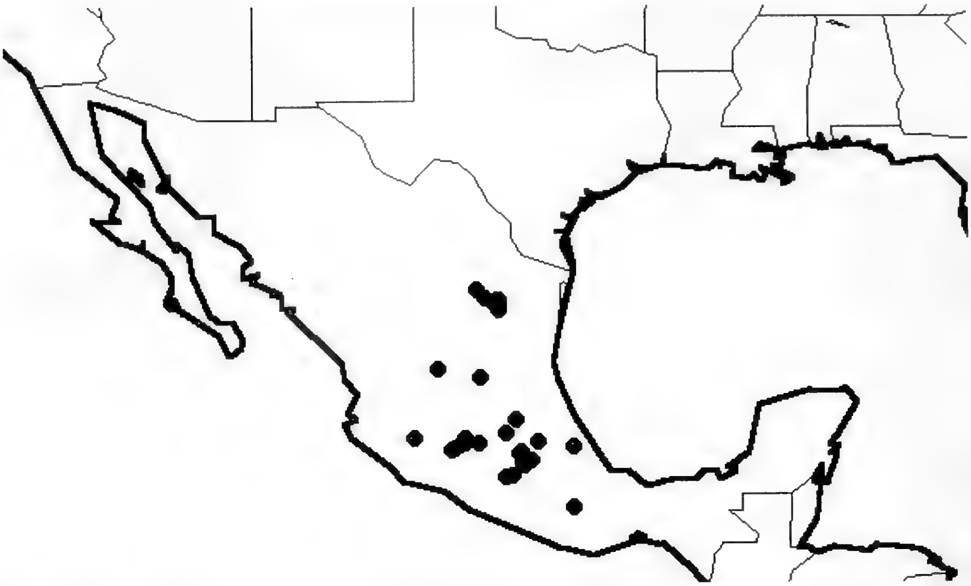


Fig. 3. Known distribution for *Ozodiceromyia mexicana.*

short setae covering basal two-thirds. Stylus 0.09 mm long, inserted subapically. Antennal base to nearest edge of eye 0.15 mm. Frons bulging 0.09 mm beyond eye in lateral view. Face below antenna with silver pruinescence. Parafacial lacking pile, with silver pruinescence extending to antennal base and dorsally along eye margin halfway up frons. Frons otherwise shiny black; with few, short, fine, black setae (up to 0.17 mm long) dorsolateral to antennal base; remainder of frons bare. Genal pile short, darkened. Palpal pile white basally, dark brown distally. Postgenal and occipital pile white; occiput with silver pruinescence only along edge of eye, and with several black setae. Median occipital sclerite flattened; glabrous, shiny black; upper edge not rounded. Postocular setae black, arranged in single, transverse row. Ocellar tubercle with silver pruinescence, and fine, forward-directed, black setae.

Thorax: Scutum and scutellum with fine, erect black pile. Scutum 2.22 mm long, 1.53 mm wide; ground color black; with silver-grey pruinescence dorsally, lacking pruinescence laterally; median vitta diffuse bronze; dc vittae absent; 1 pair dc setae. Scutellum with silver pruinescence, reduced pruinescence anteriorly. Halter brown. Katatergite with dense, long, white pile. Anepimeron, katepimeron, and meron lacking pile, and with reduced silver pruinescence, appearing as vertical brown stripe from wing base to between second and third coxae. Anepisternum with silver pruinescence, and with white pile. Katepisternum with silver pruinescence, with white pile only on vertical crest along middle of pleurite. Prepimeron with silver pruinescence, lacking pile.

Legs: Coxae with silver pruinescence, posterior surfaces less so. Posterior surface of hindcoxa lacking pile. Forefemur dark brown; dorsally with appressed, scale-like white pile, and erect, white and brown pile. Foretibia with short, erect, black setae; proximal, dorsal surface with sparser setal covering; orange on basal half, becoming dark brown distally; clavate distally. Foretarsus dark brown. Mid- and hindlegs broken off.

Wing: 5.88 mm long. Basal costal lobe with setae arranged in line along outer edge, extending into outer row of costal setae; second line of setae along base of basal costal lobe, extending into inner row of costal setae. Entire membrane slightly darkened; veins and membrane orange basally, darker distally.

Abdomen: Tergites with erect and recumbent, white pile; dorsally, with silver pruinescence; laterally, lacking pruinescence (showing dark brown ground color), except tergite 1 and posterior edges of basal tergites with silver pruinescence. Sternites with silver pruinescence only along anterior edge of sternite 2.

Terminalia: Sternite 8 with fine black setae restricted to posterior edge, which is emarginate medially. Tergite 8 dumbell-shaped, with fine black setae restricted to posterior edge. Epandrium 0.18 mm long, 0.68 mm wide at widest point; orange; emarginate anteriorly; dorsal surface with black setae on posterior half; lateral edges parallel; posterolateral corners extended and pointed posteriorly. Subepandrial plate attached to posterolateral and posterior edges; sclerotized portion V-shaped posteriorly. Sclerotized portion of cerci 0.20 mm long; extending posteriorly slightly beyond posterolateral corners of epandrium; subequal in length to ventral epandrial sclerite. Gonocoxites 0.72 mm wide; orange; with black setae, up to 0.47 mm long; fusion 0.36 mm long at midline, lacking suture. Inner gonocoxal process flanged; knob with several black setae. Outer gonocoxal process flange-like, 0.33 mm long; with short, fine setae along dorsal edge. Gonocoxal apodeme entirely within anterior edge of gonocoxite; lacking sclerotized bridge to parameral sheath of phallus. Ventral gonocoxal process 0.27 mm long, flanged; bare. Ventral lobes distinct, fused basally by thin, transparent membrane. Gonostylus expanded ventrally into large lobe; with dorsobasal lobe; with subapical, lateral spur. Dorsal apodemes (Fig. 36) of aedeagus parallel; shorter than ventral apodeme; parameral sheath smooth dorsally. Ventral apodeme uniformly wide; with ventral, longitudinal keel. Ejaculatory apodeme 0.30 mm long; stick-like, expanded distally and bilobed. Lateral ejaculatory process a complete ring dorsally, but notched; set into aedeagus; lightly sclerotized. Distiphallus swollen basally, long, undulating, recurved; distally perpendicular to ventral apodeme (Fig. 37).

Female.—Similar to ♂ except as follows: body length 9.6 mm.

Head: 1.22 mm long, 2.28 mm wide, 1.59 mm high. Distance between eyes at level of anterior ocellus 0.50 mm; at antennal level 0.95 mm; at genal level 1.04 mm. Antenna brown. Antennal base to nearest edge of eye 0.30 mm. Parafacial pruinescence ends at antennal level. Frons shiny black; lower frons bulging, with short, fine, black setae (up to 0.09 mm long) dorsolateral to antennal base; upper frons bulging and wrinkled, distinct from lower frons. Median occipital sclerite and upper edge rounded; transverse row of black setae across median occipital sclerite in addition to row of postocular setae.

Thorax: Scutum and scutellum with erect and recumbent, short, black pile [one paratype also has short, fine, appressed gold pile]. Scutum 2.58 mm long, 1.76 mm wide. Pile of anepisternum and katepisternum short, white; densest on upper half of anepisternum.

Legs: Foretibia dark brown [or orange basally]. Mid- and hindfemora dark brown. Mid- and hindtibiae light brown. Mid- and hindtarsi dark brown, except for basal two tarsomeres mostly orange.

Wing: 7.20 mm long.

Abdomen: Tergites with short, recumbent, white pile. Tergites and sternites with reduced silver pruinescence (showing dark brown ground color), except posterolateral edges of basal tergites with silver pruinescence.

Terminalia (paratype, MEI 027022): Furca (Fig. 40) 0.53 mm long, 0.32 mm wide; anterior edge not sclerotized; anterolateral prongs dorsoventrally flattened, separation narrower than greatest width of furca. Furcal bulla not sclerotized; posteriorly with indented cavity. Gonopore basal to furcal bulla, originating within posterior cavity. Common spermathecal duct basally 0.11 mm wide, tapering to 0.05 mm within 0.33 mm distance from gonopore; 0.62 mm long. Spermathecal ducts originate from clean trifurcation with central sac duct; central sac duct wider in basal diameter than spermathecal ducts. Central sac duct 0.45 mm long. Central sac 0.68 mm long, 0.41 mm wide. Spermatheca 0.17 mm in diameter; rounded, but basal edge slightly flattened.

Type materials.—HOLOTYPE ♂ (MEI 027017) with the following label: MEXICO, *Guerrero,* 4 mi. W of Chilpancingo, July 15, 1984, Carroll, Schaffner, Friedlander. This pinned specimen, which is deposited in CASC (with permission of TAMU), is in good condition except for its missing mid- and hindlegs.

Materials examined.—PARATYPES. MEXICO: same label as holotype (1 ♀, MEI 027022, SDGC); *Michoacán,* 9.3 km SE Quiroga, 25-VIII-1991, W. F. Barr, on roadside vegetation, 2,653 m (1 ♀, MEI 079906, WFBM); *Puebla,* 4.4 mi. SW [San Francisco] Acatepec, 9-VII-1981, Bogar, Schaffner, Friedlander (allotype ♀, MEI 027003, TAMU).

Diagnosis.—This species is much like *Ozodiceromyia argentifera* and *Ozodiceromyia livdahli.* The scape in this species is setose, but most of the setae are short, with few longer ones. The lower frons bulges only slightly, with silver pruinescence laterally, extending down along parafacial. The face below the antenna also has silver pruinescence. In males, the notum has some fine, erect, black setae (the holotype, the only known male, appears rubbed dorsally, and so presence or condition of appressed pile is unknown). In females, the notum has short, fine, erect and appressed black pile, and occasionally appressed gold pile. In the male genitalia, the setae of the epandrium and gonocoxites are black. The subepandrial plate is attached to the epandrium at the posterolateral corners, and the sclerotized portion of the subepandrial plate is V-shaped posteriorly. The gonocoxites lack a suture along the midline separating the two lateral halves. The outer gonocoxal process is widened distally, with a small patch of setae on the dorsolateral surface. The ventral gonocoxal process of the gonocoxites is present, elongated and flattened; there are no clumped setae at its base. The base of the ventral lobes is U-shaped and broad between the two halves. The parameral sheath of the aedeagus is smooth dorsally. The ventral apodeme has a ventral keel. The distiphallus is swollen basally, and is perpendicular to the ventral apodeme throughout. In the female terminalia, the furca is not notched posteriorly, and lacks a posterolateral peg. The anterolateral furcal prongs are separated by a distance narrower than the greatest width of the furca. The common spermathecal duct is broad basally, at half the width of the entire furca; the duct tapers quickly.

Autapomorphies.—Halter brown (character 15), ventral apodeme longer than dorsal apodemes (character 18), ventral surface of ventral apodeme with longitudinal keel (character 19), distiphallus perpendicular to dorsal apodemes (character 23, state 0), anterior prongs of furca narrowly separated (character 38).

Distribution.—The known distribution for this species is found in Fig. 4. This species is found in southern Mexico, in the states of Puebla, Michoacan, and Guerrero. The type locality, in Guerrero, is part of the northern slope foothills of the Sierra Madre de Sur range, at an elevation over 1,500 m. The remaining localities are all above this elevation, as high as 2,600 m. The distribution encompasses parts of the following biogeographical regions: the Provincia Mesoamericana de Montaña, and the Provincia Pacifica.

Etymology.—Gr., *para*: beside, near + "*argentifera,*" referring to the similarity with *Ozodiceromyia argentifera* (Kröber); to be treated as a noun in apposition.

Biology.—Adults are active at least through the months of July and August.

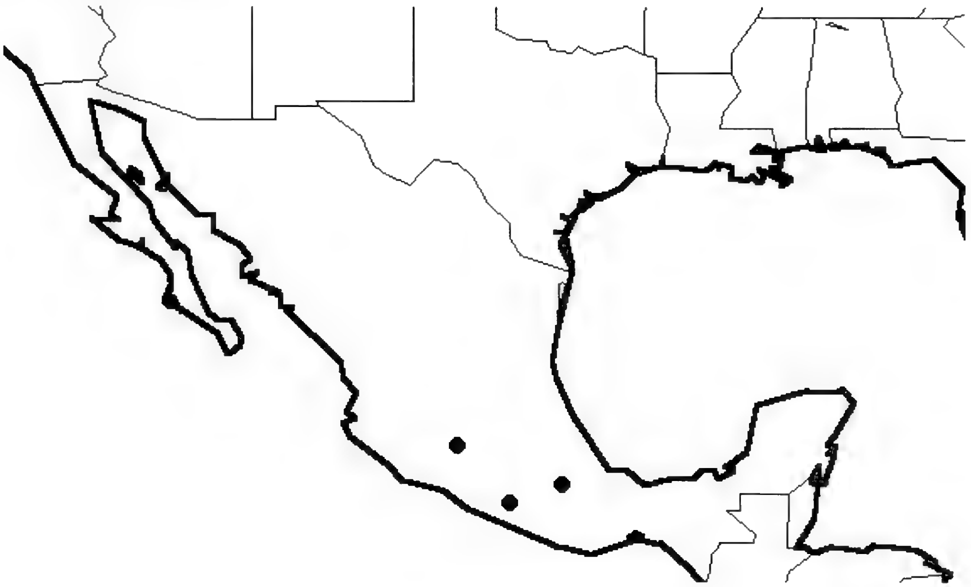


Fig. 4. Known distribution for *Ozodiceromyia parargentifera.*

KEY TO SPECIES

A comprehensive key to species of *Ozodiceromyia* is not presented herein. This will be included in the larger revision of the entire genus in progress by the authors. The current key is a continuation of Gaimari and Irwin's (2000) key to world genera of Cyclotelini. An alternative is the key to the therevid genera of North America found in Irwin and Lyneborg (1981a, b). The first couplet below separates members of the *Ozodiceromyia mexicana*-group from all other members of the genus. Note that the male genitalic characters in the key are usually visible without dissection. The female genitalic character in couplet 3 requires dissection, but should not be necessary for routine identification.

1. Antenna (Figs. 7–10) longer than head. Scape setose throughout. Pedicel barrel-shaped, longer than wide, setose throughout. First flagellomere setose over basal two-

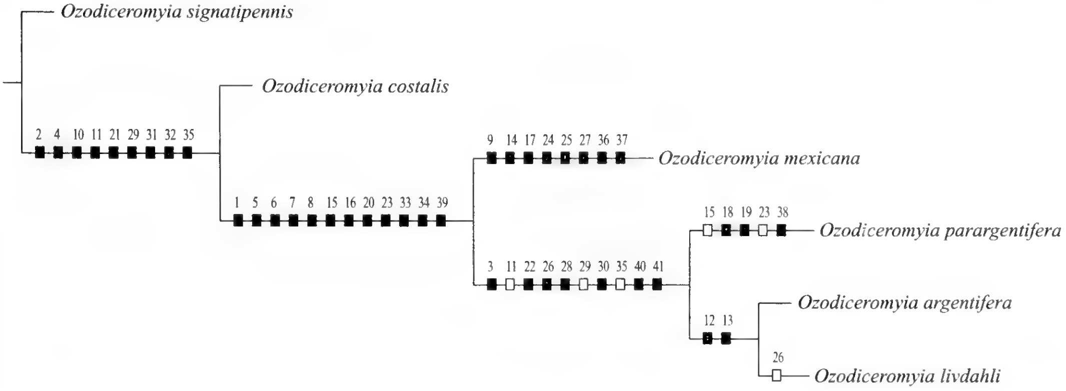


Fig. 5. Single most parsimonious cladogram for the species of the *Ozodiceromyia mexicana*-group, showing character state changes under ACCTRAN character optimization. Characters are numbered as in the text; hash marks are as follows: black = forward change with no homoplasy; white = change with homoplasy.

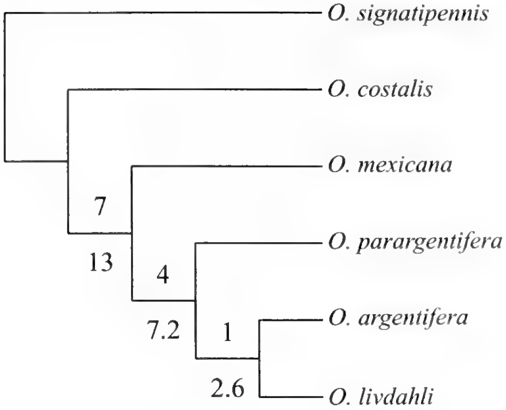


Fig. 6. Single most parsimonious cladogram for the species of the *Ozodiceromyia mexicana*-group, with Bremer support indices indicated above each branch and post-successively reweighted, rescaled Bremer support indices below each branch.

thirds. Wing membrane and veins orange, at least basally; distal third of wing often darkened, with darkened veins . . . . *Ozodiceromyia mexicana*-group

– Antenna (Fig. 11) shorter than head, rarely as long as head. Scape usually bare on median surface. Pedicel as long as wide, usually bare on median surface. First flagellomere setose at most in basal third. Wing membranes hyaline or banded, but never orange; veins dark, rarely orange; distal third of wing not darkened relative to basal two-thirds . . . . other *Ozodiceromyia*

2(1). Scape densely setose, with long setae, longer than those of first flagellomere (Figs. 9–10). Lower frons globose, distinctly bulging, and shiny black, with silver pruinescence only along eye margin (Figs. 9–10). Face beneath antenna shiny black, lacking pruinescence (Figs. 9–10). Male: notum with erect black pile; posterior surface of hindcoxa with long, white pile (Fig. 16); outer gonocoxal process tapering evenly, bare (Fig. 31); ventral gonocoxal process of genitalia absent, dense clump of orange setae on corresponding edge (Fig. 30) . . . . *Ozodiceromyia mexicana*

– Scape setose, but with short setae, with few long setae interspersed (Figs. 7–8). Lower frons not globose, only slightly bulging; silver pruinescence present dorsolaterally to antennal base (Figs. 7–8). Face beneath antenna with silver pruinescence (Figs. 7–8). Male: pile of notum variable, but usually both erect and appressed pile present; posterior surface of hindcoxa lacking pile (Fig. 14); outer gonocoxal process widened distally, with small patch of short setae on dorsolateral surface (Fig. 27); ventral gonocoxal process present, long and flattened, with no densely clumped setae (Fig. 26) 3

3(2). Halter brown in both sexes. Male: notum with erect black pile; setae of gonocoxites and epandrium black; distiphallus perpendicular to ventral apodeme throughout length (Fig. 37). Female: distance between anterolateral furcal prongs distinctly narrowed anteriorly (Fig. 40) . . . . *Ozodiceromyia parargentifera*

– Halter yellow in both sexes. Male: notum with both erect and appressed pale or gold pile; setae of gonocoxites and epandrium black or orange; distiphallus recurved before apex to become parallel with ventral apodeme (Fig. 33). Female: distance between anterolateral furcal prongs not narrowed anteriorly, subequal to widest part of furca (Fig. 39) 4

4(3). Male: setae of gonocoxites and epandrium black (Figs. 23, 26–27). Female: appressed pile on abdominal tergites gold . . . . *Ozodiceromyia argentifera*

– Male: setae of gonocoxites and epandrium pale or orange (Fig. 28). Female: appressed pile on abdominal tergites brown and white . . . . *Ozodiceromyia livdahli*

CHARACTER DESCRIPTIONS

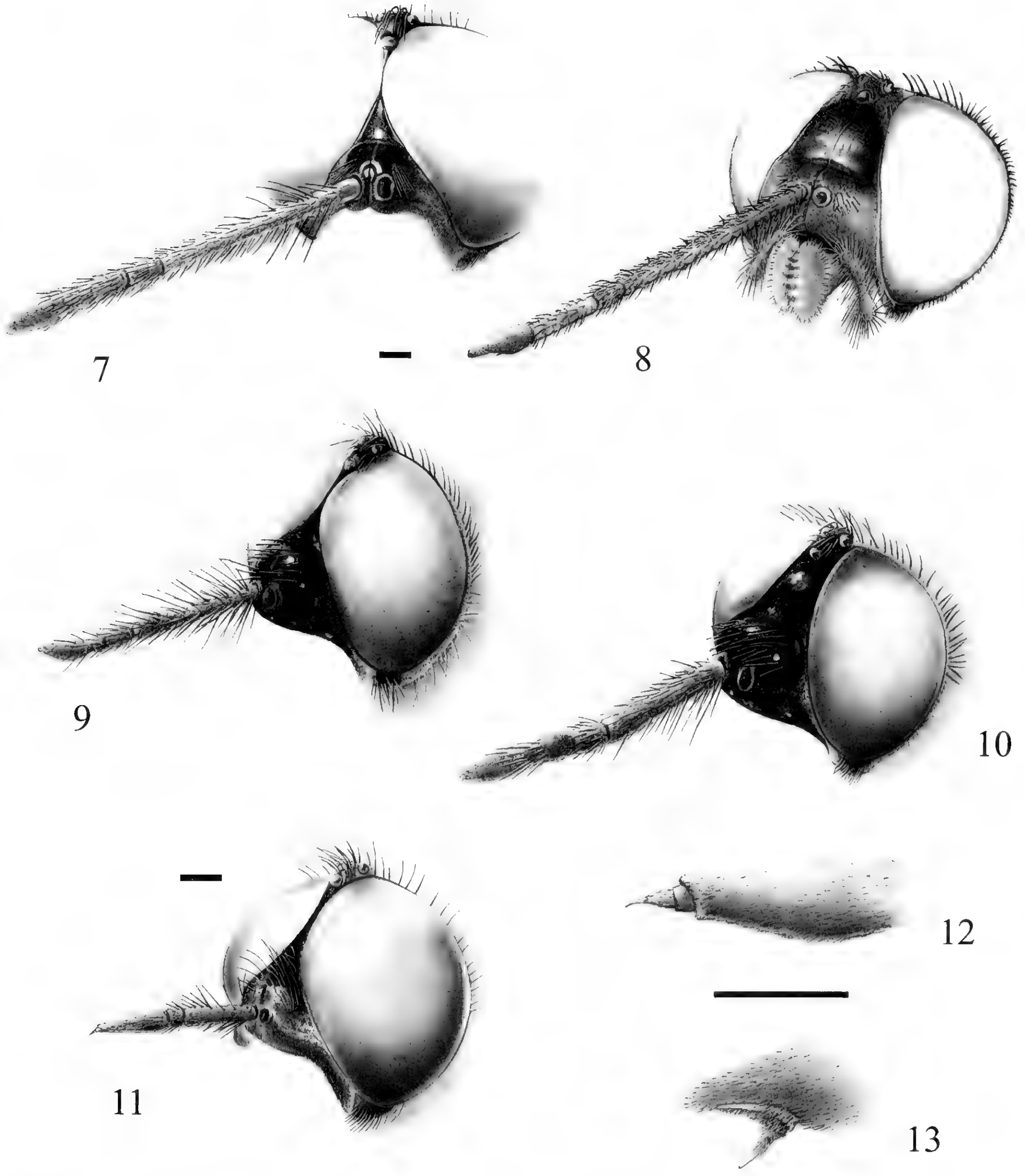
This section is devoted to description of morphology and taxon distribution of states of the 41 characters used in this analysis. Of these, 11 are taken from the head, 5 from the thorax, 19 from the male terminalia, and 6 from the female terminalia. Characters described and discussed by Gaimari and Irwin (2000) are referred to the appropriate character number therein for description, although state distributions are discussed herein. All characters are binary. Character distributions are discussed relative to the presented cladogram (Fig. 5).

HEAD

1. Antennal length

0 shorter than or subequal to head length
1 longer than head

The states for this character are described as character 1 in Gaimari and Irwin (2000).



Figs. 7–13. Heads, ♂ (7, 9, 11), ♀ (8, 10); ♀, antennal first flagellomere (12), tip only (13). (7–8) *Ozodiceromyia argentifera* (MEI 038790, 052183). (9–10, 13) *Ozodiceromyia mexicana* (MEI 052192, 107043, 070426). (11–12) *Ozodiceromyia signatipennis* (MEI 044750, 056973). Measure bars, 0.2 mm.

In the current analysis, an elongated antenna (Fig. 7) is autapomorphic for the *mexicana*-group, and is found in no other known *Ozodiceromyia.* Members of several other cycloteline genera, including *Cyclotelus* Walker, also share this state.

2. Medial surface of scape

0 without setae
1 setose

In nearly all *Ozodiceromyia,* the scape is bare on the median surface (Fig. 11). Only in the *mexicana*-group and the outgroup taxon *Ozodiceromyia costalis* (and several undescribed, putatively related species) is this surface setose (Fig. 9).

3. Setae of scape

0 longer than those of first flagellomere
1 most are shorter than or equal to those of first flagellomere

The setae of the scape are longer than those of the first flagellomere (Fig. 9), plesiomorphically, as in both outgroup taxa and *Ozodiceromyia mexicana.* As a synapomorphy for the clade of *Ozodiceromyia parargentifera* + *Ozodiceromyia argentifera* + *Ozodiceromyia livdahli,* the setae of the scape are shorter than or equal to those of the first flagellomere, at most with several longer setae interspersed among the short setae (Fig. 7).

4. Medial surface of pedicel

0 without setae
1 setose

The states for this character are described as character 3 in Gaimari and Irwin (2000). The apomorphically setose medial surface of the pedicel (Fig. 9) is present in all members of the *mexicana*-group, and in the outgroup taxon *Ozodiceromyia costalis.*

5. Setae of first flagellomere

0 basal only, or bare
1 covering more than basal half

In nearly all *Ozodiceromyia,* including both outgroup taxa, the setae of the first flagellomere are restricted to the base (Fig. 11). Only as an autapomorphy for the *mexicana*-group do these setae cover more than the basal half of the first flagellomere (Fig. 9).

6. Setae of first flagellomere

0 less dense ventrally, or bare
1 fully surrounding with equal density

Plesiomorphically, the ventral surace of the first flagellomere is bare, or only sparsely setose (Fig. 11), as in nearly all *Ozodiceromyia* including both outgroup taxa. Only as an autapomorphy for the *mexicana*-group do setae fully surround the first flagellomere with equal density (Fig. 9).

7. Antennal style

0 originates near tip, but extended beyond first flagellomere distally
1 distinctly subapical, and not extended beyond tip of first flagellomere

Plesiomorphically, the antennal style originates very close to the apex of the first flagellomere, but slightly subapical and ventral. Despite this, the tip of the style extends distally beyond the tip of the first flagellomere (Fig. 12). As an autapomorphy for the *mexicana*-group, the antennal style originates distinctly subapically on the first flagellomere within a ventral pit, with the stylar tip not reaching the apex of the first flagellomere (Fig. 13).

8. First stylar segment

0 as long as wide
1 wider than long, and ring-like

Plesiomorphically, the first stylar segment is as long as wide (Fig. 12). As an autapomorphy for the *mexicana*-group, this segment is reduced to a small, flattened ring set within a ventral pit (Fig. 13).

9. Lower frons at antennal insertion

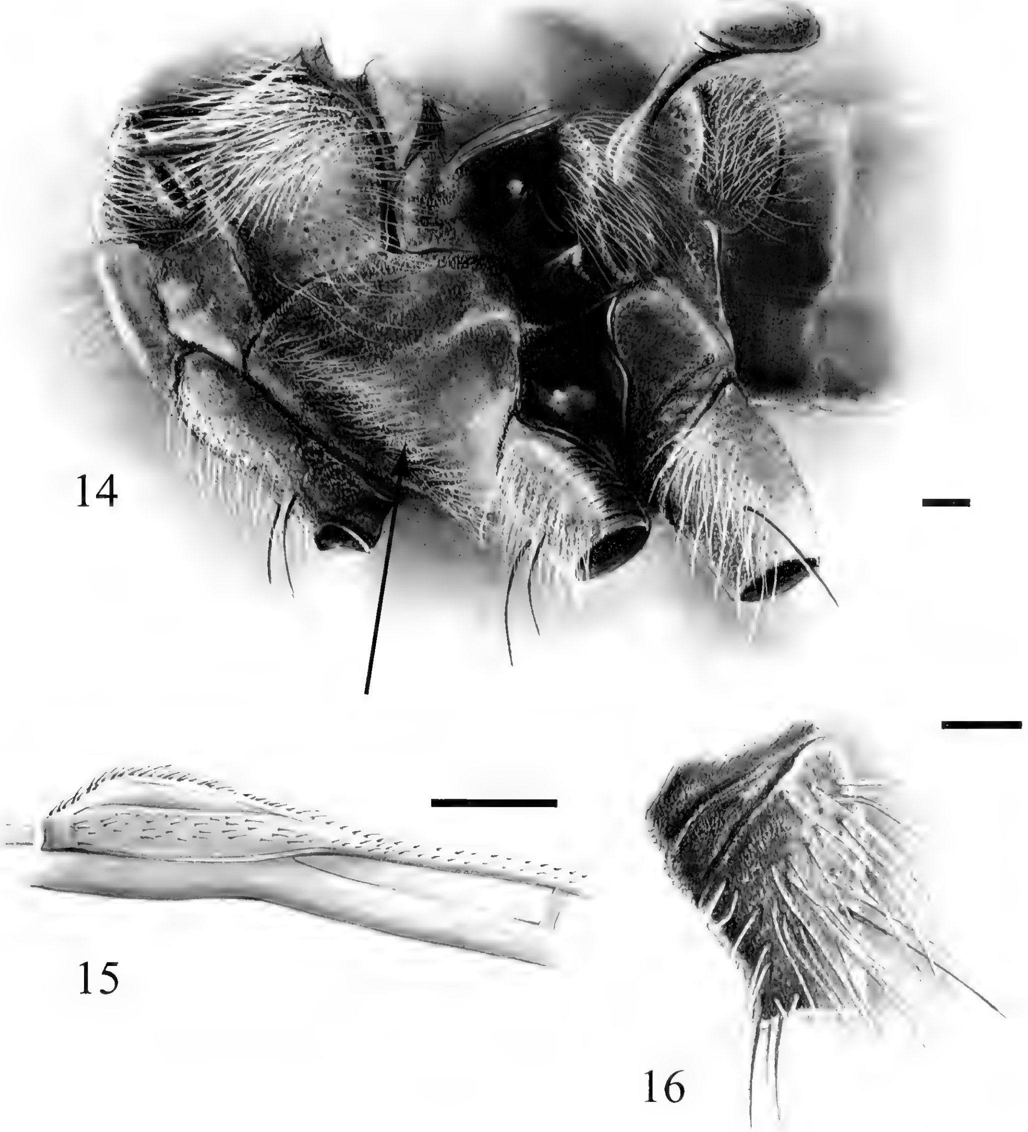
0 normal, not globose
1 globose, bulging

At the antennal insertion, the lower frons bulges slightly in most *Ozodiceromyia* (Fig. 7). As an autapomorphy for *Ozodiceromyia mexicana,* the lower frons is distinctly bulging and globose (Figs. 9–10).

10. Setae of ♂ frons

0 scattered
1 in patches or absent

In many *Ozodiceromyia,* including the outgroup taxon *Ozodiceromyia signatipennis,* the setae on the male frons are scattered (Fig. 11). In the *mexicana*-group and *Ozodiceromyia costalis,* these setae are absent or reduced to small patches located dorsolaterally from the antennal base (Fig. 7).



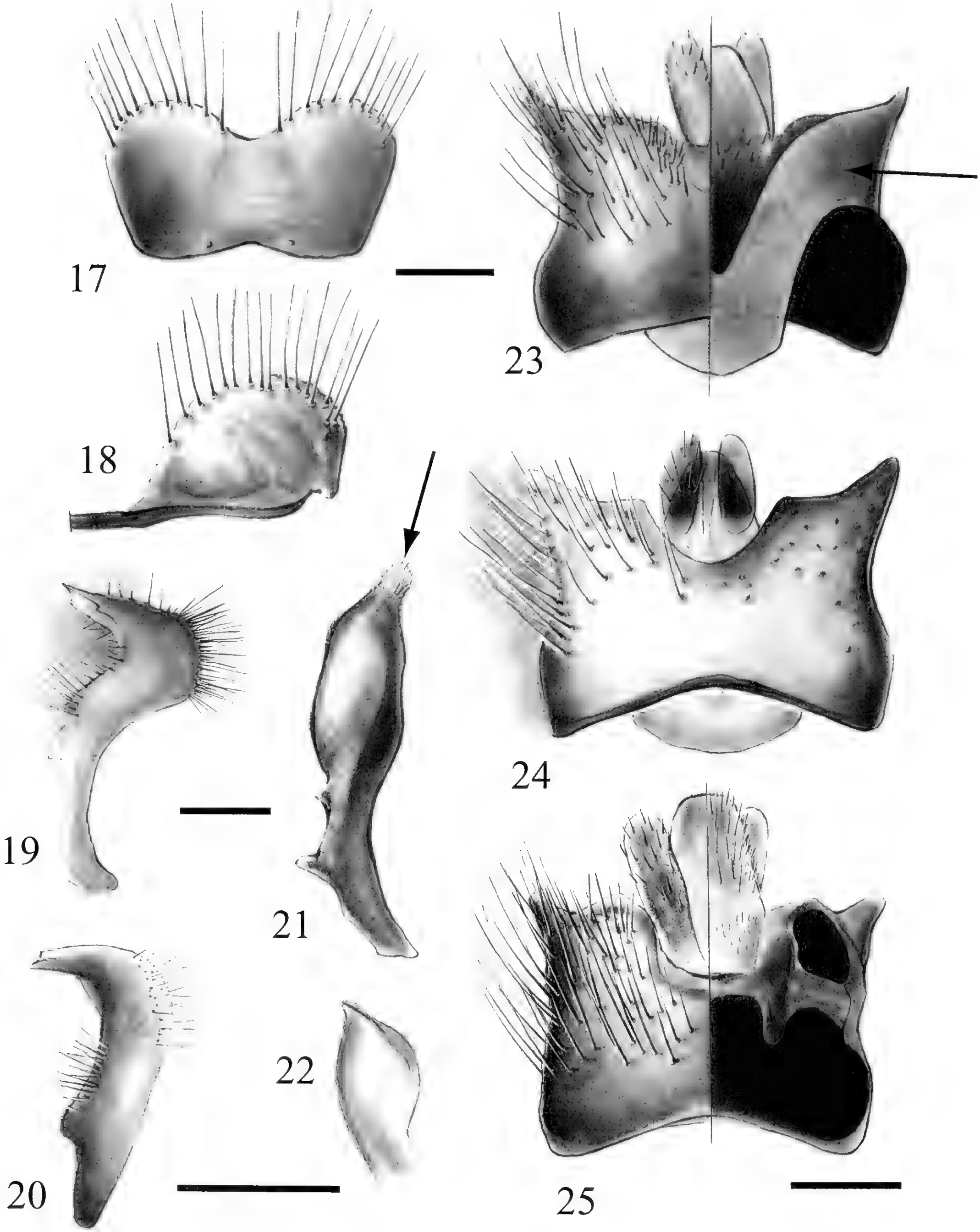
Figs. 14–16. Thorax and associated structures: lateral thorax, ♂, left is anterior (14); basal costal lobe of wing, ♀, left is basal (15); hindcoxa, ♂, left is anterior (16). (14–15) *Ozodiceromyia argentifera* (MEI 037789, 052183); arrow (14) points to katepisternum. (16) *Ozodiceromyia mexicana* (052192). Measure bars, 0.2 mm.

11. Face directly below antenna

0 with full pruinescence

1 shiny, with little or no pruinescence (usually black)

For most *Ozodiceromyia,* the face below the antenna is fully covered with silver pruinescence (Fig. 8). In *Ozodiceromyia costalis* (and several undescribed, putatively related species) and *Ozodiceromyia mexicana,* the face completely lacks pruinescence, or any other vestiture, exposing the black, shiny cuticle (Fig. 9).



Figs. 17–25. ♂ genitalic and pregenitalic structures: 8th sternite (17) and tergite (18); gonostylus (19–20); ventral lobe (21–22); epandrium, split view (left, dorsal; right, ventral) (23, 25), dorsal view (24). (17–19, 23) *Ozodiceromyia argentifera* (MEI 037789); arrow (23) points to subepandrial plate. (20, 22) *Ozodiceromyia signatipennis* (MEI 044750). (21, 25) *Ozodiceromyia mexicana* (MEI 052240); arrow (21) points to pilose, secondary distal lobe. (24) *Ozodiceromyia livdahli* (MEI 038822). Measure bars, 0.2 mm.

THORAX

12. ♂ notal vestiture

0 without decumbent pile
1 with thick decumbent pile

Although decumbent pile on the male notum is present in other members of this genus, and other therevids, its absence is considered plesiomorphic at this level of analysis. The presence of thick, decumbent pile is a synapomorphy for *Ozodiceromyia argentifera* + *Ozodiceromyia livdahli.*

13. Fine, erect setae of ♂ notum

0 some black
1 entirely pale or gold, none black

All taxa studied have fine, erect setae on the male notum. Plesiomorphically, most of these setae are black, although some pale setae may be interspersed. As a synapomorphy for *Ozodiceromyia argentifera* + *Ozodiceromyia livdahli,* all of these fine, erect, notal setae are pale or gold. Note, this does not include the notal macrosetae.

14. Posterolateral surface of hindcoxa

0 lacking pile
1 pilose

Plesiomorphically, the posterolateral surface of the hindcoxa is bare (Fig. 14). As an autapomorphy for *Ozodiceromyia mexicana,* this surface has long, thin pile (Fig. 16). This state is also present in certain other groups within *Ozodiceromyia.*

15. Halter color

0 brown
1 yellow

In most species of *Ozodiceromyia,* the halter is brown. In several groups, including the *mexicana*-group, yellow halter is synapomorphic. The only exception is the brown halter found in *Ozodiceromyia parargentifera,* which is considered an autapomorphy for the species.

16. Wing color

0 clear, or with darkened patches
1 cloudy yellow or orange

Although banded wings are known in *Ozodiceromyia,* clear wings or those with darkened patches along certain wing veins are plesiomorphic at this level of analysis. Only in the *mexicana*-group is the wing entirely cloudy yellow or orange, becoming darkened in the distal third. This is considered an autapomorphy for the *mexicana*-group.

MALE TERMINALIA

17. Parameral sheath texture

0 smooth dorsally
1 with transverse wrinkles dorsally

Plesiomorphically, the parameral sheath of the aedeagus is smooth dorsally (Fig. 32). As an autapomorphy for *Ozodiceromyia mexicana,* the parameral sheath has distinct transverse wrinkles dorsally (Fig. 34).

18. Relative lengths of dorsal and ventral apodemes

0 subequal, or dorsal apodeme longer
1 ventral apodeme longer

The states for this character are described as character 37 in Gaimari and Irwin (2000). The longer ventral apodeme (Fig. 37) is autapomorphic for *Ozodiceromyia parargentifera.*

19. Ventral surface of ventral apodeme

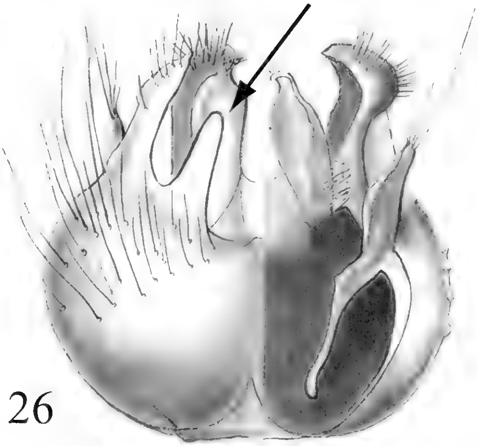
0 without longitudinal keel
1 with longitudinal keel

Most species of *Ozodiceromyia* lack a ventral longitudinal keel on the ventral apodeme. A longitudinal keel is present (Fig. 37) as an autapomorphy for *Ozodiceromyia parargentifera.*

20. Distiphallus length

0 shorter than dorsal apodemes
1 as long or longer than dorsal apodemes

At this level of analysis, having a distiphallus shorter than the dorsal apodemes is considered plesiomorphic (Fig. 38). As an autapomorphy for the *mexicana*-group, the distiphallus is distinctly longer than the dorsal apodemes (Fig. 33).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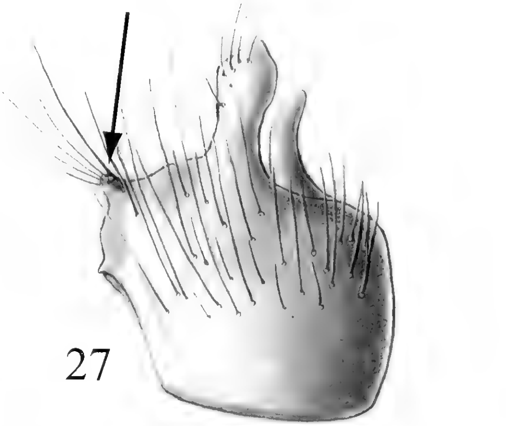
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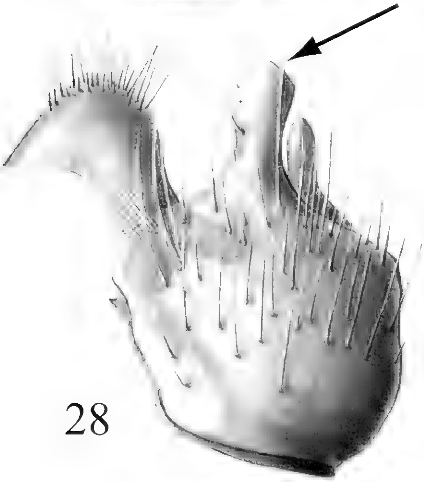
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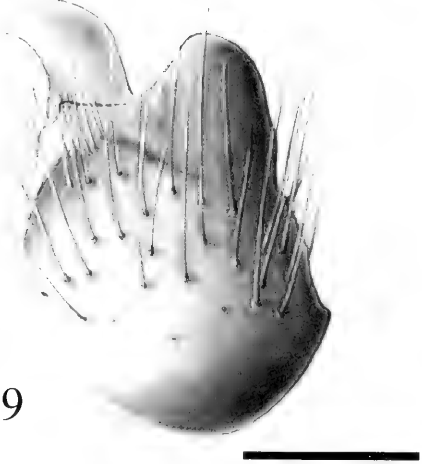
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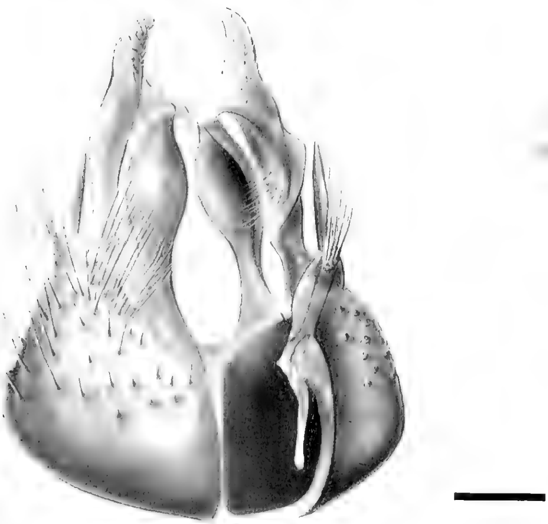
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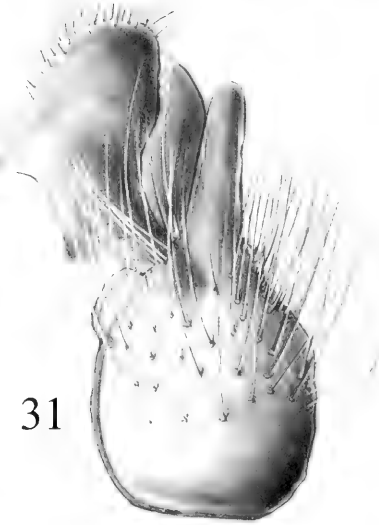
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21. Dorsal part of basal distiphallus

0 with median groove
1 without median groove, rounded

A median, longitudinal groove is present on the dorsal part of the basal distiphallus in the outgroup taxon *Ozodiceromyia signatipennis.* This groove is lacking, and the distiphallus is entirely rounded above in the *mexicana*-group and *Ozodiceromyia costalis.*

22. Basal portion of distiphallus

0 tapering evenly
1 swollen

Plesiomorphically, the basal portion of the distiphallus is not swollen and tapers gradually and evenly to the apex (Fig. 35). As a synapomorphy for *Ozodiceromyia parargentifera + Ozodiceromyia argentifera + Ozodiceromyia livdahli,* this part of the distiphallus is distinctly swollen (Figs. 33, 37).

23. Orientation of distiphallus at apex

0 perpendicular to dorsal apodemes
1 parallel with dorsal apodemes

In both outgroup taxa, the distiphallus is perpendicular to the dorsal apodemes throughout, not recurving anteriorly or posteriorly. As a synapomorphy for members of the *mexicana*-group, the distiphallus recurves anteriorly before its apex, becoming parallel with the dorsal apodemes (Figs. 33, 35). As an autapomorphy for *Ozodiceromyia parargentifera,* the distiphallus loses its curve and becomes perpendicular with the dorsal apodemes (Fig. 37), as in state 0.

24. Subepandrial plate attachment to epandrium

0 laterally and posteriorly
1 laterally only

Plesiomorphically, the subepandrial plate is solidly attached to the epandrium both laterally and posterolaterally (Fig. 23). As an autapomorphy for *Ozodiceromyia mexicana,* the subepandrial plate is greatly reduced, and is only attached to the epandrium through a lateral membranous connection (Fig. 25).

25. Posterolateral corners of epandrium

0 held by subepandrial plate
1 held by sclerotized membrane

The posterolateral corners of the epandrium are held together by the subepandrial plate (Fig. 23), plesiomorphically. As an autapomorphy for *Ozodiceromyia mexicana,* the corners are held by a separate, sclerotized membrane (Fig. 25), apparently not associated with the subepandrial plate.

26. Gonocoxal setae color

0 mostly pale
1 all black

Although this is variable throughout *Ozodiceromyia,* pale gonocoxal setae are plesiomorphic at this level of analysis. Under the accelerated transformation character optimization model, presence of all black setae (Fig. 27) is synapomorphic for the clade of *Ozodiceromyia parargentifera + Ozodiceromyia argentifera + Ozodiceromyia livdahli,* with a subsequent autapomorphic change to pale setae in *Ozodiceromyia livdahli* (Fig. 28)

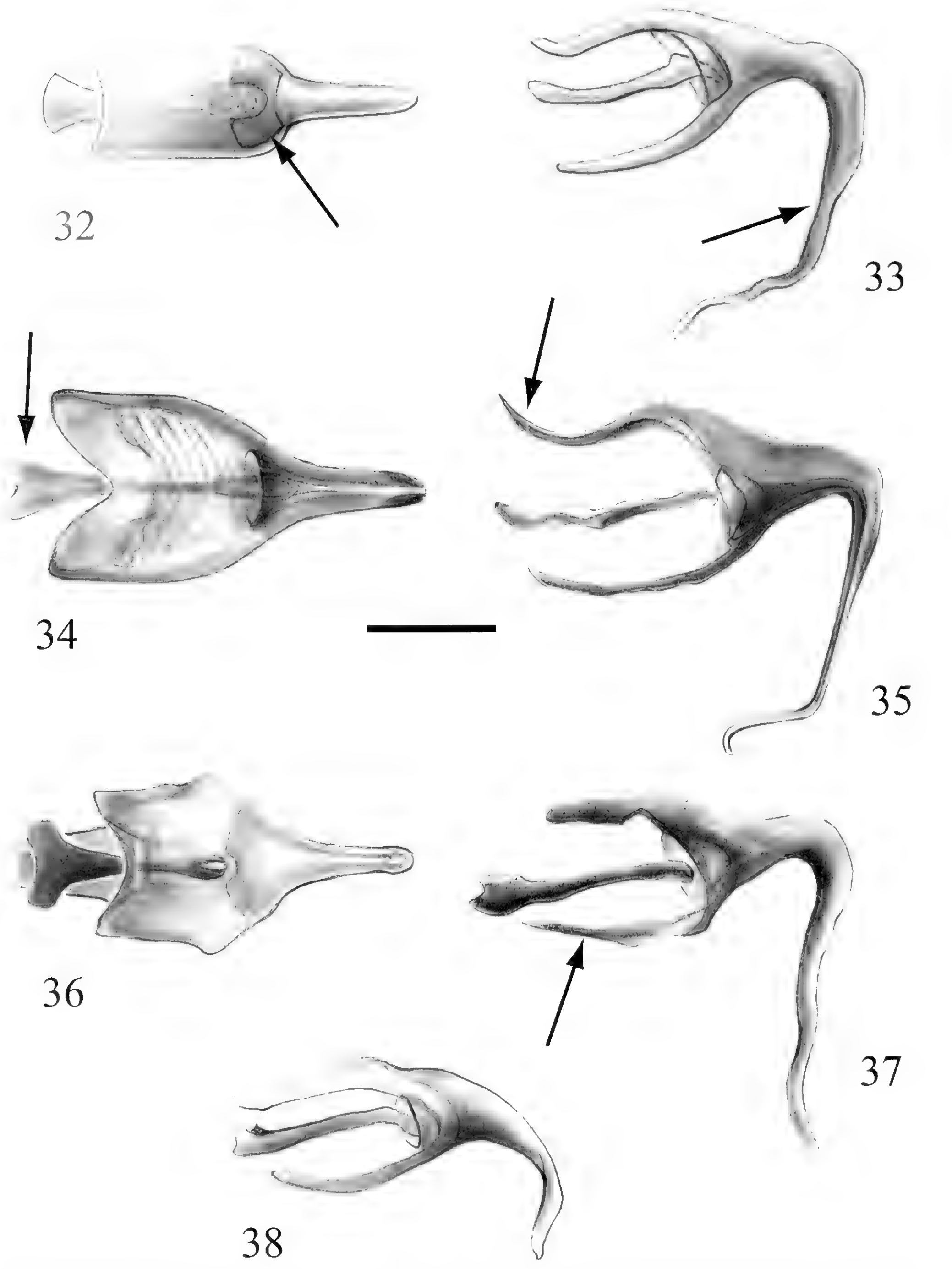
27. Distinct internal keel where gonocoxites fused

0 absent
1 present

At this level of analysis, the lack of a distinct internal keel (visible externally as a groove) where the gonocoxites are fused

←

Figs. 26–31. ♂ gonocoxites and associated structures, split view (left, ventral; right, dorsal) (26, 30), lateral view, gonostylus removed, left is dorsal (27), lateral view, left is dorsal (28–29, 31). (26–27) *Ozodiceromyia argentifera* (MEI 037789); arrow (26) points to ventral gonocoxal process, arrow (27) points to inner gonocoxal process. (28) *Ozodiceromyia livdahli* (MEI 038822); arrow points to outer gonocoxal process. (29) *Ozodiceromyia signatipennis* (MEI 044750). (30–31) *Ozodiceromyia mexicana* (MEI 052240). Measure bars, 0.2 mm.



Figs. 32–38. Aedeagal complex: dorsal view (32, 34, 36); lateral view (33, 35, 37–38). (32–33) *Ozodiceromyia argentifera* (MEI 037789); arrow (32) points to lateral ejaculatory process, arrow (33) points to distiphallus. (34–35) *Ozodiceromyia mexicana* (MEI 052240); arrow (34) points to ejaculatory apodeme, arrow (35) points to dorsal apodeme. (36–37) *Ozodiceromyia parargentifera* (MEI 027017); arrow (37) points to ventral apodeme. (38) *Ozodiceromyia signatipennis* (MEI 044750). Measure bar, 0.2 mm.

(Fig. 26) is plesiomorphic. As an autapomorphy for *Ozodiceromyia mexicana,* this distinct line of fusion is present (Fig. 30).

28. Ventral gonocoxal process

0 absent or only small fold of edge
1 elongated and flanged

Plesiomorphically, the ventral gonocoxal process is absent, or is only a small fold of the edge (Fig. 30). As a synapomorphy for the clade of *Ozodiceromyia parargentifera* + *Ozodiceromyia argentifera* + *Ozodiceromyia livdahli,* the ventral gonocoxal process is present, elongated, and flanged (Fig. 26).

29. Setae of ventral gonocoxal process (including corresponding edge if absent)

0 absent
1 distinctly different from other gonocoxal setae

Plesiomorphically, setae are absent on the ventral gonocoxal process (Fig. 26), or on the corresponding edge if absent. In *Ozodiceromyia mexicana* and *Ozodiceromyia costalis,* the setae are distinctly different from the remaining gonocoxal setae (Fig. 30).

30. Setae of outer gonocoxal process

0 absent
1 present

The outer gonocoxal process is bare of setae (Fig. 31) plesiomorphically. As a synapomorphy for the clade of *Ozodiceromyia parargentifera* + *Ozodiceromyia argentifera* + *Ozodiceromyia livdahli,* there is a small patch of short setae on the dorsolateral portion of the outer gonocoxal process (Fig. 27).

31. Outer and ventral gonocoxal processes

0 fused
1 unfused

The outer and ventral gonocoxal processes are plesiomorphically fused (Fig. 29), as in the outgroup taxon *Ozodiceromyia signatipennis.* These processes are separate and unfused (Figs. 27, 35) in the *mexicana*-group and in *Ozodiceromyia costalis.*

32. Projection on gonocoxal apodeme for articulation with aedeagus

0 absent
1 present

There is no sclerotized connection between the gonocoxal apodeme and the aedeagus in any taxon in this study. *Ozodiceromyia signatipennis* completely lacks any projections on the gonocoxal apodeme. However, in the *mexicana*-group and in *Ozodiceromyia costalis,* there is a medially directed projection of the gonocoxal apodeme (Fig. 30) that provides a site for articulation with the aedeagus.

33. Distal part of ventral lobe

0 bare, or with fine, short pile on outer edge
1 with pilose distal lobe

Most *Ozodiceromyia,* including both outgroup taxa, lack a secondary distal lobe on the ventral lobe (Fig. 22). Only as an autapomorphy for the *mexicana*-group is a finely pilose, secondary lobe present distally on the ventral lobe (Fig. 21).

34. Lobe of gonostylus

0 expanded ventrally into small lobe
1 lobe greatly expanded ventrally

In the more primitive *Ozodiceromyia* (see Gaimari 1998), the gonostylus is strap-like, with no lobe ventrally. More advanced members of the genus have a small lobe on the ventral part of the gonostylus (Fig. 20), which is the plesiomorphic state at this level of analysis. As an autapomorphy for the *mexicana*-group, this lobe is greatly enlarged (Fig. 19).

35. Subapical spur of gonostylus

0 present
1 absent

The states of this character are described as character 56 in Gaimari and Irwin (2000). The subapical spur of the gonostylus is absent in both *Ozodiceromyia* *mexicana* and the outgroup taxon *Ozodiceromyia costalis.* Although this character is quite variable in the genus, the change to state 0 appears to be a synapomorphy for the clade of *Ozodiceromyia parargentifera* + *Ozodiceromyia argentifera* + *Ozodiceromyia livdahli.*

FEMALE TERMINALIA

36. Posterior edge of furca

0 rounded
1 with notch or bend

Plesiomorphically, the posterior edge of the furca is rounded normally, with no notches or bends (Fig. 39). As an autapomorphy for *Ozodiceromyia mexicana,* a distinct, anteriorly directed notch is present (Fig. 41).

37. Medioventral edge of posterolateral furca

0 smooth
1 with small process

Plesiomorphically, there are no medially directed pegs on the inner furcal margin (Fig. 39). As an autapomorphy for *Ozodiceromyia mexicana,* there is a small process, or peg, on the inner ventral edge of the furca on the posterolateral margin (Fig. 41).

38. Space between anterior prongs of furca

0 subequal to greatest furcal width
1 distinctly narrower than greatest furcal width

The space between the anterior prongs of the furca is approximately the same width as the greatest furcal width (Fig. 39), plesiomorphically. As an autapomorphy for *Ozodiceromyia parargentifera,* the width between the anterior prongs of the furca is distinctly narrowed (Fig. 40).

39. Posterior part of furcal bulla

0 normal, not indented
1 indented as cavity to house common spermathecal duct

Plesiomorphically, the posterior part of the furcal bulla us rounded normally. As an autapomorphy for the *mexicana*-group, this posterior margin is distinctly indented as a cavity to house the common spermathecal duct (Fig. 39).

40. Basal part of common spermathecal duct

0 normal width, more or less even throughout length
1 distinctly widened, tapering quickly

The basal part of the common spermathecal duct is plesiomorphically of normal width, more or less even throughout its length, only gradually tapering (Fig. 41). As a synapomorphy for the clade of *Ozodiceromyia parargentifera* + *Ozodiceromyia argentifera* + *Ozodiceromyia livdahli,* the base is distinctly enlarged and widened, tapering quickly to normal width (Fig. 39).

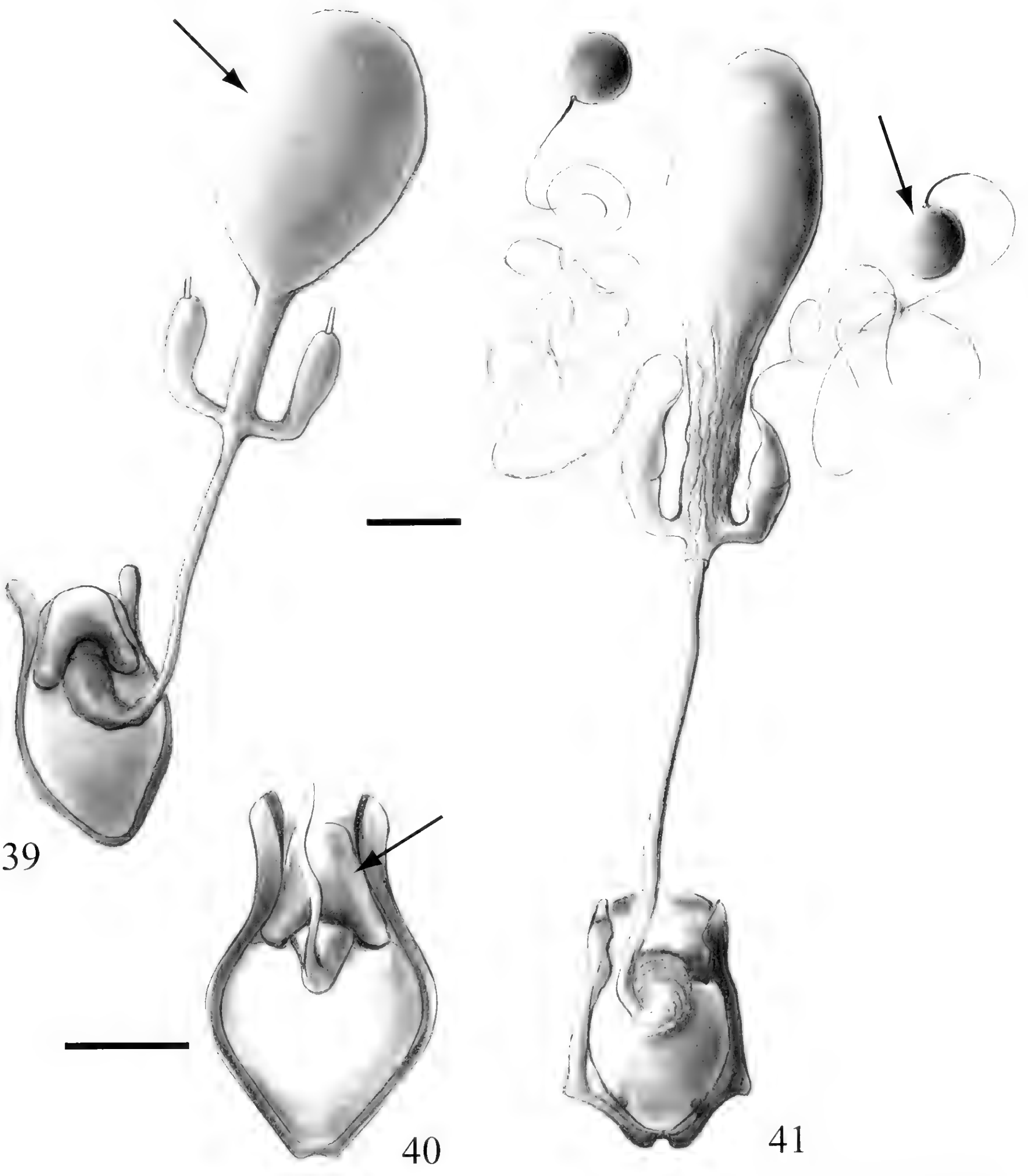
41. Individual spermathecal duct origin

0 from base of central sac
1 from common spermathecal duct

Plesiomorphically, the spermathecal ducts originates from the base of the central sac (Fig. 41). As a synapomorphy for the clade of *Ozodiceromyia parargentifera* + *Ozodiceromyia argentifera* + *Ozodiceromyia livdahli,* the spermathecal ducts originate on the common spermathecal duct, with a short duct then leading to the central sac (Fig. 39).

RESULTS AND DISCUSSION

Cladistic analysis.—The analysis produced a single most parsimonious tree (Fig. 5) of length 47, Consistency Index (Kluge and Farris 1969) of 0.87 (0.80 excluding autapomorphies), Retention Index (Farris 1989) of 0.81, and Rescaled Consistency Index (Farris 1989) of 0.71. The topology remained stable through successive weighting (Farris 1969; Carpenter 1988, 1994), implemented by PAUP by reweighting all characters on a base weight of 1,000 by the maximum values of their Rescaled Consistency Indices, leveling out at a single iteration. After this single iteration, the tree statistics above were all 0.97 or higher. Because the expected amount of homoplasy



Figs. 39–41. ♀ reproductive structures: furca (dorsal view) through central sac and basal part of spermathecal ducts (both spermathecal ducts truncated basally) (39); furca (dorsal view) with truncated common spermathecal duct (40); furca (dorsal view) through central sac and spermathecae (41). (39) *Ozodiceromyia argentifera* (MEI 052230); arrow points to central sac. (40) *Ozodiceromyia parargentifera* (MEI 027022); arrow points to furcal bulla. (41) *Ozodiceromyia mexicana* (MEI 070426); arrow points to spermatheca. Measure bars, 0.2 mm.

increases with the number of taxa in a parsimony analysis, the regression equation of Sanderson and Donoghue (1989) was used to calculate the expected value for the Consistency Index. The calculated value of 0.78 for 6 taxa is lower than the value indicated in the current analysis, excluding autapomorphies, so the amount of homoplasy is less than expected for an analysis with this number of taxa under the 1989 model. The relatively high Retention Index indicates that a high proportion of the potential synapomorphies in the data matrix are present as homologies on the cladogram.

Bremer support (aka, decay analysis) may reflect the robustness of certain elements of the resulting cladograms (Bremer 1988, Donoghue et al. 1992, Källersjö et al. 1992). A decay analysis entails calculating the difference in tree length between the most parsimonious tree and the shortest tree which lacks each nodal group. This reflects how much additional evidence, in the form of characters supporting an alternative grouping, would be necessary to overthrow a clade in the most parsimonious hypothesis. Using AUTODECAY (Eriksson 1997, currently in version 2.9.9) in combination with PAUP, Bremer support indices were calculated for each nodal group in the cladogram. Following Gaimari and Irwin (2000), Bremer support indices were also calculated using the successively reweighted data, and were rescaled per the procedure outlined by Bremer (1994). The resulting Bremer support indices for each node are displayed on the cladogram in Fig. 6. The Bremer support values are an indication of the number of characters in opposition to the current topology that would be necessary to break down the individual nodes of the tree. Justification for excluding perturbation (e.g., bootstrap, jackknife) and permutation (PTP, T-PTP) based methods to assess branch support is provided by Gaimari and Irwin (2000).

Classification.—The internal classification of the Therevidae has only recently begun to receive attention. Not until recently (Irwin and Lyneborg 1981a) was the family formally divided into two subfamilies, Therevinae and Phycinae. More recently, Gaimari and Irwin (2000) defined and proposed a phylogenetic classification for genera of Cyclotelini, including *Ozodiceromyia,* and Gaimari (1998) defined putative species-groups within the genus, including the *mexicana*-group as defined herein.

Table 3. Classification for the species of the *Ozodiceromyia mexicana*-group.

Cyclotelini Gaimari and Irwin, 2000
  Ozodiceromyia Bigot, 1890
    Ozodiceromyia ''*mexicana*-group''
      O. mexicana Bigot, 1890
      O. parargentifera, n. sp.
      O. argentifera (Kröber 1929)
      O. livdahli, n. sp.

According to the cladogram, the Bremer support index of 7 additional steps for the clade, and the rescaled Bremer support index of 13 additional steps, the *Ozodiceromyia mexicana*-group appears well supported by autapomorphies. This hypothesis will be most thoroughly tested in the phylogenetic analysis of the entire genus underway. The classification in Table 3 is presented as a phyletic sequence of taxa (Nelson 1969, 1972, 1973) within this small group of *Ozodiceromyia.* The group will be classified within the larger context of the entire genus with the pending revisionary work underway.

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REVIEW OF THE ASIAN SAWFLY GENUS *ANISOARTHRA* CAMERON (HYMENOPTERA: TENTHREDINIDAE)

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Abstract.—*Anisoarthra* Cameron includes three species, *A. coerulea* Cameron from India and Sri Lanka, *A. diascoreae* (Rohwer), **n. comb.**, from India, and *A. birmanica* (Malaise), **n. comb.**, from Burma and India (new record). The species are described and illustrated, and a key is provided. *Anisoarthra diascoreae* feeds on yam, *Dioscorea* sp. (Dioscoreaceae).

Key Words: India, Sri Lanka, Burma, *Dioscorea,* Dioscoreaceae, Blennocampinae, *Senoclia*

Species of *Anisoarthra* are relatively large, mostly metallic bluish-black or violaceous sawflies of the subfamily Blennocampinae. A characteristic, shared with several other genera of the subfamily, is the comblike, four- or five-toothed tarsal claws. The three species of the genus occur only in southern Asia—Burma, India, and Sri Lanka. Yam, *Dioscorea* sp., is a host plant for *Anisoarthra diascoreae* (Rohwer). A species in a related genus in the Blennocampinae, *Senoclidia purpurata* (Smith), is known to be a pest of yam in Papua New Guinea (Szent-Ivány 1974). Since yam is an important food plant in the tropics and is distributed by commerce, it is important to know and be able to recognize its potential pests.

Here we redescribe the species of *Anisoarthra* and give a key for their separation.

The National Museum of Natural History, Smithsonian Institution, Washington, D.C., is designated as USNM; Zoological Department, Punjabi University, as ZDPU; and Canadian National Collection, Ottawa, as CNC.

Anisoarthra Cameron

Anisoarthra Cameron 1876: 461. Type species: *Anisoarthra coerulea* Cameron. Designated by Rohwer 1911.

Senoclia Cameron 1877: 88 (unnecessary new name for *Anisoarthra* Cameron).—Rohwer 1921: 105 (new species; key to species).—Malaise 1937: 50 (separation from *Neoclia* Malaise; new species from Burma; key to species).—Benson 1938: 367 (in Senocliini).—Malaise 1964: 20 (*Anisoarthra* not preoccupied and is correct name for the genus).

Description.—Antenna covered with appressed hairs; scape about 2× longer than broad, pedicel as long as broad, 3rd and 4th segments subequal in length, each a little dilated at apices; 5th segment dilated at apex and little longer than 4th; 6th segment about ¾ length of 5th, dilated at apex; 7th segment shorter than 6th; apical two segments each slightly shorter than 7th (Fig. 2). Clypeus smooth, truncate or with slightly rounded anterior margin; malar space linear to less than half diameter of front ocellus; genal carina absent. Epicnemium absent. Mesoscutellum raised, conspicuous, smooth and shining. Forewing (Fig. 1) with vein M and Rs+M meeting before attaining Sc+R; vein 2A+3A furcate or curved up at its apex, furcation sometimes faint; 4 cubital cells. Hindwing (Fig. 1) with one middle cell; petiole of anal cell as long as cell. Tarsal claws comblike, with 4–5 teeth, if with 4 teeth, then acute basal lobe present (Figs. 3–5). Male penis valve with long apical filament (Fig. 12).

Remarks.—The comblike tarsal claws are characteristic of several other genera of Blennocampinae, such as *Neoclia* Malaise and *Brykella* Malaise, but *Anisoarthra* may be separated by the venation of the forewing (vein M and RS+M meeting before attaining Sc+R; vein 2A+3A curved up or furcate at its apex) and hindwing (petiole of anal cell about half as long as cell), absence of a genal carina, and absence of an epicnemium. The long apical filament of the male penis valve does not occur in other known Asian Blennocampinae and appears unique to *Anisoarthra.*

Much of the literature pertaining to this genus has been under the name *Senoclia* Cameron, an unnecessary replacement name for *Anisoarthra.* Cameron (1876) originally included two species, *A. coerulea* and *A cyanella* from Ceylon. Though the type of *Anisoarthra cyanella* is probably lost, strong indications are that it belongs to *Senoclidea* Rohwer and that it is not from Ceylon as given in the original description (see discussion by Smith 1982). In fact, hidden in a footnote, Cameron (1877) stated "I am told by Mr. F. Smith that the locality for *Senoclia cyanella* (*l.c.* p. 462) is New Gunea, and not Ceylon." Consequently, we do not include *A. cyanella.* Rohwer (1921) added two species from India, one of which was synonymized with *A. coerulea* by Smith (1982), and gave a key to three species. Malaise (1937) added a species from Burma and gave a key to species. Malaise did not examine types and based separation of Rohwer's species on the literature.

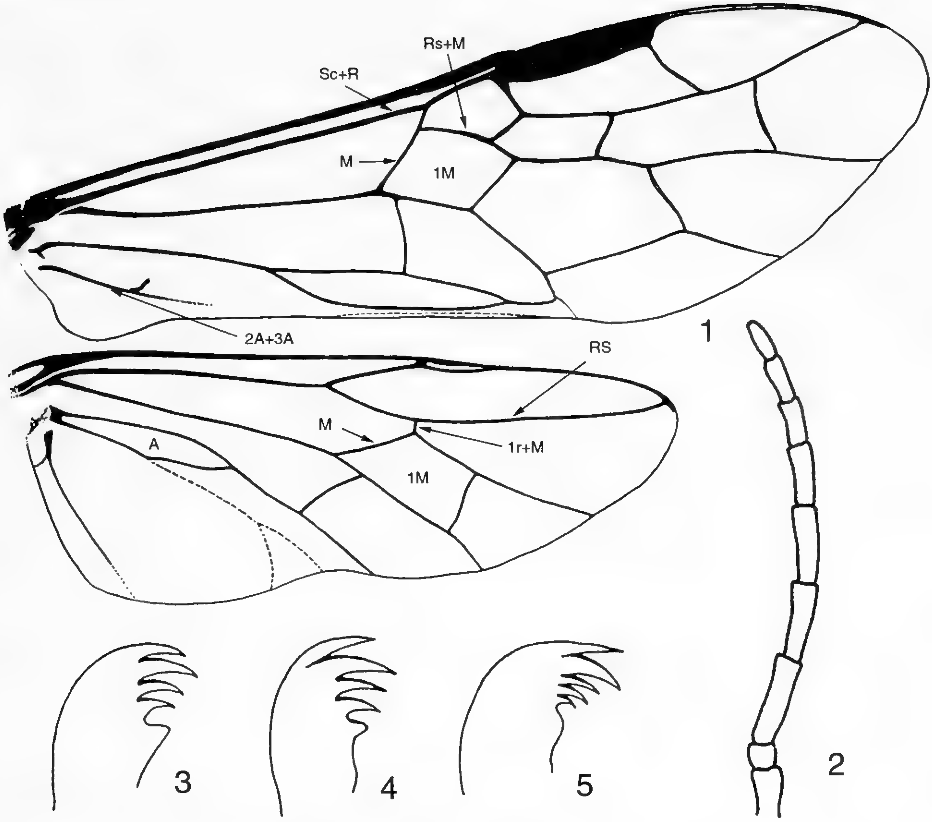
Benson (1938) placed *Anisoarthra* (mentioned as *Senoclia*) in the tribe Senocliini of the Blennocampinae. The tribe included a small group of Austro-Oriental genera (*Kampongia* Malaise, *Neoclia* Malaise, *Nesotomostethus* Rohwer, and *Anisoarthra*) separated from other Blennocampinae by the point of fusion between veins M and 1r-m of the hindwing which reaches to or very close to Rs, vein M of the forewing arising from vein Rs+M. *Nesotomostethus* is separated from *Anisoarthra* by the three-toothed tarsal claws with a basal lobe and presence of an epicnemium. *Kompongia* is separated by the two-toothed tarsal claws with a basal lobe and cell M absent in the hindwing.

KEY TO SPECIES OF *ANISOARTHRA*

1. Forewing darkly, uniformly infuscated; legs black; tarsal claws with 4 teeth and a basal lobe (Fig. 3) . . . . *A. coerulea* Cameron
– Forewing not completely infuscated, approximately basal half hyaline; bases of tibiae or most of tibiae and extreme apices of femora with a whitish or brownish spot; tarsal claws with 4 or 5 teeth (Figs. 4–5) 2
2. Tarsal claws with 4 distinct teeth and a distinct triangular basal lobe (Fig. 4); supraclypeal area flat; labrum black; lateral furrows on head parallel; postocellar area broader than long, as 4:3; about ⅙ or less of bases of tibiae whitish to brownish; foretibial spur furcate at apex; male hypopygium truncate with slight notch at center . . . . *A. diascoreae* (Rohwer)
– Tarsal claws with 5 distinct teeth, basal lobe indistinct, rounded (Fig. 5); supraclypeal area triangularly roundly raised; labrum brownish to white; lateral furrows diverging posteriorly; postocellar area broader than long, as 3:2; basal ½ or foretibia, midtibia except extreme apex, and basal ⅖ hind tibia white; foretibial spur simple; male hypopygium convex, rounded . . . . *A. birmanica* (Malaise)

Anisoarthra coerulea Cameron
(Figs. 3, 8)

Anisoarthra coerulea Cameron 1876: 462 (♀, ♂).—Smith 1982: 188, figs. 1, 9 13 (♀, ♂, Sri Lanka; syn.: *bilanga* Rohwer). *Senoclia coerulea*: Kirby 1882: 181, pl. 8,



Figs. 1–5. 1, *Anisoarthra diascoraea,* forewing and hindwing. 2, *A. diascoraea,* antenna. 3–5, Tarsal claws. 3, *A. coerulea.* 4, *A. diascoraea.* 5, *A. birminaca.*

fig. 21; Dalla Torre 1894: 186; Rohwer 1921: 105 (in key).—Malaise 1937: 52 (in key; as *caerulea*).

Senoclia bilanga Rohwer 1921: 106 (♀, ♂).

Senoclia caerulea var. *bilanga*: Malaise 1937: 52.

Female.—Length, 9.0–11.0 mm. Bluish black with metallic hue. Forewing darkly, uniformly infuscated; hindwing lightly infuscated; veins and stigma dark brown.

Antennal length shorter than abdomen, 2× head width. Clypeus with anterior margin truncate to slightly rounded; labrum broader than long, as 2:1, with deflexed and roundly pointed anterior margin; supraclypeal area triangularly raised; inner margins of eyes converging below with lower interocular distance to interocular distance at level of front ocellus to eye length as 4:5: 4; malar space linear; head in lateral view with frontal area almost on same level as eyes and supraantennal tubercles moderate, sloping backwards and confluent with low frontal ridges; median fovea prominent, ditchlike on anterior half and shallow posteriorly, reaching median ocellus; postocellar area convex, broader than long, as 3:2; temple lateral to lateral ocellus flat; post-, inter-, and circumocellar furrows distinct; lateral furrows distinct, deep, parallel and abruptly ending well before posterior margin of head; head from above narrowing behind eyes; postocellar, ocello-occipital, oculo-ocellar, and oculo-occipital distances subequal. Mesoscutellum convex, appendage not carinated or grooved; distances between cenchri to distance between tegulae as 1:5. Tarsal claws comblike with 4 distinct teeth and triangular basal lobe (Fig. 3); foretibial spur furcate at apex; hind basitarsus longer than following 3 segments combined, as 7:5; hind tibial spurs subequal in length, length of inner tibial spur to apical width of hind tibia to outer apical tibial spur length as 3:2:2. Lancet similar to Fig. 6, with 22 serrulae. Sheath short, in lateral view with dorsal margin bent down apically (Fig. 8).

Head with sparse, minute, irregular punctures, surface shining; mesonotum and mesepisternum with minute, scattered punctures, surface shining with general oily luster; mesoscutellum and appendage impunctate, surface polished; abdomen impunctate, surface subshining. Body covered with mixed metallic blue and silvery pubescence.

Male.—Length, 9.0–10.0 mm. Similar to female. Hypopygium truncate with slight notch at center. Genitalia similar to Figs. 11, 12.

Types.—The lectotype ♀ of *A. coerulea,* designated by Smith 1982, is in The Natural History Museum, London, labeled "Type, H.T."; "B.M. Type Hym. 1.363"; "B.M. Type, Hym. Anisoarthra coerulea (Cameron, 1876)"; "Ceylon"; "Kby. p. 8. f. 21."

The holotype of *Senoclia bilanga,* a ♀, is in the USNM, labeled "Kollegal, 2,000 feet (about 606 meters), Coimbatoire, S. India, 1-IX-17, Ramakrishna."

Specimens examined.—INDIA: Tamil Nadu, Kollegal (Coimbatoire), 600 m, 25.9.1917; Kollegal, 2,000 ft., 1-IX-17, Ramakrishna, coll. (♂ allotype of *S. bilanga,* USNM); Nilgiri Hills, Kallar, 1,250 ft., South India, Oct. 1955, P.S. Nathan. SRI LANKA: North Central Province; North Western Province; Central Province (see Smith 1982 for records).

Distribution.—India (Tamil Nadu); Sri Lanka.

Host.—Unknown.

Remarks.—The uniformly infuscated wings, entirely bluish black legs, short antennal length (2 times the head width), and 4-toothed tarsal claws with a basal lobe will separate this species from both other species of *Anisoarthra.* The female lancet and male genitalia are ver similar to those illustrated for S. diascoreae (Figs. 6, 11–12).

Rohwer (1921) distinguished *bilanga* because of differences he observed in the male. The females he had were identical to *A. coerulea.* The characters he used were the uniformly infuscate wings and the head more distinctly punctured and with stronger antennal furrows. We do not see these differences in the males examined.

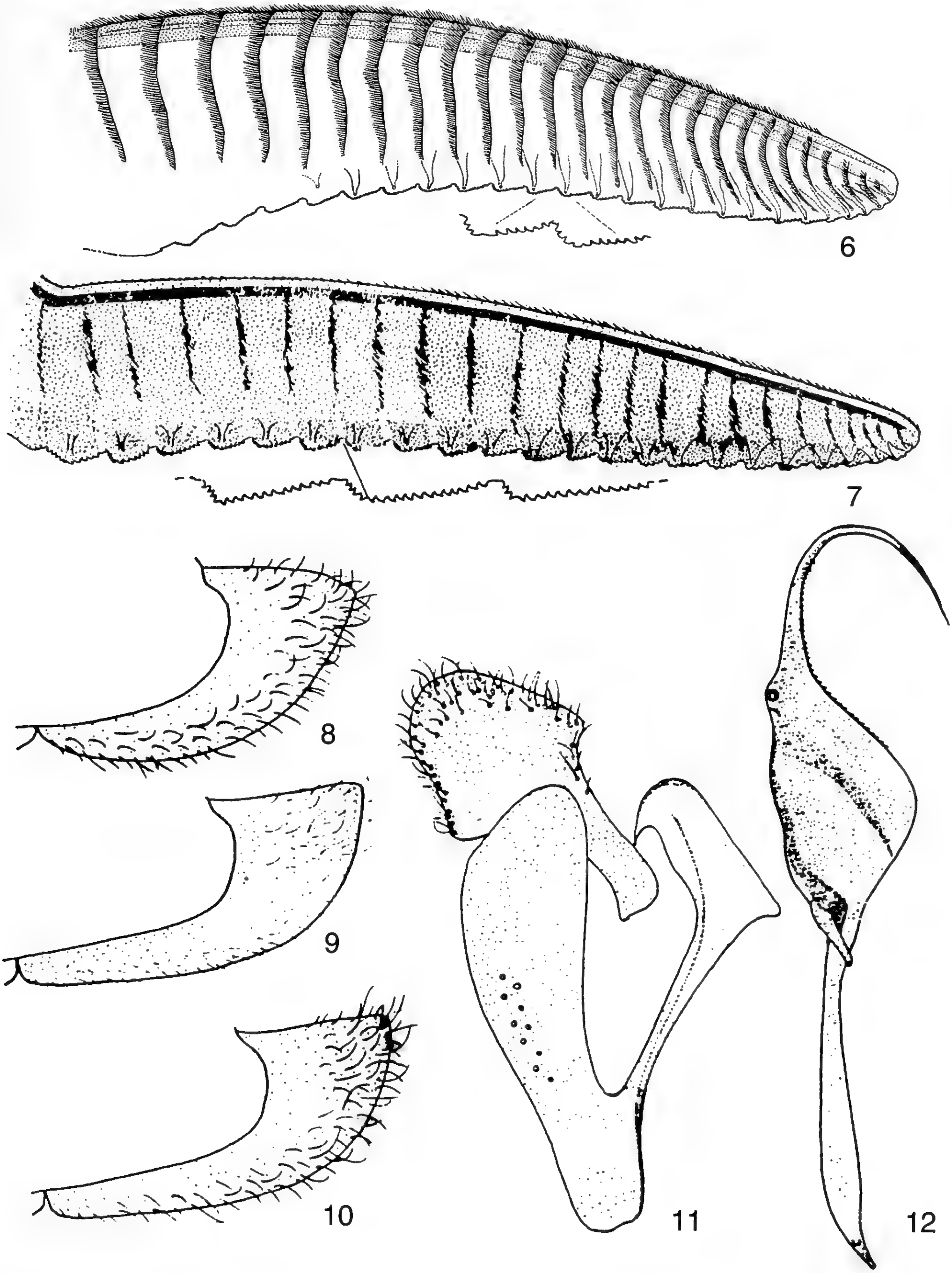
Anisoarthra diascoreae (Rohwer), **new combination**

(Figs. 1, 2, 4, 6, 9, 11–12)

Senoclia diascoreae Rohwer 1921: 105 (f, m).—Malaise 1937: 51 (in key).

Female.—Length, 10.0–11.5 mm. Bluish black with metallic hue; basal ⅙ or less of tibiae and small spot on apices of femora brownish to whitish. Wings darkly infuscated beyond proximal end of cell 1M in forewing and hindwing; rest of wings hyaline; veins and stigma dark brown to black.

Antennal length equal to abdomen length, subincrassinate in middle, 2.4× head width; clypeus truncate; labrum broader than long, as 2:1, with deflexed roundly pointed anterior margin; supraclypeal area almost flat; inner margins of eyes converging below, lower interocular distance to interocular distance at front ocellus to eye length as 7:9:8; malar space about half diameter of front ocellus; head in lateral view with frontal area though prominently raised still slightly below level of eyes and supraantennal tubercles slightly indicated and confluent with roundly raised frontal ridges; median fovea prominent, ditchlike on anterior half and shallow posteriorly, reaching median ocellus; postocellar area convex, broader than long, as 4:3; temples lateral to lateral ocelli depressed, post-, inter-, and circumocellar furrows distinct; lateral furrows distinct, deep, parallel and abruptly ending well before posterior margin of head; head from above parallel behind eyes;



Figs. 6–12. 6, Lancet of *Anisoarthra diascoreae*. 7, Lancet of *A. birmanica*. 8, Female sawsheath of *A. coerulea*. 9, Female sawsheath of *A. diascoreae*. 10, Female sawsheath of *A. birmanica*. 11, Ventral view of genital capsule of *A. diascoraea*. 12, Lateral view of penis valve of *A. diascoraea*.

postocellar, ocello-occipital, oculo-ocellar, and oculo-occipital distances as 4:7:7:5. Mesoscutellum subconvex with faintly indicated lateral carina; mesoscutellar appendage neither carinated or grooved; distance between cenchri to distance between tegulae as 2:9. Tarsal claws with 4 distinct teeth and triangular basal lobe (Fig. 4); foretibial spur furcate at apex; hind basitarsus longer than 3 following segments combined, as 5:4; length of inner tibial spur to apical width of hind tibia to outer apical tibial spur length as 5:3:4. Lancet as in Fig. 6, with 22 serrulae. Sheath in lateral view long wit dorsal margin slightly curved upward (Fig. 9).

Head with shallow and scattered punctures, surface shining, mesonotum with minute, scattered punctures, surface shining; mesoscutellum with conspicuous punctures on posterior slope, surface polished; mesoscutellar appendage impunctate, polished; mesepisternun and mesosternum punctured like mesonotum, surface shining with general oily luster; abdomen shining with some scattered and minute punctures. Body covered with mixed metallic blue and silvery pubescence.

Male.—Length, 9.0–10.0 mm. Similar to female except antennal segments 7–9 and extreme apices of femora brownish. Malar space linear; postocellar area broader than long, as 3:2. Hypopygium truncate, with shallow notch at center. Genitalia as in Figs. 11–12.

Types.—The holotype ♀ is in the USNM, labeled "N. Malabar, Taliparamba, India"; "on pepper vine June '18." Allotype and paratypes in USNM; paratypes in the Zoological Survey of India, Calcutta.

Specimens examined.—INDIA: Kerala, Poonnudi Range (Trivandrum), 3,000 ft, May 1972; South Canara Dt., Kollar Ghat, 3000 ft., 18-21-IX-18, T.V.R. (1 ♀ paratype, USNM); N. Malabar, Taliparamba, July–Aug. 1918, P.S. Nathan (♂ allotype, USNM), same data, 16-26-IX-18, Ramakrishna, coll. (1 ♂ paratype, USNM); Ammatti, Coorg, S. India, May 1951, P.S. Nathan; Nilgiri Hills, S. India, 3,500 ft., May 1950, P.S. Nathan.

Distribution.—India (Kerala).

Host.—Rohwer (1921) stated adults were bred "on a creeper, Diascorea," probably a misspelling for *Dioscorea* sp. (Dioscoreaceae). An adult was collected "on pepper vine" (? black pepper, *Piper nigrum* L. [Piperaceae]).

Remarks.—The tarsal claws with 4 teeth and a distinct triangular basal lobe, whitish to brownish bases of tibiae and extreme apices of femora, hyaline basal half of forewing, furcate foretibial spur, postocellar area broader than long, and antennal length 2.4 times head width, will separate this species from other species of *Anisoarthra.*

Anisoarthra birmanica (Malaise), **new combination**
(Figs. 5, 7, 10)

Senoclia birmanica Malaise 1937: 51 (f).

Female.—Length, 12.0–13.0 mm. Bluish-black with metallic hue antenna, labrum, extreme apex of forefemur, basal half of foretibia, midtibia except extreme apex, and basal ⅖ of hind tibia whitish to light brownish. Forewing and hindwing deeply infuscated beyond proximal end of cell 1 M and infuscation linearly extending to base of wings covering entire anal cell; veins and stigma dark brown to black.

Antennal length equal to abdomen length; subincrassinate in middle, 3.2× head width. Clypeus truncate; labrum broader than long as 2:1 deflexed and roundly pointed anteriorly; supraclypeal area subtriangularly roundly raised; inner margins of eyes converging below, lower interocular distance to interocular distance at level of front ocellus to eye length as 3:4:3; malar space linear; head in lateral view with frontal area almost at level of eyes and supraantennal tubercles significant with steep posterior slope and meeting low lying frontal ridges; median fovea prominent on anterior half and shallow posteriorly, reaching median ocellus; frontal area anterior to median ocellus conspicuously depressed, thus forming humplike raised projection between depression and median fovea; postocellar area convex, broader than long, as 3:2; temples lateral to lateral ocelli subconvex; post-, inter-, and circumocellar furrows distinct; lateral furrows quite distinct, deep, diverging backwards and abruptly ending well before hind margin of head; head from above parallel behind eyes; postocellar, ocello-occipital, oculo-ocellar, and oculo-occipital distances as 4:4:5:4. Mesoscutellum subconvex, its appendage neither carinated nor grooved; distance between cenchri to distance between tegulae as 1:5; tarsal claws comblike with 5 teeth and indistinct rounded basal lobe (Fig. 5); foretibial spur simple, hind basitarsus longer than following 3 segments combined, as 5:4; length of inner tibial spur to apical width of hindtibia to outer apical tibial spur length as 5:3:4. Lancet as in Fig. 7, with 21 serrulae; sheath in lateral view long with dorsal margin slightly curved up apically (Fig. 10).

Head with dense, irregularly spaced, prominent punctures and surface between punctures microsculptured, surface shining; mesonotum with dense, irregular, minute punctures, surface shining; mesoscutellum with distinct, irregular, scattered punctures, more conspicuous on its posterior slope, surface polished; mesoscutellar appendage impunctate, polished; mesepisternum and mesosternum with few, scattered micropunctures, surface shining with general oily luster; abdomen impunctate, shining. Body covered with mixed blackish and metallic blue pubescence.

Male.—Length, 10.0–11.0 mm. Similar to female. Hypopygium truncate at apex. Genitalia similar to Figs. 11–12.

Types.—Described from 2 ♀, deposited in the Naturhistoriska Riksmuseet, Stockholm, Sweden. From Burma (Taungdo at the south end of Inle Lake in southern Shan States, alt. 900 m, 19.IX.1934) (Malaise 1937).

Specimens examined.—INDIA: Assam, Shillong, 1,450 m, 7.6.1943 (ZDPU; Assam, Kameng, Bokhar, 28-V-61, 2,500′ (CNC).

Distribution.—Burma; India (Meghalaya).

Host.—Unknown.

Remarks.—The mostly whitish to brownish tibiae, whitish extreme apices of the femora, hyaline basal half of forewing and hindwing, triangularly raised supraclypeal area, 5-toothed tarsal claws with and indistinct rounded basal lobe, white labrum, and simple foretibial spurs will separate this species from other species of *Anisoarthra.* We did not examine the types. Malaise's (1937) description is sufficient to characterize this species. A series of three females and three males from Kameng, Assam associate the sexes.

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CHESPIRITOS, A NEW GENUS OF LIMOSININAE (DIPTERA: SPHAEROCERIDAE) FROM COSTA RICA

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Abstract.—***Chespiritos sindecimus*** **new genus, new species,** is described from specimens taken in decaying bromeliads in Costa Rica. The relationship of *Chespiritos* to other Limosininae is discussed.

Key Words: Diptera, Sphaeroceridae, Costa Rica, taxonomy

Chespiritos sindecimus new genus, new species, was collected around the leaf-bases of wind-downed bromeliads at 2,400 m in the Rio Macho reserve, Costa Rica. Most of the bromeliads examined were found to contain specimens of this new species, as well as specimens of an unidentified *Pterogramma* Spuler.

Terminology in this paper follows Marshall and Langstaff (1998). Terms used for the same structures in other recent papers on Sphaeroceridae are indicated in parentheses.

Chespiritos Marshall, new genus

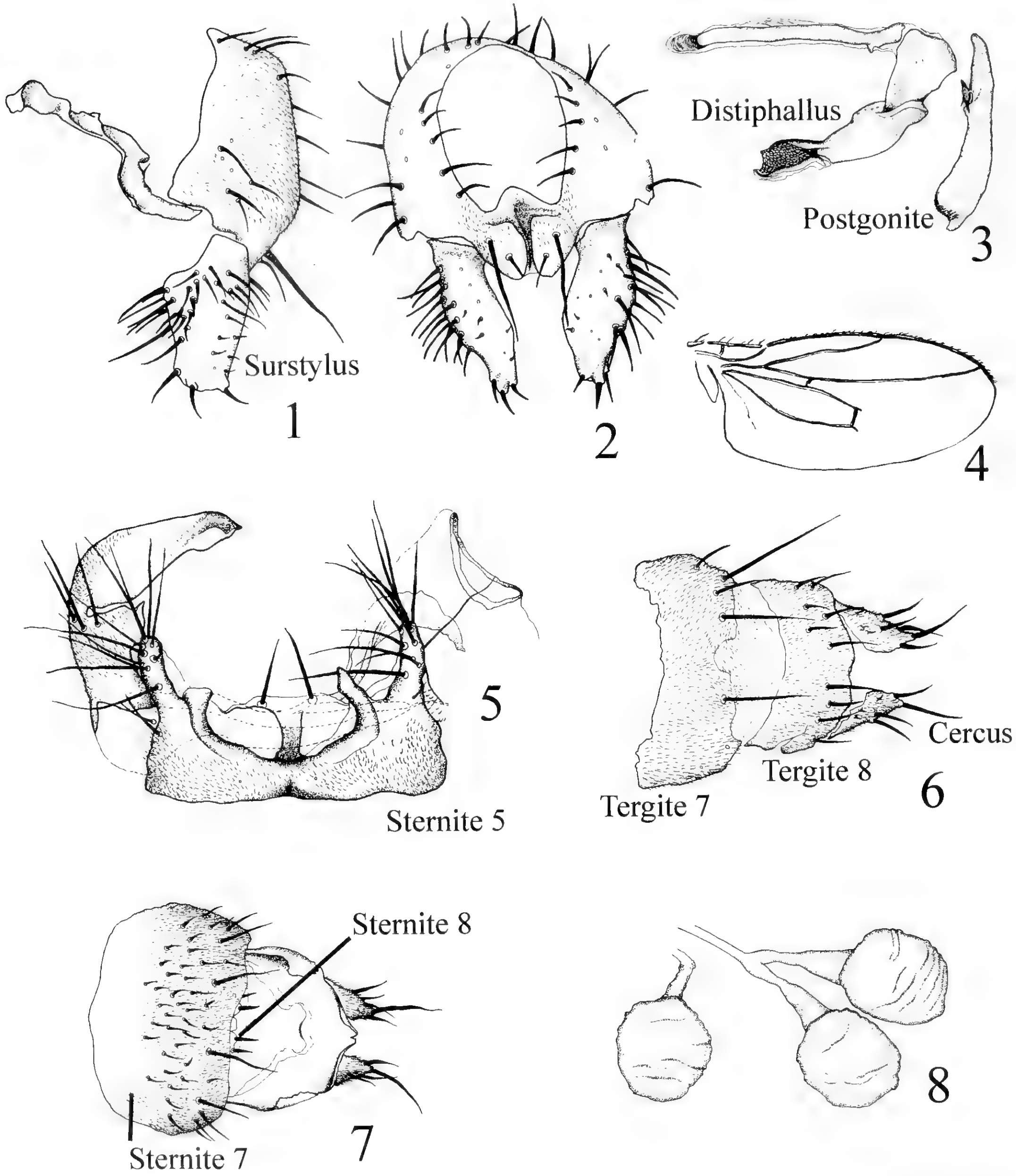
Type species.—*Chespiritos sindecimus,* new species.

Diagnostic characters and similar genera.—*Chespiritos* stands out as a distinct genus because of its broad head with a large and exposed clypeus, two pairs of large interfrontal bristles, six scutellar bristles, distinctive male genitalia, and the complete lack of a tenth tergite in the female. The most closely related genus is probably *Sclerocoelus* Marshall, with the broad lunule and well-developed intra-alar bristles providing some evidence for this relationship. *Chespiritos,* however, lacks the elaborately sclerotized male genital pouch, complex subcercus, and broad alula which define *Sclerocoelus* (Marshall 1995), and *Sclerocoelus* lacks the basal scutellar bristles, two interfrontal bristles, highly derived phallus, and totally reduced female tergite 10 (epiproct of authors) which appear to define *Chespiritos.* Similar small basal scutellar bristles do appear elsewhere in the Sphaeroceridae (some species of the *Pullimosina* subgenus *Dahlimosina* Roháĉek, and three species of *Spelobia* Spuler, for example). The female tergite 10 of other Limosininae is occasionally reduced (as in some *Sclerocoelus*), and is occasionally absent (as in some *Pterogramma* with greatly reduced cerci), but the complete absence of tergite 10 in combination with the presence of well-developed cerci is a distinctive attribute of *Chespiritos.*

Chespiritos sindecimus Marshall, new species

(Figs. 1–8)

Description.—Length from base of antenna to wing tip 3.0 mm, general color brown, tibiae and tarsi luteous. Head strikingly broad, frontal width between eyes 3× height of interfrontal area; clypeus large, dark and exposed. Frons with two equal in-



Figs. 1–8. *Chespiritos sindecimus.* 1–3 and 5, Male abdominal structures. 1, terminalia, left lateral. 2, terminalia, posterior. 3, aedeagus and associated structures. 5, sternites 5–7. 4, Right wing of male. 6–8. Female abdominal structures. 6, tergites 7–8 and cerci. 7, spermathecae. 8, sternites 7–10 and cerci.

terfrontal bristles and a small lower setula; two large orbital bristles; inner occipital bristle large, postvertical and postocellar bristles very small. Orbit, interfrontal stripe and ocellar triangle with indistinct silver pollinosity. Palpus clavate, setulose, with only weak apical hairs and a single preapical ventral bristle. First flagellomere flattened laterally, rounded apically; arista arising dorsolaterally, length twice head height, aristal hairs long (5× aristal width at midlength). Prosternum bare. Thorax heavily pollinose; 2 strong postsutural dorsocentral bristles separated by 6 rows of acrostichal setae; outer postpronotal bristle strong, both presutural and postsutural intra-alar bristles strong. Scutellum long, with 2 pairs of long marginal bristles and a pair of small basal bristles. Dorsal surface of mid tibia with 5 bristles proximally (3 anterodorsal and 2 posterodorsal; the posterodorsal bristles small and sometimes difficult to distinguish from posterodorsal setulae) and 5 bristles distally (2 anterodorsal, 2 dorsal, 1 posterodorsal). Male mid tibia with an apicoventral bristle, an anteroventral bristle near middle, and a double row of short stout ventral bristles on distal half, base of mid femur with corresponding stout bristles; female mid tibia with a mid ventral and an apical ventral bristle. Hind tibia with a small anteroventral bristle at apex. Wing (Fig. 4) long, third costal sector 0.8× length of second, vein R_{2+3} gently sinuate; costa extending very far (at least 10 vein-widths) beyond apex of vein R_{4+5}; distance between crossveins dm-cu and r-m 3× as long as dm-cu, both M_{1+2} and CuA_1 extending beyond discal cell as pigmented processes; alula narrow.

Female abdomen: Tergite 7 with a pale posteromedial notch; tergite 8 pale but convex posteromedially, laterally expanded and with differentiated posteroventral parts; tergite 10 absent (Fig. 6). Cercus short, strongly tapered, entirely setulose, with 3 small outer bristles, a long straight apical bristle and a curved inner preapical bristle. Sternite 7 with a pale posteromedial notch; sternite 8 reduced to a small, medially pale, transverse sclerite with two stout bristles on each half; sternite 10 reduced to two small plates, one under each cercus (Fig. 7). Area between sternite 8 and sternite 10 with a large, hyaline vaginal sclerite with a prominent posteromedial process. Spermathecae (3) large, spherical, transversely wrinkled, with long conical necks and short sclerotised parts of ducts (Fig. 8). Pleural membrane wrinkled and densely setose.

Male abdomen: Syntergite 1+2 twice as long as tergite 3, middle part pale almost to hind margin. Sternite 5 small but complex, with two pairs of prominent posterior lobes, outer pair long-setose and inner pair bare and blade-like. Middle part of sternite 5 dark, very short, with a long deflexed (bent upwards) posteromedial lobe ending in two small, bristle-bearing lobes (Fig. 5). Sternite 6 with a narrow ventral part anterior to a distinct (but medially membranous) genital pouch; a distinct ring sclerite in right membrane beside genital pouch. Epandrium uniformly long-setose, subanal plate broad, weakly bilobed ventrally, subepandrial sclerite broad and arching slightly above level of subanal plate; each half of subanal plate with a single long bristle (Fig. 2). Surstylus leaf-like, with a row of stout bristles on anterior edge and a basal patch of fine bristles (Fig. 1). Hypandrium stout, deeply cleft posteriorly and with an elongate apodeme anteriorly, anterior arms long and fused both with apodeme and epandrium, no median posterior part but with small lobe connecting anterior arm to postgonite, pregonite (suspensory sclerite) small and closely appressed to postgonite. Postgonite (paramere, gonostylus) dark, flattened, apex serrate with a posteroapical lobe (Fig. 3). Basiphallus stout, wedge-like; distiphallus heavily sclerotised, tubular basally and with two detached distal dorsal lobes and a spatulate ventral lobe.

Type material.—Holotype (♂, INBio) and 9 paratypes (2 ♀, 2 ♂, INBio; 2 ♀, 3 ♂ GUELPH): COSTA RICA. Cartago, Rio Macho, La Esperanza, El Guarco (8 km from km 61 Interamerican Highway) 2,400 m, LN-188200, 549800, Hoja Tapanti, in bromeliads on ground, 1.vi.1998, S. A. Marshall. Holotype and two paratype ♀ with two large mites each.

Etymology.—The genus is named after a well-known truck stop on the Interamerican Highway near the type locality; the gender is masculine. The specific name refers to the lack of tergite ten on the female abdomen.

Comments.—The type series of *Chespir-*

itos sindecimus was collected as part of an INBio (Instituto Nacional de Biodiversidad, Costa Rica) sponsored field trip for participants in a planning workshop for a major biodiversity inventory project in Costa Rica, and this description can be viewed as an initial contribution to that inventory.

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A REVIEW OF THE FLEA GENERA *HECTOPSYLLA* FRAUENFELD AND *RHYNCHOPSYLLUS* HALLER (SIPHONAPTERA: PULICIDAE)

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Abstract.—Rhynchopsyllus, a monotypic genus, is proposed as a **new junior synonym** of *Hectopsylla.* A key for the 12 species of *Hectopsylla* is provided with annotation of host preferences and geographical distribution of *Hectopsylla pulex* (Haller).

Key Words: *Hectopsylla, Rhynchopsyllus,* Siphonaptera, Pulicidae, key

Rhynchopsyllus pulex described by Haller (1880) has been a source of taxonomic confusion. Schreiter and Shannon (1927) and Traub and Gammons (1950) erected *Maxilliopsylla lilloi* and *Rhynchopsyllus megastigmata,* respectively, from females only. Tipton and Mendez (1966) subsequently described the male of *R. megastigmata* from Panama (in the presence of accompanying females). Later Méndez (1977) reported associated males and females from Colombia to be the same as *R. megastigmata* from Panama, but considered them conspecific with *R. pulex.* Jordan (1939) synonymized *M. lilloi* with *R. pulex.* Jordan and Rothschild (1906), Dalla Torre (1924), and Pinto (1930) each reported the species as *Hectopsylla* (based only on females). In addition, Anduze et al. (1947) and Cova García and Tallaferro (1959) questioned the status of *Rhynchopsyllus* because of similarities with *Hectopsylla.* If one uses the characters described by Hopkins and Rothschild (1953), Panamanian and Colombian males reported by Tipton and Méndez (1966) and Méndez (1977) clearly belong to *Hectopsylla.* This paper provides observations to support synonymizing the monotypic genus *Rhynchopsyllus* with *Hectopsylla.*

Mammalian synonymies follow those of Wilson and Reeder (1993) and avian synonymies are those described in Peters (1934, 1940), Deignan et al. (1964) and Sibley and Monroe (1990). The depositories of material examined for this study are annotated after host/locality data as: The Natural History Museum, London (BMNH), Field Muséum of Natural History, Chicago (FMNH), J.C. Beaucournu Collection (JCB), Museum d'Histoire Naturelle, Belgium (Md'HN), Michael W. Hastriter Collection (MWH), Robert E. Lewis Collection (REL), and National Museum of Natural History, Smithsonian Institution, Washington D.C. (USNM).

Genus *Hectopsylla* Frauenfeld

Hectopsylla Frauenfeld 1860: 464. Type species (by monotypy): *Hectopsylla psittaci* Frauenfeld.

Rhynchopsyllus Haller 1880: 72. Type species (by monotypy): *Rhynchopsyllus pulex* Haller. **New synonymy.**

Maxilliopsylla Schreiter and Shannon 1927: 6. Type species (by monotypy): *Maxil-*

liopsylla lilloi Schreiter and Shannon. Synoymized by Jordan 1939: 303.

The diagnostic features distinguishing *Rhynchopsyllus* from *Hectopsylla* have been based only on females of the former. Jordan (1934) and Hopkins and Rothschild (1953) based separation of these two genera by the morphology of the spermatheca and maxilla. Jordan (1934) specifies the differences as "a long, narrow, pointed and curved maxilla and a conical projection at the orifice of the spermatheca" in *Rhynchopsyllus,* whereas the maxilla of *Hectopsylla* is "short and broadly triangular and the orifice of the spermatheca is flush with the surface, not projecting on a cone". More recent descriptions of the male of *R. pulex* by Tipton and Méndez (1966) and two additional species (*H. gracilis* Mahnert, 1982 and *H. pascuali* Beaucournu and Alcover, 1989) provide evidence that would suggest *Rhynchopsyllus* is synonymous with *Hectopsylla. Hectopsylla gracilis* and *H. pascuali* also have sharply pointed maxillae that are directed caudad. Both species clearly belong to *Hectopsylla.* Comparison of these three species illustrates the similarity of their maxillae (Figs. 19–21). *Rhynchopsyllus pulex* is the only species among the two genera, which bears a broad conical projection at the orifice of the duct of the spermatheca. Although the spermatheca is morphologically distinct from that of all species of *Hectopsylla* (except *H. stomis* to which it is quite similar) the authors consider the conical structure relevant as a species distinction only.

Both genera share a common sessile parasitic mode of life (primarily in the females). Modifications for a sessile mode of life shared by females of both genera include extreme serration and sometimes extreme elongation of the lacinia, angular frons, compression of thoracic segments, partial covering of the anterior portion of antennal fossa, and expansibility of intersegmental abdominal membranes (not truely neosomic). The expansibility of intersegmental abdominal membranes is demonstrated most dramatically among females of *R. pulex, H. knighti,* and *H. psittaci* (the only species within the two genera with preference for volant hosts). This is most extreme in *R. pulex* and is accompanied by autoseverence of appendages (a feature of species of *Tunga*). Evidence of autoseverence in *R. pulex* includes catabolic scarring of remaining coxae and trochanters, absent in all species of *Hectopsylla* examined.

Neither males of *Rhynchopsyllus,* nor *Hectopsylla* have developed adaptations to accomodate a sessile mode of life (shorter mouthparts, fewer serrations on lacinia, tendency for rounded frons, and inexpansible abdomens as demonstrated by examination of mounted male specimens of *Hectopsylla* previously attached to hosts). The feeding and copulatory behavior of *Rhynchopsyllus* or *Hectopsylla* males is virtually unknown. Their lack of abundance on hosts (none for *Rhynchopsyllus*) would suggest that feeding is minimal (if at all) and the occasional collection of male specimens of *Hectopsylla* from a host likely occurs while they are seeking females for mating.

The clasper of *Rhynchopsyllus* is closely allied with that of *Hectopsylla,* possessing a posteriorly projecting manubrium termed manubrium 2 by Hopkins and Rothschild (1953). The pattern of the aedeagus of *Rhynchopsyllus* is also similar to those of all species of *Hectopsylla.* The sclerotized inner tube (S.I.T.) is nearly identical, being extremely long and narrow with a small basal capsule to guide the short penis rod into the S.I.T. (Figs. 5–6, 8). Dorsal to the capsule and running obliquely parallel to the S.I.T. is a heavily sclerotized structure referred to as the crescent sclerite by Tipton and Méndez (1966) in their description of *R. pulex* males. This pair of sclerites is present in all *Hectopsylla* species, as well as *R. pulex,* but is not present in *Tunga,* or *Echidnophaga* (the most closely allied genera). Since the structure is dorsal and distinct from the defined capsule of the aedeagus (and not the roof of the capsule = cres-

Table 1. A summary of specimens examined during this study illustrating host preferences within the genus *Hectopsylla*.

Flea species	Chiropteran	Non-Chiropteran Mammal	Aves	Host Unknown
H. broscus	0	1/13[1]	0	0
H. coniger	0	1/7	0	0
H. cypha	0	5/74	0	0
H. eskeyi	0	5/40	0	0
H. gemina	0	18/54	0	8/6
H. gracilis	0	2/9	0	0
H. knighti	0	0	0/1	0
H. pascuali	0	1/2	0	0
H. psittaci	0	0	5/61	0/5
H. pulex	0/34	0/3	0	3/3
H. stomis	0	7/55	0/5	0/4
H. suarezi	0	5/6	0	0/1

[1] 0/0 = number of males/number of females.

cent sclerite), it is not the crescent sclerite. These sclerites are herein referred to as the dorsal armature (D.A.) (Figs. 5–6). The apex of the D.A. of specimens of all species appears fused or at least contiguous with the S.I.T. (Fig. 6) (the position of the D.A. as illustrated in Fig. 5 is atypical of most specimens examined). Based on the common morphological features discussed, the authors consider the monotypic genus *Rhynchopsyllus* a junior synonym of *Hectopsylla.*

Hectopsylla pulex (Haller)
(Figs. 6–7, 19)

Rhynchopsyllus pulex Haller 1880: 72.

Rhynchopsylla pulex: Taschenberg 1880: 56.

Hectopsylla psittaci Baker 1904: 375, 434.

Hectopsylla pulex: Jordan and Rothschild 1906: 59, 63.

Rhynchopsyllus pulex: Cunha 1914: 172.

Hectopsylla pulex: Dalla Torre 1924: 20.

Maxilliopsylla lilloi Schreiter and Shannon 1927: 6 (type species of *Maxilliopsylla,* by monotypy).

Rhynchopsyllus pulex: Ewing 1929: 158.

Hectopsylla pulex: Pinto 1930: 332.

Rhynchopsyllus pulex: Jordan 1934: 19; Jordan 1939: 303 (synonymy of *M. lilloi*); Guimarães 1940: 219; Fuller 1942: 44; Anduze et al. 1947: 1–10; Macchiavello 1948: 15; Augustson and Ryan 1948: 111.

Rhynchopsyllus megastigmata Traub and Gammons 1950: 271; Hopkins and Rothschild 1953: 68.

Rhynchopsyllus pulex: Hopkins and Rothschild 1953: 66; Johnson 1957: 237; Barrera and Díaz-Ungría 1957: 174.

Hectopsylla pulex: Cova García and Tallaferro 1959: 331.

Rhynchopsyllus megastigmata: Tipton and Méndez 1966: 296.

Rhynchopsyllus pulex: Tamsitt and Fox 1970: 1093; Tipton and Machado-Allison 1972: 4; Méndez 1977: 164 (synonymy of *R. megastigmata*).

Material examined.—ARGENTINA: Buenos Aires, 1 ♀, Ex: *Nyctinomus brasiliensis* = *Tadarida brasiliensis* (I. Geoffroy) (BMNH). BOLIVIA: S. Cruz de la Sierra, 2 ♀, Ex: *Molossus obscurus* = *Molossus molossus* (Pallas) (BMNH); Magdalena, Dept. Beni, 2 ♀, Ex: *Eumops bonariensis* (Peters), 12 Nov 1966; Magdalena, Dept. Beni, 1 ♀, Ex: *Noctilio labialis* = *Noctilio albiventris* Desmarest, 20 Aug 1964 (USNM). BRAZIL: 1 ♀ (paratype), Ex: *Molossus* sp.; Lagõa Santa, 1 ♀, Ex: *Eumops perotis* (Schinz), 2 Feb 1916 (BMNH); Lagõa Santa, 2 ♀, Ex: *E. perotis,* 2 Jan 1944 (USNM); Petropolis, 1 ♀, Ex: "ear of bat"; Paraná Prov., 3 ♀, Ex: *Histiotus velatus* (I. Geoffrey) (BMHH). COLUMBIA: Ansermanuevo, Dept. Valle, 4 ♀, Ex: *M. molossus,* 20 Jul 1967; Cali, Dept. Valle, 2 ♀, Ex: *Molossus major* = *M. molossus,* 22 Nov 1962; Cali, Dept. Valle, 1♀, Ex: *M. molossus,* Jun 1967; Cartago, Dept. Valle, 2 ♀, Ex: *Molossus bondae* J.A. Allen, 10 Oct 1967 (USNM). ECUADOR: Albitigua, elev. 1,000 m, 3 ♀, Ex: *Rhipidomys leucodactylus* (Tschudi); Gualquiza, elev. 760 m, 1♀, Ex: "bat". PANAMA: Pacora, 2♂, Ex: "bat guano", 22 Jun 1961 and 27 Feb 1962 (USNM); Pacora, 1 ♂, 1 ♀, Ex: "bat guano", 20, 22 Jun 1961; Pacora, 2 ♀, Ex: "bat guano", 12, 14 Feb 1962; (MWH). PERU: Rio Chinchao, Dept. Huanuco, 1 ♀, Ex: *Molossus obscurus* = *M. molossus* (BMNH); Quince Mil, Cuzco Prov., 1♀, Ex: *T. braziliensis,* 19 Jun 1950 (USNM). TRINIDAD: Santissima, 1 ♀, Ex: "bat", 27 Jul 1915 (USNM). UNITED STATES: Frio Cave, Uvalde County, Texas, 1 ♀, Ex: *Tadarida mexicana* = *T. brasiliensis,* 30 Mar 1955 (USNM). VENEZUELA: Esteban, Djiques, 2 ♀, Ex: *M. obscurus*; Merida, 1 ♀, Ex: *Vespertilio fuscus* = *Eptesicus fuscus* (Beauvois) (BMNH); 3 km S and 46 km W Caracas, Dto. Federal, 2 ♀, Ex: *M. obscurus* = *M. molossus,* 19, 20 Aug 1966 (USNM).

Remarks.—*Hectopsylla pulex,* one of 12 species of *Hectopsylla,* occurs primarily on bats of the family Molossidae and to a lesser extent on Vespertilionidae. The remaining species parasitize either Aves (*H. knighti, H. psittaci*) or non-Chiropteran mammals (Caviidae: *H. cypha, H. eskeyi, H. gemini, H. suarezi*; Muridae: *H. pascuali, H. gracilis*; Mustelidae: *H. broscus, H. coniger*; and Chinchillidae: *H. stomis*) (Table 1). The known country records of *Hectopsylla pulex,* its host species and host synonymies are listed in Table 2. The occurrence of a single female of *H. pulex* on *Zonotrichia pileata* = *Zonotrichia capensis* (Müller) (reported in Cunha 1914) and three females examined from the Murid rodent *R. leucodactylus* are likely accidental associations.

Little is known about the life cycle of *H. pulex.* Females have been collected frequently on chiropteran hosts while males have been collected only from bat guano associated with species of *Molossus* in Colombia and Panamá.

KEY TO SPECIES OF *HECTOPSYLLA*

1. Maxilla rounded at apex (Fig. 11) (male unknown) . . . . *knighti*
– Maxilla broadly angular to sharply pointed at apex (Figs. 12–22) 2
2. Segment V of all tarsi with seven or eight (usually eight) lateral planter bristles; tarsal claws with a prominent basal tooth; metepimeron of female without a process on dorsoposterior margin of metepimeron . . . . . *psittaci*
– Segment V of all tarsi with at most six pairs of lateral plantar bristles; tarsal claws without a prominent basal tooth; metepimeron of female nearly always with a process at dorsoposterior margin (Fig. 2) (except *pulex*) . . . 3
3. Male 4
– Female 13
4. P^1 of clasper narrower at apex than at base (Figs. 3, 7) 5
– P^1 of clasper broader at apex than at base (Fig. 4) 7
5. Tarsal segments V with six pairs of lateral plantar bristles; median dorsal lobe of aedeagus absent or vestigial . . . . *broscus*
– Tarsal segments V with five or fewer pairs of lateral plantar bristles on tarsi; median dorsal lobe well developed (Fig. 5) 6
6. P^2 and P^3 of clasper pincer-like (Fig. 4); distal arm of st. IX divided into several lobes; fifth tarsal segments with four pairs of lateral plantar bristles . . . . *stomis*
– P^2 and P^3 not pincer-like (Fig. 7); distal arm of st. IX composed of a single lobe; fifth tarsal segments with five pairs of lateral plantar bristles . . . . *pulex*
7. Median dorsal lobe of aedeagus poorly developed, at most discernible 8
– Median dorsal lobe well developed (Fig. 5), distinctly visible 9
8. Median lobe (L^2) of distal portion of st. IX enlarged with concavity at ventral margin; apical margin of P^1 of clasper straight; P^2 not bifurcate apically . . . . *gracilis*
– Ventral margin of L^2 lacking concavity; apical

Table 2. Distribution and host-parasite relationships of *Hectopsylla pulex*.

Country	Host species[1]	Flea sex
Argentina	*Myotis nigricans* (Schinz)	♀
	Nyctinomus brasiliensis = *Tadarida brasiliensis* (I. Geoffroy)	♀
	Promops perotis = *Eumops perotis* (Schinz)	♀
	Zonotrichia pileata = *Zonotrichia capensis*[2] (Müller)	♀
Bolivia	*Eumops bonariensis* (Peters)	♀
	Molossus obscurus = *Molossus molossus* (Pallas)	♀
	Noctilio labialis = *Noctilio albiventris* Desmarest	♀
Brazil	*E. perotis*	♀
	Histriotus velatus = *Histiotus velatus* (I. Geoffroy)	♀
	Molossus bondae J. A. Allen	♀
	Molossus obscurus = *M. molossus*	♀
	Molossus rufus = *Molossus ater* E. Geoffroy	♀
	Nyctinomus brasiliensis = *T. brasiliensis*	♀
	Nyctinomus macrotis = *Nyctinomops macrotis* (Gray)	♀
Colombia	*Molossus bondae*	♀
	Molossus major = *M. molossus*	♀
	Molossus molossus major = *M. molossus*	♂/♀
	M. molossus	♂/♀
	Molossus obscurus obscurus = *M. molossus*	♀
	Noctilio labialis = *Noctilio albiventris*	♀
Ecuador	"Bat"	♀
	Rhipidomys leucodactylus[3] (Tschudi)	♀
México	*E. perotis*	♀
Panamá	*Tadarida yucatanica* = *Nyctinomops laticaudatus* (E. Geoffroy)	♂/♀
Perú	*Histiotus* sp.	♀
	Molossus obscurus = *M. molossus*	♀
	Tadarida brasiliensis	♀
Trinidad	"Bat"	♀
United States	*E. perotis*	♀
	Tadarida mexicana = *T. brasiliensis*	♀
Venezuela	*M. major* = *M. molossus*	♀
	M. obscurus = *M. molossus*	♀
	Myotis nigricans	♀
	Vespertilio fuscus = *Eptesicus fuscus* (Beauvois)	♀

[1] Host synonymy after Wilson and Reeder (1993).
[2] Only known record occurring on a bird.
[3] Only known record occurring on a non-Chiropteran mammal.

margin of P^1 somewhat convex; P2 strongly bifurcated into two dentate projections . . . . *pascuali*

9. Dorso-posterior margin of metepimeron with a caudally directed process (Fig. 2) . . . *coniger*

– Dorso-posterior margin of metepimeron entire, lacking process 10

10. Sclerotized inner tube (S.I.T.) with a sharp thorn-like spine at ventral midpoint (Fig. 8); apex of ventral lobe (L^3) of distal portion of st. IX pointed; fifth tarsal segments with three pairs of lateral plantar bristles (some with three and four on same metatarsus) . . . *gemina*

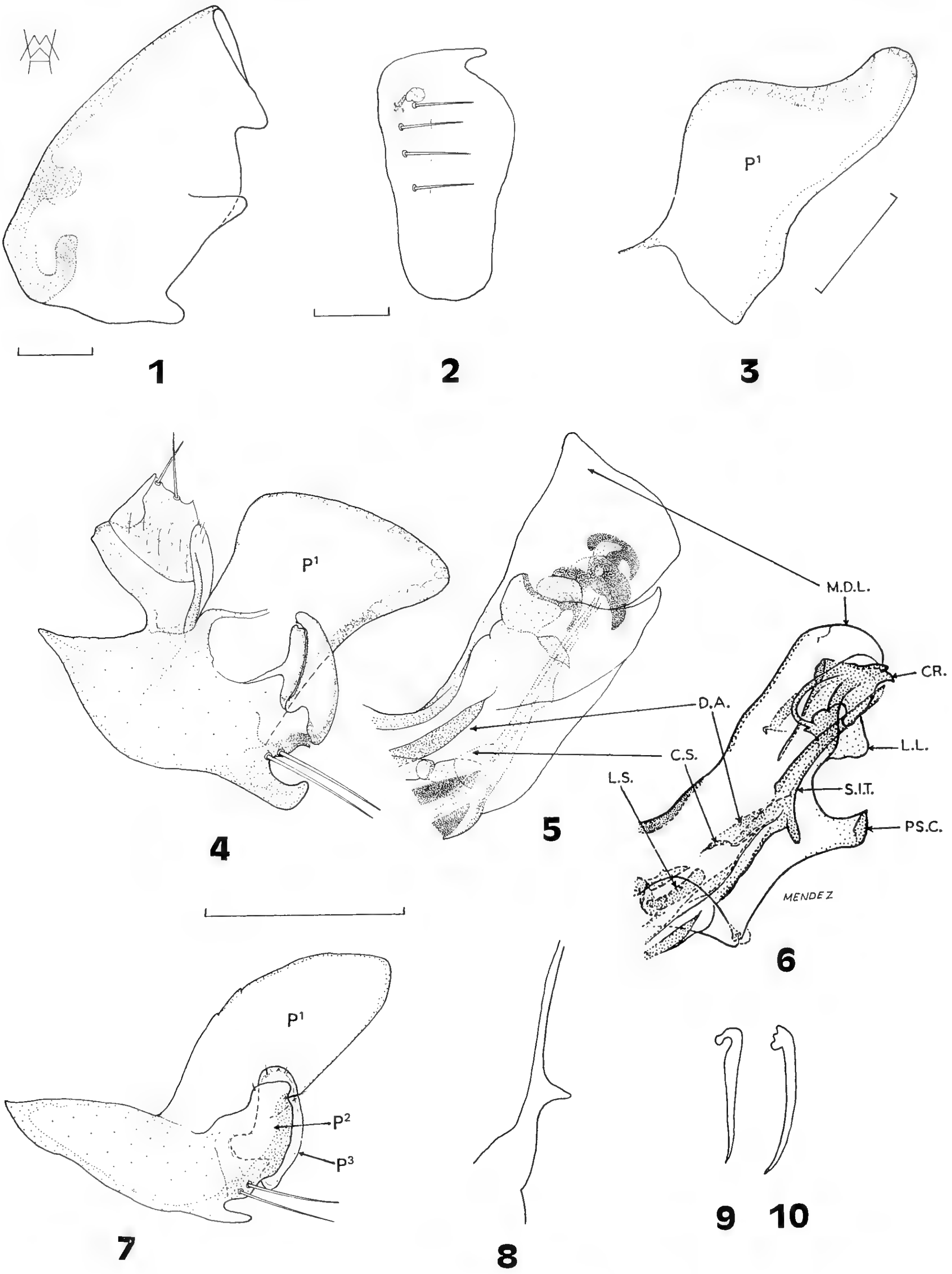
– S.I.T. without thorn-like spine at ventral midpoint, if with tubercle or protuberance then rounded and blunt (Fig. 5); apex of L^3 rounded; fifth tarsal segments with either four or five pairs of lateral plantar bristles 11

11. L^2 with lateral patch of long thin setae; usually four pairs of lateral plantar bristles on fifth tarsal segments . . . . *cypha*

– L^2 without lateral patch of setae, but with vertical line of setae; four or five pairs of lateral plantar bristles on fifth tarsal segments . . . 12

12. Fifth tarsal segments with four pairs of lateral plantar bristles . . . . *eskeyi*

– Fifth tarsal sements with five pairs of lateral plantar bristles . . . . *suarezi*



Figs. 1–10. 1, Head, female *H. broscus.* 2, Metepimeron, *H. eskeyi* (female paratype). 3, P^1 of clasper, *H. stomis.* 4, Clasper, *H. eskeyi* (holotype). 5, terminal portion of aedeagus, *H. eskeyi* (holotype), 6, Terminal prtion of aedeagus, *H. pulex.* 7, Clasper, *H. pulex.* 8, Sclerotized inner tube, *H. gemina.* 9, Metatarsal claw, *H. pascuali* (allotype). 10, Metatarsal claw, *H. gracilis* (female paratype). Abbreviations: CR. = crochet; C.S. = crescent sclerite; D.A. = dorsal armature; L.L. = lateral lobe; L.S. = lateral sclerite; M.D.L. = medium dorsal lobe; P^1, P^2 and P^3 = processes of clasper; PS.C. = pseudocrochet; S.I.T. = sclerotized inner tube. Scale = 100μ.

13. Metepimeron with a dorso-posterior projection (Fig. 2) 14
– Metepimeron without a dorso-posterior projection . . . . *pulex*
14. Posterior margin of occiput with a well defined lobe (Fig. 1) 15
– Posterior margin of occiput without a well defined lobe (though slightly indicated in *eskeyi*) 16
15. Tergum II with three setae per side and t. VII with two or three setae per side; frons with convex angle midway between oral angle and internal incrassation (Fig. 1); five or six (usually six) lateral plantar bristles on fifth tarsal segments . . . . *broscus*
– Tergum II with one or two setae per side and t. VII with one per side; frons with angular projection immediately below internal incrassation; three lateral plantar bristles on fifth tarsal segments . . . . *coniger*
16. Sclerotized rim of sensilial plate anterior to sensilial pits greater than twice width of double row of pits . . . . *stomis*
– Sclerotized rim of sensilian plate anterior to sensilial pits at most as wide as double row of pits 17
17. Fifth tarsal segments with three pairs of lateral plantar bristles; ventral apical margin of t. VIII with tooth-like projection . . . . . *gemina*
– Fifth tarsal segments with either four or five pairs of lateral plantar bristles; ventral apical margin of t. VIII without tooth-like projection 18
18. Fifth tarsal segments with five pairs of lateral plantar bristles (occasional specimens may have four and five on the same tarsus) . . . . *suarezi*
– Fifth tarsal segments with four pairs of lateral plantar bristles 19
19. Dorsal margin of metepimeron heavily sclerotized, sclerotization extending to apex of process which is markedly turned down; usually three setae on metepimeron . . . . *cypha*
– Dorsal margin of metepimeron not noticeably sclerotized (Fig. 2); usually four setae on metepimeron 20
20. Hilla of spermatheca nearly as wide throughout as width of bulga; duct of spermatheca connecting at cribriform area of bulga on ventral margin . . . . *eskeyi*
– Hilla of spermatheca much narrower than width of bulga, with marked narrowing from base of bulga to apex of hilla; duct of spermatheca connecting at cribriform area of bulga on ventral apical margin 21
21. Base of metatarsal claw with small cleft, or sinus (Fig. 9) . . . . *pascuali*
– Base of metatarsal claw without cleft, or sinus (Fig. 10) . . . . *gracilis*

OTHER MATERIAL EXAMINED

Hectopsylla broscus Jordan and Rothschild 1906
(Fig. 12)

Material examined.—ARGENTINA: Central Pampa, 1 ♀ (lectotype), Ex: *Conepatus humboldtii* Gray; Central Pampa, 5 ♀ (paralectotypes), Ex: *C. humboldtii*; San Rafael, Mendoza Prov., 1 ♂, 1 ♀, Ex: *Conepatus suffocans* = *C. chinga* (Molina); Don Roberto, San Luis Prov., 1 ♀, Ex: *Conepatus chinque* = *C. chinga,* 14 Jun 1962; "Southern Argentina," 5 ♀, Ex: *Zaedyus pichiy* (Desmarest), 30 Jun 1962 (BMNH).

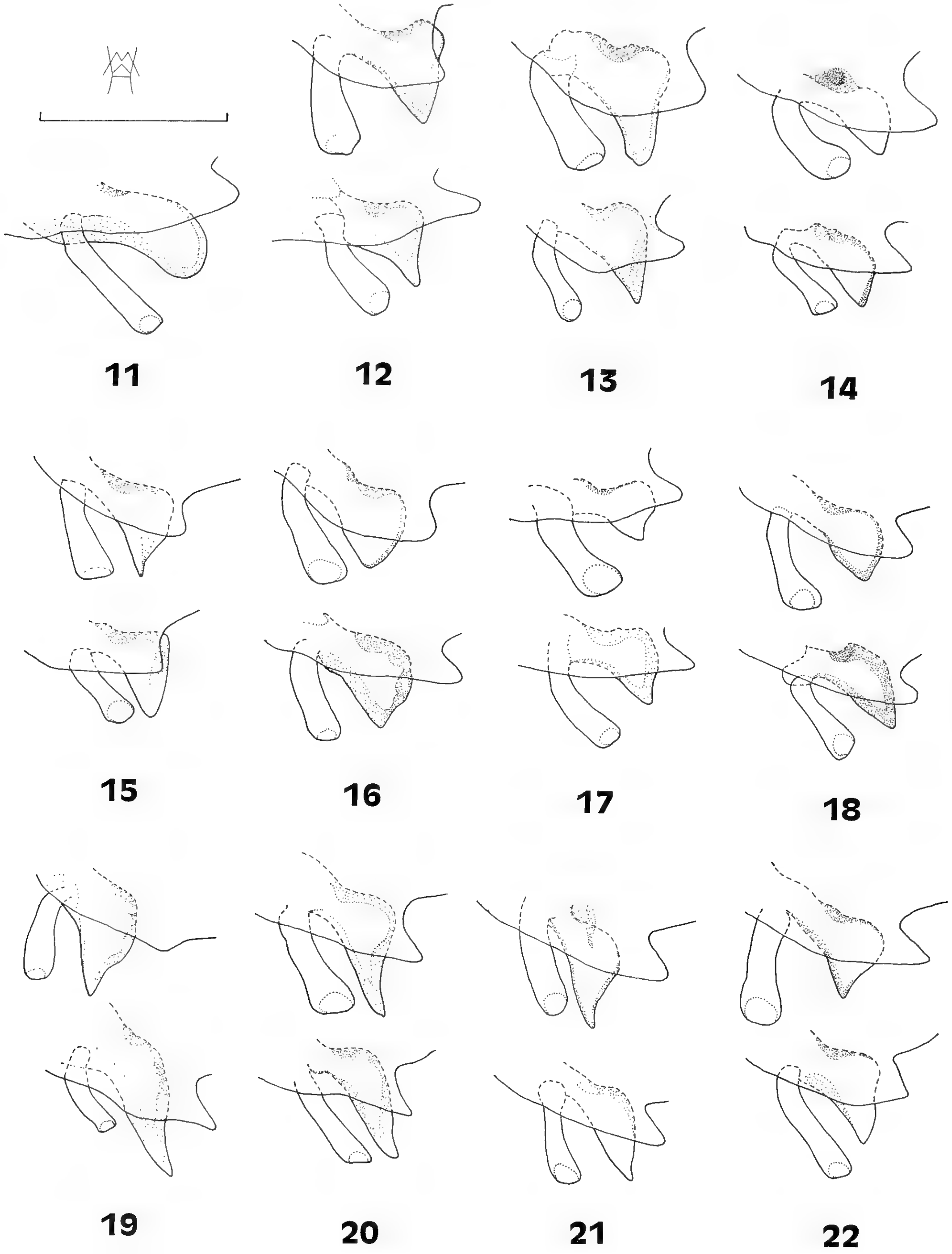
Remarks.—All records of this species are restricted to Argentina and skunks of the genus *Conepatus* appear to be the preferred host.

Hectopsylla coniger Jordan and Rothschild 1906
(Fig. 17)

Material examined.—BOLIVA: Pampa Olliga, 1 ♂ (lectotype), Ex: *Conepatus arequipae* = *C. chinga,* 19 Oct 1901; Pampa Olliga, 1 ♀ (lectoallotype), 6 ♀ (paralectotypes), Ex: *C. chinga,* 19 Oct 1901 (BMNH).

Hectopsylla cypha Jordan 1942
(Fig. 14)

Material examined.—ARGENTINA: Las Catitas, Mendoza Prov., 9 ♀ (paratypes), Ex: *Octomys barrerae* = *Tympanoctomys barrerae* (Lawrence), Jul 1939; Mendoza, 1 ♀, Ex: *Microcavia australis* (I. Geoffroy and d'Orbigny), 6 Aug 1959; Puesto "La Carpa," Mendoza, 5 ♀, Ex: *Graomys griseoflavus griseoflavus* = *Graomys griseoflavus* (Waterhouse), 12, 14 Jul 1959; Puesto "La Carpa," Mendoza, 2 ♀, Ex: *M. australis,* 13, 15 Jul 1959; San Rafael, Mendoza Prov., 1 ♀ (neoallotype), 2 ♂, 52 ♀ (paratypes), Ex: *M. australis,* Apr–Jul 1939; Santa Rosa, Mendoza Prov., 2 ♂, 4 ♀ (paratypes), Ex: *M. australis,* Jul 1939



Figs. 11–22. First segment of maxillary palpus, maxilla, and ventral margin of head (genal lobe); male is positioned directly above female for each species. 11, *H. knighti* (female holotype). 12, *H. broscus* (female lectotype). 13, *H. stomis* (female holotype). 14, *H. cypha* (paratypes). 15, *H. gemina*. 16, *H. suarezi*. 17, *H. coniger* (lectotype and allolectotype). 18, *H. eskeyi* (holotype and paratype). 19, *H. pulex*. 20, *H. pascuali* (holotype and paratype). 21, *H. gracilis* (holotype and paratype). 22, *H. psittaci*. Scale = 100μ.

(BMNH). Zapallar, La Rioja Prov., 1 ♂, Ex: "Viscacha" *Lagostomus* sp. Brookes, 8 Jan 1933 (USNM).

Remarks.—Mountain cavies (*M. australis*), which are restricted to Argentina and southern Chile, are the preferred host for this flea. The geographic distribution of *T. barrerae* is also restricted to Argentina and it is rarely collected. *Hectopsylla cypha* occurring on other hosts that have much broader geographical distributions (*Lagostomus* sp. and *G. griseoflavus*) are likely accidental associations.

Hectopsylla eskeyi Jordan 1933
(Figs. 2, 4–5, 18)

Material examined.—BOLIVIA: Pucará, elev. 2,400 m, 1 ♀, Ex: *G. griseoflavus,* 28 Sep 1954; Samaipata, Dept. Santa Cruz, elev. 1,650 m, 1 ♀, Ex: *G. griseoflavus,* 28 Jan 1955; Serrano, Dept. Chuquisaca, elev. 2,160 m, 1 ♀, Ex: *Hesperomys muriculus* = *Calomys callosus* (Rengger), 24 Jul 1955 (BMNH). ECUADOR: Riobamba, Chimborazo Prov., elev. 2,800 m, 1 ♀, Ex: *Rattus rattus* (Linn.), 12 Jun 1956; Sanjapamba, Tungurahua Prov., 6 ♀, Ex: *Cavia porcellus* (Linn.), 1956 (BNMH). PERU: Huancabamba, elev. 1,960 m, 4 ♂, 9 ♀, Ex: *Cavia cobaya* (domestic) = *C. porcellus,* 17, 19 May 1956; Lima, 1♂ (holotype), 1 ♀ (Neoallotype), 1 ♂, 18 ♀ (paratypes), Ex: "rats," 1930; Yura, Arequipa Prov., elev. 8,200 ft, 1 ♀, Ex: *Cavia musteloides* = *Galea musteloides* Meyen, 8 Aug 1939 (BMNH); Yura, Arequipa Prov., elev. 8,200 ft, 1 ♀, Ex: *G. musteloides* (REL).

Remarks.—*Hectopsylla eskeyi* occurs in the higher Andean valleys on a variety of hosts and little can be said of its host specificity.

Hectopsylla gemina Jordan 1939
(Figs. 8, 15)

Material examined.—ARGENTINA: Mendoza, 1 ♂, 4 ♀, Ex: *M. australis,* 9 Aug 1959; Las Catitas, Mendoza Prov., 1 ♂, 1 ♀, Ex: *Octomys barrerae* = *T. barrerae*; La Paz, Mendoza Prov., 3 ♂, 23 ♀, Ex: *M. australis,* Feb-Mar 1939; Puesto "La Carpa," Mendoza Prov., elev. 600 m, 1 ♂, 6 ♀, Ex: *M. australis,* 13–17 Jul 1959; Puesto "Pugin," Algarrobito, Mendoza Prov., 620 m, 4 ♂, 7 ♀, Ex: *M. australis,* 24–31 Jul 1959; San Rafael, Mendoza Prov., 8♂, 6 ♀, Mar–May 1939; Santa Rosa, Mendoza Prov., 6♂, 7 ♀ (paratypes), Ex: *M. australis,* Jul & Feb 1939; Fortin Uno, Rio Negro Prov., 1 ♂ (holotype), 1 ♀ (paratype), Ex: *M. australis,* Aug 1937; near General Roca, Rio Negro Valley, Rio Negro Prov., 1 ♂, 2 ♀, Ex: *Ctenomys* sp. Blainville, 25 Mar 1952 (BMNH). Nacunan, Mendoza Prov., 1 ♀, Ex: *Akodon* sp. Meyen, 15 Mar 1983 (REL). General Acha, La Pampa Prov., 1 ♂, Ex: *M. a. australis,* 20 May 1936; La Cristina, 1 ♀, Ex: *Galea* sp. Meyen, 26 Oct 1966 (USNM).

Remarks.—All records of this species are restricted to Argentina, the preferred host being mountain cavies (*M. australis*). Although this flea has not been associated with *H. cypha,* it parasitizes the same host species in the same general geographic region.

Hectopsylla gracilis Mahnert 1982
(Figs. 10, 21)

Material examined.—ARGENTINA: Puesto "La Carpa," Mendoza Prov., elev. 600 m, 1 ♀, Ex: *Canis familiaris* Linn., 17 Jul 1959; Puesto "La Carpa," Mendoza Prov., elev. 600 m, 6 ♀, Ex: *G. griseoflavus* ssp., 14 Jul 1959 (BMNH). Puerto Madryn, Chubut Prov., 1 ♂ (holotype), Ex: *Eligmodontia morgani* Allen, 23 Apr 1978; Puerto Madryn, Chubut Prov., 1 ♂, 1 ♀ (paratypes), Ex: *E. morgani,* 5 Apr 1978 (Md'HN); Puerto Madryn, Chubut Prov., 1 ♀, Ex: *E. morgani,* 24 Apr 1978 (REL).

Remarks.—Specimens from Mendoza Province (BMNH) were not recognized as a *H. gracilis* until Mahnert's description in 1982. The geographic range of the preferred host, *E. morgani,* is limited to Argentina and adjacent southern Chile (Wilson and Reeder 1993).

Hectopsylla knighti Traub and Gammons 1950
(Fig. 11)

Material examined.—México Michoacan State, Municipality of Tancítaro, Tancitami, 1 ♀ (holotype), Ex: "head of swift," May 1940 (FMNH).

Remarks.—Additional observations of "swifts" in the region of Michoaćan, México, are needed to find the males of this species and further elucidate its taxonomic status.

Hectopsylla pascuali Beaucournu and Alcover 1990
(Figs. 9, 20)

Material examined.—ARGENTINA: Rio Chapelco, Neuquén Province, 1♂ (holotype), 1 ♀ (allotype), 1 ♀ (paratype), Ex: *Chelemys macronyx* (Thomas), 9 Dec 1987 (JCB).

Hectopsylla psittaci Frauenfeld 1860
(Fig. 22)

Material examined.—ARGENTINA: 1 ♀ (lectotype), 2 ♀ (paralectotypes), Ex: *Strix pelate* = *Tyto alba* (Scopoli); Buenos Aires, 2 ♀, Ex: "owl," 1913; Chivilcoy, Buenos Aires Province, 2 ♀, Ex: "hen," 2 Feb 1936 (BMNH); Las Roses, (B.A.), 1 ♀, Ex: "Paloma"; Zapallar, La Rioja Prov., 3 ♀, Oct 1933 (USNM). BRAZIL: Progne, Rio de Janeiro State, 2 ♀ (USNM). CHILE: St. Jogo (Santiago de Chile), 2 ♀ (syntypes), Ex: *Cyarzolyscus patagonius* or *Enicognathus leptorhynchus* (King) (BMNH); Santiago, 1 ♀, 11 Sep 1951; Santiago, 2 ♀, Ex: "turtle dove" (USNM). HOLLAND: den Haag, 22 ♀, Ex: *Phasianus* sp. (L.), Aug 1926; Rotterdam, 4 ♀, Ex: *Gallus domesticus* = *Gallus gallus* (L.), July 1936 (BMNH); den Haag, 3 ♀, Ex: *Phasianus* sp., Aug 1926 (USNM). ENGLAND: London (Zoological Gardens), 3 ♀, Ex: *Cittocincla macrura* (sic) = *Copsychus malabaricus* (Swinhoe); London (Zoological Gardens), 3 ♂, Ex: "birds in western aviary"; London (Zoological Gardens) 3 ♀, Ex: *Cittocincla macrura* (sic) or *Copsychus saularis* (L.) (BMNH); London (Zoological Gardens), 2 ♀, Ex: "*Cittocincla* (sic) = *Kittocincla* (Gould) or *Copsychus*" (USNM). PERU: E. Ribeyro, Lima, 1 ♂, 2 ♀, Ex: "chickens"; Hacienda Las Vegas, 30 km from Barranca City, 1 ♀, Ex: swallow "variety called Santa Rosita," 1947 (BMNH); Cuzcon, Ocongata River, elev. 3,500–4,000 m, 2 ♀, Ex: *Merganetta leucogenis turneri* = *Merganetta armata* Gould, 26 Jul 1949; Hacienda Ceapano, Ocongate, Cuzco Prov., 1 ♀, Ex: *Colaptes rupicola puna* = *Colaptes rupicola* d'Orbigney, 14 Aug 1950 (USNM). UNITED STATES: Oceanside, San Diego County, California, 1 ♀, Ex: *Bubo virginianus pacificus* = *Bubo virginianus* (Gmelin), 7 Jun 1942 (BMNH); Oceanside, San Diego County, California, 1 ♀, Ex: *B. v. pacificus,* 7 Apr 1942 (USNM); Alameda (6.5 km w. Newark), California, 1 ♂, 4 ♀, Ex: cliff swallow nests, 15 Jan 1981 (REL).

Remarks.—*Hectopsylla psittaci,* a primary parasite of birds, is recorded from diverse areas. However, it is native to the southern cone of South America with populations dispersed to the southwestern United States by owls and other migratory bird species. Schwan et al. (1983) reported large numbers of this species from the nests of Cliff Swallows (*Hirundo pyrrhonota* Vieillot) and Black Phoebes [*Sayornis nigricans* (Swainson)] in southern California. The species likely occurs through Central America as well.

Hectopsylla stomis Jordan 1925
(Figs. 3, 13)

Material examined.—ARGENTINA: Mariano, Buenos Aires Prov., 1 ♀ (holotype), Ex: "bird", Dec 1912; Cañada Mariano, Buenos Aires Prov., 4 ♀ (paratypes), Ex: "birds," 30 Dec 1912; Bahia Blanca, Euenos Aires Prov., 19 ♀ (paratypes), Ex: *Mephitis* sp. E. Geoffroy and G. Cuvier (sic), only *Conepatus* spp. Gray occur in Argentina, 15 Jan 1911; Pique, Buenos Aires, 1 ♂, 4 ♀, Ex: *Lagostomus maximus*

(Desmarest), 5 May 1928; El Quebrachal, Salta Prov., elev. 620 m, 2 ♀, Ex: *L. maximus,* 30 Jul 1940; El Ojito, Santiago del Estero Prov., elev. 620 m, 1 ♀, Ex: *L. maximus,* 19 Jul 1940; La Paz, Mendoza Prov., elev. 620 m, 6 ♂, 22 ♀, Ex: *L. maximus,* 1 Mar 1939; Puesta "pugin" Algarrobito, Mendoza Prov., elev. 620 m, 4 ♀, Ex: *L. maximus,* 25 Jul 1959; San Rafael, Mendoza Prov., 1 ♀, Ex: *M. australis,* 20 Apr 1939 (BMNH). Chasicó, Buenos Aires Prov., 1 ♀, Ex: *L. m. maximus,* May 1968; Patagonia, 4 ♀, Ex: "Viscacha" *Lagostomus* sp., Sep 1962; Victoria, La Pampa Prov., 1 ♀, Ex: *Rattus* sp., 29 Jun 1935 (USNM).

Remarks.—*Lagostomus maximus,* occurring in southern Paraguay, and in northern and central Argentina is the primary host for this flea. *Hectopsylla stomis* has been collected throughout the year.

Hectopsylla suarezi C. Fox 1929
(Fig. 16)

Material examined.—ECUADOR: Guamoti, Chimborazo Prov., 1 ♂, Ex: "guinea pig"; Guamoti, Chimborazo Prov., 1 ♀, Ex: "guinea pig," 8 Aug 1927. PERÚ: near Hauncabamba, Dept. Piura, 4 ♂, 4 ♀, Ex: *Cavia aperea* Erxleben (domesticated), 1946/47; near Hauncabamba, Dept. Piura, 1 ♀, Ex: "among human clothes" (BMNH). Near Hauncabamba, Dept. Piura, 1 ♀ (USNM).

Remarks.—This flea is associated with domestic guinea pigs associated with human habitations. Astute collecting may yield many more specimens than are currently known, although the wide use of DDT in human dwellings for controlling the vectors of Chagas' disease (conenose bugs) and malaria (mosquitoes) may explain the absence of these fleas in collections after the mid-1940s.

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THE PUPAE OF THREE SPECIES IN *MINOMYIA* THEOBALD FROM NEPAL AND A KEY TO THE KNOWN PUPAE OF THE GENUS IN THE ORIENTAL AND AUSTRALASIAN REGIONS (DIPTERA: CULICIDAE)

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Abstract.—Four species of the genus *Mimomyia* are known from Nepal, *Mi. chamberlaini*, *Mi. luzonensis*, *Mi. hybrida* and *Mi. intermedia*. Complete descriptions and illustrations of the first three species are provided. A key to the known pupae of *Mimomyia* in the Oriental and Australasian regions is included.

Key Words: Mimomyia, pupae, Nepal

Four species of the genus *Mimomyia* Theobald are known from Nepal. The first to be reported was *Mi.* (*Etorleptiomyia*) *luzonensis* (Ludlow) by Pradhan and Darsie (1989); then *Mi.* (*Mimomyia*) *chamberlaini* Ludlow and *Mi.* (*Mim.*) *hybrida* (Leicester) by Darsie and Pradhan (1990); and most recently *Mi.* (*Mim.*) *intermedia* Barraud, a single female in the Nepal collection by Darsie et al. (1992). Immature stages of the latter are unknown. One of the purposes of this study is to give a complete description of the pupae of the former three species.

Due to the size of the trumpets and forms of the paddles of the three pupae being described, only these structures have been illustrated and/or briefly described by Barraud (1934), Mattingly (1957, 1971), Delfinado (1966, *Mi. chamberlaini* and *Mi. luzonensis*)) and Baisas (1974, *Mi. luzonensis* only). Chen and Lien (1956) described the pupae of *Mi. luzonensis* and *Mi. chamberlaini*, as *Mi. metallica* (Leicester) in somewhat more detail; however, no complete description and illustration has previously been made. *Mimomyia chamberlaini* and *Mi. metallica* were considered by Mattingly (1957) as the same polymorphic species, and Knight and Stone (1977) listed *Mi. metallica* as an infrasubspecies of *Mi. chamberlaini*. However, Lee et al. (1988) have raised *Mi. metallica* to a subspecies of *Mi. chamberlaini*.

The genus *Mimomyia* consists presently of three subgenera and 45 species. Of those, 32 are in Subsaharan Africa, mostly in the subgenera *Mimomyia* Theobald and *Ingramia* Edwards, while 14 occur in the Oriental and Australasian regions, 7 in the subgenus *Mimomyia* Theobald, 4 in the subgenus *Etorleptiomyia* Theobald, and 3 in the subgenus *Ingramia* (Knight and Stone 1977, Knight 1978, White 1974). Pupae of 10 species, including the three treated here, have been adequately described and are included in the following key (Belkin 1962; Knight and Chamberlain 1948; Mattingly 1957, 1971).

METHODS AND MATERIALS

The methods are as described by Darsie (1998). Morphological nomenclature follows Harbach and Knight (1980). The pupae of *Mi. chamberlaini*, collected in Nepal, are in the author's collection at the Florida Medical Entomology Laboratory, Vero Beach, FL, USA. For the other two species, no pupae from Nepal are available and those from Thailand, Malaysia, and the Philippines were borrowed from the National Museum of Natural History, Smithsonian Institution, Washington, DC. Abbreviations used in the descriptions are br meaning branches and Le and Pe meaning larval and pupal exuviae.

DESCRIPTIONS

Mimomyia (*Mimomyia*) *chamberlaini* Ludlow

(Fig. 1)

Pupa.—Position and size of setae as figured, range and modal number of branches in Table 1. Abdomen 3.01–4.21, $\bar{x}$ 3.86 mm, paddle 1.07–1.26, $\bar{x}$ 1.14 mm.

Cephalothorax: Striped and mottled with darker brown pattern, those on mesothoracic wing match adult wing venation. Setae 1,3,5-CT very long and stout, usually double; 8-CT long, mostly with 5 br (4–6); trumpet very long, 1.53–2.09, $\bar{x}$ 1.96 mm, index 12.7–17.0, $\bar{x}$ 15.6, pinna in apical 0.16–0.23 $\bar{x}$ 19.0, with normal opening for water surface respiration, tracheoid part 0.72–0.75 $\bar{x}$ 0.73 of total length.

Abdomen: Segments I–III medium brown, IV–VIII with sublateral dark brown stripes. Seta 1-I subdendritic float seta with 13–38 br; 2,3-I long, single; 1-II long, rather stout, with 5–10 br; 1-III–VII and 5-IV-VII stout, with short and long br, 1-III,IV with 6–12 br, 1-V,VI with 4–11 br, 1-VII with 4–6 br, 3–VII absent; 5-IV-VI with 4–11 br, 5-VII with 3–7 br; 6-III-VI long, single, seldom double; 6-VII ventral, short, usually double (1–4); 9-VIII attached to a rather pointed, apicolateral process, short, usually 3, 4 br (1–4); female genital lobes with rather pointed prolongation apicolaterally, with medium-sized spicules.

Paddle: uniformly brown, except for large white area laterally in basal 0.58–0.74, some pupae (70%) also with smaller white area medially; index 1.75–2.18, $\bar{x}$ 1.99; midrib extending to apex; outer margin with large spine-like spicules in apical 0.2–0.44, tiny spicules on apex in Nepal specimens, bare point apically in Thai specimens; inner margin with similar large spicules in apical 0.12–0.22; seta 1-P short, single.

Material examined.—NEPAL: Lumbini District, Shivapur, IX-13-92, 1 ♀ LePe, IX-16-92, 1 ♀ LePe, ex *Eichornia* pond (Darsie and Courtney). MALAYSIA: Perak, Tanjong Tualang F.R., 1968, 3 ♀ Pe, 2 ♂ Pe (811-15, 102, 104, 105, 113). PHILIPPINES: Mindoro Island, San Jose, II-25-45, 1 ♂ LePe, ex *Pistia* marsh (E.S. Ross).

Mimomyia (*Etorleptiomyia*) *luzonensis* Ludlow

(Fig. 2)

Pupa.—Position and size of setae as figured, range and modal number of branches in Table 2. Abdomen 3.61–3.87, $\bar{x}$ 3.72 mm, paddle 1.0–1.04, $\bar{x}$ 1.03 mm.

Cephalothorax: Uniformly light brown, setae 1,3-CT long, single, 3-CT stout; 5-CT medium long, usually double; 6-CT light in color, very long and stout, single; 8-CT unusually stout, single; trumpet extremely long, length 2.78–3.28, $\bar{x}$ 3.03 mm; index 25.9–35.4 $\bar{x}$ 32.4; tracheoid 2.14–2.63, $\bar{x}$ 2.36 and pinna 0.13–0.16 $\bar{x}$ 0.148 of total length.

Abdomen: Uniformly light tan; Seta 1-I medium long, single; 2,3-I long to very long, rather stout, single; 1-II long, stout, double, sometimes single; 1-III-VI long, stout, aciculate, usually 4 br, 1-VII very long, triple; 3-VII absent; 5-IV-VI long, stout, aciculate, usually triple, 5-VII 4,5 br; 6-II-VI long, single; 6-VII long, 4–6 br; 9-II-VII short, larger than usual, single; 9-VIII medium long or long, aciculate, 7–11 br; female genital lobe produced apicolaterally, with many large spines.

Paddle: light tan, linear, index 4.68–5.35 $\bar{x}$ 4.98, midrib extending to apex, outer margin with spicules coarse in apical 0.5, finer basally; inner margin with coarse spicules to near base, seta 1-P short, thin, single.

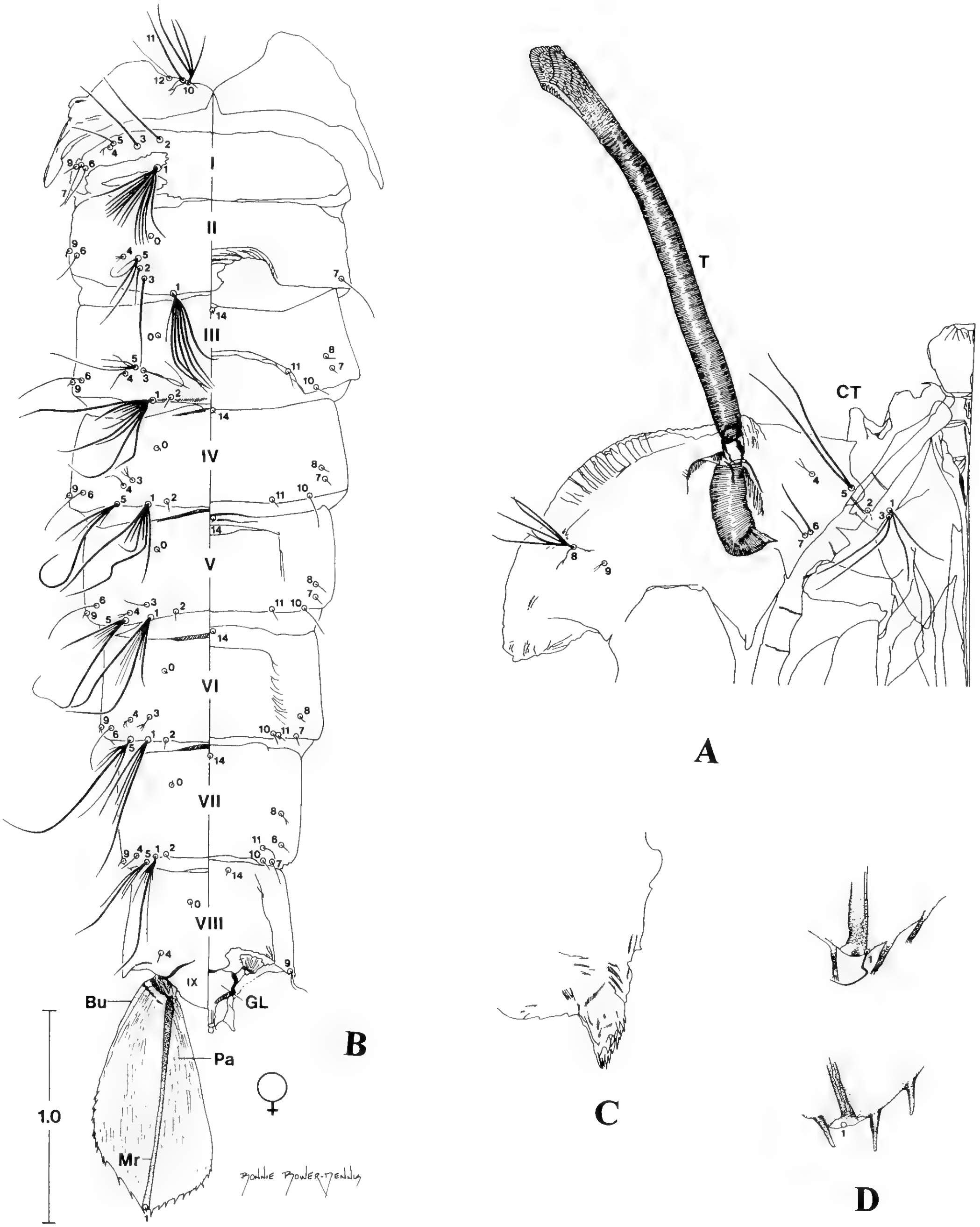

Fig. 1. Pupa of *Mimomyia* (*Mim.*) *chamberlaini*. A, Cephalothorax. B, Metanotum and abdomen. C, Lateral process of female genital lobe. D, Enlarged spicules on border of paddle, upper from Nepal, lower from Thailand. Abbreviations: Bu = external buttress; CT = cephalothorax, GL = genital lobe, Mr = midrib. Pa = paddle, T = respiratory trumpet; scale in mm.

Table 1. Setal branching of *Mimomyia chamberlaini* pupa.

Seta	Cephalo-thorax	Abdominal Segments I	II	III	IV	V	VI	VII	VIII
0	—	—	1	1	1	1	1	1	1
1	2–4 (2)[1]	13–38 (?)	6–10 (6)	7–12 (10)	6–11 (8)	4–11 (7)	4–8 (8)	4–6 (?)	—
2	1–3 (2)	1	1	1	1	1	1	1	—
3	2–4 (2)	1	1,2 (1)	1–5 (2)	2–6 (3)	1–3 (2)	1–4 (3)	—	—
4	1–5 (3)	3–5 (4)	2–6 (3)	1	1	1–5 (1)	1–3 (1)	1–2 (1)	1–4 (1)
5	1–5 (4)	1–3 (1)	2–8 (4)	3–6 (4)	4–10 (?)	5–11 (9)	4–10 (?)	3–7 (4)	—
6	1	1–4 (2)	1–4 (1)	1	1	1,2 (1)	1,2 (1)	1–4 (2)	—
7	1	1,2 (1)	1,2 (1)	1	1,2 (1)	1,2 (1)	1,2 (1)	1,2 (1)	—
8	4–6 (5)	1,2 (1)	—	1–3 (1)	1–3 (1)	1–3 (1)	1–3 (1)	1–4 (3)	—
9	1–4 (2)	—	1	1	1	1	1	1	1–4 (3)
10	2–4 (4)	—	—	1	1,2 (1)	1,2 (1)	1	1–3 (1)	—
11	1–4 (1)	—	—	1	1	1	1	1,2 (1)	—
12	1,2 (1)	—	—	—	—	—	—	1	—
14	—	—	—	1	1	1	1	1	1

[1] Range followed in parenthesis by the mode.

Material examined.—THAILAND, Chonburi Province, Bang Lamung, Khao Mai Keao, X-8-63, 2 ♀, 3 ♂, Pe, ex pond on trackway (Kol, Vuth, Chmnong; Nepal: Sunsari District, Tarahara XI-25-87, 1 ♀, SPP, RFD; Sindhuli Garhi District, Bardiagoth, IV-28-90, 2 ♀, SPP.

Mimomyia (*Mimomyia*) *hybrida* (Leicester)

(Fig. 3)

Pupa.—Position and size of setae as figured, range and modal number of branches in Table 3. Abdomen 2.92–3.47, $\bar{x}$ 3.27 mm, paddle 0.78–0.87, $\bar{x}$ 0.83 mm.

Cephalothorax: Mottled with darker brown pattern, seta 1,3-CT very long, usually triple; 5-CT very long, 3-5 br; 6-CT very long, rather stout, single; 8-CT very long, with 4-6 br; trumpet length 1.46–1.92, $\bar{x}$ 1.64 mm, index 9.0–13.2, $\bar{x}$ 11.1; tracheoid 0.82–0.1.05, $\bar{x}$ 0.93 and pinna 0.16–0.24 $\bar{x}$ 0.20 of total length, pinna split into two spinulose processes, adapted for piercing plant tissue.

Abdomen: Uniformly light tan; seta 1-I float seta, 11–16 br; stout; 1-II long, rather stout, with 4–7 br; seta 1-III-VI with thin, long or very long br, 1-III with 4–9 br, 1-IV-VI with 2–5 br, 1-VII long, single, seldom double; 2,3-I long, single, 2-I stout; 3-VII absent; 5-IV-VI with thin, moderately long or long br, 5-IV with 3–6 br, 5-V with 4 or 5 br, 5-VI with 2-4 br; 6-II-VI medium long, single, 6-VI rarely double; 6-VII ventral, short, single or double; 9-VIII short, usually double, when single, aciculate; female genital lobe with rounded projections apicolaterally, with numerous small spicules.

Paddle: ovoid, entirely light brown, bilobate apically, median lobe larger, index 1.64–1.92, $\bar{x}$ 1.78 outer margin with coarse spicules in apical 0.20–0.29, inner margin with coarse spicules in apical 0.20–0.29, seta 1-P absent.

Material examined.—THAILAND, Chiengmai Province, Chiengmai, IX-30-52, 1 ♀, 1 ♂, LePe, ex pond (M300-A, M-300-1) (M. Rattanopradith); Nonthburi Province, Pak Kert, Ko Kret, IV-17-64, 1 ♀, LePe, ex ditch (Prajim). Nepal: Sunsari District, Tarahara, IX-X-85, 2 ♀; Morang District, Khanar, IX-X-85, 2 ♀; Sonapur, IX-X-85 2 ♀ (Burgess, unpublished data).

KEY TO THE KNOWN PUPAE OF THE GENUS *MIMOMYIA* IN THE ORIENTAL AND AUSTRALASIAN REGIONS

Partially adapted from Mattingly (1957)

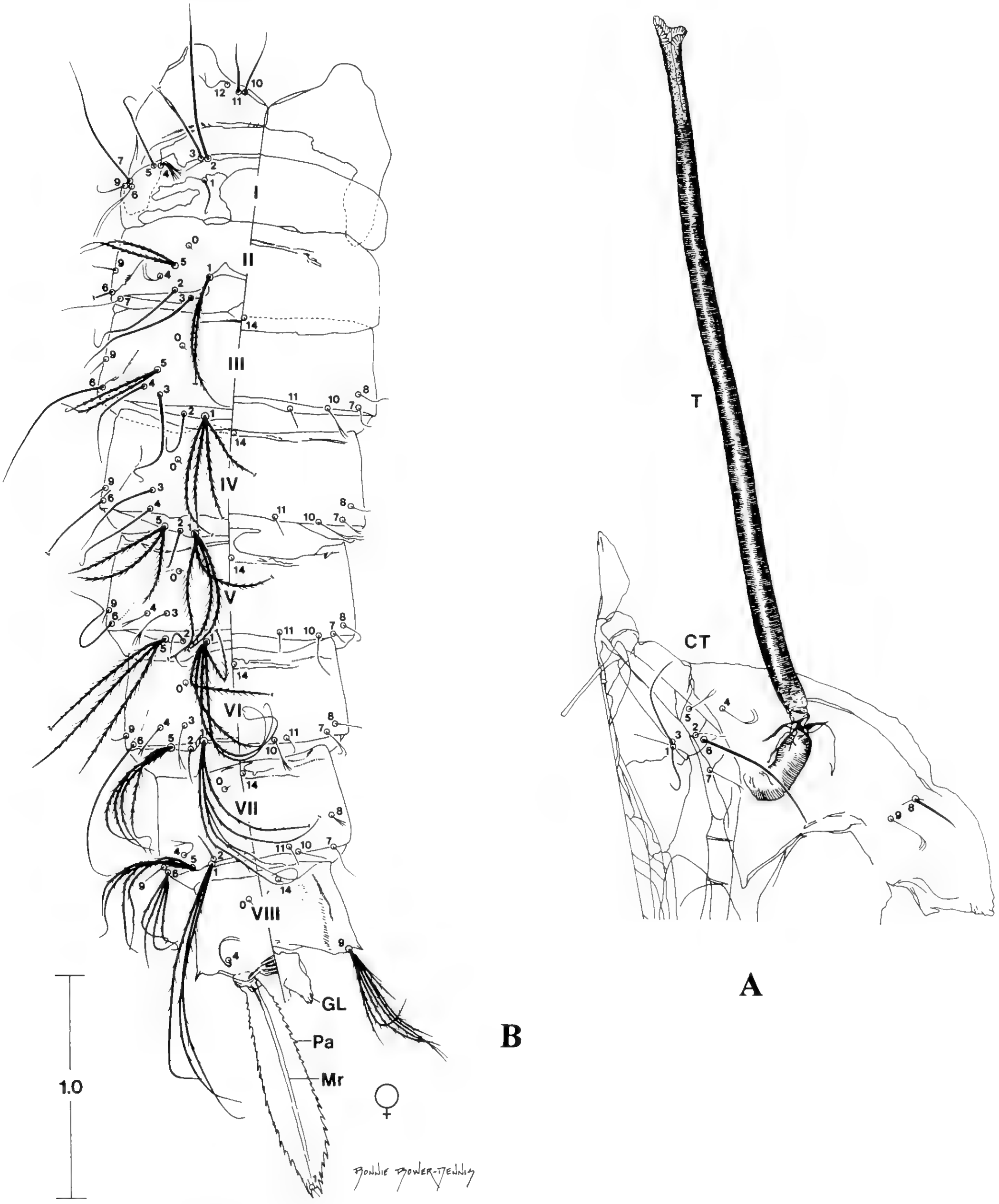

Fig. 2. Pupa of *Mimomyia* (*Eto.*) *luzonensis*. A, Cephalothorax. B, Metanotum and abdomen. For explanations of abbreviations, see Fig. 1.

1. Seta 9-VIII very large with about 8 or more br, paddle at least 4× greatest width; seta 1-I small, single or bifid; trumpet length at least 20× width at middle 2

– Seta 9-VIII small, with at most 3 br; paddle less than 3× greatest width; seta 1-I large with numerous branches; trumpet < 20× width at middle (subg. *Mimomyia*) 7

2(1). Paddle length at least 10X greatest width; seta 1,5-VII single or bifid; trumpet with tracheoid spiculose (subg. *Ingramia*) 3

– Paddle length at most 8X greatest width;

Table 2. Setal branching of *Mimomyia luzonensis* pupa.

Seta	Cephalo-thorax	Abdominal Segments I	II	III	IV	V	VI	VII	VIII
0	—	—	1	1	1	1	1	1	1
1	1	1	1,2 (2)	3,4 (4)	3,4 (4)	4,5 (4)	4–8 (5)	3	—
2	1	1	1	1	1	1	1	1	—
3	1	1	1	1	1,2 (1)	1–3 (3)	1–3 (2)	—	—
4	1-3 (2)[1]	2–6 (2)	1–3 (1)	1–4 (1)	2,3 (2)	1,2 (2)	1–3 (1)	1–3 (2)	1–4 (1)
5	2	1	1,2 (2)	2,3 (2)	3	3	3–5 (3)	4,5 (4)	—
6	1	1,2 (1)	1	1	1	1	1	4–6 (4)	—
7	1,2 (1)	1	1,2 (1)	1,2 (1)	1–3 (?)	1–3 (1)	1–3 (2)	1,2 (1)	—
8	1	—	—	1,2 (1)	1	1,2 (1)	1,2 (1)	1–3 (2)	—
9	1-3 (2)	1	1	1	1	1	1	1	7–10 (10)
10	1,2 (1)	—	—	1,2 (1)	1,2 (2)	1,2 (1)	1–5 (1)	1–3 (1)	—
11	1	—	—	1,2 (1)	1	1	1	1	—
12	1,2 (1)	—	—	—	—	—	—	—	—
14	—	—	—	1	1	1	1	1	1

[1] Range of branching followed in parenthesis by the mode.

seta 1,5-VII with at least 3 br, tracheoid of trumpet smooth (subg. *Etorleptiomyia*) . . . 4
3(2). Seta 5-II,III about 0.75 length of seta 3-II-III . . . . *fusca* (Leicester)
– Seta 5-II,III 0.35 or less length of seta 3-II,III . . . . *deguzmanae* (Mattingly)
4(2). Inner margin of paddle with small spinules in basal 0.5 5
– Inner margin of paddle with prominent spines 6
5(4). Seta 6-II, III, VII longer than following tergum . . . . *bougainvillensis* (Belkin)
– Seta 6-II, III, VII shorter than following tergum . . . . *elegans* (Taylor)
6(4). Setae 2,3-I subequal; seta 8-II present . . . . *solomonis* (Belkin)
– Seta 2-I 2.0 length of 3-I; seta 8-II absent . . . . *luzonensis* (Ludlow)
7(1). Trumpet with 2 pointed processes apically 8
– Trumpet without 2 pointed processes at apex 9
8(7). Setae 1,5-IV-VI with some branches longer than following tergum; paddle emarginate apically . . . . *hybrida* (Leicester)
– Setae 1,5-IV-VI shorter than following tergum; paddle rounded apically . . . . *gurneyi* (Belkin)
9(7). Lateral pale area in basal 0.58–0.74 of paddle, 0.5 of total length *chamberlaini* Ludlow
– Pale area in distal 0.5 of paddle, 0.3 of total length or less . . . . *aurea* (Leicester)

COMPARATIVE MORPHOLOGY OF SUBGENERA OF *MIMOMYIA* BASED ON PUPAL CHARACTERS

Based on evidence found in the descriptions of the pupae of 19 species in the subgenus *Ingramia*, five species in the subgenus *Etorleptiomyia*, and 9 in the subgenus *Mimomyia*., the latter appears to be the most primitive. That is because it has seta 8-CT a normal branched seta, seta 1-I a dendritic float seta, and paddle with indices of 1.6–2.18, similar to most other mosquito pupae. On the other hand, the subgenera *Etorleptiomyia* and *Ingramia* have seta 8-CT stout, almost spike-like in most species, seta 1-I a single seta, and the paddles linear in shape with indices of 4.5–20. All subgenera have long tracheoid respiratory trumpets; however, those of *Mimomyia* have indices of varying from, 9.0–17.0, while those of the other two subgenera have indices of 25–50. Contrarily, seta 9-VIII is greatly reduced in the subgenus *Mimomyia*, with 2–5 branches, while it is fully developed in the other two with 8–22 branches. All in all, pupal evidence supports the evolutility of *Etorleptiomyia* and *Ingramia* at a later time than *Mimomyia*. These observations also consider the work of Grjebine (1986) on the Ficalbiini of Madagascar.

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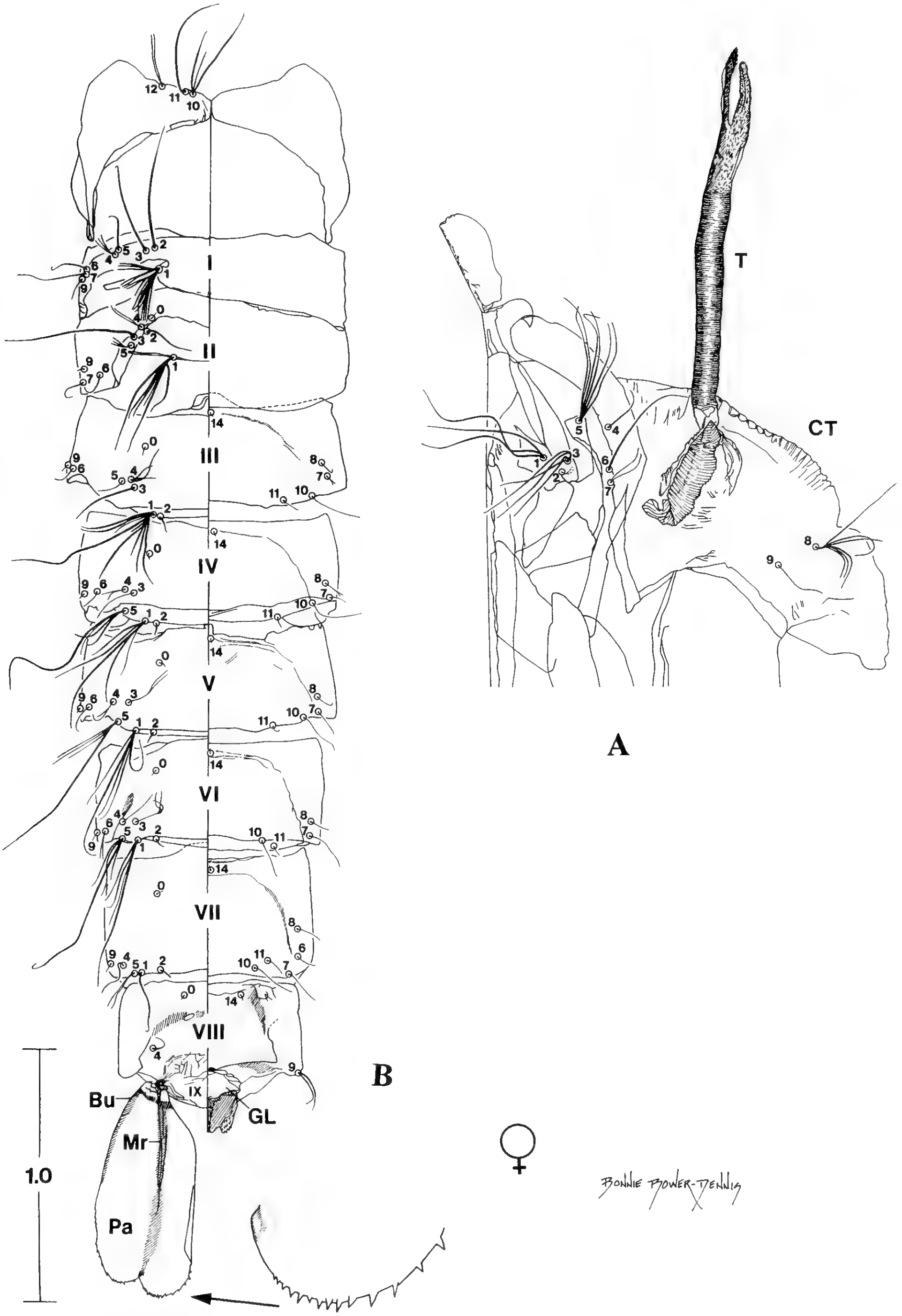

Fig. 3. Pupa of *Mimomyia* (*Mim.*) *hybrida*. A, Cephalothorax. B, Metanotum and abdomen. For explanation of abbreviations, see Fig. 1.

Table 3. Setal branching of *Mimomyia hybrida* pupa.

Seta	Cephalothorax	Abdominal Segments							
		I	II	III	IV	V	VI	VII	VIII
0	—	1	1	1	1	1	1	1	1
1	1–3 (3)[1]	11–16 (?)	4–7 (5)	4–9 (5)	2–5 (3)	2–5 (4)	2–4 (4)	1,2 (1)	—
2	2	1	1	1	1	1	1	1,2 (1)	—
3	1–4 (3)	1	1	1,2 (1)	1–3 (1)	2,3 (2)	1–3 (2)	—	—
4	1–4 (3)	2–4 (3)	1–4 (2)	3,4 (3)	2	2	1,2 (2)	1,2 (1)	1–3 (1)
5	3–6 (5)	1	2;3 (3)	1,2 (1)	3–6 (?)	4,5 (4)	2–4 (3)	1,2 (2)	—
6	1	1	1	1	1	1	1,2 (1)	1,2 (1)	—
7	1–3 (2)	1	1	1,2 (1)	1,2 (1)	1–4 (1)	1	1	—
8	4–6 (5)	—	—	1,2 (1)	1,2 (1)	1,2 (1)	1,2 (1)	1,2 (1)	—
9	1–3 (1)	1	1	1	1	1	1	1	1,2 (2)
10	2,3 (2)	—	—	1	1	1,2 (1)	1	1	—
11	1,2 (1)	—	—	1	1	1	1	1	—
12	1,2 (1)	—	—	—	—	—	—	—	—
14	—	—	—	1	1	1	1	1	1

[1] Range followed in parenthesis by the mode.

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A STUDY OF THE GENUS *FALCOSYNTRETUS* TOBIAS FROM THE NEW WORLD WITH FIVE NEW SPECIES AND A KEY TO KNOWN SPECIES (HYMENOPTERA: BRACONIDAE: EUPHORINAE)

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Abstract.—Five new species of *Falcosyntretus* Tobias from North and Central America are described and illustrated: ***F. complanatus, F. falcoi, F. fallax, F. muesebecki,*** and ***F. transversus.*** A key for the six known New World species of *Falcosyntretus* is provided.

Key Words: *Falcosyntretus,* Euphorinae, parasitoids

The genus *Falcosyntretus* Tobias was erected based on one Asian species, *F. falcifer* (Tobias 1965). Although a species now assigned to this genus, *F. venustus,* was described by Muesebeck (1936), the presence of this genus in the New World was not recognized until that species was reclassified by Shaw (1985). Shaw (1985) also established the monophyly of *Falcosyntretus* on the basis of three synapomorphies: the propodeum being mostly smooth and polished, the petiolate first metasomal tergum being smooth and polished, and the curved ovipositor which is as long or longer than the first metasomal tergum. Shaw (1985) defined the tribe Syntretini to include *Falcosyntretus* and five other genera sharing several synapomorphies including cleft tarsal claws, forewing vein M+CU absent, and the petiolate first metasomal segment being fused ventrally. Tobias (1986) indicated that the European species *Syntretus xanthocephalus* Marshall should be transferred to *Falcosyntretus.* Most recently, Papp (1992) described *F. elabsus* from Korea.

As far as known, all members of the tribe Syntretini have distinctive cleft tarsal claws (Figs. 13–16) and are koinobiont endoparasitoids of adult Hymenoptera, including bees and ichneumonids (Shenefelt 1969, Shaw 1988). This peculiar life style may partly account for their rarity in collections, because few attempts are made to rear parasitoids from hosts such as adult bumble bees or adult ichneumonids. Specimens can be identified as *Falcosyntretus* using the key provided by Shaw (1997). A generic diagnosis was provided by Shaw (1985). Morphological terminology follows that of Sharkey and Wharton (1997). Types are deposited at the University of Wyoming, Laramie (UWL); the Hungarian Natural History Museum, Budapest (HNHM); the National Museum of Natural History, Smithsonian Institution, Washington, D.C. (USNM); the Canadian National Collection, Ottawa (CNC); and the Zoological Museum, Lund (ZML).

The root of the generic name, *falco,* means "hawk" in Latin and refers to the falcate (curved) ovipositor of the type species. However, this character can be misleading for generic recognition because it is clear from examination of females of several species that the ovipositor is very flexible, and its appearance varies depending on its position at death. It may appear curved or straight, or somewhat shorter or longer depending on its position or degree or exsertion at death. A more useful character for generic recognition is the mostly smooth propodeum that lacks a carinate areola (Figs. 9–12).

KEY TO FEMALES OF THE NEW WORLD SPECIES OF *FALCOSYNTRETUS*

1. First metasomal tergite distinctly narrowest medially, giving the appearance of a constriction near the spiracles (Fig. 1); body size usually smaller than 3mm; antenna short, with 17–23 antennomeres 2

– First metasomal tergite about as broad medially as basally, or just barely narrower, but not appearing contricted at middle (Figs. 2–4); body size usually larger than 3mm, antenna longer, with more than 23 antennomeres 3

2(1) Occipital carina effaced dorsally (Fig. 5); vein cu-a of hind wing absent; vertex of head with a broad dark brown to black band that meets compound eye margins completely . . . . *Falcosyntretus transversus*, new species

– Occipital carina complete dorsally (as in Fig. 6); vein cu-a of hind wing present; vertex of head sometimes with dark markings around ocelli, but never meeting margins of compound eyes . . . . *Falcosyntretus muesebecki*, new species

3(1). First metasomal tergite distinctly broader posteriorly, surface entirely smooth (Figs. 2–4); propodeum entirely smooth (Figs. 9–10) or with scattered, extremely faint rugae or pitting postero-medially (Fig. 11) 4

– First metasomal tergite about evenly broad over its entire length, not greatly broader posteriorly than anteriorly or medially, surface smooth but with two small longitudinally striate areas latero-medially (Fig. 4); propodeum with median line distinctly rugose (Fig. 12) . . . . *Falcosyntretus falcoi*, new species

4(3). Posterior margin of median ocellus about even with anterior margins of lateral ocelli (Fig. 7); propodeum entirely smooth 5

– Posterior margin of median ocellus distinctly anterior to anterior margins of lateral ocelli (Figs. 6, 8); propodeum variable, sometimes smooth but often with faint irregular rugae or pitting postero-medially (Fig. 11) . . *Falcosyntretus fallax*, new species

5(4). Mesoscutum entirely black; propodeum with a complete semi-circular carina bordering the junction with the metasoma (Fig. 9) . . *Falcosyntretus complanatus*, new species

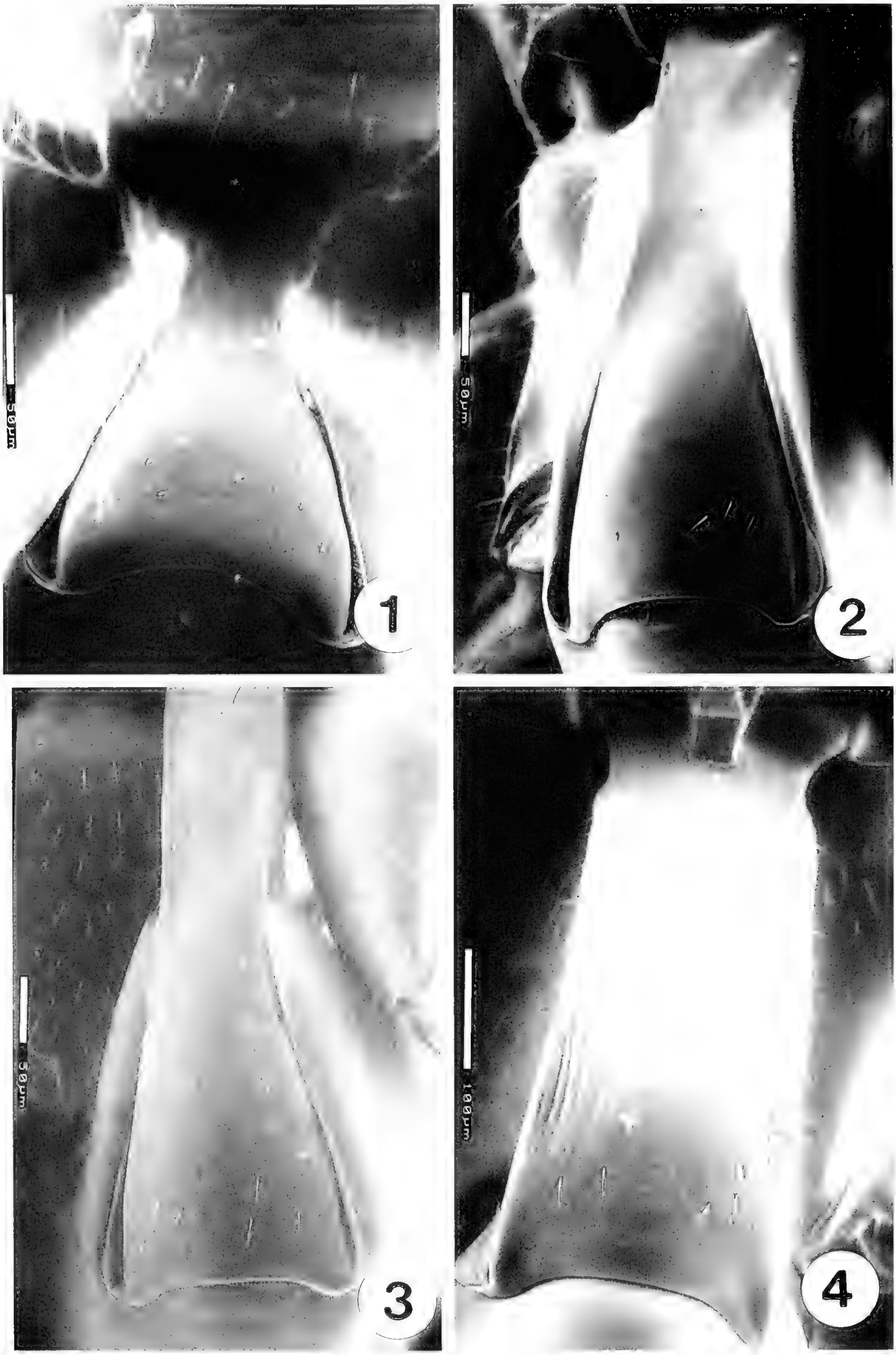
– Mesoscutum yellowish orange, with some black markings; propodeum with a distinct break medially in the carina bordering the junction with the metasoma (Fig. 10) . . . . *Falcosyntretus venustus* (Muesebeck)

Falcosyntretus complanatus Papp and Shaw, new species

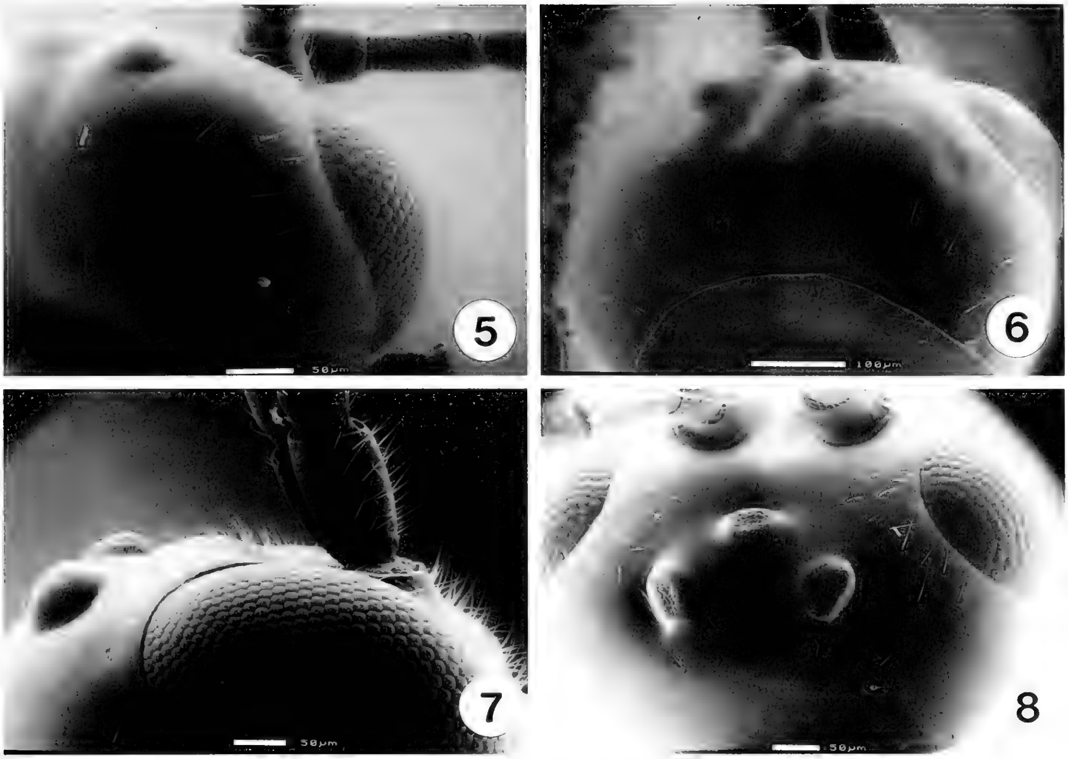
(Figs. 2, 9)

Description of holotype female.—Body length 4 mm. Head in dorsal view 1.6× broader than long, eye somewhat protruding and longer than temple, temple rounded close behind eye. Ocelli large and forming a low triangle, distance between median and lateral ocelli shorter than greatest diameter of an ocellus, posterior border of median ocellus even with anterior border of lateral ocelli. Antenna just shorter than body and with 30 antennomeres, first flagellomere 1.4× as long as second flagellomere, further flagellomeres proximo-distally 2.0–2.2× as long as broad. Mesosoma in lateral view 1.4× as long as high. Pterostigma 3.5× as long as wide. Hind wing vein cu-a present basally. Hind femur 5.3× as long as broad. Hind basitarsus as long as tarsomeres 2–3 combined. Metasoma somewhat longer than head and mesosoma combined. Proximal 0.5 of petiole flattened, its hind width 1.4× greater than basal width, petiole itself as long as tarsomeres 1–2 combined. Tergites long, second tergite slightly wider posteriorly than long medially, third tergite quadrate or as long as wide behind. Ovipositor sheath as long as hind tarsomeres 1–2 combined.

Color: Body color mostly golden yellow, darker dorsally. Antenna, longitudinal streak of vertex brownish black. Mesosoma dorsally (mesonotum, scutellum, metanotum and propodeum) and petiole black. Tergites dark brown to black. Legs mostly yellow, coxae and trochanters whitish, hind femur apically and tarsomeres dark brown.



Figs. 1–4. First metasomal tergites of *Falcosyntretus* species, dorsal view. 1, *F. muesebecki,* 300×. 2, *F. complanatus,* 210×. 3, *F. venustus,* 220×. 4, *F. falcoi,* 200×.



Figs. 5–8. Heads of *Falcosyntretus* species. 5, *F. transversus,* dorso-lateral view, 285×, note effaced occipital carina. 6, *F. fallax,* dorsal view, 200×. 7, *F. complanatus,* lateral view, 220×. 8, *F. muesebecki,* dorsal view, 200×.

Wings subhyaline, pterostigma and venation dark brown.

Variation, paratype females.—Body 4.0–4.2 mm long. Head in dorsal view 1.48–1.54 broader than long. Antenna with 25–31 antennomeres. First flagellomere 1.3–1.4× as long as second flagellomere. Pterostigma 3.4–3.8× as long as wide. Hind femur 4.1–5.0× as long as broad. Hind femur apically and tarsomeres dark brown to black.

Material examined.—Holotype ♀: COSTA RICA: Puntarenas, San Vito, Estac. Biol. Las Alturas, 1,500 m, ex. Malaise, January 1992 (P. Hanson) (UWL). Paratypes: same data as holotype, 1 ♀ (UWL); same data except December 1991, 1 ♀ (UWL); same data except June 1992, 2 ♀ (UWL); same data except March 1992, 1 ♀ (UWL); same data except May 1992, 1 ♀ (UWL); San José, Cerro de la Muerte, 26 km. N. San Isidro, ex. Malaise, 2,100 m, February–May 1991 (P. Hanson), 1 ♀ (HNHM).

Comments.—The form of the petiolate first metasomal tergum is distinctive in this species; it is broad and flat through its basal half, and is barely or not at all constricted at the middle (Fig. 2). *Falcosyntretus complanatus* is most similar to *F. venustus* (Muesebeck) but can be distinguished by the presence of a complete semi-circular carina bordering the junction of the metasoma to the propodeum (Fig. 9) and by the mesoscutum being entirely black.

Etymology.—The species name *complanatus* (= flattened) refers to the dorsally flattened petiole.

Falcosyntretus falcoi Papp and Shaw, new species

(Figs. 4, 12–13)

Description of holotype female.—Body length 4 mm. Head in dorsal view 1.6×

broader than long, eye somewhat protruding and longer than temple, temple rounded close behind eye. Ocelli large and forming a low triangle, distance between median and lateral ocelli shorter than greatest diameter of an ocellus, posterior border of median ocellus even with anterior border of lateral ocelli. Antenna just shorter than body and with 30 antennomeres, first flagellomere 1.4× as long as second flagellomere, further flagellomeres proximo-distally 2.0–2.2× as long as broad. Mesosoma in lateral view 1.4× as long as high. Pterostigma 3.5× as long as wide. Hind wing vein cu-a present basally. Hind femur 5.3× as long as broad. Hind basitarsus as long as tarsomeres 2–3 combined. Propodeum mostly smooth except median line distincty rugulose. Metasoma somewhat longer than head and mesosoma combined. broad and flat through its entire length, parallel-sided with no median constriction, and entirely smooth except for two small longitudinally striate areas latero-medially. Hind width of petiole barely broader than anterior width. Entire petiole as long as tarsomeres 1–2 combined. Tergites long, second tergite slightly wider posteriorly than long medially, third tergite quadrate or as long as wide behind. Ovipositor sheath as long as hind tarsomeres 1–2 combined.

Color: Body color mostly golden yellow, darker dorsally. Antenna, longitudinal streak of vertex brownish black. Mesosoma dorsally (mesonotum, scutellum, metanotum and propodeum) and petiole black. Tergites dark brown to black. Legs mostly yellow, coxae and trochanters whitish, hind femur apically and tarsomeres dark brown to black. Wings subhyaline, pterostigma and venation dark brown.

Variation, paratype female.—Essentially as in holotype female.

Material examined.—Holotype ♀: MEXICO: Chiapas, San Cristobal de las Casas, 7,000 ft., 7 June 1969, Malaise trap, (CNC). Paratypes: UNITED STATES: 1 ♀, North Carolina, Swain Co., Smokemont, 16 July 1977, Malaise trap, North Carolina Department of Agriculture (USNM). HONDURAS: 1 ♀, Olancho, Parque Nacional La Muralla, 15 km N La Union, 15.07N, 86.45W, April 1995, R. Cave, Malaise trap in high elevation rain forest, (ZML).

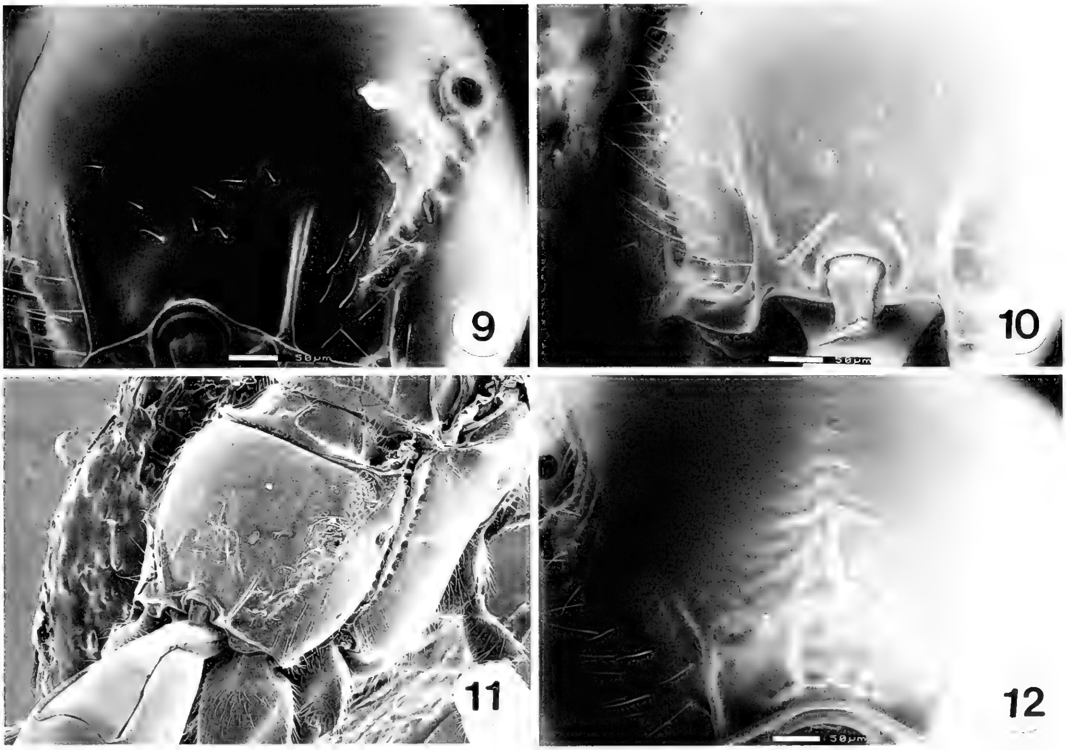
Comments.—The form of the petiolate first metasomal tergum is very distinctive in this species: it is broad and flat through its entire length, parallel-sided with no median constriction, and entirely smooth except for two small longitudinally striate areas latero-medially (Fig. 4). It is most similar to *F. complanatus* but can be distinguished by the mentioned petiolar characters, and also differs by having a distinctly rugulose median area on the propodeum (Fig. 12). The wings of this species were illustrated in Marsh et al. (1987, fig. 288).

Etymology.—This species is named in honor of Guido Falco, the owner of Penguin's restaurant in Santo Domingo de Heredia, Costa Rica.

Falcosyntretus fallax Papp and Shaw, new species

(Figs. 6, 11, 14)

Description of holotype female.—Body 3 mm long. Head in dorsal view 1.7× broader than long, eye somewhat shorter than temple, temple not rounded close behind eye. Ocelli forming a high triangle, distance between median and lateral ocelli as long as greatest diameter of an ocellus, posterior border of median ocellus distinctly anterad of anterior border of lateral ocelli. Antenna as long as body and with 27 antennomeres, first flagellomere 1.3× as long as second flagellomere, flagellomeres proximo-distally 1.6–2.0× as long as broad. Mesosoma in lateral view 1.4× as long as high. Fore wing as long as body. Pterostigma 3.6× as long as wide. Hind wing vein cu-a present basally. Hind femur 4.2× as long as broad. Hind basitarsus as long as tarsomeres 2–4 combined. Metasoma as long as head and mesosoma combined. Petiole 1.5× broader posteriorly than basally, petiole itself as long as middle tarsomeres 1–2 and half of



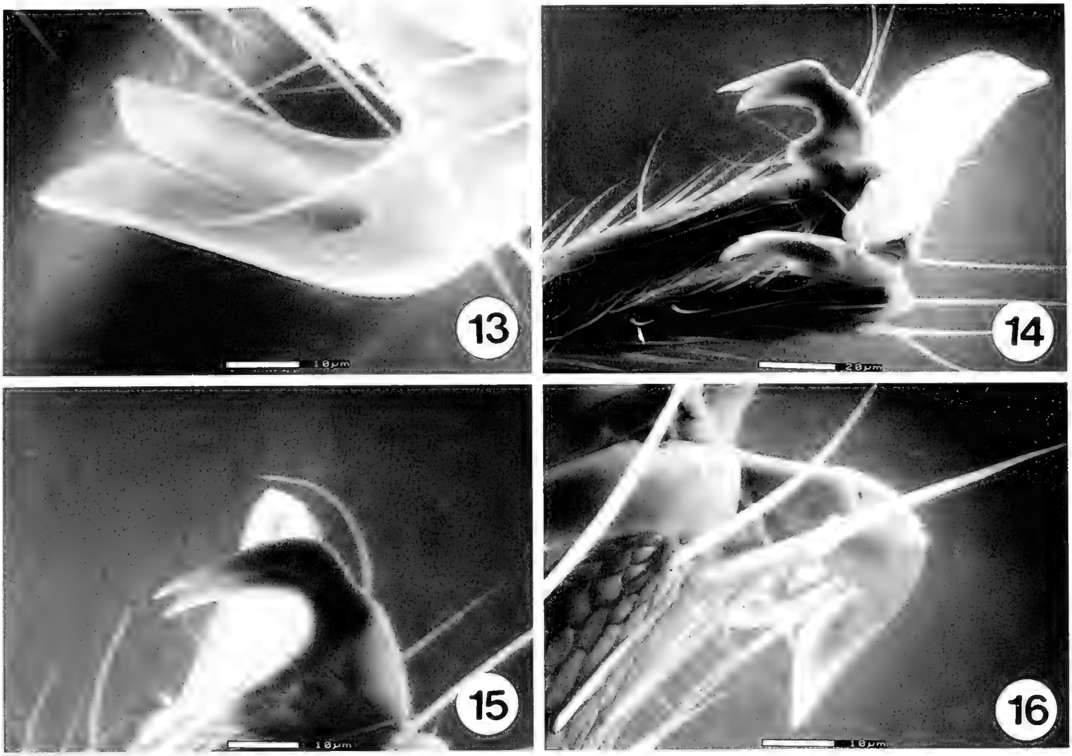
Figs. 9–12. Propodea of *Falcosyntretus* species, dorsal views. 9, *F. complanatus,* 210×. 10, *F. venustus,* 230×. 11, *F. fallax,* 110×. 12, *F. falcoi,* 200×.

tarsomere 3. Tergites 2–3 transverse, second tergite 1.4× and third tergite 2.6× as wide posteriorly as long medially. Ovipositor sheath as long as hind basitarsus and half of second tarsomere combined.

Color: Ground color of body mostly yellow. Wide longitudinal streak of vertex brownish black. Mesosoma above (mesonotum, scutellum, metanotum and propodeum) and petiole black. Tergites brown. Legs yellow, except coxae and trochanters whitish. Wings subhyaline, pterostigma brownish opaque.

Variation, paratype females.—Similar to the holotype except body length 2.6–3.1 mm, usually 2.0–3.0 mm, long; head in dorsal view 1.57–1.67×, usually 1.58–1.6×, as broad as long; antenna about as long as body and with 25–28, usually 27–28, antennomeres; pterostigma 3.3–3.7×, usually 3.5–3.7×, as long as wide; hind femur 4.1–5.1×, usually 4.4–4.7×, as long as broad medially; scutellum varying from yellow to brown; tergites 2–7 varying from brown to nearly black, pterostigma varying from pale brown to yellowish brown.

Material examined.—Holotype ♀: UNITED STATES: Wyoming, Albany County, Medicine Bow National Forest, 5 miles SW Lincoln Monument, mixed conifer/aspen forest, taken with Malaise trap, 20–26 August 1990. Paratypes: 1 ♀, same data as holotype; 5 ♀ with same locality data as holotype except collected (1 each) on following dates: 23–38 July 1990, 28 July–2 August 1990, 13–20 August 1990, 15–19 July 1991, and 29 July–5 August 1991; 1 ♀, same data except meadow east of highway, Malaise trap, 13–20 August 1990; 2 ♀, same data except mixed forest near sagebrush, Malaise trap, 28 August 1990; 1 ♀, same data except meadow near mixed forest, 20–27 August 1991, swept and aspirated, S. R. Shaw; 3 ♀, same data



Figs. 13–16. Cleft tarsal claws of *Falcosyntretus* species. 13, *F. falcoi,* 1,500×. 14, *F. fallax,* 800×. 15, *F. transversus,* 1,500×. 16, *F. venustus,* 1,500×.

except Happy Jack Recreation Area, mixed forest near sagebrush, Malaise trap, 13–20 August 1990. CANADA: 2 ♀, Quebec, Summit King Mountain, 26 June and 4 July 1977, M. Sanborne; 1 ♀, New Brunswick, Kouchibouguac National Park, 9 August 1977, S. J. Miller, code 5800B; 1 ♂, same locality except 18 July 1977, G. A. Calderwood, code 5649G. Holotype and 8 paratypes from Wyoming are deposited at UWL, four paratypes from Wyoming at HNHM, and the remaining (Canadian) paratypes at CNC.

Comments.—The new species, *F. fallax,* is somewhat similar to *F. venustus* (Muesebeck), but can be distinguished by the following characters. In *F. fallax* the posterior border of the median ocellus is set distinctly in front of the anterior margins of the lateral ocelli (Fig. 6), the mesonotum is entirely black, the propodeum often has some irregular rugose sculpture posteromedially (Fig. 11), and the junction of the propodeum and metasoma is bordered by a semicircular carina. In *F. venustus* the median ocellus is barely in front of the lateral ocelli, the mesonotum has at least some yellow markings anteriorly and is often extensively marked with yellow, the propodeum is entirely smooth posteromedially, and the carina bordering the propodeal/metasomal junction is broken medially to form two separate short carinae (Fig. 10). The wings and propodeum of this species were illustrated in Shaw (1997, figs. 19 and 58).

Etymology.—The species name *fallax* (= false) refers to the deceptive features of this species that might cause it to be confused with *F. venustus.*

Falcosyntretus muesebecki Papp and Shaw, new species
(Figs. 1, 8)

Description of holotype female.—Body 2.7 mm long. Head in dorsal view 1.6×

broader than long, eye as long as temple, temple rounded close behind eye. Ocelli small and forming a high triangle, distance between median and lateral ocelli equal to greatest diameter of lateral ocellus, hind margin of median ocellus distinctly before anterior borders of lateral pair of ocelli. Antenna about as long as body and with 22 antennomeres, first flagellomere 1.2× as long as second flagellomere, flagellomeres proximo-distally 1.8–2.2× as long as broad. Metasoma shorter than head and mesosoma combined. First metasomal tergum as long as fore femur. Tergites 2–3 quadrate, a bit shorter medially than broad behind. Ovipositor sheath as long as middle basitarsus and second tarsomere combined.

Color: Ground color of body yellow, except flagellum, ocellar triangle, scutellum, metanotum, propodeum, and dorsum of metasoma mostly brownish black. Pterostigma opaque yellowish brown.

Variation, paratype females.—Similar to holotype except body 2.7–2.8 mm long. Eye somewhat protruding and a bit longer than temple. Antenna about one-quarter shorter than body and with 19 antennomeres, first flagellomere slightly longer than second flagellomere. Pterostigma 2.8× as long as wide. Hind femur 3.8× as long as broad medially. Ovipositor sheath sometimes almost as long as hind basitarsus. Ocellar field brown to black, sometimes lateral pair of spots on mesonotum, metanotum and propodeum brownish black. Hind half of petiole and tergites 4–7 sometimes dark brown, tergites 2–3 sometimes yellow.

Variation, paratype males.—Similar to female except body 2.3–3.0 mm long. Head in dorsal view 1.65–1.7× as broad as long. Antenna with 17–23 antennomeres. Pterostigma 2.75–2.8× as long as wide. Hind femur 3.5–3.6× as long as broad. Mesosoma and metasoma brown to brownish black, pronotum yellow, tergites 2+3 yellow to brown. First metasomal tergum gradually wider apically, not constricted medially as in female.

Material examined.—Holotype ♀: UNITED STATES: Georgia, Forsyth, 5–10 June 1971, ex. Malaise trap, F. T. Naumann (CNC). Paratypes: 1 ♀, same data as holotype (CNC); 1 female, Michigan, Ontonogan County, 18 June 1960, R. and K. Dreisbach; 1 ♂, New Mexico, Catron County, 8 mi. S.E. Luna, 7,500 ft, 9–14 July 1979, S. and J. Peck (CNC); 1 ♀ (HNHM), 3 ♂ (USNM), North Carolina, Alleghany County, Doughton Park, Malaise trap operated by North Carolina Department of Agriculture, 25 July 1977; 1 ♀, CANADA: Newfoundland, South Branch, July 1973, Malaise trap, Heinrich (CNC).

Comments.—The new species, *F. muesebecki* is most similar to *F. transversus* new species, which also has a small body length (less than 3 mm) and strongly constricted first metasomal tergum (see Fig. 1). *Falcosyntretus muesebecki* can be distinguished from *F. transversus* by the presence of the occipital carina dorsally, the presence of hind wing vein cu-a, and less extensive black markings on the vertex (black blotch not reaching compound eyes).

Etymology.—This new species is dedicated to the late Carl F. W. Muesebeck (1894–1987), well-known specialist of the parasitoid wasps and the first reviser of the euphorine braconids of the Nearctic Region (see Muesebeck 1936).

***Falcosyntretus transversus* Papp and Shaw, new species**

(Fig. 5, 15)

Description of holotype female.—Body 2.2 mm long. Head in dorsal view 1.6× broader than long, eye somewhat shorter than temple, temple rounded continuously, occipital carina effaced. Ocelli small and forming a high triangle, distance between median and lateral ocelli longer than greatest diameter of lateral ocellus, hind border of median ocellus distinctly anteriad of anterior borders of lateral ocelli. Antenna somewhat shorter than body and with 21 antennomeres, first flagellomere hardly longer than second flagellomere, flagellomeres proximo-distally 1.8–2× as long as broad.

Mesosoma in lateral view 1.4× as long as high. Pterostigma 3.3× as long as wide. Hind wing vein cu-a absent. Hind femur 4.4× as long as broad, hind basitarsus as long as tarsomeres 2–3 plus half of tarsomere 4. Metasoma somewhat longer than mesosoma. Petiole half as long as hind tibia. Tergites 2–3 transverse, second tergite 1.6–1.7× and third tergite 1.8–2× as broad as long medially. Ovipositor sheath also half as long as hind tibia.

Color: Ground color of body yellow. Transverse streak on vertex dark brown. Three spots on mesonotum, scutellum, metanotum, propodeum and tergites brownish yelow to brown. Legs yellow, coxae and trochanters whitish yellow. Pterostigma opaque yellow.

Variation, partype females.—Similar to the holotype except body 2.1mm long. Head in dorsal view 1.5× as broad as long. Antennae with 20–21 antennomeres. Pterostigma 3× as long as wide. Hind femur 4.5× as long as broad.

Material examined.—Holotype ♀: UNITED STATES: Wyoming, Albany County Medicine Bow National Forest, 2 miles N on road No. 705, willow bog, taken with Malaise trap, 19–23 July 1991 (UWL). Paratypes: 1 ♀, same data as holotype except 9–15 July 1991 (UWL). CANADA: 1 ♀, Manitoba, Riding Mountain National Park, Dead Ox Creek, hardwood forest, 400 m, 28 June 1979, Mason (CNC).

Comments.—The new species, *F. transversus,* is distinctive by the absence of the occipital carina and the transverse dark brown streak on upper part of head meeting the eyes.

Etymology.—The species name "*transversus*" refers to the transverse brown streak above on the head.

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PREY SELECTION AND DIURNAL ACTIVITY OF *HOLCOCEPHALA OCULATA* (F.) (DIPTERA: ASILIDAE) IN COSTA RICA

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Abstract.—*Holcocephala oculata* (F.) is an abundant small robber fly in open areas at La Selva Biological Station, Costa Rica, and was studied during August 1995. The majority (92%) of prey taken by *H. oculata* belong to the orders Hymenoptera, Diptera, and Coleoptera, with the remaining belonging, in order of decreasing frequency, to Hemiptera, Thysanoptera, Homoptera, Araneida, Strepsiptera, and Psocoptera. A comparison of sticky trap samples of flying insects and robber fly prey items reveal differences in the proportion of orders represented. Either *H. oculata* prefers particular orders of prey, or sticky traps are inadequate in sampling insect faunas. Cannibalism was not observed for *H. oculata.* Flies are more numerous in sunny areas at the beginning and end of the day. Flies are rarely observed in exposed areas on clear days when incident radiation is high. Areas shaded from direct incident radiation through the day show little change in fly numbers. Courtship and copulation, described herein, generally occur after 1200. *Holcocephala oculata* perches less than a meter off the ground, on average, with grass species tending to be the substrate most often chosen. No evidence for invertebrate predation on *H. oculata* was found, although several suitable predaceous arthropods co-occur with the robber fly and at least one, the ponerine ant *Ectatomma ruidum* Roger, readily attacked robber flies during feeding trials.

Key Words: Asilidae, *Holcocephala oculata,* robber fly, prey selection, courtship, diurnal activity, La Selva Biological Station, Costa Rica

Robber flies are among the larger and more visible members of the Diptera but are poorly understood when it comes to details of their ecology and behavior. A number of temperate zone Asilidae have been studied in detail (Lavigne and Holland 1969; Hespenheide and Rubke 1977; Hespenheide 1978, 1989; Weeks and Hespenheide 1985), but only a few tropical species (Fisher 1983; Shelly 1984a, 1988; Fisher and Hespenheide 1992). These flies typically capture their prey by waiting at a perch, intercepting the prey in mid-flight, and then returning to the perch and consuming the item externally. In addition, some members of this group have courtship displays that usually involve characteristic aerial maneuvers on the part of the male (Fisher and Hespenheide 1982, 1992).

Holcocephala oculata (F.) (Dasypogoninae: Danilini; Fig. 1) is the smallest (mean length 5.20 mm; n = 10) of four species of *Holcocephala* that are known to occur at La Selva Biological Station, Costa Rica (E. Fisher and H. A. Hespenheide, unpublished). Adults perch on low-growing vegetation in open areas. Here I describe the prey selection and diurnal activity of *H.*

Fig. 1. *Holcocephala oculata* showing typical perch behavior.

oculata and test the hypothesis that net incident radiation affects robber fly densities more than ambient temperature or time of day.

Materials and Methods

The data were collected during 10 separate days between 9–29 August 1995 at the Organization for Tropical Studies' La Selva Biological Station which is located at the confluence of the Río Puerto Viejo and Río Sarapiquí, Heredia Province, Costa Rica (McDade et al. 1994).

I chose two 50 m transects along weedy margins bordering mono- and polyculture plots within the "Huertos" project, an ongoing study on the sustainability of soil fertility in reconstructed tropical ecosystems (J. Ewel, personal communication). One transect was continually exposed to the sun from dawn until dusk ("sunny") whereas the other was shaded most of the time ("shady"). In addition to the transects, neighboring weedy margins within the Huertos project were used for additional behavioral and ecological observations on *H. oculata.* The weedy margins are cut at three to six month intervals and maintained at a height of less than three meters, and include several species of grasses, the most common being *Paspalum conjugatum* Berg., *Digitaria* sp., and *Cynodon dactylon* (L.) Pers. In addition, sedges (*Cyperus* spp.), and a diverse assemblage of plant species adapted to disturbed areas are common within the margins, as are fallen stems and leaves from adjacent tree plots.

At least five additional asilid species (three *Holcocephala,* one *Atractia,* one *Mallophora*) also co-occur with *H. oculata* in the weedy margins, and many species of predaceous arthropods may be found there as well (personal observation). The biology of one other species (*H. affinis* (Bellardi)) has been studied at La Selva and is generally similar to that of *H. oculata* (H. A. Hespenheide, unpublished).

To determine the diversity of prey taken by *H. oculata,* I captured feeding robber flies in the sunny transect during the 10 days and collected their prey items. Prey were collected by placing a plastic vial over a robber fly disturbing it so that it released the prey item into the vial, after which the robber fly was released. Preliminary captures revealed no detrimental effects due to this method of removing prey from the robber flies; released individuals remained in the transect and were often seen with a new prey item moments later. This method of prey removal has been used by others (see Hespenheide and Rubke 1977; Hespenheide 1978, 1989; Shelley 1984a, 1988). I recorded the time at which the prey item was collected in order to observe any temporal pattern in prey choice. Prey were not sampled from robber flies in the shady transect.

To gather information on the diversity of available prey items, I placed two sticky traps (21.5 × 28 cm transparencies coated with Tanglefoot®) on poles 1 m above the ground in the sunny transect during study days 8–10 while the robber flies were being sampled. Only arthropods measuring up to 4.3 mm (the maximum prey size collected from *H. oculata*) were considered in the analysis of the sticky traps. I identified prey and sticky trap samples to order. To determine if *H. oculata* exhibits a preference for certain prey over others or is behaving opportunistically, I performed two analyses to compare the actual robber fly prey with the available prey gathered from sticky traps. In one analysis I compared a subsample of the actual prey collected during the days the sticky trap samples were being employed (days 8–10). In a second analysis I included the entire actual prey sample collected during the 10 sampling days.

To determine the daily cycle of *H. oculata,* I censused flies on all 10 days dividing each into five two-hour periods beginning at 0800 h and ending at 1600 h. I conducted a census at the beginning of each of the five periods. Flies in the shady transect were simply counted while those in the sunny transect were counted and assigned to one of four activities: Feeding, copulating, courting, or other. The activity "other" included flies that were perched but not feeding and those that were flying between perches. During the intervening time periods, I kept out of the transects to minimize my disturbing the flies.

Prior observations on the daily cycle of *H. oculata* indicated that individuals avoided areas exposed to direct sunlight during the hottest times of the day, especially on clear days. I gathered data on ambient temperature and incident radiation to determine possible influences on the daily cycle of *H. oculata.* My hypothesis was that net radiation was more important than temperature or time of day in determining robber fly density in a given area; the null hypothesis was that there was no difference among the three independent variables in determining robber fly density. Net radiation was measured with a net radiometer monitored by the Huertos project. Ambient temperature was measured at a single fixed location in the shade between the two transects.

To describe the courtship behavior of *H. oculata,* I surveyed the transects during the study periods and observed courting pairs. I recorded the time and noted whether the outcome of the courting attempt was successful or unsuccessful in initiating copulation.

To determine whether or not *H. oculata* exhibits a preference for type or height of perch, I walked the weedy margins in and around the transects and recorded the choice of perch substrate, location on substrate, and height of perch above ground for all *H. oculata* encountered. The location was defined as precisely where on the substrate the fly chose to perch. Above ground height referred to the shortest distance between the fly's position on the substrate and the ground.

For all analyses, data on mean values are evaluated with the non-parametric Wilcoxon sign rank test, and contingency tables employing the *G*-test or Fisher's exact test are used to compare percentile data.

The arthropod predators most often observed in the transects foraging on substrates used by *H. oculata* were *Ectatomma ruidum* Roger, an aggressive ponerine ant, and orb-weaving spiders (Araneidae). I preformed feeding trials to determine the palatability of this fly to *E. ruidum* with robber flies disabled by having one wing removed. Orb-weavers construct webs in the weedy margins at the level of *H. oculata*'s perch heights. Because prey items accumulate in these webs, information on the spider's prey choice is readily available. I carefully removed the silk from entrapped prey to establish whether *H. oculata* was among those preyed upon by the spiders. Other arthropod predators observed included jumping spiders (Salticidae), which have been observed to take robber flies (H. A. Hespenheide personal communication), and tiger beetles (Cicindelidae). However, I observed so few individuals (n = 4 and n =

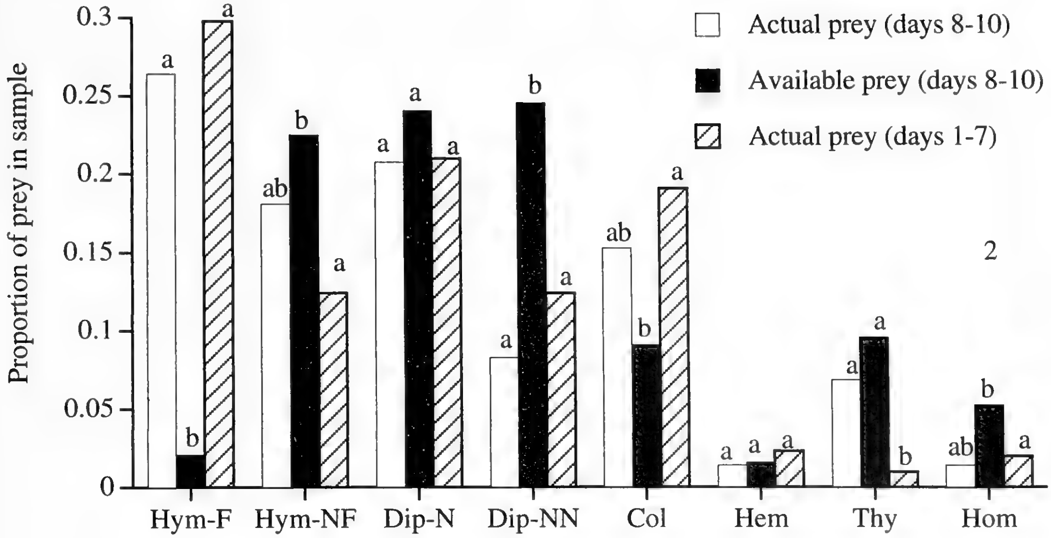
2, respectively) that I am unable to evaluate their potential as robber fly predators.

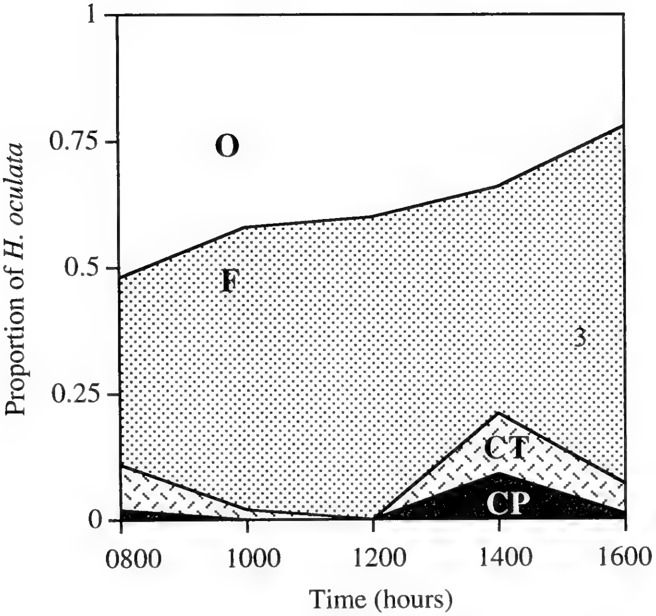
Results and Discussion

I collected nine orders of arthropod prey from *H. oculata* (Table 1). Among these the Hymenoptera, Diptera, and Coleoptera together account for 92% of the total prey sample. The most frequent prey at the study site were ant reproductives (28.5%). The average prey size was 1.48 mm (n = 379) with a range of 0.4 mm (nematocerous Diptera) to 4.3 mm (Coleoptera). Hymenoptera, Diptera, and Coleoptera were also found to dominate prey samples of *Holcocephala fusca* Bromley and *H. abdominalis* (Say) in the eastern United States (Dennis 1979, Scarbrough 1982). However, *H. calva* (Loew), also from the eastern United States and while showing a similar preference for Hymenoptera and Diptera, differs from other *Holcocephala* studied to date by prefering Hemiptera, Homoptera, and Psocoptera over Coleoptera (Scarbrough 1982). The predator to prey size ratio for *H. oculata* is 3.51 (mean robber fly length 5.20 mm). This is identical to that determined for *H. fusca* (3.5, mean robber fly length 5.9 mm; Dennis 1979), and intermediate between *H. abdominalis* and *H. calva* (3.4 and 3.7, respectively, mean robber fly lengths 5.81 mm and 7.25 mm, respectively; Scarbrough 1982). Compared to other asilid genera, the predator to prey size ratio for *H. oculata* is close to that reported for the similarly sized robber fly *Nannocyrtopogon neoculatus* Wilcox and Martin (3.66, mean robber fly length 6.62 mm) in the southwestern United States (Hespenheide1978), but differs from that reported for the much larger *Stichopogon trifasciatus* (Say) (2.23, mean robber fly length 13.00 mm), also from the southwestern United States (Weeks and Hespenheide 1985). No incidence of cannibalism by *H. oculata* was observed.

Factors that contribute to prey choice for particular asilid species likely include the relative difficulty in handling prey as well as the availability of prey in space and time (Lavigne and Holland 1969, Hespenheide and Rubke 1977). For *H. oculata,* comparisons of available prey from sticky traps with actual prey collected during the same period (days 8–10) and actual prey from the remaining days (days 1–7) show dissimilar proportions with respect to some prey orders (Fig. 2). For days 8–10, Hymenoptera, Diptera, and Coleoptera are the predominant orders of actual prey of *H. oculata* as well as of sticky trap samples at 90% and 83%, respectively. In general, there is no significant difference between the two subsamples of actual prey. This could indicate that *H. oculata* is consistent in prey choice, or that the relative availability of prey changed little over the course of the study. The higher proportion of formicid Hymenoptera among prey could be the result of robber flies preferring this group. The higher proportion of non-nematocerous Diptera in the sticky trap samples could be due to robber flies not favoring this group, perhaps because they are generally too difficult to capture. These results are in contrast to those found by Shelly (1984a) for *Atractia marginata* Osten Sacken in Panamá where non-nematocerous Diptera composed a lower proportion of prey relative to what was available from sticky traps, and Hymenoptera were insufficiently represented in either sample. Alternatively, the differences observed between robber fly prey and sticky trap samples may be an artifact of the limited ability of sticky traps to adequately sample them, and of sticky traps themselves being more attractive to some taxa than others (Shelly 1984b, 1988; Mensah 1996).

Size comparisons among and between actual and available prey also reveal significant differences (Table 1). In general, there is no difference ($P > .8$; Wilcoxon rank sum test) between the average size prey taken by *H. oculata* and the average size prey available to it. Differences emerge, however, when comparisons are made between individual prey orders. These results indicate that *H. oculata* prefers significantly





Figs. 2–3. 2, Proportions of actual and potential prey of *H. oculata*: available prey from sticky traps (days 8–10; closed bars), actual prey from *H. oculata* (days 8–10; open bars), and remaining actual prey (days 1–7; cross-hatched bars). Relationships among taxa that are significantly different at $P < .05$ (G-test) are represented by different letters. Prey taxa are defined as follows: Hym-F, ants; Hym-NF, non-ant Hymenoptera; Dip-N, nematocerous Diptera; Dip-NN, non-nematocerous Diptera; Col, Coleoptera; Hem, Hemiptera; Thy, Thysanoptera; Hom, Homoptera. 3, Proportion of *H. oculata* involved in various activities at each census period. Values for each census period are summed over the 10 study days. CP = copulating, CT = courting, F = feeding, O = other (i.e., perched without prey or flying).

Table 1. Characteristics of actual prey taken by *H. oculata* and available prey collected on sticky traps at La Selva Biological Station Costa Rica. Data on the number collected (No.), percent of sample, and size are presented for the orders represented in the samples. Analyses of size comparisons A and B are explained in the footnotes.

	Actual Prey from *H. oculata*						Actual Prey from Sticky Traps					
			Size (mm)						Size (mm)			
Order[a]	No.	%	Mean	SE[d]	Range	Size Comparison A[b]	No.	%	Mean	SE[d]	Range	Size Comparison B[c]
Hym-F	108	28.5	2.50	.06	1.2–4.2	$P = .0407$*	4	2.2	2.28	.18	2.1–2.8	$P = .0656$
Hym-NF	50	13.2	1.10	.06	0.5–2.2	$P = .0182$*	42	22.7	0.88	.08	0.4–3.5	$P = .9721$
Dip-N	78	20.6	1.00	.06	0.4–4.0	$P = .0904$	45	24.3	1.22	.07	0.6–3.5	$P = .1353$
Dip-NN	43	11.3	1.10	.05	0.5–2.0	$P = .2845$	46	24.9	1.45	.11	0.7–4.1	$P = .0440$*
Col	68	17.9	1.80	.10	0.5–4.3	$P = .8241$	17	9.2	3.12	.17	1.0–4.0	$P = .0058$*
Hem	8	2.1	1.80	.16	1.2–2.3	$P = .5730$	3	1.6	1.67	.03	1.6–1.7	—
Thy	8	2.1	1.30	.17	0.8–2.2	$P = .3270$	18	9.7	1.16	.06	0.9–1.7	$P = .2228$
Hom	7	1.9	2.40	.20	2.0–3.5	$P = .1493$	10	5.4	2.09	.40	0.5–4.0	—
Ara	6	1.6	0.95	.12	0.6–1.5	$P = .0431$*	—	—	—	—	—	
Str	2	0.5	0.80	.10	0.7, 0.9	$P = .1797$	—	—	—	—	—	
Pso	1	0.3	1.80	—	—		—	—	—	—	—	
Total	379	100.0	1.48	.19	0.4–4.3		185	100.0	1.73	.26	0.4–4.1	

[a] Arthropod orders are abbreviated as follows: Hym-F, formicid Hymenoptera; Hym-NF, non-formicid Hymenoptera; Dip-N, nematocerous Diptera; Dip-NN, non-nematocerous Diptera; Col, Coleoptera; Hem, Hemiptera; Thy, Thysanoptera; Hom, Homoptera; Ara, Araneida; Str, Strepsiptera; Pso, Psocoptera.

[b] Comparison by Wilcoxon signed rank sum test of mean size of actual prey by order against overall mean size of actual prey with all orders combined. An asterisk identifies differences that are significant at the $P < .05$ level.

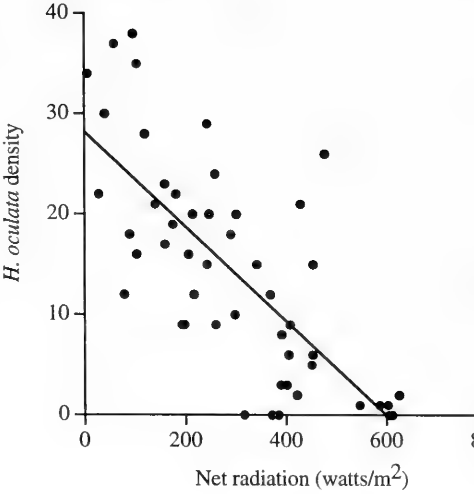
[c] Comparison by Wilcoxon signed rank sum test of mean size of actual prey (days 8–10) by order against mean size of available prey (days 8–10) by order. An asterisk identifies differences that are significant at the $P < .05$ level.

[d] Standard errors are presented in the table, but standard deviations (SD) were used in the statistical analyses.

smaller non-nematocerous Diptera prey than the average size available to it, and significantly larger Coleoptera. *H. oculata* chooses significantly larger formicid Hymenoptera than the overall average size of prey captured, and smaller non-formicid Hymenoptera and Araneida. This apparent size preference has also been observed in other robber flies (Hespenheide and Rubke 1977, Hespenheide 1978, Shelly 1984a)

The proportion of flies involved in the four activities (copulation, courtship, feeding, or other) at different times of the day is shown in Fig. 3. Copulation and courtship tend to peak in mid- to late afternoon and the proportion of flies feeding generally increases through the day. A linear regression shows a strong inverse relationship between fly densities and net radiation (Fig. 4; $P < .0001$; $r^2 = .54$) and a weaker inverse relationship between fly densities and ambient temperature ($P < .0001$; $r^2 = .34$), although these factors are correlated ($P < .0001$; $r^2 = .67$).

Differences in robber fly behavior between the shady and sunny transects further support the hypothesis that net radiation is the primary influence. The cycle of average daily robber fly density in the sunny and shady transects is shown in Fig. 5. During the study period, robber flies in the shady transect exhibited no significant change in average hourly density throughout the day whereas those in the sunny transect decreased significantly at midday compared to dawn or dusk. By 1400 h direct sunlight had entered the shady transect due to the sun's position at that hour, and the affect of this is represented in Fig. 5 as the period in the shady transect during which the fewest flies were counted. Flies in the shady transect tended to congregate in shady patches when sunlight entered the area, or relocate out of the transect. In the sunny transect, the few flies that chose to remain when net radiation was highest were found perched under grass blades, positioned in such a way so that the blade blocked the sun's rays. These observations indicate that the flies may be responding primarily to incident radiation. Robber flies in general are believed to relocate to more shaded perches presumably to maintain a more "normal"



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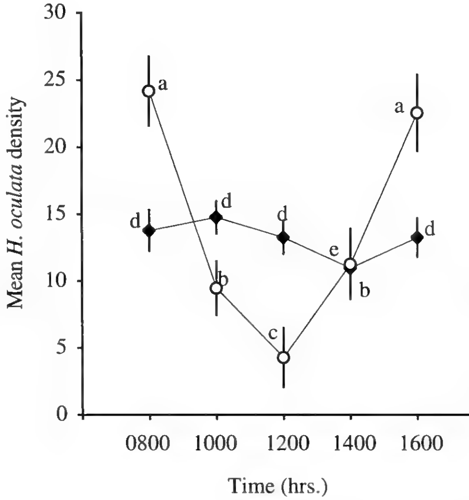

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Figs. 4–5. 4, Linear relationship between *H. oculata* density and net radiation: as net radiation increases fly density decreases ($P < .0001$; $r^2 = .54$). 5, The daily cycle of *H. oculata* in the sunny transect (open circles) and shady transect (closed circles). Data are shown as the mean density, ± SE, for each of five time periods for 10 separate days. Different letters represent significant differences among times within transects at $P < .05$ (Wilcoxon sign rank test); letters a–c refer to comparisons within the sunny transect, and letters d and e to comparisons within the shady transect.

body temperature (Lavigne and Dennis 1975).

Fourteen pairs of *H. oculata* involved in courtship were observed in detail during this study with five resulting in the male joining the female in copulo. Males locate females by slowly cruising through the habitat close to the ground, pausing briefly to inspect perch sites for females. When a perched female is located, the male hovers several centimeters behind and slightly below the perched female and begins to fly upwards and make physical contact with her. Each time the male makes contact, the female's wings are pushed apart; possibly to provide him with an exposed abdomen to hold on to for leverage in initiating copulation. These collisions happen, on average, at about seven second intervals between which the male resumes the hovering position, rubbing his tarsae together prior to the next attempt. Once in copulo the pair remains attached, tail to tail with the female perched and the male dangling upside down, for an average of 11 minutes (n = 5). The female will often relocate to another perch, towing the male behind her. The nine unsuccessful courtship attempts ended with the female, apparently uninterested in courting the male, flying far enough away such that he lost track of her. The copulatory position I describe here for *H. oculata* is similar to that of *H. fusca* in North America (Dennis 1979).

Among the 80 *H. oculata* observed during the study of perch preference, most chose grasses (90%) over woody branch tips, herbs, and sedges in and around the study area, with a mean ± SE perch height of 45.5 ± 1.7 cm. The grass species and their order of perch preference included *P. conjugatum* (39%), *Digitaria* sp. (24%), *C. dactylon* (18%), and undetermined blades (19%). Among the major parts of an individual grass, 60% of robber flies preferred the tips of spikes, 28% the main part of the blade, 9% the tip of the blade, and 3% the stem of the spike. This clear preference for grasses, and for *P. conjugatum* in particular, may be an artifact of their relative abundance being higher in these margins, which appears to be the case. Alternatively, *H. oculata* exhibits a species-specific perch behavior (see Fig. 1) like many asilids (Fisher and Hespenheide 1982, 1992), and grasses may present the optimal substrate for this.

Ectatomma ruidum seized the robber flies immediately in all 10 of the feeding trials. I conclude from this that, given the opportunity under non-experimental conditions, the ant would prey upon *H. oculata.*

Of 62 prey items removed from 18 orb-weaver webs, 47 were ant reproductives, nine were flies, and six were beetles. Interestingly, these orders also dominated the prey sampled from *Micrathena schreibersi* (Perty) webs in Panama (see Shelly 1984b). None of the orb-weaver's prey in my study were robber flies. The absence of robber flies as orb-weaver prey might be a result of robber flies cruising through the habitat at a slow enough rate as to evade becoming ensnared. I observed one case in which a robber fly collided with a web and immediately flew around it. Non-nematocerous Diptera are strong fliers and as a group have been found to be disproportionately represented in webs of *M. schreibersi* (Shelly 1984b), and this may likely be due to their ability to both avoid and escape becoming caught. This may explain the absence of *H. oculata* in orb-weaver webs during my study.

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A REVISION OF THE SHORE-FLY GENUS *LEMNAPHILA* CRESSON (DIPTERA: EPHYDRIDAE)

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Abstract.—Species of the shore-fly genus *Lemnaphila* Cresson are revised, including the description of two new species: ***L. grossoae*** (Argentina. Tucumán: San Miguel de Tucumán) and ***L. longicera*** (Peru. Loreto: Iquitos). *Lemnaphila* is known thus far only from the New World, where there are now five species. All species with known biologies are miners in various species of Lemnaceae. Although *Lemnaphila* is clearly a monophyletic clade based on several synapomorphies, its relationship to other genera of the tribe Hydrelliini is unresolved.

Key Words: Revision, Diptera, Ephydridae, shore flies, *Lemnaphila, L. longicera, L. grossoae,* New World

Specimens of *Lemnaphila* Cresson are among the smallest shore flies, with adult flies often being less than one mm in length. Their small size corresponds well with, and is apparently an adaptation to, the mining behavior of the larval instars in the tiny thalli of the duckweed family Lemnaceae, especially the genus *Lemna* L. Their small size evidently has been a deterrent to their study, as specimens are seldom collected and are poorly represented in collections, and very few studies that concern the genus have been published. Duckweed, moreover, is often an overlooked component of aquatic environments, and studies pertaining to the rearing and identification of phytophagous insects associated with species of Lemnaceae are uncommon (Scotland 1940, Buckingham 1989). Our experience in the field, however, indicates that specimens of *Lemnaphila* are frequently numerous when the duckweed habitat is adequately sampled. Indeed, recent collecting has revealed a fifth species from Peru, a sixth species from Argentina, and also major extensions in the distributions of the other species. Additional studies on their natural history, including fresh larval and puparial material of *L. scotlandae* Cresson, were conducted in Ohio. Describing and documenting these discoveries are the primary objectives for this revision. Further information on the natural history of *L. scotlandae* will be published separately (Edmiston and Foote, in preparation).

Cresson (1933) first described *Lemnaphila* as a monotypic genus, being known only from *L. scotlandae* Cresson. Miss Minnie B. Scotland, after whom this species was named, discovered the rather minute adults of *L. scotlandae* on *Lemna* that was growing in a fish hatchery in Ithaca, New York. Miss Scotland conducted studies on this species and published three papers

(1934, 1939, 1940) on its natural history. The genus remained monotypic until Lizarralde de Grosso (1977, 1978) described three additional species, all based on specimens collected in the neotropics. In the first paper, Lizarralde de Grosso (1977) described two of the new species: *L. neotropica* (Argentina (La Plata), Panama, and Jamaica) and *L. wirthi* (Ecuador). Lizarralde de Grosso (1978) described the third species, *L. lilloana,* from specimens collected in Argentina (Tucumán). In the second paper, she also described the immature stages of *L. lilloana* and *L. neotropica* and reported the occurrence of *L. wirthi* in Argentina (Tucumán). Lizarralde de Grosso (1980) published a third paper in which the larvae of *Lemnaphila* are distinguished from other shore flies.

Other than catalog entries (Wirth 1965, Mathis and Zatwarnicki 1995), new state records (Deonier and Regensburg 1978, Steinly et al. 1987), and records of parasatoids (Marsh 1979, Muesebeck 1979), few published records on *Lemnaphila* are available. Johannsen (1935) included *Lemnaphila* in his generic key to the immature stages of shore flies, as did Courtney et al. (1996) and Merritt et al. (1996). The latter two papers also summarized known information on the biology of the larvae. Wirth and Stone (1956) and Wirth et al. (1987) included *Lemnaphila* in their keys to the shore-fly genera of the Nearctic Region. In a synopsis of shore-fly biology, Foote (1995) also reviewed the biology of *Lemnaphila.*

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 Figs. 4–6 and is not repeated for comparable illustrations of other species.

Dissections of male genitalia were performed using the method of Clausen and Cook (1971) and Grimaldi (1987). External morphology and internal genitalic features were drawn using a drawing tube on a Wild M20EB compound and a M5 dissecting microscope. The species descriptions are composite and are not based solely on the holotypes. Two head and two venational ratios used in the descriptions are defined below (all ratios are based on measurements from a minimum of five specimens). All measurements were made from pinned specimens.

Eye ratio is the eye width divided by the eye height.

Gena-to-eye ratio is the genal height measured at the maximum eye height divided by the eye height.

Costal vein ratio is 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 is the straight line distance along vein M between crossveins (dm-cu and r-m)/distance apicad of dm-cu.

The phylogenetic analysis was performed with the assistance of Hennig86©, a computerized algorithm that produces cladograms by parsimony. Before analysis, character data were arranged in transformation series and then polarized, primarily using outgroup procedures.

Rearing.—All field and laboratory work was carried out in northeastern Ohio near the city of Kent in Portage County. Laboratory rearings, providing life cycle data, were carried out in an environmental chamber programmed to give a photoperiod of 16L:8D and a temperature variation between 22–32° C. Adults were collected from a marsh near the Kent State University stadium and placed in plastic tumblers with approximately 100 ml of pond water. *Lemna* thalli (approximately 25) were placed in each tumbler. The tumbler was covered with cheese cloth held in place by a rubber band.

Immature descriptions.—Specimens collected from the field or reared in the laboratory were preserved in 70% ethanol or double mounted and dried. External and internal morphologic structures were drawn using an ocular grid on a Zeiss compound microscope. Continuous characters were measured using a calibrated ocular micrometer attached to a Zeiss compound microscope. Descriptive terminology of immature stages follows McAlpine (1981). The tentoropharyngeal sclerite length and width are the maximum straight line distances in lateral view from the anterior tip to the dorsal cornu posterior tip (A-PDC), from the anterior tip to the ventral cornu posterior tip (A-VDC), and from the dorsal cornu posterior tip to the ventral cornu posterior tip (PDC-VDC).

Fecundity.—Females collected from the field were isolated in individual tumblers. The number of eggs laid on *Lemna* thalli were counted on each of four days. Each day, the female was removed from the tumbler and placed in a fresh preparation with 25 new *Lemna* thalli.

Life History.—Eggs deposited on the *Lemna* thalli were placed individually in 20 ml plastic vials. Eggs were observed each day for hatching, and individual flies were observed each day for molting between instars, pupariation, and adult emergence.

Specimens.—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; The Natural History Museum (BMNH), London, England; Canadian National Collection (CNC), Ottawa, Ontario; Cornell University (CU), Ithaca, New York; Guelph University (GUE), Guelph, Ontario; personal collection of James F. Edmiston (JEPC); Instituto Miguel Lillo (IML), Tucumán, Argentina; Ohio State University (OHSU), Columbus; Universidad de La Plata, La Plata, Argentina (UNLP) and Washington State University (WSU).

SYSTEMATICS

We follow Deonier's (1995) tribal characterization of Hydrelliini and the generic composition of the tribe that Mathis and Zatwarnicki (1995) published. Deonier (1995) published a key to the three genera, including *Cavatorella,* which he described in the same paper. Deonier's concept of *Lemnaphila,* as reflected in the key, was based primarily on *L scotlandae,* the type species, but with the addition of other species, the characterization of the genus has been adjusted as indicated in the following revised key to genera.

KEY TO GENERA OF HYDRELLIINI ROBINEAU-DESVOIDY

(modified from Deonier 1995)

1. Posterior notopleural seta inserted near dorsal angle; prescutellar acrostichal seta lacking; ocellar setae lacking; anepisternum bearing a single seta along posterior margin; lacking an intrapostalar setula . . . . *Lemnaphila* Cresson

– Posterior notopleural seta inserted at same level as anterior seta near ventral margin; prescutellar acrostichal seta present; ocellar setae usually present; anepisternum usually bearing 1 large seta and 1-2 smaller setae along posterior margin; usually bearing 1 intrapostalar setula 2

2. Wing apex broadly rounded; vein R_{2+3} long, making costal section II much longer than section III; interfacetal setulae conspicuous and dense; male lacking ventroclinate processes from dorsad of fused surstyli . . . . *Hydrellia* Robineau-Desvoidy

– Wing apex narrowly rounded, ellipsoidal; vein R_{2+3} short, making costal section II subequal to section III; costa bearing several interfractural setae; interfacetal setulae inconspicuous, sparse; male with ventroclinate styliform pro-

cesses projected from dorsad of fused surstyli
. . . . *Cavatorella* Deonier

Genus *Lemnaphila* Cresson

Lemnaphila Cresson, 1933:229. Type species: *Lemnaphila scotlandae* Cresson, 1933, monotypy; 1944:175–176 [review, tribal relationships].-Scotland, 1934:291 [biology, larval miner in *Lemna*]; 1939: 713–718 [biology, parasatoids]; 1940: 322–324 [review of biology, figs. of egg, puparium, adults].—Johanssen, 1935:48–51 [larval key].—Wirth, 1965:745 [Nearctic catalog].—Wirth and Stone, 1956: 465, 469 [key to genus, leaf mining habit].—Lizarralde de Grosso, 1977:159–164 [review]; 1980:55–60 [larval key]; 1989:54–55 [review, Argentina fauna].—Wirth et al., 1987:1035, 1041 [fig. of head, key to genus].—Mathis and Zatwarnicki, 1995:96–97 [world catalog].—Courtney et al., 1996:508 [larval key to genus].—Merritt et al., 1996:545 [habitat, habits, trophic relationships].

Diagnosis.—*Lemnaphila* is a genus of the tribe Hydrelliini, subfamily Hydrelliinae, that is similar and closely related to *Hydrellia* Robineau-Desvoidy and *Cavatorella. Lemnaphila,* which are minute to small shore flies (length 0.83–1.50 mm), is distinguished from these and other shore-fly genera by the following combination of characters:

Head: Frons much wider than long, sometimes with distinct mesofrons and parafrons; mesofrons broadly reaching anterior margin of frons, vestiture variable. Ocellar and paravertical setae lacking; pseudopostocellar setae well developed, proclinate and slightly divergent. Pedicel lacking a large, dorsoapical seta; arista with 5–9 long rays along dorsum. Face in lateral view vertically straight or shallowly concave and with ventral third slightly angled anteriorly; ventral facial margin at most shallowly arched; facial seta 1 near ventrolateral margin, sometimes with a few setulae, generally weakly developed. Eye comparatively large, especially in lateral view, bearing numerous interfacetal setulae. Gena very short, gena-to-eye ratio less than 0.15; lacking a prominent genal seta. Clypeus not generally exposed.

Thorax: Chaetotaxy: dorsocentral setae 2 (0+2 or with anterior seta on transverse suture), posterior dorsocentral seta displaced laterally (this seta has sometimes been labeled as the intra-alar seta); lacking prescutellar acrostichal setae, other acrostichal setae variable, either lacking or with a few setulae in 2 anterior rows; presutural supra-alar seta present but often reduced; lacking postpronotal, postsutural supra-alar, and intrapostalar setae; 1 postalar seta; 2 lateral scutellar setae (lacking a smaller setula between 2 larger setae), basal seta shorter than apical seta; 2 notopleural setae, anterior seta usually shorter, posterior seta inserted near dorsal angle of notopleuron; 1 anepisternal seta along posterior margin; katepisternal seta variable, lacking, reduced, or well developed. Wing: generally hyaline or very faintly infuscate; costal vein long, extended to vein M; vein R_{2+3} short, with costal section II equal to section II or much shorter than section III; lacking greatly elongate interfractural setulae other than apical seta. Legs lacking dorsoerect setae on dorsal surface.

Abdomen: Dorsum comprising tergites 1–5, with tergites 1–2 somewhat fused; sternite 1 greatly reduced or lacking, 2–5 present; 5th sternite of male comparatively well developed and much larger than sternites 2–4, bearing setulae, shape variable with species. Male terminalia: Epandrium weakly developed, incomplete dorsally with a membranous gap between lateral extensions, lateral extensions as a fused lateral phalange at base of cerci; cerci well developed, fused with median margin of epandrium; surstylus greatly reduced as a small, usually narrow process from ventral margin of fused epandrium/cerci; subepandrial plate well developed, simple, arched; aedeagus well developed, sometimes angulate in lateral view; aedeagal apodeme narrow to very broadly developed, keel variously developed, usually enlarged; postgonite well developed, usually bearing setulae near midlength; pregonite apparently lacking; hypandrium simple, lateral apices oriented posteriorly, shallowly arched or narrowly V-shaped.

Discussion.—As noted in the generic diagnosis, we place *Lemnaphila* in the tribe Hydrelliini, subfamily Hydrelliinae, where it is closely related to *Hydrellia* and *Cavatorella.* Although this tribal assignment and the generic associations are now apparent, these relationships were not always recognized and there was some confusion that led to a rather circular history. When Cresson (1933) described *Lemnaphila* he placed the genus ". . . in the tribe Hydrelliae of the subfamily Notiphilinae, near the genus *Nostima.*" Cresson based his generic placement on adult characters (setulose eyes, antennal shape, and the arrangement and number of dorsocentral setae). Cresson (1944), however, then removed *Nostima* Coquillett, *Philygria* Stenhammar, and *Lemnaphila* from the tribe Hydrelliini and created a new tribe, Hydrinini (unavailable, based on a junior homonym, = Philygriini Lizarralde de Grosso), for these three genera. Despite removing *Lemnaphila* from a close association with *Hydrellia,* Cresson (1944:176) continued to recognize that *Lemnaphila* has ". . . the appearance of a small *Hydrellia.*" The tribe Philygriini was then characterized primarily by the elevated insertion of the posterior notopleural seta and the reduced setation. Wirth (1965) followed Cresson's suprageneric arrangement for the Tribe Philygriini in his catalog of North American Ephydridae. Dahl (1959), in his review of Scandinavian Ephydridae, removed *Nostima* and *Philygria* from the subfamily Notiphilinae (= Hydrelliinae) and placed these genera along with *Hyadina* Haliday in the subfamily "Hydrininae" (unavailable, based on a junior homonym, = Ilytheinae Cresson), which Dahl described in the same paper. Mathis and Zatwarnicki (1990b) also recognized Philygriini but with only two genera: *Philygria* and *Nostima.* They suggested that *Lemnaphila* was better placed in the tribe Hydrelliini (Subfamily Hydrelliinae) near the genus *Hydrellia* based especially on characters of the male terminalia and larvae, and in subsequent publications (Zatwarnicki 1992, Deonier 1995, and Mathis and Zatwarnicki 1995), *Lemnaphila* was placed in the Hydrelliini, along with *Hydrellia* and *Cavatorella.*

Cresson (1933, 1944) first noted that adults of *Lemnaphila* are similar to *Hydrellia,* and a close relationship between these two genera is strongly supported by larval characters as well. Johannsen (1935) was able to distinguish between larvae of *Lemnaphila* and *Hydrellia* only on the basis of larval size and the preference *Lemnaphila* has for feeding on *Lemna. Hydrellia* is generally characterized by its stem- and leaf-mining habits, and Johannsen observed that the mouthparts of *Lemnaphila* and *Hydrellia* were identical except for size. Hennig (1943) also proposed a close relationship between larvae of *Lemnaphila* and *Hydrellia.* Lizarralde de Grosso (1977, 1978) described additional Neotropical species of *Lemnaphila,* including larval descriptions, and indicated that the Neotropical larvae of *Hydrellia* and *Lemnaphila* are very similar and closely related.

Specimens of *Lemnaphila* are not only tiny but they are highly derived, in part and presumably as an adaptation to the mining habit in Lemnaceae. The structures of the male terminalia also reflect their derived condition. The surstylus, for example, is highly modified as a much reduced structure at the ventral margin of the fused epandrium/cercus. The reduced epandrium that is fused to the cercus and the enlarged cerci are also evidence of the derived status.

KEY TO SPECIES OF *LEMNAPHILA* CRESSON

1. Scape, pedicel, and basal half of 1st flagellomere yellow; length of 1st flagellomere twice its height; face in profile straight; length of outer vertical seta less than half length of inner vertical seta. Katepisternum whitish yellow, concolorous with forecoxa . . . .

. . . . *L. longicera,* new species

– Antenna entirely dark brown; length of 1st flagellomere only slightly longer than its height; face shallowly concave in lateral view with ventral third slightly angled forward; length of outer vertical seta about 3/4 length of inner vertical seta. Katepisternum brown 2

2\. Fronto-orbital setulae greatly reduced, at most hairlike, none well developed; mesofrons subshiny, distinct from densely microtomentose parafrons. Scutellum lacking microtomentum or sparsely microtomentose, not appearing velvety; katepisternal seta reduced, hairlike . . . . *L. scotlandae* Cresson

– At least 1 fronto-orbital seta well developed, anterior setula proclinate, posterior seta much longer, length subequal to outer vertical seta, lateroclinate, parallel to outer vertical seta; mesofrons and parafrons densely microtomentose, appearing velvety, or with small area immediately anterior of ocellar triangle bare (*L. lilloana*), shiny. Scutellum moderately to densely microtomentose, brownish black to black, sometimes appearing velvety; katepisternal seta well developed, length subequal to posterior anepisternal seta 3

3\. Ventral third of face densely microtomentose, blackish brown, concolorous with dorsal portion of face; coxae, femora, and tibiae yellow . . . . *L. wirthi* Lizarralde de Grosso

– Ventral third of face densely microtomentose, silvery white, distinctly contrasted with blackish brown dorsal portion; femora brown, otherwise legs yellow 4

4\. Area immediately laterad and anteriad of ocellar triangle silvery white, concolorous with fronto-orbit immediately anterior and posterior of lateroclinate fronto-orbital seta . . . . *L. grossoae,* new species

– Area immediately laterad and anteriad of ocellar triangle dark brown, similar to coloration of ocellar triangle 5

5\. Mesofrons and parafrons densely microtomentose, appearing velvety blackish brown; posterior fronto-orbit extensively white to silvery white . . . . . . *L. neotropica* Lizarralde de Grosso

– Mesofrons just anterior of ocellar triangle bare, shiny, blackish brown, contrasted with densely microtomentose parafrons; posterior fronto-orbit with very small area white . . . . *L. lilloana* Lizarralde de Grosso

Lemnaphila longicera Mathis and Edmiston, new species

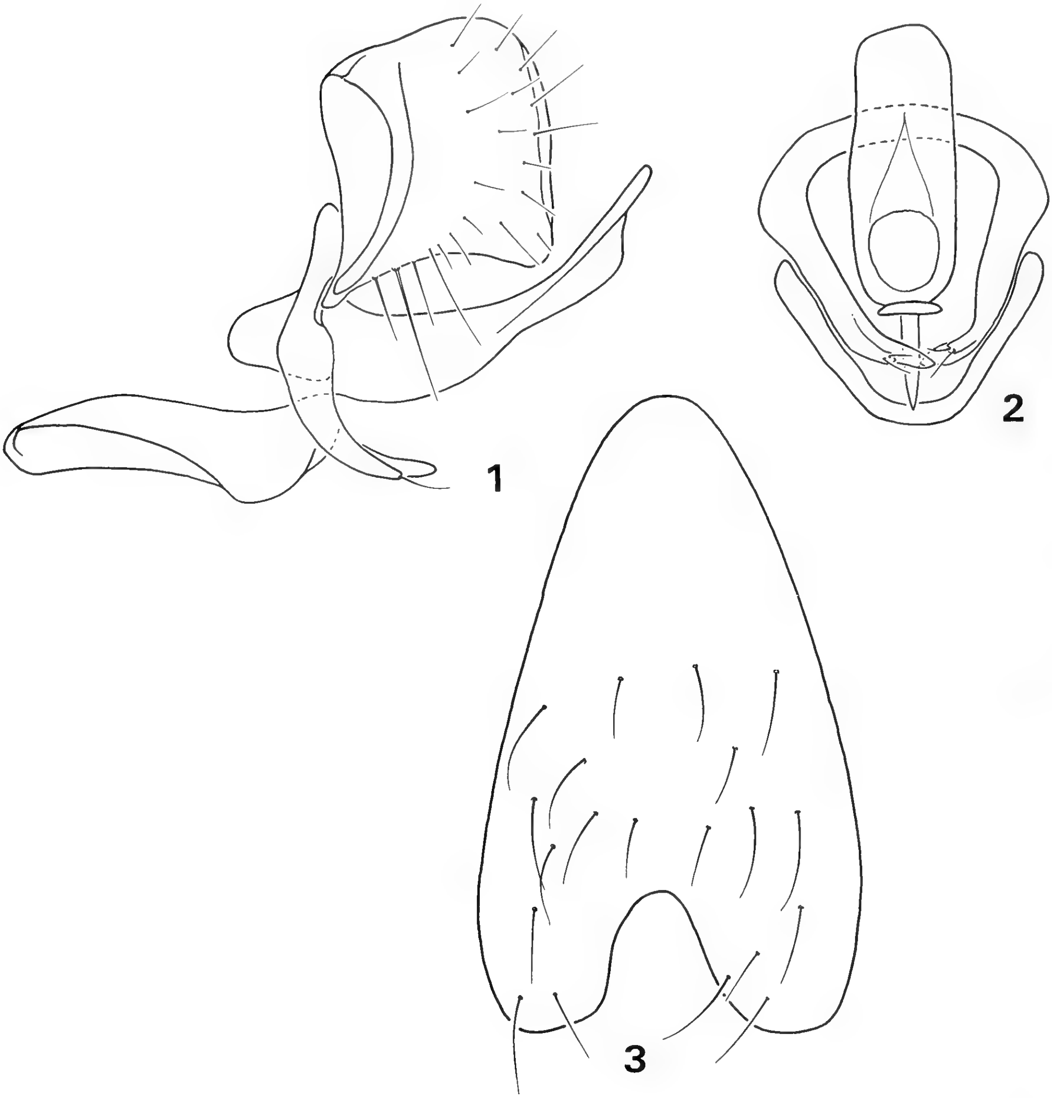
(Figs. 1–3)

Diagnosis.—This species is distinguished from congeners by the following combination of characters: Scape, pedicel, and basal half of 1st flagellomere yellow; length of 1st flagellomere twice height; face in profile straight; face mostly uniformly microtomentose and colored, coloration varies depending on angle of view, except for narrow, vertical stripe; length of outer vertical seta less than half inner vertical seta; scutellum densely microtomentose, appearing velvety, dark brown; katepisternum whitish yellow, concolorous with forecoxa; legs entirely yellow, with coxae whitish yellow and apical half of tibiae slightly brownish yellow.

Description.—Minute to small shore flies, length 0.90–1.35 mm.

Head: Frons with distinct, subshiny mesofrons; parafrons densely microtomentose, dark brown, appearing velvety. Fronto-orbital setae very weakly developed and/or lacking, at most with 1–2 hairlike setulae; length of outer vertical seta less than half inner vertical seta, outer seta curved laterally, inner seta very shallowly curved, nearly vertical; ocelli arranged in equilateral triangle, or nearly so. Scape, pedicel, and basal half of 1st flagellomere yellow, apical half of 1st flagellomere brown; length of 1st flagellomere twice height, apex bluntly rounded; arista with 8–9 long, dorsal rays. Face in profile straight at anterior margin; varying in color from different angles, from lateral view mostly yellowish with brownish yellow area at midheight, from anterior view whitish gray, sometimes slightly darker medially at midheight, and with keel-like brown vertical stripe. Eye ratio 0.68–0.71. Gena-to-eye ratio 0.10–0.13. Maxillary palpus yellow; mouthparts mostly yellow to grayish yellow.

Thorax: Mostly dark brown; scutum dark brown with moderately dense whitish gray microtomentum; scutellum with distal ⅔ densely microtomentose, dark brown, appearing velvety, basal ⅓ whitish gray; notopleuron, area of scutum immediately posteriad of notopleuron densely microtomentose, dark brown, appearing velvety; anepisternum and anepimeron concolorous, dark



Figs. 1–3. *Lemnaphila longicera.* 1, Male terminalia (epandrium, cercus, surstylus), lateral view. 2, Internal male terminalia (aedeagus, aedeagal apodeme, postgonite, hypandrium, and subepandrial plate), ventral view. 3, Fifth sternite, ventral view.

brown but lighter than notopleuron; katepisternum, meron, and coxae concolorous, whitish yellow. Chaetotaxy: anterior dorsocentral seta inserted near level of transverse suture; acrostichal setae lacking; basal scutellar seta about ⅓ length of apical seta; katepisternal seta lacking. Wing: length 1.08–1.20 mm; width 0.45–0.49 mm; vein R_{4+5} shallowly sinuous, shallowly curved toward posterior margin, than shallowly recurved, bowed anteriorly; costal vein ratio 1.0–1.07, length of costal section II about equal to section III; M vein ratio 0.42–0.47. Halter knob bright yellow; stem brownish yellow. Legs: femora whitish yellow to yellow basally, becoming more yellow apically; tibiae yellow, becoming slightly darker apically; foretarsi brownish yellow to brown, mid- and hindtarsus slightly lighter than foretarsus, more yellowish.

Abdomen: Dark brown, male 5th tergite subshiny; 5th sternite of male (Fig. 3) well developed, narrowly heart shaped, longer than wide, tapered gradually to narrowly rounded anterior margin, posterior margin deeply emarginate. Male terminalia (Figs. 1–2): Epandrium (Fig. 1) reduced to narrow, fused, lateral phalange at basolateral margin of cercus; cercus (Fig. 1) greatly enlarged, projected posteriorly, bearing 4–5 large setulae at anteroventral margin; subepandrial plate simple, arched, connected ventrally with postgonite; aedeagus in lateral view (Fig. 1) with moderately broad base tapered irregularly thereafter to narrow process, apex narrowly rounded; aedeagal apodeme with ventral keel comparatively long and narrow in lateral view (Fig. 1), slightly asymmetrical; postgonite prominent with rounded apex, bearing setulae about ¾ distance from connection with subepandrial plate; hypandrium V-shaped in ventral view (Fig. 2).

Type Material.—The holotype male is labeled "PERU. Loreto: Iquitos [,] 16Feb1984 [,] Wayne N. Mathis/HOLOTYPE Lemnaphila longicera ♂ W.N. Mathis & Edmiston USNM [red; species name, gender, and authors handwritten]." The holotype is double mounted (minuten in a block of plastic), is in excellent condition, and is deposited in the USNM. Twenty-two paratypes (8 ♂, 14 ♀; USNM) bear the same label data as the holotype.

Distribution.—*Neotropical:* Peru (Loreto).

Etymology.—The species epithet, *longicera,* alludes to the elongate antenna that, among other characters, distinguishes this species.

Remarks.—Although this species clearly belongs in *Lemnaphila,* it is very distinct structurally (see diagnosis and key) and apparently represents a lineage that has undergone considerable anagenetic evolution. We know nothing about the natural history of the immature stages but suggest that they will be found to be miners in Lemnaceae.

Lemnaphila grossoae Mathis and Edmiston, new species

Diagnosis.—This species is distinguished from congeners by the following combination of characters: Antenna entirely dark brown; length of 1st flagellomere only slightly longer than height; face in lateral view shallowly concave; ventral third of face densely microtomentose, silvery white, distinctly contrasted with blackish brown dorsal portion; mesofrons densely microtomentose, area immediately laterad and anteriad of coellar triangle silvery white, otherwise brown to blackish brown; fronto-orbit anteriad and posteriad of long lateroclinate fronto-orbital seta silvery white, otherwise velvety blackish brown; scutellum sparsely microtomentose, appearing subshiny to faintly dull, brown; katepisternum brown; femora brown; tibiae and most tarsomeres yellow.

Description.—Small shore flies, length 1.30 mm.

Head: Frons entirely microtomentose, bicolored, brown and silvery white; parafrons and anterior half of fronto-orbit concolorous, densely microtomentose, brownish black, appearing velvety, area immediately laterad and anteriad of ocellar triangle silvery white; posterior fronto-orbit (from base of outer vertical seta to base of lateroclinate fronto-orbital seta) with silvery white microtomentum, concolorous with area laterad and anteriad of ocellar triangle. One fronto-orbital seta well developed, length subequal to outer vertical seta, orientation postero-obliquely lateroclinate to lateroclinate; other fronto-orbital setae anterior of large seta, at best weakly developed, hairlike; length of outer vertical seta about ⅔ that of inner vertical seta, outer vertical seta distinctly curved laterally, inner vertical seta very shallowly curved, nearly vertical; ocelli arranged in isosceles triangle, with distance between posterior ocelli greater than between either posterior ocellus and anterior ocellus. Antenna entirely dark brown; length of 1st flagellomere only slightly longer than height; arista with 6–7 long, dorsal rays. Face shallowly concave in lateral view; ventral third of face densely microtomentose, silvery white, distinctly contrasted with blackish brown dorsal portion; dorsal portion of face with very shallow carina, mostly faintly grayish black except for black area on either side of midline just dorsad of silvery white microtomentum. Eye ratio 0.70. Gena-to-eye ratio 0.19. Maxillary palpus blackish brown; mouthparts generally brownish black.

Thorax: Mostly blackish brown; scutum subshiny, sparsely microtomentose; scutellum with moderately dense microtomentum, brownish black, somewhat dull, not velvety appearing like frons except partially along sides; pleuron mostly blackish brown to black except most of anepisternum appearing silvery gray to silvery white. Chaetotaxy: anterior dorsocentral seta inserted behind level of transverse suture; acrostichal setulae sparse anteriorly, in 2 rows, lacking posteriorly; basal scutellar seta about ⅓ length of apical seta; katepisternal seta well developed, length subequal to posterior anepisternal seta. Wing: length 1.30 mm; width 0.50 mm; vein R_{4+5} shallowly bowed anteriorly; costal vein ratio 1.25; length of costal section II about half of section III; M vein ratio 0.55. Halter knob bright yellow; stem blackish brown. Legs: Femora mostly brown, apices yellowish; tibiae and most tarsomeres yellow, 5th tarsomere brown.

Abdomen: Tergites very sparsely microtomentose to bare, blackish brown.

Type Material.—The holotype female is labeled "ARGENTINA San Miguel de TUCUMAN 2-XII-1976 Col. L. de Grosso [handwritten]/Lemnaphila lillolana det. M. Lizarralde de Grosso/PARATIPO [yellow]/ COLECCION INST.-FUND M. LILLO (4000)—S.M. TUCUMAN TUCUMAN—ARGENTINA [yellow]/HOLOTYPE Lemnaphila grossoae ♀ W.N. Mathis & Edmiston USNM [red; species name, gender, and authors handwritten]." The holotype is double mounted (glued to a large triangle), is in good condition (glue partially obscuring tarsi), and is deposited in the IML.

Distribution.—*Neotropical:* Argentina (Tucumán).

Etymology.—The species epithet, *grossoae,* is a patronym to honor and recognize the numerous contributions of Dr. Mercedes Lizarralde de Grosso to the study of shore flies, *Lemnaphila* in particular.

Remarks.—This species was misidentified as *L. lillolana* but the pattern of microtomentum and coloration of the head, especially the frons, differs from that species as noted in the diagnosis. In addition to the holotype female, we dissected the male allotype/paratype of *L. lillolana* and discovered that it is likewise not conspecific with *L. lillolana.* Our basis for this conclusion is comparison of the structures of the male terminalia with those that Lizarralde de Grosso (1978:15, figs. 6–13) published. Thus, this male, which lacks its head, may be conspecific with this species.

Lemnaphila lillolana Lizarralde de Grosso

Lemnaphila lillolana Lizarralde de Grosso, 1978:14–17 [immature stages; host plants: *Spirodela biperforata* Kock, *Wolfiella lingulata* (Hegelm.), *Salvinia minima* Baker (Lemnaceae)]; 1989:55 [review, Argentina fauna].-Mathis and Zatwarnicki, 1995:96 [world catalog].

Diagnosis.—This species is distinguished from congeners by the following combination of characters: Antenna entirely dark brown; length of 1st flagellomere only slightly longer than height; face in lateral view shallowly concave; ventral third of face densely microtomentose, silvery white, distinctly contrasted with blackish brown dorsal portion; mesofrons just anterior of ocellar triangle bare, shiny, blackish brown, contrasted distinctly with densely microtomentose parafrons; posterior fronto-orbit with very small area white; scutellum densely microtomentose, appearing velvety, dark brown; katepisternum brown; femora brown; tibiae and most tarsomeres yellow.

Description.—Small shore flies, length 1.40–1.50 mm.

Head: Frons with mesofrons except for ocellar triangle bare of microtomentum, shiny, blackish brown; parafrons, and anterior half of fronto-orbit concolorous, densely microtomentose, brownish black, appearing velvety; posterior fronto-orbit (from base of outer vertical seta to base of lateroclinate fronto-orbital seta) with whitish gray microtomentum. One fronto-orbital seta well developed, length subequal to outer vertical seta, orientation postero-obliquely lateroclinate to lateroclinate; other fronto-orbital setae anterior of large seta, at best weakly developed, hairlike; length of outer vertical seta about ⅔ that of inner vertical seta, outer vertical seta distinctly curved laterally, inner vertical seta very shallowly curved, nearly vertical; ocelli arranged in isosceles triangle, with distance between posterior ocelli greater than between either posterior ocellus and anterior ocellus. Antenna entirely dark brown; length of 1st flagellomere only slightly longer than height; arista with 7–8 long, dorsal rays. Face shallowly concave in lateral view; ventral third of face densely microtomentose, silvery white, distinctly contrasted with blackish brown dorsal portion; dorsal portion of face with very shallow carina, mostly faintly grayish black except for black area on either side of midline just dorsad of silvery white microtomentum. Eye ratio 0.75–0.77. Gena-to-eye ratio 0.11–0.12. Maxillary palpus blackish brown; mouthparts generally brownish black.

Thorax: Mostly blackish brown; scutum subshiny, sparsely microtomentose; scutellum with moderately dense microtomentum, brownish black, dull, not velvety appearing like frons; pleuron mostly blackish brown to black except dorsal half of anepisternum from some angles appearing silvery gray. Chaetotaxy: anterior dorsocentral seta inserted behind level of transverse suture; acrostichal setulae sparse anteriorly, in 2 rows, lacking posteriorly; basal scutellar seta about ⅓ length of apical seta; katepisternal seta well developed, length subequal to posterior anepisternal seta. Wing: length 1.45–1.60 mm; width 0.60–0.74 mm; vein R_{4+5} shallowly bowed anteriorly; costal vein ratio 1.30–1.33; length of costal section II about half of section III; M vein ratio 0.49–0.50. Halter knob bright yellow; stem blackish brown. Legs: Femora mostly brown, apices yellowish; tibiae and most tarsomeres yellow, 5th tarsomere brown.

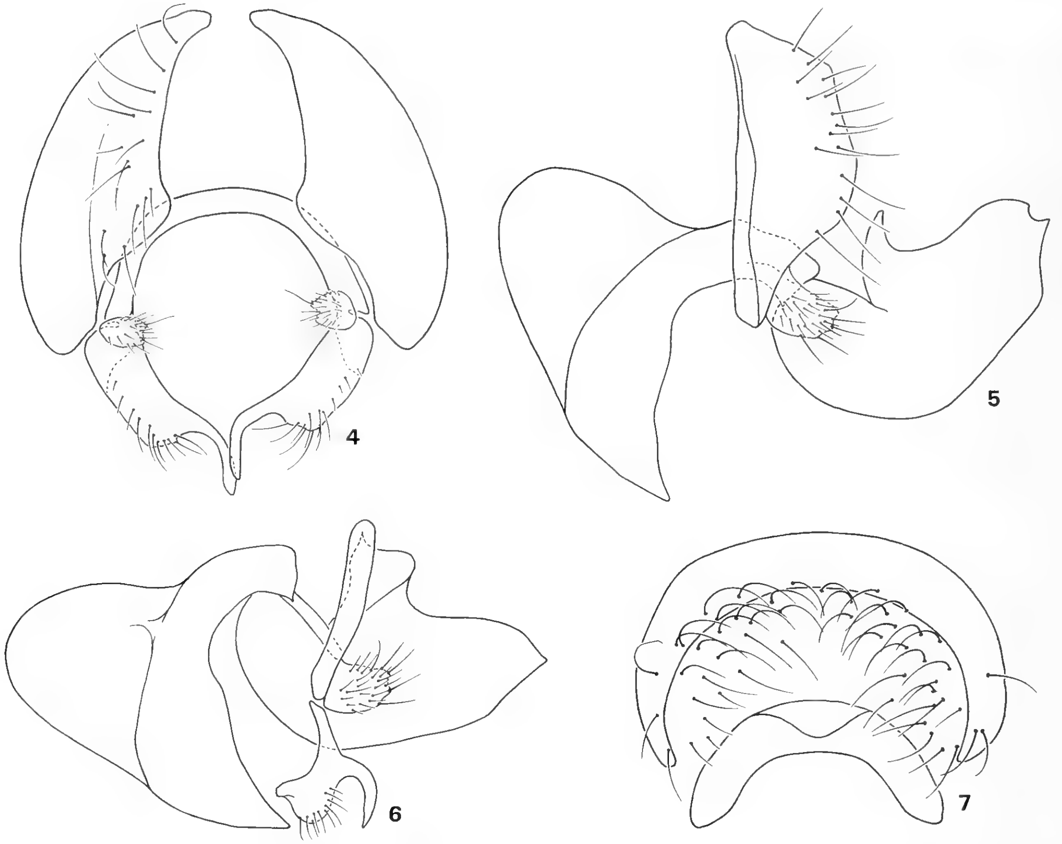
Abdomen: Dark brown.

Type Material.—The holotype female (not a male as indicated in the original description) is labeled "ARGENTINA[.] San Miguel de TUCUMAN[,] 2.XII.1976 [2 Dec 1976] Col. L. de Grosso [handwritten, black margin]/Lemnaphila Lilloana Lizarralde de Grosso det. Lizarralde de Grosso [handwritten, black margin]/HOLOTIPO [red]/COLECCION INST. - FUND. M. LILLO (4000) - S. M. TUCUMAN TUCUMAN - ARGENTINA [yellow]." The holotype is double mounted (glued to moderately large paper triangle), is in fair condition (specimen slightly teneral, eyes and face partially collapsed, right wing with posterior margin folded back on itself), and is deposited in the IML.

Other Specimens Examined.—*ARGENTINA. Tucumán:* San Miguel de Tucumán, 2 Dec 1976, M. Lizarralde de Grosso (6 ♀; paratypes; IML).

Distribution.—*Neotropical:* Argentina (Tucumán).

Remarks.—This species is structurally very similar to *L. neotropica* and is obviously closely related. The only difference that we have discovered in external structures is the shiny mesofrons with the exception of the ocellar triangle (*L. neotropica* has a completely microtomentose, velvety, blackish brown mesofrons). The other differences that Lizarralde de Grosso noted (1978:17) are variable and are within the ranges of either species. No males of this species were available for description and illustration.



Figs. 4–7. *Lemnaphila neotropica.* 4, Male terminalia (epandrium, cercus, surstylus, subepandrial plate, postgonite), posterior view. 5, Same, lateral view. 6, Internal male terminalia, lateral view. 7, Fifth sternite and hypandrium, ventral view.

Lemnaphila neotropica Lizarralde de Grosso
(Figs. 4–7)

Lemnaphila neotropica Lizarralde de Grosso, 1977:160; 1978:17–18 [biology, immature stages, host plants: *Lemna minima* Philippi, *Hydromystia stolonifera*$_S$ parasite: *Hexacola* sp. (Cynipidae)]; 1989:55 [review, Argentina fauna].—Mathis and Zatwarnicki, 1995:96–97 [world catalog].

Diagnosis.—This species is distinguished from congeners by the following combination of characters: Antenna entirely dark brown; length of 1st flagellomere only slightly longer than height; face in lateral view shallowly concave; ventral third of face densely microtomentose, silvery white, distinctly contrasted with blackish brown dorsal portion; mesofrons and parafrons entirely densely microtomentose, appearing velvety blackish brown; scutellum densely microtomentose, appearing velvety, dark brown; katepisternum brown; femora brown; tibiae and most tarsomeres yellow.

Description.—Minute to small shore flies, length 0.90–1.30 mm.

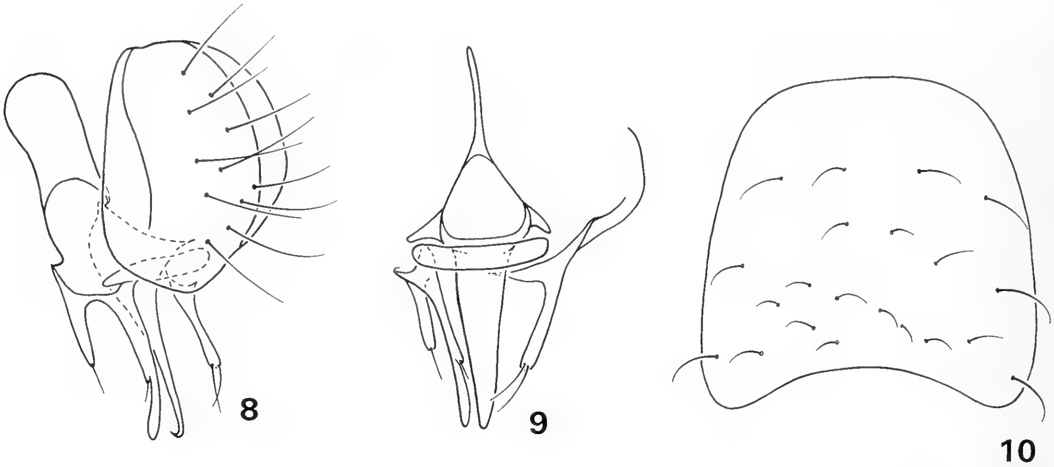
Head: Frons with mesofrons, parafrons, and anterior half of fronto-orbit concolorous, densely microtomentose, brownish black, appearing velvety; posterior fronto-orbit (from base of outer vertical seta to base of lateroclinate fronto-orbital seta) with whitish gray microtomentum. One fronto-orbital seta well developed, length subequal to outer vertical seta, orientation postero-obliquely lateroclinate to lateroclinate; other fronto-orbital setae anterior of large seta, at best weakly developed, hairlike; length of outer vertical seta about ⅔ that of inner vertical seta, outer vertical seta distinctly curved laterally, inner vertical seta very shallowly curved, nearly vertical; ocelli arranged in isosceles triangle, with distance between posterior ocelli greater than between either posterior ocellus and anterior ocellus. Antenna entirely dark brown; length of 1st flagellomere only slightly longer than height; arista with 6–7 long, dorsal rays. Face shallowly concave in lateral view; ventral third of face densely microtomentose, silvery white, distinctly contrasted with blackish brown dorsal portion; dorsal portion of face with very shallow carina, mostly faintly grayish black except for black area on either side of midline just dorsad of silvery white microtomentum. Eye ratio 0.75–0.77. Gena-to-eye ratio 0.11–0.12. Maxillary palpus blackish brown; mouthparts generally brownish black.

Thorax: Mostly brownish black to black; scutum subshiny, sparsely microtomentose; scutellum with moderately dense microtomentum, brownish black, dull, not velvety appearing like frons; pleuron mostly brownish black to black except dorsal half of anepisternum from some angles appearing silvery gray. Chaetotaxy: anterior dorsocentral seta inserted behind level of transverse suture; acrostichal setulae sparse anteriorly, in 2 rows, lacking posteriorly; basal scutellar seta about ⅓ length of apical seta; katepisternal seta well developed, length subequal to posterior anepisternal seta. Wing: length 0.80–1.30 mm; width 0.45–0.65 mm; vein R_{4+5} shallowly bowed anteriorly; costal vein ratio 1.60–1.69; length of costal section II slightly less than half of section III; M vein ratio 0.46–0.55. Halter knob bright yellow; stem blackish brown. Legs: Femora mostly brown, apices yellowish; tibiae and most tarsomeres yellow, 5th tarsomere brown.

Abdomen: Dark brown, male 5th tergite subshiny; 5th sternite of male in ventral view (Fig. 7) much wider than long, broadly and shallowly U-shaped, bearing numerous setulae along posterior margin, these also in membrane between sternite and hypandrium. Male terminalia (Figs. 4–5): Epandrium comparatively well developed as a wide phalange at base of cerci; cerci (Figs. 4–5) well developed, irregularly hemispherical around posteromedial margin, narrowed at dorsal and ventral angles, lateral margin nearly straight in lateral view, shallowly concave in posterior view; surstylus a short process, only slightly longer than wide, bearing numerous setulae, these longer apically; subepandrial plate bandlike in lateral view (Fig. 6), distinctly arched in posterior view (Fig. 4); aedeagus very well developed, angulate in lateral view, robust, especially basiphallus; aedeagal apodeme greatly enlarged, especially expanded keel, keel slightly asymmetrical in lateral view, fanlike; postgonite prominent, heavily sclerotized, base in ventral view rectangular with a narrowed, apical, arched process extended from ventromedial portion of base, apical process parallel sided, apex narrowly rounded; pregonite apparently lacking; hypandrium (Fig. 7) in ventral view a broad, arched band, posterior margin concave, anterior margin convex, with a short, tonguelike, medial process.

Type Material.—The holotype male is labeled "[Argentina. Buenas Aires:] LA PLATA 18/10/71 [18 Oct 1971] COL. [Loiácono-] DIAZ [handwritten; black submargin]/HOLOTIPO [red]/♂/MUSEO DE LA PLATA LEMNAPHILA NEOTROPICA L. DE GROSSO Det LIZARRALDE DE GROSSO [species name and author handwritten; black submargin]." The holotype is double mounted (glued to a large paper triangle), is in fair condition (abdomen missing, some setae misoriented), and is deposited in the UNLP.

Other Specimens Examined.—*ARGENTINA. Buenos Aires:* La Plata, 18 Oct 1971, Loiácono-Diaz (1 ♂, 1 ♀; paratypes; UNLP).



Figs. 8–10. *Lemnaphila scotlandae.* 8, Male terminalia (epandrium, cercus, surstylus, aedeagus, aedeagal apodeme, subepandrial plate, postgonite), lateral view. 9, Internal male terminalia (surstylus shown on right side only, postgonite shown on left side only), dorsal view. 10, Fifth sternite, ventral view.

DOMINICAN REPUBLIC. La Vega: Jarabacoa (1–2 km S; 19°06.9′N, 70°37′W; 520 m), 14–17 May 1998, D. and W. N. Mathis (11 ♂, 4 ♀; USNM).

GRENADA. St. George: Point Salines Airport (W end; 12°00.3′N, 61°47.7′W), 12 Sep 1997, W. N. Mathis (7 ♂, 11 ♀; USNM).

JAMAICA. St. Ann: Runaway Bay (stream bed), Feb 1969, W. W. Wirth (1 ♂; paratype; USNM).

PANAMA. Aguadulce Cocle, 25 Sep 1951, F. S. Blanton (1 ♂; paratype, USNM).

Distribution.—*Neotropical:* Argentina (Buenos Aires, Chaco, Tucumán), Panama, West Indies (Dominican Republic, Grenada, Jamaica).

Remarks.—This species and *L. wirthi* are very similar and obviously closely related. This relationship is established by the following synapomorphies: 1. Aedeagus large, prominent, angulate; 2. 5th sternite of male much wider than long and bearing numerous setulae along posterior, concave margin.

Lemnaphila scotlandae Cresson
(Figs. 8–21)

Lemnaphila scotlandae Cresson, 1933:229 [USA. New York: Tompkins County, Ithaca, Fall Creek; HT ♂, ANSP (6501)]; 1944:176 [tribal assignment].—Johannsen, 1935:50–51 [immature stages].—Scotland, 1934:291 [biology, larval miner in *Lemna*]; 1939:713–717 [host plant: *Lemna minor* L. (Lemnaceae); parasitoids: *Opius lemnaphilae* Muesebeck (Braconidae), *Trichopria angustipennis* Muesebeck, *T. paludis* Muesebeck (Diapriidae)]; 1940:322–324 [immature stages, host plants and parasitoids].—Muesebeck, 1939:58–62 [descriptions of parasitoids]; 1979:1146–1147 [catalog of parasitoids, *Trichopria angustipennis* and *T. paludis*].—Wirth, 1965:745 [Nearctic catalog].—Deonier and Regensburg, 1978:155 [records for Ohio].—Marsh, 1979:209 [catalog of parasitoid, *Opius lemnaphilae*].—Ferrar, 1987:169 [summary of biology].—Steinly et al., 1987: 166, 168 [records for Illinois, discussion].—Buckingham, 1989:219–221 [parasitoids: *Opius lemnaphilae* Muesebeck (Braconidae), *Trichopria angustipennis* Muesebeck, *T. paludis* Muesebeck (Diapriidae); records for Florida; review of biology].—Mansor and Buckingham, 1989:115–118 [host range].—Foote, 1995:430 [review of biology].—Mathis and Zatwarnicki, 1995:97 [world catalog].

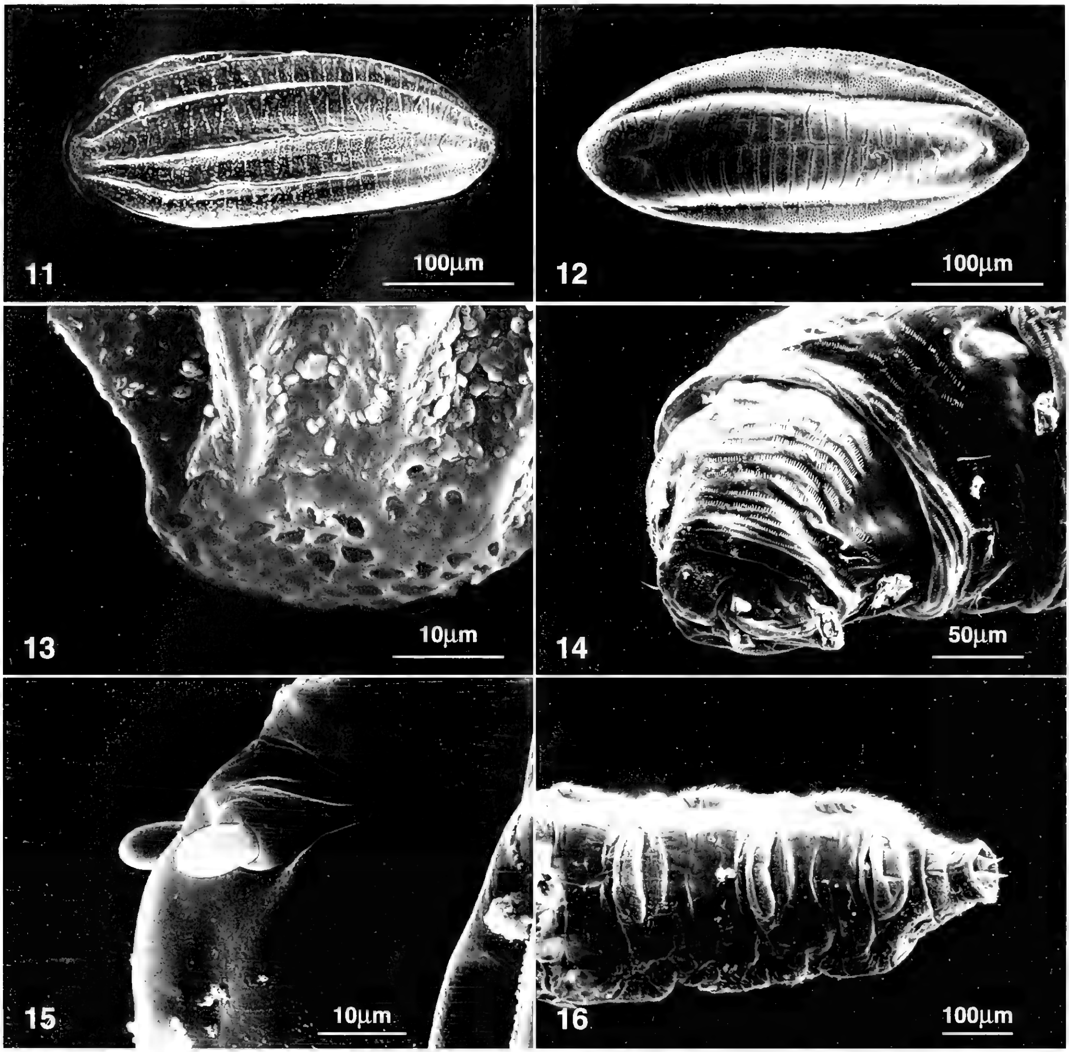
Diagnosis.—This species is distinguished from congeners by the following combination of characters: Antenna entirely dark brown; length of 1st flagellomere only slightly longer than height; mesofrons subshiny, distinct from densely microtomentose parafrons; face in lateral view shallowly concave; ventral third of face densely microtomentose, appearing velvety, dark brown to golden yellow, depending on angle; scutellum lacking dense microtomentum, gray, not appearing velvety; katepisternum brown; legs brown.

Description.—Minute to very small shore flies, length 0.83–1.2 mm; yellowish brown, dark brown, to black with silvery gray and yellowish silver microtomentum.

Head: Frons generally moderately densely invested with silvery whitish gray microtomentum; mesofrons from ocellar triangle anteriad moderately densely silvery whitish gray microtomentose, subshiny; parafrons brown; fronto-orbit generally concolorous with mesofrons or slightly more brownish. Occiput brown with yellowish silver microtomentum; outer vertical seta lateroclinate; length of outer vertical seta about ¾ inner vertical seta; inner vertical seta parallel to slightly convergent; fronto-orbital setae minute, hairlike; pseudopostocellar setae prominent, proclinate and somewhat divergent; paravertical setae absent; ocellar setae absent; postocullar setae absent; ocelli arranged in isosceles triangle, with distance between posterior ocelli much greater than between either posterior ocellus and anterior ocellus. Antenna entirely dark brown; length of 1st flagellomere only slightly longer than its height; arista bearing 5–7 rays along dorsum. Facial background coloration shiny dark brown with sparse silvery gray microtomentum. Oral margin slightly protruded dorsally. Face with transverse crease at about ventral third, shallowly concave in lateral view, ventral third slightly angled forward, densely microtomentose, dark brown. Parafacial band shiny dark brown. Eye ratio 0.78–0.83. Gena-to-eye ratio 0.14–0.17. Gena and postgena brown with sparse silvery yellow microtomentum; parafacial setae minute; gena bearing small black setulae. Maxillary palpus dark brown with prominent setae; prementum shiny dark brown, bulbous.

Thorax: Mesonotum brown with silvery yellow microtomentum; scutellum lacking microtomentum or microtomentum sparse, not appearing velvety; scutum length 0.29–0.43 mm; scutellar length 0.10–0.17 mm; subscutellum brown with yellowish silver microtomentum; anepisternum with dorsal half brown with dense silvery gray microtomentum, ventral half with sparse silvery and golden microtomentum; katepisternum brown with sparse silvery golden microtomentum; anatergite brown with yellowish silver microtomentum. Chaetotaxy: anterior dorsocentral seta inserted near level of transverse suture; acrostichal setulae lacking; scutellar setae with anterolateral setae 3¾4 length of posteromedial setae and mediolateral setulae; katepisternal seta weakly developed, hairlike, much shorter than posterior anepisternal seta. Wing: length 1.02–1.44 mm; width 0.42–0.61 mm; vein R_{4+5} shallowly bowed anteriorly; costal vein ratio 1.76–1.85, with length of costal section II about half costal section III; M vein ratio 0.46–0.55. Halter knob bright yellow; stem blackish brown. Legs: yellowish brown to brown; tarsomeres 1–4 yellowish brown, darker distally; tarsomere 5 brown.

Abdomen: Tergite 3 length, males 0.13–0.17 mm, females 0.14–0.20 mm; tergite 4 length, males 0.18–0.20 mm, females 0.18–0.20 mm. Background coloration brown to dark brown. Tergites 1–5 covered with sparse yellow microtomentum; 5th sternite slightly longer than wide, tapered slightly anteriorly, bearing numerous setulae. Male Terminalia (Figs. 8–9): Epandrium much reduced, as a small, lateral phalange at base of fused cercus; cercus comparatively greatly enlarged, height nearly equal to width of 5th sternite of male; subepandrial plate an



Figs. 11–16. Scanning electron micrographs of *Lemnaphila scotlandae*. 11, Egg, dorsal view. 12, Same, ventral view. 13, Micropylar end of egg, ventral view. 14, Third-instar larva, cephalic end, lateroblique view. 15, Same, antennae. 16, Same, posterior end, ventral view.

arched, narrow, bandlike plate; surstylus (Fig. 8) a long, narrow, parallel-sided process bearing 2 apical setulae; aedeagus cornucopialike in lateral view (Fig. 8), with broad base, tapered to narrow apex that is hooked; aedeagal apodeme with keel comparatively long and narrow in lateral view, essentially symmetrical; subepandrial plate forming rounded arch, connected ventrally with postgonite; postgonite (Fig. 8) prominent with a posterior and anterior process; posterior gonal process prominent with apical ⅓ parallel-sided, apex rounded, ventrally projected setula about ⅔ distance from connection with subepandrial plate; anterior gonal process in lateral view (Fig. 8) a small, narrow, tapered process about ½ length of surstylus, bearing apical setulae; hypandrium (Fig. 10) narrowly V-shaped.

Type Material.—The holotype male is labeled "♂/Fall Creek, Ithaca, N[ew]. Y[ork]./M. B. Scotland VII 25–46 [sic; Jul 25–26],1933/TYPE No. 6501 Lemnaphila SCOTLANDAE E.T. Cresson, Jr, [red;

number and species name handwritten]." The holotype is double mounted (glued to a pin in a rectangular block of cork), is in excellent condition (slightly teneral), and is deposited in the ANSP (6501).

Other Specimens Examined.—NEARCTIC. *CANADA. ONTARIO.* Guelph, 12 Jan 1976, J. M. Cumming (14 ♂, 16 ♀; GUE); 16 Jan 1976, J. M. Cumming (5 ♀; GUE); 8 Aug 1978, W. A. Attwater (3 ♂, 5 ♀; GUE); Limehouse, 1 Sep 1974, R. E. Roughley (1 ♂, 1 ♀; GUE); 2 Sep 1974, R. E. Roughley (1 ♂, 5 ♀; CNC, GUE); 6 Oct 1974, R. E. Roughley (on *Lemna minor* in Black Creek), (1 ♀; GUE); Ottawa, 196?, J. G. Chillcott (2 ♂, 2 ♀; CNC); Wainfleet Bog (8 km S Welland), 14–28 Sep 1987, A. Stirling (2 ♂; WSU).

UNITED STATES. FLORIDA. Alachua: Gainesville, 13–31 Oct 1986 (*Lemna valdiviana:* pools at Division of Plant Industry), G. R. Buckingham (4 ♂, 14 ♀, 1?; JEPC); Pierce's Homestead (Malaise trap; S9-T10S-R18E), 11 May 1974, W. H. Pierce (1 ♀; USNM). Broward: Ft. Laudersale (*Lemna valdiviana*), 14 Nov 1988, G. R. Buckingham (1 ♂; USNM). Putnam: Rodman Reservoir (*Lemna minor*), 6 Oct 1987, G. R. Buckingham (1 ♂, 1 ♀; USNM). Sumter: Lake Okahumpka (*Lemna valdiviana*), 22 Oct 1987, G. R. Buckingham (1 ♀; USNM). *MICHIGAN.* Clinton: Bath, 10 Oct 1965, (1 ♀; USNM). *NEW YORK.* Tompkins: Ithaca, Fall Creek, 25–26 Jul 1933, M. B. Scotland (12 ♂, 11 ♀; allotype; AMNH, ANSP, BMNH, CU, USNM); Ithaca, Sep 1933, M. B. Scotland (7 ♂, 11 ♀; CU, USNM). *OHIO.* Portage: Kent (near Kent State University stadium), 23 May–4 Aug 1986, 1987, J. Edmiston (12 ♂, 12 ♀; JEPC); Kent, 24 Jun-2 Sep 1987 (lab reared), J. Edmiston (9 ♂, 14 ♀; JEPC). Franklin: Columbus (Mirror Lake), 23 Aug 1919, W. C. Kraatz (1 ♂; OHSU). Geauga: LaDue Reservoir (41°22.2′N, 80°13.4′W; duckweed), 12 Sep 1976, B. A. Steinly (32 ♂, 21 ♀; USNM).

Distribution.—*Nearctic:* Canada (ON), USA (FL, IL, MI, NY, OH).

Natural History.—Adult *L. scotlandae* are commonly found on or flying over the surface of floating duckweed thalli. The adults utilize the *Lemna* for food, leaving characteristic elongate gouges on the surface of the thallus. Seasonal distribution and overwintering stages are unknown; adults, however, have been collected in late November, suggesting that adults are able to survive the cold season like other north-temperate Ephydridae. Adults collected from the field and reared in the laboratory lived between 2–21 days (n = 13).

Females lay eggs on the margin of a *Lemna* thallus, usually one egg per thallus. Females collected from the field and reared in the laboratory laid up to 41 eggs per day, averaging 21–26 eggs per day (n = 11) during their first four days in the laboratory. One female laid 334 eggs during 20 days.

Eggs hatch in 4–6 days (x = 4.21; n = 10), after which the first-instar larvae begin feeding on thallus tissue. Burrowing through the duckweed, the first-instar larvae feed for 1–3 days (x = 1.92; n = 10) before molting; second-instar larvae feed for 1–4 days (x = 2.62; n = 10) before molting; third-instar larvae feed for 2–7 days (x = 4.85; n = 10) before pupariation occurs within the hollowed-out duckweed thallus. The pupal period ranged between 6–8 days (x = 7.15 days; n = 10).

Although the immatures and adults of this species are very tiny, three hymenopterous parasatoids, as noted in the synonymy, have been reared from puparia (Muesebeck 1939, Scotland 1939, Buckingham 1987).

DESCRIPTION OF IMMATURE STAGES

Egg (Figs. 11–12).—Length 0.35–0.37 mm (x = 0.36; n = 12); width 0.13–0.17 (x = 0.16; n = 12); ovoid, ends bluntly rounded; micropylar end porous; 4 longitudinal ridges dorsally with parallel rows of minute pores between ridges; flattened ventrally with medioventral rows of minute pores and laterally with parallel rows of minute pores. Chorion light brown.

Mature third-instar larva (Figs. 20–21).—Length 1.11–1.34 (x = 1.24; n = 5); width 0.22–0.32 (x = 0.28; n = 5). vermiform, 12 segmented, white. Anterior end blunt with ventrally projected mandibles, posterior end with medioventrally projected spiracles. Integument covered with minute setulae. *Cephalic segment* (segment 1, pseudocephalic segment): antenna 2 segmented with rounded socket, proximal antennal segment minute, circular; distal antennal segment ovoid, greater than 10× length of proximal segment, lateroventrally with rounded sensory pits.

Segment 2 (prothoracic segment): ventrally and laterally with rows of comblike setae, projected dorsomedially over cephalic segment. Segment 3: longest segment, 1 ⅓ length of segment 2 with rows of comblike setae. Segments 3–11 similar, rounded, ventral surface with creeping welts; welts of segments 3 and 4 small; welts of segments 5–11 large. Segment 12 with perianal pad ventrally and posterior spiracles ventromedially; perianal pad bilobed, each lobe ovoid; posterior spiracle with cylindrical base and conical projection; conical projection approximately twice as long as cylindrical base and tapered to point.

Cephalopharyngeal skeleton (Figs. 17–19): A-PDC 0.20–0.21 mm (n = 7), A-VDC 0.18–0.20 mm (n = 7), PDC-VDC 0.08 mm (n = 7). Mandibles fused dorsally, anteriorly pointed, posteriorly broadened. Hypopharyngeal sclerite minute, posteriorly rounded, anteriorly slightly indented. Tentoropharyngeal sclerite anteriorly roundly pointed with anteroventral projection, dorsal cornu posteriorly sharply pointed, ventral cornu posteriorly broadened. First- and second-instar larvae similar. Distinguishable by size of tentoropharyngeal sclerite.

Puparium (Fig. 21).—Length 1.17–1.36 (x = 1.28; n = 13); width 0.53–0.60 (x = 0.56; n = 13); width broadest posteromedially in ventral view, tapering at each end; anterior end slightly curved ventrally, broadly rounded with remnants of cephalopharyngeal skeleton clearly visible; posterior end slightly curved ventrally, spiracle remnants dark, perianal pad remnants visible; margins of puparium smooth. Color uniformly pale brown except for black cephalopharyngeal skeleton remnants.

Remarks.—This species is commonly called the *Lemna* fly (Scotland 1934, 1939, 1940) or the duckweed miner, and the adults and immature stages live entirely in and around duckweed (Lemnaceae). Miss Minnie B. Scotland (1933), after whom the species was named, first reared *L. scotlandae* from duckweed (*Lemna minor* L.) that was collected in a fish hatchery at Fall Creek near Ithaca, New York. The species is now known to occur from southern Canada to northern Florida and west to Illinois.

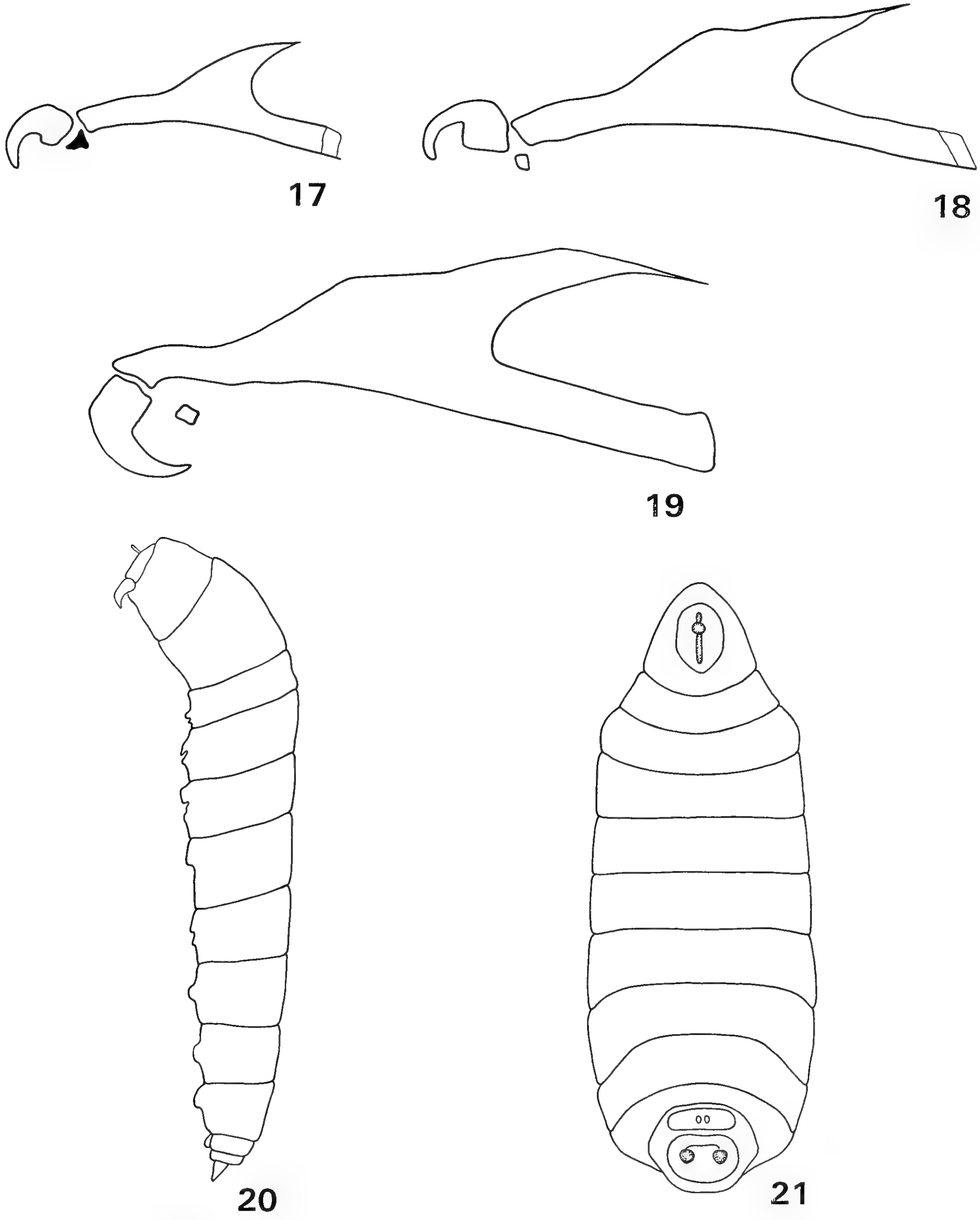
Lemnaphila wirthi Lizarralde de Grosso
(Figs. 22–26)

Lemnaphila wirthi Lizarralde de Grosso, 1977:163; 1978:18–19 [review, description of male terminalia]; 1989:55 [review, Argentina fauna].—Mathis and Zatwarnicki, 1995:97 [world catalog].

Diagnosis.—This species is distinguished from congeners by the following combination of characters: Antenna entirely dark brown; length of 1st flagellomere only slightly longer than height; face in lateral view shallowly concave; ventral third of face densely microtomentose, blackish brown, concolorous with dorsal portion of face; scutellum densely microtomentose, appearing velvety, dark brown; katepisternum brown; coxae, femora, and tibiae yellow.

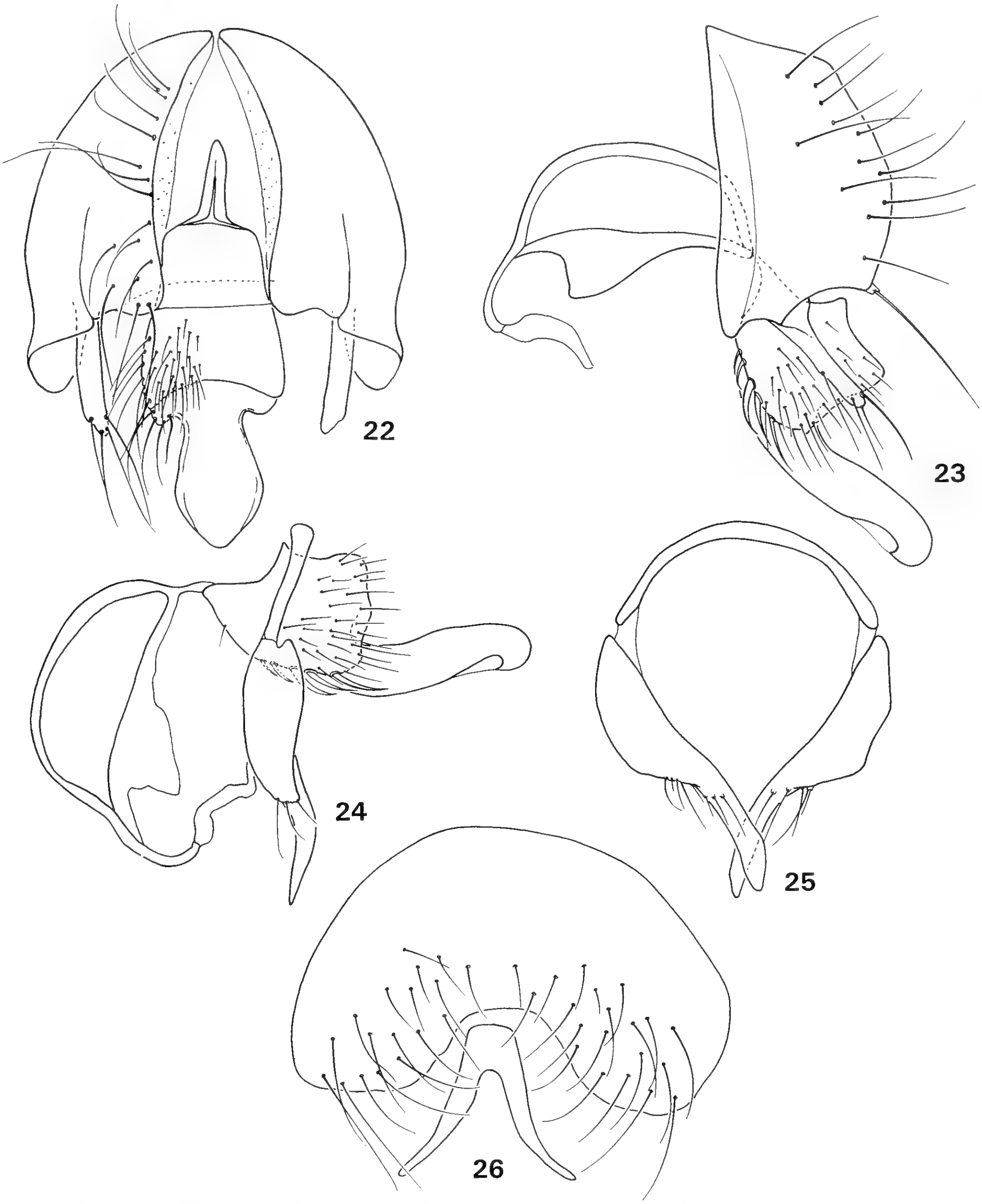
Description.—Minute to very small shore flies, length 0.95–1.20 mm.

Head: Frons with mesofrons, parafrons, and anterior half of fronto-orbit concolorous, densely microtomentose, brownish black, appearing velvety; posterior fronto-orbit (from base of outer vertical seta to base of lateroclinate fronto-orbital seta) with whitish gray microtomentum. One fronto-orbital seta well developed, length



Figs. 17–21. *Lemnaphila scotlandae.* 17, Cephalopharyngeal skeleton, first-instar larva. 18, Same, second-instar larve. 19, Same, third-instar larva. 20, Third-instar larva, lateral view. 21, Puparium, ventral view.

subequal to outer vertical seta, orientation postero-obliquely lateroclinate to lateroclinate; other fronto-orbital setae anterior of large seta, at best weakly developed, hair-like; length of outer vertical seta about ⅔ that of inner vertical seta, outer vertical seta distinctly curved laterally, inner vertical seta very shallowly curved, nearly vertical;



Figs. 22–26. *Lemnaphila wirthi.* 22, Male terminalia (epandrium, cercus, surstylus, aedeagus, aedeagal apodeme), posterior view. 23, Same (with addition of postgonite), lateral view. 24, Internal male terminalia, lateral view. 25, Postgonite and subepandrial plate, ventral lateral view. 26, Fifth sternite and hypandrium, ventral view.

ocelli arranged in isosceles triangle, with distance between posterior ocelli greater than between either posterior ocellus and anterior ocellus. Antenna entirely dark brown; length of 1st flagellomere only slightly longer than height; arista with 6–7 long, dorsal rays. Face with shallowly concave in lateral view; ventral third of face densely microtomentose, concolorous with frons; dorsal portion of face with very shallow carina, mostly black except shiny black carina. Eye ratio 0.68–0.74. Gena-to-eye ratio 0.09–0.11. Maxillary palpus blackish brown; mouthparts generally brownish black.

Thorax: Mostly brownish black to black; scutum subshiny, sparsely microtomentose; scutellum with dense microtomentum, brownish black, not shiny, but velvety appearing like frons; pleuron mostly brownish black to black except dorsal half of anepisternum from some angles appearing silvery gray. Chaetotaxy: anterior dorsocentral seta inserted behind level of transverse suture; acrostichal setulae sparse anteriorly, in 2 rows, lacking posteriorly; basal scutellar seta about ⅓ length of apical seta; katepisternal seta well developed, length subequal to posterior anepisternal seta. Wing: length 1.08–1.24 mm; width 0.45–0.57 mm; vein R_{4+5} mostly straight to very shallowly bowed anteriorly; costal vein ratio 1.5–1.73; length of costal section II about half of section III; M vein ratio 0.44–0.49. Halter knob bright yellow; stem brownish yellow. Legs: yellow except for brown 5th tarsomeres.

Abdomen: Dark brown, male 5th tergite subshiny; 5th sternite of male (Fig. 26) broadly and shallowly U-shaped, thickly formed, bearing numerous setulae along posterior margin and on membrane immediately adjacent. Male terminalia (Figs. 22–24): Epandrium (Figs. 22–23) comparatively well developed as a phalange at ventrobasal angle of cercus; cerci very well developed, in lateral view (Fig. 23) irregularly hemispherical around posteromedial margin, basolateral margin even, nearly straight in lateral view, shallowly concave in posterior view; surstylus (Figs. 22–23) long, slender, mostly parallel sided, apical ⅔ well sclerotized, bearing several setulae along length, apex rounded; subepandrial plate (Figs. 24–25) evenly arched, slender, bandlike in lateral view (Fig. 24); aedeagus angulate in lateral view (Fig. 24), basiphallus in lateral view somewhat quadrate with distiphallus extended from ventral portion of basiphallus, distiphallus long, slender, shallowly sinuous, apex recurved; aedeagal apodeme (Fig. 24) enlarged, in lateral view semioval with keel prominent, wide; postgonite in lateral view long and conspicuously sinuous, base moderately slender, apical ⅓ more slender, apex acutely pointed, apices cruciate in ventral view (Fig. 25); hypandrium in ventral view (Fig. 26) narrowly V-shaped with arms slightly flared apically, base wide and bluntly rounded.

Type Material.—The holotype female is labeled "ECUADOR. Manabi[:] Estero Balsa 9 Sept 1955/Collr.Levi-Castillo/Lemnaphila 2 n sp. det WWirth '60 [?]/LEMNAPHILA WIRTHI L. DE GROSSO [handwritten]./HOLOTYPO [red]." The holotype is double mounted (glued to a paper triangle), is in good condition (right wing in glue, some setae broken), and is deposited in the USNM.

Other Specimens Examined.—NEOTROPICAL. *DOMINICAN REPUBLIC. La Vega:* Jarabacoa (1–2 km S; 19°06.9′N, 70°37′W; 520 m), 8–21 May 1995, 1998, W. N. Mathis (29♂, 13♀; USNM).

Distribution.—*Neotropical:* Argentina (Tucumán), Ecuador, West Indies (Dominican Republic).

Remarks.—The specimens from the Dominican Republic are a major extension in the known range of this species, and emphasizes the apparent lack of collecting this species and *Lemnaphila* generally. We now know this species from Argentina in the south to Ecuador and the Dominican Republic in the north.

PHYLOGENETIC CONSIDERATIONS

Lemnaphila, as discussed previously (generic diagnosis and discussion), is similar and related to *Hydrellia* and *Cavatorella,* and these three genera comprise the tribe Hydrelliini in the subfamily Hydrelliinae. The tribe Hydrelliini is distinguished from other tribes of Hydrelliinae by the following characters: specimens usually dull and densely microtomentose (some species secondarily sparsely microtomentose, subshiny, blackish); ocellar setae seldom as strong as pseudopostocellar setae, usually much weaker; eye bearing numerous short, interfacetal, fluted setulae; postsutural supra-alar seta usually short, not longer than posterior notopleural seta; posterior notopleural seta at same level as anterior seta (independently and secondarily inserted above level of anterior seta in *Lemnaphila,* as in Atissini); costa extended to vein M; midtibiae lacking dorsal, spinelike setae.

Within Hydrelliini, the three included genera are distinguished from each other by the characters noted in the generic key (p. 654). The relationships among these genera, however, are unresolved and remain problematic. For example, although *Lemnaphila* and its included species are a well-corroborated, monophyletic lineage (see below), this lineage may eventually be found to be an included lineage within *Hydrellia,* i.e., *Hydrellia* lacks characterization by synapomorphies and its monophyly is unsubstantiated. *Cavatorella* may likekwise be an included lineage within *Hydrellia,* perhaps closely related to *Lemnaphila.*

Synapomorphies that conclusively establish the monophyly of *Lemnaphila* are: 1. Ocellar setae lacking (also lacking in some species of *Hydrellia*); 2. Prescutellar acrostichal seta lacking; 3. Vein R_{2+3} short with costal section II shorter than section III (a shortened R_{2+3} also occurs in some species of *Hydrellia* and in *Cavatorella*); 4. Posterior notopleural seta inserted near dorsal (sutural) angle, clearly higher than the level of the anterior seta; 5. Anepisternum bearing a single seta along the posterior margin; 6. Epandrium weakly developed, incomplete dorsally, with membranous gap between lateral extensions, these extensions are as narrow, lateral phalanges at base of cerci; 7. Cerci fused with medial margin of epandrium; 8. Surstylus reduced to a simple, small process at the ventral margin of the fused epandrium/cerci complex; 9. Larvae mining the thalli of Lemnaceae (*Hydrellia albilabris* (Meigen) from the Old World also mines the thalli of *Lemna* (Mathis and Zatwarnicki 1995)). The mining habit of *H. albilabris* in *Lemna* apparently arose independently. We have examined specimens of *H. albilabris* to verify that they are not closely related to *Lemnaphila.*

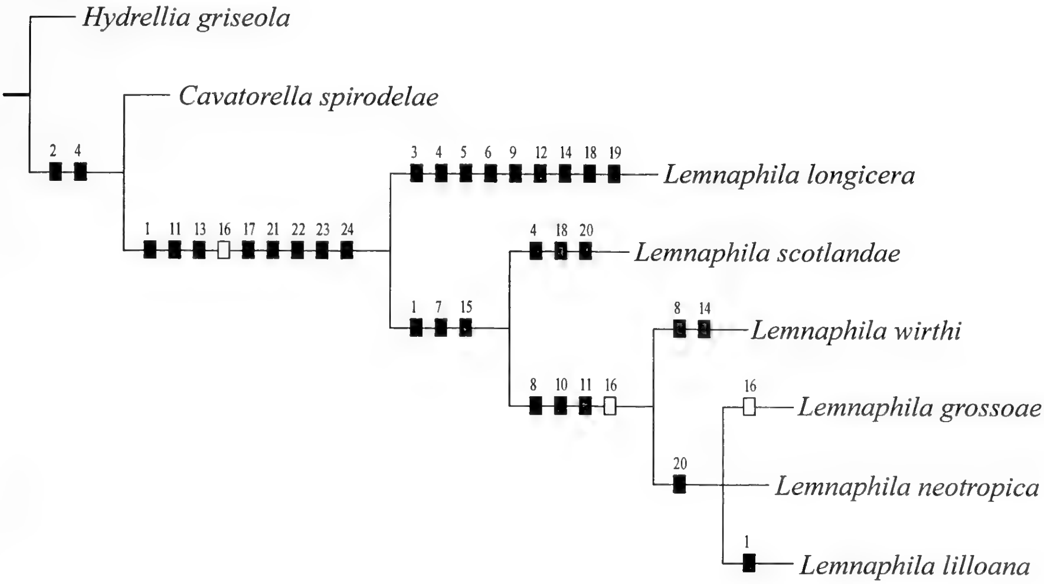
In the presentation on species-level relationships that follows, the characters used in the analysis are noted first. Each character is immediately followed by a discussion to explain its states and to provide perspective and any qualifying comments about that character. After presentation of the information on character evidence, an hypothesis of the cladistic relationships is presented and briefly discussed. The cladogram (Fig. 27) is the primary mode to convey relationships, and the discussion is to supplement the cladogram and is intended only to complement the latter. In the discussion of character data, a "0" indicates the state of the outgroup; a "1" or "2" indicate the respectively more derived states. All multistate characters (1, 4, 8, 11, 14, 18, 20) were treated as nonadditive characters (−), and characters 5, 6, and 9, which are autapomorphies for *L. longicera,* were made inactive ([]) for the analysis, such as calculation of the consistency index. The numbers used in the presentation are the same as those on the cladogram (Fig. 27), and the sequence is the same as noted in the character matrix (Table 1).

The other two genera of Hydrelliini, *Hydrellia* and *Cavatorella,* were selected as outgroups. As the exemplar of *Hydrellia,* we chose the widespread type species of the genus, *H. griseola* (Fallén), and for *Cavatorella,* which is monotypic, we studied *C. spirodelae* Deonier, which occurs in China and Japan (Deonier 1995). *Hydrellia* is represented by over 200 species worldwide (Mathis and Zatwarnicki 1995).

CHARACTERS USED IN THE PHYLOGENETIC ANALYSIS

Head:

1. *Vestiture of mesofrons:* moderately mi-



Figs. 27. Cladogram depicting hypothetical cladistic relationships among species of *Lemnaphila*.

crotomentose, appearing mostly dull (0); sparsely microtomentose, subshiny (1); densely microtomentose, appearing velvety black or whitish (2); mesofrons, except ocellar triangle, bare, shiny (3). This multistate character is treated as nonadditive.

2. *Ocellar setae:* present (laterad of anterior ocellus, smaller than pseudopostocellar setae) (0); lacking or greatly reduced (1).
3. *Arrangement of ocelli:* ocelli forming an isosceles triangle with distance between posterior ocelli about twice that between either posterior ocellus and anterior ocellus (0); ocelli forming an equilateral triangle or with distance between posterior ocelli only slightly more than between either posterior ocellus and anterior ocellus (1).

Table 1. Matrix of characters and taxa used in the cladistic analysis of *Lemnaphila* (numbers for characters correspond with those used in the text).

	000000000 123456789	11111111112 01234567890	222 123	2 4
Hydrellia	000000000	00000000000	000	0
Cavatorella	000100000	10000000000	000	0
L. longicera	111311001	02112011210	111	?
L. grossoae	210100110	11010121001	111	1
L. scotlandae	210200100	02010111102	111	1
L. wirthi	210100120	11011101000	111	1
L. neotropica	210100110	11010101001	111	1
L. lilloana	310100110	11010101001	111	1

4. *Fronto-orbital setae:* anterior fronto-orbital seta proclinate, smaller than posterior seta, which is lateroobliquely reclinate (0); posterior seta elongate, oriented laterally (1); both setae reduced but evident (2); both setae greatly reduced or lacking (3). This multistate character is treated as nonadditive.
5. *Color of antenna:* generally unicolorous, most brownish black but sometimes yellowish (0); scape, pedicel, and basal half of 1st flagellomere yellow (1). The derived state of this character is an autapomorphy for *L. longicera* and is therefore treated as an inactive character in the analysis.
6. *Length of 1st flagellomere:* about equal to or slightly greater than height (0); twice height (1). The derived state of this character is an autapomorphy for

L. longicera and is therefore treated as an inactive character in the analysis.

7. *Shape of face in lateral view:* face straight (0); shallowly concave, usually with a shallow, transverse groove (1).
8. *Facial vestiture:* face mostly uniformly microtomentose, color varying, depending on angle of view, except for narrow, vertical stripe (0); ventral third of face densely microtomentose, silvery white, distinctly contrasted with blackish brown dorsal portion (1); ventral third of face densely microtomentose, dark brown (2). This multistate character is treated as nonadditive.
9. *Length of outer vertical seta:* about ⅔–¾ length of inner vertical seta (0); less than half inner vertical seta (1). The derived state of this character is an autapomorphy for *L. longicera* and is therefore treated as an inactive character in the analysis.

Thorax:

10. *Position of anterior dorsocentral seta:* inserted posterior of transverse suture (0); inserted at level of transverse suture (1).
11. *Acrostichal setulae:* numerous setulae and 1 well-developed pair of prescutellar setae (0); sparse setulae anteriorly, in 2 rows, lacking posteriorly, including prescutellar pair (1); lacking (2). This multistate character is treated as nonadditive.
12. *Comparative length of basal scutellar seta:* long, from ½ to being subequal to length of apical seta (0); short, about ⅓ length of apical seta (1).
13. *Position of posterior notopleural seta:* inserted at about same level as anterior seta (0); inserted at elevated position relative to anterior seta (1).
14. *Scutellar vestiture:* moderately densely microtomentose, not appearing velvety (0); scutellum densely microtomentose, somewhat appearing velvety (1); scutellum densely microtomentose, appearing velvety, dark brown, similar to notopleural patch (2). This multistate character is treated as nonadditive.
15. *Length of costal sections II and III:* costal sections II and III about equal in length, vein R_{2+3} relatively long (0); costal section III considerably longer than II, vein R_{2+3} relatively short (1).
16. *Shape of anal angle of wing:* deeply rounded, greatest depth equal to or greater than distance between apices of vein R_{4+5} and M (0); very shallow rounded, greatest depth conspicuously less than distance between apices of vein R_{4+5} and M (1).
17. *Number of setae and setulae along posterior margin of anepisternum:* 1 large seta and 1–2 setulae (0); 1 seta, setulae greatly reduced or lacking (1).
18. *Presence or absence of katepisternal seta:* seta well developed, length subequal to posterior anepisternal seta (0); seta greatly reduced (1); or lacking (2). This multistate character is treated as nonadditive.
19. *Color of katepisternum:* brown (0); whitish yellow, concolorous with forecoxa (1).
20. *Color of legs:* legs entirely yellowish, with coxae whitish yellow and apical half of tibiae slightly brownish yellow (0); femora brown, tibiae and most tarsomeres yellow (1); legs unicolorous, brown (2). This multistate character is treated as nonadditive.

Abdomen:

21. *Development of epandrium at dorsum:* dorsum of epandrium well developed to weakly developed (0); epandrium incomplete dorsally with membranous gap between lateral phalanges (1).
22. *Condition of cercus relative to epandrium:* cerci free from epandrium (0); cerci fused laterally to medial margin of epandrial phalange (1).
23. *Development of surstyli:* generally well developed structures at ventral margin of epandrium (0); reduced to simple

Table 2. Analysis of characters based on the cladogram (Fig. 27).

Character	1	2	3	4	5	6	7	8	9	10	11	12
Steps	3	1	1	3	1	1	1	2	1	1	2	1
Con. Index	100	100	100	100	100	100	100	100	100	100	100	100
Ret. Index	100	100	100	100	100	100	100	100	100	100	100	100
Character	13	14	15	16	17	18	19	20	21	22	23	24
Steps	1	2	1	4	1	2	1	2	1	1	1	1
Con. Index	100	100	100	50	100	100	100	100	100	100	100	100
Ret. Index	100	100	100	0	100	100	100	100	100	100	100	100

small process at ventral margin of the fused epandrial/cercal complex (1).

Behavior:

24. *Feeding preference:* miner in various, mostly aquatic plants (0); miner in the thalli of Lemnaceae (1). Lacking rearing records for *L. lonicera,* we coded this character as a ? for this species. Like all other members of *Lemnaphila,* however, we anticipate and predict that this species will also be found to be a miner in aquatic plants of Lemnaceae.

ANALYSIS

Using the implicit enumeration (ie*) option of Hennig86, four most and equally parsimonious trees were generated, each with a length of 34 steps and consistency and retention indices of 0.91 and 0.86 respectively. The basal nodes in each of these cladograms are identical, with variation only in the more derived four species (the apical 2–3 nodes).

The matrix was then subjected iteratively to successive weighing (xs w, ie*, cc) to determine a character's contribution or weight and to find cladograms supported by the most consistent characters (Carpenter 1988, Dietrich and McKamey 1995). Successive weighing produced a single cladogram (Fig. 27) that is identical to one of the first four and is our cladogram of choice. The analysis of the characters for this cladogram is given in Table 2 and the weights of the various characters is given in Table 3.

Hydrellia was consistently the basal outgroup, with *Cavatorella* as the more immediate outgroup to *Lemnaphila.* Although the placement of *Cavatorella* as the sister group to *Lemnaphila* is currently the best indication of cladistic relationship, we do not attribute great weight to this relationship largely because only two synapomorphies (characters 2 and 4) were found to support this sister-group relationship.

The two basal lineages within *Lemnaphila* are first *L. longicera,* which is the sister lineage to the remaining species in the genus, followed by *L. scotlandae.* The next four species, which are all Neotropical in distribution (often at the same habitat), are obviously closely related and are very similar externally, and in the four equally parsimonious trees, these four species varied in position with respect to each other. In two of these trees, *L. wirthi* was basal to the other three, and in the other two trees, *L. grossoae* was the basal lineage. The single tree from successive weighing, howev-

Table 3. Status (i.e., nonadditive −; inactive]) and weights of characters after successive weighing.

Character No.	1	2	3	4	5	6	7	8	9	10	11	12
Weight, status	10− [	10+ [	10+ [	10− [	10+]	10+]	10+ [	10− [	10+]	2+ [	10− [	10+ [
Character No.	13	14	15	16	17	18	19	20	21	22	23	24
Weight, status	10+ [	10− [	10+ [	0+ [	10+ [	10− [	10+ [	10− [	10+ [	10+ [	10+ [	10+ [

er, has *L. wirthi* as the basal lineage with the other three species forming an unresolved trichotomy (Fig. 27).

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ON THE VALIDITY OF *HELICONIUS TRISTERO* BROWER AND *HELICONIUS MELPOMENE MOCOA* BROWER, WITH NOTES ON SPECIES CONCEPTS IN *HELICONIUS* KLUK (LEPIDOPTERA: NYMPHALIDAE)

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Abstract.—Lamas' (1998) criticisms of Brower's (1996a) taxonomy are shown to be based on misinterpretations of the evidence and of the rules of nomenclature. The names *H. amaryllis amaryllis f. bellula* Stichel and *H. melpomene bellula* Turner are unavailable. The name *H. bellula* Brower is available but invalid. The name *H. melpomene mocoa* Brower is the valid name for the subspecies of *H. melpomene* from the Putumayo region of southeastern Colombia. The Genotypic Cluster Species Concept is contrasted unfavorably to the Phylogenetic Species Concept with respect to the aims of systematics in general, and the resolution of relationships among geographically differentiated *Heliconius* taxa in particular.

Key Words: *Heliconius melpomene bellula, Heliconius tristero,* nomenclature, circumscription, subspecies

Recently, Lamas (1998) published a critical discussion of two new names applied to *Heliconius* butterflies from the upper Rio Putumayo basin in southeastern Colombia (Brower 1996a). The taxa in question are Müllerian mimics: one (*H. tristero*) was described as a species in the *H. cydno* Doubleday clade, while the other was named as a subspecies, *H. melpomene mocoa.* Most members of the *cydno* clade exhibit blue-and-white or blue-and-yellow wing patterns and mimic species in the *sara-sapho* group (cf. Brown 1981, Brower 1994, and Brower and Egan 1997 for reviews of phylogenetic hypotheses among *Heliconius* species), so it was a surprise to discover a new species mimicking sympatric races of *H. melpomene* (L.) and *H. erato* (L.).

That these formerly conflated taxa represent two distinct entities is supported by robust evidence stemming from three different sources (mitochondrial DNA sequences, genitalic morphology and wing patterns), and that at least one of them required a new name is not at issue. Lamas' criticisms of my paper focussed on the following problems: (1) the availability of *H. bellula* Stichel (1923); (2) the supposed synonymy of *H. melpomene mocoa* Brower with *bellula* auctt.; (3) my interpretation of the International Code of Zoological Nomenclature (1985) with regard to hybrids; and (4) the logic of my species concept. First, I will address these problems in narrow relation to Lamas' critique of my paper (1996a). My rebuttal of Lamas' criticisms is followed by a brief discussion of the species problem in *Heliconius.* An English translation of the relevant section of Lamas' paper is included as Appendix 1.

REPLY TO LAMAS' CRITIQUE

Is Heliconius bellula Stichel (1923) an available name?

As Lamas (1998) pointed out, Stichel (1923) applied the name *bellula* to a form of *H. amaryllis amaryllis* C. & R. Felder (*H. amaryllis* is now considered to be a subspecies of *H. melpomene*; cf. Ackery and Smiles, 1976). Lamas argued that Stichel's employment of *bellula* was infrasubspecific and therefore formally unavailable. However, Neustetter (1929) cited Stichel's name as a trinominal form of *H. amaryllis,* thus implying that the name was available (ICZN Article 16). The subsequent employment of the name for a geographical race by more recent authors (e.g., Turner 1971, Brown 1979, Sheppard et al. 1985, Mallet 1993, Brower 1996b) further suggests that the name has been treated as available (Art. 45gii), and it was under that premise that I dealt with it in my paper (Brower 1996a)[1].

However, given that Stichel's holotype is not a representative of the *melpomene* clade (see Brower 1996a and below), Lamas' opinion that Stichel's name was quadrinominal provides a convenient excuse to sink it and avoid the complications described above. If its original designation is deemed infrasubspecific, a name remains unavailable until a description is provided (Art. 10c). Lamas claimed that Turner (1971) employed the name *bellula* to refer to a subspecific entity, thereby becoming its author (Arts. 23j and 50c). However, Turner's tentative use of the name in a figure legend (followed by a question mark) was not accompanied by a description. Likewise, Brown (1979), Sheppard et al. (1985), Mallet (1993) and Brower (1996b) used the name, but none of them provided a description of the taxon, nor did any of them cite Stichel's description (which would not per se change its availability, in any case: Art. 11dii). All of those uses of *bellula* employ it as a nomen nudum and none of them satisfies the criteria of availability (Art. 13a).

Holzinger and Holzinger (1994) provided a description and illustration of *H. melpomene bellula* and cited Stichel (1923), but their book is not consistently binominal (it uncritically employs numerous infrasubspecific names), and its contents are thus unavailable (Art.11c). Ironically, it appears that my 1996 paper is the first to provide a description for *H. bellula* that would render it available under all the criteria of Art. 11 (via illustrations, description of differentiating features, identification of a holotype, and citation of Stichel 1923). But because I circumscribed the concept narrowly, to refer to a hybrid form typified by Stichel's original type specimen, the name is invalid. Even so, my definition prevents subsequent usage of *bellula* for any other *Heliconius* taxon (Art. 23h; see hybrid section, below). Thus, the correct authorship of *Heliconius bellula* is Brower (1996a), but the name does not refer to any valid taxon, regardless of its repeated misapplication in recent works (including my own).

Subjective synonymy of bellula and mocoa?

Lamas (1998) argued that *H. melpomene mocoa* Brower is a junior subjective synonym of *H. melpomene bellula* auctt. Since *bellula* is not a valid name, this is a moot point, but it raises another important issue: Lamas' claim shows that has been deceived by Müllerian mimicry! It is the holotype of *bellula* and the holotype of *H. tristero* that are closely-related, while the holotype of *H. melpomene mocoa* represents a different clade. Had Lamas examined the relevant characters, he would have seen that *bellula* and *mocoa* are not the same under any reasonable circumscription *H. bellula* (what-

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[1] I examined and discussed Stichel's holotypes of *bellula, permira* and *degener.* Lamas suggested that I was unaware of four additional forms described by Stichel from the Mocoa region. Rather, these were deliberately omitted from discussion, because it was clear from the original descriptions that they represent various hybrid forms with recombinant wing patterns that are even less similar to the modern "*bellula*" concept than the two other forms I discussed.

ever its status) is not an example of the *H. melpomene* species group; instead, it is close to *H. tristero* in the *H. cydno species* group. To include *bellula* and *mocoa* in the same species, one would have to view *H. cydno* Doubleday as a subjective junior synonym of *H. melpomene* (L.)! I described this problem explicitly in Brower (1996a), and it was precisely the desire to avoid such confusion that prompted me to coin new names for both the *cydno* relative (*H. tristero*) and the *melpomene* relative (*H. melpomene mocoa*) in the first place.

Even if *bellula* and *mocoa* were closely related, it is clear from Stichel's (1923) descriptions (Appendix 2) that he felt that *bellula* was different enough from the local "nominate form" to warrant a separate name. Stichel believed (in error) that his three "typical" specimens were *H. amaryllis amaryllis,* today recognized as a distinct *H. melpomene* subspecies with an allopatric distribution in the Huallaga valley of Peru (Sheppard et al., 1985). Although ideas about what entities within *Heliconius* deserve names have changed as knowledge of phenotypic variation and geographical distribution has grown, efforts to redefine an old name of dubious availability in specific contradiction to its original author's intent seem procrustean. A more reasonable view is that the "nominate form" of *H. melpomene* from Mocoa and environs was anonymous until I (Brower 1996a) named it.

Hybrids and the ICZN

Lamas (1998) also criticized as erroneous my invocation of Articles 1b and 23h to curtail the current usage of *bellula* because its holotype is a hybrid (Brower 1996a). He pointed out that because the definition of "hybrid" in the ICZN glossary states that offspring of crosses between conspecific subspecies are not hybrids, *bellula* cannot be considered a hybrid taxon. Re-examination of Brower (1996a) shows Lamas' point to be technically incorrect: I hypothesized that the *bellula* holotype specimen was the result of hybridization between *H. heurippa* and *H. tristero,* both of which I explicitly claimed were species in that paper. Under such circumstances ICZN article 23h specifically applies[2].

Whether or not the *bellula* holotype actually represents a hybrid or not (and which parental species might have spawned it) is difficult to determine in retrospect and without extensive data from experimental genetic crosses. That additional specimens displaying the same pattern have not been collected suggests that the holotype exhibits a rare recombinant wing pattern (typical of the phenotypic diversity found in other *Heliconius* hybrid zones). By contrast, there are multiple specimens from multiple localities that appear very similar to the holotype of *H. melpomene mocoa,* and illustrations of "*H. melpomene bellula*" in recent works (e.g., Turner 1971, Brown 1979, Holzinger and Holzinger 1994) all lack the yellow spots that are present in the *bellula* holotype. My interpretation that the specimen does not represent a "pure" geographical race is complementary to Stichel's (1923) opinion that the *bellula* holotype is transitional, as shown by his description of it as distinct and separate from his series of specimens of the local "nominate" form.

Logical Consistency

I made several statements that Lamas chose to overlook in his conclusion that my taxonomic argumentation (Brower 1996a) "no tiene sustento lógico al ser refutable." First, I did not argue that the current classification of *Heliconius* is not illogical. Indeed, I stated that I chose the ranks I employed to preserve nomenclatorial stability,

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[2] Lamas objected my use of the term "forbid" (translated as "prohibe" in his paper) with reference to the ICZN rule on names applied to interspecific hybrids. Article 23h says, "A species-group name established for an animal later found to be a hybrid . . . must not be used as a valid name for either of the parental species, even if it has priority over all other available names for them, but it may enter into homonymy." I leave it to the reader to contemplate whether "must not be used" and "forbids the use of" mean the same thing, or not.

even though I knew that the species delimitations among geographically polymorphic *Heliconius* butterflies were effectively arbitrary. The final points of my paper were that,

> "The mitochondrial DNA data suggest that the degrees of relationship among the *H. melpomene* races and among the *H. cydno* races are similar, and that divergence times within each group are also approximately the same, implying that the taxonomic rank of each group should also be the same. The entire species-level classification of the genus will probably require revision as additional data become available."

Ignoring these qualifying remarks, Lamas offered (without providing new data or examining the characters discussed in Brower [1996a]) a hypothesis of circumscription that he considered "more valid" than my view: that *H. timareta* Hewitson, *H. heurippa* Hewitson and *H. tristero* are conspecific. He based this notion on these entities' geographical proximity on the northeastern slope of the Andes, evidence of hybridization among them (which he denied on the following page), and their hypothesized close relationship (based on studies of mtDNA: Brower 1996a, 1996b). However, both the mtDNA studies and data from a more comprehensive recent analysis (Brower and Egan 1997) imply that *H. timareta, H. heurippa* and *H. tristero* are no more closely related to one another than any of them is to *H. cydno* or *H. pachinus* Salvin. Therefore, if one wanted to lump diagnosably different taxa based on the symplesiomorphy of potential interbreeding, the logically consistent choice would be to collapse all of these taxa under the oldest species-group name (*H. cydno*). I said as much in 1996a.

If Lamas (1998) were as concerned with the consistent assignment of taxa to the appropriate rank as his criticism of Brower (1996a) implies, then according to his "more valid" hypothesis, he should have named his new *Heliconius* subspecies (described in the same paper) not "*H. timareta timoratus*," but "*H. heurippa timoratus*" (if *timareta* and *heurippa* are conspecific, then the former is either a junior synonym or a subspecies of the latter). Under the interpretation Lamas claimed that he prefers, *timoratus* would seem to be an infrasubspecific form of the subspecies *H. heurippa timareta*! The complexity of sorting out names, ranks and relationships among geographic races in *Heliconius* obviously presents a challenge that neither Lamas nor I have yet resolved in a fully satisfactory manner.

Synonymies

Heliconius melpomene mocoa Brower, 1996a.

Heliconius melpomene bellula auctt. (Turner 1971, Brown 1979, Sheppard et al. 1985, Mallet 1993, Brower 1994, Holzinger & Holzinger 1994) [misidentifications; unavailable name].

Heliconius melpomene mocoa Brower 1996a: 328. Holotype: Colombia, Dpto. Putumayo, 1–3 km N. Mocoa on rd. to Pitalito, 25 March 1992 leg. AVZ Brower. Deposited in Cornell University Insect Collection (examined).

***Heliconius heurippa* × *Heliconius tristero*,** natural hybrid

Heliconius amaryllis amaryllis f. *bellula* Stichel, 1923: 262. Original type specimen: Colombia, Río Putumayo, Río Guayuyaco, 7 July 1921 leg. W Hopp (see Brower 1996a for transcript of original labels).

Heliconius amaryllis f. *bellula* Stichel; Neustetter 1929: 58.

Heliconius amaryllis f. *bellula* Stichel; Brower 1996a [identified as hybrid *H. heurippa* × *H. tristero*].

NOTES ON SPECIES CONCEPTS IN *HELICONIUS*

I suspect that the root of Lamas' criticisms of my concepts of *tristero* and *mocoa* lies in his concept of species in *Heliconius,* which differs from mine. The species problem in *Heliconius* has been controversial for many years (e.g., Eltringham 1916 vs. Kaye 1916); indeed, it is the very complexity of geographical diversification within the genus that has led it to become a model system for the study of the evolutionary genetics of mimicry (Sheppard 1960, Emsley 1964, Turner 1971, Brown et al. 1974, Mallet 1993). Many of the *Heliconius* papers from the post-typological period applied the biological species concept (BSC; Mayr 1940)), which unites allopatric taxa based on their potential to interbreed. In recent years, the BSC has been criticized on theoretical and practical grounds, and numerous alternative species definitions have been proposed that offer more operational criteria for species delimitation (Eldredge and Cracraft 1980, Mishler and Donoghue 1982, de Queiroz and Donoghue 1988, Nixon and Wheeler 1990, Baum and Shaw 1995, Mallet 1995). Lamas' critique implied that he favors the "genotypic cluster" species concept (GCSC; Mallet 1995), while I (Brower 1996a) applied the phylogenetic species concept (PSC) as elaborated by Nixon and Wheeler (1990).

Evidence and Criteria of Specific Distinctness

Mallet (1995) argued that the PSC fails to provide "clear guidelines" for dividing species because it recognizes groups based on apomorphy: "With detailed morphology and modern molecular techniques," he asserted, "one can find apomophies for almost every individual," which he suggested would result in rampant splitting and proliferation of species. This simplistic caricature of the cladistic method misrepresents the procedure of species delimitation, which has been explored in depth by Davis and Nixon (1992), Doyle (1995) and Brower (1999). Cladists identify populations of organisms that they hypothesize to be distinct, and seek discrete differences between them. If they discover such differences, cladists consider the populations to be separate species; otherwise, they are collapsed into a single species. That the cladistic approach may yield finer resolution of the hierarchical pattern of diversity than alternative methods is considered by many to be an asset. In short, the guidelines of the PSC are clear: it is Mallet's understanding of them that seems cloudy.

Mallet's (1995) alternative, the GCSC, views species as "identifiable genotypic clusters" recognizable by "a deficit of intermediates" at single and multiple loci, and views speciation as "the production of divergent populations that can coexist in sympatry." There are a number of problems with this approach. First, there are no explicit criteria for identification of genotypic clusters. That Mallet employed "deficit" instead of "absence" implies that he believes that the clusters need not be fixed for alternate alleles, but merely differ in allele frequency by some "significant" amount. Further ambiguities include how many markers should be sampled (Mallet [1996] suggested multiple loci), and what should be done if one locus suggests continuity, while another suggests distinction. The across-locus averages that Mallet (1995) employed in the hybrid indices he presented would disguise heterogeneity among loci. A more sophisticated and logically consistent, but equally labor-intensive approach to multilocus species discrimination was presented by Doyle (1995). In practice, however, methods like these that rely on exhaustive characterization of gene pools are rarely employed in the study of biological diversity, because they entail intensive, quantitative sampling that is not feasible in most circumstances.

Another difficulty with the GCSC is nondimensionality.—Mallet's concept is only useful for contemporaneous taxa in sympatry or parapatry. To cover everything else, Mallet (1995) suggested that "closely related allopatric forms should mostly be considered conspecific." But how are we to determine that allopatric forms are "closely related?" If allopatric populations are "identifiable," then they logically satisfy Mallet's GCSC criteria and are distinct species by definition; if they are not identifiable, then why would we hypothesize that they were different in the first place? When the hypothetical taxa under investigation occur in allopatry, researchers are forced to turn to the empirical comparison of features of organisms to draw inferences about their taxonomic relationships. The PSC recognizes separate species only when fixed differences are discovered between hypothesized groups, which will always result in the recognition of a minimal number of taxa in comparison to methods based on frequency differences. The claim that the PSC oversplits taxa relative to the GCSC is simply false.

In summary, Mallet's GCSC is a methodologically explicit version of the nondimensional BSC (Mayr 1963). It is labor-intensive, depending upon sampling of multiple individuals at multiple loci to provide empirical evidence of the absence of interbreeding. It bases the decision of specific distinctness on an arbitrary and unstated level of phenetic bimodality in a histogram of average genetic scores. Although Mallet and colleagues have made a rather convincing case for the distinctness of *Heliconius erato cyrbia* Godart and *H. himera* Hewitson on the basis of this method (Jiggins et al. 1996), that work represents a laborious multi-year, multi-authored effort to corroborate a conclusion about a single pair of taxa that had already been hypothesized by systematists years before (Descimon and Mast-de Maeght 1984). How Mallet's concept could be useful in the best of circumstances to a museum taxonomist working with qualitative samples of preserved, dead specimens on pins is not clear. What is quite evident is that Lamas has never employed the GCSC in any of his published taxonomic work, including the descriptions of new subspecies in Lamas (1998). Given this lack of consistency and rigor, it is especially ironic that my (1996a) names should be subject to such scrutiny, when they are perhaps the most thoroughly-diagnosed *Heliconius* taxa that have been published, the differentiating characters having been drawn from the results of cladistic analyses of mtDNA, and corroborated with diagnostic characters from external and internal morphology (Brower 1996a) and data from a nuclear gene (Brower and Egan 1997).

Recognition and Circumscription of Subspecies

Although the genus *Heliconius* contains numerous diagnosably different populations that bear valid species-group names, most of these are considered to refer to intraspecific variations. Since the rejection of rampant typological splitting in the early 20th Century (e.g., Riffarth 1902), *Heliconius* species have been circumscribed primarily by the BSC criterion of interbreeding. Under that criterion, otherwise uniform parapatric populations that hybridize where they abut have been considered conspecific. Likewise, distinct populations that hybridize with each of two otherwise allopatric neighbors provide a transitive link that has allowed lumping of chains of populations into single, geographically extensive "biological species." These species' component "geographical races" are diagnosably different (i.e., they display heritable characters that allow their unambiguous determination), and have been considered by many researchers (e.g., Brown et al. 1974, Sheppard et al. 1985, Brower 1996a, 1996b) to represent historically distinct entities. That their names are in common use in the literature and in museum classification schemes is a de facto acknowledgement of their recognition as taxa, even by those biologists who would emphatically deny their specific status. According to the PSC, diagnosably distinct groups that it is useful to name are considered separate species, and every recognized "geographical race" in *Heliconius* should be a phylogenetic species.

The ICZN (Art. 45a) considers names at

both specific and subspecific levels to be labels for taxa of a single category, the Species Group. The concept of subspecies is simply a convenient label for taxa at one of the potentially many hierarchical levels nested within the genus, as revealed by cladistic studies. The Code is sensibly silent on the problems of definition and boundary determination of concepts associated with name-bearing type specimens; such decisions are considered subjective, and left to the judgement of the describer and subsequent employers of the name. In most instances, the older *Heliconius* names were described from one or a few dead specimens in European collections, and were not accompanied by any discussion of the circumscription of the associated concept, beyond designation of an intraspecific level (e.g., subspecies, form, aberration, etc.). A good example of such a perfunctory description is Stichel's original diagnosis (1923) of *H. amaryllis amaryllis f. bellula* (Appendix 2).

Minimal original descriptions leave a great deal of latitude for subsequent interpretation. Such interpretations should strive to maintain nomenclatorial stability, but only when the names preserved are precisely and accurately associated with empirically supported concepts. If a concept diverges from the description due to the acquisition of new specimens and data to the point that the description is no longer adequate, some action is called for, ranging from redescription of the holotype to the separate description of differentiated concepts as distinct taxa. The currently-recognized "geographical races" (= phylogenetic species) of *Heliconius* are taxa corroborated by a century of empirical research in laboratories, museums, and the field. They bear names originally applied to the single holotype or short type series, and to which the current concepts correspond. The focus of modern systematic effort should be on the empirical diagnosis of such taxa and the inference of hierarchical relationships among them, not on empty disputes over the arbitrarily determined ranks that particular taxa do or do not represent. *H. melpomene mocoa* and *H. tristero* are both diagnosably distinct taxa of the Species Group.

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APPENDIX 1

Translation of Lamas' (1998: 119–120) critique. Translation is as precise as possible, but some idioms were translated freely to improve comprehensibility. For complete literature citations, see Lamas (1998)

Status of Heliconius tristero Brower and H. melpomene mocoa Brower

Recently, Brower (1996) has described two new taxa of *Heliconius* from Putumayo, southeastern Colombia, based on preliminary data from analysis of mitochondrial DNA sequences. Both names are discussed separately here.

Heliconius tristero was diagnosed by Brower (1996) as a taxon of the species group, belonging to the *H. cydno* Doubleday clade, and narrowly separated from *H. heurippa* Hewitson and *H. timareta* Hewitson. Although he did not mention it explicitly, Brower seems to imply that *heurippa, tristero* and *timareta* could constitute a subclade of the *cydno* group. The three taxa exhibit an allopatric distribution, *heurippa* occurring in the central eastern region of Colombia, *tristero* in southeastern Colombia and *timareta* in eastern Ecuador (and northern Peru, *vide infra*); while *heurippa* and *tristero* (so far as is known) are phenotypically monomorphic, *timareta* is polymorphic. Brower (1996: 330) concluded that "... *tristero* is considered a species only because its geographically adjacent close relatives, *H. heurippa* and *H. timareta,* have been traditionally considered species as well." This conclusion is not so logical as to be irrefutable. A more valid (and refutable) hypothesis would be to consider the three taxa conspecific, based on Brower's own molecular and morphological analyses (which would show their narrow evolutionary relationship), their allopatric distributions (and geographical proximity), and the supposed existence of transitional forms ("hybrids") between *heurippa* and *tristero* (represented by the "type" of *bellula* Stichel, but vide infra), which might suggest that, as Mallet (1995) put it nicely in his definition of species as "genotypic aggregations:" "... closely related allopatric forms should mostly be considered conspecific." Naturally, even though it is well known that in the absence of evidence of specific distinctness in sympatry the conspecificity of allopatric taxa is arbitrary, such arbitrariness is certainly less than to assign a taxon to a particular taxonomic level following a "tradition."

In synthesis, there are two opposing taxonomic hypotheses: 1) *tristero* is a taxon at the species level, evolutionarily independent of *heurippa* and *timareta,* with its own historical destiny; or 2) *heurippa, tristero* and *timareta* constitute a polytypic species with three geographical races (subspecies) which have the same historical destiny. With the scarce taxonomic and genetic information available at the moment, it is impossible to decide which of these is closer to the truth.

The case of *Heliconius melpomene mocoa* seems much simpler, and here I offer the hypothesis that *mocoa* is no more than a new synonym of *H. m. bellula* Turner, 1971, as I will demonstrate below. The name *bellula* was introduced for the first time in the literature by Stichel (1923), who proposed it as a form of *Heliconius amaryllis amaryllis* C. & R. Felder, thus constituting an infrasubspecific name (excluded by the ICZN). The name *bellula* recently became available when Turner (1971) elevated it to the subspecific level (as a subspecies of *H. melpomene* (L.), making the name attributable to Turner (ICZN Arts. 10c, 23j, 50c). Brower examined the male specimen upon which Stichel based his infrasubspecific name *bellula* (and which constitutes the holotype of *bellula* Turner) and decided that it represented an individual belonging to the *cydno* clade, and not to *melpomene.* Brower also examined the "holotypes" of two other infrasubspecific names proposed by Stichel (1923), *permira* and *degener* (which have never been elevated to the subspecific level and thus are nomenclaturally unavailable), suggesting that they might represent hybrids between *H. heurippa* and *H. tristero.* What is more, he assumed that the type of *bellula* appeared to be a recombinant backcross between these hybrids and *tristero.* Arguing that the ICZN "forbids" the use of species-level names that are based on hybrids, he decided to set aside the name *bellula* and establish new names for the member of the *cydno* clade (*tristero*) and the subspecies of *melpomene* present in the upper Río Putumayo (*mocoa*).

Brower does not seem to have realized that Stichel (1923), in addition to *bellula, permira* and *degener,* described four other "forms" of *amaryllis* from the region of the upper Putumayo (*anacreontica, perrara, rufata* and *aglaspis*), and that other authors introduced six additional names for specimens from the same zone (*parva* Neustetter, *tenuifasciata* Neustetter, *aurofasciata* Neustetter, *paula* Neustetter, *paulina* Niepelt and *carminata* Niepelt). In my opinion—and contrary to Brower's view—these 13 names pertain to examples of *melpomene,* and represent transitional forms ("hybrids") between the subspecies *bellula* Turner and *malleti* Lamas. All those specimens were captured around Mocoa (01°09′N, 76°37′W) by collectors who worked for Werner Hopp, and were very likely obtained in the hybrid zone near Villa Garzón (= Villa Amazónica; 01°05′N, 76°35′W, 420 m), a site studied by Mallet (1993), a few km. East of Mocoa. The holotype of *bellula* is labeled as having been obtained on the Río Guayuyaco (written "Guagzayaco" on the label), possibly very near the village of Guayuyaco (= Nápoles; 01°04′N, 76°26′W). The other specimens bear the localities Río Mulato (01°08′N, 76°36′W), 500 m; Mocoa, 530 m; or simple "Mocoa" (for a general description of the area, see Salazar 1995). Mallet (1993) referred to the hybrids found near Villa Garzón as the product of the transition between *bellula* and *aglaope* C. & R. Felder; the correct name of the latter subspecies is *malleti* Lamas, since the subspecies *aglaope* is limited to the lower Río Marañon, lower Río Huallaga and the Río Ucayali basin in Peru (Lamas 1988).

Of the 14 names applied to *bellula* × *malleti* hybrids, the "purest" example corresponds to the holotype of *bellula,* which only shows tiny yellow spots at the costal inner edge of the discal red forewing band, appearing almost identical to the holotype of *mocoa* (which lacks the yellow spots). Brower based his judgement on the presence of these yellow spots, and the morphology of the genitalia of the *bellula* holotype, to assert that that specimen was a *heurippa* × *tristero* "hybrid," (the same as *permira* and *degener*). But, in the first place, *heurippa* (one of the supposed parents) is not known from the Mocoa region, only from much further north, from the Meta and Guayabero basins, while surely *tristero* should occur in the basin of the Río Orteguaza, since *bellula* has been reported from there. (It would be very interesting to discover if *heurippa,* or *tristero,* or both, occur in the Río Caguán basin, between the Guayabero and the Orteguaza). Further, even though Brower admitted that "male genitalia of the taxa examined are similar, and display substantial intra-racial variability in form," he concluded that the genital morphology of the *bellula* holotype corresponded to the *cydno* clade, based on the examination of that one specimen.

Finally, Brower argued that the name *bellula* should be set aside because it is applied to a hybrid (which, as indicated by the discussion above, I consider completely erroneous) and because the ICZN "forbids" the use of names applied to hybrids. In the glossary of the Code (1985: 256) it is clearly indicated that "The progeny of two individuals belonging to different subspecies of same species are not hybrids." The Code does not "forbid" the use of names given to interspecific hybrids, it simply excludes them from nomenclature, except for the principle of homonymy. Therefore, if the name *bellula* does not correspond to an interspecific hybrid, its use to designate a subspecific taxon is perfectly valid, and in consequence, *Heliconius melpomene mocoa* Brower, 1996 is a subjective junior synonym of *Heliconius melpomene bellula* Turner, 1971.

APPENDIX 2

Translation of Stichel's (1923) description of *H. amaryllis amaryllis* and *H. amaryllis amaryllis* f. *bellula.*from the upper Putumayo of Colombia.

H. amaryllis amaryllis Feld.
Forma typ.

Two males.—Forewing with a somewhat variable broad red discal patch, somewhat like the figure of *H. amaryllis euryades* Riff. in Gen. Ins. v. 112, plate 3, fig. 10, but with a more blurred distal margin, and which is somewhat indented below the forewing median vein. The yellow transverse band of the hindwing fragmented near the base by thin black lines, and the veins cutting across the band are more or less black. Mocoa (Put[umayo]), September, October.

Among other things, a character of this species is said to be the absence of red basal streaks on the costal margin of the forewing underside. This feature is present in all of the observed nominate and closely allied forms, but based on the other specific characters, particularly the position of the hindwing band, they can only be considered forms of *amaryllis.* This band is somewhat variable, but it is always positioned such that the posterior border lies outside the posterior edge of the discal cell. In a third male specimen (Mocoa, May), the forewing band is somewhat smaller, so that it scarcely touches the end of the cell, the red is faded and greasy, which is often seen as a pathological feature of red-banded *Heliconius.*

Forma *bellula* f. nov.

One male.—Most similar to the nominate form, the crimson forewing patch more ragged on the margin, partly dusted with black scales, the cell almost completely free of red, an additional character is a sulfur-yellow spot proximal to the subcostal vein. The yellow transverse band on the hindwing is broad, extending nearly 7 mm. from the apex to the trailing edge. Hindwing beneath very similar to *H. amaryllis rosina* Bsd. With red basal streaks on the leading edge of the forewing and three red basal spots in the hindwing. Forewing length 41 mm. Rio Guaqzayaco (Put[umayo]).

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APHID PARASITOIDS (HYMENOPTERA: BRACONIDAE: APHIDIINAE) OF NORTHWEST USA

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Abstract.—A comprehensive assessment is provided of the Northwest USA aphid-parasitoid species (Hymenoptera, Braconidae, Aphidiinae). Eighty-one species of parasitoids in 19 genera are recognized; 35 species are new to the region; 7 species are newly described: ***Aphidius segmentatus*** Pike and Starý [hosts: *Hyperomyzus* on *Hieracium, Lactuca, Senecio,* and other Compositae, and on *Uroleucon* on *Achillea*]; ***Betuloxys alnicolus*** Pike & Starý [host: uncertain, possibly *Boernerina variablilis* Richards on *Alnus*]; ***Monoctonus campbellianus*** Pike & Starý [hosts: *Brachycaudus, Hyalopterus,* and *Phorodon* on *Prunus*]; ***Monoctonus pacificus*** Pike & Starý [host: *Macrosiphum tuberculaceps* (Essig) on *Achlys triphylla*]; ***Praon coniforme*** Pike & Starý [host: *Aphthargelia symphoricarpi* (Thomas) on *Symphoricarpos*]; ***Praon fulvum*** Pike & Starý [hosts: *Macrosiphum* spp. on *Achlys, Crepis, Lupinus, Spiraea*]; ***Trioxys setaceus*** Pike & Starý [host: *Acyrthosiphon macrosiphum* (Wilson) on *Amelanchier*]. Seventy genera of aphids (200+ spp.) were attacked by aphidiine parasitoids. Some 400+ parasitoid-aphid associations, and hundreds more tritrophic (parasitoid-aphid-plant) combinations are reported for the first time in North America.

Key Words: aphid, parasitoid, systematics, Northwest USA

The aphidiine parasitoids of Northwest USA were previously understood to include about 54 species in 13 genera; these were linked with about 100 species of aphids (Pike et al. 1996, 1997, 1999). Based on new environmental studies, the parasitoid guilds are recognized now to be much larger. Presented here is a comprehensive review of Northwest species, including an abridgment of previously published records.

Eighty-one species of aphidiine parasitoids in 19 genera are now recognized in Northwest USA; 35 species are new to the region; 7 species are newly described. Collectively, these parasitoids attacked more than 200 species in 71 genera of aphids. Some 400+ parasitoid-aphid associations, and hundreds more tritrophic (parasitoid-aphid-plant) combinations are reported for the first time in North America.

The work is a foundation study of the Northwest aphidiine fauna. It provides background documentation for possible future studies on a variety of fronts, such as

Table 1. Legend for listings.

[Example]

PARASITOID

Praon americanum (Ashmead)

Aphis coweni Palmer: WA, KITTITAS [*] – Stampede Pass, 8-VIII-96 on *Veratrum viride* (96K147†‡).

APHID HOST
STATE
COUNTY
SPECIFIC COLLECTION SITE
DATE COLLECTED
APHID PLANT HOST
WSU CODE

[*] indicates previous published record, see Pike et al. 1996, 1997, 1999.
[†] indicates collection contained more than one species of aphid.
[‡] indicates parasitoid-aphid association shown is not certain.

Abbreviations: ALE, Arid Lands Ecology Reserve; CA, California; CG, Campground; Cr, Creek; det., determined; E, east; FR, forest road; G&P, Gillette & Palmer; HRL, Hille Ris Lambers; HMU, Habitat Management Unit; ID, Idaho; Lk, Lake; mi, mile; MT, Montana; Mt, Mount; Mtn, Mountain; N, north; nr, near; OR, Oregon; RNP, Mount Rainier National Park; Pk, Park; Rd, Road; S, south; sp., species; SP, State Park; W, west; WA, Washington; WLA, Wildlife Area or Refuge; WSU, Washington State University; YIR, Yakama Indian Reservation.

biosystematics, including new species descriptions; parasitoid guilds; population genetics; host adaptation, switching, and cross habitat movement; geographic spread of exotic species; interspecies population development; ecosystem relationships and effects on parasitoid and predator complexes, and target pests; application and advantages of aphid-plant biodiversity for maintaining, stabilizing, and/or increasing parasitoids of merit; and uses and possible export of Northwest parasitoids to other global areas.

MATERIALS AND METHODS

Aphidiine parasitoids were obtained from aphid rearings, with the aphids collected from a wide range of host plants from Northwestern USA, principally Washington. In total, more than 5,300 aphid collections were taken, of which 2,940 were parasitized. The aphid populations sampled varied in size. Where possible 50 to >200 aphids were taken per sample; a subsample of 5 to 30 aphids were preserved in 70% ethanol for later identification. For the parasitoid rearings, aphids were held in-laboratory at 20 ± 3°C for 25–30 days in screen-covered semi-transparent plastic containers (two sizes used: 300 ml, 10 cm dia × 4 cm ht; and 3500 ml, 19 cm dia × 13 cm ht) or occasionally in paper lunch bags. After emergence, the parasitoids were placed in 70% ethanol for subsequent determination. Voucher specimens of both aphids and parasitoids are in Washington State University-Prosser collections, Prosser, WA.

Descriptions of new species were based on whole dry and dissected slide-mounted specimens examined under 40–400× magnification. Body lengths were measured and recorded in millimeters. Holotypes were dry-mounted on paper tabs and pinned. Descriptive terminology is after Huber and Sharkey (1993). Holotypes are deposited in the National Museum of Natural History, Smithsonian Institution, Washington, DC (USNM).

For cross reference and other information on aphid parasitoids of North America, see Gahan 1911; Smith 1944; Liu 1977; Marsh 1979; Johnson 1987; Pike et al. 1996, 1997, 1999; for world information, see Mackauer and Starý 1967.

Aphid nomenclature follows Remaudière and Remaudière 1997.

Results

Aphidiine parasitoid genera and species.—Parasitoid genera and species are listed alphabetically, as are aphid hosts under each species. Locations are indicated by state (large caps), county (small caps), and nearest city or identifiable site. Numbers in parentheses represent authors' codes of specimens (aphid-parasitoid vouchers) in Washington State University–Prosser collections (Table 1). Collections and determinations were by authors unless otherwise specified. Aphids collected by A. Jensen were determined by A. Jensen. Authorship of new species is attributed to K. S. Pike and P. Starý.

APHIDIINE PARASITOIDS OF NORTHWEST USA

Genus *ACANTHOCAUDUS* Smith

Acanthocaudus caudacanthus (Smith)

Uroleucon sp.: WA, Pend Oreille—Le Clerc WLA, 3-VIII-95 on *Aster* sp. (95T400); Spokane—nr Peone, 24-VIII-95 on *Centaurea pratensis* (95T473†).

***Acanthocaudus* sp.**?

Undetermined sp.: WA, Garfield—Pataha Cr, nr FR160 & FR40, 21-IX-95 on *Chimaphila umbellata* (95T597).

Genus *ADIALYTUS* Foerster

Adialytus ambiguus (Haliday)

Sipha elegans del Guercio: MT, Sanders [on *Agropyron intermedium**].
Sipha sp.: WA, Asotin [on unknown Gramineae*].

Adialytus fuscicornis (Ashmead)

Aphis armoraciae Cowen: OR, Umatilla—Hermiston, 17-VI-90 on unknown plant (90J002); WA, Yakima—Wenas Lk, 30-V-96 on *Erysimum arenicola* (96G120), & 11-VI-97 on *Lomatium* sp. (97G051†).
Aphis helianthi Monell: WA, Yakima—Wenas Lk, 11-VI-97 on *Lomatium* sp. (97G051†‡).
Forda marginata Koch: WA, Garfield—Dye Seed Airfield, 5-IX-95 on *Bromus* sp. (95G542); Kirby, 1-IX-95 on *Bromus inermis* (95K160).
Undetermined sp.: WA, Asotin [on *Populus trichocarpa**].

Adialytus salicaphis (Fitch)

Chaitophorus populicola Thomas [on *Populus trichocarpa* unless otherwise indicated]: ID, Boundary [*]; WA, Asotin—Asotin WLA, 31-VII-96 & 15-VIII-96 (96T355, 96T454); Benton—Grandview, 10-X-95 (95G694); Whitman—Pullman, 9-X-96 on *Populus tremuloides* (96T582); Yakima—YIR, Lucy Canyon, 25-IV-96 & 16-V-96 (96G021, 96G061) & nr Satus, 1-VI-96 (96K062).
Chaitophorus populifolii (Essig) [on *Populus trichocarpa*]: WA, Kittitas—Manastash Cr, 16-VIII-96 (96G485); Ellensburg, 13-VI-97 (97G083); Yakima—Naches, 27-IX-96 (96G600).
Chaitophorus utahensis (Knowlton) [on *Salix* sp.]: WA, Asotin—Chief Timothy HMU, 16-VIII-95 (95T442); Benton—nr Grandview, 24-VIII-95 (95G514); Yakima [*]—Grandview, 22-V-95 & 15-V-96 (95G078, 96G047).
Chaitophorus viminalis Monell [or nr *viminalis*] [on *Salix* sp.]: WA, Okanogan—Alta Lk, 10-IX-97 (97K026, 97K028); Yakima—Wenas Cr, 13-VIII-96, (96G459).
Chaitophorus sp. [nr *nigrae* Oestlund & *pallipes* Richards]: WA, Asotin—Heller's Bar, 11-VII-95 on *Salix* sp. (95T210†).
Chaitophorus sp. [on *Salix* sp. unless otherwise indicated]: WA, Asotin [*]; Benton [*]—Prosser, 10-X-95 on *Populus trichocarpa* (95G693); Grant—Potholes Reservoir, 13-VI-97 (97G101).
Periphyllus nr *brevispinosus* G&P: WA, Pend Oreille—Sullivan Lk Rd, Harvey Cr, 3-VIII-95 on *Acer* sp. (95T395); Spokane—Mt Spokane SP, 24-VIII-95 on *Acer* sp. (95T487).
Periphyllus sp.: WA, Asotin [on *Acer* sp. *].

Genus *APHIDIUS* Nees

Aphidius avenaphis (Fitch)

Acrthosiphon lactucae (Passerini): WA, Whitman—Pullman, 13-VI-96 on *Lactuca serriola* (96T032†‡).

Diuraphis noxia (Kurdjumov): WA, Asotin—Anatone, 24-VII-96 & 22-VII-97 on *Hordeum vulgare* (96T596, 97J005–97J023); Klickitat—Bickleton, 29-VII-97 & 6-VIII-97 on *Triticum aestivum* (97G300, 97G354).

Rhopalosiphum padi (L.): WA, Grant—Ephrata, 8-VII-97 on *Zea mays,* K. Volker collector (97K058).

Sitobion avenae (F.) [on *Triticum aestivum* unless otherwise indicated]: ID, Latah—Moscow Mtn, 3-VIII-96 on unknown Gramineae (96T396†); Shoshone—Thompson Pass, 29-VII-95 on *Agropyron caninum* (95G478), *Arabis* sp. (95G475†), & *Poa nervosa* (95G470); OR, Umatilla—Harris Pk, 11-VI-96, on *Dactylis glomerata* (96G230†); WA, Adams—Bruce, I-VII-96 (96B004, 96B007); Othello, 26-VI-95, 1-VII-96 (95B009, 96B009); Asotin—Anatone, 24-VII-96 on *Hordeum vulgare* (96T337); Benton—Prosser, 2, 28 & 30-VI-95, 17-VII-95, 24-VI-96, 1 & 8-VII-96, 3-VII-97, (95G103, 95G276, 95G279, 95G285, 95G352, 95G354, 95G357†, 95G358, 96G271, 96G312, 96G328, 96G330, 97F201); Richland, 21-VI-95 (95G221†); West Richland, 28-VI-95 (95G279); WSU-Prosser, 18-VII-97 on *Setaria lutescens* (97G243); Douglas—Waterville, 24-VII-96 (96B025); Franklin—Kahlotus, 6-VII-95 (95G290, 95G308†); Star School, 6-VII-95 (96G289); Grant—WSU-Royal Slope, 26-VI-95 (95B007); Kittitas—S. Fork Manastash Cr, 24-VII-95 on *Agropyron repens* (95G375), *Agropyron caninum* (95G383), & *T. aestivum* (95G372); 11-IX-95 on *Bromus* sp. (95G384); Manastash Rd, 11-IX-95, on *D. glomerata* (95G565); Stampede Pass, 8-VIII-96 on *Phleum* sp. (96K142); Klickitat [on *H. vulgare* & *Triticosecale rimpani**] —Bickleton, 9 & 17-VII-95 (95G317†–95G319†, 95G362), 7-VII-97 (97G224); Trout Lk, 29-VI-97 on *D. glomerata* (97G160); Lincoln—Harrington, 19-VII-96 (96B023); Davenport, 16 & 19 -VII-96 (96B011, 96B020, 96B023); Reardan, 16-VII-96 (96B014); Pierce—Graham, 25-V-96 on unknown grass (96T001); Whitman—Colton, 31-VII-96 on *H. vulgare* (96T358A); Hay, 6-VII-95 (95G307); Pullman, 5-VII-94, 19-VII-96 (94T022, 96T320A); Ridpath, 6-VII-95 (95G299†, 95G300†); Rosalia, 16-VII-96 (96T294); Yakima—Sunnyside, 28-VI-95 & 5-VII-95 (95G272, 95G286); Zillah, 28-VI-95 (95G270); 25-VI-95 on *D. glomerata* (95G250); YIR, nr Signal Peak, 25-VII-95, on *Agropyron spicatum* (95G416); Chinook Pass, 24-VII-97, on *Poa gracillima* (97G260); 24-VII-97, on *Poa nervosa* (97G268).

Undetermined spp.: WA, Garfield—Ruckert Rd & Fitzgerald Rd, 15-VII-96 on *Hordeum* sp., W. Turner & J. Rumph collectors (96J069A); King—Stampede Pass, 8-VIII-96 on *Caltha biflora* (96G447); Pend Oreille—Le Clerc WLA, 3-VIII-95 on unknown grass (95T401).

Aphidius colemani Viereck

Aphis nerii Boyer de Fonscolombe: WA, Yakima—Union Gap, 23-X-95 on *Asclepias speciosa* (95G725).

Brachycaudus helichrysi (Kaltenbach): WA, Whitman—Pullman, 28-VI-96 on *Anthemis arvensis* (96T162).

Hyadaphis foeniculi (Passerini): WA, Island—Clinton, 4-VI-96 on *Lonicera* sp. (96G156).

Lipaphis erysimi (Kaltenbach): WA, Whitman—Pullman, 3-VII-96 on unknown plant (96T163†).

Macrosiphum euphorbiae (Thomas): WA, Whitman—Pullman, 3-VII-96 on unknown plant (96T163†).

Myzus persicae (Sulzer): WA, Snohomish—Monroe, 24-VII-96 on *Pisum sativum* (96T594†).

Myzus sp.: WA, Spokane—Spokane, 11-VII-96 on *Antirrhinum majus* (96T258); Whitman—Pullman, 14-IX-93, on *Forsythia* (93T019).

Undetermined sp.: WA, King [on *Hibiscus* sp.*].

Aphidius ervi Haliday

Acyrthosiphon kondoi Shinji: ID, Shoshone—Thompson Pass, 29-VII-95 on *Melilotus alba* (95G466†); WA, Klickitat, Hwy 14 nr Alderdale, 14-V-96 on *Melilotus* sp. (96G033†).

Acyrthosiphon lactucae (Passerini) [on *Lactuca serriola*]: ID, Benewah—McCroskey SP, 31-VIII-95 (95T514†); WA, Asotin—Anatone, 28-VI-96 (96T088); Asotin, 28-VI-96 (96T068); Asotin Cr WLA, 5-VII-96 & 8-VIII-96 (96T144, 96T419); Couse Cr, 10-VIII-95 (95T422); Snake River Rd, 18-VII-95 & 28-VI-96 (95T249†, 96T072); South Fork Asotin Cr, 22-VIII-95 & 11-VII-96 (95T468, 96T230); Benton—Prosser, 17-VII-95 (95G359†); 24-VI-96 & 8-VIII-96 (96G270, 96G434); ALE, 19-V-95 (95G071); Chelan—Chelan SP, 11-IX-97 (97K038); Spokane—Plaza, 16-IV-96 (96T279); Whitman—Pullman, 16, 30-VII-96 & 1, 8-VIII-96 (96T304, 96T362, 96T382, 96T436); Ridpath, 6-VII-95 (95G296); Yakima—Mabton, 28-VI-95 (95G265); Sunnyside, 22-V-95 (95G076); Wenas Lk, 11-VI-97 (97G055).

Acyrthosiphon pisum (Harris) [on *Medicago sativa* unless otherwise indicated]: ID, Shoshone—Thompson Pass, 29-VII-95 on *Melilotus alba* (95G466†); MT, Sanders [on *Lathyrus odoratus**]; WA, Adams—Macmaranon Rd, 2-VIII-96 (96B026); WSU-Othello, 26-VI-95 (95B008); Asotin—Couse Cr & Snake River Rds, 18-VII-95 on *Helianthus annuus* (95T252); Benton [on *M. sativa* & *Trifolium pratense**] – 28-VI-95 (5G277†); Prosser, 27-VI-96 on *Vicia angustifolia* (96A009); 23-VII-9, on *T. pratense* (96G391); WSU-Prosser, 26, 28-IV-97 & 14-V-97 (97G014, 97G015, 97G030); Whitstran, 1-V-97 (97G019);

Columbia—Hwy 124 & Tucannon Rd, 5-X-95 (95G678†); Grant—WSU-Royal Slope, 26-VI-95 (95B003); Island—South Whidbey, 4-VI-96 on *Trifolium* sp. (96G161); Klickitat—Hwy 14 nr Alderdale, 14-V-96 on *Melilotus* sp. (96G033†); Roosevelt, 24-IV-96, on *Melilotus* sp. (96G014†); Lincoln—Lk Roosevelt, 31-VII-97 on *M. lupulina* (97G304); Snohomish—Monroe, 24-VII-96 on *Pisum sativum* (96T594†); Spokane—Four Lk, 25-VII-97 on *Allium* sp. (97K005); Whitman—Pullman, 16, 30-VII-96 on *P. sativum* (96T303, 96T359); 14-IV-96 on *Trifolium* sp. (96T272); 26-VI-96 on *Vicia* sp. (96T063) & unknown legume (96T064), & 5-VII-96 on *Lathyrus oderata* (96T178); Ridpath, 6-VII-95 on *Lactuca serriola* (95G296), *Medicago sativa* (95G297), & *Vicia* sp. (95G302); Yakima—Outlook, 1-VI-96 (96K059); Rimrock Lk, 23-VII-96 on *Melilotus* sp. (96G383); Wenas Valley, 30-V-96 (96G111); YIR, Signal Peak, 25-VII-95 on *Vicia* sp. (95G408) & 19-IX-95 on *Melilotus* sp. (95G625†).

Aphis craccivora Koch: WA, Whitman—Pullman, 25-VII-95 on *Capsella bursa-pastoris* (95T331); 14-1V-96, on *Trifolium* sp. (96T271).

Aphis sp.: ID, Latah [on *Solanum lycopersicon* *]; WA, Asotin—De Spain Springs, 11-VI-96 on *Umbelliferae* sp. (96T254).

Aspidophorodon longicauda (Richards): WA, Skamania—South Prairie, 11-VII-95 on *Spiraea* sp. (95G343).

Brachycaudus helichrysi (Kaltenbach) [on *Amsinckia* sp.]: WA, Asotin—Anatone, 28-VI-96 (96T089); Franklin—Eureka, 14-V-96 (96G041); Skagit—Campbell Lk, 4-VI-96 on *Prunus* sp. (96G165†).

Brevicoryne brassicae (L.): WA, Benton [on *Brassica napus**].

Chaetosiphon nr *hottesi* Stroyan: WA, Clark—Vancouver, 14-IX-95 on *Fragaria* sp. (95V002).

Diuraphis noxia (Kurdjumov) [on *Triticum aestivum* unless otherwise indicated]: WA, Asotin [on *Avena fatua**] Asotin—Anatone, 22-VII-97 on *Hordeum vulgare* (97J007–97J026); Benton [on *H. vulgare* & *T. aestivum**]—WSU-Prosser, 28-V-96 (on *H. vulgare,* 96G087, 96G088), 24-VII-97 (97G274); Klickitat—Rock Cr, 30-Vi-95 (95G283); Bickleton, 7-VII-97 (97G223, 97G238); Cleveland, 7-VII-97 (97G232, 97G234); Walla Walla—Hadley, 11-VI-96 on *H. vulgare* (96G240); Whitman—Pullman, 9-VII-96 on *H. vulgare,* W. Turner & J. Rumph collectors (96J053–96J055); Yakima [*].

Hayhurstia atriplicis (L.) [on *Chenopodium alba*]: WA, Benton—WSU-Prosser, 18 & 25-VII-97 (97F238, 97F262); Whitman—Pullman, 16-VII-96 (96T302).

Hyalopteroides humilis (Walker) [on *Dactylis glomerata*]: WA, Skagit—Bow, 5-V-96 (96K026); Edison, 5-V-96 (96K027).

Hyalopterus pruni (Geoffroy): WA, Skagit—Campbell Lk, 4-VI-96 on *Prunus* sp. (96G165†‡).

Hyperomyzus lactucae (L.): WA, Yakima—Yakima Arboretum, 26-IX-95 on *Sonchus oleraceus* (95G658†).

Hyperomyzus nigricornis (Knowlton): ID, Benewah—McCroskey SP, 31-VIII-95 on *Lactuca serriola* (95T514†); WA, Garfield—Stentz Springs, 22-VIII-95 on *Senecio* sp. (95T456); Yakima–YIR, Cedar Cr, 19-IX-95 on *Agoseris* sp. (95G622).

Illinoia davidsoni (Mason): WA, Klickitat—Trout Lk, 11-VII-95 on *Rubus parviflorus* (95K069).

Illinoia spp.: WA, Kittitas—Quartz Mtn, 25-VII-96 on *Rhododendron albiflorum* (96G405); Pierce—RNP, Tipsoo Lk, 16-VIII-95 on *Spiraea densiflora* (95A037); Skagit—La Conner, 5-VI-96 on *Rhododendron* sp. (96G193); Snohomish—Monroe, 5-VI-96 on *Chaenomeles* sp. (96G201).

Macrosiphum albifrons Essig: WA, Pierce—RNP, Tipsoo Lk, 11-IX-96 on *Lupinus* sp. (96G547).

Macrosiphum euphorbiae (Thomas): ID, Latah—Moscow, 7-X-96 on *Solanum* sp. (96T577); WA, Asotin—De Spain Springs 11-VII-96 on *Potentilla* sp. (96T250), 1-VIII-95 on *Senecio* sp. (95T381), 5 & 11-VII-96 on *Compositae* (96T159, 96T249†); Benton—Prosser, 15-V-96 on *Tulipa* sp. (96G045); 24-X-96 on *Medicago sativa* (96G651); WSU-Prosser, 27-X-95 on *Lamium amplexicaule* (95K213†), 18-XI-95 on *Brassica napus* (95G751†), & 1-X-97 on *Malva neglecta* (97G471†); Garfield—nr FR40 & FR44, 22-VIII-95 on *Osmorhiza chilensis* (95T464†); Skamania—Twin Falls CG, 4-VIII-95 on *Potentilla* sp. (95K098†); Yakima—Bird Cr Meadows, 26-VI-95, on *Castilleja* (95A017†); YIR, Old Maid Canyon, 25-VI-95 on *Cynoglossum grande* (95G440).

Macrosiphum gaurae (Williams): WA, Asotin—Anatone, 28-VI-96 on *Oenothera* sp. (96T073).

Macrosiphum nr *pallidum* (Oestlund): WA, Skamania—Twin Falls CG, 4-VIII-95 on *Potentilla* sp. (95K098†‡).

Macrosiphum rosae (L.): WA, Snohomish—Snohomish, 5-V1–96 on cultivated *Rosa* sp. (96G198).

Metopolophium dirhodum (Walker): OR, Umatilla—Harris Pk, 11-VI-96 on *Elymus glaucus* (96G221); WA, Klickitat—John Day Dam, 14-V-96 on *Phalaris arundinacea* (96G036†); Lincoln—Lk Roosevelt, Goldsmith CG, 31-VII-97 on *P. arundinacea* (97G305).

Myzus nr *ornatus* Laing: WA, Skagit—La Conner, 5-VI-96 on *Trifolium pratense* (96G195†‡).

Myzus persicae (Sulzer): WA, Skagit—La Conner, 5-VI-96 on *Trifolium pratense* (96G195†); Benton—WSU-Prosser, 1-X-97 on *Solanum tuberosum* (97G477†); Whitman—Pullman, 16-VII-95 on *Raphanus sativum* (95T248); 8-VIII-95, on *Solanum nigrum* (95T412); 31-VII-96 on *Beta vulgaris* (96T366).

Myzus sp.: WA, Whitman—Pullman, 14-IX-93 on *Forsythia* sp. (93T019).

Ovatus crataegarius (Walker): WA, Grant—Othello, 12-VII-95 on *Mentha piperita* (95B010).

Phorodon humuli (Schrank): WA, Skagit—Campbell Lk, 4-VI-96 on *Prunus* sp. (96G165†‡).

Rhopalosiphum maidis (Fitch): WA, Benton—WSU-Prosser, 18-XI-95 on *Capsella bursa-pastoris* (95G750†).

Rhopalosiphum padi (L.): WA, Asotin—De Spain Springs, 25-VII-96 on *Aquilegia* sp. (96T347†); Benton [on *Triticum aestivum**]; Douglas—Waterville, 12-VIII-95 on *T. aestivum* (95B016); Franklin—nr Kahlotus, 26-X-95 on *T. aestivum* (95K207†); Grant—Ephrata, 8-VII-97 on *Zea mays* (97K058); Walla Walla—Prescott, 30-X-97 on *Phalaris arundinacea* (97G516).

Sitobion avenae (F.) [on *Triticum aestivum* unless otherwise indicated]: ID, Boundary—Moyie Springs, 29-VII-95, on *Avena sativa* (95G445); Shoshone—Thompson Pass, 29-VII-95 on *Poa nervosa* (95G470) & *Arabis* sp. (95G475†); WA, Adams—Othello, 1-VII-96 (96B004, 96B007), WSU-Othello, 26-VI-95, 1-VI-96 (95B009, 96B009); Asotin [*]—Clarkston, 18-VII-95 on Gramineae (95T255); Field Springs SP, 5-VIII-93 on Gramineae (93T013); Couse Cr, 18-VII-95 on *Setaria* sp. (95T259); Anatone, 12-VII-94 (94T023); Benton [on *Hordeum vulgare* & *T. aestivum**]—Prosser, 25, 28 & 30-VI-95, (95G253, 95G274, 95G276, 95G285); 17-VII-95 (95G352, 95G354, 95G355, 95G358); 24-VI-96 (96G271); 1 & 8-VII-96 (96G312 & 96G328); WSU-Prosser, 20-I-96 on *Capsella bursa-pastoris* (96G003†); 18-VII-97 on *Setaria lutescens* (97G243); Richland, 28-VI-95 (95G279); Columbia—Dayton, 16-VI-94 (94T020); Grant—WSU-Royal Slope, 26-VI-95 (95B007); Franklin—Pasco, Star School, 6-VII-95 (95G289); Klickitat—Bickleton, 9-VII-95 (95G318); Cemetery Rd nr Bickleton, 7-VII-97 on *Hordeum vulgare* (97G226†); Kittitas—S. Fork Manastash Cr, 24-VII-9, on *Agropyron caninum* (95G383); Ellensburg, 9-VII-96 (96G331); Buck Meadows, 9-VII-96 on *Dactylis glomerata* (96G346); Stampede Pass, 8-VII-96 on *Phleum* sp. (96K142); Lincoln—Almira, 26-VI-95 (95B002); Davenport, 16 & 19-VII-96 (96B011, 96B020); Harrington, 19-VII-96 (96B023); Reardan, 16-VII-96 (96B014); Wilbur, 19-VII-96 (96B019); Pierce—Graham, 25-V-96 on Gramineae (96T001); RNP, Tipsoo Lk, 11-IX-96 on *Poa* sp. (96G543); Whitman [*]—Hay, 6-VII-95 (95G307); Pullman, 5-VII-94 (94T022); Colton, 31-VII-96 on *H. vulgare* (96T358A); Rosalia, 16-VII-96 (96T294); Yakima—Grandview, 5-Vii-95 (95G286); 23-V-96 on *D. glomerata* (96G074); Zillah, 28-VI-95 (95G270, 95G272); 28-VI-95 on *Avena sativa* (95G271).

Uroleucon (Lambersius) sp.: WA, Kittitas—Lost Lk Trailhead, 6-VIII-97 on *Achillea millefolium* (97G318).

Undetermined spp.: WA, Benton—Prosser, 25-X-95 on *Berberis aquifolium* (95G732); 29-X-95 on *Senecio vulgaris* (95G735); Chelan—Stevens Pass, 16-IX-95 on Gramineae (95K137); Klickitat—Cleveland, 7-VII-97 on *Lotus pinnatus* (97G233); Whitman—Pullman, 1-VII-96 on *Penstemon* sp. (96T125), 5 & 9-VII-96 on *Geranium viscosissimum* (96T171, 96T228); 9-VII-96 on *Vicia* sp. (96T229).

Aphidius* nr *hortensis Marshall

Ericaphis gentneri (Mason): WA, Chelan—Stevens Pass, 16-IX-95 on *Spiraea densiflora* (95K138).

Liosomaphis berberidis (Kaltenbach): OR Multnomah & WA, Yakima [on *Berberis* sp.*].

Aphidius kakimiaphidis Smith

Nasonovia alpina (G&P): WA, Yakima [on *Mimulus lewisii**].

Nasonovia aquilegiae (Essig) [on *Aquilegia formosa* or sp.]: WA, Benton—Prosser, 24-VI-96 (96G278); Kittitas [†*]—Buck Meadows, 16-VIII-96 (96G501); Yakima—Yakima Arboretum, 3-VI-96 (96G249); YIR, Old Mead Canyon, 25-VII-95 (95GG441).

Nasonovia cynosbati (Oestlund): WA, Kittitas—Lost Lk, 7-VII-94 on *Ribes* sp. (94K026).

Nasonovia nr *cynosbati* (Oestlund): WA, Yakima—YIR, nr Mt. Adams Lk, 4-VIII-95 on *Ribes viscosissimum* (95K089).

Nasonovia nr *houghtonensis* (Palmer): WA, Yakima—Nile, 28-VII-97 on *Collomia linearis* (97G282).

Nasonovia wahinkae (Hottes): WA, Kittitas—Buck Meadows, 11-IX-95 on *Aconitum columbianum* (95G557).

Nasonovia sp.: MT, Sanders [on *Castilleja* sp.*]; WA, Lewis—RNP, Stevens Canyon, 23-VII-96 on *Pedicularis* sp. (96G372†).

Aphidius lupini Liu

Macrosiphum albifrons Essig [on *Lupinus* sp.]: WA, Benton—Prosser 22-VI-95 & 24-VI-96 (95G249, 96G276); Kittitas—S. Fork Manastash Cr, 24-VII-95 (95G390); Quartz Mtn 25-VII-96 (96G408); Pierce—RNP, Tipsoo Lk, 11-IX-96, 5-IX-97 (96G547, 97G362); Whitman—Pullman, 1-VII-96 (96T129); Yakima [*]—YIR, nr Howard Lk, 19-IX-95 (95G638) & nr Mt Adams Lk, 25-VII-95 (95G419); Little Naches River, nr Timothy Meadows, 9-IX-97 (97G389).

Aphidius matricariae Haliday

Aphis fabae Scopoli [on *Cirsium arvense*]: WA, Asotin—Sangster Rd, 22-VII-97 (97J003†‡, Turner & Rumph collectors); Kittitas—Buck Meadows, 11-IX-95 (95G580).

Aphis helianthi Monell: WA, Yakima—Chinook Pass Hwy & Bald Mt Rd, 23-X-97 on *Cirsium arvense* (97G499).

Aphthargelia symphoricarpi (Thomas): WA, Kittitas—Lost Lk, 6-VIII-97 on *Silene douglasii* (97G345).

Brachycaudus cardui (L.): WA, Asotin—Sangster Rd, 22-VII-97 on *Cirsium arvense,* Turner & Rumph collectors (97J003†).

Brachycaudus helichrysi (Kaltenbach): WA, Benton—WSU-Prosser, 1-X-97 on *Solanum tuberosum* (97G478); King [on *Senecio vulgarais**]; Klickitat—Bickleton, 30-V1–95 on *Chrysanthemum* sp. (95G282); Whitman—Pullman, 26-VI-96, on *Achillea millefolium* (96T065).

Brevicoryne brassicae (L): WA, Benton—WSU-Prosser, 6-VII-95 on *Brassica napus* (95A024).

Capitophorus elaeagni (del Guercio) [on *Cirsium arvense* or sp.]: WA, Kittitas—Buck Meadows, 11-IX-97 (97G437†); Yakima—Mabton, Morgan Lk, 28-VI-95 (95G266); Little Naches River (FR 789 & FR 1914), 9-IX-97 (97G409); 9-IX-97 (97G408); Little Naches River, nr Timothy Meadows, 9-IX-97 (97G394).

Diuraphis noxia (Kurdjumov) [on *Triticum aestivum*]: WA, Benton—Rattlesnake Hills, 17-VII-95 (95G357†); WSU-Prosser, 30-IX-97 (97F457†, 97463†); Yakima—Mabton Grade, 31-X-97 (97G517†).

Dysaphis plantaginea (Passerini): WA, Chelan—WSU-Wenatchee, 30-V-96 on *Pyrus malus* (96R011†‡).

Hyalopterus pruni (Geoffroy): WA, Skagit—Campbell Lk, 4-VI-96 on *Prunus* sp. (96G165†‡).

Illinoia corylina (Davidson) [det. by A. Jensen]: WA, Whitman—Pullman, 14-VIII-96 on *Aquilegia* sp. (96T442).

Macrosiphum euphorbiae (Thomas): WA, Benton—WSU-Prosser, 1-X-97 on *Malva neglecta* (97G471†).

Myzus persicae (Sulzer): ID, Bonner—Sandpoint, 30-IV-97 on *Viola tricolor* (97T006); OR, Umatilla—Hermiston, 23-VII-93 on unknown plant, A. Jensen collector (93J005); WA, Benton—WSU-Prosser, 27-X-95 on *Malva neglecta* (95K212†), 1-X-97 on *Chenopodium album* (97G470†), *Solanum sarrachoides* (97G472†), & *S. tuberosum* (97G476); Klickitat—John Day Dam, 28-IV-95 on *Veronica anagallis-aquatica* (95G009†); Spokane—Spokane, Manito Pk, 19-IX-96 on *Syngonium* sp. (96T538); Whitman—Pullman, 22-VII-95 on *Solanum lycopersicon* (95T299†).

Myzus sp.: WA, Whitman—Pullman, 14-IX-93 on *Forsythia* sp. (93T019).

Ovatus crataegarius (Walker): ID, Bonner—Sandpoint, 10-IV-97 on *Origanum* sp. (97T003); WA, Adams—Othello, 19-VI-96 & 16-VII-96 on *Mentha piperita* (96B006, 96B010).

Phorodon humuli (Schrank) [on *Humulus lupulus*]: WA, Benton [*]—WSU-Prosser, 9-IX-95 (95K154).

Rhopalosiphum insertum (Walker): WA, Chelan—WSU-Wenatchee, 30-V-96 on *Pyrus malus* (96R011†).

Rhopalosiphum padi (L.) [on *Triticum aestivum*]: WA, Benton—Rattlesnake Hills, 17-VII-95 (95G357†); WSU-Prosser, 30-IX-97 (97F457†, 97F463†); Yakima—Mabton Grade, 31-X-97 (97G517†).

Sitobion avenae (F.): WA, Benton—WSU-Prosser, 11 & 18-VII-97 on *Triticum aestivum* (97F225, 97F243).

Undetermined sp.: WA, Benton—WSU-Prosser, 29-X-95 on *Senecio vulgaris* (95G735).

Aphidius nigripes **Ashmead**

Macrosiphum euphorbiae (Thomas): WA, Kittitas—Manastash Rd & FR112, 9-VII-96 on *Agoseris elata* (96G341) & *Arnica cordifolia* (96G332); Lost Lk, 2-IX-95 on *Aster* sp. (95G528) & *Castilleja* sp. (95G527), & 11-IX-95 on *Arabis* sp. (95G568) & *Monardella odoratissima* (95G569†).

Macrosiphum clydesmithi Robinson: WA, Yakima—Clear Lk, 15-VI-96 on *Holodiscus discolor* (96K081).

Aphidius ohioensis **Smith**

Macrosiphoniella ludovicianae (Oestlund) [on *Artemisia ludoviciana*]: CA. Shasta [*]; WA, Asotin—Asotin Cr WLA, 5-V11–96, (96T138); Yakima—Wenas Lk, 17-VI-97 (97G090).

Macrosiphoniella tanacetaria (Kaltenbach): WA, Pierce—RNP, Tipsoo Lk, 5-IX-97 on *Tanacetum vulgare* (97G369).

Macrosiphum creelii Davis: WA, Kittitas—Manastash Cr Rd, mi marker 8, 16-VIII-96 on *Vicia* sp. (96G492).

Macrosiphum sp.?: ID, Latah—Moscow Mtn, 6-VII-96 on *Holodiscus discolor* (96T182).

Macrosiphum valerianae (Clarke) [on *Epilobium angustifolium*]: WA, Kittitas—Lost Lk, 24-VII-95 (95G399†‡); S. Fork Manastash Cr, 24-VII-95 (95G381); Yakima—YIR, Signal Peak, 11-VII-95 (95G322‡).

Microsiphoniella artemisiae (Gillette): WA, Asotin—Asotin Cr HMU, 5-VII-96 on *Artemisia ludoviciana* (96T141).

Uroleucon adenocaulonae (Essig): WA, Klickitat—Trout Lk, 29-VI-97 on *Adenocaulon bicolor* (97G163).

Uroleucon nr *arnesense* Robinson: MT, Sanders—18 mi E of Thompson Pass, 29-VII-95 on *Solidago,* sp. (95G457).

Uroleucon nr *epilobii* (Pergande): WA, Spokane—Mt Spokane SP, 27-VII-95 on *Epilobium angustifolium* (95T358).

Uroleucon erigeronense (Thomas) [on *Conyza canadensis* unless otherwise indicated]: WA, Chelan—Leavenworth, 16-IX-95 (95K141); Kittitas—Lost Lk, 6-VIII-97 on *Haplopappus hirtus* (97G340†), &

11-IX-95 on *Achillea* millefolium (95G574); Manastash Rd & Rd 112, 11-IX-95 on *Cirsium arvense* (95G564†); S. Fork Manastash Cr, 11-IX-95 on *Achillea millefolium* (95G563), & 24-VII-95 on Crepis sp. (95G386†); Lincoln—Lk Roosevelt, Goldsmith CG, 31-VII-97 (97G302); Pierce—RNP, 8-IX-95 on *Aster* sp. (95K106) & on *Senecio* sp. (95K120†), Tipsoo Lk, 5-IX-97 on *Aster* sp. (97G364†, 97G366), & 24-VII-97 on Compositae (97G252); Yakima—Grandview, 9-VII-95 (95G314); Pleasant Valley CG, 24-VII-97 on *Crepis rucinata* (97G258); Sunnyside, 23-X-95 & 13-X-96 (95G707, 96G645); YIR, nr Mt Adams Lk, 4-VIII-95 on *Eriophyllum lanatum* (95K092), Signal Peak, 11-VII-95 on *Aster* sp. (95K049†), Cedar Cr, 19-IX-95 on *Achillea millefolium* (95G620†), Klickitat Canyon (95G628†), & White Deer Cr, 11-VII-95 on *Crepis modocensis* (95K048†).

Uroleucon nr *erigeronense* (Thomas): WA, Lincoln—Lk Roosevelt, Goldsmith CG, 31-VII-97, on *Aster* sp. (97G307); Spokane—Peone, 20-VII-95 on *Solidago* sp. (95T278); Yakima—Mabton Grade, 23-V-96, on *Balsamorhiza careyana* (96G069); YIR, nr Mt Adams Lk, 4-VIII-95 on *Hieracium* sp. (95K083†).

Uroleucon escalantii (Knowlton): WA, Benton—ALE, 8-VI-95 on *Chrysothamnus viscidiflorus* (95G148).

Uroleucon nr *escalantii* (Knowlton): WA, Klickitat—Box Springs, nr Bickleton, 29-VI-97 on *Chrysothamnus* sp. (97G178).

Uroleucon gigantiphagum Moran: WA, Yakima—YIR, Signal Peak, 11-VII-95 on *Solidago* sp. (95G329).

Uroleucon ivae Robinson [on *Iva xanthifolia*]: WA, Benton [*]—ALE, Lower Snively Spring, 12-VIII-95 (95K104); Yakima [*]—Grandview, 7,9 & 22-VII-95, & 30-VII-96, (95G309, 95G313, 95G366 & 96G431); Harrah, 29-IX-97 (97G465); Selah, 10-VIII-95 (95G500); Wenas-Ellensburg Rd, Ellensburg Pass, 7-VII-96 (96G317).

Uroleucon katonkae (Hottes) [on *Aster* sp.]: WA, Yakima—Wenas Lk, 17-VI-97 (97G099); YIR, Lost Springs, 11-VII-95 (95K049†).

Uroleucon olivei Moran: WA, Benton—WSU-Prosser, 21-VII-94 on *Iva xanthifolia* (94R012).

Uroleucon russellae (HRL) [on *Anaphalis margaritacea* unless otherwise indicated]: WA, Lewis—RNP, 8-IX-95 on *Senecio* sp. (95K120†); Skamania—June Lk, 4-VIII-95 (95K101); Spokane—Mt Spokane SP, 20-VII-95 & 24-VIII-95 (95T294, 95T494); Yakima—YIR, Lost Springs (95G412) & Soda Springs (95G423), 25-VII-95.

Uroleucon sonchi (L.): WA, Yakima—Grandview, 17-VII-95, 8-VII-96 on *Sonchus oleraceus* (95G348, 96G326); Sunnyside, 23-X-95 on *Sonchus* sp. (95G703); Satus, 1-VI-96 on *Sonchus* sp. (96K064).

Uroleucon suzannae Robinson: WA, Kittitas—Lost Lk, 6-VIII-97 on *Haplopappus hirtus* (97G340†‡).

Uroleucon spp.: ID, Benewah—McCroskey SP, 31-VIII-95 on *Adenocaulon bicolor* (95T527, 95T536); WA, Chelan—Chiwawa Canyon, 3-VIII-96 on *Adenocaulon bicolor* (96R044); Kittitas—Lost Lk, 11-IX-95 & 6-VII-97 on Aster sp. (95G579); Lost Lk Trailhead, 6-VIII-97 on *Agoseris retrorsa* (97G319); S. Fork Manastash Cr, 24-VII-95 on *Hieracium* sp. (95G389); Lincoln—Lk Roosevelt, Goldsmith CG, 31-VII-97 on *Tragopogon dubius* (97G303); Pierce—RNP, Tipsoo Lk, 5-IX-97 on *Anaphalis margaritacea* (97G367); Spokane—Mt Spokane SP, 24-VIII-95 on *Centaurea pratensis* (95T477); Yakima [on *Iva xanthifolia* *]—Hwy 410, Fife Peak Viewpoint, 24-VII-97 on *Senecio serra* (97G270†); Raven's Roost, 28VII–97 on *Hieracium gracile* (97G298†); Sawmill Flats CG, 26-VII-97 on *Aster* sp. (97G287); Union Gap, 23-X-95 on *Centaurea maculosa* (95G720); YIR, Big Spring, 4-VIII-95 on *Agoseris elata* (95K090†), Lost Spring, 25-VII-95 on *Cichorium intybus* (95G413), Signal Peak, 11-VII-95 on *Eriophyllum lanatum* (95K055), 25-VII-95 on *Achillea millefolium* (95G410, 95G417); 19-IX-95 on *Grindelia* sp. (95G618), Signal Peak Guard Station, 19-IX-95 on *Antennaria* sp. (95G616), & Windy Point, 19-IX-95 on *Aster* sp. (95G629).

***Aphidius* nr *pisivorus* Smith**

Acyrthosiphon pisum (Harris): WA, Benton—WSU-Prosser, 11-VII-97 on *Melilotus officinalis* (97F218†).

***Aphidius polygonaphis* (Fitch)**

Acyrthosiphon lactucae (Passerini) [on *Lactuca serriola*]: WA, Whitman—Kamiak Butte, 12-IX-95 (95T550); Yakima—Sunnyside, 28-VI-95 (95G257).

Amphorophora parviflori Hill: WA, Yakima—N. Fork Tieton River & Rd 820, 27-VI-96 on *Rubus parviflorus* (96G304).

Amphorophora sp.?: WA, Lewis—RNP, Stevens Canyon, 23-VII-96 on *Arnica* sp. (96G359†).

Aphis ceanothi Clarke: WA, Yakima—Windy Point CG, 3-VI-95 on *Ceanothus integerrimus* (95G107).

Aphis helianthi Monell: WA, Yakima—YIR, nr. Mt. Adams Lk., 25-VII-95 on *Epilobium angustifolium* (95G402†‡).

Aphis nr *oenotherae* Oestlund: WA, Garfield—Stentz Springs, 14-IX-95 on *Epilobium* sp. (95T565).

Brachycaudus cardui (L.): MT, Sanders—Thompson Pass, 17-VI-95 on *Senecio* sp. (95G191†‡).

Capitophorus elaeagni (del Guercio): WA, Kittitas—Frost Meadows, 11-IX-95 on *Cirsium arvense* (95G583†).

Ericaphis wakibae (Hottes): WA, Yakima—Clear Lk, 15-VI-96 on native *Rosa* sp. (96K084, 96K085†).

Hyperomyzus nigricornis (Knowlton): WA, Yakima—Bird Cr Meadows, 26-VI-95 on *Hieracium* sp. (95A016†).

Hyperomyzus sp. [nr *nigricornis* (Knowlton) & *sandilandicus* (Robinson)] WA, Kittitas—S. Fork Manastash Cr, 24-VII-95 on *Hieracium albiflorum* (95G388).

Illinoia nr *azaleae* (Mason): WA, Yakima—Raven's Roost, 28-VII-97 on *Rhododendron albiflorum* (97G297).

Illinoia davidsoni (Mason): WA, Lewis—RNP, Stevens Canyon, 23-VII-96 on *Arnica* sp. (96G359†); Yakima—Bird Cr Meadows, 26-VI-95 on *Rubus parviflorus* (95A019).

Illinoia sp. [on *Vaccinium* sp.]: ID, Shoshone—Thompson Pass, 29-VII-95 (95G472); WA, Skamania—Keenes Horse Camp, 11-VII-95 (95G337).

Macrosiphoniella ludovicianae (Oestlund) [on *Artemisia ludoviciana*]: WA, Yakima [on *Artemisia ludoviciana**]—YIR, Bedground Springs, 16-V-96 (96G053†).

Macrosiphum clydesmithi (Robinson): WA, Yakima—YIR, Piscoe Meadows, 5-VII-95 on *Pteridium aquilinum* (95G433†).

Macrosiphum clydesmithi (Robinson): WA, Spokane—Mt Spokane SP, 20-VII-95 on unknown Polypodiaceae (95T298); Yakima—Clear Lk, 15-VI-96 on *Holodiscus discolor* (96K081).

Macrosiphum euphorbiae (Thomas): MT, Sanders—Thompson Pass, 17-VI-95 on *Senecio* sp. (95G191†); WA, Asotin—De Spain Spring, 11-VII-96 on *Potentilla* sp. (96T250); 11-VII-96, on unknown plant (96T252); Kittitas [on *Rosa* sp.*]—Manastash Canyon, 2-IX-95 on *Lactuca serriola* (95G544); Lost Lk Trail, 6-VIII-97 on *Luina nardosmia* (97G327); Whitman—Pullman, 22-VII-95 on *L. serriola* (95T300) & 18-VI-96 on cultivated *Rosa* sp.(96T037); Yakima—Clear Lk, 15-VI–96 on native *Rosa* sp. (96K085†); Bird Cr Meadows, 26-VI-95 on *Hieracium* sp. (95A016†).

Macrosiphum nr *euphorbiae* (Thomas): WA, Yakima—YIR, Klickitat Canyon, 25-VII-95 on *Cynoglossum grande* (95G418); Mill Cr Guard Station, 6-VI-95 on *Lomatium nudicaule* (95G115).

Macrosiphum pteridis (Wilson): OR, Benton—McDonald Forest, 14-IV-94 on *Holodiscus discolor,* A. Jensen collector (94J001).

Macrosiphum rosae (L.): OR, Benton—Corvallis, 18-V-93 on unknown plant, A. Jensen collector (93J003).

Macrosiphum valerianae (Clarke): WA, Yakima—YIR, nr. Mt. Adams Lk., 25-VII-95 on *Epilobium angustifolium* (95G402†).

Macrosiphum sp.: ID, Benewah—McCroskey SP, 7-VI-96 on native *Rosa* sp. 96T005); WA, Garfield—FR160 & FR40, 21-IX-95, on *Streptopus* sp. (95T601); Kittitas—Manastash Cr, mi marker 12, 6-VIII-97 on *Holodiscus discolor* (97G314); Yakima—YIR, Piscoe Meadows, 25-VII-95 on *Pteridium aquilinum* (95G433†); Howard Lk, 19-IX-95 on *P. aquilinum* (95G640).

Nasonovia crenicorna (Smith & Knowlton): WA, Whitman—Pullman, 27-V-97 on *Geranium viscosissimum* (97T035)

Nasonovia houghtonensis (G&P): WA, Whatcom—Birch Bay, 29-V-93 on *Oemleria cerasiformis,* A. Jensen collector (93J004).

Sitobion sp.: CANADA, B.C.—Vancouver, Univ. of British Columbia, 29-V-93 on *Dicentra formosa,* A. Jensen collector (93J003).

Uroleucon nr *arnesense* Robinson: WA, Chelan—Leavenworth, Icicle Cr, 1-VIII-95, on *Solidago canadensis* (95G490).

Uroleucon nr *erigeronense* (Thomas): WA, Kittitas—Manastash Rd & Rd112, 9-VII-96 on *Hieracium albiflorum* (96G340).

Uroleucon ivae Robinson: WA, Yakima—Sunnyside, 13-VII-94 & 11-VII-97, on *Iva xanthifolia* (94G009, 97G242).

Wahlgreniella nervata (Gillette): ID, Shoshone—Thompson Pass, 29-VII-95 on *Pachistima myrsinites* (95G471).

Aphidius* nr *polygonaphis (Fitch)

Macrosiphum walkeri Robinson: OR, Benton—Corvallis, 17-III-90 on *Polypodium* sp. (90J001).

Aphidius pulcher Baker

Acyrthosiphon pisum (Harris): WA, Benton—WSU-Prosser, 1-VII-96 on *Melilotus officinalis* (96G311†).

Aphidius rhopalosiphi DeStefani

Metopolophium dirhodum (Walker): WA, Benton—WSU-Prosser, 6-VIII-97 on *Triticum aestivum* (97F226†).

Sitobion avenae (F.): WA, Benton—WSU-Prosser, 11, 18 & 25-VII-97 on *Triticum aestivum* (assorted collections between 97F204–97F277).

Aphidius* nr *rosae Haliday

Macrosiphum pallidum (Oestlund): WA, Spokane—nr Cheney, 23-V-95 on native *Rosa* sp. (95K006).

Aphidius salicis Haliday

Cavariella aegopodii (Scopoli): WA, BENTON—WSU-Prosser, 21-VII-97 on *Anethum graveolens* (97G247†); KITTITAS—Reecer Cr, nr Ellensburg, 20-VI-95 on *Angelica canbyi* (95G203); Manastash Cr Rd, mi marker 12, 25-VI-97, on *Osmorhiza occidentalis* (97G132); Lost Lk, 6-VIII-97 on *Osmorhiza chilensis* (97G331); Quilomene WLA, Crossover Rd & Colockum Ridge, 2-VII-97 on *Osmorhiza purpurea* (97G207); PEND OREILLE—Tiger Meadows, 9-VII-96 on unknown Umbelliferae (96T219†); YAKIMA—Hwy 410, Fife Peak Viewpoint, 24-VII-97 on *Osmorhiza chilensis* (97G271†); YIR, Signal Peak, 19-Ix-95 on *Salix* sp. (95G623).

Cavariella pastinacae (L.) [on *Heracleum lanatum* unless otherwise indicated]: WA, ASOTIN—De Spain Springs, 5-VII-96 & 25-VII-96 (96T156, 96T350); ISLAND—N. Whidby Island, 5-VI-96 (96G171); KING—Tinkham exit, 4-VI-96 (96G137); KITTITAS—Reecer Cr, nr Ellensburg, & S. Fork Manastash Cr, & Manastash Rd, 20-VI-95, 24-VII-95, & 25-VII-96 (95G217, 95G393, 96G417); Taneum Lk, 11-IX-97 on *Angelica* sp. (97G413); PIERCE—RNP, Ipsut Pass, 25-IX-97 (97G447); Mowich Lk, 25-IX-97 (97G450); YAKIMA—Yakima, 28-VI-95 on *Heracleum lanatum* (95G269†); YIR, Klickitat Canyon, 23-VI-95 (95G235), & Signal Peak, 11-VII-95 (95G335).

Aphidius segmentatus Pike and Starý, new species

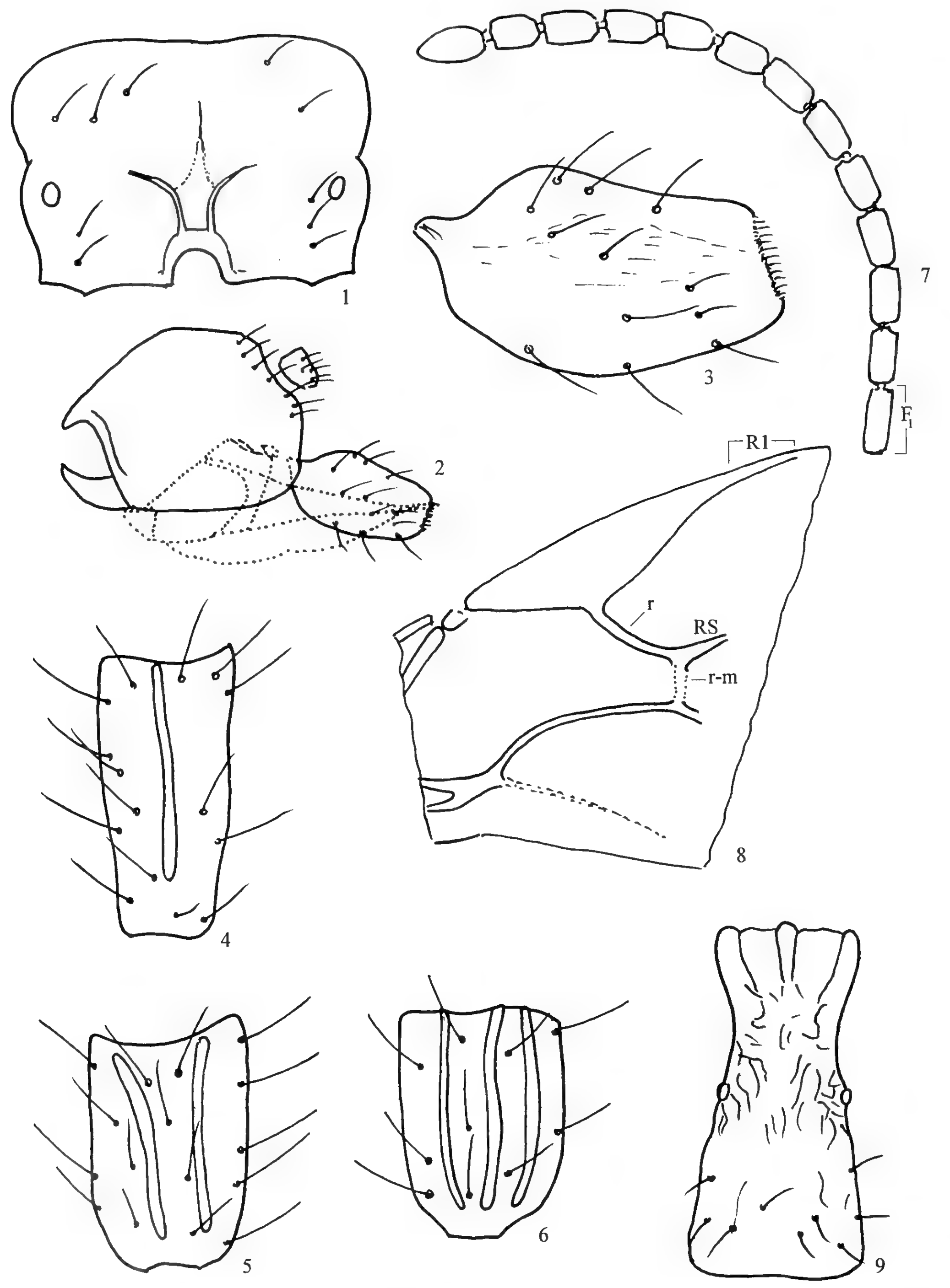
(Figs. 1–9)

Diagnosis.—The new species is distinguished by several characters, but especially a short antenna (14–15 segments, noticeably widening to apex), and short distal abscissa of R1 (= metacarpus). In Smith (1944), the new species keys to *Aphidius ribis* Haliday, but the latter's antenna is longer, not remarkably thickened, and the metacarpus is long. Similar differences also distinguish the new species from a European species, *A. sonchi* Marshall that attacks *Hyperomyzus* aphids (Starý 1963, 1966).

Etymology.—The name of the new species is derived from the somewhat unusual segmentation of the flagellum.

Description.—Female. *Head:* Eye length 3× malar space. Tentorio-ocular line ½ intertentorial line. Antenna 14–15 (prevalently 15) segmented, short, as long as head, mesosoma and metasomal tergum 1 together, thickened to apex, segmentation of flagellum rather distinct (Fig. 7). Flagellomeres with semierect setae (Figs. 4–6). Flagellomere 1 [F_1] (Fig. 4) length 2× width, with 0–1 longitudinal placodes, setae about ⅔ segment diameter. F_2 similar to F_1, with 2–3 placodes. Middle F (Fig. 5) length about 1.3× width, distinctly wider than F_2. Preapical F (Fig. 6) length about 2× width, wider than middle F. *Mesosoma:* Mesonotum glabrous, with rows of sparse setae indicating the effaced notauli on the disc. Propodeum (Fig. 1) with rather small areola, carinae sometimes indistinct to slightly indicated in upper portion. *Forewing:* (Fig. 8): Stigma length 3× width; distal abscissa of R1 (metacarpus) equal or subequal to stigma width. Vein r slightly longer than stigma width, and twice RS length; r-m equal to RS in length. Marginal setae 3× length of surface setae. *Metasoma:* Metasomal tergum 1 (Fig. 9) length 2.5× width at spiracles; surface slightly rugose in anterior portion; anterolateral area costulate. *Genitalia* (Fig. 2): Ovipositor sheath (Fig. 3) apex blunt. *Coloration:* Head brown; face, gena, and mouthparts yellow, except brown apices of mandibles. Antenna brown; a ring between pedicel and flagellum sometimes yellow. Mesosoma brown, propleuron yellow; mesopleuron sometimes with yellow markings in lower portion. Tegula yellow. Wings hyaline, venation brown. Legs light brown; coxa, trochanter and base of tibia yellow; a dark tinge increasing from fore to hind legs, the latter the darkest. Metasoma: Tergum 1 and apical half of metasoma yellow, terga 2 and 3 and some times 4, with brown banding. Ovipositor sheath brown. *Length of body:* about 2.2–2.7 mm.

Male.—Antenna 17–18 segmented. Coloration: head brown; mouthparts mainly (apices of mandibles brown, palpi light brown). Mesosoma brown. Legs brown, base of tibia yellow to light brown. Metasoma brown, tergum 1 yellow to light brown.



Figs. 1–9. *Aphidius segmentatus,* ♀ [illustrations not to equal scale]. 1, Propodeum. 2, Genitalia. 3, Ovipositor sheath. 4, Flagellomere 1 [F_1]. 5, Middle flagellomere. 6, Preapical flagellomere. 7, Antenna [flagellum]. 8, Fore wing, in part. 9, Metasomal tergum 1. Abbreviations: R1, distal abscissa of postmarginal vein [= metacarpus]; RS, r, and r-m, wing veins.

Holotype.—♀, USA, WA, Yakima Co., Yakama Indian Reservation, 25-VII-1995, G. Graf collector, (collection code, 95G406). Host aphid: *Hyperomyzus nigricornis* (Knowlton) on *Hieracium cynoglossoides.* Deposited in USNM.

Paratypes.—16 specimens, collection data same as holotype, deposited in part in collections of WSU-Prosser (10 ♀, 4 ♂) and P. Starý, Ceské Budejovice, Czech Republic (1 ♀, 1 ♂); 11 specimens, USA, WA, Kittitas Co., L.T. Murray WLA, S. Fork Manastash Creek, 24-VII-1996, on *Hyperomyzus* sp. (nr *nigricornus* or *sandilandicus*) on *Hieracium albiforum* (96G388), deposited in part in collections of WSU-Prosser (6 ♀) and P. Starý, Ceské Budejovice, Czech Republic (3 ♀, 2 ♂).

Other material reared from.—

Hyperomyzus lactucae (L.): WA, Whitman—Pullman, 12-IX-95, on *Lactuca serriola* (95T559).

Hyperomyzus nigricornis (Knowlton) [on *Hieracium* sp. unless otherwise indicated]: ID, Latah—Moscow Mtn, 3-VII-96 on Compositae (96T399); WA, Garfield—FR40 nr Teal Springs, 1-VIII-95 on *Senecio* sp. (95T378†); Pataha Cr Rd, 25-VII-95 (95T323‡); Wickiup CG, 29-VIII-95 (95T508); Kittitas—Lost Lk, 6-VIII-97 (97G317†, 97G344); Klickitat—Cleveland, 7-VII-97 (97G229); Pierce—RNP, Paradise, 8-IX-95 *on Senecio* sp. (95K119), & Tipsoo Lk, 5-IX-97 (97G359); Spokane—Mt Spokane SP, 24-VIII-95 on Compositae (95T486); Yakima—Little Naches River, 5 mi W of Timothy Meadows, 9-IX-97 (97G388, 1 specimen); Hwy 410, Ravens's Roost, 28-VII-97 (97G298†); Pleasant Valley CG, 24-VII-97 (97G259†); Sawmill Flats, 28-VII-97 (97G288†); Wenas Lk, 17-VI-97 on Compositae (97G087); R, Signal Peak, 11-VII-95 (95K056).

Hyperomyzus sp. [*nigricornis* (Knowlton) or *sandilandicus* (Robinson)]: WA, Kittitas—Manastash Rd & FR112, 11-IX-95 on *Hieracium* sp. (95G559†); L. T. Murray Wildlife Reserve, South Fork Manastash Cr, 24-VII-95 on *Hieracium albiflorum* (95G388).

Uroleucon erigeronense (Thomas): WA, Kittitas—Manastash Ridge, nr Lost Lk, 2-IX-95 on *Achillea millefolium* (95G533‡).

Aphidius smithi **Sharma & Subba Rao**

Acyrthosiphon pisum (Harris): WA, Benton [on *Medicago sativa*†*].

Aphidius **spp.**

Acyrthosiphon lactucae (Passerini) [on *Lactuca serriola*]: ID, Benewah—McCroskey SP, 31-VIII-95 (95T534); WA, Asotin—Asotin, 10-VII-95 (95T419); Chelan—Chelan SP, 11-IX-97 (97K038); Spokane—nr Peone, 24-VIII-95 (95T470).

Acyrthosiphon macrosiphum (Wilson) [on *Amelanchier alnifolia*]: MT, Lincoln—Libby, 6-VII-96 (96G322); WA, Pend Oreille—Le Clerc WLA, Panhandle CG, 3-VIII-95 (95T402).

Acyrthosiphon pisum (Harris): WA, Benton [on *Medicago sativa**]; Kittitas [on *Rhododendron albiflorum**].

Amphorophora geranii G&P: WA, Spokane—Turnbull National WLA, 25-V-95 on *Geranium* sp. (95T030†).

Amphorophora nr *rubitoxica* Knowlton: WA, Island—South Whidbey Island, 4-VI-96 on *Rubus* sp. (96G163).

Aphis armoraciae Cowen: WA, Kittitas [on *Mertensia paniculata**].

Aphis craccivora Koch: WA, Whitman—Pullman, 5-VII-97 on *Trifolium* sp. (96T170).

Aphis fabae Scopoli: WA, Asotin—Field Springs SP, 18-VII-95 on *Cirsium arvense* (95T272).

Aphis helianthi Monell: WA, Benton—WSU-Prosser, 21-VII-97 on *Anethum graveolens* (97G247†).

Aphis holodisci Robinson: WA, Asotin—nr FR40 & FR44, 26-VI-96 on *Holodiscus discolor* (96T052).

Aphis nigratibialis Robinson: WA, Yakima—Nile, 28-VII-97 on *Cornus stolonifera* (97G280).

Aphis varians Patch: WA, Pierce [on *Epilobium angustifolium**].

Aphis (*Zyxaphis*) sp.: WA, Klickitat—Frost Meadows, 11-IX-97 on *Artemisia tridentata* (97G435).

Aspidophorodon longicauda (Richards): WA, Skamania—South Prairie, 8-IX-94 on *Spiraea douglasii* (94R192).

Brachycaudus helichrysi (Kaltenbach): WA, Spokane—Plaza, 16-VII-96 on unknown plant (96T278).

Brachycaudus tragopogonis (Kaltenbach): WA, Benton—WSU-Prosser, 25-VII-97 on *Tragopogon dubius* (97F266).

Capitophorus elaeagni (del Guercio): WA, Yakima—Rimrock Lk, 14-IX-95 on *Cirsium vulgare* (95G589).

Carolinaia howardii (Wilson): WA, Whitman—Pullman, 1-VII-96 on unknown plant (96T123).

Chaetosiphon fragaefolii (Cockerell): WA, Pend Oreille—Le Clerc WLA, 3-VIII-95 on native *Rosa* sp. (95T398); Stevens—Little Pend Oreille National WLA, 9-VII-96 on native *Rosa* sp. (96T209†).

Chaetosiphon nr *hottesi* Stroyan: WA, Spokane—Mt Spokane SP, 24-VIII-95 on native *Rosa* sp. (95T491†‡).

Chaetosiphon tetrarhodum (Walker): WA, Spokane—Mt Spokane SP, 24-VIII-95 on native *Rosa* sp. (95T491†‡).

Diuraphis noxia (Kurdjumov) [on *Triticum aestivum*]: WA, Asotin—Field Springs SP, 20-VI-95 (95T158); Benton [*].

Ericaphis gentneri (Mason) [on *Crataegus* sp.]: WA, Chelan—Stevens Pass, 16-IX-95 on *Spiraea densiflora* (95K138); Kittitas—Coleman Canyon, 2-VII-97 (97G214); Spokane—Chapman Lk, 16-VII-96 (96T282).

Ericaphis nr *gentneri* (Mason): WA, Whitman—Pullman, 6-VIII-96 on *Crataegus* (96T409).

Ericaphis scammelli (Mason): WA, Stevens—Little Pend Oreille National WLA, 9-VII-96 on native *Rosa* sp. (96T209†).

Ericaphis wakibae (Hottes): WA, Yakima—N Fork Tieton River, 15-VI-96 on native *Rosa* sp. (96K090†).

Euceraphis gillettei Davidson: WA, Kittitas—L.T. Murray WLA, S Fork Manastash Cr, 24-VII-95 on *Alnus* sp. (95G394†‡).

Hyperomyzus nigricornis (Knowlton): WA, Kittitas—Lost Lk, 6-VIII-97 on *Hieracium* sp. (97G344).

Hyperomyzus sp.: WA, Benton [on *Sonchus oleraceus**].

Illinoia crystleae bartholomewi (Essig) [det. by A. Jensen]: WA, Kittitas—Lost Lk, on *Lonicera involucrata* (97G336).

Illinoia nr *crystleae* (Smith & Knowlton): WA, Kittitas—Lost Lk, 7-VII-94 on *Lonicera involucrata* (94K028).

Illinoia davidsoni (Mason): WA, Garfield—Alder Thicket, 22-VIII-95 on *Arnica latifolia* (95T450).

Illinoia rhododendri (Wilson): WA, Kittitas [on *Rhododendron albiflorum**].

Illinoia spp.: WA, Garfield—Stentz Springs, 1-VIII-95 on *Aquilegia formosa* (95T362†); Skagit—La Conner, 6-VI-96 on *Rhododendron* sp. (96G193); Skamania [on *Vaccinium* sp.*].

Liosomaphis berberidis (Kaltenbach): WA, Skagit—La Conner, 5-VI-96 on *Berberis* sp. (96G192).

Macrosiphoniella ludovicianae (Oestlund): WA, Asotin—Anatone, 18-VII-95 on *Artemisia ludoviciana* (95T257).

Macrosiphum californicum (Clarke) [on *Salix* sp.]: WA, Kittitas [†*]; Yakima—YIR, Lost Springs, 11-VII-95 (95K052).

Macrosiphum clydesmithi (Robinson): WA, Chelan—Chiwawa Canyon, 5-IX-95 on *Pteridium aquilinum* (95R026†).

Macrosiphum euphorbiae (Thomas): ID, Latah—Moscow Mtn, 6-VII-96 on unknown plant (96T187); 6-VII-96 on Compositae (96T185); MT, Sanders—Thompson Pass, 17-VI-95 on *Hieracium* sp. (95G185), & *Arabis* sp. (95G190†); WA, Garfield—Stentz Springs, 1-VIII-95 on *Arnica latifolia* (95T370); Spruce Springs, 22-VIII-9, on *Ranunculus* sp. (95T459); Kittitas—Manastash Rd 25-VII-96 on *Ranunculus* sp. (96G416); Taneum Lk, 11-IX-97 on *Silene* sp. (97G415); Lost Lk, 6-VIII-97 on *Angelica canbyi* (97G330†); Klickitat—Cleveland Pk, 7-VII-97 on *Lupinus* sp. (97G230); Spokane—Mt Spokane SP, 29-VI-95 on *Ranunculus* sp. (95T190); Whitman—Pullman, 5-VII-96 on cultivated *Rosa* sp. (96T172†); Yakima—N. Fork Tieton River, 27-VI-96 on *Hieracium scouleri* (96G297); Buckhorn Meadows, 14-IX-95 on *Trautvetteria caroliniensis* (95G597).

Macrosiphum pallidum (Oestlund): MT, Sanders—Thompson Pass, 17-VI-95 on *Arabis* sp. (95G190†‡).

Macrosiphum rhamni (Clarke) [det. by A. Jensen]: WA, King—Stampede Pass, 8-VIII-96, on *Pteridium aquilinum* (96G441); Klickitat—Trout Lk, 29-VI-97 on *Pteridium aquilinum* (97G169).

Macrosiphum rosae (L.): Whitman—Pullman, 5-VII-96 on cultivated *Rosa* sp. (96T172†).

Macrosiphum tuberculaceps (Essig): WA, Yakima—Hell Crossing CG, 11-IX-96 on *Achlys triphylla* (96G517); N. Fork Tieton River, 15-VI-96 on *A. triphylla* (96K096).

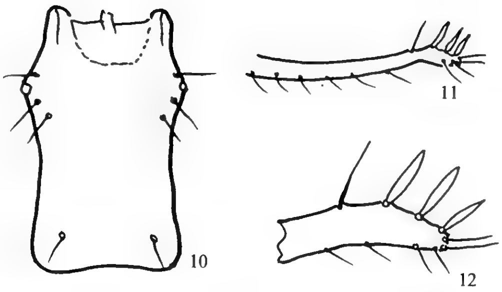
Macrosiphum sp.: WA, King—Kittitas—Waptus Lk, 27-VII-95 on *Spiraea douglasii menziesii* (95K075); Manastash Cr, mi marker 12, 25-VI-97 on *Holodiscus discolor* (97G128); Spokane—Turnbull National WLA, 25-V-95 on *Geranium* sp. (95T030†); Yakima—Nile, 28-VII-97 on *Clematis ligusticifolia* (97G278).

Metopolophium dirhodum (Walker): WA, Kittitas [on *Rhododendron albiflorum**]; Snohomish—Monroe, 5-VI-96 on *Phalaris arundinaceae* (96G202†); Yakima—N Fork Tieton River, 15-VI-96 on native *Rosa* sp. (96K090†).

Myzus cerasi (F.): WA, Skagit—Campbell Lk, 5-VI-96 on *Prunus emarginata* (96G170).

Nasonovia aquilegiae (Essig): WA, Garfield—Stentz Springs, 1-VIII-95 on *Aquilegia formosa* (95T362†).

Nasonovia nr *aquilegiae* (Essig): WA, Spokane—Manito Pk, 11-VII-96 on *Aquilegia* sp. (96T262†).



Figs. 10–12. *Betuloxys alnicolus,* ♀ [illustrations not to equal scale]. 10, Metasomal tergum 1. 11–12, Prong.

Nasonovia polemonii (G&P): WA, Kittitas—Buck Meadows, 9-VII-96 on *Polemonium pulcherrimum* (96G347).

Nasonovia sp.: MT Sanders [on *Castilleja* sp.*].

Oestlundiella flava (Davidson): WA, Kittitas—L.T. Murray WLA, S Fork Manastash Cr, 24-VII-95 on *Alnus* sp. (95G394†‡).

Ovatus crataegarius (Walker): ID, Bonner—Sandpoint, 10-IV-97 on *Origanum* sp. (97T003); WA, Adams—Othello, 1-VII-96 on *Mentha piperita* (96B003).

Prociphilus sp.: WA, Yakima—Clear Lk, 15-VI-96 on *Lonicera* sp. (96K083).

Rhopalosiphum padi (L.): WA, Snohomish—Monroe, 5-VI-96 on *Phalaris arundinaceae* (96G202†).

Sitobion avenae (F.): WA, Benton—WSU-Prosser, 18-VII-97 on *Setaria lutescens* (97G243).

Sitobion fragariae (Walker): WA, Island—Whidbey Island, 5-VI-96 on *Dactylis glomerata* (96G177).

Uroleucon erigeronense (Thomas): WA, Yakima—Buckhorn Meadows, 14-IX-95 on *Achillea millefolium* (95G598).

Uroleucon ivae Robinson [on *Iva xanthifolia*]: WA, Benton [*]; Yakima [*]—Grandview, 21-VIII-95 (95G503).

Uroleucon russellae (HRL): WA, Skamania—Council Lk, 4-VIII-95 on *Anaphalis margaritacea* (95K095).

Uroleucon sonchi (L.): WA, Benton [on *Sonchus oleraceus*†*].

Uroleucon sp.: WA, Pend Oreille—Sullivan Lk, 3-VIII-95 on *Adenocaulon bicolor* (95T391); Tiger Meadows, 9-VII-96 on *Senecio* sp. (96T220).

Utamphorophora humboldti (Essig): OR. Multnomah [on *Physocarpus* sp.*].

Undetermined spp.: WA, Asotin [on *Chrysothamnus nauseosus**]; Douglas—Waterville, 13-VII-95 on *Triticum aestivum* (95B013, 95B014); Kittitas—Quartz Mtn 25-VII-96 on *Rubus lasiococcus* (96G407); Taneum Lk, 11-IX-97 on *Pedicularis bracteosa* (97G425); Lewis—RNP, Louise Lk, 1-VII-95 on *Luetkea pectinata* (95K042); Spokane—Mt Spokane SP, 22-VIII-96 on *Vaccinium* sp. (96T492); Yakima—Clear Lk, 15-VI-96 on *Holodiscus discolor* (96K080); YIR, Mabton Rd, 16-V-96 on *Grindelia* sp. (96G051).

Genus *BETULOXYS* Mackauer

Betuloxys alnicolus Pike & Starý, new species

(Figs. 10–12)

Diagnosis.—The new species is easily distinguished from *B. compressicornis* (Ruthe) by its distinctly smaller size, generally brown coloration, and characters on prongs (distal portion less differentiated and bearing three lanceolate setae). The new species was collected near colonizing aphids [*Boernerina variabilis* (Richards)] on *Alnus* in Washington. By comparison, *B. compressicornis* is generally yellow (exception, flagellum mostly brown, and brown areas on mesonotum, scutellum, apices of legs and prongs), distal portion of prong with five lanceolate setae, known as a parasitoid of *Euceraphis punctipennis* (Zett.) on *Betula,* from E. Canada and Europe.

Etymology.—The name of the new species is derived from its association with *Alnus.*

Description.—Female. *Head:* Eyes medium sized; antenna 12-segmented, filiform, reaching to half of metasoma. *Mesosoma:* Mesonotum smooth, with sparse setae, notauli indicated anteriorly. Propodeum feebly granulate rugose, with sparse setae. *Forewing:*

Stigma slightly more than 3× as long as wide (length/width [L/W] = 3.2); distal abscissa of R1 (= metacarpus) 2× width of stigma, about ⅓ shorter than stigma length; RS vein long, 1.2× stigma length. *Metasoma:* Metasomal tergum 1 (Fig. 10) smooth, length 1.6× width, spiracular tubercles distinct, prominent laterally, situated at end of first third of tergite. *Genitalia* (Figs. 11–12): Prongs arcuate, apical portion somewhat dilated with three lanceolate, perpendicular setae on dorsal side. *Coloration:* Head and mesosoma dark brown. Mouthparts light brown. Antenna largely brown, except scape, pedicel, and F_1 yellow, F_2 yellow brown. Wings subhyaline, venation light brown. Legs brown. Metasoma brown, tergum 1 somewhat darker at base. Ovipositor sheaths and prongs brown, concolorous with metasoma. *Length of body:* about 1.8 mm.

Male.—Unknown.

Holotype.—♀, USA, WA, Yakima Co., N. Fork of Tieton River, 15-VI-1996, K. S. Pike collector (collection code, 96K089). Host aphid uncertain, collected near colonizing aphids, *Boernerina variabilis* Richards on *Alnus.* Deposited in USNM.

Genus *BINODOXYS* Mackauer

Binodoxys carolinensis (Smith)

Aphis ceanothi Clarke: WA, Kittitas—S. Fork Manastash Cr, 25-IV-97 on *Ceanothus velutinus* (97G137).

Aphis helianthi Monell: WA, Chelan—Johnny Cr, 1-VIII-95 on *Epilobium angustifolium* (95G482†); Pend Oreille—Le Clerc WLA, 3-VIII–95 on *Cornus stolonifera* (95T399†), Yakima—YIR, Signal Peak, 11-VII-95 on *Lomatium* sp. (95G334†).

Aphis nigratibialis Robinson [on *Cornus stolonifera*]: WA, Klickitat—Trout Lk, 28-VI-97 (97G156); Yakima—Nile, 28-VII-97 (97G280); YIR, Miller Point, 11-VII-95 (95K062).

Aphis nr *oenotherae* Oestlund: WA, Yakima—Pleasant Valley CG, 24-VII-97 on *Epilobium minutum* (97G267†).

Aphis salicariae Koch: WA, Pend Oreille—Le Clerc WLA, 3VIII–95 on *Cornus stolonifera* (95T399†‡).

Aphis varians Patch [on *Epilobium angustifolium*]: ID, Shoshone—Thompson Pass, 29-VII-95 (95G468†); MT, Sanders [*].

Aphis nr *varians* Patch: WA, Lewis—RNP, Stevens Canyon, 23-VII-96 on *Epilobium angustifolium* (96G380).

Aphis sp. n.: WA, Yakima—YIR, Miller Point, 11-VII-95 on *Ceanothus* sp. (95K061).

Aphis sp.: WA, Yakima—Pleasant Valley CG, 24-VII-97 on *Epilobium minutum* (97G267†).

Cavariella nr *aegopodii* (Scopoli): WA, Kittitas—nr Ellensburg, Reecer Cr, 20-VI-95 on *Salix* sp. (95G207‡).

Binodoxys clydesmithi Pike & Starý

Aphis canae Williams: WA, Franklin—Kahlotus Hwy, 11-VI-96 on *Artemisia tridentata* (96G242†‡).

Artemisaphis artemisicola (Williams) [on *Artemisia tridentata*]: WA, Franklin—Kahlotus Hwy, 28-V-96 & 11-VI-96 (96G096, 96G242†‡).

Obtusicauda coweni (Hunter): WA, Kittitas [on *Artemisia tridentata**].

Binodoxys conei Pike & Starý

Phorodon humuli (Schrank): WA, Benton [on *Humulus lupulus**].

Binodoxys coruscanigrans (Gahan)

Obtusicauda coweni (Hunter): WA, Yakima [on *Artemisia tridentata**]—Wenas Lk, 30-V-96, (96G115).

Binodoxys grafi Pike & Starý

Aphis fabae Scopoli: WA, Yakima—American River, 5-IX-97 on *Epilobium angustifolium* (97G377†).

Aphis helianthi Monell [on *Epilobium angustifolium*]: WA, Chelan—Stevens Pass, 16-IX-95 (95K134†); Kittitas [*]—Lost Lk, 24-VII-95 (95G399†); Spokane—Mt Spokane SP, 27-VII-95 on unknown Umbelliferae (95T335†).

Aphis holodisci Robinson: WA, Kittitas—Manastash Cr, mi marker 12, 25-VI-97 on *Holodiscus discolor* (97G133).

Aphis salicariae Koch: ID, Kootenai—Rathdrum, 29-VII-95 on *Epilobium angustifolium* (95G443†).

Aphis nr *salicariae* Koch: WA, Chelan—Swauk Pass, 1-VIII-95 on *Epilobium angustifolium* (95G492†).

Aphis nr *triglochinis* Theobald: WA, Spokane—Mt Spokane SP, 29-VI-95 on native *Ribes* sp. (95T189).

Aphis varians Patch [on *Epilobium angustifolium*]: ID, Kootenai—Rathdrum, 29-VII-95 (95G443†); WA, Chelan—Stevens Pass, 16-IX-95 (95K134†); Kittitas—Lost Lk, 24-VII-95 (95G399†); Stampede Pass, 8-VIII-96 (96K139).

Aphis nr *varians* Patch: WA, Kittitas—Lost Lk, 24-VII-95 on *Epilobium angustifolium* (95G399†).

Binodoxys rhagii (Ashmead)

Uroleucon russellae (HRL) [on *Anaphalis margaritacea*]: WA, Chelan—Chatter Cr, 1-VIII-95 (95G484); Yakima—YIR, Delaney Springs (95G412) & Panther Butte (95G423), 25-VII-95.

***Binodoxys* spp.**

Aphis salicariae Koch: WA, Yakima [on Cornus stolonifera*].

Chaetosiphon fragaefolii (Cockerell): WA, Pend Oreille—Le Clerc WLA, 3-VIII-95 on native *Rosa* sp. (95T398).

Illinoia rhododendri (Wilson): WA, Kittitas [on *Rhododendri albiflorum**].

Genus *DIAERETELLUS* Starý

Diaeretellus palustris Starý

Rhopalosiphum nymphaeae (L.): WA, Yakima—Outlook, 23-X-95 on *Typha latifolia* (95G709).

Genus *DIAERETIELLA* Starý

Diaeretiella rapae (M'Intosh)

Acyrthosiphon lactucae (Passerini) [on *Lactuca serriola*]: WA, Asotin—Asotin, 10-VIII-95 (95T419); S. Fork Asotin Cr, 22-VIII-95 (95T468); Benton—WSU-Prosser, 17-VII-95 (95G353); Whitstran, 18-IX-97 (97G439); Whitman—Pullman, 16 & 30-VII-96, 1,6 & 19-VIII-96, 9 & 12-IX-96 (96T304, 96T362, 96T382, 96T407, 96T408, 96T468, 96T528, 96T532).

Acyrthosiphon pisum (Harris): MT, Ravalli—Stevensville, 25-V-96 on *Melilotus* sp. (96G083); WA, Benton—WSU-Prosser, 18 & 25-VII-97, on *Melilotus officinalis* (97F254†, 97F274†).

Aphis craccivora Koch: WA, Whitman—Pullman, 25-VII-95 on *Capsella bursa-pastoris* (95T331).

Aphis fabae Scopoli: ID, Latah—Moscow Mtn, Paradise Cr, 25-IX-96 on *Cirsium arvense* (96T542).

Aphis nr *fabae* Scopoli: WA, Pierce—RNP, Paradise, 8-IX-95 on *Spiranthes romanzoffiana* (95K118).

Aphis helianthi Monell: WA, Garfield—Stentz Springs, 1-VIII-95 on *Ranunculus* sp. (95T363†).

Brachycaudus cardui (L.): WA, Asotin—De Spain Springs, 5-IX-96 on *Onopordum acanthium* (96T518).

Brachycaudus helichrysi (Kaltenbach): ID, Benewah—McCroskey SP, 31-VIII-95 on *Conyza canadensis* (95T516†); WA, Asotin—Anatone, 28-VI-96 on *Amsinckia* sp. (96T089); Wickiup CG, 29-VIII-95 on *Sonchus* sp. (95T505); Benton—WSU-Prosser, 1-X-97 on *S. tuberosum* (97G478); Whitman—Pullman, 28-VI-96 on *Anthemis arvensis* (96T162); 16-VII-96 on *Anthemis cotula* (96T298).

Brachycaudus tragopogonis (Kaltenbach) [on *Tragopogon dubius*]: WA, Benton—WSU-Prosser, 3, 18, 25-VII-97 (97F194, 97F242, 97F266); Klickitat—Bickleton, 8-X-96 (96G628); Yakima—Grandview, 24-V-96, 25-VI-96 (96G080, 96G273).

Brachycorynella asparagi (Mordvilko) [on *Asparagus officinalis*]: WA, Benton [*]—WSU-Prosser, 6 & 25-IX-95 (95K144, 95G548†, 95G649); Yakima—Harrah, 29-IX-97 (97G462, 97G468, 97G469).

Braggia sp.[det. by G. Remaudière]: WA, Yakima [on *Eriogonum elatum**].

Brevicoryne brassicae (L.): WA, Benton [on *Brassica napus, B. oleracea & Descurainia sophia**]—WSU-Prosser, 6-VII-95, 24-VIII-95, 5-VIII-96, 30-IX-96, 17-I-97, 23-V-97, & 1-X-97 on *B. napus* (95A024, 95G508, 96G438, 96G622, 97G004, 97G039, 97G475); 9-IX-95 on *B. oleracea capitata* (95K155); 11-VII-97 on *Sisymbrium altissimum* (97G241); 1-X-97, on *Malva neglecta* (97G471†); West Richland 12-VII-95 on *B. oleracea acephala* (95K074); Chelan—Chelan SP, 11-IX-97 on *Erysimum* sp. (97K045); Clark—WSU-Vancouver, 21-IX-95 on *B. oleracea capitata* (95K179); Skagit—Mt Vernon, 16-X-95 on *B.* sp. (95K190); Pierce—Graham, 8-IX-96 on Cruciferae (96T525); Walla Walla—Hwy 124, 10 mi E of Burbank, 28-V-96 on *B. napus* (96G099); 28-V-96 on *Sisymbrium altissimum* (96G098); Whitman [on *B. napus**]—Pullman, 2-VIII-96 on *B. napus* (96T390); Yakima– nr Bickleton 7-VII-97 on *B. napus* (97G235); on *Sisymbrium altissimum* (97G237).

Diuraphis noxia (Kurdjumov) [on *Hordeum vulgare* unless otherwise indicated]: OR, Umatilla—Hermiston, 17-VI-90 on unknown plant (90J003); WA, Asotin—Columbia Center, Pataha Cr Rd, 10-VIII-95 on *Agropyron cristatum* (95T431); Anatone, 24-VII-96, 1,8 & 15-VIII-96 (96T596 to 96T600); Anatone, 22 & 31-VII-97 (97J011 to 97J025); Benton [*]—WSU-Prosser, 28-V-96 & 24-X-96 (96G087 to 96G090, 96G654); [Klickitat, on *Aegilops cylindrica**]—Cemetery Rd nr Bickleton, 7-VII-97 (97G226†); Walla Walla—Valley Grove, 11-VI-96 (96G240); Waitsburg, 11-VII-96 (96J056, W. Turner & J. Rumph collectors); Whitman—Pullman, 9-VII-96 (96J053 to 96J055, W. Turner & J. Rumph collectors); Yakima

[*]; [Following on *Triticum aestivum* unless otherwise indicated] Adams [*]; Asotin [*]—Couse Cr Rd, 10-VIII-95 (95T421); Field Springs SP, 10-VIII-95 (95T427); Asotin WLA, 15 & 29-VIII-96, 24-IX-96, 3-X-96 (96T455, 96T457, 96T503, 96T555, 96T569); De Spain Spring, 5-IX-96, 3-X-96 (96T516, 96T571); Benton [*]—WSU-Prosser, 15-V-95, 24-V-96, 3-VI-96, 24, 28-VII-97 (95G065, 96G081, 96G132, 97G274, 97G301); 29-IV-97 thru 24-IX-97, (97F001–97F004, 97F042–97F455); 1-IV-97, 6-VI-97 (97G005, 97G040, 97G041); 3 mi S of Prosser, 6-VI-97 (97G045); Sellards & Travis Rds, 25-VI-95 (95G252); Rotha Rd 17-VII-97 (97G245); Douglas—Waterville, 12-VIII-95 (95B019); Franklin [*]– Star School, 6-VII-95 (95G287); Kahlotus, 6-VII-95 (95G291); Garfield—Columbia Center, 10-VIII-95, 7-IX-95 (95T435, 95T538, 95T539); Spruce Springs, 14-IX-95 (95T574); Klickitat [*]—Bickleton, 31-X-95, 7-VII-97 (95G743, 97G223); nr Bickleton, 18-VI-97 & 7 & 29-VII-97, 6-VIII-97 (97G119, 97G238, 97G300, 97G354); Brannon Rd nr Cleveland, 7-VII-97 (97G234); Cleveland, 18-VI-97, 27-VI-97, 7-VII-97 (97G114 to 97G117, 97G145, 97G232); Spokane—Mt Spokane SP, 22-VII-95 (95T495); Whitman [*]—Hole in the Ground, 8-VI-95 (95T085); Dusty, 9-VII-96 on *Triticum* sp. (96J065, W. Turner & J. Rumph collectors); Yakima [*]—nr Bickleton, 23-V-96, 17-VI-96 (96G073, 96G250, 96G251, 96G252); Sunnyside, 24-VII-97 (97G273).

Dysaphis plantaginea (Passerini): WA, Benton—Prosser, 24-VI-96 on *Pyrus malus* (96G279†).

Hayhurstia atriplicis (L.) [on *Chenopodium album*]: ID, Latah—Moscow, 28-IX-96 (96T561); WA, Asotin—Anatone 28-VI-96 (96T091); De Spain Springs, 31-VII-96 (96T358); Benton—WSU-Prosser, 20-VIII-96, & 3,18,25-VII-97 (96G509, 97F190, 97F238, 97F262); Klickitat—Bickleton 18-VI-97, 7-VII-97 (97G111, 97G118, 97G239); nr Cleveland, Dot & Brannon Rds, 27-VI-97, 7-VII-97 (97G143, 97G231); Whitman—Pullman, 16 & 30-VII-96, 7-VIII-96 (96T302, 96T360, 96T361†, 96T417); Yakima [*]—Grandview, 22-VII-95, 17-V-96, 3-VI-96, 8 & 30-VII-96, 29-VI-97 (95G367, 96G067, 96G131, 96G327, 96G430, 97G181); nr Bickleton, 29-VIII-95 (95G524); Glade Cr, 7-VII-97 (97G218); Bickleton Hwy & County Line Rd, 7-VII-97 (97G236); Wenas Cr & Maloy Rd, 11-VI-97 (97G065); Wenas Lk, 17-VI-97 (97G091); YIR, Signal Peak Guard Station, 19-IX-96 (96G578).

Illinoia corylina (Davidson): WA, Whitman—Pullman, 14-VIII-96 on *Aquilegia* sp. (96T442).

Lipaphis erysimi (Kaltenbach): WA, Benton—WSU-Prosser, 30-IX-96, on *Brassica napus* (96G621†); Whitman—Pullman, 3-VII-96 on *Capsella bursa-pastoris* (96T166†).

Macrosiphum euphorbiae (Thomas): ID, Latah—Moscow, 7-X-96, on *Solanum* sp. (96T577); WA, Pierce [on *Epilobium angustifolium**].

Macrosiphum nr *euphorbiae*: WA, Yakima—YIR, Mill Cr Guard Station, 6-VI-95 on *Lomatium nudicaule* (95G115).

Macrosiphum sp.: WA, Asotin [on *Triticum aestivum**].

Myzus persicae (Sulzer): WA, Benton [on *Raphanus sativum**]—23-VII-96 on *Chrysanthemum* sp. (96G388†); WSU-Prosser, 29-VII-96 on *Carthamus tinctorius* (96G428); 31-VIII-95, 1-X-97 on *Chenopodium album* (97G476); 27-X-95 on *Malva neglecta* (95K212†); 1-IX-95 on *Solanum tuberosum* (95G525, 95G526); 6-VII-95 on *Sonchus oleraceus* (95A026†); Prosser, 23-VII-96 on *Chrysanthemum* sp. (96G388); Skagit [on *Brassica oleracea**]; Snohomish—Monroe, 24-VII-96 on *Pisum sativum* (96T594†); Whitman—Pullman, 16-VII-95, 3-VIII-95 on *Raphanus sativum* (95T248, 95T407), 22-VII-95 on *Solanum lycopersicon* (95T299†), & 3-VIII-95 on *Spinacia oleracea* (95T408); Ridpath, 6 & 22-VII-95 on *Amsinckia retrorsa* (95G295†).

Myzus sp.: WA, Whitman [on *Forsythia* sp.*].

Phorodon humuli (Schrank) [on *Humulus lupulus* unless otherwise indicated]: WA, Benton [*]—WSU-Prosser, 9-IX-95 (95K154), & 27-X-95 on *Lamium amplexicaule* (95K213†); Yakima—Grandview, 8-VI-95 (95G145).

Rhopalosiphum insertum (Walker): WA, Douglas—Orondo, 28-V-96 on *Pyrus malus* (96R003).

Rhopalosiphum maidis (Fitch): WA, Benton [on *Panicum milliaceum**]—WSU-Prosser, 18-XI-95 & 20-I-96 on *Capsella bursa-pastoris* (95G750†, 96G003†), & 2-IX-96 on *Hordeum vulgare* (96G655).

Rhopalosiphum padi (L.) [on *Triticum aestivum* unless otherwise indicated]: WA, Benton [on *Hordeum vulgare* & *Triticum aestivum**]—Prosser, 20-VIII-96 on *Zea mays* (96G510); WSU-Prosser, 1-X-95, 24-VI-96 (95G668, 96G272); Cemetery Rd & Hwy 241, 12-X-95 (95G690); Douglas—Waterville, 12-VIII-95 (95B016, 95B018); Yakima [*]—Grandview, 22-X-97 (97G490).

Sitobion avenae (F.) [on *Triticum aestivum* unless otherwise indicated]: WA, Benton [*]—Sellards & Travis Rds, 25-VI-95 (95G253); Prosser, 30-VI-95, 17-VII-95, 24-VI-96, 1 & 8-VII-96, (95G285, 95G352, 95G354, 95G356, 95G358, 96G271, 96G312, 96G330); WSU-Prosser, 22,30-VI-97, 3,11,18,25-VII-97 (assorted collections between 97F183 & 97F277), & 18-VII-97 on *Setaria lutescens* (97G243); nr Whitstran, 17-VII-95, 8-VII-96 (95G355, 96G328); Franklin—Star School, 6-VII-95 (95G289); Kahlotus, 6-VII-95 (95G290); KLICKITAT [*]—Bickleton, 9-VII-95 (95G318); WHITMAN [*]—Rosalia, 16-VII-96 (96T294); YAKIMA—Grandview, 5-VII-95 (95G286).

Uroleucon ivae (Robinson): WA, YAKIMA—Grandview, 9-VII-95, on *Iva xanthifolia* (95G313).

Uroleucon sp. YAKIMA—Grandview, 18-I-96, on *Brassica oleracea* (96G001).

Genus *EPHEDRUS* Haliday

Ephedrus californicus Baker

Acyrthosiphon lactucae (Passerini) [on *Lactuca serriola*]: WA, Asotin [*]; CHELAN—Chelan SP, 11-IX-97 (97K038); YAKIMA—YIR, Signal Peak Guard Station, 19-IX-95 (95G621).

Aphis fabae Scopoli: WA, ASOTIN—Field Springs SP, 18-VII-95 on *Cirsium arvense* (95T272).

Aphis helianthi Monell: MT, SANDERS—nr Thompson Pass, 29-VII-95 on *Ligusticum verticillatum* (95G460); WA, CHELAN—Stevens Pass, 16-IX-95 on *Epilobium angustifolium* (95K134†); GARFIELD—Stentz Springs, 22-VIII-95 (95T452); KITTITAS—Lost Lk, 24-VII-95 on *Epilobium angustifolium* (95G399†), & 11-IX-95 on *Heracleum lanatum* (95G572); 2-IX-95 on *Lomatium* sp. (95G535†); LEWIS—RNP, Bench Lk, 8-IX-95 on *Ligusticum* sp. (95K113); PIERCE—RNP, Tipsoo Lk, 11-IX-96 on *Osmorhiza* sp. (96G535†); YAKIMA—RNP, Dewey Lk Trail, 11-IX-96 on *Ligusticum* sp. (96G552†); YIR, 25-V-96 on *Lomatium dissectum* (96K052), Mt Adams Lk, 25-VII-95 on *Osmorhiza occidentalis* (95G428), & Windy Point, 19-IX-95 on *Xerophyllum tenax* (95G635).

Aphis holodisci Robinson [on *Holodiscus discolor* unless otherwise indicated]: WA, SPOKANE—Mt Spokane SP, 27-VII-95 (95T338); Manito Pk, 11-VII-96 (96T260); YAKIMA—Clear Lk, 15-VI-96 (96K082); Bird Cr Meadows Rd & FR822, 26-VI-95 on *Physocarpus malvaceus* (95A020, 95A021).

Aphis nr *oenotherae* Oestlund: WA, GARFIELD—Pataha Cr Rd, 7-IX-95 on *Epilobium* sp. (95T541).

Aphis varians Patch [on *Epilobium angustifolium*]: ID, SHOSHONE—Thompson Pass, 29-VII-95 (95G468†); WA, CHELAN—Stevens Pass, 16-IX-95 (95K134†); KITTITAS—Lost Lk, 24-VII-95 (95G399†); PIERCE—Naches Pass, 25-IX-97 (97G460); RNP, Bench Lk, 8-IX-95 (95K114).

Aphis nr *varians* Patch: WA, KITTITAS—Lost Lk, 24-VII-95 on *Epilobium angustifolium* (95G399†).

Aphthargelia symphoricarpi (Thomas) [on *Symphoricarpos sp.*]: WA, KITTITAS [*]; SPOKANE—nr Peone, Cooper Rd & Hwy 206, 29-VI-95 (95T178); YAKIMA—nr Rimrock Lk, 9-VI-95 (95A004).

Brachycaudus helichrysi (Kaltenbach): WA, ASOTIN—nr FR 40 & FR44, 1-VIII-95 on *Achillea millefolium* (95T382†‡).

Braggia eriogoni (Cowen): WA, KITTITAS—Taneum Lk, 11-IX-97 on *Epilobium umbellatum* (97G428).

Brevicoryne brassicae (L.): WA, FRANKLIN—Eureka, 14-V-96 on *Brassica napus* (96G040).

Capitophorus elaeagni (del Guercio): WA, YAKIMA—FR 1010, 8 mi S of Tieton River, 14-IX-95 on *Cirsium vulgare* (95G596).

Cavariella aegopodii (Scopoli) [on *Ligusticum grayi*]: WA, PIERCE—RNP, Tipsoo Lk, 5-IX-97 (97G363†); YAKIMA, YIR, Windy Point, 19-IX-95 (95G642†‡).

Cavariella pastinacae (L.): WA, ASOTIN—Asotin Cr Rd, 11-VII-95 on *Oenothera* sp. (95T196).

Chaetosiphon fragaefolii (Cockerell) [*Rosa* sp.]: ID, BOUNDARY [†*]; WA, PEND OREILLE—Le Clerc WLA, 3-VIII-95 (95T398).

Diuraphis noxia (Kurdjumov): WA, ASOTIN—Anatone, 8-VIII-96 on *Hordeum vulgare* (96T598); Asotin Cr WLA, 3-X-96 on *Triticum aestivum* (96T565).

Ericaphis wakibae (Hottes): WA, YAKIMA—Clear Lk, 15-VI-96 on native *Rosa* sp. (96K085†‡).

Hyperomyzus lactucae (L.): WA, KLICKITAT—Rock Cr & Columbia River, 28-IV-95 on *Sonchus oleraceus* (95G011†).

Hyperomyzus nigricornis (Knowlton) [on *Hieracium* sp. unless otherwise indicated]: ID, LATAH—Moscow Mtn 13-VII-96 on unknown plant (96T264); 3,15-VIII-96, on Compositae (96T399, 96T446); MT, SANDERS—nr Thompson Pass, 29-VII-95 (95G462†); WA, GARFIELD—Alder Thicket, 21-IX-95 (95T587); KITTITAS—Manastash Rd, 25-VII-96, 16-VII-96 (96G415, 96G490); Manastash Cr & FR125, 16-VIII-96 (96G493); Ellensburg, 23-VI-96 on *Ribes* sp. (96G267); Lost Lk, 6-VIII-97 (97G344); Klickitat—Cleveland, 16-VI-96 on *Madia minima* (96K109); 7-VII-97 (97G229); PIERCE—RNP, Tipsoo Lk, 11-IX-96 (96G541), & 5-IX-97 on *Agoseris aurantica* (97G384†); SPOKANE—Mt Spokane SP, 24-VIII-95 on *Compositae* (95T486); Mt Spokane Hwy, mi marker 18.5, 22-VIII-96, on Compositae (96T487, 96T488); WHITMAN—Kamiak Butte, 7-VII-96, on unknown plant (96T205); Pullman, 10-VIII-95 on *Lapsana communis* (95T436†); YAKIMA—Ravens Roost, 28-VII-97 on *Hieracium albertinum* (97G296); Wenas Lk, 30-V-96 on *Ribes aureum* (96G123); YIR, Signal Peak, 19-IX-95 (95G622) & Fish Lk (95G637) on *Agoseris aurantica,* Delaney Springs, 25-VII-95 on *Hieracium cynoglossoides* (95G406), & Goat Butt, 19-IX-96 (96G585);

Hyperomyzus sp.: WA, KITTITAS—S. Fork Manastash Cr, 24-VII-95 on *Hieracium albiflorum* (95G388).

Illinoia sp.: WA, GARFIELD—FR 160 & FR 40, 21-IX-95 on *Vaccinium* sp. (95T596).

Macrosiphoniella ludovicianae (Oestlund) [on *Artemisia ludoviciana*]: WA, YAKIMA [*]; YIR, Randell Springs, 16-V-96 (96G049†).

Macrosiphoniella tanacetaria (Kaltenbach): WA, CHELAN—Stevens Pass, 16-IX-95 on *Tanacetum vulgare* (95K133).

Macrosiphum albifrons Essig [on *Lupinus* sp.]: WA, KITTITAS—Buck Meadows, 9-VII-96 (96G338); KLICKITAT—Trout Lk, 11-VII-95 (95K068); LEWIS—RNP, Stevens Canyon, 23-VII-96 (96G364); PIERCE—RNP, Tipsoo Lk, 11-IX-96 (96G547) & 5-IX-97 (97G362); SPOKANE—Manito Pk, 11-VI-96 (96T033); nr Peone, 2-VII-96 (96T098); YAKIMA—American River, 5-IX-97 (97G376).

Macrosiphum californicum (Clarke): WA, KITTITAS—Murray WLA, S Fork Manastash River, 11-IX-95 on *Salix* sp. (95G391†).

Macrosiphum creelii Davis: WA, KITTITAS—Manastash Cr Rd, mi marker 8, 16-VIII-96 on *Vicia* sp. (96G492).

Macrosiphum euphorbiae (Thomas): ID, LATAH—Moscow Mtn, 6-VII-96 on unknown plant (96T181); 6-VII-96 on Compositae (96T185, 96T192); MT, SANDERS—nr Thompson Pass, 29-VII-95 on *Hieracium* sp. (95G462†); WA, ASOTIN—De Spain Springs, 11-VII-96 on unknown plant (96T252); nr FR 40 & FR44, 1-VIII-95 on *Achillea millefolium* (95T382†); BENTON – WSU-Prosser, 27-X-95 on cultivated *Rosa* sp. (95K220†); GARFIELD—Stentz Springs, 1-VIII-95 on *Arnica latifolia* (95T370); KING – Issaquah, 4-VI-96 on native *Rosa* sp. (96G145†); KITTITAS [on *Rosa* sp.*]—Buck Meadows, 9-VII-96 on native *Rosa* sp. (96G335) & 16-VIII-96 on *Silene* sp. (96G497); Lost Lk Trail, 6-VIII-97 on *Luina nardosmia* (97G327); Stampede Pass, 8-VIII-96 on *Castilleja* sp. (96K140†); KLICKITAT—Cleveland, 7-VII-97 on *Lupinus* sp. (97G230); LEWIS—RNP, Stevens Canyon, 23-VII-96 on *Crepis* sp. (96G357); PEND OREILLE—Cusick, 9-VII-96 on native *Rosa* sp. (96T223); SKAMANIA—Twin Falls CG, 4-VIII-95 on *Potentilla* sp. (95K098†); WHITMAN—Kamiak Butte, 7-VII-96 on Compositae (96T200); Pullman, 10-VIII-95 on *Lapsana communis* (95T436†) & 18-VI-96 on cultivated *Rosa* sp.(96T037); YAKIMA [on *Ligusticum grayi*†*]—Clear Lk, 15-VI-96 on native *Rosa* sp. (96K085†); N. Fork Tieton River, 15-VI-96, on *Hieracium albertinum* (96K094); Buckhorn Meadows, 14-IX-95 on *Trautvetteria caroliniensis* (95G597); YIR, Bird Cr Meadows, 26-VI-95, on *Osmorhiza chilensis* (95A014).

Macrosiphum nr *euphorbiae* (Thomas): WA, YAKIMA—N. Fork Wenas Cr, 30-V-96 on *Arabis* sp. (96G129).

Macrosiphum gaurae (Williams): WA, WHITMAN—Colton, 19-IX-95 on *Gaura parviflora* (95T585).

Macrosiphum pallidum (Oestlund): WA, SKAMANIA—Twin Falls CG, 4-VIII-95 on *Potentilla* sp. (95K098†‡).

Macrosiphum rosae (L.) [on *Rosa* sp. unless otherwise indicated]: OR, BENTON—Corvallis, 18-V-93 on unknown plant, A. Jensen collector (93J002); WA, BENTON—WSU-Prosser, 27-X-95 (95K220†); KING—Issaquah, 4-VI-96 (96G145†); SPOKANE—Manito Pk, 19-IX-96 (96T540); YAKIMA [*]—Grandview, 13 & 21-V-97 (97G021†, 97G037).

Macrosiphum valerianae (Clarke): WA, KITTITAS—Lost Lk, 24-VII-95 on *Epilobium angustifolium* (95G399†‡).

Metopolophium dirhodum (Walker): WA, BENTON—WSU-Prosser, 27-X-95 on *Conyza canadensis* (95K216†‡).

Myzus cerasi (F.): WA, BENTON—Prosser, 28-V-96 on *Prunus* sp. (96G091); WHITMAN—Pullman, 5-VII-96 on *P. avium* (96T173).

Myzus persicae (Sulzer): WA, YAKIMA—Cliffdell, 23-X-97 on *Linaria dalmatica* (97G496).

Nasonovia ribisnigri (Mosley): WA, WHITMAN—Pullman, 5-VII-96 on unknown plant (96T177).

Nasonovia (*Kakimia*) sp.: WA, WHITMAN—Pullman, 10-VIII-95 on *Lapsana communis* (95T436†).

Obtusicauda artemisiphila (Knowlton & Allen): WA, KLICKITAT [on *Artemisia tridentata**].

Obtusicauda coweni (Hunter): WA, YAKIMA [on *Artemisia tridentata**].

Obtusicauda sp.: WA, KLICKITAT [on *Artemisia tridentata**].

Pleotrichophorus nr *amsinckii* Richards: WA, GARFIELD—Alder Thicket CG, 14-IX-95 on *Amsinckia* sp. (95T562).

Pleotrichophorus pseudoglandulosus (Palmer): WA, YAKIMA—YIR, Randell Springs, 16-V-96 on *Artemisia ludoviciana* (96G049†‡).

Rhopalosiphum insertum (Walker): WA, KITTITAS—Ellensburg, 17-V-96 on *Crataegus columbiana* (96G066).

Rhopalosiphum maidis (Fitch): WA, BENTON—WSU-Prosser, 18-XI-95 on *Capsella bursa-pastoris* (95G750†‡).

Rhopalosiphum padi (L.): WA, BENTON—WSU-Prosser, 18-XI-95 on *Capsella bursa-pastoris* (95G750†‡).

Sitobion avenae (F.): WA, KING—Stampede Pass on *Dactylis glomerata* (96G442); KITTITAS—Manastash Rd & FR 112, 9-VII-96 on *D. glomerata* (96G346); PIERCE—Graham, 25-V-96, on Gramineae (96T001); RNP, Tipsoo Lk, 5-IX-97 on *Agoseris aurantica* (97G384†);YAKIMA—Blowout Mtn, 9-IX-97 on *D. glomerata* (97G401).

Uroleucon nr *arnesense* Robinson: MT, Sanders—18 mi E of Thompson Pass, 29-VII-95 on *Solidago* sp. (95G457).

Uroleucon erigeronense (Thomas): WA, Benton—WSU-Prosser, 27-X-95 on *Conyza canadensis* (95K216†); Chelan—Leavenworth, 16-IX-95 on *Conyza canadensis* (95K141); Kittitas—Lost Lk, 2-IX-95, on *Anaphalis margaritacea* (95G532) & 6-VIII-97 on *Aster* sp. (97G346); Manastash Rd & FR 112, 11-IX-95 on *Achillea millefolium* (95G563), on *Anaphalis margaritacea* (95G561†) & *Cirsium arvense* (95G564†); Pierce—RNP, Tipsoo Lk, 5-IX-95 (95K106) & 8-IX-97 (97G364†) on *Aster* sp.; Whitman—Pullman, 10-IX-96 on unknown plant (96T530); Yakima—Hells Crossing CG, 11-IX-96 on *Aster* sp. (96G524†); YIR, White Deer Cr, 11-VII-95 on *Anaphalis margaritacea* (95G326), & Signal Peak, 19-IX-95 on *Achillea millefolium* (95G620†).

Uroleucon nr *erigeronense* (Thomas): WA, Okanogan—Bridgeport SP, 9-IX-97 on *Conyza canadensis* (97K023).

Uroleucon ivae Robinson: WA, Yakima—Grandview, on *Iva xanthifolia* (96G431).

Uroleucon katonkae (Hottes): WA, Yakima—Hells Crossing CG, 11-IX-96 on *Aster* sp. (96G524†).

Uroleucon russellae (HRL) [on *Anaphalis margeritacea*]: MT, Sanders [*]; WA, Chelan—Chatter Cr, 1-VIII-95 (95G484); Kittitas—Manastash Rd & FR112, 11-IX-95, on *Anaphalis margaritacea* (95G561†); Skamania—June Lk, 4-VIII-95 (95K101); Spokane—Mt Spokane SP, 24-VIII-95 (95T494).

Uroleucon sonchi (L.) [on *Sonchus oleraceus* unless otherwise indicated]: WA, Clark—WSU-Vancouver, 21-IX-95 (95K172); Klickitat—Rock Cr & Columbia River, 28-IV-95 (95G011†); Pierce—Graham, 8-IX-96, on *Lactuca* sp. (96T527); Whitman—Pullman, 9-IX-96 on *Lactuca* sp. (96T529); Yakima—Yakima Arboretum, 26-IX-95 (95G658†); YIR, Satus, 1-VI-96, on *Sonchus* sp. (96K064).

Uroleucon spp.: ID, Benewah—McCroskey SP, 31-VIII-95 on *Adenocaulon bicolor* (95T518, 95T527, 95T536); WA, Asotin [on *Dipsacus sylvestris**]; Chelan—Chiwawa Canyon, 3-VIII-96 on *A. bicolor* (96R044); Kittitas—Lost Lk, 6-VIII-97 on *Achillea millefolium* (97G318); S. Fork Manastash Cr, 24-VII-95 on *Hieracium* sp. (95G389); Klickitat—nr Bickleton, Box Springs, 27-VI-97 on *Balsamorhiza sagittata* (97G154); Pend Oreille—Sullivan Lk, 3-VIII-95 (95T391); Tiger Meadows, 9-VII-96 on *Senecio* sp. (96T220); Pierce—RNP, Tipsoo Lk, 5-IX-97 on *Anaphalis margaritacea* (97G367); Spokane—Mt Spokane SP, 24-VIII-95 on *Centaurea pratensis* (95T477); Whitman [on *Lactuca serriola**]; Yakima [on *Aster* sp.*]—Union Gap, 23-X-95 on *Centaurea maculosa* (95G720); YIR, Signal Peak, 19-IX-95 on *Grindelia* sp. (95G618).

Wahlgreniella nervata (Gillette): WA, Yakima—Grandview, 13-V-97 on cultivated *Rosa* sp. (97G021†‡).

Undetermined spp.: Wa, Spokane—Mt Spokane SP, 24-VIII-95 on *Epilobium* sp. (95T490); Whitman—Pullman, 25-VII-95 on *Lapsana communis* (95T332); Yakima—YIR, Mabton Rd, 16-V-96 on *Crepis atrabarba* (96G050).

Ephedrus chaitophori Gärdenfors

Chaitophorus populifolii (Essig) [on *Populus trichocarpa*]: WA, Kittitas—Manastash Cr Rd, 5 mi marker, 16-VIII-96 (96G485); Yakima—Wenas Lk, 11-VI-97 (97G062).

Ephedrus clavicornis Pike & Starý

Aphis helianthi Monell: WA, Pend Oreille [on unknown Umbelliferae†*]; Whitman [on *Helianthus annuus**].

Aphis nr *oenotherae*: WA, Garfield, Kittitas, & Lewis [on *E. angustifolium**]; Yakima [on *E.* spp. & *E. minutum**]—Wenas Cr, 13VIII–96 (96G467) on *Epilobium* sp.

Aphis varians Patch [on *Epilobium angustifolium*]: MT, Sanders, W. Fork Thompson River, 26-VII-94 (94R029); WA, Lewis [*] & Yakima [*].

Aphthargelia symphoricarpi (Thomas): WA, Yakima [on *Symphoricarpos* sp.*].

Dysaphis plantaginea (Passerini): WA, Douglas [on *Pyrus malus**].

Illinoia maxima (Mason): WA, Spokane [on *Rubus parviflorus**].

Prociphilus sp.: WA, Yakima [on *Amelanchier alnifolia**].

Sitobion avenae (F.): WA, Lewis [on *Agropyron caninum**].

Undetermined spp. [on *Epilobium* sp. unless otherwise indicated]: CANADA, British Columbia [from sweepings*]; WA, Garfield [*], Kittitas [*], & Yakima [*].

Ephedrus incompletus (Provancher)

Ovatus crataegarius (Walker): ID, Bonner—Sandpoint, 10-IV-97 on *Origanum* sp. (97T003).

Ephedrus lacertosus (Haliday)

Aspidophorodon nr *longicauda* (Richards): WA, Skamania—nr Keenes Horse Camp, 11-VII-95 on *Lupinus* sp. (95K065†‡).

Ericaphis gentneri (Mason): WA, Chelan—Stevens Pass, 16-IX-95 on *Spiraea densiflora* (95K138).

Macrosiphum albifrons Essig: WA, Skamania—nr Keenes Horse Camp, 11-VII-95 on *Lupinus* sp. (95K066).

Macrosiphum euphorbiae (Thomas): WA, Yakima—YIR, Old Maid Canyon, 25-VII-95 on *Cynoglossum grande* (95G440).

Macrosiphum sp.: WA, Chelan—Chatter Cr, 1-VIII-95 on *Oplopanax horridum* (95G488†).

Macrosiphini aphids [immatures]: WA, Yakima—Morse Cr, 24-VII-97 on *Achlys triphylla* (97G255).

Metopolophium sp.: WA, Skamania—nr Keenes Horse Camp, 11-VII-95 on *Lupinus* sp. (95K065†‡).

Sitobion sp.: OR, Benton—Mary's Peak, 14-IX-93 on *Dicentra formosa,* A. Jensen collector (93J006).

Ephedrus persicae Froggatt

Brachycaudus cardui (L.): WA, Skagit—La Conner, 5-VI-96 on *Cirsium vulgare* (96G189).

Brachycaudus helichrysi (Kaltenbach): WA, Skagit—La Conner, 5-VI-96 on *Prunus salicina* (96G196).

Undetermined sp.: WA, Whitman—Pullman, 3-VIII-96 on *Pyrus malus* (96T042).

***Ephedrus* spp.**

Aphis coweni Palmer: WA, Kittitas [on *Veratrum viride**].

Aphis varians Patch: MT, Sanders, Thompson Pass, 27-VII-94 on *Epilobium angustifolium* (94R040).

Chaetosiphon fragaefolii (Cockerell): WA, Stevens—Little Pend Oreille National WLA, 9-VII-96 on native *Rosa* sp. (96T209†‡).

Diuraphis noxia (Kurdjumov): WA, Benton—WSU-Prosser, 15-V-97 on *Triticum aestivum* (97F045).

Ericaphis scammelli (Mason): WA, Stevens—Little Pend Oreille National WLA, 9-VII-96 on native *Rosa* sp. (96T209†‡).

Hyperomyzus nigricornis (Knowlton): ID, Latah—Moscow Mtn, 3-VIII-96 on Compositae (96T402).

Macrosiphum nr *euphorbiae* (Thomas): WA, Yakima—N. Fork Tieton River, 27-VI-96 on *Lilium columbianum* (96G299).

Macrosiphum rhamni (Clarke): ID, Shoshone—Murray, 17-VI-95 on *Rhamnus purshiana* (95G192).

Prociphilus sp.: WA, Whitman—Pullman, 13-VI-96 on unknown plant (96T029).

Undetermined sp.: WA, Garfield—Spruce Springs, 14-IX-95 on *Cirsium vulgare* (95T571).

Genus *EUAPHIDIUS* Mackauer

Euaphidius cingulatus (Ruthe)

Pterocomma beulahense (Cockerell): WA, King—Stampede Pass, 8-VIII-96 on *Populus trichocarpa* (96G445†); Whitman—Pullman, 9-X-96 on *Populus* sp. (96T584).

Pterocomma bicolor (Oestlund) [on *Salix* sp. unless otherwise indicated]: WA, King—Stampede Pass, 8-VIII-96 on *Populus trichocarpa* (96G445†); Klickitat—nr Bickleton, Pine Cr, 18-VI-97, on *P. trichocarpa* (97G113); Pierce [*]; Skamania—Council Lk, 4-VIII-95, (95K096); Whitman—Pullman, 12-IX-95 (95T558†); Yakima—Wenas Lk, 17-VI-97 (97G093).

Pterocomma sanguiceps Richards: WA, Kittitas—Ellensburg, 10-IV-95 on *Salix* (95G004†).

Pterocomma smithiae (Monell) [on *Salix* sp.]: WA, Kittitas—Ellensburg, 10-IV-95 (95G004†); Whitman—Pullman, 12-IX-95 (95T558†).

Pterocomma sp.: OR, Multnomah [on *Salix* sp.*]; WA, Yakima—YIR, Signal Peak, 19-IX-95 on *Salix* sp. (95G619).

Undetermined sp.: WA, Asotin—De Spain Springs, 26-VI-96 on *Salix* sp. (96T057).

Euaphidius setiger Mackauer

Periphyllus californiensis (Shinji): OR, Benton—Corvallis, McDonald State Forest, 1-V-93 on unknown plant, A. Jensen collector (93J001).

Periphyllus lyropictus (Kessler): WA, Benton [on *Acer platanoides* *]; Grant—Sun Lakes SP, 8-IX-97 on *A.* sp. (97K010); Yakima—Grandview, 13-VI-96 on *A.* sp. (96G243).

Periphyllus sp.: WA, Spokane—Spokane, Manito Pk, 19-IX-96 on *Acer* sp. (96T539).

Genus *HARKERIA* Cameron

Harkeria rufa Cameron

Nasonovia houghtonensis (Troop): OR, Benton—Corvallis, McDonald State Forest, 15-IV-94 on *Oemleria cerasiformis,* A. Jensen collector (94J002).

Genus *LYSAPHIDUS* Smith

Lysaphidus adelocarinus (Smith)

Aphis canae Williams: WA, Asotin—Asotin Cr Rd, 13-VI-95 on *Artemisia tridentata* (95T089).

Aphis (*Zyxaphis*) sp.: WA, Kittitas—Frost Meadows, Manastash Rd, 11-IX-97 on *Artemisia tridentata* (97G435).

Artemisaphis artemisicola (Williams): WA, Franklin—Kahlotus Hwy, 28-V-96 on *Artemisia tridentata* (96G096).

Epameibaphis atricornis G&P [on *Artemisaphis tridentata*]: WA, Benton [†*]—Ale, 19-V-95 (95G072†); Yakima [†*]—nr Mabton, 9-V-95 (95G031†); Selah Cr & Hwy 821, 15-V-95 (95G067†).

Flabellomicrosiphum knowltoni Smith [on *Artemisaphis tridentata*]: WA, Benton [†*]; Yakima—YIR, Ft. Simcoe, 30-V-96 (95G091†).

Flabellomicrosiphum tridentatae (Wilson): WA, Klickitat—Alderdale Cr & Columbia River, 28-IV-95 on *Artemisaphis tridentata* (95G013†‡).

Flabellomicrosiphum sp.: WA, Klickitat [on *Artemisaphis tridentata*†*].

Microsiphoniella artemisiae (Gillette): WA, Asotin—Asotin Cr HMU, 5-VII-96 on *Artemisia ludoviciana* (96T141).

Obtusicauda coweni (Hunter): WA, Asotin—Asotin Cr HMU, 7-V-96 on *Artemisia tridentata* (96T142†).

Obtusicauda sp. [on *Artemisia tridentata*]: WA, Klickitat [*] & Yakima [*].

Pleotrichophorus nr *amsinckii* Richards: WA, Benton [*]—ALE, 8-VI-95 on *Cryptantha* sp. (95G147†).

Pleotrichophorus palmerae (Knowlton): WA, Klickitat—nr Alderdale, 9-V-95 on *Chrysothamnus* sp. (95G026†).

Pleotrichophorus sp.: WA, Garfield—Alder Thicket, 21-IX-96 on *Amsinckia* sp. (95T592†); Kittitas [on *Artemisia tridentata*†*]; Klickitat—nr Alderdale, 9-V-95 on *Chrysothamnus nauseosus* (95G026†).

Pseudoepameibaphis essigi Knowlton & Smith: WA, Klickitat [on *Artemisia tridentata*†*].

Pseudoepameibaphis glauca G&P [on *Artemisia tridentata*]: WA, Kittitas [†*]—Taneum Rd, 11-IX-95 (95G586†); Yakima—YIR, Goat Butte, 9-X-96 (96K169).

Pseudoepameibaphis tridentatae (Wilson) [on *Artemisia tridentata*]: WA, Benton [*]—Ale, 19-V-95 (95G072†); Kittitas [*]; Klickitat [†*]—Alderdale Cr & Columbia River, 28-IV-95 (95G013†); Yakima [†*]—Naught Rd, 18-VI-97 (97G120); nr Mabton, 9-V-95 (95G031†); Selah Cr & Hwy 821, 15-V-95 (95G067†); YIR, Ft. Simcoe, 30-V-96 (95G091†).

Lysaphidus ramithyrus (Smith)

Pleotrichophorus nr *wasatchii* (Knowlton): WA, Kittitas—Yakima Canyon, 11-IX-95 on *Chrysothamnus* sp. (95G549†).

Pleotrichophorus elongatus (Knowlton): WA, Lincoln—Lake Roosevelt, Goldsmith CG, 31-VII-97 on *Chrysothamnus* sp. (97G306).

Lysaphidus rosaphidis (Smith)

Aphis (*Zyxaphis*) sp.: WA, Kittitas—Taneum Rd, 11-IX-95 on *Artemisia tridentata* (95G585†‡).

Chaetosiphon fragaefolii (Cockerell) [on cultivated *Fragaria* sp.]; WA, Clark—Vancouver, 30-VIII-95 (95K124); WSU-Vancouver, 21-IX-95 (95K166, 95K170).

Chaetosiphon nr *thomasi* HRL: WA, Clark—WSU-Vancouver, Greenhouse, 15-V-97 on *Fragaria* sp. (97X020).

Pleotrichophorus sp.: Kittitas—Taneum Rd, 11-IX-95 on *Artemisia tridentata* (95G585†‡).

***Lysaphidus* spp.**

Aphthargelia symphoricarpi (Thomas): WA, Spokane—Mt Spokane SP, 14-VI-95 on *Symphoricarpos* sp. (95T116).

Chaetosiphon fragaefolii (Cockerell): WA, Stevens—Little Pend Oreille National WLA, 9-VII-96 on native *Rosa* sp. (96T209†‡).

Ericaphis gentneri (Mason): WA, Chelan—Stevens Pass, 16-IX-95 on *Spiraea densiflora* (95K138).

Ericaphis scammelli (Mason): WA, Stevens—Little Pend Oreille National WLA, 9-VII-96 on native *Rosa* sp. (96T209†‡).

Macrosiphum euphorbiae (Thomas): WA, Garfield—FR40 nr Teal Springs, 1-VIII-95 on *Penstemon* sp. (95T379†).

Nasonovia (*Kakimia*) sp.: WA, Spokane—Mt Spokane, Scribner Rd, 29-VI-95 on *Phlox* sp.? (95T176).

Genus *LYSIPHLEBUS* Foerster

Lysiphlebus flavidus Gahan

Cedoaphis incognita Hottes & Frison: WA, Yakima [on *Symphoricarpos* sp.*].

Lysiphlebus testaceipes (Cresson)

Acyrthosiphon lactucae (Passerini) [on *Lactuca serriola*]: ID, Latah—Moscow Mtn, 15-VIII-96 (96T447);

WA, Asotin [*]; Benton—WSU-Prosser, 5-VIII-96 (96G434); Chelan—Chelan SP, 11-IX-97 (97K038); Kittitas [*]; Whitman—Pullman, 17-VIII-95 (95T446); Yakima—YIR, Signal Peak, 19-IX-95 (95G621).

Acyrthosiphon macrosiphum (Wilson): WA, Spokane—nr Peone, 13-VII-95 on *Ribes* sp.? (95T227).

Acyrthosiphon pisum (Harris): WA, Benton—WSU-Prosser, 26-IV-97 on *Medicago sativa* (97G014).

Anoecia corni (F.): WA, Yakima—Ahtanum Mission, 26-IX-95 on *Cornus stolonifera* (95G662†‡).

Aphis armoraciae Cowen: MT, Lincoln—Libby, 16-VI-95 on *Centaurea maculosa* (95G172); WA, Asotin—Anatone, 24-VII-96 on unknown plant (96T330); Kittitas [on *Mertensia paniculata* *]—Reecer Cr., 20-VI-95 on *Centaurea diffusa* (95G205†); Klickitat—Bickleton, 7-VII-97 on *Tragopogon dubius* (97G225); Walla Walla—Prescott, 30-X-97 on *Taraxacum officinale* (97G509); Yakima—nr Hause CG, 15-VI-96 on *Achillea millefolium* (96K104†); Wenas Lk, 11-VI-97 on *A. millefolium* (97G053).

Aphis nr *armoraciae* Cowen: WA, Yakima—nr Parker, 28-IX-95 on *Centaurea* sp. (95G664).

Aphis canae Williams: WA, Asotin—Asotin Cr Rd, 30-V-95 on *Artemisia tridentata* (95T045†‡).

Aphis ceanothi Clarke [on *Ceanothus velutinus* unless otherwise indicated]: MT Sanders—13 mi E of Thompson Pass, 29-VII-95 (95G459); WA, Kittitas—Manastash Cr Rd, mi marker 7, 16-VIII-96 on *C.* sp. (96G487); Manastash Cr, 25-VI-9 (97G137); Quilomene WLA, 2-VII-97 (97G213); Lost Lk, 6-VIII-97 (97G332); Klickitat—Trout Lk, 29-VI-97 on *C. sanguineus* (97G161); Yakima—YIR, nr. Mt. Adams Lk., 25-VII-95, 4-VIII-95 on *C. sanguineus* (95G409, 95K078†), Miller Point, 19-IX-95 (95G627†) on]), Howard Lk Rd 19-IX-95 (95G641).

Aphis nr *ceanothi* Clarke: WA, Yakima—YIR, Signal Peak, 23-VI-95 on *Ceanothus* sp. (95G231†), & nr. Mt. Adams Lk., 19-IX-95 on *C. velutinus* (95G607).

Aphis nr *chrysothamni* Wilson: WA, Asotin—Asotin Cr Rd, 13-VI-95 on *Chrysothamnus* sp. (95T088).

Aphis coweni Palmer [on *Veratrum viride* unless otherwise indicated]: WA, Asotin—De Spain Springs, 5-VII-96 (96T155); Chelan—Chatter Cr, 1-VIII-85 on *Pyrola asarifolia* (95G485†); Kittitas—Wells Meadow, 25-VII-96 (96G413).

Aphis craccivora Koch: WA, Benton—WSU-Prosser, 3-X-95 & 8-XI-95 on *Asparagus officinalis* (95G672, 95G747); Crow Butte, 24-VI-96, on *Astragalus* sp. (96G013); Kittitas—Indian John Hill, 11-X-96 on *Kochia scoparia* (96G639); Klickitat—Alderdale Rd & Hwy 14, 9-V-95 on *Astragalus* sp. (95G025); Hwy 14, 4 mi W of Alderdale Rd, 14-V-96 on *Medicago sativa* (96G030); Whitman—Pullman, 25-VII-95 on *Capsella bursa-pastoris* (95T331); 2-VIII-96 on *Melilotus alba* (96T391); 3, 7,16 & 31-VII-96, 2,7,16,19 & 29-VIII-96, 9-X-96 on *Robinia pseudo-acacia* (96T133, 96T199, 96T301, 96T364, 96T393, 96T415, 96T462, 96T469, 96T511 & 96T580); Yakima—Grandview, 30-IX-96 & 3-VIII-96 on *Robinia pseudo-acacia* (95G666, 96G433); nr Union Gap, 23-X-95 on *Medicago sativa* (95G721†); YIR, Yakima Chief & Pioneer Rds, 16-V-96 on *Astragalus* sp.(96G059).

Aphis nr *epilobiaria* Theobald: WA, Okanogan—Bridgeport SP, 9-IX-97 on *Epilobium minutum* (97K017†).

Aphis fabae Scopoli [on *Cirsium arvense* unless otherwise indicated]: ID, Latah—Moscow Mtn, 15-VIII-96 (96T448); 13-VII-96 on *Holodiscus discolor* (96T267); Moscow Mtn, nr start of Paradise Cr, 21-IX-96 (96T542); WA, Asotin—Field Springs SP, 18-VII-95 (95T272); Wickiup CG, 29-VIII-95 (95T504); Anatone, 28-VI-96 (96T083); Garfield—Pataha Cr Rd, 5.6 mi S of Columbia Center, 7-IX-95 (95T544); Columbia Center, on *Philadelphus lewisii* (95T430); Grant—Sun Lakes SP, 8-IX-97 on *C.* sp. (97K008); Kittitas—Buck Meadows, 11-IX-95 (95G590), & on *C. vulgare* (95G580); Frost Meadows, 11-IX-95 (95G583†); Lost Lk, 11-IX-95 (95G556†, 95G564†, 95G571†) & on *C. vulgare* (95G577); 6-VIII-97, on *Senecio* sp. (97G335); Manastash Rd, 11-IX-95, 25-VII-96, & 16-VIII-96 (95G556†, 96G424, 96G478, [96G481 on *C. vulgare*]); Lost Lk Trailhead, 6-VIII-97 (97G320); Lewis—RNP, Bench Lk, 23-VII-96 on native *C.* sp. (96G375); Klickitat—nr Bickleton, Cemetery Rd 1 mi N of Hwy, 18-VI-97, 7-VII-97 (97G107, 97G227); Klickitat River Hwy 142, 28-VI-97 on *C. vulgare* (97G155); Okanogan—Winthrop, 10-IX-97 on *Arctium minus* (97K031); Spokane—Mt Spokane SP, 20 & 27-VII-95, 24-VIII-95, (95T293, 95T340, 95T349, 95T474); 13-VII-95, on Umbelliferae (95T241); 24-VIII-95 on *C. ochrocentrum* (95T476, 95T481); Whitman—Pullman, 1-VIII-95, & 7, 18-VII-96 (95T387, 96T198, 96T323); Yakima—Buckhorn Meadows, 14-IX-95 on *C. vulgare* (95G600); American River, 5-IX-97 (97G373) & on *Epilobium angustifolium* (97G377†); Blowout Mtn, end of Little River Rd, 9-IX-97 (97G390); YIR, Piscoe Cr 25-VII-95, on *Rumex crispus* (95G437); Signal Peak, 19-IX-96 on *C. vulgare* (96G563).

Aphis nr *fabae* Scopoli: ID, Latah—Moscow Mtn, 15-VIII-96 on *Rumex crispus* (96T450); WA, Pend Oreille—Sullivan Lk Rd & Harvey Cr, on *Chrysanthemum leucanthemum* (95T394); Pierce—RNP, Tipsoo Lk, 11-IX-96 on *Osmorhiza* sp. (96G531).

Aphis filifoliae (G&P): WA, Asotin—Asotin Cr Rd, 11-VII-95 on *Artemisia tridentata* (95T202).

Aphis nr *frangulae* Kaltenbach [on *Nepeta cataria*]: WA, Asotin—Couse Cr Rd, 10-VIII-95 (95T424); nr FR40 & FR44, 5 & 19-VII-96 (96T161, 96T242, 96T243); De Spain Spring, 11-VII-96 (96T242, 96T243).

Aphis gossypii Glover: WA, Asotin—Heller's Bar, 30V–95 on unknown plant (95T039).

Aphis hederae Kaltenbach: OR, Benton—Corvallis, 21-V-91 on unknown plant (91J001).

Aphis helianthi Monell: ID, Kootenai—Fernan Lk, on *Rumex* sp. (95K030); Shoshone—Marble Cr 9-VI-96 on *Philadelphus lewisii* (96T012); MT, Sanders—Thompson Pass, 17-VI-95 on *Heracleum lanatum* (95G179†); 13 mi E of Thompson Pass, 29-VII-95 on *Ligusticum verticillatum* (95G460); WA, Asotin—Asotin Cr HMU, 29-VIII-95 on *Helianthus annuus* (95T496); Bracken Point, 7-IX-95 on *H. annuus* (95T548); Anatone, 11-VII-95 on *Lomatium* sp. (95T217); De Spain Springs, 11-VII-96 on *Lomatium* sp. (96T245); Chelan—Chatter Cr, 1-VIII-95 on *Oplopanax horridum* (95G488†); Stevens Pass, 16-IX-95 (95K134†); Garfield—Stentz Springs, 22-VIII-96 on *Osmorhiza chilensis* (95T452); Kittitas [on *Heracleum lanatum**]—S Fork Manastash Cr, 24-VII-95 on *Angelica* sp. (95G392); Buck Meadows, 24-VII-95 on native *Cirsium* sp. (95G396); Manastash Rd, 24-VII-95 & 11-IX-95 on *Heracleum lanatum* (95G378, 95G560†); 24-VII-95 on *Penstemon* sp. (95G379); Lost Lk, 11-IX-95 on *Heracleum lanatum* (95G572), 2-IX-95 on *Epilobium angustifolium* (95G530†), & 6-VIII-97 on *Angelica arguta* (97G333†); Manastash Cr, mi marker 5, 16-VIII-96 on *Heracleum lanatum* (96G483); Reecer Cr, 20-VI-95 on *Ligusticum* sp. (95G201) & 20-VI-95 on *Lomatium nudicaule* (95G209); Quartz Mtn, 25-VII-96 on *Penstemon procerus* (96G399) & *Ligusticum grayi* (96G398†); Colockum Ridge, 2-VII-97 on *Camassia quamash* (97G196); Colockum Ridge, 1 & 2-VII-97 on *Lomatium nudicaule* (97G189) & *Lomatium triternatum* (97G191†); Quilomene WLA, 2-VII-97, on *Lomatium* sp. (97G212); Lewis—RNP, Stevens Canyon, 23-VII-96 on native *Cirsium* sp. (96G355) & 8-IX-95 on *Ligusticum* sp. (95K113); Okanogan—Bridgeport SP, 9-IX-97 on *Helianthus annuus* (97K016); Pierce [on *Cirsium* sp. & *Heracleum lanatum**]—RNP, nr Paradise, 8-IX-95 on native *Cirsium* sp. (95K122) & *Xerophyllum tenax* (95K121); Tipsoo Lk, 5-IX-97 on *Ligusticum grayi* (97G363†); Skamania [on *Ligusticum apiifolium**]; Spokane—nr Peone, 13-VII-95 on *Cornus stolonifera* (95T236); Turnbull National WLA on *Cornus stolonifera* (95T009); Mt Spokane SP, 29-VI-95 on *Cornus stolonifera* (95T186); nr Mt Spokane, 29-VI-95 on *Heracleum lanatum* (95T171); nr Peone, 13-VII-95 on *Heracleum lanatum* (95T229); Whitman—nr Colton, Steptoe Canyon Rd, 19-IX-95 on *Helianthus annuus* (95T586); Pullman, I-VIII-95 on *Coriandrum sativum* (95T386†); Yakima [on *Cirsium* sp.*]—Mabton & Alderdale Rds, 23-V-96 on *Lomatium* sp. (96G071); Wenas Lk, 30-V-96 & 11-VI-97 on *Lomatium* sp. (96G118, 97G063†) & 17-VI-97 on unknown Umbelliferae (97G088); American River, 5-IX-97 on *Cirsium* sp. (97G379), 5-IX-97 on *Heracleum lanatum* (97G382); Blowout Mtn, end of Little Naches River Rd, 9-IX-97 on *Cirsium* sp. (97G399) & on *Xerophyllum tenax* (97G395, 97G398); Sawmill Flats CG, 28-VII-97 on *Cornus stolonifera* (97G286); YIR, Lower Mill Cr, 25-V-96 on *Lomatium dissectum* (96K052) & *Lomatium tritematum* (96K053); Piscoe Cr, 25-VII-95 on *Ligusticum grayi* (95G432); Potato Hill Guard Station, 25-VII-95 on *Xerophyllum tenax* (95G429);

Aphis nr *helianthi* Monell: ID, Benewah—McCroskey SP, 31-VIII-95 on *Lomatium* sp. (95T517†‡); WA, Kittitas—Manastash Cr Rd, mi marker 4, 16-VIII-96 on *Cornus stolonifera* (96G474); Yakima—Chinook Pass, 27-IX-96 on *Ligusticum* sp. (96G604).

Aphis hermistonii Wilson: WA, Grant—Sun Lakes SP, 8-IX-97 on *Chrysothamnus nauseosus* (97K009).

Aphis holodisci Robinson [on *Holodiscus discolor* unless otherwise indicated]: MT, Sanders—Bull River Valley, 16-VI-95 on *Physocarpus malvaceus* (95G176); WA, Asotin—De Spain Springs, 26-VI-96, 5-VII-96 (96T059, 96T150); Kittitas—Manastash Cr, mi marker 12, 25-VI-97 (97G133); Klickitat—Trout Lk, 11-VII-95 (95G340†); Spokane—Mt Spokane SP, 27-VII-95 (95T338); Spokane, Manito Pk, 11-VII-96 (96T260); Yakima [*]—Clear Lk, 15-VI-96 (96K079, 96K082); Bird Cr Meadows Rd, FR 82 & FR 822, 26-V95 on *Physocarpus malvaceus* (95A020, 95A021); YIR, White Deer Cr, 11-VII-95 (95G324) & Signal Peak (95G333), & nr Mill Cr Guard Station, 25-V-96 (96K047).

Aphis lugentis Williams: WA, Yakima [on *Senecio triangularis* & *Arnica* sp.*].

Aphis lupini G&P [on *Lupinus* sp.]: WA, Garfield—Pataha Cr, 7-IX-95 (95T546); Stevens—Little Pend Oreille Nat. WLA, 9-VII-96 (96T212).

Aphis neogillettei Palmer [on *Cornus stolonifera*]: WA, Klickitat [*]; Yakima—Sawmill Flats CG, 28-VII-97 (97G285).

Aphis nerii Boyer de Fonscolombe [on *Asclepias speciosa*]: WA, Benton [*]; Chelan—WSU-Wenatchee, 25-VIII-95 (95R025); Yakima [*]—Sunnyside, 24-VIII-95, 1-X-95, 23-X-95, 13-VIII-96, 29-IX-96, 4, 22-X-97 (95G517, 95G670, 95G704, 96G452, 96G618, 97G486, 97G489); Union Gap, 23-X-95 (95G725); Mabton, 30-VIII-96 (96G513).

Aphis nigratibialis Robinson [on *Cornus stolonifera*]: WA, Kittitas—Manastash Cr, mi marker 12, 6-VIII-97 (97G312); Klickitat—Trout Lk, 28-VI-97 (97G156); Spokane—Mt Spokane SP, 13-VII-95 (95T239); Yakima—Chinook Pass, 28-VII-97 (97G280).

Aphis oenotherae Oestlund: WA, Okanogan—Bridgeport SP, 9-IX-97 on *Epilobium minutum* (97K017†); Pierce—RNP, nr Chinook & Cayuse Passes, 16-VIII-95 on *Ribes viscosissimum* (95A039).

Aphis nr *oenotherae* Oestlund [on *Epilobium* sp. unless otherwise indicated]: WA, Benton—Kennewick, 28-

IX-96 (96G597); Garfield—Pataha Cr Rd, 7-IX-95 (95T541, 95T545); Spruce Springs, 22-VIII-95 on *Physostegia parviflora* (95T462†); Okanogan—Bridgeport SP, 9-IX-97 on *Oenothera strigosa* (97K020); Yakima—American River, 5-IX-97 on *Epilobium minutum* (97G375†); Fifes Peak Viewpoint, 27-IX-96 (96G603); Nile, 5-IX-97 (97G358); nr Rimrock, 14-IX-95 (95G594).

Aphis pomi de Geer: WA, Douglas—Bridgeport, 17-VI-96 on *Pyrus malus* (96X007†‡).

Aphis rumicis L. [on *Rumex crispus*]: WA, Benton [*]; Yakima—YIR, Satus, 1-VI-95 (96K065).

Aphis salicariae Koch [on *Epilobium angustifolium*]: ID, Kootenai—Rathdrum, 29-VII-95 (95G443†); WA, Asotin—Anatone, 24-VII-96 (96T336); Chelan—1-VIII-95 (95G481†); Kittitas—Lost Lk, 2-IX-95 (95G530†); Okanogan—Washington Pass, 10-IX-97 (97K033); Spokane—nr Cheney, 23-V-95 on *Cornus stolonifera* (95K007); Yakima—YIR, nr. Mt. Adams Lk., 19-IX-95 (95G610†).

Aphis nr *salicariae* Koch: WA, Chelan—Swauk Pass, 1-VIII-95 on *Epilobium angustifolium* (95G492†).

Aphis sambuci L: WA, Pierce, [on *Sambucus racemosa**].

Aphis spiraecola Patch: WA, Benton [on *Lactuca serriola**]; Chelan—WSU-Wenatchee, 7-VII-95 on *Pyrus malus* (95R018†); Kittitas—Lost Lk, 6-VIII-97 on *Angelica arguta* (97G333†); Yakima—Sunnyside, 3-VI-95, on cultivated *Spiraea* sp. (95G109); nr Sunnyside, 28-VI-95 (95G259†).

Aphis nr *triglochinis* Theobald: WA, Spokane—Mt Spokane SP, 29-VI-95 on native *Ribes* sp. (95T189).

Aphis nr *valerianae* Cowen: WA, Pierce—RNP, Mowich Lk, 25-IX-97 on *Valeriana sitchensis* (97G446).

Aphis varians Patch [on *Epilobium angustifolium* unless otherwise indicated]: MT, Sanders [*]: ID, Kootenai—Rathdrum, 29-VII-95 (95G443†); WA, Chelan—Stevens Pass, 16-IX-95 (95K134†); Pierce [*]—RNP, nr Paradise, 8-IX-95 (95K114, 95K117), Tipsoo Lk, 5-IX-97 (97G368), & Mowich Lk, 25-IX-97 (97G442); Naches Pass, 25-IX-97 (97G460); Spokane—Mt Spokane SP, 24-VIII-95 (95T483); Yakima [*]—Green Lk, 31-VIII-94 on *E. latifolium* (94R140); Blowout Mtn, end of Little Naches River Rd, 9-IX-97 (97G404); YIR, Hussen Meadows, 19-IX-95 (95G643) & Howard Lk,19-IX-95 on *Lupinus* sp. (95G639);

Aphis nr *varians* Patch [on *Epilobium angustifolium*]: WA, Chelan—Dryden, 1-VIII-95 (95G481†); Lewis—RNP, Bench Lk, 23-VII-96 (96G376); Stevens Cr, 23-VII-96 (96G380).

Aphis (*Zyxaphis*) sp.: WA, Asotin—Asotin Cr Rd, 22-VIII-95 on *Chrysothamnus* sp. (95T469).

Aphis sp. n.: WA, Yakima—YIR, Klickitat River nr Miller Point, 23-VI-95 & 11-VII-95 on *Ceanothus* sp. (95K061, 95G230) & 19-IX-95 & 19-IX-96 on *C. velutinus* (95G627†, 96G580).

Aphis sp.: ID, Benewah—McCroskey SP, 31-VIII-95 on *Cirsium vulgare* (95T531); Latah—Moscow, 15-IX-93 on *Solanum lycopersicon* (93T020); WA, Asotin—Anatone, 28-VI-96, on *Lamium* sp. (96T086); Schumaker Rd mi marker 1, 10-VIII-95 on *Cirsium arvense* (95T428); 28-VI-96, on *Holodiscus discolor* (96T085); De Spain Spring, 5-VII-96, on *Nepeta cataria* (96T161); 11,24-VII-96 on unknown Umbelliferae (96T254, 96T341); Chelan—Chelan SP, 11-IX-97, on *Salix* sp. (97K042†); Garfield—Alder Thicket (FR 40), 22-VIII-95 on native *Cirsium* sp. (95T448); Kittitas [on *Pedicularis bracteosa*† & *Senecio triangularis**]—Lost Lk, 6-VIII-97 on *Symphoricarpos* sp. (97G341†); Taneum Lk, 11-IX-97 on *Pedicularis racemosa* (97G411†); [Klickitat, on *Rheum rhabarbarum**]—Trout Lk, 29-VI-97 on *Amsinckia* sp. (97G172); Pend Oreille—Cusick, 9-VII-96 on *Ceanothus sanguineus* (96T225); Pierce—RNP, Tipsoo Lk, 5-IX-97 on *Valeriana sitchensis* (97G360); Spokane—Mt Spokane SP, 14-VI-95 on *Philadelphus lewisii* (95T117); 24-VIII-95 on *Salix* sp. (95T484), 29-VI-95 on unknown Umbelliferae (95T183); Hwy 206 mi marker 16.3, 8-VI-95 on unknown Umbelliferae (95T070); Whitman—Pullman, 1-VIII-95 on *Coriandrum sativum* (95T386); Yakima [on Umbelliferae*]—nr Chinook Pass, 11-IX-96 on *Cryptantha* sp. (96G519) & on *Epilobium angustifolium* (96G555); Little Naches River Rd, 28-VII-97 on *Cryptantha thompsonii* (97G291); Wenas Cr & Maloy Rd, 11-VI-97 on *Heracleum lanatum* (97G070); YIR, Delaney Springs, 25-VII-95 on *Holodiscus discolor* (95G404), Windy Point, 19-IX-95 on *Cimicifuga laciniata* (95G631), & Signal Peak Guard Station, 19-IX-95 on *Cornus stolonifera* (95G617).

Aphthargelia symphoricarpi (Thomas) [on *Symphoricarpos* sp. unless otherwise indicated]: WA, Kittitas [*]—Colockum Rd, mi marker 4, 1-VII-97 (97G183); Lost Lk, 6-VIII-97 (97G334); Klickitat [on *S. albus**]; Spokane—Mt Spokane SP, 14-VI-95, 13-VII-95 (95T116, 95T242); Turnbull Nat. WLA, 16-VII-96 on unknown plant (96T287); Fish Lk, 14-VI-97 on *S. occidentalis* (97K004); Yakima—Wenas Cr & Maloy Rd, 11-VI-97 (97G066); YIR, Signal Peak, 11-VII-95 (95K057).

Boernerina variabilis Richards: WA, Kittitas—Buck Meadows, 9-VII-96 on *Alnus* sp. (96G336).

Brachycaudus cardui (L.) [on *Cirsium vulgare* unless indicated otherwise]: ID, Latah—Moscow Mtn, 3 & 15-VIII-96 (96T401, 96T449); Nez Perce—Hwy 95 & Hwy 195, 22-VII-97 on *C. arvense* (97J004); WA, Asotin—Heller's Bar, 11-VII-95 on *C. arvense* (95T212); Anatone, 24-VII-96 (96T333) & on *Onopordum acanthium* (96T329); Asotin, 28-VI-96 on *O. acanthium* (96T066); Weisenfels Ridge Rd nr Snake River Rd) 28-VI-96 on *O. acanthium* (96T070); Benton [*]—Prosser, Rotha Rd, 24-VIII-95 (95G512); Garfield—Spruce Springs, 22-VIII-95 on *C. arvense* (95T457); Pataha Cr Rd, 7-IX-95 (95T542);

KLICKITAT—Bickleton, 18-VI-96 & 7-VII-97 on *C.* sp. (96K112) & *C. vulgare* (97G228); Brooks Memorial SP, 21-IX-95 on *C.* sp. (95K162†); SPOKANE—Mt Spokane SP 24-VIII-95 (95T475, 95T482, 95T488); Whitman—Pullman, 1,13-VIII-96, 3-IX-96 (96T369, 96T383, 96T439, 96T514); YAKIMA—nr Naches Pass, FR 789 & FR 1914, 9-IX-97 (97G410); YIR, nr. Mt. Adams Lk., 25-VII-95 (95G405), Signal Peak, 19-IX-95 (95G624), Satus, 1-VI-96 on native *C.* sp. (96K066), & Snow Cr, 19-IX-95 (95G608).

Brachycaudus helichrysi (Kaltenbach): WA, FRANKLIN—Ice Harbor Dam, 28-V-97 on *Amsinckia* sp. (96G097); KITTITAS [on *Rudbeckia hirta**]; WHITMAN—Pullman, 19-VII-96 on *Tragopogon dubius* (96T320); YAKIMA—YIR, nr. Mt. Adams Lk., 4-VIII-95 on native *Cirsium* sp. (95K077).

Brachycaudus tragopogonis (Kaltenbach) [on *Tragopogon dubius*]: ID, SHOSHONE—Kingston, 29-VII-95 (95G479); OR, UMATILLA—Milton-Freewater, 11-VI-96 (96G239); WA, BENTON—WSU-Prosser, 27-VI-96, 15-VII-96, 30-V-96, 14-V-97 (96A003, 96A014, 96G100, 97G028); Rotha Rd, 18-VI-96 (96G256); Badger Springs, 28-IX-96 (96G595); West Richland, 27-V-96 (96K056); CHELAN—Chelan SP, 11-IX-97 (97K040); KITTITAS—Ellensburg Pass, Wenas-Ellensburg Rd, 9-VI-96 (96G209); Indian John Hill, 11-X-96 (96G638); KLICKITAT [*]—Bickleton, 17,18-VI-96, 27-VIII-96, 8-X-96 (96G254, 96K113, 96G512, 96G628); Box Springs, 27-VI-97 (97G147); WHITMAN—Pullman, 1,2,7,12-VII-96, 2,9-VIII-96, 3-X-96 (96T126, 96T132, 96T197, 96T325, 96T387, 96T427, 96T574); YAKIMA—Grandview, 24-V-96, 2 & 26-VI-96, 13-X-96, 14-V-97 (96G080, 96G130, 96G273, 96G283, 96G646, 97G022); Halfway Flat CG, 27-IX-96 (96G616); Hause CG, 15-VI-96 (96K106); nr Bickleton, 18-VI-97 & 7-VII-97 (97G102, 97G222); Sunnyside, 1-VI-96 (96K058); Wenas Lk, 30-V-96 (96G124); YIR, Signal Peak, 19-IX-96 (96G560) & Goat Butte, 19-IX-96, 9-X-96 (96G583, 96G631).

Brachycorynella asparagi (Mordvilko) [on *Asparagus officinalis*]: WA, BENTON [*]—WSU-Prosser, 6,25-IX-95 (95K144, 95G649).

Braggia eriogoni (Cowen): MT, GALLATIN—Big Sky, Gallatin Rd, 26-VI-96 on *Eriogonum* sp. (96K119); WA, ASOTIN—De Spain Springs, 11,19-VII-96 on *E.* sp. (96T246, 96T317); Round Prairie Springs, 18-VII-96 on *E.* sp. (96T311); KING—Stampede Pass, 8-VIII-96 on *E. compositum* (96G446); KITTITAS—Colockum Ridge Rd, 2-VII-97 on *E. compositum* (97G190, 97G193); Taneum Lk Trail, 11-IX-97 on *E. umbellatum* (97G428); KLICKITAT [on *E. heracleoides**]–Bickleton (Pine Cr Rd), 3-V-95 on *E. heracleoides* (95G099); Cemetery Rd 1 mi from Hwy, 18-VI-97 on *E.* sp. (97G106); Cleveland, 18-VI-96 on *E. heracleoides* (96K111).

Braggia nr *eriogoni* (Cowen) [on *Eriogonum compositum* unless otherwise indicated]: OR, UMATILLA—Harris Pk, 11-VI-96 (96G234); WA, KITTITAS—Lost Lk, 6-VIII-97 (97G350); KLICKITAT—Roosevelt, 14-V-96 (96G035); Bickleton, 18-VI-97 (97G110); 18-VI-97, on *E.* sp. (97G109); YAKIMA—Little Naches River Rd, 28-VII-97, on *E. strictum* (97G290).

Braggia sp.: WA, KLICKITAT—nr Bickleton, Pine Cr Rd, 31-V-95 on *Eriogonum umbellatum* (95G100); Box Springs, 29-VI-97 on *E. compositum* (97G176); YAKIMA [on *E. compositum* & *E. elatum* (aphid det. by G. Remaudière)*]—Hause CG, 15-VI-96 on *E. elatum* (96K105); Wenas Lk, 11-VI-97 on *E.* sp. (97G060); YIR, Klickitat River, 7-VI-95 on *E. compositum* (95G126).

Braggia sp. n. [on *Eriogonum elatum* unless otherwise indicated]: WA, DOUGLAS—Orondo, 28-V-96 (96R002); KITTITAS—Lost Lk, 2-IX-95 on *E. compositum* (95G529); Reecer Cr, 20-VI-95 (95G213); YAKIMA—Bear Cr nr Rimrock Lk, 9-VI-95 (95A006); Naught Rd, 18-VI-97 (97G104) & 7-VII-97 on *E. compositum* (97G220); Naches, Hwy 410 & Hwy 12, 28-VII-97 (97G276); Naches River, Horseshoe Bend, 5-IX-97 (97G357); nr Rimrock Lk, 14-IX-95 on *E.* sp. (95G595); Wenas Lk, 30-V-96,11-VI-97 (96G114, 97G061); Windy Point CG, 3-VI-95, 1-VII-95, 26-VI-96 (95G105, 95K040, 96G305), & 16-VIII-95 on *E. compositum* (95A031); YIR, Fort Simcoe, 6-VI-95 (95G117), Mill Cr, 19-IX-95 (95G605), Signal Peak, 19-IX-95 (95G626), & 20 mi S of Satus Pass, 7-VI-95 on *E.* sp. (95G142).

Brevicoryne brassicae (L.): WA, BENTON—WSU-Prosser, 6-VII-95 on *Brassica napus* (95A024).

Capitophorus elaeagni (del Guercio): WA, YAKIMA—Buckhorn Meadows, 14-IX-95 on *Cirsium vulgare* (95G596); nr Naches Pass, FR 789 & FR 1914, 9-IX-97 on *Cirsium* sp. (97G408).

Cavariella aegopodii (Scopoli): WA, KITTITAS—nr Lost Lk, 6-VIII-97 on *Osmorhiza chilensis* (97G331) & 2-IX-95 on *Lomatium* sp. (95G535†); YAKIMA—nr Wenas Lk, 17-VI-97 on *Lomatium* sp. (97G095†).

Cavariella pastinacae (L.): MT, SANDERS—Thompson Pass, 17-VI-95 on *Heracleum lanatum* (95G179†‡); WA, ASOTIN—Asotin Cr Rd, 11-VII-95 on *Oenothera* sp. (95T196); YAKIMA—YIR, Klickitat Canyon, 23-VI-95 on *Heracleum lanatum* (95G235).

Ceruraphis viburnicola (Gillette): WA, YAKIMA—Yakima Arboretum, 26-IV-95 on *Viburnum* sp. (95G008).

Chaetosiphon fragaefolii (Cockerell): WA, PEND OREILLE—Le Clerc WLA, 3-VIII-95 on native *Rosa* sp. (95T398).

Chaitophorus populicola Thomas: WA, ASOTIN—Asotin Cr Rd, 23-V-95 on *Populus trichocarpa* (95T013).

Chaitophorus viminalis Monell: WA, Yakima—Naches, 27-IX-96 on *Salix* sp. (96G601).

Cinara chinookiana Hottes: WA, Yakima—Darland Mtn, 31-VIII-94 on *Abies lasiocarpa* (94R138).

Cinara sp.: WA, Asotin—FR44 8mi S of WLA, 18-VII-96 on *Pinus ponderosa* (96T308).

Diuraphis noxia (Kurdjumov) [on *Triticum aestivum*]: WA, Asotin—Anatone, 10-VIII-95 (95T427); Pataha Cr Rd, 5.6 mi S of Columbia Center, 10-VIII-95 (95T435); Benton [*]—WSU-Prosser, 1-IV-97, 24-VII-97 (97G005, 97G274); Klickitat—nr Cleveland, 7-VII-97 (97G232, 97G234); Bickleton, 29-VII-97 (97G300); Spokane—Mt Spokane SP, 22-VII-95 (95T495); Yakima [*]—Ridge Rd, 17-VI-96 (96G250, 96G251); Sunnyside, 24-VII-97 (97G273).

Dysaphis plantaginea (Passerini) [on *Pyrus malus* unless otherwise indicated]: WA, Benton—Prosser, 22-VI-97 (97G123); Chelan—WSU-Wenatchee, 7-VII-95 & 30-V-96 (95R018†, 96R009, 96R011†); Whitman—Pullman, 30-VI-96, on unknown plant (96T119); Yakima—Grandview 26,28-VI-96 (96G282, 96G308); nr Sunnyside, 28-VI-95 (95G259†).

Ericaphis nr *gentneri* (Mason): WA, Spokane—nr Peone, 13-VII-95 on *Crataegus* sp. (95T223).

Eriosoma americanum (Riley): WA, Chelan—Swakane WLA, 3-VI-96 on *Ulmus americanus* (96R018‡).

Eriosoma lanigerum (Hausmann): WA, Chelan—WSU-Wenatchee, 7-VII-95 on *Pyrus malus* (95R019‡).

Hyadaphis foeniculi (Passerini): ID, Benewah—McCroskey SP, 31-VIII-95 on *Lomatium* sp. (95T517†‡).

Hyperomyzus nigricornis (Knowlton): WA, Yakima—Wenas Lk, 30-V-96, on *Ribes aureum* (96G123); YIR, 19-IX-95 on *Agoseris* sp. (95G622).

Illinoia spiraeae (MacGillivray): WA, Garfield—Teal Springs, 1-VIII-95 on *Holodiscus discolor* (95T376).

Macrosiphum euphorbiae (Thomas): ID, Kootenai—Rathdrum, 29-VII-95 on *Epilobium angustifolium* (95G443†); Latah—Moscow, 29-VIII-96 on *Solanum* sp. (96T512†); WA, Asotin—De Spain Springs 5-VII-96 on Compositae (96T159); Benton—Prosser, 24-X-96 on *Medicago sativa* (96G651); Klickitat—Trout Lk, 11-VII-95 on *Holodiscus discolor* (95G340†); Pierce [on *Epilobium angustifolium**].

Macrosiphum gaurae (Williams): WA, Asotin—nr Weissenfels Ridge & Snake River Rds, 28-VI-96 on *Oenothera* sp. (96T073).

Macrosiphum nr *pallidum* (Oestlund): WA, Yakima—American River, 5-IX-97 on *Epilobium minutum* (97G375†‡).

Macrosiphum sp. [nr *fuscicornis* MacDougall & *pallidum* (Oestlund)]: WA, Chelan—Swauk Pass, 1-VIII-95 on *Epilobium angustifolium* (95G492†).

Myzus ascalonicus Doncaster: WA, Yakima [on moss*].

Myzus cerasi (F.) [on *Prunus* sp. unless otherwise indicated]: WA, Benton—WSU-Prosser, 28-V-96 (96G091); Chelan—Wood Reservoir, 6-VI-96 (96R019); Chelan SP, 11-IX-97 (97K041); Whitman—Pullman, 5-VII-96, on *P. avium* (96T173).

Myzus nr *cerasi* (F.): WA, Whitman—Pullman, 6-VII-96 on unknown plant (96T411).

Myzus persicae (Sulzer): ID, Latah—Moscow, 29-VIII-96 on *Solanum* sp. (96T512†).

Nasonovia (Kakimia) sp.: WA, Spokane—nr Peone, 13-VII-95 on native *Ribes* sp. (95T235).

Nearctaphis bakeri (Cowen): WA, Benton—WSU-Prosser, 5-V-95 on *Crataegus* sp. (95G023); Klickitat—Trout Lk, 29-VI-97 on *Trifolium pratense* (97G170).

Nearctaphis californica HRL: WA, Klickitat—Brooks Memorial SP, 8VI–94 on *Crataegus douglasii* (94–100).

Nearctaphis kachena (Hottes): WA, Kittitas—Taneum Lk, 11-IX-97 on *Pedicularis racemosa* (97G411†‡).

Nearctaphis yohoensis Bradley: WA, Yakima—YIR, White Deer Cr, 11-VII-95 on *Sorbus* sp. (95K051).

Nearctaphis sp. ID, Latah—Moscow, 13-VI-97 on unknown plant (97T050).

Phorodon humuli (Schrank): WA, Benton [on *Humulus lupulus* & *Prunus salicina**]—WSU-Prosser, 19,25-IV-95, 23-V-96, 15-IV-97, on *P. salicina* (95G005, 95G006, 95G007, 96G075, 97G006).

Pseudoepameibaphis tridentatae (Wilson): WA, Asotin—Asotin Cr Rd, 30-V-95 on *Artemisia tridentata* (95T045†‡).

Pterocomma sp.: WA, Yakima—YIR, Signal Peak, 19-IX-95, on *Salix* sp. (95G619).

Rhopalosiphum cerasifoliae (Fitch) [on *Prunus virginiana* unless otherwise indicated]: MT, Lincoln—Libby, 29-VII-95 (95G451); Sanders – 20mi E of Thompson Pass, 29-VII-95 (95G454); WA, Kittitas—Reecer Cr, 20-VI-95 (95G202); Klickitat—E end of Colockum Pass Rd, 2-VII-97, 97G215); Whitman—Pullman, 19-VI-96, 16-VII-96 on unknown plant (96T046, 96T300); Yakima—Wenas Lk, Wenas Cr & Maloy Rd, 11-VI-97 (97G069).

Rhopalosiphum enigmae Hottes & Frison: WA, Yakima—Buena, 23-X-95 on *Typha latifolia* (95G715).

Rhopalosiphum insertum (Walker) [on *Pyrus malus* unless otherwise indicated]: WA, Chelan—Chelan, 11-VI-96 (96X001, 96X002); WSU-Wenatchee, 30-V-96 (96R011†).; Douglas—Bridgeport, 17-VI-96

(96X007†); Orondo, 25-V-95 (95R010); 11-VI-96 (96X003, 96X004, 96X005); Bridgeport, 12,17-VI-96 (96X006, 96X008); Kittitas—Ellensburg, 17-V-96 on *Crataegus columbiana* (96G066).

Rhopalosiphum maidis (Fitch): WA, Benton [on *Echinochloa crus-galli*†, *P. milliaceum*, & *Triticum aestivum**]—WSU-Prosser 23-XI-94 on *Panicum milliaceum* (94G113), 2-XI-96 on *Hordeum vulgare* (96G655), 18-XI-95 & 20-I-96 on *Capsella bursa-pastoris* (96G003†, 95G750†).

Rhopalosiphum nymphaeae (L.): WA, Yakima—Outlook, 23-X-95 on *Typha latifolia* (95G709).

Rhopalosiphum padi (L.) [on *Triticum aestivum* unless otherwise indicated]: WA, Benton [on *Echinochloa crus-galli*†, *T. aestivum*, & *Zea mays**]—WSU-Prosser, 1-X-95 (95G668); nr Paterson, 12-X-95 (95G688); Cemetery Rd (3 mi east of Hwy 221), 12-X-95 (95G690); Douglas—Waterville, 12-VIII-95 (95B016, 95B017, 95B018); Yakima [*]. [Following collections on *Zea mays*]: Asotin—Chief Timothy HMU, 16-VIII-95 (95T439); Benton [on *Echinochloa crus-galli* & *Zea mays* *]; Benton—WSU-Prosser, 24-VII-95, 18-IX-95, 6-X-95, 28-IX-96, 3-XI-97 (95G511, 95G601, 95G683, 95G684, 96G591, 97G518); Prosser, 21-IX-96 (96G626); Grandview, 24-VIII-95 (95G513); Grant—Ephrata, 8-VII-97 (97K058); Walla Walla—Hwy 124 (nr Ice Harbor Dam), 5-IX-95, 5,18-X-95 (95G543, 95G675, 95G699); Eureka, 5-X-95 (95G681, 95G698); Prescott, 30-X-97 on *Phalaris arundinacea* (97G516); Yakima—Grandview, 25-VIII-95, 18-IX-95, 24-X-95, (95G520, 95G602, 95G702); Harrah, 19-IX-95 (95G604); nr Toppenish, 19-IX-95, 16-X-95, 5-XI-95 (95G603, 95G695, 95G745).

Schizaphis graminum (Rondani): WA, Benton—15-VI-82, (82K001).

Sitobion avenae (F.) [on *Triticum aestivum* unless otherwise indicated]: WA, Asotin [*]; Benton—WSU-Prosser, 3,11,18 & 25-VII-97 (97F192, 97F193, 97F199, 97F200, 97F209, 97F215, 97F223, 97F231,97F249, 97F252, 97F260, 97F263, 97F264, 97F265, 97F273), & 18-VII-97 on *Setaria lutescens* (97G243); Klickitat—Bickleton Hwy & County Line Rd, 7-VII-97 (97G224).

Sitobion sp.: WA, Klickitat—Trout Lk, 11-VII-95 on *Holodiscus discolor* (95G340†‡).

Tuberculatus columbiae Richards: WA, Yakima—YIR, Mill Cr Guard Station, 6-VI-95 on *Quercus garryana* (95G112, 95G113), & on *Salix* sp. (95G114).

Uroleucon cirsii (L.): WA, Klickitat—Brooks Memorial SP, 21-IX-95 on *Cirsium* sp. (95K162†); Pierce [on *Cirsium arvense**].

Uroleucon sp.: ID, Kootenai—Rathdrum, 29-VII-95 (95G443†).

Undetermined spp.: ID, Latah—Moscow, 29-VIII-96 on *Coriandrum sativum* (96T513); Benton—Prosser, 1-VIII-95 on *Portulaca oleracea* (95A028); Kittitas—Stampede Pass, 8-VIII-96 on *Epilobium angustifolium* (96K146); Lewis—RNP, 8-IX-95 on *Luetkea pectinata* (95K115); Whitman [on *Lupinus* sp.*]—Pullman, 19-VI-96, 3-VII-96 on *P. malus* (96T042); Yakima—Grandview, 12-X-96 on *Sonchus* sp. (96G647).

Lysiphlebus utahensis (Smith)

Aphis canae Williams: WA, Franklin—Kahlotus Hwy, 11-VI-96 on *Artemisia tridentata* (96G242†‡).

Artemisaphis artemisicola (Williams) [on *Artemisia tridentata*]: WA, Franklin—Kahlotus Hwy, 28-V-96 & 11-VI-96 on *Artemisia tridentata* (96G096, 96G242†‡); Okanogan—Bridgeport SP, 9-IX-97 (97K018); Yakima—Naught Rd, 18-VI-97 (97G103†‡).

Epameibaphis atricornis G&P: WA, Benton—Byron Rd, 14-V-97 on *Artemisia tridentata* (97G024†‡).

Flabellomicrosiphum tridentatae (Wilson): WA, Klickitat—nr Roosevelt, 16-IV-96 on *Artemisia tridentata* (96G012†‡).

Obtusicauda artemisiphila (Knowlton & Allen): WA, Klickitat—nr Roosevelt, 16-IV-96 on *Artemisia tridentata* (96G012†‡).

Obtusicauda coweni (Hunter) [on *Artemisia tridentata*]: WA, Asotin—Asotin Cr HMU, 7-V-96 (96T142†); Yakima [*].

Obtusicauda filifoliae (G&P) [on *Artemisia tridentata*]: WA, Benton—Byron Rd, 14-V-97 (97G024†‡); Klickitat [*]—nr Roosevelt, 16-IV-96 (97G012†‡).

Obtusicauda sp.: WA, Klickitat [on *Artemisia tridentata**].

Pseudoepameibaphis tridentatae (Wilson) [on *Artemisia tridentata*]: WA, Benton—Byron Rd, 14-V-97 (97G024†‡); Klickitat—nr Roosevelt, 16-IV-96 (96G012†‡); Yakima—Naught Rd, 18-VI-97 (97G103†‡).

***Lysiphlebus* sp.**

Aphis helianthi Monell: WA, Pierce [on *Heracleum lanatum**].

Aphis sp.: WA, Pierce [on *Heracleum lanatum**]; Yakima [on unknown *Umbelliferae**].

Brachycaudus tragopogonis (Kaltenbach): WA, Klickitat [on *Tragopogon dubius**].

Genus *MONOCTONUS* Haliday

Monoctonus campbellianus Pike & Starý, new species

(Figs. 13–24)

Diagnosis.—The new species does not key to any of the North American species because of its reduced wing venation. According to the classification by van Achterberg (1989), it is part of the *M. cerasi* (Marshall) group. [Note, a part of the specimens of some species classified by Starý & Smith (1976) as European species, but distributed in N. America, are probably this new species].

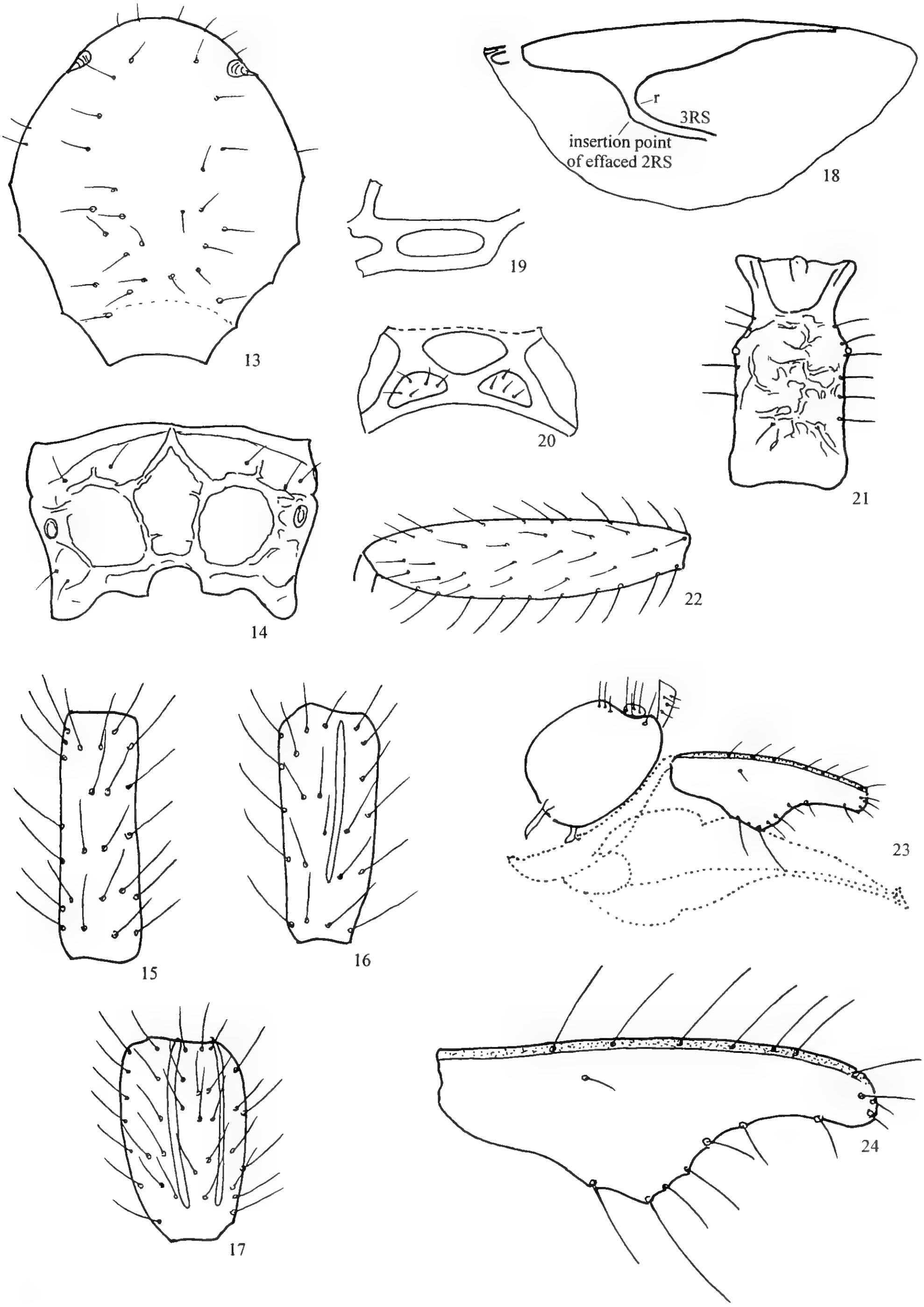
Etymology.—The name of the new species is derived from the type locality, Campbell Lake, Skagit Co., Washington.

Description.—Female. *Head:* Eyes with sparse setae in lower half. Tentorio-ocular line subequal to ⅓ of intertentorial line; malar space somewhat longer than ⅕ of eye length, equal to half of intertentorial line. Antenna 13-segmented, short, as long as head, mesosoma and metasomal tergum 1 together, thickened to apex. Flagellomere 1 [F_1] (Fig. 15) length 3.5× width, without placodes, setae equal to segment diameter; F_2 (Fig. 16) slightly shorter than F_1, about ⅓ wider than F_1, with 3 placodes; preapical F-segments (Fig. 17) (length/width = 1.7) ¼ wider than F_2. *Mesosoma:* Antescutal depression evident (Fig. 20). Mesonotum with notauli distinct anteriorly, smooth except for sparse setae tracing effaced notauli on the disc (Fig. 13). Propodeum (Fig. 14) with narrow central pentagonal areola. *Forewing* (Fig. 18): Stigma length about 3.5× width; distal abscissa of R1 (= metacarpus) short, about ⅕ of stigma length; r + 3RS vein (radial sector) distinctly sclerotized (insertion point for completely effaced 2RS vein defines separation between r and 3RS veins). Stigma width 2× length of r-vein; 3RS vein 2–3× length of r-vein. Cubital cell narrow, distinctly complete or closed (Fig. 19). *Legs:* Femora (Fig. 22). *Metasoma:* Metasomal tergum 1 (Fig. 21) length nearly 2× width at spiracles, disc coarsely rugose; spiracular tubercles positioned 1/3 from anterior margin; distance between spiracles and apex greater than width at spiracles. *Genitalia* (Fig. 23): Ovipositor sheath (Fig. 24) distinctly ploughshare-shaped. *Coloration:* Head dark brown; lower part of gena and mandibles yellow brown, palpi yellow. Antennae brown, except scape, pedicel and F_1 yellow. Mesosoma brown, sometimes propleurae, and part of mesopleurae and propodeum yellow brown. Wings subhyaline, venation light brown. Legs yellow, apices of tarsi darkened. Metasomal tergum 1 and central part of tergum 2 yellow to yellow brown, otherwise metasoma brown, the apex yellow brown to light brown. Ovipositor sheaths concolorous with the apex of metasoma, upper portion darker. *Length of body:* about 2.0–2.3 mm.

Male.—Antenna 16-segmented. Head brown. Antennae brown, articulation between pedicel and F_1 lighter. Mandibles yellow brown, palpi yellow. Mesosoma brown. Legs yellow brown, coxae darkened. Metasoma brown, tergum 1 yellow brown.

Holotype.—♀, USA, WA, Skagit Co., Campbell Lake, 04-VI-1996, G. Graf & P. Starý collectors (collection code, 96G165). Host aphid (reared from a mixed collection): *Brachycaudus helichrysi* (Kaltenbach), *Hyalopterus pruni* (Geoffroy), and *Phorodon humuli* (Schrank) on *Prunus* sp. Deposited in USNM.

Paratypes.—31 specimens, collection data same as holotype; deposited in part in collections of WSU-Prosser (16 ♀, 6 ♂) and P. Starý, Ceské Budejovice, Czech Republic (7 ♀, 2 ♂).



Figs. 13–24. *Monoctonus campbellianus,* ♀ [illustrations not to equal scale]. 13, Mesonotum. 14, Propodeum. 15–17, Flagellomeres 1, 2, and preapical. 18, Fore wing, in part. 19, Cubital cell. 20, Mesosoma—pronotum with antescutal depression. 21, Metasomal tergum 1. 22, Femora. 23, Genitalia. 24, Ovipositor sheath. Abbreviations: 2RS, 3RS, and r, wing veins.

Monoctonus pacificus Pike and Starý, new species
(Figs. 25–32)

Diagnosis.—The new species is similar to *M. nervosus* (Haliday) (see van Achterberg 1989), but differs from the latter in coloration, number of antennal segments, absence of placodes on flagellar segments 1–4, and arcuate r-vein in the forewing.

Etymology.—The name of the new species is derived from the general type locality, the Pacific Northwest, USA.

Description.—Female. *Head:* Eyes with sparse setae in lower half. Tentorio-ocular line subequal to ¼ of intertentorial line; malar space 2× length of intertentorial line or ⅕ of eye length. Antenna 17–18-segmented, filiform, reaching to half of metasoma. Flagellomere 1 [F_1] (Fig. 27) length 4.0× width, the setae as long to longer than segment diameter. F_2 (Fig. 28) subequal to F_1. F_{1-4} without placodes; F_5, 1 placode; F_6, 3 placodes. Preapical F-segments (Fig. 29) about ⅐ wider than F_2. *Mesosoma:* Antescutal depression evident (Fig. 32). Mesonotum with large bare areas in central and lateral lobes. Propodeum (Fig. 25) with narrow central areola. FOREWING (Fig. 31): Stigma length 6.0× width; distal abscissa of R1 (metacarpus) short, equal to ⅐ of stigma length; r + 3RS vein (radial sector) distinctly sclerotized; r-vein arcuate, slightly shorter than stigma width; 3RS equal to r-vein. 2RS vein colorless but distinct. RS + M vein distinct. *Metasoma:* Metasomal tergum 1 (Fig. 26) length 2× width at spiracles, with spiracles positioned ⅓ from anterior margin; disc coarsely rugose. *Genitalia* (Fig. 30): Ovipositor sheath ploughshare-shaped. *Coloration:* Largely yellow. Head, including mandibles brown; palpi yellow; antennae light brown, except scape, pedicel, F_{1-4} yellow (sometimes F_3 and F_4 infuscated). *Length of body:* about 2.3 mm.

Male. Antenna 19–20-segmented. Coloration similar to female, metasoma somewhat darkened.

Holotype.—♀, USA, WA, YAKIMA CO., nr Clear Lake, 15-VI-1996, K. S. Pike collector, (collection code, 96K099). Host aphid: *Macrosiphum tuberculaceps* (Essig) on *Achlys triphylla.* Deposited in USNM.

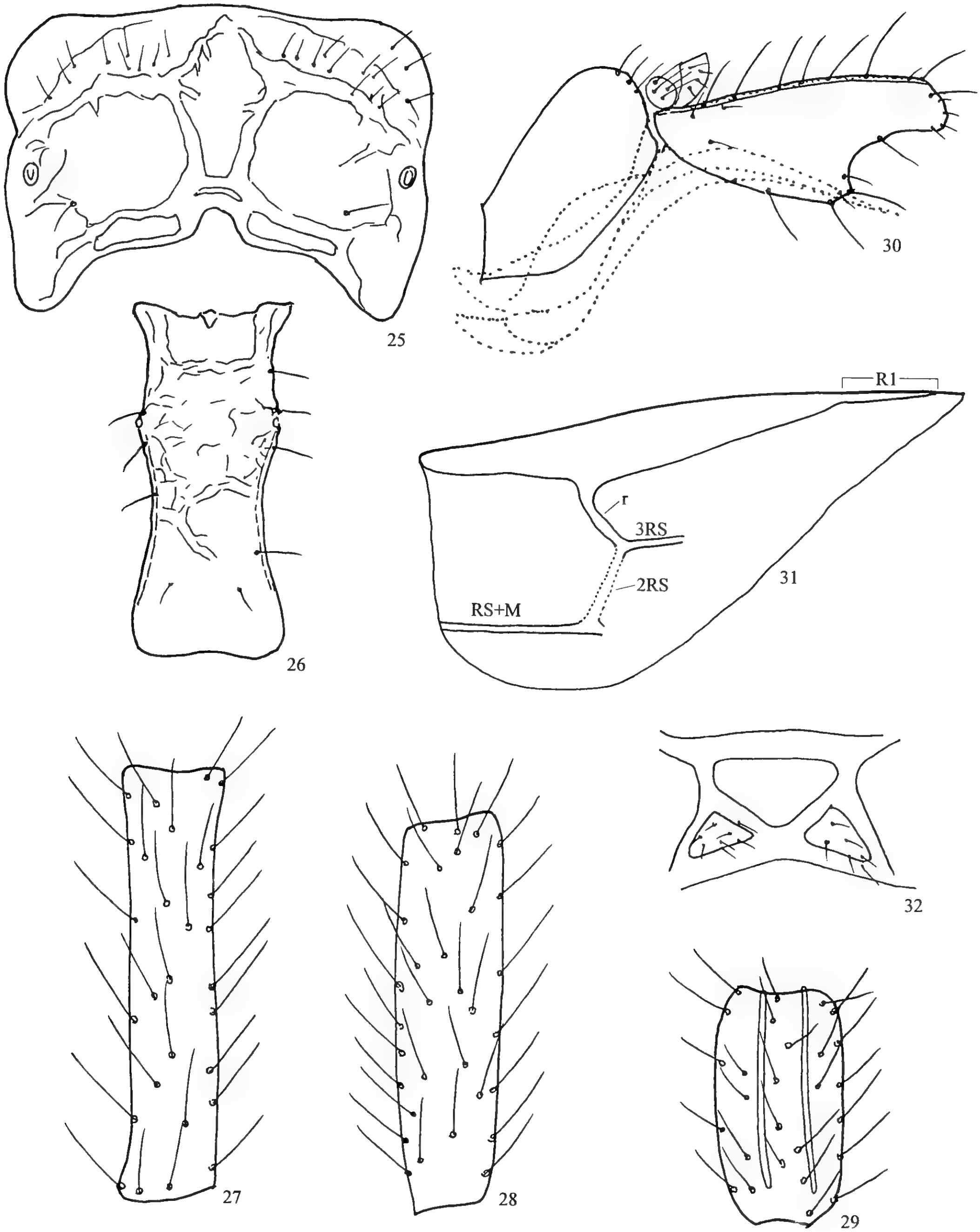
Paratypes.—5 specimens, USA, WA, YAKIMA CO., N Fork of Tieton River, 27-VI-1996. Host aphid: *Macrosiphum tuberculaceps* (Essig) on *Achlys triphylla* (96G298), deposited in part in collections of WSU-Prosser (3 ♀, 1 ♂) and P. Starý, Ceské Budejovice, Czech Republic (1 ♀).

Other material reared from:

Macrosiphum tuberculaceps (Essig): WA, YAKIMA, Morse Cr, 24-VII-97 on *Achlys triphylla* (97G255), N Fork of Tieton River, 27-VI-1996 on *Achlys triphylla* (96G298); nr Clear Lake, 15-VI-1996, on *Achlys triphylla* (96K099).

Monoctonus washingtonensis Pike & Starý
- *Aphis* nr *oenotherae* Oestlund: WA, GARFIELD—Spruce Springs, 22-VIII-95 on *Epilobium* sp. (95T462†).
- *Diuraphis noxia* (Kurdjumov): WA, BENTON [on *Triticum aestivum**].
- *Rhopalosiphum padi* (L.): WA, BENTON [on *Triticum aestivum**].

***Monoctonus* spp.**
- *Acyrthosiphon pisum* (Harris): WA, KITTITAS [on *Rhododendron albiflorum**].
- *Illinoia rhododendri* (Wilson): WA, KITTITAS [on *Rhododendron albiflorum**].
- *Illinoia* sp.: WA, YAKIMA [on *Rhododendron albiflorum**].
- *Macrosiphum euphorbiae* (Thomas): WA, SKAMANIA—Twin Falls CG, 4-VIII-95 on *Pteridium aquilinum* (95K099).
- *Macrosiphum walkeri* Robinson: OR, BENTON—McDonald State Forest, 21-V-91 on *Polypodium* sp. (91J003).
- *Metopolophium dirhodum* (Walker): WA, KITTITAS [on *Rhododendron albiflorum**].



Figs. 25–32. *Monoctonus pacificus,* ♀ [illustrations not to equal scale]. 25, Propodeum. 26, Metasomal tergum 1. 27–29, Flagellomeres 1, 2, and preapical. 30, Genitalia. 31, Fore wing, in part. 32, Mesosoma—pronotum with antescutal depression. Abbreviations: R1, distal abscissa of postmarginal vein [= metacarpus]; 2RS, 3RS, RS+M, and r, wing veins.

Genus *PAUESIA* Quilis

Pauesia ahtanumensis Pike & Starý

Cinara ponderosae (Williams) [on *Pinus ponderosa* unless otherwise indicated]: ID, LATAH—Moscow Mtn, 6-VII-96 on *Pinus* sp. (96T195); MT, LINCOLN—Libby, 16-VI-95 (95G171); WA, ASOTIN—De Spain Springs, 5-VII-96 (96T149); KLICKITAT—Bickleton, 18-VI-97 (97G112); OKANOGAN—Carlton, 11-IX-97 (97K034); SKAMANIA & YAKIMA [*].

Cinara sp.: WA, ASOTIN—Copper Canyon, 18-VII-96 on *Pinus ponderosa* (96T308).

Pauesia bicolor (Ashmead)

Cinara sp.: ID, BOUNDARY—Bonners Ferry, 29-VII-95 on *Pinus contorta* (95G444).

Pauesia juniperaphidis (Gahan)

Cinara pilicornis (Hartig): WA, YAKIMA [on *Picea pungens**].

Pauesia pahtonis Pike & Starý

Cinara ponderosae (Williams): WA, SKAMANIA [on *Pinus ponderosa**].

Pauesia ponderosaecola Pike & Starý

Cinara ponderosae (Williams) [on *Pinus ponderosa* unless otherwise indicated]: MT, LINCOLN—Libby, 16-VI-95 (95G171); WA, ASOTIN—De Spain Spring, 5-VII-96 (96T149, 96T151); KITTITAS—S Fork Manastash Cr, 25-VI-97 (97G136); KLICKITAT [*]—Bickleton, 18-VI-97 (97G112); WHITMAN—Kamiak Butte, 7-VII-96 on *Pinus* sp. (96T203); YAKIMA [*]—YIR, White Deer Cr, 11-VII-95 (95K050).

Pauesia pseudotsugae Pike & Starý

Cinara pseudotaxifoliae Palmer: WA, KITTITAS [on *Pseudotsuga menziesii**].

***Pauesia* spp.**

Cinara brevispinosa (G&P): WA, SPOKANE—Chapman Lk, 1-VI-95 on *Pinus ponderosa* (95T046B); YAKIMA [on *Pseudotsuga menziesii**]—YIR, Potato Hill Guard Station, 11-VII-95 on *Pinus contorta* (95K063).

Cinara ponderosae (Williams): WA, SPOKANE—Deer Pk, 23-V-95 on *Pinus ponderosa* (95K015).

Cinara pseudotsugae (Wilson): WA, YAKIMA [on *Pseudotsugae menziesii**].

Cinara sp.: WA, YAKIMA—N Fork Tieton River, 27-VI-96 on *Abies amabilis* (96G293).

Undetermined sp.: WA, YAKIMA—Clear Lk, 15-VI-96 on *Pinus ponderosa* (96K087).

Genus *PRAON* Haliday

Praon americanum (Ashmead)

Aphis coweni Palmer: WA, KITTITAS—Stampede Pass, 8-VIII-96 on *Veratrum viride* (96K147).

Aphis salicariae Koch: WA, YAKIMA—YIR, nr. Mt. Adams Lk., 19-IX-95 on *Epilobium angustifolium* (95G610†).

Praon artemisaphis Smith

Obtusicauda coweni (Hunter): WA, YAKIMA [on *Artemisia tridentata**].

Obtusicauda sp.: WA, KLICKITAT† & YAKIMA [on *Artemisia tridentata* *].

Praon artemisicola Pike & Starý

Artemisaphis artemisicola (Williams): WA, BENTON—Six Prong Rd, 24-IV-97 on *Artemisia tridentata* (97G008†).

Epameibaphis atricornis G&P [on *Artemisia tridentata*]: WA, KLICKITAT [*†], & YAKIMA [*†].

Flabellomicrosiphum sp. [on *Artemisia tridentata*]: WA, KLICKITAT [*†], & YAKIMA [*†].

Pleotrichophorus quadritrichus (Knowlton & Smith): WA, YAKIMA—Mabton, 24-IV-97 on *Artemisia tridentata* (97G007†).

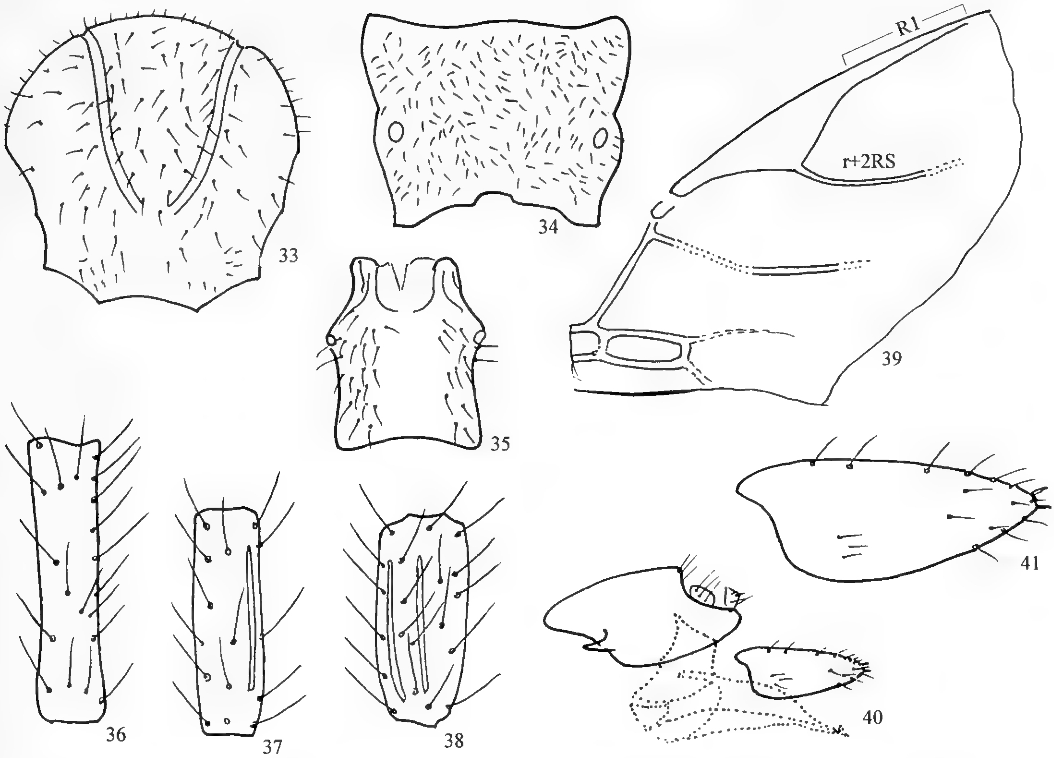
Pleotrichophorus sp.: WA, KLICKITAT—Alderdale Rd, 9-V-95 on *Artemisia tridentata* (95G028†‡).

Pseudoepameibaphis tridentata (Wilson) [on *Artemisia tridentata*]: WA, BENTON [*], KLICKITAT [*†]—Alderdale Rd, 9-V-95 (95G028†); YAKIMA [*].

Praon coniforme Pike and Starý, new species

(Figs. 33–41)

Diagnosis.—The new species belongs to a species group characterized by the absence of an m-cu vein in the forewing. Other distinguishing characters are antenna 16–17 segmented (in female), flagellomere 1 (F_1) yellow, and ovipositor sheath coniform in



Figs. 33–41. *Praon coniforme,* ♀ [illustrations not to equal scale]. 33, Mesonotum. 34, Propodeum. 35, Metasomal tergum 1. 36–38, Flagellomeres 1, 2, and preapical. 39, Fore wing, in part. 40, Genitalia. 41, Ovipositor sheath. Abbreviations: R1, distal abscissa of postmarginal vein [= metacarpus]; r+2RS, wing vein.

shape. The new species is similar to *Praon yakimanum* (see Pike & Starý 1995), but differs from the latter in antennal segment number (*P. yakimanum,* 15-segmented [rarely 16]), shape of the ovipositor sheath, and aphid host. At present, the new species is only known from snowberry aphid, *Aphthargelia symphoricarpi* (Thomas).

Etymology.—The name of the new species is derived from the shape of the ovipositor sheath that resembles a cone.

Description.—Female. *Head:* Eyes medium sized, with sparse setae in lower half. Tentorio-ocular line subequal to 1/4 of intertentorial line; malar space 1.5× length of tentorio-ocular line or slightly longer than ⅙ of eye length. Antenna 16–17 segmented, filiform, slightly thickened in apical third, reaching to half of metasoma. Flagellomere 1 [F_1] (Fig. 36) slightly more than 4.0× width; 1.6× as long as F_2; setae slightly longer than segment diameter; without placodes. F_2 (Fig. 37) width equal to F_1, with 1 placode. Preapical F-segments (Fig. 38) 1.3× width of F_2. *Mesosoma:* Mesonotum (Fig. 33) with bare areas on the lateral lobes. Propodeum (Fig. 34) pubescent. FOREWING (Fig. 39): Stigma length 3.5× width; distal abscissa of R1 (metacarpus) longer than half stigma length; r + 3RS vein (radial sector) slightly longer than distal abscissa of R1; m-cu vein absent. *Metasoma:* Metasomal tergum 1 (Fig. 35) somewhat longer than width at spiracles (7:6); distance between spiracles and anterior margin ¼ shorter than width at spiracles. *Genitalia* (Fig. 40): Ovipositor sheath (Fig. 41) cone-like in shape. *Coloration:* Head dark brown, mouthparts bright yellow. Antenna brown; apex of pedicel and F_1 yellow. Mesosoma dark brown. Wings subhyaline, venation light brown. Legs yellow, apices of tarsi infuscate. Metasomal tergum 1 yellow brown, darker in basal portion. Metasoma brown. Ovipositor sheaths dark brown. *Length of body:* about 2.4 mm.

Male.—Antenna 19–20-segmented, filiform, longer than the body. Antenna brown, F_1 with a narrow yellow base. Legs light brown.

Holotype.—♀, USA, WA, YAKIMA CO., Maloy Rd and Wenas Creek, 30-V-1996, G. Graf collector, (collection code, 96G127). Host aphid: *Aphthargelia symphoricarpi* (Thomas) on *Symphoricarpos* sp. Deposited in USNM.

Paratypes.—3 specimens, collection data same as holotype, deposited in part in collections of WSU-Prosser (2 ♂) and P. Starý, Ceské Budejovice, Czech Republic (1 ♀).

Other Material reared from:

Aphthargelia symphoricarpi (Thomas) [on *Symphoricarpos* sp. unless otherwise indicated]: WA, KITTITAS—Lost Lake, 29-VI-1994 (94G005) & 6-VIII-1997 (97G334); KLICKITAT—Trout Lake, 28-VI-1997 (97G159); SPOKANE—Cooper Rd, 29-VI-95 (95T178); Fish Lake, 14-VI-1997 on *S. occidentalis* (97K004); YAKIMA—Maloy Rd & Wenas Cr., 11-VI-1997 (97G066).

Praon exsoletum (Nees)

Therioaphis riehmi (Börner) [on *Melilotus* sp. unless otherwise indicated]: WA, BENTON—WSU-Prosser, 11-VII-97 on *M. officinalis* (97F218†); YAKIMA—Grandview, 22-VI-96 (96G261); nr Parker, 29-IX-95 (95G665†); YIR, Signal Peak, 19-IX-95 (95G625†).

Therioaphis trifolii (Monell) [on *Medicago sativa*]: WA, BENTON [*]; YAKIMA, nr Union Gap, 23-X-95 (95G721†).

Therioaphis sp.: WA, BENTON—WSU-Prosser, 28-VI-95 on *Medicago sativa* (95G277†).

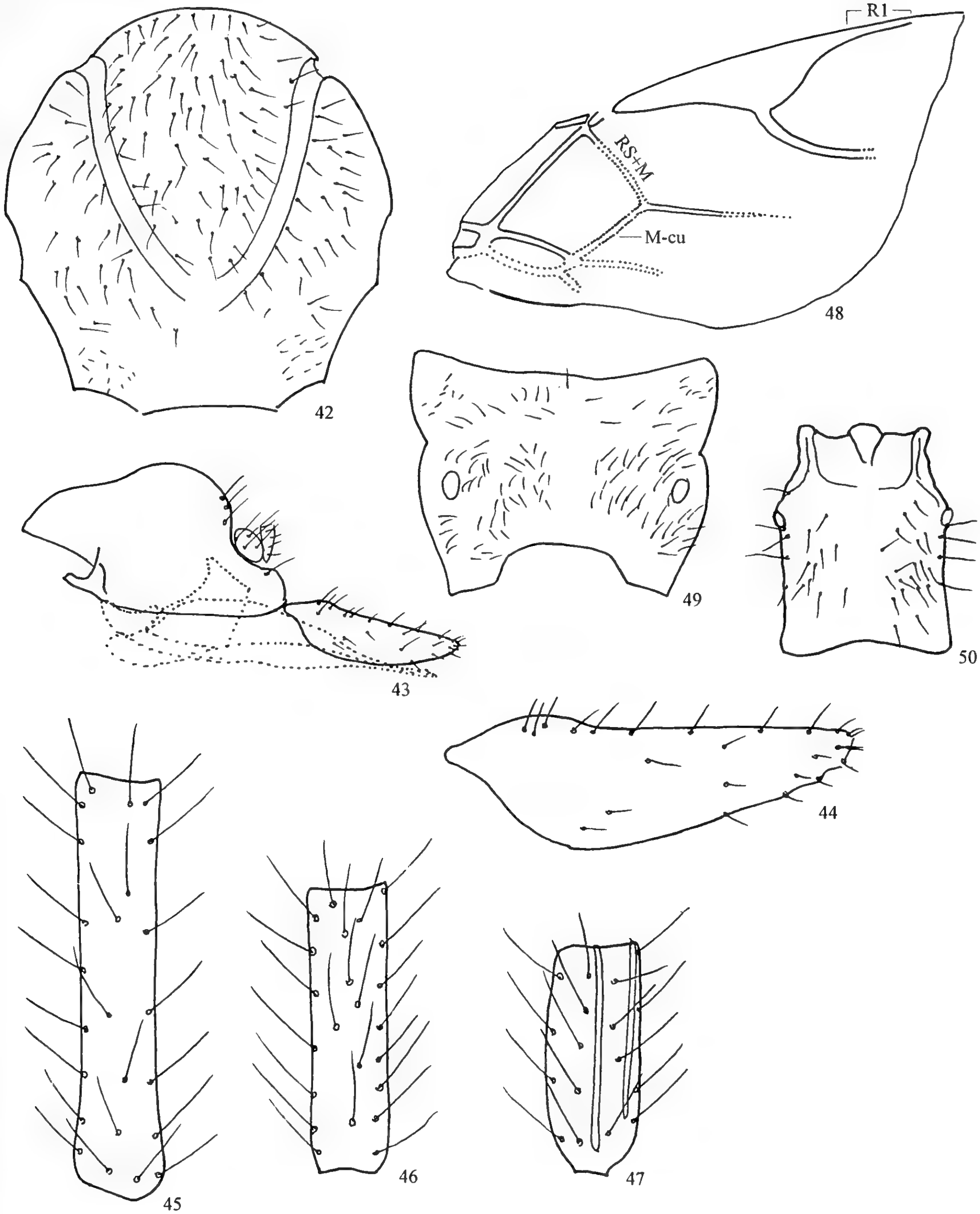
Praon fulvum Pike and Starý, new species

(Figs. 42–50)

Diagnosis.—Yellow coloration of F_1 (flagellomere 1) and F_2 keys the new species to *P. gallicum* Starý (see key by Johnson 1987), but it differs from the latter in the number of antennal segments [*P. fulvum* with 18–19 (rarely 20) vs. *P. gallicum* with 15–16 (rarely 17)], the presence of the m-cu vein in the forewing (absent with *P. gallicum*), and the mesonotum pubescence on the lateral lobes of the mesonotum (large bare areas with *P. gallicum*).

Etymology.—The name of the new species is derived from its prevailing body coloration.

Description.—Female. *Head:* Eyes medium sized, with sparse setae in lower half. Tentorio-ocular line ⅓ of intertentorial line or ¼ of malar space. Antenna 18–19 (rarely 20) segmented, filiform, slightly thickened towards apex, subequal to body length. Flagellomere 1 [F_1] (Fig. 45) long, length nearly 5× width, setae slightly longer than segment diameter, without placodes. F_2 (Fig. 46) ⅓ shorter than F_1, without placodes. Preapical F-segments (Fig. 47) 1/8 wider than F_2. *Mesosoma:* Mesonotum (Fig. 42) with very small to no areas on the lateral lobes without setae. Propodeum (Fig. 49) pubescent, somewhat bare in center. FOREWING (Fig. 48): Stigma length 3.5× width; distal abscissa of R1 (metacarpus) slightly longer than half stigma length; RS + M vein distinct, subcolored in basal ¼–⅓, remaining portion colorless; m-cu vein complete, subcolored. *Metasoma:* Metasomal tergum 1 (Fig. 50) longitudinal, length ¼ longer than width at spiracles; width at spiracles ⅕ longer than the distance from spiracles to anterior margin. *Genitalia* (Fig. 43): Ovipositor sheath (Fig. 44) long, subarcuate. *Coloration:* Body almost completely yellow. Head yellow, frons more or less brown. Apices of mandibles brown. Antenna brown; scape, pedicel, F_1 and F_2 yellow. F_2 sometimes infuscated at apex.



Figs. 42–50. *Praon fulvum,* ♀ [illustrations not to equal scale]. 42, Mesonotum. 43, Genitalia. 44, Ovipositor sheath. 45–47, Flagellomeres 1, 2, and preapical. 48, Fore wing, in part. 49, Propodeum. 50, Metasomal tergum 1. Abbreviations: R1, distal abscissa of postmarginal vein [= metacarpus]; RS+M and M-cu, wing vein.

Mesosoma yellow. Wings subhyaline, venation light brown. Legs yellow. Metasoma yellow. Ovipositor sheaths light brown. *Length of body:* about 2.0–2.6 mm.

Male.—Unknown.

Holotype.—♀, USA, WA, Lewis Co., Mt. Rainier Nat. Park, Stevens Canyon, 23-VII-

1996, G. Graf collector, (collection code, 96G357). Host aphid: *Macrosiphum euphorbiae* (Thomas) on *Crepis* sp. Deposited in USNM.

Paratypes.—6 specimens, collection data same as holotype, deposited in part in collections of WSU-Prosser (3 ♀) and P. Starý, Ceské Budejovice, Czech Republic (3 ♀).

Other material reared from:

Macrosiphum euphorbiae (Thomas): WA, Klickitat—Cleveland, 7-VII-1997, on *Lupinus* sp. (97G230).

Macrosiphum tuberculaceps (Essig): WA, Yakima—Wenas Creek & Maloy Rd, 11-VI-1997 on *Achlys triphylla,* (96G298).

Macrosiphum sp.: WA, Yakima—Wenas Creek & Maloy Rd, 11-VI-1997 on *Spiraea pyramidata* (97G073).

Praon gallicum Starý

Diuraphis noxia (Kurdjumov) [on *Triticum aestivum*]: WA, Benton—WSU-Prosser, 22-VII-97 (97F295); Klickitat—Crider Valley Rd, 22-VII-97 (97G250†‡); Yakima—nr Sunnyside, 17-VII-97 (97G246†).

Metopolophium dirhodum (Walker) [on *Triticum aestivum*]: WA, Yakima—Glade Rd, 7-VII-97 (97G217†); nr Sunnyside, 17-VII-97 (97G246†).

Rhopalosiphum padi (L.): WA, Grant—Ephrata, 8-VII-97 on *Zea mays* (97K058); Klickitat—Crider Valley Rd, 22-VII-97 on *Triticum aestivum* (97G250†‡).

Sitobion avenae (F.) [on *Triticum aestivum*]: WA, Klickitat—Crider Valley Rd, 22-VII-97 (97G250†‡); Yakima—Glade Rd, 7-VII-97 (97G217†).

Praon humulaphidis Ashmead

Acyrthosiphon macrosiphum (Wilson): MT, Lincoln—Libby, 6-VII-96 on *Amelanchier alnifolia* (96G322).

Macrosiphum euphorbiae (Thomas): WA, Whitman—Pullman, 18-VI-96 on cultivated *Rosa* sp. (96T037) & 5-VII-96 on unknown plant (96T176).

Macrosiphum sp. ID, Benewah—McCroskey SP, 7-VI-96 on native *Rosa* sp. (96T005).

Nasonovia ribisnigri (Mosley): WA, Whitman—Pullman, 5-VII-96 on unknown plant (96T177).

Illinoia sp.: ID, Shoshone—Thomas Pass, 29-VII-95 on *Vaccinium* sp. (95G472).

Illinoia sp.?: WA, Chelan—Chatter Cr CG, 1-VIII-95 on *Aruncus sylvester* (95G487).

Praon occidentale Baker

Acyrthosiphon lactucae (Passerini) [on *Lactuca serriola*]: ID, Benewah—McCroskey SP, 31-VIII-95 (95T514†); WA, Benton—WSU-Prosser, 11,22-V-95 (95G034, 95G081); Prosser, 22-VI-97 (97G121); Whitman—Chambers, 19-IX-95 (95T581); Nisqually John Landing, 19-IX-95 (95T584); Pullman, 2-VIII-96 (96T386); Yakima—Grandview, 23-VI-96 (96G263); Wenas Lk, 11-VI-97 (97G055).

Acyrthosiphon pisum (Harris): WA, Benton—28-VI-95 on *Medicago sativa* (95G277†); Prosser, 23-VII-96 on *Trifolium repens* (96G393); Grant—WSU-Othello, 26-VI-95 on *Medicago sativa* (95B008); Skamania—Underwood, 11-VII-95 on *Lathyrus* sp. (95K072).

Amphorophora geranii G&P: WA, Whitman—Long Rd nr Hole in the Ground, 18-V-95 on *Geranium* sp. (95T012†).

Aphis craccivora Koch: ID, Latah—Moscow Mtn, 3-VIII-96 on *Trifolium* sp. (96T400†‡).

Aphis helianthi Monell: WA, Garfield—Stentz Springs, 22-VIII-95 on *Osmorhiza chilensis* (95T452).

Aphis lugentis Williams: WA, Yakima—Bird Cr Meadows, 8-IX-94 on *Arnica* sp. (94R172).

Brachycaudus helichrysi (Kaltenbach): WA, Garfield—FR160 & FR40, 21-IX-95 on *Anaphalis margaritacea* (95T595†‡); Pierce—RNP, Tipsoo Lk, 5-IX-97 on *Aster* sp. (97G364†‡); Yakima—Mabton-Bickleton Rd, Glade Cr, 7-VII-97 on *Artemisia ludoviciana* (97G219).

Capitophorus elaeagni (del Guercio): WA, Yakima—Grandview, 28-VI-96 on *Cirsium vulgare* (96G309†‡).

Chaetosiphon thomasi HRL: WA, Pierce—WSU-Puyallup, 10-VI-96 on cultivated *Fragaria* sp. (96T022).

Diuraphis noxia (Kurdjumov) [on *Triticum aestivum*]: WA, Benton [*]; Klickitat—Bickleton, 29-VII-97 (97G300).

Dysaphis plantaginea (Passerini): WA, Yakima—Grandview, 10-VI-96 on *Pyrus malus* (96G214).

Ericaphis wakibae (Hottes): WA, Yakima—N Fork Tieton River, 15-VI-96 on native *Rosa* sp. (96K090†‡).

Hyperomyzus nigricornis (Knowlton) [on *Hieracium* sp. unless otherwise indicated]: ID, Benewah—McCroskey SP, 31-VIII-95 (95T514†); Latah—Moscow Mtn, 15-VIII-96 on Compositae (96T446); MT, Sanders—nr Thompson Pass, 29-VII-95 (95G462†); WA, Garfield—Alder Thicket, 21-IX-95 (95T587); Kittitas—Buck Meadows, 16-VIII-96 (96G493); Manastash Rd, 25-VII-96 (96G415); Klickitat—

Cleveland, 18-VI-96 on *Madia minima* (96K109); Spokane—Mt Spokane Hwy (mi marker 18.5), 22-VIII-96 on Compositae (96T487, 96T488); Yakima—Bird Cr Meadows, 26-VI-95 (95A016†).

Hyperomyzus sp.: WA, Kittitas—S Fork Manastash Cr, 24-VII-95 on *Hieracium albiflorum* (95G388); Spokane—nr Peone, 24-VIII-95 on *Centaurea pratensis* (95T473†); Whitman—Pullman, 10-VIII-95 on *Lapsana communis* (95T436†).

Illinoia davidsoni (Mason): MT, Sanders—nr Thompson Pass, 29-VII-95 on *Arnica* sp. (95G463); WA, Kittitas—Quartz Mtn, 25-VII-96 on *Arnica cordifolia* (96G406†‡).

Illinoia richardsi: *WA*, Garfield—FR160 & FR40, 21-IX-95 on *Anaphalis margaritacea* (95T595†‡).

Illinoia nr *thalictri* (MacGillivray): WA, Garfield—Stentz Springs (FR 40), 22-VIII-95 on *Thalictrum* sp. (95T454).

Illinoia spp.: ID, Benewah—McCroskey SP 7-VI-96 on unknown plant (96T006); WA, Garfield—Stentz Springs, 1-VIII-95 on *Aquilegia formosa* (95T362†); Kittitas [on *Aquilegia formosa*†*]; Pierce—RNP, Tipsoo Lk, 11-IX-96 on *Carex* sp. (96G542†‡).

Macrosiphoniella ludovicianae (Oestlund): WA, Asotin—Asotin Cr WLA, 26-VI-96 on *Artemisia ludoviciana* (96T048).

Macrosiphoniella nr *ludovicianae* (Oestlund): WA, Yakima [on *Artemisia ludoviciana**].

Macrosiphum albifrons Essig: WA, Pierce—RNP, Tipsoo Lk, 11-IX-96 on *Lupinus* sp. (96G547).

Macrosiphum euphorbiae (Thomas): ID, Latah—Moscow Mtn, 6-VII-96 on *Castilleja* sp. (96T188); 6-VII-96, on native *Rosa* sp. (96T184); 6-VII-96 on Compositae (96T185, 96T192); MT, Lincoln—Libby, 15-VI-95 on native *Rosa* sp. (95G168); Sanders—nr Thompson Pass, 29-VII-95 on *Hieracium* sp. (95G462†); WA, Asotin—De Spain Springs, 1-VIII-95 on *Senecio* sp. (95T381), 26-VI-96 on unknown plant (96T051), 5-VII-96 on Compositae (96T159), 11-VII-96 on *Potentilla* sp. (96T250) & Compositae (96T251); Benton—WSU-Prosser, 27-X-95 on *Chenopodium album* (95K218†), & 27-X-95 on cultivated *Rosa* sp. (95K220†); Kittitas—Buck Meadows, 9-VII-96 on *Agoseris elata* (96G341), 9-VII-96 on native *Rosa* sp. (96G335); Manastash Cr, FR125, 16-VIII-96 on *Silene* sp. (96G497); Manastash Ridge, 2-IX-95 on *Gnaphalium microcephalum* (95G537); Lost Lk Trail, 6-VIII-97 on *Luina nardosmia* (97G327); Quartz Mtn, 25-VII-96 on *Arnica cordifolia* (96G406†); Pend Oreille, Tiger Meadows, 9-VII-96 on Compositae (96T221); Spokane—Mt Spokane SP, 24-VIII-95 on native *Rosa* sp. (95T491†); Stevens—Little Pend Oreille WLA, 9-VII-96 on Compositae (96T210); Whitman—Pullman, 10-VIII-95 on *Lapsana communis* (95T436†) & 18-VI-96 on cultivated *Rosa* sp.(96T037); WA, Yakima—Bird Cr Meadows, 26-VI-95 on *Hieracium* sp. (95A016†); Grandview, 28-VI-96 on *Cirsium vulgare* (96G309†); Hwy 410 & Sawmill Flat, 28-VII-97 on native *Rosa* sp. (97G289†).

Macrosiphum osmaroniae (Wilson): WA, Whatcom—Bellingham, 3-V-96 on *Oemleria cerasiformis* (96K013);

Macrosiphum rosae (L.) [on cultivated *Rosa* sp.]: WA, Benton—WSU-Prosser, 27-X-95 (95K220†); nr Prosser, Richards Rd, 22-VI-97 (97G122); Yakima [†*]—Grandview, 13 & 21-V-97 (97G021†‡, 97G037).

Macrosiphum sp.: ID, Benewah—McCroskey SP, 7-VI-96 on native *Rosa* sp. (96T005); WA, Asotin—nr Anatone, 24-VIII-93 on *Triticum aestivum* (93T015); Yakima—nr Chinook Pass, Morse Cr, 24-VII-97 on *Oplopanax horridum* (97G256); Sunnyside, 24-VIII-95 on *Zea mays* (95G519†).

Macrosiphum sp.?: WA, Kittitas—Manastash Ridge, 2 mi E of Lost Lk, 2-IX-95 on *Silene* sp. (95G545).

Metopolophium dirhodum (Walker): WA, Yakima—N Fork Tieton River, 15-VI-96 on native *Rosa* sp. (96K090†‡).

Metopolophium sp.?: WA, Yakima—YIR, Windy Point, 19-IX-95 on *Poa* sp. (95G634).

Microlophium nr *sibiricum*: WA, Yakima—Sunnyside, 28-VI-95 on *Urtica dioica* (95G255).

Myzus persicae (Sulzer): WA, Benton—WSU-Prosser, 27-X-95 & 1-X-97 on *Chenopodium album* (95K218†, 97G476).

Nasonovia aquilegiae (Essig): WA, Garfield—Stentz Springs, 1-VIII-95 on *Aquilegia formosa* (95T362†).

Nasonovia polemonii (G&P): WA, Kittitas—Quartz Mtn, 25-VII-96 on *Polemonium occidentale* (96G409).

Nasonovia (*Kakimia*) sp.: WA, Whitman—Pullman, 10-VIII-95 on *Lapsana communis* (95T436†‡).

Nearctaphis bakeri (Cowen): ID, Latah—Moscow Mtn, 3-VIII-96 on *Trifolium* sp. (96T400†‡).

Nearctaphis kachena (Hottes): WA, Spokane—nr Mt Spokane SP, 24-VIII-95 on *Castilleja* (95T485).

Phorodon humuli (Schrank): WA, Benton—WSU-Prosser, 9-IX-95 on *Humulus lupulus* (95K154).

Rhopalosiphum insertum (Walker): WA, Douglas—Orondo, 28-V-96 on *Pyrus malus* (96R004).

Rhopalosiphum padi (L.): WA, Benton [on *Triticum aestivum**]; Grant—Ephrata 8-VII-97 on *Zea mays* (97K058); Yakima—Sunnyside, 24-VIII-95 on *Zea mays* (95G519†).

Sitobion avenae (F.): WA, Benton—WSU-Prosser, 3 & 11-VII-97 on *Triticum aestivum* (97F192, 97F211); Kittitas—Buck Meadows, 9-VII-96 on *Dactylis glomerata* (96G346); Pierce—RNP, Tipsoo Lk, 11-IX-96 on *Carex* sp. (96G542†‡).

Uroleucon erigeronense (Thomas): WA, Kittitas—Lost Lk, 6-VIII-97 on *Aster* sp. (97G346); Lewis—Pierce—RNP, Tipsoo Lk, 8-IX-95 & 5-IX-97 on *Aster* sp. (95K106, 97G364†).

Uroleucon sonchi (L.): WA, Franklin—Mesa, 8-IX-97 on *Lactuca serriola* (97K006).

Uroleucon zymozionense (Knowlton): WA, Chelan—Swauk Pass, 1-VIII-95, on *Aster* sp. (95G491).

Uroleucon sp.: ID, Benewah—McCroskey SP, 31-VIII-95 on Compositae (95T528); WA, Pend Oreille—Tiger Meadows, 9-VII-96 on *Achillea millefolium* (96T222); Pierce—RNP, Tipsoo Lk, 5-IX-97 on *Anaphalis margaritacea* (97G367); Skamania [on Aster sp.*]; Spokane—nr Peone, 24-VIII-95 on *Centaurea pratensis* (95T473†).

Wahlgreniella nervata (Gillette): WA, Benton—Grandview, 13-V-97 on cultivated Rosa sp. (97G021†‡); Yakima—Hwy 410 & Sawmill Flat, 28-VII-97 on native *Rosa* sp. (97G289†‡).

Undetermined spp.: WA, Benton—Prosser, 23-VII-96 on *Sonchus oleraceus* (96G389); Kittitas—S Fork Manastash Cr, 24-VII-95 on *Potentilla* sp. (95G395); Whitman—Pullman, 5-VII-96, on *Geranium viscosissimum* (96T171).

Praon* nr *occidentale Baker

Illinoia sp.: WA, Yakima—Blowout Mtn, end of Little Naches River Rd, 9-IX-97 on *Rhododendron albiflorum* (97G400).

Uroleucon erigeronense (Thomas): WA, Kittitas—Lost Lk, 6-VIII-97 on *Haplopappus hirtus* (97G340†).

Uroleucon nr *ivae* Robinson: WA, Yakima—Harrah, 29-IX-97 on *Iva xanthifolia* (97G465).

Uroleucon suzannae Robinson: WA, Kittitas—Lost Lk, 6-VIII-97 on *Haplopappus hirtus* (97G340†‡).

Praon pequodorum Viereck

Acyrthosiphon macrosiphum (Wilson): WA, Asotin—nr Anatone, 18-VII-95, on *Amelanchier alnifolia* (95T266).

Acyrthosiphon pisum (Harris) [on *Medicago sativa* unless otherwise indicated]: WA, Adams—WSU-Othello, 26-VI-95 (95B008); Benton [†*]—WSU-Prosser, 27-VI-96 on *Vicia angustifolia* (96A009), 30-VI-97, & 11-VII-97 (97F186, 97F202); Grant—WSU-Royal City, 26-VI-95 (95B003, 95B006); Mattawa, 26-VI-95 (95B005); Yakima—Wenas Valley, 5 mi N of Selah, 30-V-96 on *Melilotus* sp. (96G109).

Amphorophora rubi (Kaltenbach): WA, Klickitat—Trout Lk, 29-VI-97 on *Rubus* sp. (97G168).

Illinoia sp.: WA, Spokane—Mt Spokane SP, 20-VII-95 on *Vaccinium* sp. (95T297).

Therioaphis riehmi (Börner): WA, Benton—WSU-Prosser, 18 & 25-VII-97, on *Melilotus officinalis* (97F254†‡).

Uroleucon ivae Robinson [on *Iva xanthifolia*]: WA, Yakima [*]—Grandview, 17,22, 30-VII-95 (95G313, 95G349, 95G366).

Uroleucon sonchi (L.): WA, Yakima—Grandview, 17-VII-95 on *Sonchus oleraceus* (95G348).

Praon simulans (Provancher)

Macrosiphum rhamni (Clarke) [det. by A. Jensen]: WA, King—Stampede Pass, 8-VIII-96 on *Pteridium aquilinum* (96G441).

Praon unicum Smith

Acyrthosiphon lactucae (Passerini) [on *Lactuca serriola*]: WA, Asotin—Asotin Cr WLA, 7-IX-95 (95T547); Benton—Prosser, 22-V-95 (95G079); Chelan—Chelan SP, 11-IX-97 (97K038); Kittitas [*].

Aphis coweni Palmer [on *Veratrum viride*]: WA, Skamania [*]; Yakima [*]—Pleasant Valley CG, 24-VII-97 (97G266).

Aphis craccivora Koch: WA, Whitman—Pullman, 7-VII-96, 2-VIII-96 on *Robinia pseudo-acacia* (96T199, 96T393).

Aphis nr *fabae* Scopoli: WA, Yakima—YIR, Windy Point, 19-IX-95 on *Cimicifuga laciniata* (95G630).

Aphis helianthi Monell: WA, Chelan—Stevens Pass, 16-IX-95 on *Epilobium angustifolium* (95K134†‡); Kittitas—Lost Lk, 24-VII-95 on *E. angustifolium* (95G399†‡); S. Fork Manastash Cr, 24-VII-95 on *Heracleum lanatum* (95G378); Whitman—Pullman, 1-VIII-95 on *Coriandrum sativum* (95T386†); Yakima—American River, 5-IX-97 on *Heracleum lanatum* (97G382); nr Wenas Lk, 17-VI-97 on *Lomatium* sp. (97G095†); YIR, Piscoe Cr, 25-VII-95 on *Ligusticum grayi* (95G432) & *Osmorhiza occidentalis* (95G428).

Aphis nigratibialis Robinson: WA, Kittitas—S. Fork Manastash Cr, mi marker 12, 25-VI-97 on *Cornus stolonifera* (97G129).

Aphis oenotherae (Oestlund): ID, Benewah—McCroskey SP, 31-VIII-95 on *Epilobium angustifolium* (95T533).

Aphis nr *oenotherae* (Oestlund) [on *Epilobium* sp. unless otherwise indicated]: WA, Benton—Kennewick, 28-IX-96 (96G597); Garfield—FR 160 & FR 40, 21-IX-95 (95T594); Spruce Springs, 22-VIII-95 (95T462†); Stentz Springs, 14-IX-95 (95T565); Yakima—American River, 5-IX-97 on *Epilobium minutum*

(97G375†); Pleasant Valley CG, 24-VII-97 on *Epilobium minutum* (97G267†); Wenas Cr, 13-VIII-96 (96G467).

Aphis pomi de Geer: WA, Douglas—Bridgeport, 17-VI-96 on *Pyrus malus* (96X007†‡).

Aphis rumicis L.: WA, Benton, on [*Rumex crispus**].

Aphis salicariae Koch [on *Epilobium angustifolium*]: ID, Kootenai—Rathdrum, 29-VII-95 (95G443†); WA, Chelan—1-VIII-95 (95G481†).

Aphis nr *salicariae* Koch [on *Epilobium angustifolium*]: WA, Chelan—Swauk Pass, 1-VIII-95 (95G492†); Yakima—YIR, Old Mead Canyon, 25-VII-95 (95G442).

Aphis varians Patch [on *Epilobium angustifolium*]: ID, Kootenai—Rathdrum, 29-VII-95 (95G443†); WA, Chelan—Stevens Pass, 16-IX-95 (95K134†‡); Kittitas—Lost Lk, 24-VII-95 (95G399†‡).

Aphis nr *varians* Patch: WA, Chelan—1-VIII-95 on *Epilobium angustifolium* (95G481†).

Aphis sp.: WA, Chelan—Chelan SP, 11-IX-97 on *Salix* sp. (97K042†); Garfield—Bear Cr Rd, 14-IX-95 on *Lilium columbianum* (95T577); Kittitas—Taneum Lk, 11-IX-97 on *Pedicularis racemosa* (97G411†‡); Whitman—Pullman, 12-VIII-96 on *Helianthus annuus* (96T438); Yakima—YIR, Windy Point, 19-IX-95 on *Cimicifuga laciniata* (95G631).

Brachycaudus helichrysi (Kaltenbach): WA, Yakima—Wenas, 11-VI-97 on *Prunus domestica* (97G079).

Brachycaudus tragopogonis (Kaltenbach): WA, Whitman—Pullman, 12-IX-95 on *Tragopogon dubius* (95T561).

Cavariella aegopodii (Scopoli): WA, Yakima—nr Wenas Lk, 17-VI-97 on *Lomatium* sp. (97G095†) & Umbelliferae (97G097).

Cavariella pastinacae (L.): WA, Yakima—N. Fork Tieton River, 27-VI-96 on *Heracleum lanatum* (96G288).

Diuraphis noxia (Kurdjumov) [on *Triticum aestivum*]: WA, Asotin—Asotin Cr Rd, 20-VI-95 (95T161); Benton [*]; Klickitat—Bickleton, 6-VIII-97 (97G354); Spokane—Mt Spokane SP, 22-VII-95 (95T495).

Dysaphis plantaginea (Passerini) [on *Pyrus malus*]: WA, Chelan—WSU-Wenatchee, 30-V-96, 13-VI-96 (96R009, 96R028); Yakima—Grandview, 26,28-VI-96 (96G282, 96G308).

Ericaphis gentneri (Mason): WA, Benton—WSU-Prosser, 24-VI-97 on *Crataegus* sp. (97G124).

Hyperomyzus lactucae (L.): WA, Whitman—Pullman, 12-IX-95 on *Lactuca serriola* (95T559).

Hyperomyzus nigricornis (Knowlton): WA, Garfield—Alder Thicket, FR 40, 22-VIII-95 on *Senecio* sp. (95T447); Kittitas—Ellensburg, 13-VI-97 on *Ribes* sp. (97G084).

Macrosiphum euphorbiae (Thomas): ID, Kootenai—Rathdrum, 29-VII-95 on *Epilobium angustifolium* (95G443†); WA, Kittitas—Lost Lk, 6-VIII-97 on *Castilleja* (97G342†); Yakima [on *Solanum lycopersicon**].

Macrosiphum gaurae (Williams): WA, Yakima—Wenas Lk, 11-VI-97 on *Madia* sp. (97G059).

Macrosiphum pallidum (Oestlund): WA, Yakima—American River, 5-IX-97 on *Epilobium minutum* (97G375†).

Macrosiphum valerianae (Clarke): WA, Kittitas—Lost Lk, 24-VII-95 on *Epilobium angustifolium* (95G399†‡).

Macrosiphum sp. [nr *fuscicornis* MacDougall & *pallidum* (Oestlund)]: WA, Chelan—Swauk Pass, 1-VIII-95 on *Epilobium angustifolium* (95G492†).

Metopolophium dirhodum (Walker): WA, Yakima—Glade Rd, 7-VII-97 on *Triticum aestivum* (97G217†).

Myzodium knowltoni Smith & Robinson: WA, Klickitat—John Day Dam, 28-IV-95 on *Veronica anagallis-aquatica* (95G009†‡).

Myzus cerasi (F.): WA, Chelan—Wenatchee Heights, 6-VI-96 on *Prunus* sp. (96R019).

Myzus persicae (Sulzer): WA, Douglas—Orondo, 25-V-95 on *Prunus armeniaca* (95R011); Klickitat—John Day Dam, 28-IV-95 on *Veronica anagallis-aquatica* (95G009†); Whitman—Pullman, 13-VI-96 on unknown plant (96T031†).

Myzus sp.: WA, Whitman [on *Forsythia* sp.*].

Nasonovia ribisnigri (Mosley): WA, Pierce—RNP, Tipsoo Lk, 5-IX-97 on *Castilleja* sp. (97G361†).

Nasonovia (Kakimia) sp.: WA, Garfield—Spruce Spring, 22-VIII-95 on *Castilleja* sp. (95T463†‡); Kittitas—Lost Lk, 6-VIII-97 on *Castilleja* sp. (97G342†); Whitman—Kamiak Butte, 12-IX-95 on *Penstemon* sp. (95T551).

Nearctaphis bakeri (Cowen): WA, Asotin—De Spain Springs, 1-VIII-95 on *Penstemon* sp. (95T383).

Nearctaphis kachena (Hottes) [on *Castilleja* sp. unless otherwise indicated]: ID, Benewah—McCroskey SP, 31-VIII-95 (95T522); WA, Garfield—Spruce Spring, 22-VIII-95 (95T463†‡); Teal Springs, 22-VIII-96 (96T484); Kittitas—Lost Lk, 6-VIII-97 (97G342†); Taneum Lk, 11-IX-97 on *Pedicularis racemosa* (97G411†‡); Spokane—Mt Spokane SP, 24-VIII-95 (95T479, 95T485); Yakima—YIR, Mt Adams Lk Rd, 23-VI-95 (95G242).

Phorodon humuli (Schrank) [on *Prunus salacina* unless otherwise indicated]: WA, Benton—WSU-Prosser, 19,25-IV-95, 1-V-95 (95G006, 95G007, 95G016), 9-IX-95 on *Humulus lupulus* (95K154); Yakima—Sunnyside, 24-V-96 on *H. lupulus* (96G079†); Yakima Arboretum, 30-V-96 (96G104).

Rhopalosiphum insertum (Walker): WA, Chelan—WSU-Wenatchee, 30-V-96 on *Pyrus communis* (96R015), 17-V-95 on *Pyrus malus* (95R007); Douglas—Orondo, 25-V-95 on *Pyrus communis* (95R010), 11 & 28-V-96 on *Pyrus malus* (96R003, 96R004, 96X005); Bridgeport, 12 & 17-VI-96 on *Pyrus malus* (96X006, 96X007†); Kittitas—Ellensburg, 17-V-96 on *Crataegus columbiana* (96G066).

Rhopalosiphum maidis (Fitch): WA, Benton [on *Panicum milliaceum**]; Yakima—Sunnyside, 2-X-95 on *Hordeum vulgare* (95G671†).

Rhopalosiphum padi (L.): WA, Benton [on *Triticum aestivum & Hordeum vulgare**]—WSU-Prosser, 24-IV-92, on *T. aestivum* (92A010); Grant—Ephrata, 8-VII-97, on *Zea mays* (97K058); Yakima—Sunnyside, 2-X-95 on *H. vulgare* (95G671†).

Sitobion avenae (F.) [on *Triticum aestivum* unless otherwise indicated]: WA, Asotin—De Spain Springs, 24-VII-96 on *Aquilegia formosa* (96T339); Benton—West Richland, 28-VI-95 (95G279); WSU-Prosser, 3, 11 & 18-VII-97 (97F191, 97F192, 97F215, 97F217, 97F227, 97F243, 97F249, 97F253, 97F256); Yakima—Glade Rd, 7-VII-97 (97G217†).

Uroleucon sp.: ID, Benewah—McCroskey SP, 31-VIII-95 on unknown plant (95T520); Kootenai—Rathdrum, 29-VII-95 on *Epilobium angustifolium* (95G443†).

Undetermined spp.: WA, Whitman—Pullman, 19-VI-96 on *Pyrus malus* (96T042).

Praon* nr *unicum Smith

Euceraphis gillettei Davidson: WA, Kittitas—Manastash Rd, 25-VI-97 on *Alnus* sp. (97G134†‡).

Oestlundiella flava (Davidson): WA, Kittitas—Manastash Rd, 25-VI-97 on *Alnus* sp. (97G134†‡).

Praon yakimanum Pike & Starý

Cavariella pastinacae (L.): WA, Asotin—Asotin Cr, 11-VII-95 on *Oenothera* (95T196).

Diuraphis noxia (Kurdjumov) [on *Triticum aestivum*]: WA, Asotin—Pataha Cr Rd, 10-VIII-95 (95T435); Benton [*]—WSU-Prosser, 23-V-97 (97F100, 97F112); Klickitat—Bickleton, 9-VII-95 (95G319†).

Metopolophium dirhodum (Walker): WA, Yakima—Sunnyside, 28-VI-95 on *Phalaris arundinacea* (95G254).

Rhopalosiphum padi (L.): WA, Benton [on *Triticum aestivum & Hordeum vulgare**]; Grant—Ephrata, 8-VII-97 on *Zea mays* (97K058).

Sitobion avenae (F.): WA, Klickitat—Bickleton, 9-VII-95 on *Triticum aestivum* (96G319†).

Undetermined sp.: WA, Spokane—Turnbull National WLA, 13-VI-95 on *Amelanchier alnifolia* (95T414).

***Praon* spp.**

Acyrthosiphon lactucae (Passerini) [on *Lactuca serriola*]: WA, Kittitas—S Fork Manastash Cr, 24-VII-95 (95G376); Ellensburg, 22-VI-96 (96G266); Yakima—Grandview, 20-X-95 (95G728).

Acyrthosiphon pisum (Harris): MT, Sander [on *Lathyrus odoratus**]; WA, Yakima—YIR, Delaney Springs, 25-VII-95 on *Vicia* sp. (95G408).

Amphorophora rubi (Kaltenbach): WA, Klickitat—Trout Lk, 29-VI-97 on *Rubus* sp. (97G168).

Amphorophora sensoriata Mason: WA, Yakima—Grandview, 22-VII-95 on *Rubus* sp. (95G368).

Aphis armoraciae Cowen: WA, Kittitas [on *Mertensia paniculata**].

Aphis ceanothi Clarke: WA, Kittitas—S Fork Manastash Cr, 25-VI-97 on *Ceanothus velutinus* (97G137).

Aphis coweni Palmer: WA, Kittitas [on *Veratrum viride**].

Aphis fabae Scopoli: WA, Kittitas—Lost Lk, 6-VIII-97 on *Senecio* sp. (97G335).

Aphis pomi de Geer: WA, Yakima [on *Pyrus malus**].

Aphthargelia symphoricarpi (Thomas) [on *Symphoricarpos* sp.]: WA, Kittitas [*]; Klickitat—Trout Lk, 29-VI-97 (97G159).

Aspidophorodon longicauda (Richards): WA, Skamania [on *Spiraea* sp. *].

Cavariella aegopodii (Scopoli): WA, Garfield—nr FR40 & FR44, 22-VIII-95 on *Osmorhiza chilensis* (95T464†‡).

Ceruraphis viburnicola (Gillette): WA, Skamania [on *Carex* sp.*].

Chaetosiphon fragaefolii (Cockerell): ID, Boundary [on *Rosa* sp.†*]; WA, Pend Oreille—Le Clerc WLA, 3-VIII-95 on native *Rosa* sp. (95T398); WA, Stevens—Little Pend Oreille National WLA, 9-VII-96 on native *Rosa* sp. (96T209†‡).

Epameibaphis atricornis G&P: WA, Benton—WSU-Prosser, 4-V-95 on *Chrysothamnus nauseosus* (95G020†‡).

Ericaphis gentneri (Mason): WA, Kittitas—Colockum Pass, 2-VII-97 on *Crataegus* sp. (97G214).

Ericaphis scammelli (Mason): Stevens—Little Pend Oreille National WLA, 9-VII-96 on native *Rosa* sp. (96T209†‡).

Hyperomyzus lactucae (L.): WA, Benton [on *Sonchus oleraceus*†*].

Hyperomyzus nigricornis (Knowlton): WA, GARFIELD—Wickiup CG, 29-VIII-95 on *Hieracium* sp. (95T508); KITTITAS—Ellensburg, 23VI–96 on *Ribes* sp. (96G267).

Hyperomyzus sp.: WA, BENTON [on *Sonchus oleraceus**].

Illinoia nr *crystleae* (Smith & Knowlton): WA, KITTITAS—S Fork Manastash Cr Rd, mi marker 8, 16-VIII-96 on *Lonicera involucrata* (96G489).

Illinoia maxima (Mason): WA, KLICKITAT—Trout Lk, 29-VI-97 on *Rubus parviflorus* (97G164).

Illinoia rhododendri (Wilson): WA, KITTITAS [on *Rhododendron albiflorum**].

Illinoia sp.: WA, GARFIELD—Stentz Springs, 1-VIII-95 on *Thalictrum* sp. (95T367); PIERCE—RNP, nr Tipsoo Lk, 16-VIII-95 on *Spiraea densiflora* (95A037); SPOKANE—Mt Spokane SP, 27-VII-95, on *Vaccinium* sp. (95T346).

Macrosiphoniella ludovicianae (Oestlund): WA, ASOTIN—Couse Cr Rd, mi marker 5, 18-VII-95 on *Artemisia ludoviciana* (95T257).

Macrosiphoniella tanacetaria (Kaltenbach): WA, SPOKANE—nr Mt Spokane, 29-VI-95 on *Tanacetum vulgare* (95T172†‡).

Macrosiphum albifrons Essig [on *Lupinus* sp.]: WA, KING—Stampede Pass, 8-VIII-96 (96G444); KLICKITAT—Trout Lk, 11-VII-95 (95K068).

Macrosiphum californicum (Clarke): WA, SPOKANE—Mt Spokane SP, 27-VII-95, on *Salix* sp. (95T348).

Macrosiphum euphorbiae (Thomas): ID, LATAH—Moscow Mtn, 3-VIII-96 on *Castilleja* sp. (96T398); WA, GARFIELD—nr FR40 & FR44, 22-VIII-95 on *Osmorhiza chilensis* (95T464†‡); SPOKANE—nr Mt Spokane, 29-VI-95 on *Tanacetum vulgare* (96T172†); YAKIMA [on *Chenopodium album*†*]—N Fork Tieton River, 15-VI-96 on *Hieracium albertinum* (96K094).

Macrosiphum nr *euphorbiae* (Thomas): WA, YAKIMA—YIR, Mill Cr Guard Station, 6-VI-95 on *Lomatium nudicaule* (95G115).

Macrosiphum nr *gaurae* (Williams) [det. by A. Jensen]: WA, YAKIMA—Wenas Lk, 11-VI-97 on *Mentzelia laevicaulis* (97G052).

Macrosiphum pallidum (Oestlund): WA, SPOKANE—Cheney, 23-V-95 on native *Rosa* sp. (95K006).

Macrosiphum rosae (L.): WA, WHITMAN—Pullman, 1-VIII-96 on cultivated *Rosa* sp. (96T376); YAKIMA [on *Rosa* sp.*].

Macrosiphum sp.: WA, YAKIMA—YIR, Howard Lk, 19-IX-95 on *Pteridium aquilinum* (95G640).

Macrosiphini [immatures]: WA, BENTON—WSU-Prosser, 27-X-95 on *Malva neglecta* (95K212†).

Metopolophium dirhodum (Walker): WA, YAKIMA—Sunnyside, 28-VI-95 on *Phalaris arundinacea* (95G254).

Microsiphoniella artemisiae (Gillette): WA, ASOTIN—Asotin Cr HMU, 5-VII-96 on *Artemisia ludoviciana* (96T141).

Myzus cerasi (F.) [on *Prunus avium*]: WA, BENTON [*] WHITMAN—Pullman, 5-VII-96 (96T173).

Myzus persicae (Sulzer): WA, BENTON—WSU-Prosser, 20V–97 on *Prunus persica* (97G036).

Myzus sp.: WHITMAN [on *Forsythia* sp.*].

Nasonovia nr *cynosbati* (Oestlund): WA, YAKIMA—N Fork Tieton River, 15-VI-96 on native *Ribes* sp. (96K091).

Nasonovia polemonii (G&P): WA, KITTITAS—Buck Meadows, 9-VII-96, on *Polemonium pulcherrimum* (96G347).

Nasonovia (*Kakimia*) sp.: WA, SPOKANE—nr Peone, 29-VI-95 on *Phlox* sp. (95T176); YAKIMA—YIR, nr Mt Adams Lk, 4-VIII-95 on *Lonicera cilosa* (95K091).

Nearctaphis sp.: WA, ASOTIN—De Spain Springs, 11-VII-96 on *Castilleja* sp. (96T236).

Pleotrichophorus sp.: WA, BENTON—WSU-Prosser, 4-V-95 on *Chrysothamnus nauseosus* (95G020†‡); KLICKITAT—Alderdale & Mabton-Bickleton Rds, 28-IV-95 on *Chrysothamnus* sp. (95G012).

Rhopalomyzus lonicerae (Siebold): WA, SPOKANE—nr Peone, 13-VII-95 on unknown Gramineae (95T228).

Rhopalosiphum maidis (Fitch): WA, BENTON [on *Echinochloa crus-galli*†*].

Rhopalosiphum nymphaeae (L.): WA, YAKIMA—Morgan Lk, 28-VI-95 on *Nymphaea* sp. (95G262).

Rhopalosiphum padi (L.): WA, BENTON [on *Echinochloa crus-galli*†*].

Sitobion avenae (F.) [on *Triticum aestivum*]: WA, BENTON—WSU-Prosser, 25-VII-97 (97F276); YAKIMA—Zillah, 28-VI-95 (95G270).

Uroleucon nr *erigeronense* (Thomas): WA, KITTITAS—Buck Meadows, 9-VII-96 on *Hieracium albiflorum* (96G340).

Uroleucon ivae Robinson: WA, YAKIMA [on *Iva xanthifolia**].

Uroleucon russellae (HRL): WA, SKAMANIA [on *Anaphalis margaritacea**].

Uroleucon sonchi (L.): WA, BENTON—WSU-Prosser, 6-VII-95 on *Sonchus oleraceus* (95A025).

Uroleucon sp.: WA, YAKIMA—Union Gap, 23-X-95 on *Centaurea maculosa* (95G720).

Undetermined spp.: MT, SANDERS [on *Senecio* sp.*]; OR, UMATILLA—Harris Pk, 11-VI-96 on *Pteridium* *aquilinum* (96G235); WA, Asotin—nr Anatone, 30-V-95 on *Philadelphus lewisii* (95T042); De Spain Springs, 24-VII-96 on Compositae (96T346); Kittitas—Quartz Mtn, 25-VII-96 on *Rubus lasiococcus* (96G407); Klickitat—nr Cleveland, 7-VII-97 on *Lotus pinnatus* (97G233); Whitman—Pullman, 9-VII-96 on *Lactuca serriola* (96T228); 25-VII-95, on *Lapsana communis* (95T332); Yakima—N Fork Tieton River, 27-VI-96 on *Achlys triphylla* (96G289).

Genus *PSEUDOPRAON* Starý

Pseudopraon mindariphagum Starý

Mindarus abietinus Koch: WA, Yakima—Yakima Arboretum, 30-V-96, on *Abies concolor* (96G102).

Mindarus sp.: WA, Yakima—Grandview, 10-VI-96, on *Abies grandis* (96G215); N. Fork Tieton River, 15-VI-96, on *Abies* sp. (96K098†).

Genus *TOXARES* Haliday

Toxares deltiger (Haliday)

Macrosiphum adianti (Oestlund): OR, Benton—McDonald State Forest, on unknown plant, 21-V-91 (91J002).

Macrosiphum walkeri Robinson [det. by A. Jensen]: OR, Hood River—Starvation Cr, 21-IX-95 on *Polypodium glycyrrhiza* (95K180).

Genus *TRIOXYS* Haliday

Trioxys artemisiarum Pike & Starý

Aphis (*Zyxaphis*) *canae* Williams: WA, Douglas—Badger Mtn, 13-VII-95, on *Artemisia tridentata* (95B012†‡).

Macrosiphoniella ludovicianae (Oestlund) [on *Artemisia ludoviciana*]: WA, Asotin [*]—Asotin Cr WLA, 5-VII-96 (96T138).

Microsiphoniella artemisiae (Gillette): WA, Asotin—Asotin Cr HMU, 5-VII-96, on *Artemisia ludoviciana* (96T141).

Trioxys bonnevillensis Smith

Aphis canae Williams [on *Artemisia tridentata*]: WA, Douglas—Badger Mtn, 13-VII-95 (95B012†); Franklin—Kahlotus Hwy, 11-VI-96 (96G242†‡).

Artemisaphis artemisicola (Williams) [on *Artemisia tridentata*]: WA, Benton—Six Prong Rd, 24-IV-97 (97G008†); Franklin—Kahlotus Hwy, 11-VI-96 (96G242†); Yakima, Glade Rd, 18-VI-97 (97G103†‡).

Epameibaphis atricornis G&P [on *Artemisia tridentata*]: WA, Benton [*]—Ale, 19-V-95 (95G072†); Byron Rd, 14-V-97 (97G024†‡); Klickitat [*]; Yakima [†*].

Epameibaphis utahensis Knowlton & Smith: WA, Klickitat [on *Artemisia tridentata*†*].

Epameibaphis sp.: WA, Benton—Ale, 8-Vi-95 on *Artemisia tridentata* (95G151†).

Flabellomicrosiphum knowltoni Smith [on *Artemisia tridentata*]: WA, Benton [†*]; Yakima [†*]—YIR, Fort Simcoe, 30-V-95 (95G091).

Flabellomicrosiphum tridentatae (Wilson) [on *Artemisia tridentata*]: WA, Franklin [*]—Juniper Sand Dunes, 23-V-95 (95G088†, 95G089†); Klickitat [†*]—Alderdale Cr & Columbia River Rds, 28-IV-95 (95G013).

Flabellomicrosiphum sp. [on *Artemisia tridentata*]: WA, Klickitat [†*] & Yakima [†*].

Microsiphoniella acophorum (Smith & Knowlton) [on *Artemisia tridentata*]: WA, Franklin [*]—Juniper Sand Dunes, 23-V-95 (95G088†, 95G089†); Franklin [†*].

Microsiphoniella sp. (Smith & Knowlton): WA, Benton [on *Artemisia tridentata* †*].

Obtusicauda artemisiphila (Knowlton & Allen): WA, Benton—ALE, 10-V-95 on *Chrysothamnus nauseosus* (95G033†); Klickitat—nr Roosevelt [on *Artemisia tridentata*†*].

Obtusicauda coweni (Hunter): WA, Asotin—Asotin Cr HMU, 7-V-96 on *Artemisia tridentata* (96T142†).

Obtusicauda filifoliae (G&P) [on *Artemisia tridentata*]: WA, Benton—Byron Rd, 14-V-97 (97G024†‡); nr Prosser, Rotha Rd, 2-V-95 (95G017†‡); Klickitat [†‡*]; Yakima [†‡*].

Obtusicauda sp. [on *Artemisia tridentata*]: WA, Benton [†‡*]; Klickitat [†‡*]; Yakima [†‡*].

Pleotrichophorus quadritrichus (Knowlton & Smith)?: WA, Yakima—Wenas Lk, 11-VI-97 on *Artemisia tridentata* (97G058†‡).

Pleotrichophorus sp. [on *Artemisia tridentata*]:. WA, Benton [†‡*]; Klickitat—Alderdale Rd, 9-V-95 (95G028†‡).

Pseudoepameibaphis essigi Knowlton & Smith: WA, Klickitat [on *Artemisia tridentata* †*].

Pseudoepameibaphis tridentata (Wilson) [on *Artemisia tridentata*]: WA, Benton [†*]—Ale, 19-V-95 (95G072†); Byron Rd, 14-V-97 (97G024†‡); Klickitat [†*]—Alderdale Rd, 9-V-95 (95G028†); Kittitas

[†*]; YAKIMA [†*]—Naught Rd, 18-VI-97 (97G103†‡, 97G120); Wenas Lk, 11-VI-97 (97G058†); YIR, Ft. Simcoe, 30-V-96 (95G091†).

Trioxys cirsii (Curtis)

Drepanosiphum platanoidis (Schrank): WA, BENTON [on *Acer pseudoplatanus**].

Trioxys complanatus Quilis

Therioaphis riehmi (Börner) [on *Melilotus* sp.]: WA, BENTON—WSU-Prosser, 11 & 18-VII-97 on *Melilotus officinalis* (97F218†, 97F254†); KLICKITAT—Roosevelt, 24-IV-96 (96G014†); YAKIMA, YIR, Signal Peak, 19-IX-95 (95G625†).

Therioaphis sp.: WA, BENTON—WSU-Prosser, 28-VI-95 on *Medicago sativa* (95G277†).

Trioxys pallidus (Haliday) [group]

Chromaphis juglandicola (Kaltenbach) [on *Juglans regia*]: WA, BENTON—WSU-Prosser, 6-IX-95 (95K143†); KLICKITAT—Bickleton, 27-VIII-96 (96G511); YAKIMA [*]—Yakima Arboretum, 26-IX-95 (95G657).

Eucallipterus tiliae (L.) [on *Tilia americana*]: MT, LINCOLN—Libby, 29-VII-95 (95G449); WA, BENTON—Prosser, 1-VIII-95, 25-IX-95 (95A029, 95G647, 95G648); WHITMAN—Pullman, 9-X-96 (96T586).

Monelliopsis caryae (Monell) [on *Juglans nigra* unless otherwise indicated]: WA, BENTON [on *J. regia**]; WSU-Prosser, 6-IX-95 (95G650†); YAKIMA [*]—Yakima Arboretum, 7-VII-94 & 26-IX-95 (94K020, 95G656).

Myzocallis coryli (Goeze): WA, CLARK—WSU-Vancouver, 21-IX-95 on *Corylus* sp. (95K176).

Myzocallis multisetis Boudreaux & Tissot: WA, BENTON—WSU-Prosser, 9-IX-95 on *Quercus borealis* (95K158).

Myzocallis sp.: WA, BENTON [on *Quercus rubra**]; WHITMAN—Pullman, 9-X-96 on *Quercus* sp. (96T579).

Panaphis juglandis (Goeze) [on *Juglans regia*]: WA, BENTON [*]—Prosser 25-IX-95 (95G646); WSU-Prosser, 6-IX-95 (95K143†); YAKIMA [*]—Grandview, 25-IX-95 (95G653).

Trioxys rosae Pike & Starý

Macrosiphum pallidum (Oestlund): WA, SPOKANE—nr Cheney, 23-V-95 on native *Rosa* sp. (95K006).

Macrosiphum rosae (L.): WA, YAKIMA [on native *Rosa* sp.*].

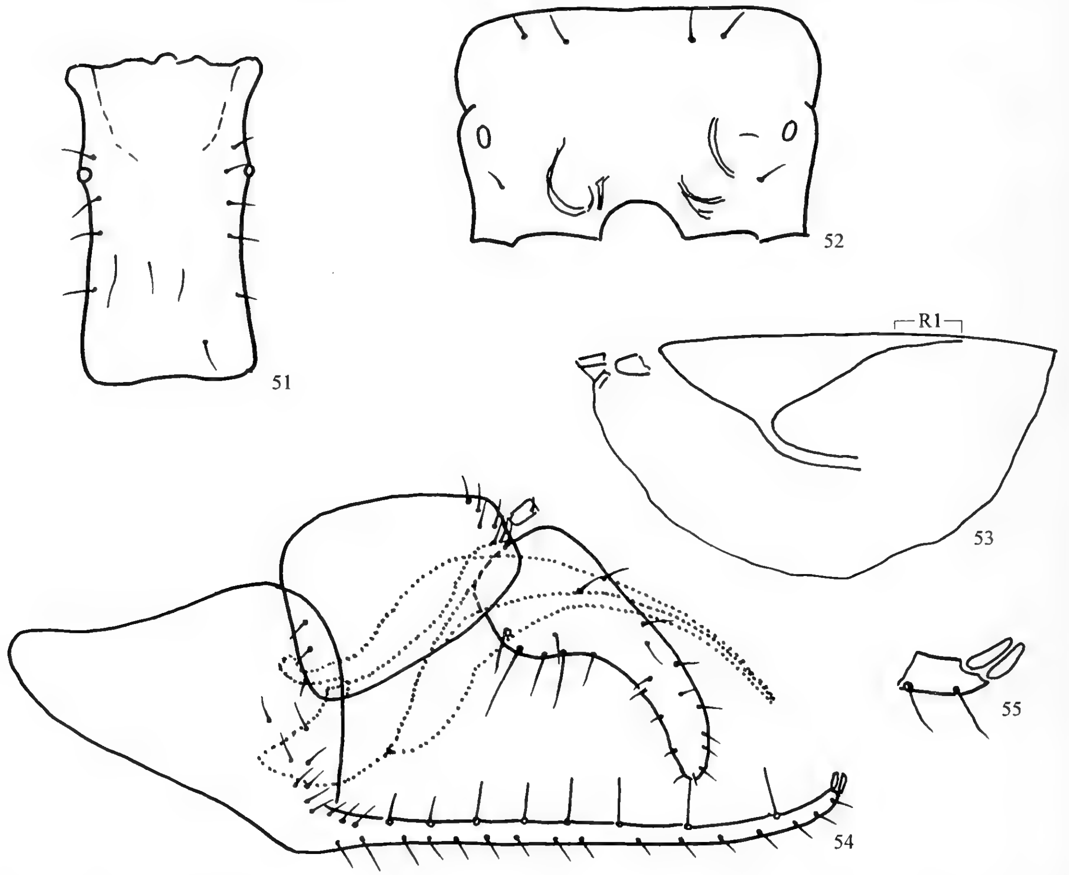
Trioxys setaceus Pike and Starý, new species

(Figs. 51–55)

Diagnosis.—The new species is similar to *T. artemisiarum* Pike and Starý, from which it may be distinguished as follows: head prevalently dark brown; antenna 11-segmented; metasomal tergum 1 parallel-sided, not dilated to apex; prong dorsal surface with 6 perpendicular setae and 2 shorter setae close to the base; last sternum with a group or longitudinal row of setae equal in length with 2 neighboring setae at dorsal base of prong.

Etymology.—The name of the new species is derived from the presence of numerous setae on the prong of the last metasomal sternum.

Description.—Female. *Head:* Eye large. Malar space equal to $\frac{1}{7}$ eye length. Tentorio-ocular line $\frac{1}{7}$ intertentorial line. Antenna 11-segmented, reaching to mid-metasoma. Flagellomeres F_3 to F_9 approximately equal in size, F_2 to F_5 as long as wide. *Mesosoma:* Mesosoma smooth, with a simple row of sparse individual setae tracing the effaced notauli on the disc. Propodeum (Fig. 52) smooth, with indications of short carinae or longitudinal rugosites in the distal portion. *Forewing* (Fig. 53): Stigma triangular, length 3× width; distal abscissa of R1 (metacarpus) short, distinctly shorter than stigma width. *Metasoma:* Metasomal tergum 1 (Fig. 51) length almost 2× width at spiracles (spiracles slightly prominent), roughly parallel sided from spiracle to posterior margin. *Genitalia* (Fig. 54): Prong straight, except for slight curve apically, apex with 2 longitudinally dilated setae (Fig. 55). Prong dorsal setae perpendicular (6 setae about 2× prong diameter, 2 near base short equal to prong diameter and to setae on distal part of last sternum); prong ventral setae numerous, oblique, about equal to prong diameter. *Coloration:* Head dark brown; lower part, clypeus, and gena yellow, palpi light yellow. Antenna scape, pedicel, and base of flagellomere 1 yellow, remaining antenna brown. Legs yellow brown, trochanters and base of tibia somewhat lighter. Hind leg with dark tinge. Metasomal tergum 1 yellow,



Figs. 51–55. *Trioxys setaceus,* ♀ [illustrations not to equal scale]. 51, Metasomal tergum 1. 52, Propodeum. 53, Fore wing, in part. 54, Genitalia. 55, Prong, close-up of apex. Abbreviations: R1, distal abscissa of postmarginal vein [= metacarpus].

terga 2 and 3 with yellow center and brown lateral spots; middle terga brown; distal tergum yellow. Ovipositor sheath yellow with brown apex; prong completely yellow to brownish at apex. *Length of body:* about 1.9–2.2 mm.

Male.—Antenna 13-segmented. Coloration: head brown; clypeus and mandibles yellow, palpi light brown. Mesosoma brown. Wings hyaline, venation brown. Legs light brown, trochanter and base of tibia yellow. Metasoma brown, except tergum 1 yellow.

Holotype.—♀, USA, WA, Asotin Co., Schumaker Rd, 18-VII-1995, T. Miller collector (collection code 95T266). Host aphid: *Acyrthosiphon macrosiphum* (Wilson) on *Amelanchier alnifolia.* Deposited in USNM.

Paratypes.—5 specimens, collection data same as holotype, deposited in collection of WSU-Prosser (4 ♀, 1 ♂).

Other material reared from:

Acyrthosiphon macrosiphum (Wilson) [on *Amelanchier alnifolia,* unless indicated otherwise]: MT, Lincoln—Libby, 6-VII-96 (96G322); WA, Asotin—Anatone, 18-VII-95 (95T266, 13 specimens); Pend Oreille—Le Clerc WLA, 3-VIII-95 (95T402); Spokane, Cooper Rd nr Hwy 206, 29-VI-1995 (95T180, 5 specimens); nr Mt Spokane, on *Ribes* sp.?, (95T174).

Trioxys tenuicaudus Starý

Eucallipterus tiliae (L.): WA, BENTON—Prosser, 25-IX-95 on *Tilia americana,* (95G647, 95G648); KLICKITAT—Trout Lk, 29-VI-97 on *T.* sp. (97G174); WHITMAN—Pullman, 14-VIII-96 on *T. americana,* (96T443).

***Trioxys* spp.**

Aphis coweni Palmer: WA, KITTITAS [on *Veratrum viride**].

Chaetosiphon fragaefolii (Cockerell): WA, SPOKANE—Turnbull National WLA, 1-VI-95, on native *Rosa* sp. (95T048).

Eucallipterus tiliae (L.): WA, WHITMAN—Pullman, 1-VIII-96 on *Tilia americana* (96T377).

Euceraphis sp.: WA, SKAMANIA—Yellow Jacket Cr, 25-IX-94 on *Trautvetteria caroliniensis* (94G021†‡).

Macrosiphoniella ludovicianae (Oestlund): WA, YAKIMA—Naches, 28-VII-97 on *Artemisia ludoviciana* (97G277).

Macrosiphum rosae (L.): WA, YAKIMA—nr Yakima, 3-VI-94 on native *Rosa* sp. (94/063).

Monelliopsis nr *caryae* (Fitch): WA, BENTON—WSU-Prosser, 24-VI-97 on *Juglans nigra* (97G126).

Myzocallis nr *granovskyi* Boudreaux & Tissot: WA, BENTON—WSU-Prosser, 24-VI-97 on *Quercus rubra* (97G125).

Oestlundiella flava (Davidson): WA, SKAMANIA—Yellow Jacket Cr, 25-IX-94 on *Trautvetteria caroliniensis* (94G021†‡).

Panaphis juglandis (Goeze): WA, BENTON—WSU-Prosser, 24-VI-97 on *Juglans regia* (97G127).

Pleotrichophorus sp.: WA, YAKIMA [on *Haplopappus resinosus**].

Genus *XENOSTIGMUS* Smith

Xenostigmus bifasciatus (Ashmead)

Cinara ponderosae (Williams) [on *Pinus ponderosa*]: WA, ASOTIN—De Spain Spring, 5-VII-96 (96T149); YAKIMA [*].

Cinara sp.: WA, ASOTIN—Cooper Canyon, 18-VII-96 on *Pinus ponderosa* (96T308).

Undetermined sp.: WA, YAKIMA—Clear Lk, 15-VI-96 on *Pinus ponderosa* (96K087).

APHID HOST—PARASITOID INDEX

‡—INDICATES APHID-PARASITOID ASSOCIATION NOT CERTAIN

- *Acyrthosiphon kondoi*
  - *Aphidius ervi*
- *Acyrthosiphon lactucae*
  - *Aphidius avenaphis* ‡
  - *Aphidius ervi*
  - *Aphidius polygonaphis*
  - *Aphidius* sp.
  - *Diaeretiella rapae*
  - *Ephedrus californicus*
  - *Lysiphlebus testaceipes*
  - *Praon occidentale*
  - *Praon unicum*
  - *Praon* sp.
- *Acyrthosiphon macrosiphum*
  - *Aphidius* sp.
  - *Lysiphlebus testaceipes*
  - *Praon humulaphidis*
  - *Praon pequodorum*
  - *Trioxys setaceus*
- *Acyrthosiphon pisum*
  - *Aphidius ervi*
  - *Aphidius* nr *pisivorus*
  - *Aphidius pulcher*
  - *Aphidius smithi*
  - *Aphidius* sp.
  - *Diaeretiella rapae*
  - *Lysiphlebus testaceipes*
  - *Monoctonus* sp.
  - *Praon occidentale*
  - *Praon pequodorum*
  - *Praon* sp.
- *Amphorophora geranii*
  - *Aphidius* sp.
  - *Praon occidentale*
- *Amphorophora parviflori*
  - *Aphidius polygonaphis*
- *Amphorophora rubi*
  - *Praon pequodorum*
  - *Praon* sp.
- *Amphorophora* nr *rubitoxica*
  - *Aphidius* sp.
- *Amphorophora sensoriata*
  - *Praon* sp.
- *Amphorophora* sp.?
  - *Aphidius polygonaphis*
- *Anoecia corni*
  - *Lysiphlebus testaceipes* ‡
- *Aphis armoraciae*
  - *Adialytus fuscicornis*
  - *Aphidius* sp.
  - *Lysiphlebus testaceipes*
  - *Praon* sp.
- *Aphis* nr *armoraciae*
  - *Lysiphlebus testaceipes*
- *Aphis canae*
  - *Binodoxys clydesmithi* ‡
  - *Lysaphidus adelocarinus*
  - *Lysiphlebus testaceipes* ‡
  - *Lysiphlebus utahensis* ‡
  - *Trioxys artemisiarum* ‡
  - *Trioxys bonnevillensis* ‡
- *Aphis ceanothi*
  - *Aphidius polygonaphis*
  - *Binodoxys carolinensis*
  - *Lysiphlebus testaceipes*
  - *Praon* sp.
- *Aphis* nr *ceanothi*
  - *Lysiphlebus testaceipes*
- *Aphis* nr *chrysothamni*
  - *Lysiphlebus testaceipes*
- *Aphis coweni*
  - *Ephedrus* sp.
  - *Lysiphlebus testaceipes*
  - *Praon americanum*
  - *Praon unicum*
  - *Praon* sp.
  - *Trioxys* sp.
- *Aphis craccivora*
  - *Aphidius ervi*
  - *Aphidius* sp.
  - *Diaeretiella rapae*
  - *Lysiphlebus testaceipes*
  - *Praon occidentale* ‡
  - *Praon unicum*
- *Aphis* nr *epilobiaria*
  - *Lysiphlebus testaceipes*
- *Aphis fabae*
  - *Aphidius matricariae*
  - *Aphidius* sp.
  - *Binodoxys grafi*
  - *Diaeretiella rapae*
  - *Ephedrus californicus*
  - *Lysiphlebus testaceipes*
  - *Praon* sp.
- *Aphis* nr *fabae*
  - *Diaeretiella rapae*
  - *Lysiphlebus testaceipes*
  - *Praon unicum*
- *Aphis filifoliae*
  - *Lysiphlebus testaceipes*
- *Aphis frangulae*
  - *Lysiphlebus testaceipes*
- *Aphis* nr *frangulae*
  - *Lysiphlebus testaceipes*
- *Aphis gossypii*
  - *Lysiphlebus testaceipes*
- *Aphis hederae*
  - *Lysiphlebus testaceipes*
- *Aphis helianthi*
  - *Adialytus fuscicornis*
  - *Aphidius matricariae*
  - *Aphidius polygonaphis* ‡
  - *Aphidius* sp.
  - *Binodoxys carolinensis*
  - *Binodoxys grafi*
  - *Diaeretiella rapae*
  - *Ephedrus californicus*
  - *Ephedrus clavicornis*
  - *Lysiphlebus testaceipes*
  - *Lysiphlebus* sp.
  - *Praon occidentale*
  - *Praon unicum*
- *Aphis* nr *helianthi*
  - *Lysiphlebus testaceipes*
- *Aphis hermistonii*
  - *Lysiphlebus testaceipes*
- *Aphis holodisci*
  - *Aphidius* sp.
  - *Binodoxys grafi*
  - *Ephedrus californicus*
  - *Lysiphlebus testaceipes*
- *Aphis lugentis*
  - *Lysiphlebus testaceipes*
  - *Praon occidentale*
- *Aphis lupini*
  - *Lysiphlebus testaceipes*
- *Aphis neogillettei*
  - *Lysiphlebus testaceipes*
- *Aphis nerii*
  - *Aphidius colemani*
  - *Lysiphlebus testaceipes*
- *Aphis nigratibialis*
  - *Aphidius* sp.
  - *Binodoxys carolinensis*
  - *Lysiphlebus testaceipes*
  - *Praon unicum*
- *Aphis oenotherae*
  - *Lysiphlebus testaceipes*
  - *Praon unicum*
- *Aphis* nr *oenotherae*
  - *Aphidius polygonaphis*
  - *Binodoxys carolinensis*
  - *Ephedrus californicus*
  - *Ephedrus clavicornis*
  - *Lysiphlebus testaceipes*

- *Monoctonus washingtonensis*
- *Praon unicum*

Aphis pomi
- *Lysiphlebus testaceipes* ‡
- *Praon unicum*
- *Praon* sp.

Aphis rumicis
- *Lysiphlebus testaceipes*
- *Praon unicum*

Aphis salicariae
- *Binodoxys carolinensis* ‡
- *Binodoxys grafi*
- *Binodoxys* sp.
- *Lysiphlebus testaceipes*
- *Praon americanum*
- *Praon unicum*

Aphis nr *salicariae*
- *Binodoxys grafi*
- *Lysiphlebus testaceipes*
- *Praon unicum*

Aphis sambuci
- *Lysiphlebus testaceipes*

Aphis spiraecola
- *Lysiphlebus testaceipes*

Aphis nr *triglochinis*
- *Binodoxys grafi*
- *Lysiphlebus testaceipes*

Aphis nr *valerianae*
- *Lysiphlebus testaceipes*

Aphis varians
- *Aphidius* sp.
- *Binodoxys carolinensis*
- *Binodoxys grafi*
- *Ephedrus californicus*
- *Ephedrus clavicornis*
- *Ephedrus* sp.
- *Lysiphlebus testaceipes*
- *Praon unicum*

Aphis nr *varians*
- *Binodoxys carolinensis*
- *Binodoxys grafi*
- *Ephedrus californicus*
- *Lysiphlebus testaceipes*
- *Praon unicum*

Aphis (Zyxaphis) sp.
- *Aphidius* sp.
- *Lysaphidus adelocarinus*
- *Lysaphidus rosaphidis* ‡
- *Lysiphlebus testaceipes*

Aphis sp. n.
- *Binodoxys carolinensis*
- *Lysiphlebus testaceipes*

Aphis spp.
- *Aphidius ervi*
- *Binodoxys carolinensis*
- *Lysiphlebus testaceipes*
- *Lysiphlebus* sp.
- *Praon unicum*

Aphthargelia symphoricarpi
- *Aphidius matricariae*
- *Ephedrus californicus*
- *Ephedrus clavicornis*
- *Lysaphidus* sp.
- *Lysiphlebus testaceipes*
- *Praon coniforme*
- *Praon* sp.

Artemisaphis artemisicola
- *Binodoxys clydesmithi*
- *Lysaphidus adelocarinus*
- *Lysiphlebus utahensis*
- *Praon artemisicola*
- *Trioxys bonnevillensis*

Aspidophorodon longicauda
- *Aphidius ervi*
- *Aphidius* sp.
- *Praon* sp.

Aspidophorodon nr *longicauda*
- *Ephedrus lacertosus* ‡

Boernerina variabilis
- *Betuloxys alnicolus* ‡
- *Lysiphlebus testaceipes*

Brachycaudus cardui
- *Aphidius matricariae*
- *Aphidius polygonaphis*‡
- *Diaeretiella rapae*
- *Ephedrus persicae*
- *Lysiphlebus testaceipes*

Brachycaudus helichrysi
- *Aphidius colemani*
- *Aphidius ervi*
- *Aphidius matricariae*
- *Aphidius* sp.
- *Diaeretiella rapae*
- *Ephedrus californicus* ‡
- *Ephedrus persicae*
- *Lysiphlebus testaceipes*
- *Monoctonus campbellianus*
- *Praon occidentale*
- *Praon unicum*

Brachycaudus tragopogonis
- *Aphidius* sp.
- *Diaeretiella rapae*
- *Lysiphlebus testaceipes*
- *Lysiphlebus* sp.
- *Praon unicum*

Brachycorynella asparagi
- *Diaeretiella rapae*
- *Lysiphlebus testaceipes*

Braggia eriogoni
- *Ephedrus californicus*
- *Lysiphlebus testaceipes*

Braggia nr. eriogoni.
- *Lysiphlebus testaceipes*

Braggia sp. n.
- *Lysiphlebus testaceipes*

Braggia sp.
- *Diaeretiella rapae*
- *Lysiphlebus testaceipes*

Brevicoryne brassicae
- *Aphidius ervi*
- *Aphidius matricariae*
- *Diaeretiella rapae*
- *Ephedrus californicus*
- *Lysiphlebus testaceipes*

Capitophorus elaeagni
- *Aphidius matricariae*
- *Aphidius polygonaphis*
- *Aphidius* sp.
- *Ephedrus californicus*
- *Lysiphlebus testaceipes*
- *Praon occidentale* ‡

Carolinaia howardii
- *Aphidius* sp.

Cavariella aegopodii
- *Aphidius salicis*
- *Ephedrus californicus*
- *Lysiphlebus testaceipes*
- *Praon unicum*
- *Praon* sp. ‡

Cavariella nr *aegopodii*
- *Binodoxys carolinensis* ‡

Cavariella pastinacae
- *Aphidius salicis*
- *Ephedrus californicus*
- *Lysiphlebus testaceipes*
- *Praon unicum*
- *Praon yakimanum*

Cedoaphis incognita
- *Lysiphlebus flavidus*

Ceruraphis viburnicola
- *Lysiphlebus testaceipes*
- *Praon* sp.

Chaetosiphon fragaefolii
- *Aphidius* sp.
- *Binodoxys* sp.
- *Ephedrus californicus*
- *Ephedrus* sp. ‡
- *Lysaphidus rosaphidis*
- *Lysaphidus* sp. ‡
- *Lysiphlebus testaceipes*
- *Praon* sp.
- *Trioxys* sp.

Chaetosiphon nr *hottesi*
- *Aphidius ervi*
- *Aphidius* sp. ‡

Chaetosiphon tetrarhodum
- *Aphidius* sp. ‡

Chaetosiphon thomasi
- *Praon occidentale*

Chaetosiphon nr *thomasi*
- *Lysaphidus rosaphidis*

Chaitophorus populicola
- *Adialytus salicaphis*
- *Lysiphlebus testaceipes*

Chaitophorus populifolii
  Adialytus salicaphis
  Ephedrus chaitophori
Chaitophorus utahensis
  Adialytus salicaphis
Chaitophorus viminalis
  Adialytus salicaphis
  Lysiphlebus testaceipes
Chaitophorus sp.
  Adialytus salicaphis
Chromaphis juglandicola
  Trioxys pallidus
Cinara brevispinosa
  Pauesia sp.
Cinara chinookiana
  Lysiphlebus testaceipes
Cinara pilicornis
  Pauesia juniperaphidis
Cinara ponderosae
  Pauesia ahtanumensis
  Pauesia pahtonis
  Pauesia ponderosaecola
  Pauesia sp.
  Xenostigmus bifasciatus
Cinara pseudotaxifoliae
  Pauesia pseudotsugae
Cinara pseudotsugae
  Pauesia sp.
Cinara spp.
  Lysiphlebus testaceipes
  Pauesia ahtanumensis
  Pauesia bicolor
  Pauesia sp.
  Xenostigmus bifasciatus
Diuraphis noxia
  Aphidius avenaphis
  Aphidius ervi
  Aphidius matricariae
  Aphidius sp.
  Diaeretiella rapae
  Ephedrus californicus
  Ephedrus sp.
  Lysiphlebus testaceipes
  Monoctonus washingtonensis
  Praon gallicum
  Praon occidentale
  Praon unicum
  Praon yakimanum
Drepanosiphum platanoidis
  Trioxys cirsii
Dysaphis plantaginea
  Aphidius matricariae ‡
  Diaeretiella rapae
  Ephedrus clavicornis
  Lysiphlebus testaceipes
  Praon occidentale
  Praon unicum
Epameibaphis atricornis
  Lysaphidus adelocarinus
  Lysiphlebus utahensis ‡
  Praon sp. ‡
  Praon artemisicola
  Trioxys bonnevillensis
Epameibaphis utahensis
  Trioxys bonnevillensis
Epameibaphis sp.
  Trioxys bonnevillensis
Ericaphis gentneri
  Aphidius nr *hortensis*
  Aphidius sp.
  Ephedrus lacertosus
  Lysaphidus sp.
  Praon unicum
  Praon sp.
Ericaphis nr *gentneri*
  Aphidius sp.
  Lysiphlebus testaceipes
Ericaphis scammelli
  Aphidius sp.
  Ephedrus sp. ‡
  Lysaphidus sp. ‡
  Praon sp. ‡
Ericaphis wakibae
  Aphidius polygonaphis
  Aphidius sp.
  Ephedrus californicus ‡
  Praon occidentale ‡
Eriosoma americanum
  Lysiphlebus testaceipes ‡
Eriosoma lanigerum
  Lysiphlebus testaceipes ‡
Eucallipterus tiliae
  Trioxys pallidus
  Trioxys tenuicaudus
  Trioxys sp.
Euceraphis gillettei
  Aphidius sp. ‡
  Praon nr *unicum* ‡
Euceraphis sp.
  Trioxys sp. ‡
Flabellomicrosiphum knowltoni
  Lysaphidus adelocarinus
  Trioxys bonnevillensis
Flabellomicrosiphum tridentata
  Lysaphidus adelocarinus ‡
  Lysiphlebus utahensis ‡
  Trioxys bonnevillensis
Flabellomicrosiphum sp.
  Lysaphidus adelocarinus
  Praon artemisicola
  Trioxys bonnevillensis
Forda marginata
  Adialytus fuscicornis
Hayhurstia atriplicis
  Aphidius ervi
  Diaeretiella rapae
Hyadaphis foeniculi
  Aphidius colemani
  Lysiphlebus testaceipes ‡
Hyalopteroides humilis
  Aphidius ervi
Hyalopterus pruni
  Aphidius ervi ‡
  Aphidius matricariae ‡
  Monoctonus campbellianus
Hyperomyzus lactucae
  Aphidius ervi
  Aphidius segmentatus
  Ephedrus californicus
  Praon unicum
  Praon sp.
Hyperomyzus nigricornis
  Aphidius ervi
  Aphidius polygonaphis
  Aphidius segmentatus
  Aphidius sp.
  Ephedrus californicus
  Ephedrus sp.
  Lysiphlebus testaceipes
  Praon occidentale
  Praon unicum
  Praon sp.
Hyperomyzus spp.
  Aphidius polygonaphis
  Aphidius segmentatus
  Aphidius sp.
  Ephedrus californicus
  Praon occidentale
  Praon sp.
Illinoia nr *azaleae*
  Aphidius polygonaphis
Illinoia corylina
  Aphidius matricariae
  Diaeretiella rapae
Illinoia crystleae bartholomewi
  Aphidius sp.
Illinoia nr *crystleae*
  Aphidius sp.
  Praon sp.
Illinoia davidsoni
  Aphidius ervi
  Aphidius polygonaphis
  Aphidius sp.
  Praon occidentale
Illinoia maxima
  Ephedrus clavicornis
  Praon sp.
Illinoia rhododendri
  Aphidius sp.
  Binodoxys sp.
  Monoctonus sp.
  Praon sp.

- *Illinoia richardsi*
  - *Praon occidentale* ‡
- *Illinoia spiraeae*
  - *Lysiphlebus testaceipes*
- *Illinoia* nr *thalictri*
  - *Praon occidentale*
- *Illinoia* spp.
  - *Aphidius ervi*
  - *Aphidius polygonaphis*
  - *Aphidius* sp.
  - *Ephedrus californicus*
  - *Monoctonus* sp.
  - *Praon humulaphidis*
  - *Praon occidentale*
  - *Praon* nr *occidentale*
  - *Praon pequodorum*
  - *Praon* sp.
- *Illinoia* sp. ?
  - *Praon humulaphidis*
- *Liosomaphis berberidis*
  - *Aphidius* nr *hortensis*
  - *Aphidius* sp.
- *Lipaphis erysimi*
  - *Aphidius avenaphis*
  - *Aphidius colemani*
  - *Diaeretiella rapae*
- *Macrosiphoniella ludovicianae*
  - *Aphidius ohioensis*
  - *Aphidius polygonaphis*
  - *Aphidius* sp.
  - *Ephedrus californicus*
  - *Praon occidentale*
  - *Praon* sp.
  - *Trioxys artemisiarum*
  - *Trioxys* sp.
- *Macrosiphoniella* nr *ludovicianae*
  - *Praon occidentale*
- *Macrosiphoniella tanacetaria*
  - *Aphidius ohioensis*
  - *Ephedrus californicus*
  - *Praon* sp. ‡
- *Macrosiphum adianti*
  - *Toxares deltiger*
- *Macrosiphum albifrons*
  - *Aphidius ervi*
  - *Aphidius lupini*
  - *Ephedrus californicus*
  - *Ephedrus lacertosus*
  - *Praon occidentale*
  - *Praon* sp.
- *Macrosiphum californicum*
  - *Aphidius* sp.
  - *Ephedrus californicus*
  - *Praon* sp.
- *Macrosiphum clydesmithi*
  - *Aphidius nigripes*
  - *Aphidius polygonaphis*
  - *Aphidius* sp.
- *Macrosiphum creelii*
  - *Aphidius ohioensis*
  - *Ephedrus californicus*
- *Macrosiphum euphorbiae*
  - *Aphidius colemani*
  - *Aphidius ervi*
  - *Aphidius matricariae*
  - *Aphidius nigripes*
  - *Aphidius polygonaphis*
  - *Aphidius* sp.
  - *Diaeretiella rapae*
  - *Ephedrus californicus*
  - *Ephedrus lacertosus*
  - *Lysaphidus* sp.
  - *Lysiphlebus testaceipes*
  - *Monoctonus* sp.
  - *Praon fulvum*
  - *Praon humulaphidis*
  - *Praon occidentale*
  - *Praon unicum*
  - *Praon* sp.
- *Macrosiphum* nr *euphorbiae*
  - *Aphidius polygonaphis*
  - *Diaeretiella rapae*
  - *Ephedrus californicus*
  - *Ephedrus* sp.
  - *Praon* sp.
- *Macrosiphum gaurae*
  - *Aphidius ervi*
  - *Ephedrus californicus*
  - *Lysiphlebus testaceipes*
  - *Praon unicum*
- *Macrosiphum* nr *gaurae*
  - *Praon* sp.
- *Macrosiphum osmaroniae*
  - *Praon occidentale*
- *Macrosiphum pallidum*
  - *Aphidius* nr *rosae*
  - *Aphidius* sp. ‡
  - *Ephedrus californicus* ‡
  - *Praon unicum*
  - *Praon* sp.
  - *Trioxys rosae*
- *Macrosiphum* nr *pallidum*
  - *Aphidius ervi* ‡
  - *Lysiphlebus testaceipes* ‡
- *Macrosiphum pteridis*
  - *Aphidius polygonaphis*
- *Macrosiphum rhamni*
  - *Aphidius* sp.
  - *Ephedrus* sp.
  - *Praon simulans*
- *Macrosiphum rosae*
  - *Aphidius ervi*
  - *Aphidius polygonaphis*
  - *Aphidius* sp.
  - *Ephedrus californicus*
  - *Praon occidentale*
  - *Praon* sp.
  - *Trioxys rosae*
  - *Trioxys* sp.
- *Macrosiphum tuberculaceps*
  - *Aphidius* sp.
  - *Monoctonus pacificus*
  - *Praon fulvum*
- *Macrosiphum valerianae*
  - *Aphidius ohioensis*
  - *Aphidius polygonaphis*
  - *Ephedrus californicus* ‡
  - *Praon unicum* ‡
- *Macrosiphum walkeri*
  - *Aphidius* nr *polygonaphis*
  - *Monoctonus* sp.
  - *Toxares deltiger*
- *Macrosiphum* spp.
  - *Aphidius ervi*
  - *Aphidius polygonaphis*
  - *Aphidius* sp.
  - *Diaeretiella rapae*
  - *Ephedrus lacertosus*
  - *Lysiphlebus testaceipes*
  - *Praon fulvum*
  - *Praon humulaphidis*
  - *Praon occidentale*
  - *Praon simulans*
  - *Praon unicum*
  - *Praon* sp.
  - *Toxares deltiger*
- *Macrosiphum* sp. ?
  - *Aphidius ohioensis*
  - *Praon occidetale*
- Macrosiphini [immatures]
  - *Ephedrus lacertosus*
  - *Monoctonus pacificus*
  - *Praon* sp.
- *Metopolophium dirhodum*
  - *Aphidius ervi*
  - *Aphidius rhopalosiphi*
  - *Aphidius* sp.
  - *Ephedrus californicus* ‡
  - *Monoctonus* sp.
  - *Praon gallicum*
  - *Praon occidentale* ‡
  - *Praon unicum*
  - *Praon yakimanum*
  - *Praon* sp.
- *Metopolophium* sp.
  - *Ephedrus lacertosus* ‡
- *Metopolophium* sp. ?
  - *Praon occidentale*
- *Microlophium* nr *sibiricum*
  - *Praon occidentale*
- *Microsiphoniella acophorum*
  - *Trioxys bonnevillensis*
- *Microsiphoniella artemisiae*
  - *Aphidius ohioensis*

  - *Lysaphidus adelocarinus*
  - *Praon* sp.
  - *Trioxys artemisiarum*
- *Microsiphoniella* sp.
  - *Trioxys bonnevillensis*
- *Mindarus abietinus*
  - *Pseudopraon mindariphagum*
- *Mindarus* sp.
  - *Pseudopraon mindariphagum*
- *Monelliopsis caryae*
  - *Trioxys pallidus*
- *Monelliopsis* nr *caryae*
  - *Trioxys* sp.
- *Myzocallis coryli*
  - *Trioxys pallidus*
- *Myzocallis* nr *granovskyi*
  - *Trioxys* sp.
- *Myzocallis multisetis*
  - *Trioxys pallidus*
- *Myzocallis* sp.
  - *Trioxys pallidus*
- *Myzodium knowltoni*
  - *Praon unicum* ‡
- *Myzus ascalonicus*
  - *Lysiphlebus testaceipes*
- *Myzus cerasi*
  - *Aphidius* sp.
  - *Ephedrus californicus*
  - *Lysiphlebus testaceipes*
  - *Praon unicum*
  - *Praon* sp.
- *Myzus* nr *cerasi*
  - *Lysiphlebus testaceipes*
- *Myzus* nr *ornatus*
  - *Aphidius ervi* ‡
- *Myzus persicae*
  - *Aphidius colemani*
  - *Aphidius ervi*
  - *Aphidius matricariae*
  - *Diaeretiella rapae*
  - *Ephedrus californicus*
  - *Lysiphlebus testaceipes*
  - *Praon occidentale*
  - *Praon unicum*
  - *Praon* sp.
- *Myzus* spp.
  - *Aphidius colemani*
  - *Aphidius ervi*
  - *Aphidius matricariae*
  - *Diaeretiella rapae*
  - *Praon unicum*
  - *Praon* sp.
- *Nasonovia alpina*
  - *Aphidius kakimiaphidis*
- *Nasonovia aquilegiae*
  - *Aphidius kakimiaphidis*
  - *Aphidius* sp.
  - *Praon occidentale*
- *Nasonovia* nr *aquilegiae*
  - *Aphidius* sp.
- *Nasonovia crenicorna*
  - *Aphidius polygonaphis*
- *Nasonovia cynosbati*
  - *Aphidius kakimiaphidis*
- *Nasonovia* nr *cynosbati*
  - *Aphidius kakimiaphidis*
  - *Praon* sp.
- *Nasonovia houghtonensis*
  - *Aphidius polygonaphis*
  - *Harkeria rufa*
- *Nasonovia* nr *houghtonensis*
  - *Aphidius kakimiaphidis*
- *Nasonovia polemonii*
  - *Aphidius* sp.
  - *Praon occidentale*
  - *Praon* sp.
- *Nasonovia ribisnigeri*
  - *Ephedrus californicus*
  - *Praon humulaphidis*
  - *Praon unicum*
- *Nasonovia wahinkae*
  - *Aphidius kakimiaphidis*
- *Nasonovia* spp.
  - *Aphidius kakimiaphidis*
  - *Aphidius* sp.
  - *Ephedrus californicus*
  - *Lysaphidus* sp.
  - *Lysiphlebus testaceipes*
  - *Praon occidentale* ‡
  - *Praon unicum*
  - *Praon* sp.
- *Nearctaphis bakeri*
  - *Lysiphlebus testaceipes*
  - *Praon occidentale* ‡
  - *Praon unicum*
- *Nearctaphis californica*
  - *Lysiphlebus testaceipes*
- *Nearctaphis kachena*
  - *Lysiphlebus testaceipes* ‡
  - *Praon occidentale*
  - *Praon unicum*
- *Nearctaphis yohoensis*
  - *Lysiphlebus testaceipes*
- *Nearctaphis* spp.
  - *Lysiphlebus testaceipes*
  - *Praon* sp.
- *Obtusicauda artemisiphila*
  - *Ephedrus californicus*
  - *Lysiphlebus utahensis* ‡
  - *Trioxys bonnevillensis*
- *Obtusicauda coweni*
  - *Binodoxys clydesmithi*
  - *Binodoxys coruscanigrans*
  - *Ephedrus californicus*
  - *Lysaphidus adelocarinus*
  - *Lysiphlebus utahensis*
  - *Praon artemisaphis*
  - *Trioxys bonnevillensis*
- *Obtusicauda filifoliae*
  - *Lysiphlebus utahensis* ‡
  - *Trioxys bonnevillensis* ‡
- *Obtusicauda* spp.
  - *Ephedrus californicus*
  - *Lysaphidus adelocarinus*
  - *Lysiphlebus utahensis*
  - *Praon artemisaphis*
  - *Trioxys bonnevillensis* ‡
- *Oestlundiella flava*
  - *Aphidius* sp. ‡
  - *Praon* nr *unicum* ‡
  - *Trioxys* sp. ‡
- *Ovatus crataegarius*
  - *Aphidius ervi*
  - *Aphidius matricariae*
  - *Aphidius* sp.
  - *Ephedrus incompletus*
- *Panaphis juglandis*
  - *Trioxys pallidus*
  - *Trioxys* sp.
- *Periphyllus* nr *brevispinosus*
  - *Adialytus salicaphis*
- *Periphyllus californiensis*
  - *Euaphidius setiger*
- *Periphyllus lyropictus*
  - *Euaphidius setiger*
- *Periphyllus* sp.
  - *Adialytus salicaphis*
  - *Euaphidius setiger*
- *Phorodon humuli*
  - *Aphidius ervi* ‡
  - *Aphidius matricariae*
  - *Binodoxys conei*
  - *Diaeretiella rapae*
  - *Lysiphlebus testaceipes*
  - *Monoctonus campbellianus*
  - *Praon occidentale*
  - *Praon unicum*
- *Pleotrichophorus* nr *amsinckii*
  - *Ephedrus californicus*
  - *Lysaphidus adelocarinus*
- *Pleotrichophorus elongatus*
  - *Lysaphidus ramithyrus*
- *Pleotrichophorus palmerae*
  - *Lysaphidus adelocarinus*
- *Pleotrichophorus pseudoglandulosus*
  - *Ephedrus californicus* ‡
- *Pleotrichophorus quadritichus*
  - *Praon artemiscola*
  - *Trioxys bonnevillensis* ‡
- *Pleotrichophorus* nr. *wasatchi*
  - *Lysaphidus ramithyrus*
- *Pleotrichophorus* spp.
  - *Lysaphidus adelocarinus*

  - *Lysaphidus rosaphidis* ‡
  - *Praon artemisicola* ‡
  - *Praon* sp.
  - *Trioxys bonnevillensis* ‡
  - *Trioxys* sp.
- *Prociphilus* sp.
  - *Aphidius* sp.
  - *Ephedrus clavicornis*
  - *Ephedrus* sp.
- *Pseudoepameibaphis essigi*
  - *Lysaphidus adelocarinus*
  - *Trioxys bonnevillensis*
- *Pseudoepameibaphis glauca*
  - *Lysaphidus adelocarinus*
- *Pseudoepameibaphis tridentatae*
  - *Lysaphidus adelocarinus*
  - *Lysiphlebus testaceipes* ‡
  - *Lysiphlebus utahensis* ‡
  - *Praon artemisicola*
  - *Trioxys bonnevillensis*
- *Pterocomma beulahense*
  - *Euaphidius cingulatus*
- *Pterocomma bicolor*
  - *Euaphidius cingulatus*
- *Pterocomma sanguiceps*
  - *Euaphidius cingulatus*
- *Pterocomma smithiae*
  - *Euaphidius cingulatus*
- *Pterocomma* sp.
  - *Euaphidius cingulatus*
  - *Lysiphlebus testaceipes*
- *Rhopalomyzus lonicerae*
  - *Praon* sp.
- *Rhopalosiphum cerasifoliae*
  - *Lysiphlebus testaceipes*
- *Rhopalosiphum enigmae*
  - *Lysiphlebus testaceipes*
- *Rhopalosiphum insertum*
  - *Aphidius matricariae*
  - *Diaeretiella rapae*
  - *Ephedrus californicus*
  - *Lysiphlebus testaceipes*
  - *Praon occidentale*
  - *Praon unicum*
- *Rhopalosiphum maidis*
  - *Aphidius ervi*
  - *Diaeretiella rapae*
  - *Ephedrus californicus* ‡
  - *Lysiphlebus testaceipes*
  - *Praon unicum*
  - *Praon* sp.
- *Rhopalosiphum nymphaeae*
  - *Diaeretellus palustris*
  - *Lysiphlebus testaceipes*
  - *Praon* sp.
- *Rhopalosiphum padi*
  - *Aphidius avenaphis*
  - *Aphidius ervi*
  - *Aphidius matricariae*
  - *Aphidius* sp.
  - *Diaeretiella rapae*
  - *Ephedrus californicus* ‡
  - *Lysiphlebus testaceipes*
  - *Monoctonus washingtonensis*
  - *Praon gallicum* ‡
  - *Praon occidentale*
  - *Praon unicum*
  - *Praon yakimanum*
  - *Praon* sp.
- *Schizaphis graminum*
  - *Lysiphlebus testaceipes*
- *Sipha elegans*
  - *Adialytus ambiguus*
- *Sipha* sp.
  - *Adialytus ambiguus*
- *Sitobion avenae*
  - *Aphidius avenaphis*
  - *Aphidius ervi*
  - *Aphidius matricariae*
  - *Aphidius rhopalosiphi*
  - *Aphidius* sp.
  - *Diaeretiella rapae*
  - *Ephedrus californicus*
  - *Ephedrus clavicornis*
  - *Lysiphlebus testaceipes*
  - *Praon gallicum*
  - *Praon occidentale*
  - *Praon unicum*
  - *Praon yakimanum*
  - *Praon* sp.
- *Sitobion fragariae*
  - *Aphidius* sp.
- *Sitobion* spp.
  - *Aphidius polygonaphis*
  - *Ephedrus lacertosus*
  - *Lysiphlebus testaceipes*
- *Therioaphis riehmi*
  - *Praon exsoletum*
  - *Praon pequodorum* ‡
  - *Trioxys complanatus*
- *Therioaphis trifolii*
  - *Praon exsoletum*
- *Therioaphis* sp.
  - *Praon exsoletum*
  - *Trioxys complanatus*
- *Tuberculatus columbiae*
  - *Lysiphlebus testaceipes*
- *Uroleucon adenocaulonae*
  - *Aphidius ohioensis*
- *Uroleucon* nr *arnesense*
  - *Aphidius ohioensis*
  - *Aphidius polygonaphis*
  - *Ephedrus californicus*
- *Uroleucon cirsii*
  - *Lysiphlebus testaceipes*
- *Uroleucon* nr *epilobii*
  - *Aphidius ohioensis*
- *Uroleucon erigeronense*
  - *Aphidius ohioensis*
  - *Aphidius segmentatus* ‡
  - *Aphidius* sp.
  - *Ephedrus californicus*
  - *Praon occidentale*
  - *Praon* nr *occidentale*
- *Uroleucon* nr *erigeronense*
  - *Aphidius ohioensis*
  - *Aphidius polygonaphis*
  - *Ephedrus californicus*
  - *Praon* sp.
- *Uroleucon escalantii*
  - *Aphidius ohioensis*
- *Uroleucon* nr *escalantii*
  - *Aphidius ohioensis*
- *Uroleucon gigantiphagum*
  - *Aphidius ohioensis*
- *Uroleucon ivae*
  - *Aphidius ohioensis*
  - *Aphidius polygonaphis*
  - *Aphidius* sp.
  - *Diaeretiella rapae*
  - *Ephedrus californicus*
  - *Praon pequodorum*
  - *Praon* sp.
- *Uroleucon* nr *ivae*
  - *Praon* nr *occidentale*
- *Uroleucon katonkae*
  - *Aphidius ohioensis*
  - *Ephedrus californicus*
- *Uroleucon oliveri*
  - *Aphidius ohioensis*
- *Uroleucon russellae*
  - *Aphidius ohioensis*
  - *Aphidius* sp.
  - *Binodoxys rhagii*
  - *Ephedrus californicus*
  - *Praon* sp.
- *Uroleucon sonchi*
  - *Aphidius ohioensis*
  - *Aphidius* sp.
  - *Ephedrus californicus*
  - *Praon occidentale*
  - *Praon pequodorum*
  - *Praon* sp.
- *Uroleucon suzannae*
  - *Aphidius ohioensis* ‡
  - *Praon* nr *occidentale* ‡
- *Uroleucon zymozionense*
  - *Praon occidentale*
- *Uroleucon* spp.
  - *Acanthocaudus caudacanthus*
  - *Aphidius ervi*
  - *Aphidius ohioensis*
  - *Aphidius* sp.

  Diaeretiella rapae
  Ephedrus californicus
  Lysiphlebus testaceipes
  Praon occidentale
  Praon unicum
  Praon sp.
Utamphorophora humboldti
  Aphidius sp.
Wahlgreniella nervata
  Aphidius polygonaphis
  Ephedrus californicus ‡
  Praon occidentale ‡

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ARCHIPS GOYERANA, N. SP. (LEPIDOPTERA: TORTRICIDAE) AN IMPORTANT PEST OF BALDCYPRESS (TAXODIACEAE) IN LOUISIANA AND MISSISSIPPI

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Abstract.—***Archips goyerana*, new species,** is described and illustrated from southern Louisiana and southwestern Mississippi. It appears to be host-specific on baldcypress (*Taxodium distichum*; Taxodiaceae) and has become a serious pest of that tree species since its discovery in 1983. Notes on its biology are given, and differences between it and its sister species, *A. argyrospila,* are outlined. Although morphological differences between *A. goyerana* and *A. argyrospila* are subtle, they are corroborated by differences in forewing pattern, larval food plant preferences, and molecular data.

Key words: Tortricinae, Archipini, *Taxodium*

Archips (Hübner) is a large genus of at least 80 species widely distributed in the Nearctic, Palaearctic and Oriental regions (Razowski 1977, 1997). The fruittree leafroller, *Archips argyrospila* (Walker), is probably the most widespread of the approximately 25 species of *Archips* in North America. It is a notorious, polyphagous pest of orchard trees throughout the northern United States and southern Canada (Chapman and Lienk 1971, Smirle 1993, Meeker and Goyer 1994, Goyer and Chambers 1997). Owing to the presence of numerous geographic forms and its considerable phenotypic variation, MacKay (1962) and Goyer et al. (1995) suggested that *A. argyrospila* may consist of a number of different sibling species that are differentiated by food plant preference and/or geographical distribution. In this paper I describe *A. goyerana,* a sibling species that feeds on baldcypress (*Taxodium distichum* L. Rich., Taxodiaceae) in Louisiana and Mississippi. This species has inflicted serious and widespread defoliation in southern Louisiana since its discovery in 1983 (Braun et al. 1990, Meeker and Goyer 1993, Goyer et al. 1995). Aerial surveys conducted annually have found as many as 60,000 ha of baldcypress forest affected by this insect in southern Louisiana (Goyer and Chambers 1997).

MATERIALS AND METHODS

Institutions are abbreviated throughout the text as follows: Essig Museum of Entomology (EMEC), University of California, Berkeley, Ca, USA; Louisiana State Arthropod Museum (LSAM), Baton Rouge, LA, USA; Mississippi Entomological Museum (MEM), Mississippi State, MS, USA; National Museum of Natural History (NMNH), Smithsonian Institution, Washington, DC, USA; University of Minnesota, Saint Paul (UMSP), MN, USA. Specimens were obtained from the EMEC, MEM, and Louisiana State University Agricultural Center (LSUAC), Baton Rouge, LA, USA.

Dissection methodology follows that summarized in Brown and Powell (1991) except that preparations were transferred to 95% isopropyl alcohol (instead of xylene) after the 95% EtOH wash, and all parts were slide-mounted with Euparol mounting medium (Bioquip, Gardena, CA) rather than Canada balsam. Forewing measurements were made with an ocular micrometer mounted in a Zeiss Stemi SV6 dissecting microscope. Terminology for genitalic structures follows Horak (1984). Colors were described with the standards of Kornerup and Wanscher (1983).

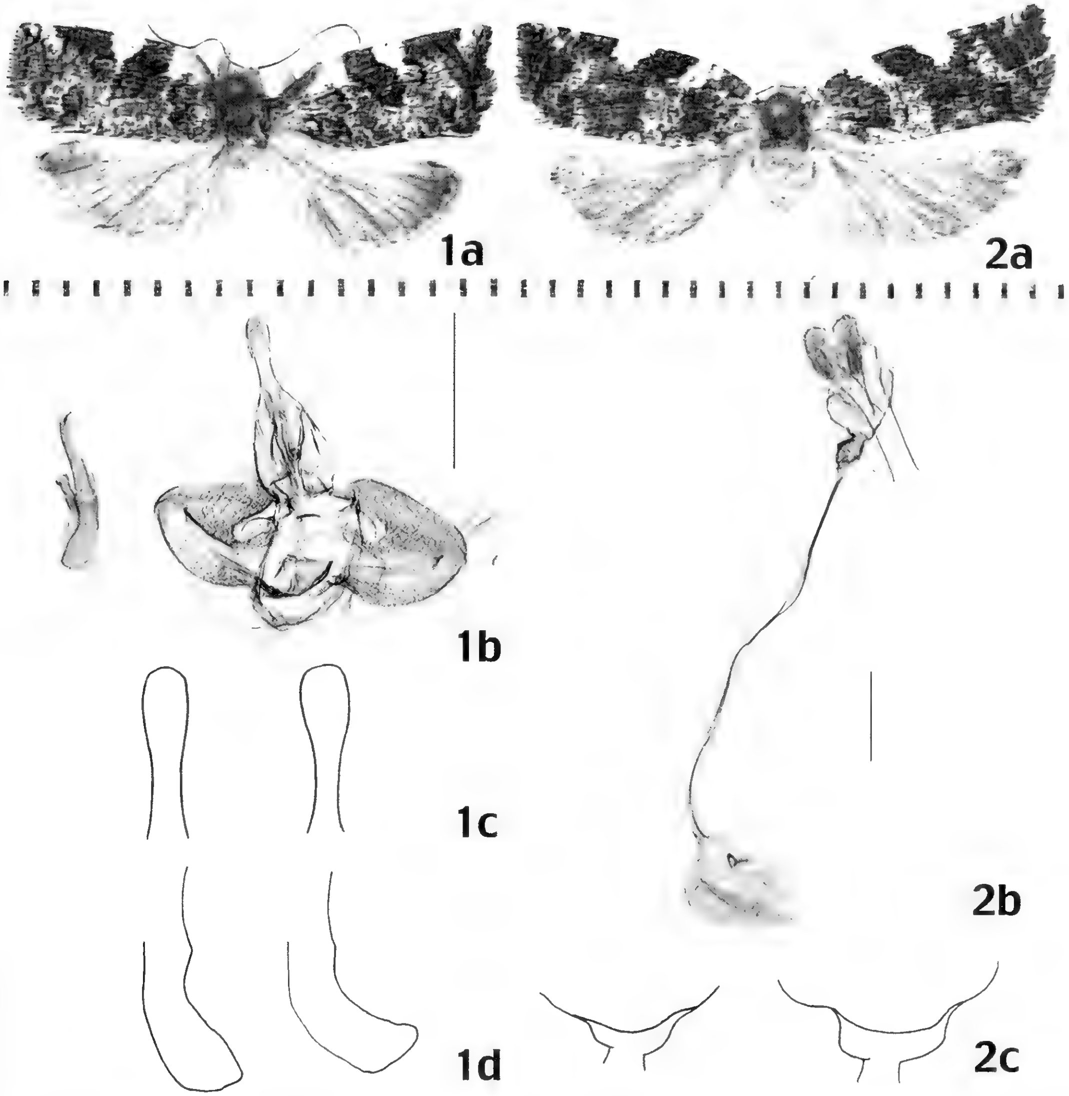
SYSTEMATICS

Archips goyerana Kruse, new species
(Figs. 1–2)

Male (Fig. 1a).—*Head:* Vertex and upper frons golden yellow to brownish orange, brown or brownish orange between antennae in most specimens. Labial palpus with golden yellow and brownish orange scaling. *Mesonotum:* Golden yellow and brownish orange scaling, dark reddish brown scaling also present in many specimens; tegulae usually concolorous with mesonotum, but often with more brownish orange or reddish brown scaling. *Forewing:* Length 6.8–8.5 mm (mean 7.4 mm, n = 37). Costal fold extending from base to near proximal margin of median fascia, i.e., ca. 30–35% length of FW costa. Upper side with underscaling gray to grayish red, grayish red concentrated near center, extending basally and dorsally; overscaling pattern elements include distinct but broken reddish brown fasciae and black, broken strigulae and irregular white, yellowish white, gray, and golden yellow scaling throughout; basal fasciae indistinct; subbasal and median fasciae distinct and strongly contrasting with yellowish white interfascial regions near costa; postmedian fasciae distinct at costa, breaking dorsally; subterminal and terminal fasciae indistinct, represented by reddish brown strigulae or reddish brown patches, broken by yellowish white and golden yellow scaling. Fringe gray with reddish brown and/or brownish orange scales replaced by gray scales at tornus. Under side with upper side pattern near costa, becoming gray dorsally in area of hindwing overlap. *Hindwing:* Upper side uniformly gray, except some dark gray and/or orange scaling near apex in some individuals. Under side gray, yellowish white near costa, orange strigulae or dark gray or orange scaling near apex. *Genitalia:* As in Fig. 1b (slide JJK 220; n = 6). Uncus large, prominent, slightly narrowed from base, slightly broadened apically, width of apex generally less than or equal to base (Fig. 1c). Gnathos arising from triangular projections of the tegumen, gently concavely curved and fused together apically, extending slightly beyond coastal margin of valva; socius vestigal; valva ovate; sacculus gradually broadening terminad with produced tip arising subapically of valva. Aedeagus straight or gently curved, terminating in slender tip strongly curved to left. Phallobase gently curved (Fig. 1d).

Female (Fig. 2a).—FW length 8.0–10.0 mm (mean 8.9 mm, n = 50). Superficially as in male except forewing ground color gray, with very little grayish red near center of wing, and generally with less yellowish white and golden yellow overscaling, but more black strigulae throughout. *Genitalia:* As in Fig. 2b (slide JJK 221; n = 7). Papillae anales setose, without projections; sterigma short, produced as a shallow bowl; antrum ovate; ductus bursae long; signa long, bladelike. Genitalia are virtually indistinguishable from *A. argyrospila* except for a more weakly produced sterigma (Fig. 2c).

Types.—Holotype ♂: LOUISIANA: Assumption Parish, Pierre Part, 27 April 1999 as pupa (R. A. Goyer), in LSAM. Paratypes: (n = 101). LOUISIANA: Assumption Parish, Pierre Part, 27 April 1999 as pupae, 14 ♂, 23 ♀ (R. A. Goyer); St. Charles Parish, Norco, 27 April 1999 as pupae, 19 ♂, 42 ♀ (R. A. Goyer); MISSISSIPPI: Hinds County, Clinton, 2 ♀, 18–19 May 1996 (M.



Figs. 1–2. Adults and genitalia of *Archips goyerana*. 1a, Male of *A. goyerana*, holotype, Assumption Parish, Louisiana; scale in mm. 1b, Male of *A. goyerana*; valvae spread, aedeagus removed, holotype, Assumption Parish, Louisiana, slide number JJK 220.; scale bar = 1 mm. 1c, Detail of uncus of male *A. goyerana* (left) and detail of uncus of male *A. argyrospila* (right), Harrison County, Long Beach, Mississippi, drawn from slide number JJK 117. 1d, Detail of aedeagus of male *A. goyerana* (left) and detail of aedeagus of male *A. argyrospila* (right). 2a, Female of *A. goyerana*, paratype, St. Charles Parish, Louisiana. scale in mm. 2b, Female of *A. goyerana*, paratype, St. Charles Parish, Louisiana, slide number JJK 221; scale bar = 1 mm. 2c, Detail of sterigma of female *A. goyerana* (left) and detail of sterigma of female *A. argyrospila* (right), Bossier Parish, Barksdale Air Force Base, Louisiana, drawn from slide number JJK 214.

and E. Roshore); Harrison County, Long Beach, 1 ♀, 13 May 1997 (R. Kergosien). Paratypes are deposited in LSAM (36), MEM (10), UMSP (5), NMNH (20), and EMEC (30).

Diagnosis.—*Archips goyerana* was discovered in 1983 in Iberville Parish, Louisiana (Goyer and Lenhard 1988). It is very similar in appearance to *A. argyrospila* but it is far less variable. In *A. goyerana* the fasciae are usually dark reddish brown, interfascial spots are strongly contrasting with fasciae, and black striae are usually present. Interfascial spots are generally less well defined in *A. argyrospila,* and fasciae typically consist of various shades of brown or brownish orange. A pale form of *A. goyerana* is brownish orange on the forewing and pale brownish orange or light gray on the hindwing. This form appears to dominate in Mississippi and is difficult to distinguish from co-occurring *A. argyrospila.* In male genitalia of *A. argyrospila* the uncus is distinctly widened terminally, weakly club shaped (Fig. 1c). In addition, the phallobase in *A. argyrospila* is typically curved at an angle greater than 45° from the plane of the aedeagus as opposed to less than 35° in *A. goyerana* (Fig. 1d). Female genitalia of *A. goyerana* are nearly indistinguishable from those of *A. argyrospila,* although the sterigma tends to be slightly more robust and squarish in *A. argyrospila,* in comparison to the shallow mildly angled bowl of *A. goyerana* (Fig. 2c). Molecular data indicates a divergence ranging from 1.47 to 2.53% between *A. argyrospila* and *A. goyerana* in 475 base pairs of mitochondrial DNA in the Cytochrome Oxydase I gene, while widely separated populations of *A. argyrospila* differ by 1.26% or less (Kruse and Sperling, unpublished data).

Distribution and biology.—*Archips goyerana* occurs in southern Louisiana and southwestern Mississippi (Fig. 3). It originally may have been endemic to forested wetlands, but has undergone a population explosion and expansion of its range since 1983 (Goyer et al. 1990, Zhou et al. 1993, Goyer et al. 1995). In 1988, *A. goyerana* was found for the first time on baldcypress east of the Mississippi River (in Baton Rouge) and by 1993 had spread eastward to the suburbs of New Orleans (Goyer et al. 1995). Noticeable defoliation was evident over portions of at least eleven Louisiana parishes (Meeker and Goyer 1993, 1994). It was collected in southwestern Mississippi in 1996 (Clinton) and in 1997 (Long Beach). *Archips argyrospila* and *A. goyerana* are known to co-occur near Baton Rouge, Louisiana and Long Beach, Mississippi. Individuals captured away from forested wetlands are speculated to feed on ornamental baldcypress.

Like *A. argyrospila, A. goyerana* is univoltine throughout its range, with overwintering egg masses attached to the bark of thin twigs of the host plant in obligate diapause (Braun et al. 1990, Goyer et al. 1990, Brown 1991, Meeker and Goyer 1993, Goyer and Chambers 1997). Dormant eggs hatch by bud break of baldcypress trees during late February and early March (Goyer et al. 1990, Meeker and Goyer 1993, Goyer and Chambers 1997). First instar larvae disperse and seek out the terminal portions of expanding baldcypress foliage, burrow within the cluster of young needles, and begin feeding inconspicuously (Goyer and Chambers 1997).

Larvae of *A. goyerana* feed on the opening leaf buds and elongating leaves (Braun et al. 1990). As the foliage expands, developing *A. goyerana* larvae produce silk to roll adjacent needles and branchlets into a tight mass, surrounding themselves individually and then feeding on the foliage inside (Braun et al. 1990, Goyer and Chambers 1997). Larvae remain inconspicuous on baldcypress unless the tree is severely defoliated, at which time they become very active, crawling on branches and spinning down on silk (Braun et al. 1990). Massive mortality to mature larvae by drowning in standing water was observed on many occasions where baldcypress were completely defoliated (Braun et al. 1990).

Larvae undergo five larval instars before pupation (Braun et al. 1990). Adults emerge between late-April and mid-May (Goyer and Chambers 1997). The development time for *A. argyrospila* from egg hatch to adult emergence takes about 6 weeks (Braun et al. 1990). For *A. goyerana,* development time is considerably longer, about 8 to 10 weeks on baldcypress in the field (Braun et al. 1990, Goyer and Cham-

Fig. 3. Range of *Archips goyerana* in Louisiana and Mississippi. Counties where *A. goyerana* is known to occur are shaded.

bers 1997). Previous studies have shown that *A. goyerana* is virtually unable to survive on oaks, a major food source for nearby populations of *A. argyrospila* (Goyer et al. 1995). Differences in pheromonal responses between citrus-feeding *A. argyrospila* and baldcypress-feeding *A. goyerana* populations suggest evolutionary divergence in mating behavior (Goyer et al. 1995). The forested wetland habitat of *A. goyerana* and the distant relationship between its food plant and the food plants of *A. argyrospila* further confirm that the two are distinct.

Archips goyerana is a wetlands pest in Louisiana. Repeated defoliation of baldcypress has been observed in several areas of southern Louisiana, with dramatic reductions in radial growth and death of portions of the tree canopy in all age groups, and mortality primarily in the small, understory trees that do not recover fully from complete and repeated defoliation (Goyer and Lenhard 1988, Goyer et al. 1990, Goyer and Chambers 1997). In addition, baldcypress defoliation is closely linked with excessive flooding, affecting tree successional patterns in forest wetlands (Goyer and Chambers 1997). With 70% of Louisiana's baldcypress growing stock located within or near areas now infested with *A. goyerana,* the persistence and continued spread of defoliation poses an additional threat to this dwindling and unique forest resource (Meeker and Goyer 1993).

Etymology.—The species is named for Richard A. Goyer of the Department of Entomology, Louisiana Agricultural Experiment Station, Louisiana State University Agricultural Center, Baton Rouge, Louisiana. He collected the holotype as well as most of the paratypes, and is responsible for the majority of the research on the biology and ecology of the species.

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DISCOVERY OF THE SMALL JAPANESE CEDAR LONGHORNED BEETLE, *CALLIDIELLUM RUFIPENNE* (MOTSCHULSKY) (COLEOPTERA: CERAMBYCIDAE), IN LIVE ARBORVITAE IN CONNECTICUT

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Abstract.—The small Japanese cedar longhorned beetle, *Callidiellum rufipenne* (Motschulsky) (Coleoptera: Cerambycidae), was discovered principally in three cultivars of American arborvitae, *Thuja occidentalis* L., in four towns in Fairfield and New Haven Co. in southwestern Connecticut. Between September 1998 and March 1999, infestations of *C. rufipenne* were found in 102 (0.5%) of 20,000 cupressaceous plants that were inspected in garden centers, nurseries, landscaped areas, and the wild in Connecticut. Within 2 years of planting, 94 (92.2%) of infested plants had been balled and burlaped, which may have stressed them. Of the 102 plants, 101 (99%) were 0.9–2.1 m high arborvitae that averaged 6.3 beetles/plant, and the other one was yellow cedar, *Chamaecyparis nootkatensis* (D. Don) Sprach. Arrivals of beetles in wood material at ports of entry, increased international trade and travel, and the high abundance of potential hosts in coastal North America probably have facilitated introduction and establishment. Adults, life cycle, and damage of *C. rufipenne* are described briefly.

Key Words: Arborvitae, *Callidiellum,* Cerambycidae, *Chamaecyparis,* Coleoptera, Connecticut, Cupressaceae, *Juniperus,* larval damage, plant pest, state record, *Thuja occidentalis*

The small Japanese cedar longhorned beetle, *Callidiellum rufipenne* (Motschulsky) (Coleoptera: Cerambycidae), is best known as a borer of Japanese cedar, *Cryptomeria japonica* D. Don (Taxodiaceae), and Japanese cypress or Hinoki false cypress, *Chamaecyparis obtusa* (Siebold & Zuccarini) Endlicher (Cupressaceae) (Makihara 1984, Shibata 1994), which are important trees in Japanese plantations (Kobayashi 1985). Larvae of *C. rufipenne,* however, also tunnel into the wood of other species of Cupressaceae and rarely Pinaceae (Bates 1873, Gressitt 1951, Shiraki 1952, Campadelli and Sama 1988, Bahillo and Iturrondobeitia 1995). Shibata (1994) and others have suggested that *C. rufipenne* attacks only dead or dying wood of its coniferous hosts. Other species of *Callidiellum, C. cupressi* (Van Dyke) and *C. virescens* Chemsak and Linsley in the western United States (Chemsak and Powell 1964, Chemsak and Linsley 1966) and *C. flavosignatus* Pu and *C. villosulum* (Fairmaire) in China (Gressitt 1951, Pu 1991), also are restricted to conifers in the Cupressaceae, Pinaceae, and Taxodiaceae.

In May 1997, a single adult of *C. rufipenne* was collected on wild eastern red cedar, *Juniperus virginiana* L., at Manteo, Dare Co., North Carolina (E.R. Hoebeke, in litt.). This represented the first record of this eastern Asian beetle in the wild in the United States. After the initial discovery of the lone adult, K. Ahlstrom (in litt.) reared additional adults from larvae collected in the wood of dead eastern red cedar at Manteo. Before its recent introduction into Italy (Campadelli and Sama 1988), Spain (Bahillo and Iturrondobeitia 1995), and this country, *C. rufipenne* had a distributional range of Russia (Sakhalin), Japan (including the Ryukyu Islands), Korea, Taiwan, and northeastern China (e.g., Gressitt 1951, Duffy 1968, Makihara et al. 1989). Gressitt (1951) suggested that *C. rufipenne* probably was introduced into Taiwan. Port inspectors have repeatedly intercepted this beetle in dunnage and other wood products shipped to New Zealand (Bain 1974, 1977), the United States (Mumford 1965, 1966, 1967; Girard 1968, 1969, 1971, 1972a, 1972b, 1973, 1974; USDA 1979, 1980, 1981, 1982, 1984), and other countries.

Here we report the discovery of *C. rufipenne* in Connecticut, document its infestation of live plants, mainly American arborvitae or northern white cedar, *Thuja occidentalis* L., and briefly describe its life history and the appearance of damage. We initiated this and additional studies because *C. rufipenne* may pose a threat to the nursery industry and to northern forests. Arborvitae are important to the nursery trade because they are popular ornamental shrubs grown widely and planted especially near homes and commercial buildings. In addition, northern white cedars are an integral part of some forests in northeastern and north-central North America.

MATERIALS AND METHODS

Adult records from Connecticut are based on inspecting plants for larval injury and then removing or rearing beetles from plants with damage. We extracted adults from wood mainly between late September 1998 and February 1999 by finding holes (the eventual adult exit routes that had been plugged with chewed wood by larvae) in branches and then by splitting the wood to reveal the individual adults in their pupal chambers. Between November 1998 and March 1999, additional infested arborvitae (about 80% of all infested plants) were transported from garden centers or landscaped areas, mostly residential yards in Fairfield and New Haven Co., to two outdoor enclosures with double screening at Lockwood Farm, Hamden, New Haven Co., Connecticut. In late March, branches that appeared to be uninfested were pruned from these shrubs and burned in accordance with state regulations. The remaining wood that had evidence of larval boring was divided into two equal groups. Wood of each of the shrubs in one lot was placed in a sealed white plastic drum (18.9 liters) in an environmental chamber adjusted to 21 ± 1°C and to a 15L:9D photoperiod. The remainder of the wood was put into screened cages of various sizes in one of the outdoor screened houses. Adults were collected from drums or cages every 3–7 days until emergence ended.

Data for infestations of *C. rufipenne* discovered by federal inspectors at ports of entry between 1964 and 1982 (Mumford 1965, 1966, 1967; Girard 1968, 1969, 1971, 1972a, 1972b, 1973, 1974; USDA 1979, 1980, 1981, 1982, 1984) were used in Fig. 1. Yearly records were based on the fiscal year, which changed during the mid-1970's. Between 1964 and 1982, *C. rufipenne* had a quarantine status of an actionable pest. In 1982, the Animal and Plant Health Inspection Service (APHIS) changed its quarantine status from an actionable to a non-reportable pest (J. Cavey, in litt.), which resulted in a rapid decrease in records of its interception. In 1998, *C. rufipenne* again became an actionable pest.

Voucher specimens are deposited at the Connecticut Agricultural Experiment Station, New Haven; Cornell University, Ithaca, New York; National Museum of Natural History, Smithsonian Institution, Washington, D.C.; and Essig Museum of Entomology, University of California, Berkeley, California.

Table 1. Location and characteristics of live arborvitae, *Thuja occidentalis*, infested by the small Japanese cedar longhorned beetle, *Callidiellum rufipenne*, in Connecticut during 1998.

Location of Infested Plants					No. Beetles	
County	Town	Variety of Arborvitae	Height (m)	No. Infested	Mean	Range
Fairfield	Greenwich	Smaragd	1.8–2.1	7	4.4	2–9
Fairfield	Greenwich/Stamford[1]	Smaragd	1.5–1.8	4	10.3	2–27
Fairfield	Stamford	Brandon	1.8–2.1	2	4.0	3–5
Fairfield	Stamford	Smaragd	1.5–1.8	26	11.1	2–37
Fairfield	Stamford/Greenwich[1]	Smaragd	1.5–1.8	16	5.5	2–11
New Haven	Milford	Nigra	1.5–1.8	2	2.0	
New Haven	Milford	Smaragd	0.9–1.5	8	1.9	1–3
New Haven	Milford	Smaragd	1.2–1.8	31	4.5	1–16
New Haven	North Haven	Smaragd	1.5–1.8	5	3.4	1–9

[1] In 1998, these arborvitae initially were at the garden center in the town listed first, and then, usually in spring of the same year, they were planted in yards in the town listed second.

RESULTS AND DISCUSSION

Infestations in Connecticut.—On 22 September 1998, one adult of *C. rufipenne* was found in a branch of a emerald green arborvitae, *T. occidentalis* 'Smaragd', planted in spring 1998 near a small factory in Milford, New Haven Co. Subsequent inspection of the planting of 42 arborvitae at this site revealed 7 live plants (16.7% of the total) with injury from larval boring. The 42 arborvitae planted by the factory were purchased at a nearby garden center that also had infested arborvitae that had not been sold. This find represents the second North American record of this beetle outside a port of entry, and the first from a live arborvitae that visually appeared to be healthy. In 1967, an inspector at a port in the United States did intercept *C. rufipenne* in dunnage of a *Thuja* species on a cargo ship (Girard 1968).

Between autumn 1998 and spring 1999, state inspectors found 102 (0.5% of total) infested plants among 20,000 cupressaceous shrubs or trees examined in garden centers, nursery fields, landscaped areas, and the wild throughout Connecticut. Plants infested with *C. rufipenne* were located mainly in four garden centers and in nearby residential areas with arborvitae that recently had been purchased from the garden centers (see Table 1 for the locations). Of 102 infested plants, 100 (98.0%) had been imported from western North America, and 94 (92.2%) had been balled and burlaped within 2 years of inspection for *C. rufipenne*. Thorough examination of nursery fields at the points of origin in British Columbia (J. Bell and B. Gill, in litt.) and Oregon (R. Westcott, in litt.) and inspection of shipments from the western North America in 1999 did not reveal any damage or specimens of *C. rufipenne*. The plants with *C. rufipenne* apparently became infested in Connecticut; however, the origin and time of introduction are unknown.

Of the 102 infested plants, 101 (99.0%) were arborvitae (Table 1), and one was a yellow cedar, *Chamaecyparis nootkatensis* (D. Don) Spach. Among the 101 infested arborvitae of three cultivars, 97 (96.0%) were the variety 'Smaragd', which currently is the most widely grown and planted arborvitae in Connecticut. Infested arborvitae had between 1 and 37 beetles, and ranged in height from 0.9 to 2.1 m. In all, 632 beetles developed in the wood of the 101 arborvitae (mean = 6.3 live beetles/plant), and 6 in that of yellow cedar. An unknown number of arborvitae that may have been infested by *C. rufipenne* at the four garden centers were sold and probably planted in southwestern Connecticut.

Even though most infested plants that

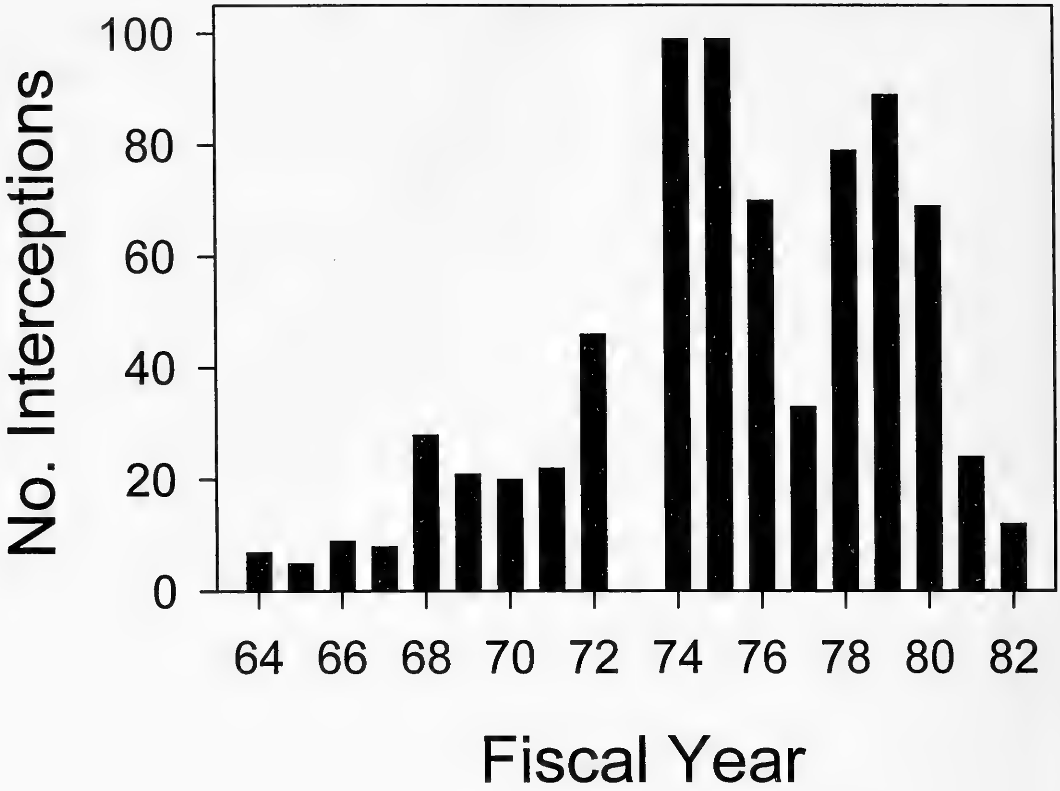

Fig. 1. Frequency of interceptions of the small Japanese cedar longhorned beetle, *Callidiellum rufipenne,* at ports of entry in the United States between 1964 and 1982. The change in the fiscal year in the early 1970's apparently caused some inconsistencies in compilation of data between 1973 and 1975.

were balled and burlaped appeared healthy, they may have been susceptible to attack by *C. rufipenne* because they were stressed by root and branch breakage and possibly inadequate watering before, during, and after shipment to Connecticut. Furthermore, these arborvitae occasionally were infested by bark beetles (Scolytidae), such as *Phloeosinus canadensis* Swaine and *Polygraphus rufipennis* (Kirby).

Factors contributing to accidental introduction and establishment.—The small Japanese cedar longhorned beetle has repeatedly been intercepted by federal and state inspectors at ports of entry in the United States (Mumford 1965, 1966, 1967; Girard 1968, 1969, 1971, 1972a, 1972b, 1973, 1974; USDA 1979, 1980, 1981, 1982, 1984; R. Penrose, in litt.). In most cases, the intercepted beetles were associated with dunnage or other wooden material from eastern Asia. In Vancouver, British Columbia, in 1927, *C. rufipenne* was reared from imported wood of Japanese origin (Leech 1949). Hatch (1971) recorded another specimen from Seattle, Washington, but this beetle, too, was likely associated with an imported wood product.

Between 1964 and 1982, when federal inspectors actively reported infestations of *C. rufipenne,* they repeatedly discovered them in imported wood material (Fig. 1). During these years, infestations were found in dead wood, especially dunnage, in 21 states in the United States and in Puerto Rico (Mumford 1965, 1966, 1967; Girard 1968, 1969, 1971, 1972a, 1972b, 1973, 1974; USDA 1979, 1980, 1981, 1982, 1984). Although *C. rufipenne* was not discovered at ports of entry in Connecticut, it was found in ports of the nearby states of New Jersey, New York, and Pennsylvania. In coastal counties in Connecticut and nearby states, potential hosts abound in residential areas and forests. In particular, overmature, often dead and dying trees of *J. virginiana* are numerous in successional areas along major highways and in regrowth forests. We suggest that the frequency of arrivals of *C. rufipenne* in imported wood, increased international trade and travel, and the high abundance of potential hosts near coastal areas probably have facilitated the accidental introduction and establishment of *C. rufipenne* in the United States.

Brief description of adult appearance, life history, and damage.—Males are iridescent deep blue with a single brownish red to red patch at the anterolateral corner of the upper surface of each elytron. The females (Fig. 2) have entirely reddish brown elytra and a reddish abdomen. The antennae of males are longer than the body, whereas those of females are shorter, about ⅔ to ¾ the length of the body. Thus, the sexes can be separated by both color and antennal length. When they are reared from arborvitae, adults vary from 5–13 mm in length.

The life history of *C. rufipenne* (Shibata 1994, in litt.; Maier 1999; Y. Soma, in litt.) is similar to that of other species of *Callidiellum* (Chemsak and Powell 1964, Nakamura and Kojima 1981). Adults of *C. rufipenne* emerge from wood in spring and soon mate on the host. Females of *C. rufipenne* then lay eggs singly or in small groups in cracks or crevices in stems or bark. After hatching, larvae bore into the cambium and phloem. They expand their feeding tunnel until they become full-grown (Fig. 3) in late summer. After feeding is completed, larvae bore into the sapwood and carve an ellipsoidal pupal cell. The pupal chamber is connected to the surface of a branch by an exit tunnel (Fig. 4) that is oval in cross-section. Larvae plug the eventual exit route with fragments of chewed wood. They pupate in late summer or early fall, and adults eclose within 2–3 weeks, usually in the autumn. Adults remain in the pupal cell until the following spring when they remove the plug to the pupal cell and emerge. In Connecticut, *C. rufipenne* has one generation per year. In Japan, the life cycle also usually requires 1 year. In some northern regions of Japan, however, it may require 2 years to complete the life cycle (Y. Soma, in litt.).

In live arborvitae, injury from larval boring becomes most obvious between late summer and the following spring when the bark of small arborvitae often splits to reveal the sinuous larval tunnels (Fig. 5). The larval gallery is packed with frass, which apparently is also mixed with chewed wood fragments. In some cases, these tunnels may encircle branches and, thereby, disrupt the flow of water and nutrients within the plant. The material packed in the larval gallery has both light and dark particles, giving it a "salt-and-pepper" look.

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Figs. 2–5. Small Japanese cedar longhorned beetle, *Callidiellum rufipenne*. 2, Adult female, 12 mm in length. 3, Full-grown larva exposed after removal of bark of arborvitae, 13 mm in length. 4, Larva in its ellipsoidal pupal cell; note the pupal plug of chewed wood fragments. 5, Branch injury caused by larval boring. Arrows show frass and chewed wood exposed after the bark splits in late summer.

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NOTE

Ectoparasitic Insects from Migrating Saw-Whet Owls (*Aegolius acadicus*) in Central Wisconsin

A total of 833 saw-whet owls (*Aegolius acadicus* Gmelin) were trapped, providing an opportunity to survey these birds for ectoparasitic insects. This is the largest survey of ectoparasitic insects from this bird ever conducted during migration and should provide baseline data for future investigators.

Mist nets were used with a tape-recorded conspecific call to trap migrating saw-whet owls at Linwood Springs Research Station (44°28′N, 89°40′W) in central Wisconsin during their fall and spring nocturnal migrations (IX-23 to XI-08-1997, II-18 to III-26-1998, IX-28 to XI-11-1998, and II-20 to III-27-1999). The birds were placed in temporary holding compartments for less than two hours. Of the 833 trapped owls, 644 were checked for ectoparasitic insects by hand during banding activities. One hundred and sixty-nine of the 644 trapped owls were randomly selected (1/5 of the sample) and extensively examined for a 2-minute period. Collected insects were fixed in 70% ethanol, dehydrated through an ethanol series to xylene, and mounted in Canada Balsam. Voucher specimens are deposited in the National Museum of Natural History, Smithsonian Institution, Washington, DC, accession number TM2014200.

Sixty-four of 644 (9.9%) owls searched during banding and 19/169 (11.2%) when examined for 2 min. were positive for ectoparasitic insects. Hippoboscids (*Icosta americana* Leach, *Ornithoica vicina* Walker, *Ornithomyia fringillina* Curtis) were harbored by 1.7% of the birds, Mallophaga (*Kurodaia acadicae* Price and Beer, *Strigiphilus acadicus* Emerson and Price) by 5.8%, and Siphonaptera (*Cediopsylla simplex* Baker, *Orchopeas leucopus* Baker) by 3.8%. Table 1 shows the prevalence of single and multiple infestations during fall and spring migrations of owls.

Except for hippoboscids and a single specimen of *C. simplex* (new host record), all ectoparasites were collected during both fall and spring. The three hippoboscids were only collected during the fall (Table 1). As part of a larger study on Wisconsin hippoboscids during 11 autumns and 6 springs, Mueller et al. (1969. Transactions of the Wisconsin Academy of Sciences, Arts and Letter 57: 189–207) collected two *O. vicina* and two *O. fringillina* from 234 saw-whet owls during migration. These authors also noted that hippoboscids are uncommon or absent during the spring.

Orchopeas leucopus was collected from 31 birds. Holland (1985. Memoirs of the Entomological Society of Canada, No. 130, pp. 130, 631) reported *O. leucopus* on 4 saw-whet owls from Ontario, Canada. Specimens of this flea most likely transferred to the owls from rodents, while our sole specimen of *C. simplex* may have come from a rabbit. Rodents and rabbits are natural hosts for these fleas. Forty-eight birds harbored *K. acadicae* and *S. acadicus.* The relatively low numbers of fleas and lice may be explained as follows: Fleas are intermittent parasites on mammalian or avian hosts, and, in the case of raptors, may be accidental. Mallophagans complete their entire life cycle on their host but are extremely small, attach themselves firmly to feathers, and are sometimes difficult to detect on living birds. Additionally, lice may be present only as nits during bird migration (Dogiel. 1964. *In* General Parasitology. Oliver and Boyd, Edinburgh and London 516 pp.).

Table 1. Number of single and multiple infestations and prevalence of ectoparasitic insects from saw-whet owls.

Ectoparasites	Fall 1997	Spring 1998	Fall 1998	Spring 1999	Parasite Totals
Diptera					
Hippoboscidae					
Icosta americana	2/644 = 0.31%	0/644 = 0.00%	0/644 = 0.00%	0/644 = 0.00%	2
Ornithoica vicina	6/644 = 0.93%	0/644 = 0.00%	0/644 = 0.00%	0/644 = 0.00%	6
Ornithomyia fringillina	2/644 = 0.31%	0/644 = 0.00%	3/644 = 0.47%	0/644 = 0.00%	5
O. vicina, O. fringillina	1/644 = 0.16%	0/644 = 0.00%	0/644 = 0.00%	0/644 = 0.00%	1
Mallophaga					
Menoponidae					
Kurodaia acadicae	3/644 = 0.47%	2/644 = 0.31%	9/644 = 1.40%	0/644 = 0.00%	14
Philopteridae					
Strigiphilus acadicus	10/644 = 1.55%	3/644 = 0.47%	7/644 = 1.09%	0/644 = 0.00%	20
K. acadicae, S. acadicus	1/644 = 0.16%	1/644 = 0.16%	1/644 = 0.16%	0/644 = 0.00%	3
Siphonaptera					
Pulicidae					
Cediopsylla simplex	0/644 = 0.00%	1/644 = 0.16%	0/644 = 0.00%	0/644 = 0.00%	1
Ceratophyllidae					
Orchopeas leucopus	2/644 = 0.31%	8/644 = 1.24%	4/644 = 0.62%	6/644 = 0.93%	20
Multispecies Infestations					
O. leucopus, K. acadicae	2/644 = 0.31%	2/644 = 0.31%	0/644 = 0.00%	0/644 = 0.00%	4
O. leucopus, S. acadicus	0/644 = 0.00%	3/644 = 0.47%	0/644 = 0.00%	3/644 = 0.47%	6
O. leucopus, K. acadicae, S. acadicus	1/644 = 0.16%	0/644 = 0.00%	0/644 = 0.00%	0/644 = 0.00%	1
Seasonal Totals	30	20	24	9	83

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NOTE

First Record of the California Pine Needle Aphid, *Essigella* (*Essigella*) *californica* (Essig) (Homoptera: Aphididae: Lachninae), in Southern Brazil

The genus *Essigella* del Guercio 1909 is the only native Nearctic representative of the subtribe Eulachnina (Sorensen. 1994. The Pan-Pacific Entomologist 70: 1–102). The genus has recently been revised and includes three subgenera, 13 species, and two subspecies, all of which are linear-bodied and feed on needles of Pinaceae, mainly *Pinus,* but also *Pseudotsuga* and *Picea* (Sorensen 1994; Remaudière and Remaudière. 1997. Catalogue of the World's Aphididae. Institut National de la Recherché Agronomique, Paris, 473 pp.). *Essigella* is close to the native Palearctic *Eulachnus* del Guercio, 1909, and to *Pseudessigella* Hille Ris Lambers, 1966 (Sorensen. 1990. Annals of the Entomological Society of America 83: 394–408). The genus has bifid tarsal claws; a sclerotized dorsum; head and pronotum fused; meso- and metanotum fused dorsally; abdominal tergite I usually free from the metanotum; and abdominal tergites II-VII fused (Sorensen 1994).

Essigella (*Essigella*) *californica* (Essig 1909) is a lime green, small-sized (1.5–2.0 mm) aphid found in western North America from southern British Columbia and Alberta to southern Mexico (Sorensen 1994; Blackman and Eastop. 1994. Aphids on the World's Trees—An Identification and Information Guide. CAB International and The Natural History Museum, London, 987 pp. + 16 pls.). One confirmed record from Miami, Florida, suggests that it may occur in the Caribbean and have a pan-Mexican distribution (Sorensen 1994). This species has been recently introduced into Europe. In France, it has been found causing damage on several *Pinus* species (Turpeau and Remaudière 1990, as cited by Sorensen 1994). In Spain, it has been captured by suction pan traps (Seco Fernandez and Mier Duarte. 1992. Boletin de la Asociacion Espanhola de Entomologia 16: 255–256).

In Brazil, *E. californica* was first collected by early June 1999 on slash pine *Pinus elliotti* Engelm. in Rolândia, Paraná State (23°19′S, 51°22′W, altitude about 540 m a.s.l.) and on Mexican weeping pine *Pinus patula* Schiede & Deppe, in the Agronomy Campus of the Universidade Federal do Paraná, Curitiba, Paraná (25°25′S, 49°14′W, altitude 945 m a.s.l.) (R. C. Z. Carvalho, collector). Both localities represent urban areas where the plants are used for landscaping. In October 1999, *E. californica* was collected at a farm in Corbélia, Paraná (24°45′S, 53°20′W, altitude 750 m a.s.l.), on *P. elliotti* (S. M. N. Lazzari, collector).

Alate and apterous viviparae and nymphs were found on the branch tips of isolated plants, feeding on the base of the pine needles, and moving quite rapidly when disturbed. Colonies of *E. californica* on *P. patula* from Curitiba were small and associated with *Cinara pinivora* (Wilson 1919) (Lachninae: Cinarini), while the populations from Rolândia and Corbélia were more numerous, only on a few trees, and were not associated with other aphid species.

According to J. Sorensen (in litt.), *E. californica* is quite variable geographically, occurs on various hosts, and might be a complex. The one collected from Brazil is in the same phena as those which have been taken from Spain, France, Australia, and New Zealand. It seems to be the same that occurs in Mendocino County, along the northern coast of California, principally on *Pinus attenuata* Lemmon and *Pinus muricata* D. Don. These pines are in the subsection Oocarpae as is the Mexican weeping pine, which is closely related to and hybridizes well with slash pine in the Australis subsection. In Europe and Australia, *E. californica* occurs on *Pinus radiata* D. Don, another Oocarpae pine. In California, this aphid can be found on *P. radiata,* but they are less robust and much less common than other *Essigella* species. Sorensen also mentions that *E. californica* doesn't do much damage, if any, on pines in New Zealand.

Another Eulachnina that has been recorded from Brazil feeding on *Pinus, Eulachnus rileyi* (Williams 1911) (Eastop, Costa, and Blackman. 1993. Pesquisa Agropecuária Brasileira 28: 269–280) may be confused with *E. californica,* but they can be distinguished by the following characters: *E. rileyi* has 6-segmented antennae, claws without bifid tips, color in life varying from dark olive green to gray, with a dusting of bluish-gray wax; *E. californica* has 5-segmented antennae, tarsal claws incised with double tips, and lime green color in life.

Slide-mounted specimens of *E. californica* are deposited in the Pe. Jesus S. Moure Entomological Collection, Departamento de Zoologia, Universidade Federal do Paraná (DZUP). One sample of *P. elliotti* from Rolândia is deposited under the number 8599 and one of *P. patula* under the number 8598 in the Herbarium of the Forestry Department (EFC) of the Universidade Federal do Paraná, Brazil.

We are thankful to Dr. John Sorensen, Plant Pest Diagnostics Center, California Department of Food & Agriculture, for confirming the aphid identification and for his valuable comments; to Dr. David Voegtlin, Illinois Natural History Survey, for his valuable suggestions; to Dr. Jarbas Yukio Shimizu, EMBRAPA/Centro Nacional de Pesquisa de Florestas; and to Dr. Carlos Vellozo Roderjan, Forestry School of the Universidade Federal do Paraná for the identification of the pine species.

Regina Célia Zonta de Carvalho, *Centro de Diagnóstico Marcos Enrietti—SEAB, Rua Jaime Balão 575, 80040-340, Curitiba, Paraná, Brasil (e-mail: regcarva@zaz.com.br)* and Sonia Maria Noemberg Lazzari, *Departamento de Zoologia, Universidade Federal do Paraná, Caixa Postal 19020, 81531-990, Curitiba, Paraná, Brasil (e-mail: lazzari@bio.ufpr.br).*

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NOTE

New Distributional and First Specific Host-Plant Records for *Thionia acuta* Doering and *T. producta* Van Duzee (Auchenorrhyncha: Fulgoroidea: Issidae)

The mostly Neotropical issid genus *Thionia* Stål (ca. 72 spp.) includes eight species in America north of Mexico (Wheeler and Wilson. 1987. Journal of the New York Entomological Society 95: 440–451). Information on host plants of North American *Thionia* species and descriptions of their nymphal stages have been published mainly in the last few years (Wheeler and Wilson 1987; 1988. Journal of the New York Entomological Society 96: 266–273; Wheeler. 1996. Proceedings of the Entomological Society of Washington 98: 374–375). Wilson et al. (1994. pp. 7–113 *In* Denno and Perfect, eds., Planthoppers: Their Ecology and Management, Chapman and Hall, New York) provided a list of recorded host plants of the Fulgoroidea. Herein, I provide new state records and the first host-plant associations for the seldom-collected *T. acuta* Doering, as well as the first specific host records for the morphologically similar *T. producta* Van Duzee.

Thionia acuta Doering

Doering (1939. University of Kansas Science Bulletin 25: 447–575[1938]) described this issid under the name *T. naso* Fowler, relying on the identification of E. D. Ball, who compared Doering's specimens from Concan, Tex., with Fowler's holotype of *T. naso* from Jalapa, Mexico. Once Doering had access to the holotype of *T. naso*, she realized the Texas material represented a new species, which she named *acuta* (Doering. 1941. University of Kansas Science Bulletin 27:185–233) and described by bibliographic reference to her previous paper (Doering 1939). No records of *T. acuta* have been published since Doering's (1939) description, and host relationships have remained unknown.

In 1999, I collected nymphs and adults of *T. acuta* in Kansas and Oklahoma on juniper (*Juniperus* spp.; Cupressaceae) in native stands and landscape plantings. Voucher specimens of *T. acuta* (and *T. producta* from Arizona) have been deposited in the National Museum of Natural History, Smithsonian Institution, Washington, D.C. (USNM), and the S.W. Wilson Collection, Central Missouri State University, Warrensburg.

Collection records.—KANSAS: Riley Co., Kansas State University, Manhattan (39°11′39″N, 96°34′57″W; elev. 330 m), 22 June 1999, ex *Juniperus virginiana* trees (9♂, 16♀, 3 5th instars). OKLAHOMA: Cleveland Co., University of Oklahoma, Norman (35°12′26″N, 97°26′54″W; elev. 292 m), 12 June 1999, ex *Juniperus chinensis, J. virginiana* (11♂, 12♀, 3 5th instars); Garvin Co., unnamed road SW of Rts. 7 & 35, W of Davis (34°29′32″N, 97°11′46″W; elev. 252 m), 13 June 1999, ex *Juniperus virginiana* (1♂, 6♀, 1 5th instar); Woodward Co., Rt. 34, 3.7 km N of Vici (36°10′45″N, 99°19′55″W, elev. 690 m), 25 June 1999 (2♂, 7♀).

Thionia producta Van Duzee

Described from Colorado by Van Duzee (1908. Proceedings of the Academy of Natural Sciences of Philadelphia 59:467–498[1907]), *T. producta* has since been recorded from Arizona, Texas, and Utah (Doering 1939; Metcalf. 1958. General Catalogue of the Homoptera, Fasc. IV, Part 15 Issidae, Waverly Press, Baltimore). The host plant, based on R. H. Beamer's collecting at Leakey, Tex., on 8 July 1936, is "cedar" (Doering 1939). My collections of *T. producta* in Arizona's Huachuca Mountains confirm cedar (*Juniperus*) as a host, specifically alligator juniper, *J. deppeana* Steudel.

Collection records.—ARIZONA: Cochise Co., Ash Canyon Rd. nr. Twin Oaks Rd., 0.4 km W of Rt. 92 (31°23.3′N, 110°14.1′W; elev. 1540 m), 4 June 1997, ex *Juniperus deppeana* (9♂, 7♀; 1 3rd, 1 4th, and 13 5th instars); Miller Canyon Rd., 1.2 km W of Rt. 92 (31°25.7′N, 110°15.2′W; elev. 1525 m), 5 June 1997, ex *Juniperus deppeana* (6♂, 1♀; 13 5th instars).

Discussion.—Kansas and Oklahoma are new state records for *T. acuta,* known previously only from Concan, Tex. The Kansas collection extends the range of this planthopper northeast by more than 1,100 km. In addition, collections of nymphs and adults from native stands of *Juniperus virginiana* and in landscape plantings from *J. virginiana* trees (10–15 m high) and a *J. chinensis* hedge (ca. 10 m long) represent the first published host associations for *T. acuta.* One specimen from the series that P.W. Oman collected at the type locality in Texas bears a "juniper" label, but host data were not mentioned by Doering (1939, 1941). Collections of *T. producta* nymphs from alligator juniper in the Huachuca Mountains of Arizona represent the first specific host records for a species known previously only from "cedar."

In describing *T. acuta* (erroneously as *T. naso*), Doering (1939) noted its resemblance to the juniper-feeding *T. producta.* Because male genitalia of both species are similar—she alluded to minor differences—she did not describe those of *T. acuta,* but referred to the genitalic description under *T. producta* in the same publication. Although Doering (1939) acknowledged that some taxonomists might consider the two issids varieties of a single species, she felt it less confusing if they were recognized as separate species.

Doering's (1939) hesitancy in recognizing *T. acuta* and *T. producta* as distinct species might have been influenced not only by the morphological similarity of these planthoppers, but also by her awareness that both species had been collected on juniper at Concan, Tex. (assuming she saw the single specimen of *T. acuta* that bears host information). Only in the case of *T. producta,* however, did she publish a host association (Doering 1939).

Adults of *T. acuta* and *T. producta,* although similar, differ morphologically more than those of many cryptic or sibling species. The two species can be distinguished by length of the vertex (see Doering 1939: plate 51), even accounting for the intraspecific variation that she noted in *T. producta,* and by total body length with wings in repose (*T. acuta* = 6.8–8.4 mm, *T. producta* = 5.5–6.8 mm). These morphologically similar, juniper-feeding issids, nymphs of which are both green, might prove to be sister taxa when *Thionia* is analyzed cladistically.

I thank Thomas J. Henry (Systematic Entomology Laboratory, c/o National Museum of Natural History, Washington, D.C.) for companionship in the field, for helping collect issids, for comparing specimens of *T. acuta* collected in 1999 with determined material in the USNM, and for calling my attention to host information on a specimen of *T. acuta*; and Stephen W. Wilson (Department of Biology, Central Missouri State University, Warrensburg) for verifying (and in some cases correcting) my preliminary sorting of *Thionia* nymphs to instar, and for verifying the identification of both *Thionia* species.

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OBITUARY
A TRIBUTE TO TED SPILMAN

Theodore James Spilman
(1925–1996)

All who knew Theodore James Spilman will remember his earnest and varied interests in many subjects, from U.S. presidents to music, in addition to his thorough command of all things entomological. Ted was fascinated by the lives of entomologists as much as by entomology itself. As a devoted member of the Entomological Society of Washington, serving over the years in several offices including President, he had an unofficial role as the Society's historian. On the occasion of the one-thousandth meeting of the ESW in February 1995, he told stories of the early meetings and formation of the ESW, complete with century-old "gossip" and detailed knowledge of the lives of some founding members, leaving those of us present wanting to hear much more. This was however to be Ted's last address to the membership, as an ongoing battle with cancer ended his productive life in September 1996. But Ted's recollections and writings on the growth of the ESW certainly still give its present members, and those to come, a sense of their organization's unique history and purpose. As fellow ESW members representing three generations of entomologists who knew and worked with Ted, we offer some personal remembrances of him, followed by a list of his published contributions to the science and history of entomology.

REMINISCENCES OF TED SPILMAN

by John M. Kingsolver

Theodore J. Spilman died September 22, 1996 at 71 years of age. He and I worked together for 23 years in our positions with the U.S. Department of Agriculture in Washington, D.C., and were the closest of friends. My first meeting with Ted was in March, 1960, while I was on a type-study trip to eastern museums. He and Rose Ella Spilman (then Warner) helped me find the type specimens I needed to see. By 1962, when I joined the U.S. Department of Agriculture staff at the National Museum, Ted and Rose Ella were married. The three of us were part of a group of seven USDA and two Smithsonian Coleopterists with offices in the National Museum, although entomological offices and the insect collection were then housed temporarily in a building on Lamont St. north of the main museum. We were a congenial group although our respective institutional duties were somewhat divergent. The USDA "crew" included Donald Anderson, George Vogt, Ted, Rose Ella and myself, whereas the SI group consisted of Oscar Cartwright and Paul Spangler. Later, Robert Gordon and Richard White joined the USDA group and Terry Erwin the SI group.

Of course, I picked brains to learn procedures, and everyone on both staffs was helpful. Ted and I became near "brothers" after we learned that he was one day older than I. This led to joint birthday celebrations in March for as long as we were associated. Several years later, I discovered that one of my ancestors was named Spilman. Although Ted tried desperately, he could never connect our family lines.

Ted was well liked by everyone. He had a thorough knowledge of the darkling beetle family, the click beetles, and several other smaller coleopterous families. He didn't publish many large papers but seemed fated to put out small emergency fires that constantly cropped up in agricultural entomology. His papers were meticulous, practical, and useful. He was well-read in the arts and the classics, and had a considerable library at home.

Ted was very professional, usually wearing a lab coat or jacket and tie whereas some of the others of us dressed more casually. He was especially at home with visitors to the museum, helping them to find specimens in the collection, and making certain that they had everything they needed during their visit.

For several reasons, Ted and Rose Ella and my wife and I seldom socialized. We had children in school, my wife worked evenings in a hospital, and opportunities for visiting were scarce. One series of social gatherings thrived for several years in the 1960's. Several couples and singles from both the USDA and Smithsonian staffs formed a loosely organized group to meet and read plays. Parts would be assigned ahead of time, and we would meet in a member's home where the plays would be read but not acted out. Refreshments would be furnished by the hosts to round out the evening.

Ted often came to work at the museum after his retirement in 1985 although the last few years of his life he was seriously ill. I last spoke with him shortly before he died.

R. J. Gagne (1997, American Entomologist 43 (3):191–192) wrote a fine obituary for Ted and listed his vital statistics and many accomplishments, especially of his association with the Entomological Society of Washington.

TED SPILMAN, FRIEND

by Ross H. Arnett, Jr.

I first met Ted when I returned to Cornell for a short visit soon after I went to work at the U.S. National Museum. V. S. L. Pate told me that a friend of his had a former student at the University of Louisville, now registered at Cornell, who wanted to do graduate work on beetle taxonomy. Pate wanted me to meet him. When I was in Comstock Hall that morning, Ted was in class, so I didn't get to meet him there. I drove to College Town and was parking the car to get some lunch when this young fellow ran up to the car and said: "You are Ross Arnett?" "Yes." "I am Ted Spilman and I want to work on Pythidae!"

Thus began a close friendship that lasted the rest of our lives. We were in close touch both entomologically and personally in so many ways. When I left the Museum to teach, Ted took over my job, and the groups of beetles I was working on. As I wrote the "beetle book" Ted helped in so many unacknowledged ways. He looked up things for me. He found specimens for me. He criticized (most valuable). As everyone knows who has tried to do a big piece of work, without friends of the caliber of Ted, they never would complete their project.

When I moved back to Washington to teach I had no place to live until we sold our house in Rochester. Ted put me up in his apartment (this was before the days of Rose Ella). I slept on a "hide-a-bed" in the living room. My head was near a fish tank. During the night the fish clicked their gills (courtship sounds?). Ted didn't believe me. I don't know if he ever found out about his talking fish.

We sold our house up north. Ted and I went house hunting in Bladensburg. One day coming back from such a trip, Ted had an accident with his Studebaker. No one was hurt, but the front of the car was a mess. Ted never got it fixed. He drove it for quite awhile, and then traded it off. Ted and I picked out a house which my wife Mary and the children never saw until the day we moved in.

Ted took the job in Washington before he finished his doctoral thesis and took his orals at Cornell. I suggested that he finish his degree at Catholic University of America under my direction. He did register for a semester as a graduate student, but he was much too busy at the museum to bother with the trivial academic hurdles on a campus across town, so finishing the degree was always put aside for something more important—his research. Therefore, he remained "Mr." Spilman, but in our minds he was "Doctor."

Then came Rose Ella Warner. Ted and Rosa Ella were made for each other. It was my distinct honor and pleasure to be Ted's best man at their wedding. Nothing between close friends can ever be as wonderful as having this role in the ceremony of the Holy Matrimony. I offered the toast the best man is supposed to do, not very elegant, I am afraid, but I wished them a happy married life, and it was to the very last.

No matter where I moved, Ted was always back there at the USNM (entomological Mecca) willing to answer questions, send specimens, and help in every way I asked. He called me a few days before he died to say good-bye. I said "Good-bye, dear friend."

TED SPILMAN'S CONTRIBUTIONS TO ENTOMOLOGY

by Warren E. Steiner, Jr.

The wide range of entomological topics that attracted Ted Spilman's interest, paired with his cordial willingness to share his findings with others, made him a great resource to the research community at all levels. In the late 1970s when I was at the National Museum as a student and contract technician, I first got to know Ted and found him to be a living encyclopedia. Being able to tap this irreplaceable source of information, then simply chat about topics of mutual interest, was then a real help to a beginning student, and is now truly missed.

I often relied on Ted for a quick identification, or help in finding references on a particular beetle or natural history topic. Because so many unrelated beetle taxa were the subjects of his research over the years, primarily the tenebrionoid families but also Ptinidae, Bostrichidae, Elateridae, Cerambycidae, and the odd little "jumping shore beetles" (intertidal Limnichidae), asking Ted was much faster (and more entertaining) than searching the library.

Fieldwork was not a major part of Ted's entomological career, but he did travel to Dominica for about 3 months in 1964 to participate in the Bredin-Archbold-Smithsonian biological survey of the island, where he made some significant collections. Most of his collecting and work on rearing of larval beetles was centered in the eastern U.S. where he helped show me that, when it came to knowledge of beetles, the back yard was frontier. He and I made at least two local field trips in the early 1980s in search of new finds—we picked at polypore fungi along the Potomac, sorted through sand of Delaware dunes, salvaged drowned specimens from the beach drift line, and had a good time trading trivia. But we turned back at Assateague Island when, to our dismay, we unknowingly had chosen the day of the annual wild pony roundup for our visit. Glamorous megafauna had overwhelmed entomology once more, but my adaptable travel partner was equally happy to find a camp along the Pocomoke, where the mosquitoes are at least smaller than those at the beach.

Ted's research products are a complex quilt of subject matter. Without hesitation he can be called a coleopterist. Fossil beetles, beetles of medical importance, cave beetles, morphology of beetle genitalia, beetles in mammal nests, introduction of foreign beetles, beetle nomenclature, rearing the larvae and pupae of beetles, the lives (and even grave sites) of people who studied beetles, were among his topics addressed. His curatorial and identification responsibilities covered several of the largest families of beetles and many unrelated smaller groups. He liked island faunas and was keeping and building separate survey collections of West Indian and Hawaiian Tenebrionidae. He seemed to enjoy solving complex nomenclatural problems, and in several papers, delved into the definition of terms and usage of names. The odd and atypical attracted his attention—he even named a beetle species "extraordinaria."

The diversity of subjects was equally broad when it came to the books that Ted reviewed. These included systematic revisions, catalogs, identification manuals, treatments of biology, morphology, and agricultural importance of insects, and biographies of entomologists. His reviews are still useful and amusing to read—he talks frankly and informally about any shortcomings and yet gives the book a good sell, often with humorous flair. It is obvious that he enjoyed reading and commenting on the writings of others, including works by colleagues, and he sometimes published the same review in two or more places.

Ted was a long-time member of the Coleopterists' Society and served as Editor of the Coleopterists' Bulletin for five years, succeeding Ross Arnett in 1962. With his writing style and acute command of taxonomic principles, terms and literature, he was an excellent and dependable reviewer of manuscripts. Alas, production of some taxonomic works surely must have been set back because of his loyal service to others in many ways and his constant attention to many duties on the job.

A lot of Ted's research pursuits went unfinished, but he leaves behind a wealth of information for the next students of these special topics, in the form of literature collections and notes, card files, manuscripts in progress, copies of correspondence with colleagues, and identified specimens. His sixty published works (not including book reviews) listed below are only the tip of a great iceberg of accomplishments—Ted's separate files on research topics, grouped by subject and by taxon, will be most useful and unique products of his labors. These will perpetuate his contributions to the science, as will the professional example he set for all of us and the generations to follow.

Publications by T. J. Spilman

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1958. The transfer of *Anamphidora* from the Tenebrionidae to the Alleculidae (Coleoptera). Proc. Ent. Soc. Washington 60(6): 288.

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1959b. A study of the Thaumastodinae, with one new genus and two new species (Limnichidae). Coleopt. Bull. 13: 111–122.

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1962b. The New World genus *Centronopus,* with new generic synonymy and a new species (Coleoptera: Tenebrionidae). Trans. Amer. Ent. Soc. 88: 1–19.

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1963b. On larvae, probably *Tauroceras,* from the Neotropics (Coleoptera: Tenebrionidae). Coleopt. Bull. 17: 58–64.

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1966b. Larva and pupa of *Amarygmus morio* from Hawaii (Coleoptera: Tenebrionidae). Proc. Hawaiian Ent. Soc. 19(2): 297–301.

1966c. A new species of *Martinius* from Cuba (Coleoptera: Limnichidae). Coleopt. Bull. 20(4): 123–125.

1967a. A new North American Ulomine genus and species, *Doliodesmus charlesi* (Coleoptera: Tenebrionidae). Pan-Pac. Ent. 43(2): 149–154.

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1972c. *Uloma* Dejean, 1821 (Insecta: Coleoptera): Proposed designation of a type-species under the plenary powers. Z.N.(S) 1979. Bull. Zool. Nomencl. 29(1): 32–34.

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Book Review

The Genus Rhipicephalus *(Acari, Ixodidae): A Guide to the Brown Ticks of the World.* Jane B. Walker, James E. Keirans and Ivan G. Horak. Cambridge University Press, The Edinburgh Building, Cambridge CB2 2RU, United Kingdom. xii + 643 pp., 279 figs., 71 tabs., 74 maps. 2000. $100.00/cloth. ISBN 0-521-48008-6. www.cup.cam.ac.uk.

Through nearly two centuries of study, no tick genus has proved as taxonomically intractable as *Rhipicephalus.* Particularly in tropical Africa, exclusive home to 60 of the world's 74 known species, misidentifications of rhipicephalids have rendered suspect numerous otherwise valuable veterinary and parasitological papers. Now, however, as if in tribute to the new millennium, acarology's own Gordian knot lies sundered by the peerless team of Drs. Walker (Onderstepoort Veterinary Institute, South Africa), Keirans (U.S. National Tick Collection, Georgia Southern University, Statesboro) and Horak (Faculty of Veterinary Science, University of Pretoria, South Africa), whose decades-long synergy has yielded the most comprehensive—and attractive—volume ever published on a single genus of ticks, the sixth in a series of monographs on the Ixodoidea begun by George Henry Falkiner Nuttall (1862–1937) and colleagues in 1908 and championed from the outset by Cambridge University Press.

Introductory sections of this sumptuous work provide a definition of *Rhipicephalus* in the context of the family Ixodidae (section 2), augmented by illustrations of key characters (section 3) and a glossary (section 4) of all morphological, taxonomic and other terms that are associated with members of this genus (some of these, like "shagreened" (p. 19), are uniquely rhipicephalid descriptors). There follows (section 5) a worldwide annotated checklist of all the *Rhipicephalus* species names ever published, including junior synonyms, new combinations and *lapsus calamorum,* together with full citations for original descriptions, and collection data and depositories for types and type series. The book then neatly divides itself in two: sections 6, 7 and 8 describe the rich rhipicephalid fauna of the Afrotropical Zoogeographic Region; sections 9, 10 and 11 address the 10 *Rhipicephalus* species that occur outside the Afrotropics. As noted by the authors, this dichotomy does not work for all taxa. Included in their Afrotropical discussion is the circumglobal *R. sanguineus,* the world's most widespread tick species and the only representative of its genus in the Western Hemisphere, as well as *R. fulvus,* most collections of which have come from Tunisia (i.e., the Palearctic Zoogeographic Region), and *R. camicasi* and *R. turanicus,* with vast ranges in Africa and adjacent lands. Also, the trans-African subspecies *R. e. evertsi* apparently has been recently introduced by humans into Yemen and the Red Sea coast of Saudi Arabia. But for the most part, the *Rhipicephalus* faunas of Africa and the rest of the world do not intersect, and the preliminary discussions of each (sections 6 and 9) comprise fascinating historical reviews of regional tick research, exhaustive lists of country-specific references, and the authors' long-anticipated male and female identification keys, whose user-friendliness is immeasurably enhanced by inclusion of information on preferred hosts and distributions within the key couplets themselves.

At the core of this effort are the individual species accounts (sections 7 and 10), each wholly self-contained, which collectively constitute over three quarters of the text. In these accounts, thorough descriptive diagnoses of all known active stages are accompanied by stunning scanning electron photomicrographs, conventional light micrographs of slide-mounted female genital apertures à la Feldman-Muhsam (1956, Bull. Res. Council Israel 5B: 300–306), and, for both sexes, the heartbreakingly beautiful pen-and-ink drawings of A. Olwage, Walker's long-time artistic collaborator. Olwage's preeminence as a tick illustrator gained world renown with the publication of his series of color plates depicting the adults of *Amblyomma* species capable of transmitting the agent of heartwater, *Cowdria ruminantium* (1987, Onderstepoort J. Vet. Res. 54: 353–379). In the opus at hand, his skill is perhaps best exemplified in drawings of the ornate *R. pulchellus,* whose specific epithet means "beautiful" (p. 366), and the densely punctate male of *R. ramachandrai* (p. 562). Olwage also produced the final versions of each tick distribution map, wherein data as diverse as type locality (if known), and confirmed and unconfirmed records of various authors are precisely but harmoniously plotted (excellent examples are the distribution of *R. guilhoni,* p. 207, and *R. sulcatus,* p. 431). Given the biomedical importance of this genus, it is surprising how many diagnoses are incomplete for at least one life history stage. While males and females are known for all species, both nymphs and larvae are unknown for the Afrotropical *R. aquatilis, R. bequaerti, R. bergeoni, R. boueti, R. deltoideus, R. dux, R. interventus, R. longiceps, R. masseyi, R. oreotragi* (one of two new species described in this book; the other is *R. warburtoni,* known from all stages), *R. punctatus, R. serranoi* and *R. supertritus.* In addition, the nymph of *R. longicoxatus* is unknown, as is the larva of *R. pseudolongus.* Preimagines of *R. complanatus* and *R. ziemanni* exist in collections but have not been described. Outside Africa, the immatures of *R. scalpturatus* are unknown, as well as the larva of *R. leporis,* while the larva of *R. pusillus* was not available for study.

Each species diagnosis closes with one or more paragraphs of critically important "notes on identification," in which the authors offer insights for separating similar species, often discerning helpful differences in minor morphological expressions, such as those accompanying engorgement, or in tick ecology, distribution, and host specificity. This discussion leads seamlessly to a tabulation of all known hosts of each tick species, these data having been gleaned from large and small tick collections worldwide and from the literature (hosts are entirely unknown for *R. deltoideus* and *R. scalpturatus*). Statements on tick zoogeography, incorporating altitudinal data, rainfall and vegetation zones, and often explaining or clarifying the map records, round out each account, together with a summary of disease relationships (only 27 *Rhipicephalus* species (36%) have ever been linked to any human or animal disease, several transmitting only in the laboratory to splenectomized hosts) and a list of species-specific references. At the close of both the African and non-African species accounts, the tick/host tables of the accounts are combined and inverted, yielding checklists of all *Rhipicephalus* species collected from each host animal (sections 8 and 11). In this reversed arrangement, tick names in boldface generally indicate that the animal under which they are listed is a preferred host of the adults. However, in the Afrotropical *R. follis, R. gertrudae* and *R. simus,* the hosts of immatures (usually small rodents) are entirely unrelated to the hosts of adults (usually ungulates), so these three tick species appear twice at opposite ends of the checklist. With additional field collections of immatures, this bimodal pattern of parasitism is likely to apply to many more rhipicephalids. Dual entries also appear for the immatures of the Afrotropical *R. pravus, R.* sp. near *pravus* and *R. warburtoni,* which are often found on lagomorphs (like most African *Rhipicephalus*) but chiefly parasitize elephant shrews.

Section 12, "Species groups based on the immature stages," is a first attempt to help taxonomists identify the maddeningly similar immatures of this genus by sorting known nymphs and larvae into 10 more or less recognizable groups (8 Afrotropical, 2 non-Afrotropical) based on diagnostic capitular characters, again admirably drawn by Olwage. Brief descriptions of these characters are provided for each group and, as in the adult key, summaries of each species' geographic distribution assist in clinching identifications. The authors take pains to note that these groups may not be "natural," although the immatures of the Afrotropical *R. evertsi* group—*R. bursa, R. evertsi* and *R. glabroscutatum*—are both morphologically similar and the only species in their genus known to have a two-host, rather than three-host, life cycle. As well, species in the "pointy-palp" groups of nymphs and larvae (i.e., the Afrotropical *R. capensis, R. follis* and *R. simus* groups), which are exceedingly difficult to identify, seem to share the habit of feeding on specific small mammals that are not parasitized by the adult stages.

To describe in any detail the variety of diseases associated with members of the genus *Rhipicephalus,* and the research that has been conducted in this sphere, would necessitate doubling the present volume. This is, after all, a book about ticks: how to identify them, how they live, and where and when they may be found. But just as the authors employ host/tick checklists to summarize the discussions of host relationships in the individual species accounts, in their final section (13) they leave disease-oriented readers with two multipage, landscape-format tables on the transmission of diseases to animals and humans. Both are superb synopses. The animal table lists 25 *Rhipicephalus*-borne diseases and 28 causative agents, plus two afflictions (tick paralysis and tick toxicosis), with additional headers for the animals affected, the tick vectors (including, if known, the primary natural vectors and any that have transmitted experimentally), the number of hosts utilized by each tick species (in *Rhipicephalus* generally 3, sometimes 2), the tick stages that acquire and transmit disease, and one or more classic references (an appended bibliography provides 80 additional reviews of animal diseases vectored by rhipicephalid ticks). The table for tickborne diseases of humans is similar, listing 15 diseases and causative agents, with further headers for tick vectors, number of hosts, the mode of infection or isolation of the causative agents, and classic references (the appended bibliography for this table provides 33 additional reviews).

Even at the dawn of the 21st century, books of this length and complexity are certain to contain at least a few minor typographical errors. Accordingly, the publishers have agreed to issue an erratum slip, which currently makes the following emendations: the correct date of publication for the new species *R. oreotragi* (p. 31) and *R. warburtoni* (p. 38) is 2000, the date 1999 being an unfortunate carryover from publication delays; the Rocky Mountain Laboratory is in Montana, a state that should be abbreviated MT, not MA (Massachusetts) (p. 45); and under the "notes on identification" for *R. serranoi* (p. 408), "XX" and "YY" should be replaced by male and female symbols. Such minutiae aside, this authoritative and beautiful book is the best beginning we could wish for acarology's third century. No one who visits its pages will fail to find instruction or inspiration. Surely somewhere Cecil Warburton (1854–1958), whose meticulous studies of *Rhipicephalus* intraspecific variation made him the obvious choice for this work's dedicatory frontispiece, is smiling serenely at his reward: an infinite number of ticks and an eternity in which to examine them.

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FLOWER FLIES OF THE SUBGENUS *OCYPTAMUS* (*MIMOCALLA* HU (DIPTERA: SYRPHIDAE)

F. CHRISTIAN THOMPSON AND MANUEL A. ZUMBADO

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Abstract.—The subgenus *Ocyptamus* (*Mimocalla*) is revised. ***Ocyptamus* (*Mimocalla*) *tristani* Zumbado, new species,** is described and two **new synonyms** are proposed (*Salpingogaster flukei* Curran 1941 and *Baccha polista* Hull 1943 = *Baccha bonariensis* Brèthes 1905). A key to the species, along with synonymies, descriptions, distributions, and figures for all species are given.

Key Words: Neotropical, key

The New World tropics have the richest diversity of flower flies in the World. This diversity holds great promise for sustainable agriculture. The flower fly diversity largely resides in three genera (*Toxomerus* (150 spp.), *Ocyptamus* (300 spp.) and *Copestylum* (320 spp.)). The flies of the genus *Ocyptamus* are predators of a diverse array of plant pests (mites, scales, plant hoppers, aphids, etc.). To fully utilize their potential, the species must be named and described so that their life-histories can be studied and reported. Then the relative contribution of these predators to agroecosystems can be assessed and, perhaps, enhanced.

Consider coffee production: While most coffee is today grown in large, open, single crop systems which require insecticide use, there is a growing trend to return to more natural shade-grown systems. In such systems, the new species described herein may be a useful biological control agent. The species is a predator of black, soft-brown and hemispherical scales, which are pests of coffee and various ornamental plants.

This paper is the second in a series to treat various components of the large diverse genus *Ocyptamus.* The first part (Thompson, in preparation) includes a description and diagnosis of the genus and a key to the components (subgenera and species groups) along with the treatment of several species groups. This paper treats the species group named and treated as a subgenus by Hull. Until a cladistic analysis is done of the genus as a whole, we, for pragmatic reasons, retain *Mimocalla* as a subgenus. The likely sister to *Mimocalla* is *O. conjunctus* Wiedemann and the sister to *O. conjunctus* + *Mimocalla* is *O. sargoides* Macquart. Using these species as outgroups, we include a preliminary cladistic hypothesis for the species of *Mimocalla.* Redescriptions, complete synonymies, illustrations, and distributions are given for all species. Terminology follows Thompson (1999), the abbreviations found in the synonymies follow Thompson (2000), the use of the asterisk in the distribution statement means verified records to be found below

Fig. 1. Habitus of *Ocyptamus tristani*, dorsal.

in the material examined section. Color images of these flies along with the rest of the information in this paper may be found on the Diptera WWW site (http://www.sel.barc.usda.gov/Diptera/) and on the *Diptera Data Dissemination Disk.*

Genus *Ocyptamus*

Ocyptamus Macquart 1834: 554. Type species, *fascipennis* Macquart (Coquillett 1910: 577) = *fuscipennis* Say.

Subgenus Mimocalla Hull

Baccha subg. *Mimocalla* Hull 1943d: 46. Type species, *Baccha capitata* Loew (orig. des.); Hull 1949: 97 (discussion, key).

Description.—Face usually yellow, rarely with weak brownish vitta or black with narrow yellow vitta, with strong tubercle; frons prominent; vertex short, broad, with ocellar triangle about 1½ times its length anterior to hind margin of eye; occiput with 2 rows of cilia, with cilia normal, not scale-like; metasternum bare; metathoracic episternum pilose; postmetacoxal bridge incomplete; scutellum yellow or rarely entirely black, with 1 row of strong and long ventral pile; plumula long to absent; calypter with strong fringe only on ventral edge; mesonotum usually with bright yellow pollinose vittae, rarely entirely dark; metatrochanter always with a tuft of long black pile, frequently males with long ventral pile also on metacoxa and femur; abdomen clavate, constricted at base of 2nd tergum and gradually widening apically, brown to black, with yellow fasciae; male genitalia greatly enlarged, with cercus and apicolateral corners of 9th tergum enlarged; male 5th sternum variously modified on apical half.

Wing: Alula normal, about 1½ times as broad as cell BM, bare or microtrichose; crossvein r-m at basal ⅓ of cell DM, slightly beyond termination of vein Sc; vein M1 sinuate, ending approximately at termination of vein R1; vein R4+5 sinuate, making a shallow loop into cell R4+5.

Length: 12–16 mm; wing, 10–14 mm.

Discussion.—The subgenus *Mimocalla* is readily distinguished from all other groups of *Ocyptamus* by: 1) strongly petiolate and clavate abdomen; 2) large size; 3) enlarged male genitalia including a modified 4th sternum; 5) vein R4+5 sinuate; 6) vein M1 sigmoid; and 7) metatrochanter with a strong pile tuft. In appearance *Mimocalla* can only be confused with *O.* (*Theranta*) *conjunctus,* but *Mimocalla* is readily distinguished by the sinuate vein R4+5 and short antenna.

While a full cladistic analysis has not been done, the characters of the male genitalia suggest these relationships (*Mimocalla* = (*giganteus* + *willistoni*) + ((*bonariensis* + *erebus*) + (*nymphaea* + (*capitatus* + *tristani*)))). In most *Ocyptamus,* the cercus is unmodified, small, and oval, but in *Mimocalla* the cercus is enlarged. In one group (*giganteus* + *willistoni*), the shape of the cercus is triangular and the surstylus short, blunt apically and directed ventrally. In the other group, the cercus is elongate and the surstylus is also elongate, tapered apically and directed posteriorly. Within this second group, the genitalia of *capitatus* and *tristani* are the same, and those of *nymphaea* are very similar. These three species also share the more or less simple 5th sternum. The other two species (*bonariensis, erebus*) have the 5th sternum produced apicolaterally on the right side.

Little is known about the biology of *Ocyptamus* species. However, the life history of one species of *Mimocalla* has been published. We review that work in light of our rearing of *tristani,* new species. Bruch (1923) noted that *bonariensis* larvae completely suck dry a scale insect before moving on to the next and that the complete larval cycle probably lasts about three weeks. Once the larva finishes feeding, the larva remains quiescent for about two days, then evacuates the gut and changes position in order to pupate, either on the same plant or nearby, and finally resting about one more day before pupating. The larva slowly becomes smaller and releases a viscous transparent liquid, which when hardens to anchor the puparium. During the process of transformation the posterior part of the larva becomes narrower, while undulatory and contraction movements of the pupa forming inside inflates bit by bit the anterior portion; this process lasts about two hours. The recently formed puparium is colored the same as the mature larva but shortly after pupation it becomes pale brown. The pupal stage lasts about two weeks.

Observations by M. Zumbado and J. A. Ugalde on *tristani* confirm Bruch's observations. Mature *tristani* larvae (Figs. 20–22) measure between 12 and 14 mm long and about 5 mm wide. The body is subparallel along its length, rather convex dorsally and flat ventrally; anteriorly it is narrower and posteriorly is obliquely truncated. The color is similar to that of *bonariensis.* The puparium (Fig. 23) is smaller than the larva and measures 8 to 9 mm long; in a dorsal view, its shape is pyriform; the anterior portion is highly convex dorsally, becoming narrower and cone shaped posteriorly. Ventrally the puparium is flat posteriorly and slightly concave anteriorly. The surface is coarse, without tubercules. The posterior breathing tube is very short and black.

We reared *tristani* from July 1st to October 13, 1993 and from June 20 to October 10, 1994, at INBio headquarters in Santo Domingo, Heredia Province, Costa Rica, at an elevation of 1,100 m. During the first season we did not successfully rear a single adult, just parasitic wasps (Hymenoptera: Pteromalidae and Encyrtidae). Larvae and puparia were found from June to October, during the rainy season in Costa Rica, when humidity favors scale insect development. Adults were present from February to August.

We found *tristani* larvae feeding on scale insects (Homoptera: Sternorrhyncha: Coccoidea: Coccidae) on various plant species (Rutaceae: *Citrus* sp., Fabaceae: *Acacia* sp., *Gliricidia sepium* (Jacq.) Kunth ex Walp, Solanaceae: *Datura* sp., Rubiaceae: *Coffea arabica* Linnaeus, Lamiaceae: *Ocimum basilicum* Linnaeus).

The larvae use a glue-like saliva (Rotheray 1986) to defend themself against aggressive organisms such as ants. Two *Camponotus* ants were seen attacking a larva that responded by turning the anterior portion of the body towards the ant and releasing a drop of this liquid substance on them. The ants were trapped for at least 2 minutes before freeing themselves.

Several species of parasitic wasps were found to attack *tristani,* all of them emerging from puparia. All reared parasitic wasps belong to the Encyrtidae, mainly *Syrphophagus* sp. which attacks the larval stage (Noyes 1995), and Pteromalidae, mainly *Pachyneuron* sp. In most cases, several to many (4 to 75 encyrtids, 1 to 33 pteromalids) emerged from a single puparium. These natural enemies seem to be very effective against *tristani* larvae. Neither *Pachyneuron* nor *Syrphophagus* are host specific in *Ocyptamus,* both are hyperparasitoids in aphids (Homoptera: Aphididae) or primary parasitoids in syrphids (Hanson and Gauld 1995). *Syrphophagus* also parasitizes Braconidae and Aphelinidae hymenopterans (Noyes 1995).

In our first attempts to rear the fly (60 puparia), we got only parasitic wasps (636 Encyrtidae and 260 Pteromalidae). So we started taking very recently formed puparia (17) and were then successful in getting adult flies (12). This suggests that female wasps are ovipositing on freshly formed puparia, perhaps attracted by the chemicals released during the transformation into pupae.

KEY TO SPECIES OF *OCYPTAMUS* (*MIMOCALLA*)

1. Legs black; mesonotum black; wing broadly black anteriorly; large, body length 20 mm . . . . *giganteus*
– Legs partially or entirely pale, always with mesotibia yellow; wing hyaline or at most narrowly light brownish anteriorly 2
2. Metafemur and tibia black; mesonotum black; face yellow; large, body length 16 mm or more . . . . *willistoni*
– Metafemur and tibia partially pale, brownish orange to yellow; mesonotum at least yellow on postalar callus; if mesonotum extensively dark, then face extensively dark; smaller, body length less than 16 mm 3
3. Abdomen yellow on 1st, 2nd and basal ⅓ of 3rd segments, elsewhere black; pleuron entirely yellow; legs yellow. Alula microtrichose . . . . *nymphaea*
– Abdomen not as such, with 1st and 2nd segment partially dark, brown to black; pleuron and legs partially dark 4
4. Postpronotum brownish black, only margins pale; notopleuron extensively brownish black; face extensively brownish black, only narrowly yellow laterally; abdomen appearing totally dark, abdominal pale fasciae greatly reduced . . . . *erebus*
– Postpronotum and notopleuron extensively yellow; face yellow or with narrow brown vitta; abdomen with distinct yellow fasciae 5
5. Alula almost entirely bare. Antenna pale, orange to brownish orange; scutellum yellow or obscurely grayish on disc (West Indies) . . . . *capitatus*
– Alula more extensively microtrichose, entirely (♀) or partially bare medially (♂). Antenna and scutellum usually partially dark (not West Indies) 6
6. 2nd tergum brown to black, except broadly yellow basolaterally and with medial triangular macula; scutum with lateral yellow vitta continuous behind transverse suture; abdominal

fasciae on 3rd & 4th terga broad, about ⅓ as wide as segment . . . . *tristani*

– 2nd tergum reddish brown except narrowly yellow basolaterally; scutum with lateral yellow vitta broadly interrupted behind transverse suture; abdominal fasciae on 3rd & 4th terga narrow, about ⅙ as wide as segment . . . . *bonariensis*

Ocyptamus (*Mimocalla*) *bonariensis* (Brèthes)
(Figs. 2–4)

Baccha bonariensis Brèthes 1905: 340 Argentina, Buenos Aires (HT ♂ MACN lost); Kertész 1910: 157 (cat. cit.); Fluke 1957: 153 (cat. cit.).

Ocyptamus bonariensis: Thompson et al. 1976: 13 (cat. cit.).

Salpingogaster flukei Curran 1941: 284 Ecuador, Tungurahua, Baños (HT ♂ AMNH); Arnaud and Owen 1981: 125 (type data). **New synonym.**

Baccha flukei: Hull 1949: 98, 105 (key ref., note); Fluke 1956: 246 (cat. cit.).

Ocyptamus flukei: Thompson et al. 1976: 18 (cat. cit.).

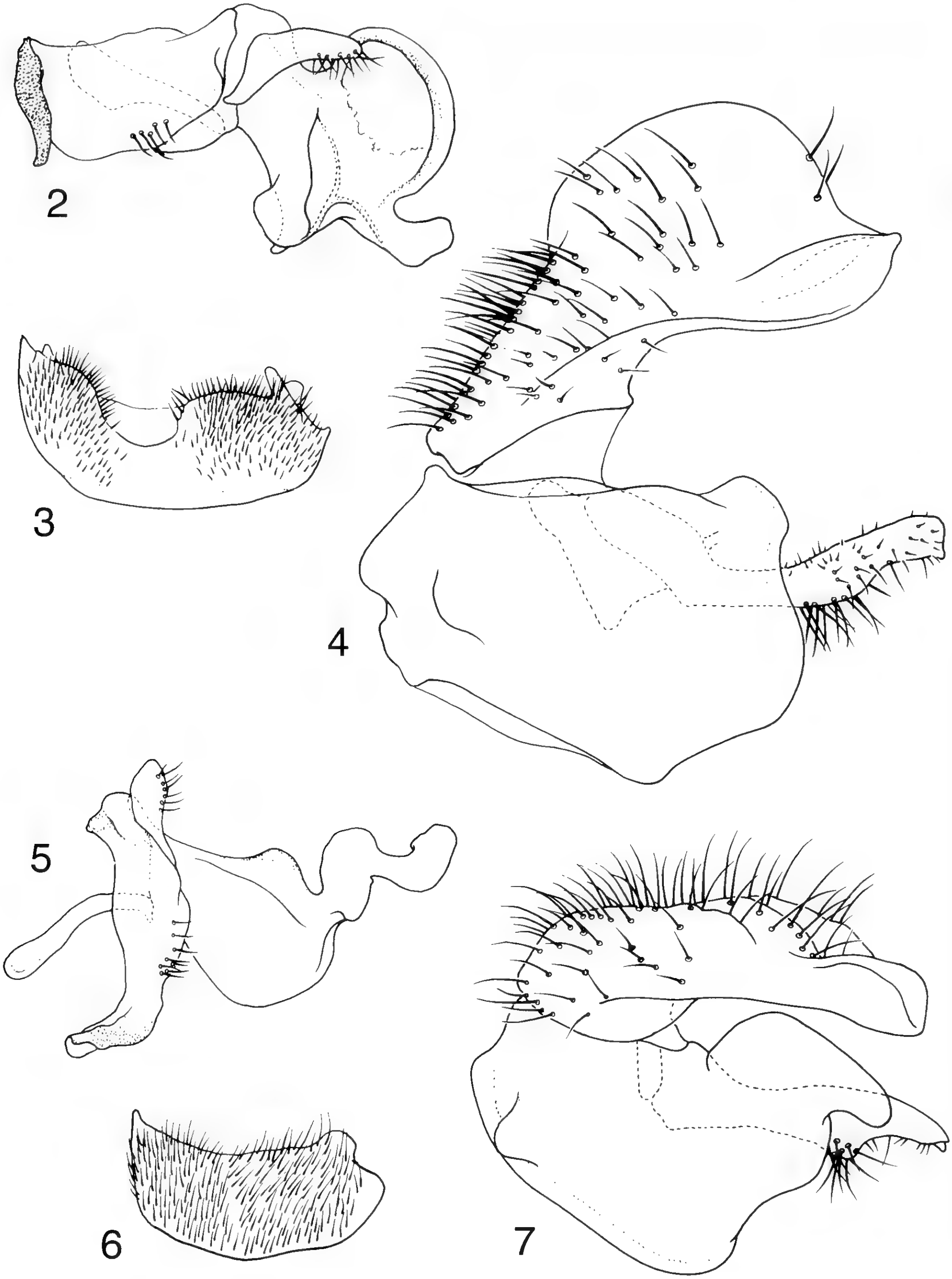
Baccha (*Mimocalla*) *phobia* Hull 1943b: 51 Ecuador, Tungurahua, Baños, Chaupi (HT ♂ AMNH); Hull 1949: 240 (fig. (abdomen pattern)). Syn. Hull 1949: 98.

Baccha (*Mimocalla*) *polista* Hull 1943c: 89 Brazil, Santa Catarina, Nova Teutonia (HT ♂ AMNH); Hull 1949: 98, 105, 236 (fig. (abdomen pattern), key ref.). **New synonym.**

Baccha nigriventris (misidentifications): Sack 1920: 249, 1921: 135 (puparium); Bruch 1923: 1 (cat. cit.); Knutson 1971: 29 (notes).

Male.—*Head:* Face yellow, with light brown medial vitta, sparsely white pollinose laterally, only densely pollinose narrowly along eye margin, white pilose except black pilose ventrad to antenna; gena yellow, shiny, bare; lunule yellow except brown medially; frontal triangle brown on anterior ½, yellow posteriorly, black pilose; vertical triangle black, black pilose; occiput black except yellow on ventral ⅙, densely whitish gold pollinose ventrally becoming more golden dorsally, white pilose ventrally becoming more golden dorsally; antenna brownish black except reddish brown basoventrally on basoflagellomere, black pilose; basoflagellomere elongate, about ⅓ longer than wide.

Thorax: Mainly brownish black with yellow maculae; postpronotum yellow, with rest of prothorax brownish yellow; scutum black except with broad yellow vitta running from postpronotum to and including anterior ½ of postalar callus but broadly interrupted behind transverse suture and dorsad to wing base, with vitta about as wide as postpronotum, with black areas black pollinose except for broad golden pollinose submedial vitta which tapers posteriorly and does not reach scutellum and a very narrow indistinct brown pollinose medial vitta on anterior ⅔ which expands into a broader golden pollinose vitta at level of postalar callus, long yellow pilose anteriorly and laterally, short intermixed black and yellow pile elsewhere; scutellum brownish black except yellow base and apical margin, short sparse black pilose with a few intermixed yellow pili basally; subscutellar fringe singular, white; pleuron blackish brown except yellow dorsad to procoxa and broadly yellow on posterior anepisternum, dorsal ½ of katepisternum, anterior ½ anepimeron and anterior ½ katatergum, very sparsely white pollinose except denser dorsally on katepisternum, yellow pilose; plumula very short, white; calypter yellowish white except dorsal margin brownish; halter brownish yellow. *Legs:* Procoxa orange, sparsely gray pollinose, yellow pilose; mesocoxa brown, black pilose medially, yellow pilose laterally; metacoxa black, long black pilose with a few intermixed yellow pili laterally; protrochanter orange; mesotrochanter brownish black; metatrochanter black, long black pilose; profemur orange, yellow pilose; mesofemur orange except blackish basally and apicoposteriorly, yellow pilose except for a few black pili on dorsoposterior surface; metafemur orange except black ventrally, orange



Figs. 2–7. Male genitalia. 2, *Ocyptamus bonariensis,* 9th sternum, aedeagus and associated structures, lateral view. 3. *O. bonariensis,* 4th sternum, ventral view. 4, *O. bonariensis,* 9th tergum and associated structures, lateral view. 5, *O. tristani,* 9th sternum and associated structures, lateral view. 6, *O. tristani,* 4th sternum, ventral view. 7, *O. tristani,* 9th tergum and associated structures, lateral view.

pilose except black pilose ventrally; pro and mesotibiae and tarsi yellow, yellow pilose; metatibia orange except yellow basal ⅓ and apex, yellow pilose; metatarsus brownish orange, yellow pilose. *Wing:* Narrowly brown anteriorly, hyaline posteriorly, microtrichose except bare cell R1 anterior to vein Rs, cell R, cell BM, anterobasal ⅓ of cell CuP, cell R4+5 posterior to spurious vein, narrowly on basoposteriorly in cell DM, basomedial ⅓ of cell CuA1, anterior to vein A2; alula entirely microtrichose to bare basomedially, normal, as wide as cell CuP; brown area including base and extending posteriorly to veins R and R1.

Abdomen: Dark brown with yellow fasciae; 1st tergum brownish black except yellow basally, white pilose basolaterally, black pilose elswhere; 2nd tergum brownish black except narrowly yellow basolaterally, yellow pilose basolaterally, black pilose elsewhere; 3rd tergum yellow on basal ⅛, brownish black apically, yellow pilose on yellow area, black pilose elsewhere; 4th tergum brown except yellow basal ⅕, black pilose except yellow pilose basolaterally; 5th tergum brown, black pilose except yellow laterally; genitalia brown and yellow, black pilose; 1st sternum brown, white pilose; 2nd sternum brown except yellow basal ½, yellow pilose; 3rd & 4th sterna brown except narrowly yellow basally, black pilose; 5th sternum brown, yellow pilose. Male genitalia: See Figs. 2–4.

Female.—Similar to male except for normal sexual dimorphism and frons black anteriorly except broadly yellow along eye margin, brown on medial ⅓, black posteriorly, shiny on anterior ⅓, sparsely gray pollinose medially, black pollinose on posterior ¼, short black pilose.

Length.—15 mm; wing, 12 mm.

Distribution.—Ecuador*, Peru*, Brazil (Santa Catarina*), Uruguay*, Argentina (Buenos Aires*, Misiones*).

Types.—*Baccha bonariensis* was described from a unique male from Palermo, Buenos Aires, Argentina, collected on 11 April 1904. A search of the Diptera collection of MACN failed to find this specimen. However, there is a single reared female from Buenos Aires (9 Dec 1904) which was identified by Brèthes.

Salpingogaster flukei was described from a series of 4 males from Ecuador collected by W. Clark McIntyre. The holotype is now in the AMNH and was examined. Paratypes are in the CNC and UWEC.

Baccha phobia was described from a series of 2 males from Ecuador collected by W. Clark McIntyre. The holotype is now in the AMNH and paratype is in the CNC. Both were examined.

Baccha polista was described from a series of 6 specimens from Brazil (Santa Catarina) collected by Fritz Plaumann and in the Fluke Collection. The holotype is now in the AMNH and was examined. Paratypes are in the CNC and UWEC.

Material examined (15 ♂, 6 ♀).—ECUADOR. Types of *flukei* and *phobia*. PERU. Cuzco, Kilometer 94, Machu Picchu RailRoad, 7 Mar 1978, P. M. Marsh (♂ USNM ENT 00037937 USNM); Lima, Bosque Carrion, 2,400 m, 16 April 1987, P. Hocking (♂ USNM ENT 00030147 USNM). BRAZIL. Santa Catarina: types of *polista*; Nova Teutonia, 300–500 m, Jan 1965, F. Plaumann (2♂ ♀ USNM ENT 00037924–6 USNM); . . . Feb 1965 (♂ USNM ENT 00037927 USNM); . . . Feb 1972 (♂ USNM ENT 00037930 USNM); . . . Nov 1971 (♂ USNM ENT 00037929 USNM); . . . Feb 1972, F. Plaumann (♂ USNM ENT 00037977 USNM); . . . Dec 1964 (♂ USNM ENT 00037928 USNM). URUGUAY. Montevideo, "Rec. 3.1.42," H. L. Parker (♀ with puparium USNM ENT 00037938 USNM). ARGENTINA. Buenos Aires: Buenos Aires, 4 Dec 1904 (MACN); Moreno, Dec 1971, Fritz (♂ USNM ENT 00037931 USNM); . . . Dec 1972 (2 ♀ USNM ENT 00037932–3 USNM); . . . Jan 1973 (♀ USNM ENT 00037934 USNM); Villa Elisa, 15–29 Dec 1979, C. M. & O. S. Flint, Jr. (♀ USNM ENT 00037935 USNM); Santa Catalina, near Buenos Aires, 10 Nov 1970, J. W.

Boyes (♂ USNM ENT 00022541 CNC). Misiones: Dos de Mayo, Dec 1973, M. Fritz (♂ USNM ENT 00037936 USNM).

Discussion.—*Ocyptamus bonariensis* is very similar to *erebus,* but differs in having distinct yellow pollinose vittae on the mesonotum and broader yellow fasciae on the abdomen. The shape of the male cercus is also distinctive.

The concepts of *flukei* Curran and *polista* Hull are very close. Hull (1949: 105) separated them by two characters (shape of the 2nd tergum (2nd tergum narrow, only as wide basally as apically (*flukei*) versus broader, about twice as wide apically as basally (*polista*)) and color of hind femur (hind femur entirely brownish yellow (*flukei*) versus black ventrally (*polista*))). While these differences are supported by the material we have examined, we consider them to be a function of geographic variation which will be bridged once material from intermediate localities are studied. Hence, we have synonymized the two concepts. The name *bonariensis* was unknown to Hull, hence he could not have known that it was an older synonym for his *polista.* Also, we include here a single male from Peru (Cuzco) with a bare alula, no basal yellow fascia on 4th tergum, greatly reduced yellow fascia on 3rd tergum and which is slightly larger than typical *Mimocalla* (16 mm body length, 14 mm wing length). As the male genitalia are the same as those of typical specimens, we consider this to be an aberrant specimen.

Ocyptamus (*Mimocalla*) *capitatus* (Loew)

Baccha capitata Loew 1863: 14 Cuba (LT ♂ MCZ here designated); Williston 1887: 124 (Cuba, redescr.); Aldrich 1905: 354 (cat. cit.); Kertész 1910: 157 (cat. cit.); Fluke 1956: 239 (cat. cit.); Wolcott 1923: 217, 1936: 346, 1948: 461 (Puerto Rico, with *Saissetia hemisphaerica* on coffee).

Ocyptamus captitatus: Thompson et al. 1976: 14; Thompson 1981: 44 (figs. (abdomen pattern, male genitalia, wing), West Indies).

Doros insularis Bigot 1883: 330 Cuba (HT ♀ BMNH); Williston 1887: 299 (note). Syn. Thompson 1981: 44.

Xanthogramma insulare: Aldrich 1905: 369 (cat. cit.); Kertész 1910: 152 (cat. cit.).

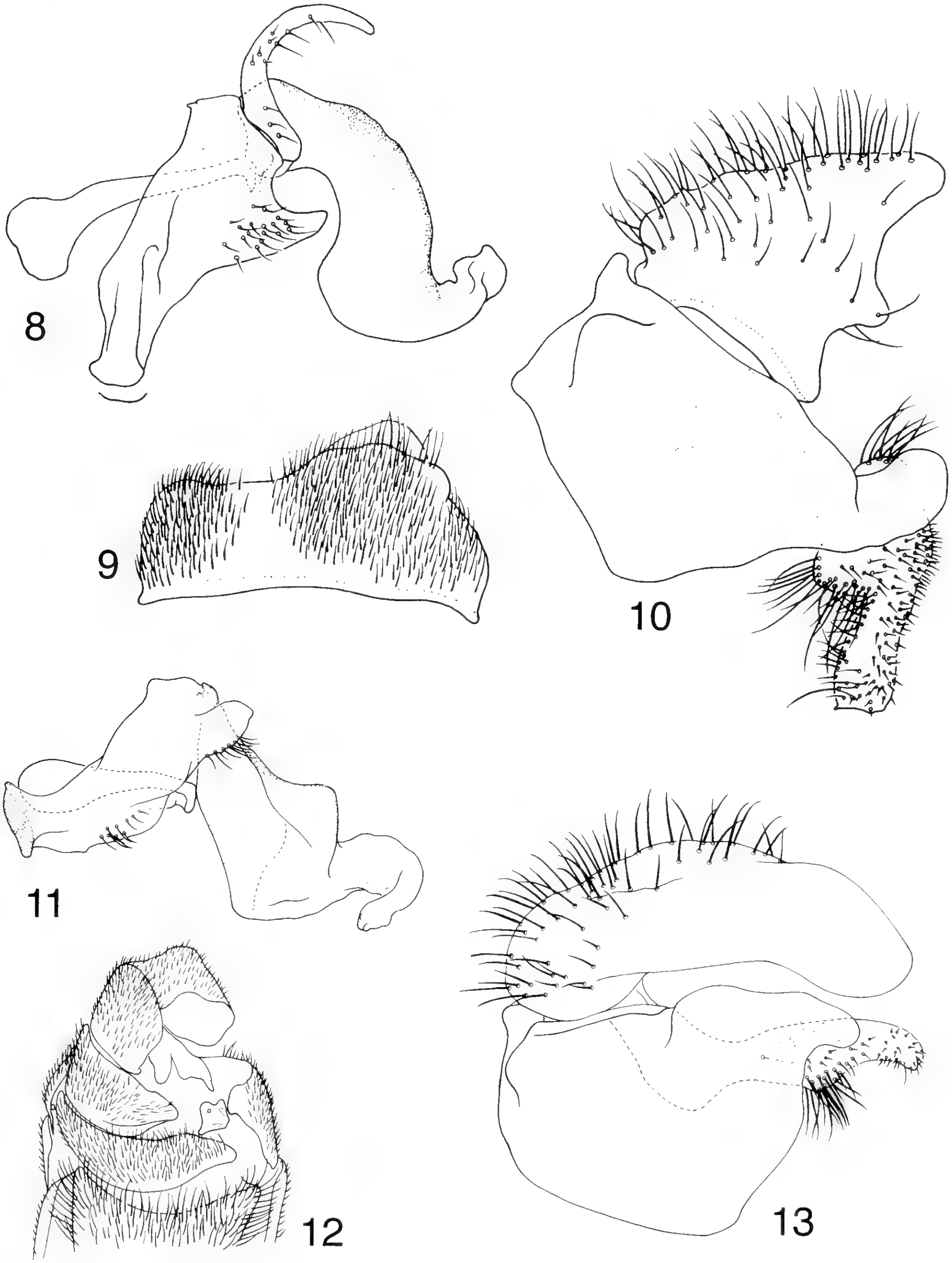
Ocyptamus insularis: Thompson et al. 1976: 20 (cat. cit.).

Baccha carlota Curran 1929: 491 Cuba, Trinidad Mountain, Mina Carlota (HT ♀ AMNH); Hull 1949: 98, 105. 238, 240 (fig. (abdomen pattern), key ref.); Fluke 1956: 239 (cat. cit.); Arnaud and Owen 1981: 83 (type data). Syn. Thompson 1981: 44.

Ocyptamus carlota: Thompson et al. 1976: 14 (cat. cit.).

Male.—*Head:* Face yellow, with light brown medial vitta, sparsely white pollinose laterally, only densely pollinose narrowly along eye margin, white pilose except black pilose ventrad to antenna; gena yellow, shiny, bare; lunule brown except yellow submedially; frontal triangle yellow except brown along lunule, black pilose; vertical triangle black, black pilose; occiput black except yellow on ventral ⅕, densely golden pollinose becoming more brownish on dorsal ⅓, yellow pilose except pile more golden dorsally; antenna orange except more brownish orange on dorsoapical ¾ of basoflagellomere, black pilose; basoflagellomere elongate, slightly less than twice as long as wide.

Thorax: Mainly black with yellow maculae; postpronotum yellow; scutum black except with broad yellow vitta running from postpronotum to and including anterior ½ of postalar callus but broadly interrupted behind transverse suture and dorsad to wing base, with vitta about as wide as postpronotum, with black areas black pollinose except for broad golden pollinose submedial vitta which tapers posteriorly and does not reach scutellum and a very narrow indistinct brown pollinose medial vitta on anterior ⅔ which expands into a broader golden pollinose vitta at level of postalar callus, long yellow pilose anteri-



Figs. 8–13. Male genitalia. 8, *Ocyptamus giganteus,* 9th sternum, aedeagus and associated structures, lateral view. 9, *O. giganteus,* 4th sternum, ventral view. 10, *O. giganteus,* 9th tergum and associated structures, lateral view. 11, *O. nymphaea,* 9th sternum and associated structures, lateral view. 12, *O. nymphaea,* 4th sternum, ventral view. 13, *O. nymphaea,* 9th tergum and associated structures, lateral view.

orly and laterally, short intermixed black and yellow pile elsewhere; scutellum yellow except disc blackish, short sparse black pilose with a few intermixed yellow pili basally; subscutellar fringe singular, white; pleuron black except yellow dorsad to procoxa and broadly yellow on posterior anepisternum, dorsal ½ of katepisternum and anterior ½ anepimeron, very sparsely white pollinose except denser dorsally on katepisternum, yellow pilose; plumula very short, yellow; calypter yellowish white except dorsal margin brownish; halter yellow. *Legs:* Procoxa brownish black except yellow apex, sparsely gray pollinose, yellow pilose; mesocoxa black, black pilose medially, yellow pilose laterally; metacoxa black, long black pilose with a few intermixed yellow pili laterally; protrochanter yellowish brown; mesotrochanter brownish black; metatrochanter black, long black pilose; profemur yellow, yellow pilose; mesofemur yellow except black on basodorsal ⅓, yellow pilose except for a row of black pili on dorsoposterior surface; metafemur black except yellow apical ⅕, black pilose except yellow pilose on yellow area; pro and mesotibiae and tarsi yellow, yellow pilose; metatibia black except yellow basal ⅓ and apex, black pilose; metatarsus yellow, yellow pilose. *Wing:* Brown anteriorly, hyaline posteriorly, microtrichose except bare cell R posterior to spurious vein on apical ⅓, cell BM, anterobasal ⅓ of cell CuP, cell R4+5 posterior to spurious vein, narrowly on basoposteriorly in cell DM, basomedial ⅓ of cell CuA1, anterior to vein A2; alula bare, normal, as wide as cell CuP; brown areas including base and extending posteriorly to vein M to level of end of vein RS, to spurious vein in apical portion of cell R, to vein R4+5 except narrowly hyaline along sinuate portion.

Abdomen: Dark brown with yellow fasciae and orange apex; 1st tergum yellow except brownish black apicomedial ⅓, yellow pilose; 2nd tergum brownish black except for yellow basolateral triangular macula, with maculae broadly separated medially, yellow pilose basolaterally, black pilose elsewhere; 3rd tergum yellow on basal ⅓, brownish black apically, yellow pilose on yellow area, black pilose elsewhere; 4th tergum brown except with yellow basal fascia which is narrowly isolated from lateral margin and occupies basal ¼, with apical portion of tergum becoming more orange, black pilose; 5th tergum orange, black pilose; genitalia yellowish orange, black pilose; 1st sternum yellow, yellow pilose; 2nd sternum brown except yellow basally, yellow pilose; 3rd sternum brown except yellow basal ⅓, black pilose except yellow pilose basally; 4th sternum brown, brown pilose; 5th sternum orange except yellow apically, brown pilose. Male genitalia. See Figs. 56a–c in Thompson (1981: 59); essentially the same as *tristani* (Figs. 5–7).

Female.—Similar to male except for normal sexual dimorphism and frons yellow except may be darker medially and along lunule, orange pollinose except maybe more brownish medially, short black pilose.

Length.—14 mm; wing, 11 mm.

Variation.—The brownish black color in some examined individuals is brownish orange; also the antenna may be entirely orange and scutellum entirely yellow.

Distribution.—West Indies (Cuba*, Dominican Republic*, Puerto Rico*, Lesser Antilles*).

Types.—*Baccha capitata* was described from an unspecified number of male specimens from Cuba from Gundlach. In the MCZ, there is a male with a silver square and labelled "capitata mihi" in Loew's hand. This specimen is here designated lectotype so as to fix and stabilize the current concept of the name, and has been so labelled.

Doros insularis was described from a unique female specimen from Cuba. The holotype is now in the BMNH and has been examined.

Baccha carlota was described from a unique female from Cuba collected by G. Salt and in the Curran collection. The holotype is now in the AMNH and was examined.

Material examined (8 ♂, 7 ♀).—CUBA. Types of *capitata, insularis* & *carlota.* DOMINICAN REPUBLIC. Pedernales, 23.5 km N Cabo Rojo, 18-16N 71-38W, 540 m, 13 July 1990, C. Young, J. Rawlins & S. Thompson (♂ USNM ENT 00037907 USNM). PUERTO RICO. Comerio, 10 Aug 1913, J. R. Johnston (♂ USNM ENT 00037900 USNM); Mayaguez, 4 Mar 1912, C. W. Hooker (♀ USNM ENT 00037901 USNM); . . . 26 Jul 1915, R. H. van Zwalenberg (♂ USNM ENT 00037902 USNM); . . . 5 May 1939, H. K. Plank (3 ♂♂ 2 ♀♀ with puparia USNM ENT 00037904–6, . . . 72–73 USNM) VIRGIN ISLANDS. St. Croix, 6 Jul 1963, R. M. Bond & R. Boyd (♂ ♀ USNM ENT 00037899, . . . 903 USNM).

Discussion.—*Ocyptamus capitatus* is similar to *tristani* and *bonariensis* in having distinctive yellow pollinose vittae on mesonotum, but differs from these species in having a yellow scutellum and the apex of the abdomen orange to brownish orange.

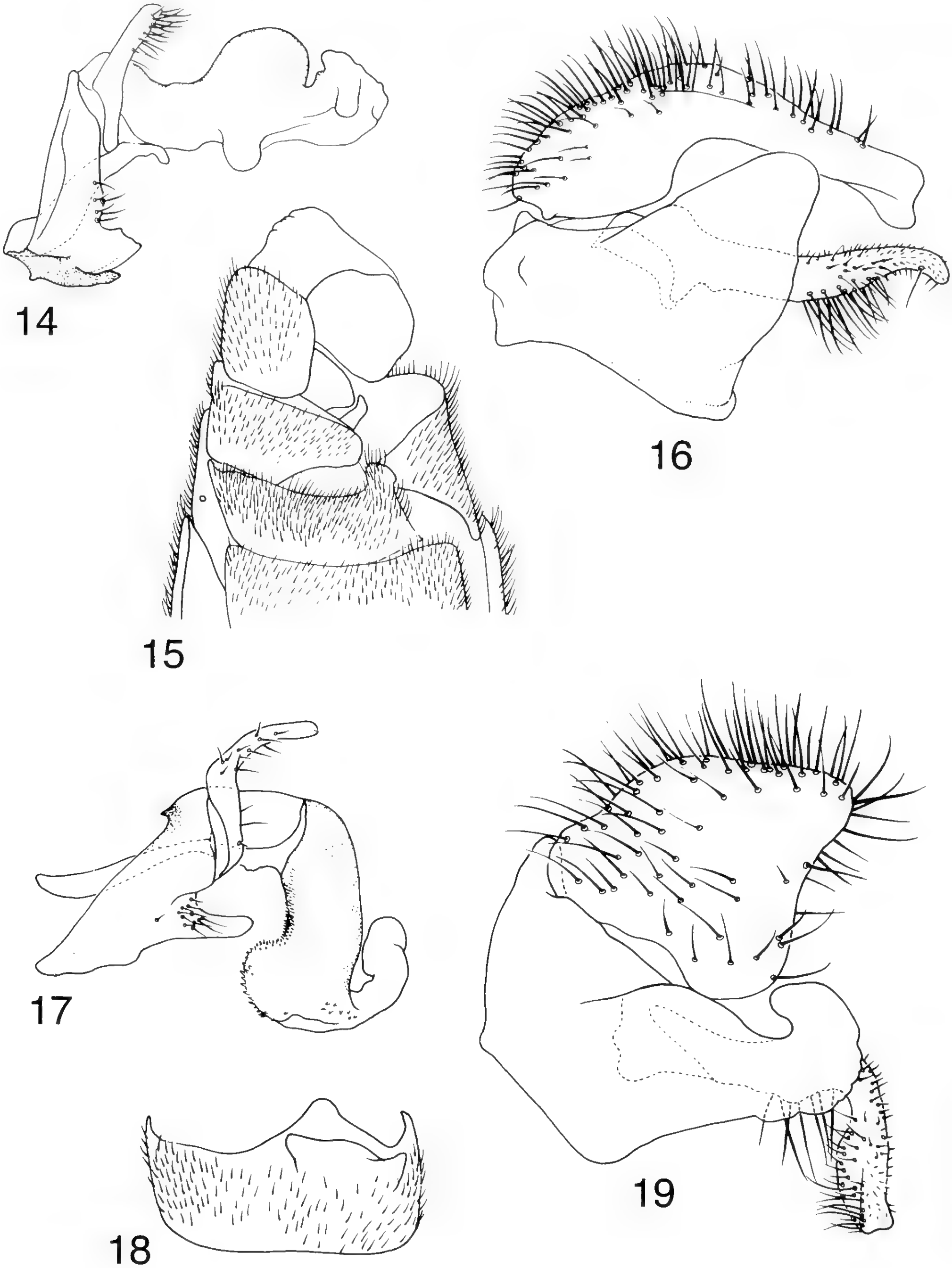
Ocyptamus (*Mimocalla*) *erebus* (Hull)
(Figs. 14–16)

Baccha (*Mimocalla*) *erebus* Hull 1943d: 54; 1943e: 137 Brazil, Santa Catarina, Nova Teutonia (HT ♂ AMNH); Hull 1949: 98, 105, 240 (fig. (abdomen pattern), key); Fluke 1956: 245 (cat. cit.).

Ocyptamus erebus: Thompson et al. 1976: 17 (cat. cit.).

Male.—*Head:* Face yellowish brown, with dark brown medial vitta, sparsely white pollinose laterally, only densely pollinose narrowly along eye margin, white pilose except black pilose ventrad to antenna; gena yellow, shiny, bare; lunule black except brownish submedially; frontal triangle black except narrowly yellow along eye margin, shiny except dull pollinose on posterior ½, black pilose; vertical triangle black, black pilose; occiput black except yellow on ventral ⅙, densely gray pollinose, white pilose; antenna black except more brownish orange basoventrally on basoflagellomere, black pilose; basoflagellomere elongate, slightly less than twice as long as wide.

Thorax: Mainly brownish black; postpronotum reddish brown; scutum black except with obscure narrow reddish brown vitta posterior to postpronotum and another anterior to and including anterior ½ of postalar callus, with area behind transverse suture and dorsad to wing base dark, with black areas black pollinose except for narrow golden pollinose submedial vitta which tapers posteriorly and does not reach scutellum and a narrow golden pollinose medial vitta on posterior ⅓ at level of postalar callus, long yellow pilose anteriorly and laterally, short intermixed black and yellow pile elsewhere; scutellum dark brown except brownish yellow on base and apical margin, short sparse black and yellow pilose; subscutellar fringe singular, white; pleuron black except obscurely yellow on posterior anepisternum, dorsal ½ of katepisternum and medially on katatergum, very sparsely white pollinose except denser dorsally on katepisternum, white pilose; plumula very short, yellow; calypter brownish white except dorsal margin brown; halter brown. *Legs:* Procoxa yellow, sparsely white pollinose, yellow pilose; mesocoxa orange, brownish-orange pilose; metacoxa black, long black pilose with a few intermixed yellow pili laterally; pro and mesotrochanter brown; metatrochanter black, long black pilose; pro and mesofemur reddish brown, yellow pilose except for a few black pili on dorsoposterior surface; metafemur reddish brown except yellow apical ⅕, orange pilose except black apicoventrally; pro and mesotibiae and tarsi yellow, yellow pilose; metatibia yellow except reddish brown medially, orange pilose; metatarsus dark brown, yellow pilose. *Wing:* Light brown anteriorly, hyaline posteriorly, microtrichose except bare cell R1 anterior to vein Rs, cell R, cell BM, anterobasal ⅓ of cell CuP, cell R4+5 posterior to spurious



Figs. 14–19. Male genitalia. 14, *Ocyptamus erebus,* 9th sternum, aedeagus and associated structures, lateral view. 15, *O. erebus,* 4th sternum, ventral view. 16, *O. erebus,* 9th tergum and associated structures, lateral view. 17, *O. willistoni,* 9th sternum and associated structures, lateral view. 18, *O. willistoni,* 4th sternum, ventral view. 19, *O. willistoni,* 9th tergum and associated structures, lateral view.

vein, narrowly on basoposteriorly in cell DM, basomedial ⅓ of cell CuA1, anterior to vein A2; alula microtrichose, normal, as wide as cell CuP; brown areas including base and extending posteriorly to vein R and R1.

Abdomen: Dark brown with greatly reduced yellow fasciae; 1st tergum brownish black, white pilose; 2nd tergum brownish black except for small yellow basolateral triangular macula, with maculae broadly separated medially, yellow pilose basolaterally, black pilose elsewhere; 3rd and 4th terga brownish black except for very narrow obscure yellow fasciate maculae broadly separated medially and occupying less ⅒ of tergal length, yellow pilose laterally, black pilose elsewhere; 5th tergum black, black pilose; genitalia brownish black, black pilose; 1st sternum brown, white pilose; 2nd sternum brown except yellow basally, yellow pilose; 3rd and 4th sterna brown except yellow apical margin, black pilose; 4th sternum brown, brown pilose; 5th sternum brownish orange, brown pilose. Male genitalia. See Figs. 14–16.

Female.—Similar to male except for normal sexual dimorphism and frons black except narrow yellow vitta along eye margin, shiny anteriorly, gray pollinose on medial ⅓, black pollinose posteriorly, short black pilose.

Length.—13 mm; wing, 11 mm.

Distribution.—Brazil (Minas Gerais*, São Paulo*, Santa Catarina*).

Type.—*Baccha erebus* was described from 4 male specimens collected in southern Brazil (Santa Catarina) by Fritz Plaumann and in the Fluke Collection. The holotype is now in the AMNH and was examined. Paratypes are in the CNC and the University of Wisconsin Entomology Collection. The name was first validated in a key which appeared before the original description.

Material examined (10 ♂ 6 ♀).—BRAZIL. Minas Gerais: Arceburgo, F. Fortaleza, Dec 1946, Barretto (2 ♀♀ USNM ENT 00037974–5 MZUSP). São Paulo: Cantareira, Chapadao, Nov 1946, Barretto (♀ USNM ENT 00037976 MZUSP). Santa Catarina: types of *erebus*; Nova Teutonia, 27-11S 52-23W, 300–500 m, Feb 1965, F. Plaumann (2 ♂♂ USNM ENT 00037908–9 USNM); . . . Feb 1972 (♀ USNM ENT 00037916 USNM); . . . Mar 1957 (♀ USNM ENT 00037910 USNM); . . . Mar 1960 (♀ USNM ENT 00037912 USNM); . . . Nov 1952 (♂ USNM ENT 00037911 USNM); . . . Nov 1971 (3 ♂♂ USNM ENT 00037913–5 USNM).

Discussion.—*Ocyptamus erebus* is a dark version of *bonariensis,* the yellow vittae on the mesonotum and abdominal fasciae are greatly reduced, obscure or absent. The shape of the male cercus is also very distinctive.

Ocyptamus (*Mimocalla*) *giganteus*
(Schiner)
(Figs. 8–10)

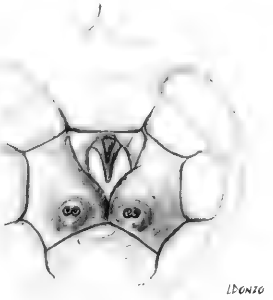
Baccha gigantea Schiner 1868: 340 "South America" = Venezuela (LT ♂ NMW here designated); Williston 1886: 314 (cat. cit.); Kertész 1910: 160 (cat. cit.); Fluke 1956: 154 (cat. cit.).

Ocyptamus giganteus: Thompson et al. 1976: 19 (cat. cit.).

Male.—*Head:* Mainly black; face black, with narrow yellow medial vitta, white pollinose except narrowly shiny medially, with pollinosity denser along eye margin becoming sparser medially, black pilose; gena black, shiny, bare; frontal triangle black except narrowly yellow medially along eye margin, black pilose, black pollinose except white pollinose on yellow areas; lunule black except brownish submedially; vertical triangle black, black pollinose and pilose; occiput black, black pilose except mesial row of cilia mainly white and white pilose on ventral ⅕; antenna black except slightly reddish basoventrally on basoflagellomere, black pilose, elongate, with basoflagellomere about twice as long as wide.

Thorax: Black, black pilose except white pilose along anterior margin of scutum and

20 a



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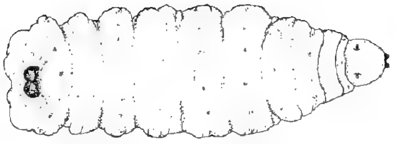

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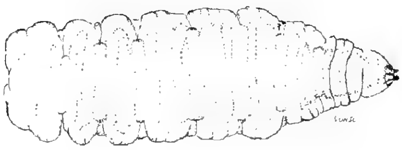

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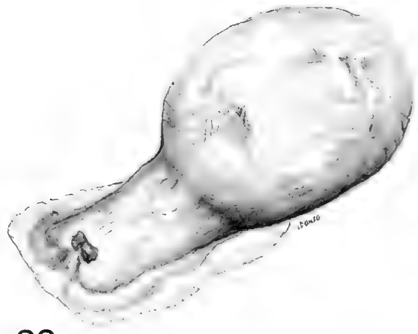

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Figs. 20–23. Immature stages of *Ocyptamus tristani.* 20, Larva, a, lateral view, b, dorsal view, c, ventral view. 21, Larva, anterior view. 22, Larval posterior spiracle, posterior view. 23, Puparium, dorsoblique view.

posterior anepisternum; scutum brownish gray to black pollinose, with whitish to gray submedial and medial vittae; scutellum brownish black pollinose, subscutellar fringe singular, white; pleuron black pollinose except katepisternum white pollinose on dorsal ½; calypter black; plumula long; halter black. *Legs:* Black except grayish white basal ¼ of mesotibia, black pilose; metatrochanter with distinct pile tuft; metafemur without long pile. *Wing:* Dark anteriorly, hyaline posteriorly, microtrichose except bare on anterobasal ⅓ of cell CuP; alula dark, normal, as wide as cell CuP, microtrichose; black area covering base of wing including base of cell CuP, all of cell BM, most of cell R except posterior to spurious vein on apical ⅔, anterobasal corner of cell R4+5, extending almost to level of middle of cell R4+5; brownish orange area between black area and gray apex; gray area covering apex of wing, anterior to vein R4+5, distal to end of vein R1.

Abdomen: Black except yellow basolateral triangular macula on 2nd tergum and narrow yellow fascia on base of 3rd, black pilose except white pilose on 1st, bases of 2nd and 3rd terga and on yellow areas and male genitalia. Male genitalia. See Figs. 8–10.

Female.—Similar to male except for normal sexual dimorphism and frons black except very narrowly yellow on ventrolateral ⅔, black pollinose sublaterally becoming gray pollinose medially, black pilose.

Length.—20 mm; wing, 14 mm.

Distribution.—Costa Rica*, Colombia*, Venezuela*.

Types.—*Baccha giganteus* was described from an unspecified number of specimens from an unspecified locality in South America. In NMW, there are a male and two females from Venezuela, Lindig collector, labelled as *giganteus*. The male is here designated lectotype so as to fix and stabilize the current concept of the name, and has been so labelled.

Material examined (3 ♂ 4 ♀).—VENEZUELA. Types of *giganteus*. COSTA RICA. Puntarenas: Las Alturas, Cerro Chai, 2,100 m, 14 Aug 1995, T. Pape (2 ♂ USNM ENT 00037918 NRS, . . . 00030146 USNM); Quijada del Diablo, 3.1 km NE de Mellizas, 1,800 m, LS 316900_600600, 17 Aug 1997, A. Picado, Lot# 47696 (♀ INBIOCRI002546773 INBIO). COLOMBIA. Antioquia: Caldas, Oct 1973, R. Velez (♀ USNM ENT 00037917 USNM).

Discussion.—*Ocyptamus giganteus* is readily recognized by its overall dark coloration, black thorax, legs, anterior wing margin and abdomen except for a single yellow fascia on the base of the 3rd tergum. Also, true to its name, *giganteus* is the largest species of the genus.

Ocyptamus (*Mimocalla*) *nymphaea* (Hull)
(Figs. 11–13)

Baccha nymphaea Hull 1943a: 40 Brazil, São Paulo, Campinas (HT ♂ USNM); Hull 1949: 98, 105, 238 (fig. (abdomen pattern), key ref.); Fluke 1956: 256 (cat. cit.).

Ocyptamus nymphaea: Thompson et al. 1976: 23 (cat. cit.).

Male.—*Head:* Face orange, shiny except narrowly white pollinose laterally, white pilose; gena yellow, shiny, bare; frontal triangle orange on posterior ½ along eye margins, brownish black anteromedially, black pilose, shiny anteriorly, dull pollinose posteriorly; lunule orange except black medially; vertical triangle black, black pilose; occiput black on dorsal ⅔, orange basally, densely yellow pollinose, yellow pilose; antenna orange except more brownish orange on dorsoapical ¾ of basoflagellomere, densely black pilose; basoflagellomere elongate, slightly less than twice as long as wide.

Thorax: Orange except brownish black medially on scutum; scutum broadly orange laterally and anterior to scutellum, brownish black and brown-black pollinose medially, with broad golden pollinose submedial vitta and a very narrow indistinct brown pollinose medial vitta on anterior ⅔ which expands into a large triangular golden pollinose macula on posterior ⅓, long yellow pilose anteriorly and laterally, short intermixed black and yellow pile elsewhere; scutellum orange, short sparse black pilose; subscutellar fringe singular, yellow; pleuron sparsely white pollinose, yellow pilose; calypter orange except dorsal margin brownish; plumula absent; halter orange. *Legs:* Orange except metatarsus brownish orange, yellow pilose except black ventral pile tufts on metacoxa and trochanter and scattered intermixed black pile on posterior surface of mesofemur and medially on metatibia.

Wing: Hyaline except cell C brownish orange and cell Sc brownish, extensively microtrichose except bare: cell R posterior to spurious vein, cell BM, anterobasal ⅓ of cell CuP, cell R1 anterior to spurious vein; cell R4+5 posterior to spurious vein, narrowly on base of cells DM and CuA1.

Abdomen: Orange and orange pilose on 1st, 2nd and basal ¼ of 3rd segment; black and black pilose elsewhere. Male genitalia. See Figs. 11–13.

Female.—Similar to male except for normal sexual dimorphism and frons black and shiny on anterior ⅓, orange and orange pollinose on posterior ⅔, short black pilose.

Length.—14 mm; wing, 11 mm.

Distribution.—Brazil (São Paulo*, Minas Gerais*).

Type.—*Baccha nymphaea* Hull was described from two reared males from Brazil. Although Hull headed his description as "female," the types are males. The holotype is preserved in the USNM and has been examined. The paratype is now in CNC.

Material examined (5 ♂ 2 ♀).—BRAZIL. Minas Gerais: Arceburgo, F. Fortaleza, Dec 1946, Barretto (3 ♂ 2 ♀ USNM ENT 00037978–82 USNM MZUSP). São Paulo: Campinas, 14 Oct 1939, H. F. G. Sauer (Holotype ♂ with puparium USNM ENT 00037983 USNM); Campininha, Mogi Guacu, 23 Oct 1970, J. W. Boyes (♂ USNM ENT 00022540 CNC).

Discussion.—*Ocyptamus nymphaea* is readily recognized by the orange and black abdomen. The other species of *Mimocalla* have the abdomen fasciate or mostly dark.

Ocyptamus (*Mimocalla*) *tristani* Zumbado, new species

(Figs. 1, 5–7)

Male.—*Head:* Face yellow, with light orange medial vitta, sparsely white pollinose laterally, only densely pollinose narrowly along eye margin, white pilose except black pilose ventrad to antenna; gena yellow, shiny, bare; lunule yellow except brown medially; frontal triangle yellow except brown along lunule, black pilose; vertical triangle black, black pilose; occiput black except yellow on ventral ⅕, densely yellowish-white pollinose ventrally becoming more golden dorsally, white pilose ventrally becoming more golden dorsally; antenna brown except more brownish orange basoventrally on basoflagellomere and yellow on inner side of scape and pedicel, black pilose; basoflagellomere elongate, slightly less than twice as long as wide.

Thorax: Mainly yellow with black maculae; prothorax yellow; scutum black except with broad yellow vitta running from postpronotum to and including anterior ½ of postalar callus but narrowly attenuated dorsad to wing base, with vitta about as wide as postpronotum, with black areas black pollinose except for broad golden pollinose submedial vitta which tapers posteriorly and does not reach scutellum and a very narrow indistinct brown pollinose medial vitta on anterior ⅔ which expands into a broader golden pollinose vitta at level of postalar callus, long yellow pilose anteriorly and laterally, short intermixed black and yellow pile elsewhere; scutellum yellow except disc blackish, short sparse black pilose with a few intermixed yellow pili basally; subscutellar fringe singular, white; pleuron yellow except black narrowly on anterior convex surface of posterior anepisternum, ventral ⅔ of katepisternum, posteriorly on katatergum and anteriorly on anatergum, very sparsely white pollinose except denser dorsally on katepisternum, yellow pilose; plumula absent short, yellow; calypter yellowish white except dorsal margin brownish; halter yellow, with capitulum brownish. *Legs:* Proleg yellow except slightly brownish subapically on posterior of femur, sparsely gray pollinose, yellow pilose; mesoleg yellow except sligthly brownish on base of and subapically on posterior of femur, yellow pilose except for a row of black pili on dorsoposterior surface; metacoxa brown, long black pilose with intermixed yellow pili laterally; metatrochanter brown, long black pilose; metafemur yellow except black ventrally and posteriorly except apically, black pilose except yellow pilose on yellow area; metatibia yellow except brownish medial ⅓, yellow pilose; metatarsus yellow except brownish-orange basotarsomere, yellow pilose. *Wing:* Hyaline except stigma brownish and cell Sc yellowish orange, microtrichose except bare cell R posterior to spurious vein on apical ⅓, cell BM, anterobasal ⅓ of cell CuP, cell R4+5 posterior to spurious vein, narrowly on basoposteriorly in cell DM, basomedial ⅓ of cell CuA1, anterior to vein A2; alula microtrichose, normal, as wide as cell CuP.

Abdomen: Dark brown with broad yellow fasciae; 1st tergum yellow on basal ⅔, black apically, yellow pilose basally, black pilose apically; 2nd tergum brownish black except for large yellow basolateral triangular macula and medial inverted V-shaped macula, with basolateral maculae narrowly separated medially and occupying basal ½ of tergal length, with V-shaped macula slightly beyond middle of tergum and completely surrounded by black areas, yellow pilose basolaterally, black pilose elsewhere; 3rd tergum yellow on basal ⅜, brownish black apically, yellow pilose on yellow area, black pilose elsewhere; 4th tergum yellow on basal ⅓, margin and apicolateral corner, elsewhere black, yellow pilose; 5th tergum yellow except with broad medial black fasciate macula, black pilose; genitalia yellow, black pilose; 1st sternum yellow, yellow pilose; 2nd sternum brown except yellow basally, yellow pilose; 3rd sternum brown except yellow basal ⅓, black pilose except yellow pilose basally; 4th sternum brown, brown pilose; 5th sternum orange except yellow apically, brown pilose. Male genitalia. See Figs. 5–7.

Female.—Similar to male except for normal sexual dimorphism and frons black except yellow broadly along eye margin, short black pilose.

Length.—14 mm, wing, 12 mm.

Distribution.—Mexico*, El Salvador*, Costa Rica*, Colombia*, Venezuela*.

Holotype.—Male, Costa Rica, Heredia, Santo Domingo, Instituto Nacional de Biodiversidad, 1,100 m, LN 217300 526200, 2 Jul 1994, M. A. Zumbado, voucher# 94-MAZ-28, with puparium (INBIOCRI001146854), deposited in INBio, Santo Domingo.

Paratypes (25 ♂, 25 ♀).—MEXICO. Vera Cruz: Fortin de la Flores, 9 June 1959, H. E. Evans (♂ ♀ USNM ENT00022536–7 CNC). EL SALVADOR. Santo Tecla, 7 Sep 1970, J. Lipes (2 ♀ USNM ENT 00037962–3 USNM). COSTA RICA. Alajuela: Sarchí, 27 Jul 1954, L. A. Salas, ex larva feeding on *Saisseta hemisphaerica* on coffee (2 ♂ ♀ USNM ENT 00037957–9 USNM); Upala, Dos Rios, Sect. San Ramón, 620 m, LN 318100 381900, 18 Mar-13 Apr 1995, F. A. Quesada, lot# 5274 (♂ with puparium INBIOCRI002246265 INBIO). Guanacaste: Volcan Cacao, Cerro Pedregal, 1,000 m, Feb–Apr 1989, I. Gauld (♀ USNM ENT 00037970 MIUCR). Heredia: same data as holotype (♀ INBIOCRI001146855 INBIO, ♂ with puparium INBIOCRI002153879 INBIO); same locality as holotype, 4 Jul 1994, M. A. Zumbado (♂ with puparium, INBIOCRI002153880 INBIO); . . . 7 July 1994, M. A. Zumbado (♂ with puparium INBIOCRI002153881 INBIO); . . . Oct 1994, M. A. Zumbado (3♂ 2♀ INBIOCR002153891–5 INBIO); . . . 11–13 Aug 1994, L. Donzo lot# 3317, (♂ INBIOCRI002112689 INBIO); . . . 2 Jul 1994, J. A. Ugalde (♂ with puparium, INBIOCRI002153889 INBIO); . . . 4 Jul 1994, J. A. Ugalde (♂ with puparium, INBIOCRI002153887 INBIO); . . . 13 Jul 1994, J. A. Ugalde (♀ with puparium, INBIOCRI002153888 INBIO); Heredia, 1 Apr 1960, A. Morales, "feeding on black scale" (♂ USNM ENT 00037960 USNM); Santo Domingo, 7 Jun 1974, E. Solera (♀ USNM ENT 00037961 USNM); Belén, San Antonio, 950 m, LN 218800 516175, 8 Aug 1996, M. A. Zumbado, reared from scales on *Ocimum basilicum* (Lamiaceae) (♂ ♀ with puparia INBIOCRI00215877–8 INBIO). San José: San José, May 1930, J. F. Tristán (♀ USNM ENT 0037956 USNM);

San Sebastian, 16 May 1988, A. Retana, "Comiendo escama" (♂ with puparium, 3 ♀ USNM ENT 00037964–7 USNM); Cuidad Colón, 800 m, Feb 1990, L. Fournier (♀ USNM ENT 00037968 USNM); San Antonio de Escazú, 1,300 m, Apr 1989, P. Hanson (♂ USNM ENT 00037969 MIUCR). COLOMBIA. Antioquia: Medellín Valley, Apr–Jun 1947, F. L. Gallego (3♀ USNM ENT 00037939–41 USNM); . . . [no date], F. L. Gallego, "larva predator of aphids" (♀ USNM ENT 00037942 USNM); Bello, 25 Dec 1970, G. Sanchezg, "larva feeding on *Saisetia coffeae* on ornamental palm" (7 ♂ 5 ♀ with puparia USNM ENT 00037943–54 USNM). VENEZUELA. Distrito Federal: Cumbre de Boquerón, Frente a Bajo Seco, 1,700 m, 7 Mar 1970, larva predator of *Coccus hesperidum* on "naranjo" (♂ with puparium USNM ENT 00037955 USNM).

Etymology.—This species is named after José Fidel Tristán Fernández (1874–1932), the outstanding Costa Rican naturalist who published the first list of the insects of Costa Rica (Tristan 1897) and collected the first specimen of this species known to us.

Discussion.—This species has been reared a number of times, and specimens have been submitted for identification to the Systematic Entomology Laboratory, USDA. The species has been reared as a predator of various scales (*Saissetia coffaea* (Walker), *S. oleae* (Olivier) and *Coccus hesperidum* Linnaeus) on a range of hosts. The determination labels associated with the specimens in the USNM indicate that the species was first incorrectly identified as *Baccha bromleyi* by Hull and this mistake was perpetuated by subsequent specialists (e.g., W. W. Wirth, L. V. Knutson) as either *bromleyi* or new species near *bromleyi*. Apparently none of these misidentifications were published.

Ocyptamus tristani is similar to *capitatus* but differs by the presence of a yellow fascia on the 2nd tergum and broader yellow fasciae on the 3rd and 4th terga.

Ocyptamus (*Mimocalla*) *willistoni* Thompson
(Figs. 17–19)

Baccha dolosa Williston 1891: 37 (preocc. Walker 1857) AH* H* Mexico, Guerrero, Omiltemi, 8,000 ft.; Amula, 6,000 ft.; Xucumanatlán, 7,000 ft.; Guatemala, Cerro Zunil, 4,000–5,000 ft. (ST ♂♀ AMNH, BMNH); Aldrich 1905: 355 (cit.); Kertész 1910: 158 (cit.); Hull 1949: 98, 105, 234 (abdomen pattern, key ref.); Fluke 1956: 244 (cit.).

Ocyptamus willistoni Thompson in Thompson et al. 1976: 30 (new name for *dolosa* Williston).

Male.—*Head:* Face yellow, white pollinose laterally, shiny medially, white pilose; gena yellow, shiny, bare; frontal triangle broadly yellow along eye margin, black medially, black pilose, sparsely gray pollinose medially; lunule yellow except black medially; vertical triangle black, black pilose; occiput black, densely white pollinose, white pilose; antenna black except reddish basally on scape and basoflagellomere; basoflagellomere about ¼ longer than wide.

Thorax: Bluish gray to black except yellow base of scutellum and pre-alar area; scutum grayish-white pollinose except with black pollinose submedial and sublateral vittae, long white pilose along anterior margin and laterally, short black pilose elsewhere; scutellum yellow on basal ¼, black elsewhere, short black pilose; subscutellar fringe multiple, white; pleuron sparsely silver pollinose except dense silver pollinose on dorsal ½ of katepisternum and posterior anepisternum, white pilose except black pilose on anepimeron; calypter white except black dorsal margin; plumula short; halter yellow. *Legs:* Coxae and trochanters black, silver pollinose, black pilose except white pilose apicolaterally; pro and mesofemora black except yellow apex, white pilose except black pilose on anteroapical ⅓; metafemur black, white pilose except black pilose on apical

⅓; pro and mesotibiae yellowish white, white pilose; metatibia black, black pilose; pro and meso tarsi black except brownish basal ⅔ of mesobasitarsomere, white pilose on basotarsomere and basally on 2nd tarsomere, black pilose elsewhere; metatarsus yellowish white to orange on basal 3 tarsomeres, black apically, white pilose; pile tufts distinct on metacoxa and trochanter. *Wing:* Hyaline except black apex and cell Sc, extensively bare; microtrichose on apical ⅓ of cell C, cell Sc, apical ⅘ of cell R1, apicomedial ⅔ of cell R2+3, apicomedial ¾ of cell R4+5 and DM, apicomedial ⅔ of cell CuA1, apicoposterior ¼ of cell CuP, along posterior edge from apical ½ of cell CuP to apex; dark apex extending apically from end of vein R1 and posterior to vein R4+5; alula hyaline, bare, normal, as wide as cell CuP.

Abdomen: 1st segement black, white pilose, sparsely grayish pollinose; 2nd segment black except yellow basolaterally, black pilose except white pilose basolaterally; 3rd segment yellow on basolateral ⅓, black apically, shiny, black pilose on dark areas, white pilose on yellow areas; 4th segment black, shiny, black pilose; 5th segment red except black basomedially on tergum, black pilose; genitalia red, yellow pilose, see Figs. 17–19.

Female.—Similar to male except for normal sexual dimorphism and: frons yellow on lateral ¼, black elsewhere, sparsely gray pollinose medially, black pilose; wing with black area more extensive, including all of cell C and R1.

Length.—16–17 mm; wing, 12–14 mm.

Types.—*Baccha dolosa* was described from 5 specimens collected in southern Mexico (Guerrero) by H. H. Smith, and Guatemala by G. C. Champion. A male specimen labelled "Omilteme, Guerrero, 8,000 ft., July, H. H. Smith," "Biol. Centr. Amer., Dipt.—Syrphidae, F. D. Godman, O. Salvin, 1903–51," [yellow cotype label] and printed Williston determination label, in the BMNH is here designated lectotype to fix and stabilize the current concept of the name, and has been so labelled. A paralectotype is in the AMNH.

Distribution.—Mexico (Guerrero*, Morelos*, Mexico*, Chiapas*), Guatemala (Williston), Costa Rica*.

Material examined (19 ♂, 8 ♀).—MEXICO. [no data] (♀ with puparium USNM ENT 00037920 USNM); "Cuernavaca, 8/24" [handwritten, illegible], G. Lassman (♀ USNM ENT 00022539 CNC). Chiapas: Teopisca, 2 miles W of, 4 Aug 1957, J. A. Chemsak & B. J. Rannells (6♂ 3♀ USNM ENT 00022547–55 CNC). Distrito Federal: Mexico City, Nov 1916, R. Muller (♂ USNM ENT 00037919 USNM); Carretera Pedregal, Ajusco, Km 7, 6 Sep 1979, J. Butze (♂ USNM ENT 00028744 UNAM); . . . 25 Oct 1979, J. Butze, J. Gutierrez (2 ♂ USNM ENT 00028745, 7 UNAM). Guerrero: Tuxpan, Torre microondas, 1,650 m, 16 Aug 1984, J. Butze (♂ USNM ENT 00028738 UNAM). Mexico: Tequesquinahuac, Cerro Tlaloc, 12 Oct 1983, M. Paz (3 ♂ USNM ENT 00028742 UNAM); Tequesquinahauc, Encinar, 12 Oct 1983, G. Sampedro (♂ USNM ENT 00028746 UNAM). Morelos: Tetela del Volcan, 8 Jul 1978, G. Aratz (♀ USNM ENT 00028748 UNAM); 6 mi E Cuernavaca, 1 Sep 1974, G. Bohart & W. Hanson (3 ♂ USNM ENT 00037921–3 USNM); Cuernavaca-Cuautla Highway, Canyon de Lobos, 26 Nov 1965, M. W. McFadden (♀ USNM ENT 00037971 USNM) COSTA RICA. Puntarenas: Gravel pit near Las Alturas, 8-57-9N 82-51-1W GPS, 1,600 m, 16 Aug 1995, M. A. Metz (♂ USNM ENT 00021672 USNM); Las Alturas, Cerro Chai, 2,100 m, 14 Aug 1995, T. Pape (♂ USNM ENT 00037984 NRS); Send. a c. Pittier, 1 km de la Estación, 1,800–2,000 m, LS 331800_577400, 8–20 July 1997, M. M, Moraga Red, Lot#47388 (♀ INBIOCRI002567298 INBIO).

Discussion.—Associated with a puparium in the AMHH are the notes from its collector (Marston Bates) which declares the adult was reared "from aphis colony on *Citrus* (probably *Aphis* sp.)," the larva being a "beautiful rose and blue, looking much like a limacodid."

Ocyptamus willistoni is readily recognized by the lack of yellow pollinose vittae on the mesonotum, the red apex of the abdomen, and the blackish apical wing macula.

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This work began as a review of the Mesoamerican species done as a class project by the junior author under the direction of the senior, who later expanded the manuscript to cover the subgenus as a whole.

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A NEW SPECIES OF *TRIASPIS* HALIDAY (HYMENOPTERA: BRACONIDAE) PARASITIC ON THE PEPPER WEEVIL, *ANTHONOMUS EUGENII* CANO (COLEOPTERA: CURCULIONIDAE)

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Abstract.—A new species of braconid wasp, ***Triaspis eugenii,*** is described. This species is a parasitoid of the pepper weevil, *Anthonomus eugenii,* in Nayarit, Mexico. It is being investigated as part of a classical biological control program directed against this pest in Florida. Diagnostic features are provided for separating this species from other species of *Triaspis* attacking weevil pests. The overall similarity to another pepper weevil parasitoid in the genus *Urosigalphus* is also noted.

Key Words: Braconidae, Helconinae, Brachistini, pepper weevil, parasitoid, biological control, Mexico

The genus *Triaspis* was first described by Haliday (1835), and is currently placed in the tribe Brachistini of the subfamily Helconinae by most workers (Mason 1974, Sharkey 1997). Though confused with *Sigalphis* Latreille for nearly 80 years, the true identity of *Triaspis* was fixed in the early 1900s and has remained stable ever since (Martin 1955). *Triaspis* is characterized by the presence of a completely fused carapace and the absence of the r-m crossvein in the fore wing. In typical *Triaspis,* the carapace retains the two transverse furrows: all that remain of the sutures that originally separated the three segments comprising the carapace. *Schizoprymnus* Foerster, sometimes recognized as a separate genus and sometimes treated as a subgenus of *Triaspis,* is separated from typical *Triaspis* by the absence of the two transverse furrows, at least dorsally. Most other brachistines have at least the first two metasomal segments separated by a flexible suture. The only exception in the New World is the genus *Urosigalphus* Ashmead, otherwise distinguished by having the outer tarsal claw of the hind leg much larger than the inner claw. In the New World, various species of *Triaspis* have been reared from the same weevil hosts as other brachistines in the genera *Urosigalphus, Nealiolus* Mason, and/or *Aliolus* Say.

The most recent revisions or reviews of *Triaspis* include those of Martin (1955) for North America, Papp (1984) for Australia, Tobias (1986) for the European part of the former USSR, Priore and Tremblay (1987) for Italy, Chou and Hsu (1996) for Taiwan, and Belokobylskij (1998) for Eastern Russia. The neotropical fauna has never been revised and isolated descriptions of only five species have been published to date (Shenefelt 1970). A Palaearctic species attacking the pea weevil, *Bruchus pisorum* (L.), has also been introduced to the Neotropics (Shenefelt 1970).

In general, members of the genus *Triaspis* are poorly known biologically (Shaw and Huddleston 1991). Nevertheless, a few species have been reared from weevils, bruchids, and anthribids, and those that are best studied oviposit in the host egg and emerge from late instar larvae. The species described here has been reported as the most abundant parasitoid of the pepper weevil, *Anthonomus eugenii* Cano, in the Mexican state of Nayarit, attaining 50% parasitism in some of the samples from commercial hot pepper crops there (Mariscal et al. 1998). The species is currently being tested for possible use in the biological control of the pepper weevil in Florida. Information on the host weevil has recently been summarized by Clark and Burke (1996).

MATERIAL AND METHODS

All of the material used for this study was collected in Nayarit, Mexico, and was reared from peppers containing the pest weevil *A. eugenii.* The majority of the specimens were collected by Eugenio Mariscal and by Marco Toapanta and Phil Stansly as part of a biological control program through the University of Florida, in cooperation with Mario Urias of the National Institute of Agriculture and Forestry Research (INIFAP).

Terminology for the desciption generally follows Sharkey and Wharton (1997). Additionally, the 3 segments of the carapace are referred to as T1, T2, and T3. Total length of ovipositor was determined by dissection of 10 individuals, and comparing the total length with that of the dissected metasoma. Approximate length of ovipositor is also indicated in the description, as distance protruding beyond apex of carapace. The carapace is bordered by a thin flange called the marginal lamella (Martin 1955). Variation in quantitative traits is indicated by a range and mean, based on 10 males and 10 females.

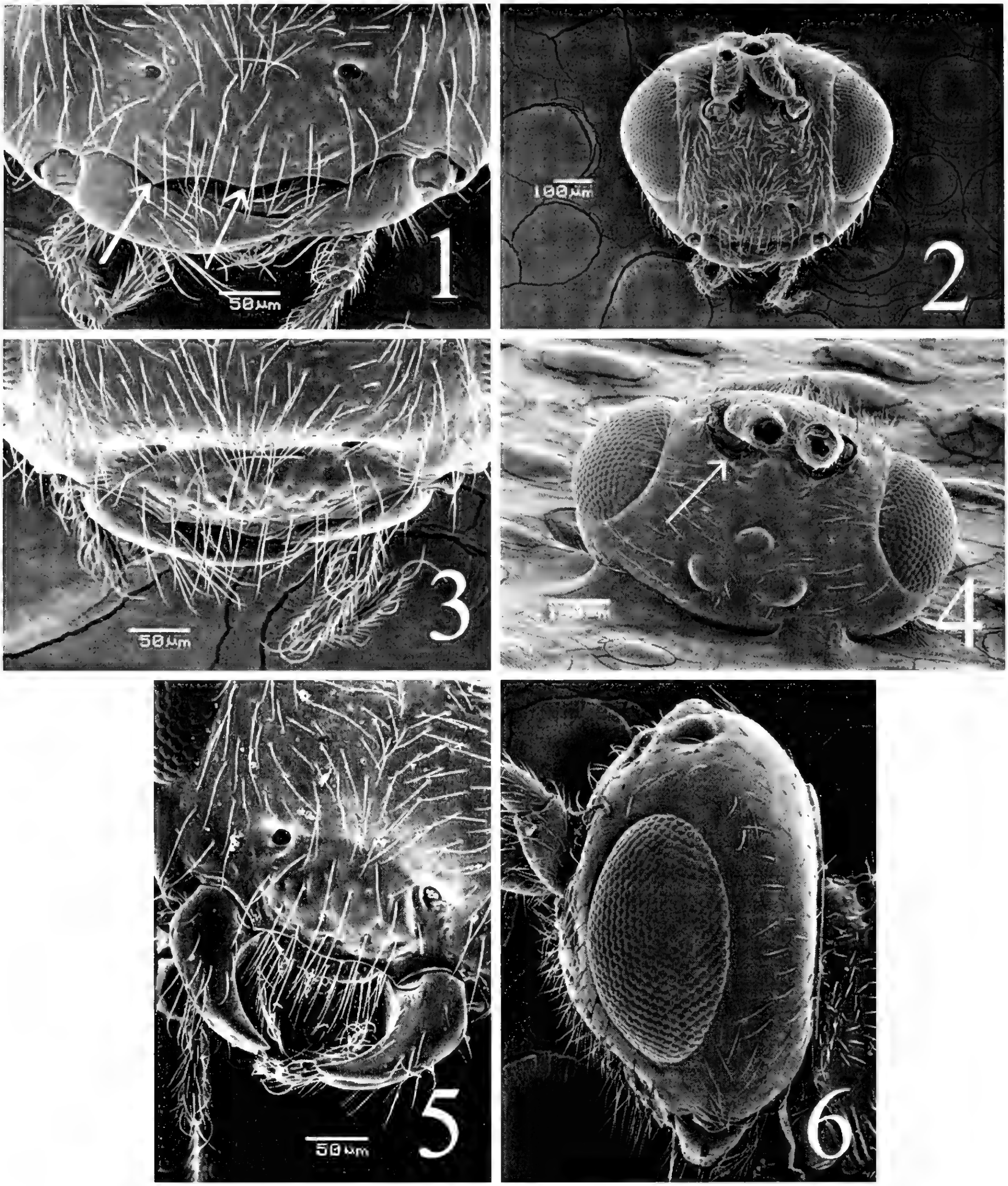
Figures were produced using a scanning electron microscope (SEM). All SEM images were shot at 10kv on a JOEL JSM-5600. Specimens were coated with about 20 nm gold, using a Hummer 6.2 sputtering unit with argon as a source gas.

RESULTS

Triaspis eugenii Wharton and López-Martínez, new species
(Figs. 1–17)

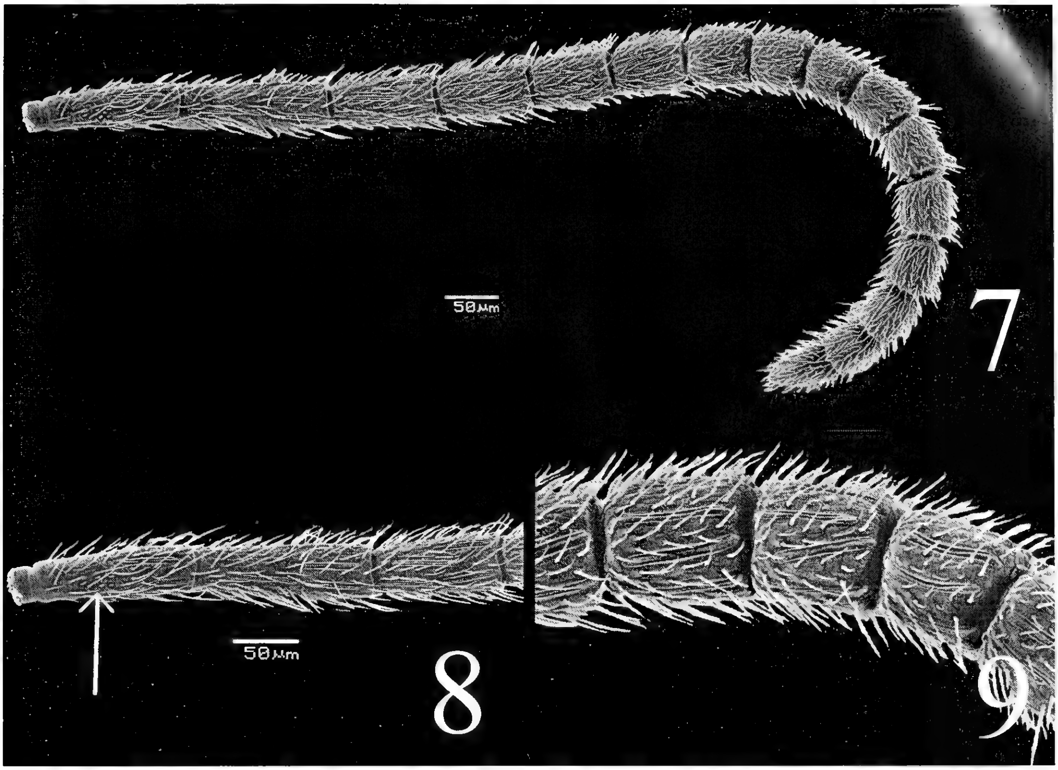
Holotype female.—Top label = "MEXICO: Nayarit Mpio. Santiago Ixcuintla, Puerta de Mango, 24.iii.1999 Toapanta & Stansly" Second label = "reared from Anthonomus eugenii on Serrano pepper emerged 7.iv.1999". Deposited in collection of Universidad Nacional Autónoma de Mexico, Mexico City. Paratypes: 9 females, 10 males, same data as holotype. 25 females, 26 males, "MEXICO: Nayarit Baladero 2.ii.1997 E. Mariscal"; 3 females, "Santiago Ixc. Nay. 23 febrero 1997 E. Mariscal Chile Serrano 11 msnm Hosp. Anthonomus eugenii". Paratypes deposited in the entomological collections of the following institutions: Texas A&M University, College Station; The Natural History Museum, London; Universidad Autónoma de Yucatán, Mérida; Universidad Postgraduados, Montecillos; Universidad Autónoma de Nuevo León, Monterrey; The Canadian National Collection, Ottawa; El Colegio de la Frontera Sur, Tapachula; National Museum of Natural History, Smithsonian Institution, Washington, DC; and Instituto de Ecologia, Xalapa.

Diagnosis.—This species is characterized by the nearly bare mesoscutum and scutellum (Fig. 13), the propodeum with a very short anterior face and sharply declivous posterior face (Figs. 10–11), the pattern of sculpture on the metasoma (Figs. 14–17), and a clypeus that is twice wider than high (Figs. 1–2). *Triaspis eugenii* is most similar to *Triaspis azteca* Martin from Mexico and especially *Triaspis vestiticida* Viereck from Peru. The flagellum is uniformly dark in *T. azteca* but the basal flagellomeres are pale (especially ventrally) in *T. eugenii* and most specimens of *T. vestiticida.* The mesonotum is almost uniformly sparsely setose in *T.*



Figs. 1–6. Head of *Triaspis eugenii.* 1, Clypeus in frontal view, arrows showing median and lateral lobes. 2, Face in frontal view showing setal pattern. 3, Anterior-dorsal view of clypeus showing rugulose and pitted surface. 4, Head in dorsal view, arrow showing depression on frons immediately posteriorad antennal base. 5, Mandible. 6, Lateral view of head.

vestiticida but largely bare in *T. eugenii.* Of the North American species treated by Martin (1955), *T. eugenii* most closely resembles *Triaspis virginiensis* Ashmead and *Triaspis rectangulata* Martin. From *T. virginiensis,* the species described here differs in having more extensive sculpture on the carapace, and a taller, narrower clypeus (clypeus "transverse" in *T. virginiensis,* about 0.75 × width of face). From *T. rec-*



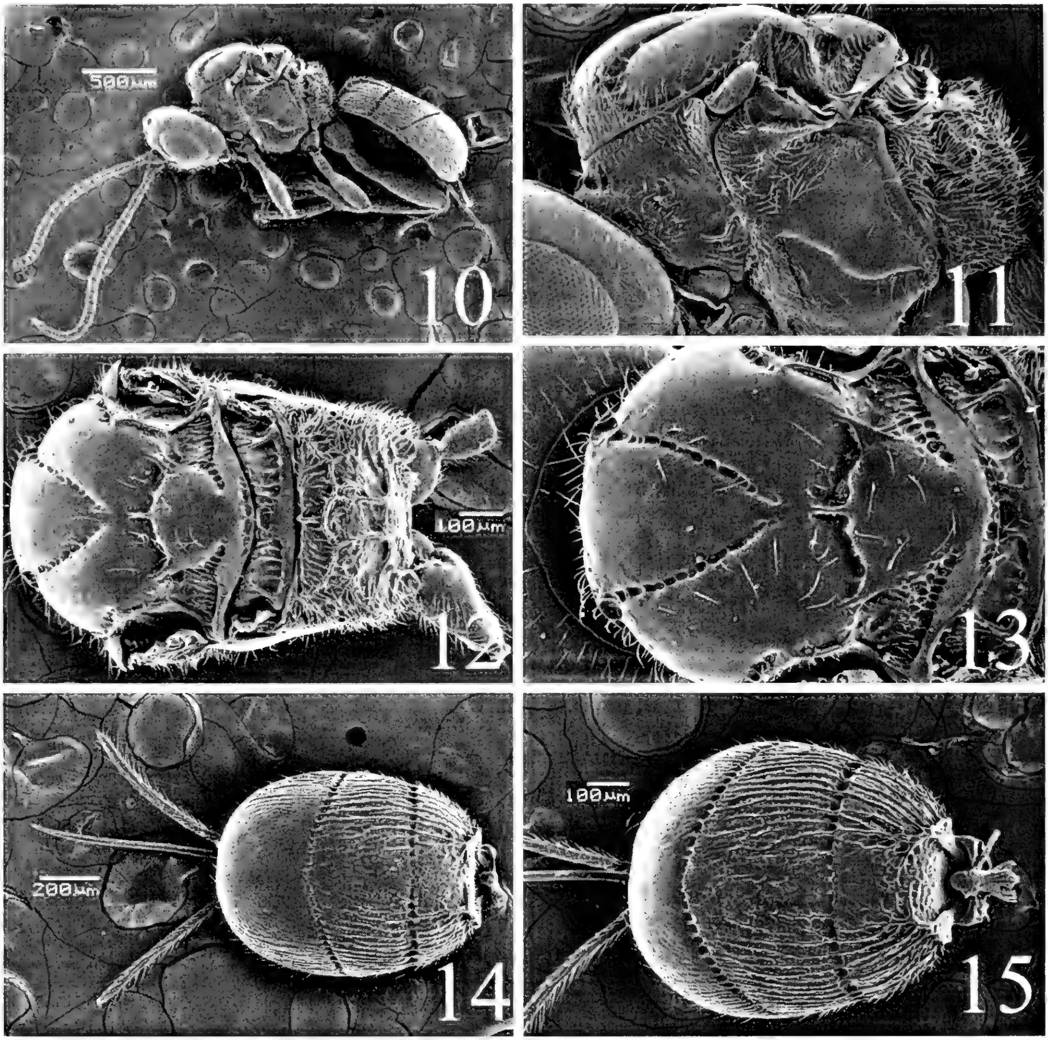
Figs. 7–9. Antenna of female *Triaspis eugenii.* 7, Composite view of flagellum (scape and pedicel absent). 8, Basal 3 flagellomeres showing relative lengths of the 3 segments and patch of short sensilla (arrow) on flagellomere 1. 9, Flagellomeres 7–9, showing patch of irregular setae and placode sensilla; see Fig. 7 for scale.

tangulata, it differs in antennal coloration and shape of the head.

Description.—Female. *Length*: 1.85–2.15 mm.

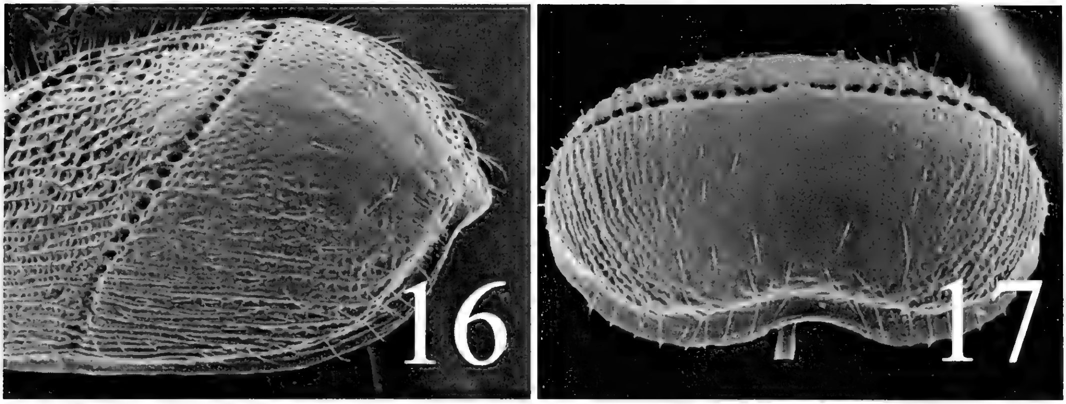
Head: Polished; somewhat trapezoidal, slightly narrowed ventrally in frontal view (gena thus not inflated: Fig. 2); vertex, occiput, temple, and gena sparsely setose (Figs. 4, 6), the setae arising from indistinct punctures; face smooth, more densely covered with ventrally and ventral-medially directed setae (Fig. 2); frons (Fig. 4) sparsely setose laterally, bare medially, with shallow depressions posteriorad scape on either side of a low, median ridge, depressions weakly sculptured in part, frons otherwise polished; eye large, about twice longer than temple in dorsal view, with temple strongly receding behind eye; malar space 0.25–0.3 × eye height, 0.4–0.45 × height of face; face 1.65–1.85 (m = 1.75) × wider than high; epistomal suture deeply impressed throughout; clypeus narrow: width 0.57–0.65 (m = 0.62) × width of face, about twice wider than high, surface uneven and distinctly punctate (Fig. 3), ventral margin sinuate: with weak, broadly rounded median lobe and a large, very obtuse angulation near the base of each mandible (Figs. 1, 5), weakly convex in profile; mandible (Fig. 5) lacking obvious sculpture; ocelli not surrounded by an impressed groove; antenna (Fig. 7) with 18–19 segments; first two flagellomeres equal in length (Fig. 8), flagellomeres 3–9 gradually shortening towards apex, flagellomeres 9 through 14–15 bead-like (Fig. 9), nearly as wide as long; maxillary palps short, about equal in length to eye height, 6-segmented; labial palps with only three apparent segments.

Mesosoma: Pronotum dorsally deeply pitted along posterior margin, the sculpture



Figs. 10–15. *Triaspis eugenii.* 10, Lateral view of body, showing relative lengths of antenna and ovipositor. 11, Lateral view of thorax and propodeum. 12–13, Dorsal view of mesosoma. 14–15, Dorsal view of metasoma showing slightly different degrees of development of sculpture.

weakening laterally, extending for a varying distance ventrally as a crenulate line; lateral face of pronotum (Fig. 11) bare medially, largely unsculptured in most specimens except at extreme ventral and posterior corners. Mesoscutum with anterior declivity and extreme base of notauli setose (Fig. 11), with 1–2 rows of scattered setae along notauli and around lateral margin of scutum (Figs. 12–13), median and lateral lobes otherwise bare and highly polished; notauli very finely crenulate and weakly impressed throughout, very narrowly separated posteriorly, the area of convergence completely impunctate (Fig. 13); scutellar sulcus finely rugulose and with a distinct midridge; scutellum polished, nearly bare; mesopleuron (Fig. 11) bare medially, setose only along anterior and posterior margins, dorsally along subalar depression, and ventrally beneath sternaulus; sternaulus shallow, sinuate, unsculptured or nearly so. Metanotum (Figs. 11, 13) short, length along midline, when viewed in profile (Fig. 11),



Figs. 16–17. Metasoma of *Triaspis eugenii* showing marginal lamella and apically sinuate carapace margin. 16, Posterior-lateral view. 17, Posterior view.

equal to or shorter than median carina of propodeum; metapleuron densely and uniformly rugose beneath a mat of short, white setae. Propodeum (Figs. 10–12) very short anteriorly, steeply declivous posteriorly; short-setose throughout, the sculpture readily visible through the setae; with well-defined pentagonal areola occupying roughly median third of declivity, declivity (including areola) otherwise irregularly carinate-rugulose, the sculpture varying in intensity, posterior-lateral ridge distinctly protruding. Hind femur short, broad, 2.85–3.1 (m = 3.0) × longer than wide; tarsal claw with distinct basal tooth. Fore wing 2.4–2.5 × longer than maximal width; basal cell sparsely setose; 1M distinctly bowed; R1a 1.55–2.1 (m = 1.8) × longer than R1b, the latter not extending to wing tip; m-cu 1.7–2.3 (m = 1.9) × longer than (RS+M)b; 1cu-a distinctly postfurcal, 1.15–2.5 (m = 1.5) × longer than 1CUa; 2cu-a absent, 2-1A usually very short, thus 1st subdiscal cell broadly open posterior-distally.

Metasoma: Approximately equal in length to mesosoma. Carapace short and broadly oval, in dorsal view 1.25–1.35 (m = 1.27) × longer than maximum width; extensively sculptured; T1 and T2 carinate over a finely rugulose and variously pitted background, the surface of T1+T2 usually (80%) completely sculptured (Figs. 15–16), more rarely with sculpture evanescent posterior-medially adjacent T2/T3 suture (Fig. 14), sculpture usually more strongly carinate laterally, with at least some carinae extending across the foveolate T1/T2 suture; T3 polished and unsculptured over medial 0.2–0.4 (Fig. 17), strigose laterally, T2/T3 suture (Figs. 14–15) complete, very broadly u-shaped, finely crenulate; dorsal carinae of T1 distinctly elevated above surrounding sculpture and weakly converging over basal half, separated by about 0.4 × carapace width at this point, parallel-sided and gradually weakening over distal half, usually reaching suture as a pair of simple carinae similar in appearance to adjacent carinate sculpture; carapace somewhat truncate posteriorly, with distinct concavity mid-ventrally (Fig. 17); marginal lamella (Figs. 10, 16–17) present as a very narrow ridge along T1 and T2, widening posteriorly on T3, extending completely around posterior margin of carapace as a broad, thin flange. Ovipositor 1.15–1.4 (m = 1.25) × longer than metasoma; at rest, extending roughly 0.7 × carapace length beyond apex (Fig. 14).

Color: Black; tegula mostly black except outer margin brown; antenna dark brown with scape, pedicel, and basal 3–6 flagellomeres yellowish ventrally; clypeus variously dark reddish brown; mandible yellow except apically; palps pale yellow to whitish; legs patterned as follows: hind coxa dark brown to black basally and posteriorly, yellow anteriorly and apically, fore and mid coxae more extensively yellow; trochanters yellow; hind femur yellow with broad, subapical brown band, band somewhat more diffuse and largely limited to dorsal and posterior sides of mid femur, fore femur yellow with dark brown spot dorsally over much of basal half; hind tibia gradually darkening from base to apex, at least basal fourth dark brown, fore and mid tibiae yellow; tarsi brown to light brown dorsally, yellowish ventrally.

Male.—As in female except face 1.75–2.0 (m = 1.85) × wider than high; antenna with 19–20 segments, flagellomeres gradually becoming shorter towards apex, but subapical flagellomeres longer and usually not as distinctly bead-like as in female, first flagellomere shorter, 0.75–0.9 (m = 0.8) × length of second. Hind femur somewhat more slender, 2.95–3.55 (m = 3.25) × longer than maximum width. Carapace distinctly narrower, in dorsal view 1.3–1.45 (m = 1.4) × longer than maximum width. Subapical brown band on hind femur often more diffuse, fore and mid femora more extensively yellow.

Discussion.—Martin (1955), in his revision of the North American species, delineated several species groups in *Triaspis.* The species described here, however, is not readily assignable to any of Martin's informal groups. To accommodate the neotropical species in general, species groups will have to be re-defined using a larger suite of characters including the propodeal structure and shape of the clypeus. The sculpture of the carapace is of value in separating some species and species groups, but examination of the large amount of reared material available to us indicates that caution is needed when using sculpture alone to identify isolated individuals. In *T. eugenii,* for example, the sculpture underlying the carinations may vary from rugulose and distinctly punctate to nearly smooth.

The two previously described neotropical species that most closely resemble *T. eugenii* have both been reared. *Triaspis azteca* attacks the bean pod weevil, *Apion godmani* Wagner (Martin 1952, Perez 1985), and the description of *T. vestiticida* was based on material reared from *Anthonomus vestitus* Boheman infesting cotton (Viereck 1912).

Members of the genus *Triaspis* are superficially similar to members of the genus *Urosigalpus,* since both have a carapace-like abdomen and similar wing venation. Since both can be reared from the same weevil hosts (including pepper weevil), it is important to exercise care when identifying reared material. As noted above, the species of *Urosigalphus* have an unusually large outer claw on the hind leg.

Etymology.—The species epithet is taken from the only known host, *Anthonomus eugenii.*

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NEW HOST PLANT AND DISTRIBUTION RECORDS IN MEXICO FOR *ANASTREPHA* SPP., *TOXOTRYPANA CURVICAUDA* GERSTACKER, *RHAGOLETIS ZOQUI* BUSH, *RHAGOLETIS* SP., AND *HEXACHAETA* SP. (DIPTERA: TEPHRITIDAE)

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Abstract.—We report the results of a nine-year study (1990–1998), aimed at determining the distribution of fruit flies (Diptera: Tephritidae) and identify their host plants in Veracruz, Mexico. Twenty *Anastrepha* species, *Toxotrypana curvicauda* and several unidentified *Hexachaeta* species were captured in McPhail traps. Among the 20 *Anastrepha* species, *A. limae, A. dentata,* and *A. canalis* are new records for Veracruz. Out of a total of 51 species of native, wild plants and exotic, cultivated plants collected in Veracruz, Mexico (representing 3,736 kg of fruit), 34 were infested by 13 *Anastrepha* species, 4 plants were infested by 4 *Rhagoletis* species, 2 plants were infested by *Toxotrypana curvicauda,* and one by an undescribed *Hexachaeta* species. Our observations include new host plant records for *Anastrepha hamata* (larvae feed only on seeds), *A. bahiensis, A. chiclayae, A. fraterculus, A. obliqua, T. curvicauda, Rhagoletis zoqui, R.* sp. and *Hexachaeta* sp. We present host plant data based on size of fruit and degree of infestation, provide information on local names and fruiting phenology, and discuss our findings in light of their practical implications and with respect to the zoogeography of Mexican fruit flies.

Resumen.—Reportamos los resultados de un estudio de nueve años (1990–1998), encaminado a determinar la distribución de moscas de la fruta (Diptera: Tephritidae) e identificar sus plantas hospederas en Veracruz, México. Veinte especies de *Anastrepha, Toxotrypana curvicauda* y varias especies no identificadas de *Hexachaeta* fueron capturadas en trampas McPhail. De estas especies *A. limae, A. dentata* y *A. canalis* representan nuevos reportes para Veracruz. De un total de 51 especies de plantas nativas (silvestres) y exóticas (cultivadas) colectadas en Veracruz, México (representando 3,736 kg de fruta), 34 fueron infestadas por 13 especies de *Anastrepha,* otras 4 por 4 especies de *Rhagoletis,* 2 por *Toxotrypana curvicauda* y una por una especie no descrita de *Hexachaeta.* Nuestras observaciones incluyen nuevas plantas hospederas para *Anastrepha hamata* (las larvas se alimentan sólo de semillas), *A. bahiensis, A. chiclayae, A. fraterculus, A. obliqua, T. curvicauda, Rhagoletis zoqui, R.* sp. y *Hexachaeta* sp. Presentamos información sobre plantas hospederas basada en el tamaño de fruto y grado de infestación, proporcionamos información acerca de nombres locales de los frutos, su fenología de fructificación y discutimos nuestros descubrimientos en relación a sus implicaciones prácticas y con respecto a la zoogeografía de las moscas de la fruta presentes en México.

Key Words: *Anastrepha, Rhagoletis, Toxotrypana, Hexachaeta,* distribution, host plants, zoogeography

Flies in the genera *Anastrepha* Schiner, *Rhagoletis* Loew, *Toxotrypana* Gerstacker, and *Hexachaeta* Loew are widely distributed in the Neotropics (Norrbom et al. 1999). In *Anastrepha,* there are 197 described species distributed from the southern USA to northern Argentina (Aluja 1994, Norrbom et al. 2000). The host plants of *Anastrepha* were recently reviewed by Norrbom (2000) and Norrbom et al. (2000). These combined reports indicate that plant species in more than 75 families are used as hosts. For *Toxotrypana curvicauda* Gerstacker, host plants are restricted to two families only: Caricaceae and Asclepiadaceae. They include species such as *Carica papaya* L., *Carica cauliflora* Jacq., *Morrenia odorata* Lindl., and *Gonolobus sorodius* Gray. (Mason 1922, Castrejón-Ayala and Camino-Lavín 1991, Landolt 1994). For flies in the genus *Hexachaeta,* almost no host-plant data are available. This genus includes 25 described species and many undescribed species, and the few host plant reports available are predominantly plants in the family Moraceae (Norrbom et al. 1999).

Here, we report the results of a long-term study (nine years of year-round fruit collections and trapping activities) aimed at determining the distribution of the fruit fly genera *Anastrepha, Rhagoletis, Toxotrypana,* and *Hexachaeta* and identifying their host plants in the State of Veracruz, Mexico.

MATERIALS AND METHODS

Study sites.—During nine years (1990–1998) we collected all wild or cultivated fruit (potential fruit fly hosts) we could find in 42 sites located in the state of Veracruz, Mexico. Two of these 42 sites are located in northern Veracruz (Morgadal and Alamo), one site is located in southern Veracruz (Los Tuxtlas), and the rest (39 sites) are located in central Veracruz. All study sites, their exact location (latitude, longitude) and altitude are described in Table 1.

Fruit sampling methods.—Ripe, and on occasion unripe, fruits of the plants listed in Table 2, were collected in areas with unperturbed and perturbed native vegetation, in backyard gardens, and in semicommercial and commercial orchards as described by Aluja et al. (1987). Samples were placed in plastic washbowls and transported to our laboratory in Xalapa, Veracruz, Mexico. There, samples were individually weighed and placed in plastic trays which in turn were placed over a plastic washbowl containing vermiculite as a pupation medium.

Processing of larvae and pupae.—We inspected, on a daily basis, the pupation medium in the washbowls described above and collected all pupae and larvae. These were transferred to labeled, 500 ml plastic containers with vermiculite. All containers (one per sample) were kept in the laboratory at 26 ± 2°C and 60–70% RH until all adult flies had emerged from the pupae.

Trapping of adult flies.—Traps to survey adult flies were placed in Apazapan, Llano Grande, Monte Blanco, and Martínez de la Torre, Veracruz. With the exception of Martínez de la Torre, we worked in commercial mango orchards surrounded by patches of native vegetation, coffee plantations, and other orchards. In Martínez de la Torre we worked in a commercial grapefruit (*Citrus paradisi* Macfad.) orchard. At all sites we placed 16 McPhail traps baited with 250 ml of a mixture of hydrolyzed protein, water, and borax in each orchard. In Apazapan we also placed 16 traps in a commercial chicozapote (*Manilkara zapota* [L.] P. Royen) orchard adjacent to the mango orchard. Bait preparation, and placement and service of traps are described in detail in Aluja et al. (1996).

Identification of adult flies and plants.—All flies emerging from puparia or caught in McPhail traps were identified at the Instituto de Ecología, A. C., by Vicente Hernández-Ortiz. Plants were dried, pressed, and identified by Carlos Durán, staff member of the IXAL herbarium at the Instituto de Ecología, A. C., in Xalapa, Veracruz. Voucher specimens of plants and insects not already represented in the permanent collections were kept in the IXAL herbarium and IXAL permanent insect collection. All plant names used here correspond to those listed in the USDA's GRIN online database (USDA 2000).

RESULTS

Fruit sampling.—A total of 3,736 kg of fruit, representing 51 species from 22 plant families, was processed during this study (Table 2). Of these, 42 species from 17 families were found to be natural hosts of 13 *Anastrepha* species, 4 *Rhagoletis* species, *Toxotrypana curvicauda,* and an undescribed *Hexachaeta* species (Table 3). The fruiting phenology of all of these plant species is described in Table 4.

The more polyphagous species were *A. ludens* (Loew) (8 plant species attacked), followed by *A. obliqua* (Macquart) and *A. fraterculus* (Wiedemann) with 7 plant species attacked. In Apazapan we found *Myrciaria floribunda* (H. West ex Will.) O. Berg (Myrtaceae) simultaneously infested by three species of *Anastrepha*: *A. fraterculus, A. obliqua,* and *A. bahiensis* Lima (new host plant records for the latter two species). We were also able to confirm that *Terminalia catappa* L. (Combretaceae) is a natural (i.e., field-infested) host plant of *A. fraterculus* (first report in the State of Veracruz).

In contrast to the polyphagous *A. obliqua, A. ludens* and *A. fraterculus, A. aphelocentema* Stone and *A. alveata* Stone were monophagous species attacking *Pouteria hypoglauca* (Standley) Baehni (Sapotaceae) and *Ximenia americana* L. (Olacaceae), respectively. *Anastrepha hamata* (Loew) was an oligophagous species attacking seeds of both *Chrysophyllum mexicanum* Brandegee ex. Stand. and *Pouteria campechiana* (Kunth) Baehni fruits, belonging to the family Sapotaceae. *Rhagoletis zoqui* Bush, *R. pomonella* Walsh, *R. turpiniae* Hernández and *R.* sp. adults were obtained from *Juglans pyriformis* Liebm., *Crataegus mexicana* DC., *Turpinia insignis* (H.B. & K.) Tul., and *Solanum ionidium* Bitter, respectively. *Toxotrypana curvicauda* adults were obtained from *Gonolobus niger* (Cav.) R. Br. (Asclepiadaceae) fruits collected in the Llano Grande region. *Hexachaeta* sp. adults attacked *Trophis mexicana* (Liebm.) Bur. (Moraceae) fruits in the Monte Blanco region (details of all the above are in Table 5).

Infestation patterns (i.e., number of larvae per kg of fruit) are described in Table 5. Notably, the smaller, wild fruits were the most infested (Table 5, Fig. 1).

The highest infestation levels (larvae/kg of fruit) were found in *Spondias mombin* L., followed by *Ximenia americana* L. (fruits in the families Anacardiaceae and Olacaceae attacked by *A. obliqua* and *A. alveata,* respectively), while the lowest infestation levels were found in *Inga jinicuil* G. Don (Leguminoseae), infested by *A. distincta* Greene, followed by *Tabernaemontana alba* Mill. (Apocynaceae) attacked by *A. cordata* Aldrich (Table 5).

Trapping.—We captured 20 *Anastrepha* species in McPhail traps. Of these, 16 species were captured in Apazapan, 12 species in Llano Grande, 14 in Monte Blanco and 11 in Martínez de la Torre (Table 6). In the mango orchards, *A. obliqua* was by far the most abundant species, followed by *A. lu-*

Table 1. Study site locations.

No.	Study site	Northern latitude	Western longitude	Altitude (meters)
1	El Conchal	19°04′	96°06′	17
2	La Mancha	19°35′	96°22′	18
3	Cardel	19°22′	96°22′	31
4	Playa Azul	19°32′	96°23′	47
5	Playa Oriente	19°21′	96°19′	121
6	Paso de Ovejas	19°17′	96°26′	122
7	Morgadal (Poza Rica)	20°24′	97°21′	128
8	Alamo	22°55′	97°40′	180
9	Puente Nacional	19°19′	96°28′	198
10	Los Tuxtlas	18°25′	95°06′	200
11	Coyolar	19°17′	96°36′	228
12	El Aguaje	19°25′	96°36′	250
13	El Crucero	19°17′	96°35′	281
14	Actopan	19°30′	96°36′	311
15	Plan del Río	19°23′	96°39′	319
16	Rinconada	19°21′	96°33′	322
17	Apazapan	19°19′	96°42′	331
18	Martínez de la Torre	19°58′	96°47′	400
19	Emiliano Zapata	19°21′	96°33′	416
20	Cerro Gordo	19°25′	96°41′	559
21	Llano Grande	19°22′	96°53′	680
22	Corral Falso	19°27′	96°45′	744
23	San Pedro	19°24′	96°52′	904
24	Tejería	19°22′	96°56′	924
25	Miradores	19°28′	96°46′	966
26	Limones	19°20′	96°55′	1,021
27	Monte Blanco	19°23′	96°56′	1,026
28	Bella Esperanza	19°26′	96°52′	1,057
29	Vaquería	19°19′	96°57′	1,103
30	Coatepec	19°26′	96°57′	1,142
31	Xico	19°25′	97°00′	1,145
32	Teocelo	19°24′	96°58′	1,163
33	Jilotepec	19°37′	96°56′	1,292
34	Cosautlán	19°20′	96°59′	1,318
35	Texín	19°20′	97°01′	1,464
36	Xalapa	19°31′	96°54′	1,468
37	Amatla	19°19′	97°03′	1,478
38	El Diez	19°21′	97°01′	1,498
39	La Perla	19°19′	97°03′	1,578
40	El Arenal	19°19′	97°05′	1,649
41	Acajete	19°34′	96°59′	1,875
42	La Joya	19°37′	97°02′	2,004

dens (Monte Blanco and Llano Grande) and *A. serpentina* (Wiedemann) (Apazapan). At Martínez de la Torre (citrus orchard), *A. ludens* was the most common *Anastrepha* species captured. All of these species are considered agricultural pests of economic importance in Mexico.

Many *Anastrepha* species of non-economic importance were also captured at all four trapping sites (e.g., *A. bicolor* [Stone], and *A. spatulata* Stone). In contrast, *A. bahiensis, A. dentata* (Stone), *A. robusta* Greene, and *A. zuelaniae* Stone were found only in Apazapan, while *A. canalis* Stone was captured only in Monte Blanco. Adults of *Hexachaeta* spp. were commonly cap-

Table 2. Plant species sampled in central Veracruz, Mexico, to determine their host status to the local tephritid fruit flies.

Plant family	Scientific name	Local common name	Locality code*
Anacardiaceae	*Mangifera indica* L.		1–9, 11–12, 14–15, 17, 19–21, 24, 27
	var. criollo	Mango corriente	
	var. manila	Mango manila	
	var. Kent	Mango petacon	
	Spondias mombin L.	Jobo	1–3, 5–6, 10, 16–17, 19–21, 23, 24, 27–28
	Spondias purpurea L.	Ciruelo tropical	1–6, 9–11, 13–17, 19–21, 23
	Spondias radlkoferi Donn. Sm.	Jobo Cimarron	24, 27
	Spondias sp.	Cundoria	5, 23, 25, 27
	Tapirira mexicana Marchand	Cacao silvestre	27, 30
Annonaceae	*Annona muricata* L.	Guanábana	5, 16–17
Apocynaceae	*Tabernaemontana alba* Mill.	Huevo de gato	10
Asclepiadaceae	*Gonolobus niger* (Cav.) R. Br.	Vaquitas	21, 27
Bombacaceae	*Quararibea funebris* (La Llave) Vischer	Canela	10
Caricaceae	*Carica papaya* L.	Papaya	8, 15, 17
Combretaceae	*Terminalia catappa* L.	Almendro	2, 5, 9, 16
Euphorbiaceae	*Ricinus communis* L.	Higuerilla	21
Guttiferae	*Mammea americana* L.	Zapote domingo	2
Juglandaceae	*Juglans pyriformis* Liebm.	Nogal	34, 36
Leguminoseae	*Inga jinicuil* G. Donht.	Jinicuil	21, 23, 24, 26, 27, 28–30, 34
	Inga spuria Humbl.	Chalahuite peludo	21, 24, 27
	Inga vera Willd.	Chalahuite	21, 24, 27
Malpighiaceae	*Byrsonima crassifolia* (L.) Kunth	Nanche	26, 32
Moraceae	*Trophis mexicana* (Liebm.) Bur.	Jobo Cimarron	27
	Brosimum alicastrum Sw.	Ramon (Ojite)	2, 13
Myrsinaceae	*Icacorea compressa* (Kunth) Standley	Capulin silvestre	27
Myrtaceae	*Myrciaria floribunda* (H. West ex Willd.) O. Berg	Guayabilla	17
	Psidium guajava L.	Guayaba	1–6, 9–17, 19–34, 36–40
	Psidium guineense Sw.	Guayaba acida	24
	Psidium sartorianum (O. Berg.) Nied.	Guayaba Tejon	6, 21, 27
	Syzygium jambos (L.) Alston	Pomarrosa	23, 24, 26–32, 36
Olacaceae	*Ximenia americana* L.	Ciruela de monte	16, 17, 21
Passifloraceae	*Bunchosia biocellata* Schlecht.	Granada de arbol	13
	Passiflora ciliata Aiton	Granada roja	27
	Passiflora edulis Sims.	Granada amarilla	27
	Passiflora edulis f. flavicarpa Deg.	Maracuyá	24, 27, 32
Rosaceae	*Cordia dodecandria* Sesse & Moc.	Copite	16
	Crataegus mexicana DC.	Tejocote	41, 42
	Eriobotrya japonica (Thunb.) Lindl.	Nispero	21, 24, 27, 32, 36
	Prunus persica (L.) Batsch	Durazno	21, 24, 27, 31, 36
Rutaceae	*Casimiroa edulis* La Llave & Lex.	Zapote Blanco	27, 36
	Citrus maxima (Burm.) Merr.	Pomelo	12, 16, 19
	Citrus reticulata Blanco	Mandarina	7, 16, 18
	Citrus paradisi Macfad.	Toronja	2, 18, 23, 25, 35
	Citrus sinensis (L.) Osbek		5, 6, 16, 18, 19, 21, 24, 26, 27, 29, 32, 34, 36
	var. valencia	Naranja Valencia	
	var. navel	Naranja Ombligona	

Table 2. Continued.

Plant family	Scientific name	Local common name	Locality code*
	Citrus aurantium L.	Naranja Cucha	1, 9, 14–16, 19–21, 23–25, 27, 28, 30, 31, 33, 40
Sapotaceae	*Bumelia spiniflora* A. DC.	Pionche	17
	Calocarpum mammosum (L.) P. Royen	Zapote Mamey	5, 21, 23, 24, 26, 27
	Chrysophyllum mexicanum Brandegee ex. Stand.	Zapote Niño	10
	Chrysophyllum cainito L.	Caimito	8
	Manilkara zapota (L.) P. Royen	Chico Zapote	14–17, 19
	Pouteria hypoglauca (Standl.) Baehni	Zapote calentura	2, 7
	Pouteria campechiana (Kunth) Baehni	Zapote Niño	27
Solanaceae	*Solanum ionidium* Bitter	Tomatillo	36
Staphyleaceae	*Turpinia insignis* (H.B. & K.) Tul.	Turpinia	36

* Places in which plant species were sampled. Numbers correspond to those presented in Table 1.

tured in McPhail traps in all four trapping sites. *Toxotrypana curvicauda* was captured only in Apazapan, Veracruz.

DISCUSSION

We discovered new host plants for *Anastrepha bahiensis, A. hamata* (2 plant species), *A. chiclayae* Greene, *A. fraterculus,* and most significantly, for the economically-important species, *A. obliqua.* New host plants are also reported for *Toxotrypana curvicauda, Rhagoletis zoqui, R.* sp. and *Hexachaeta* sp. We were further able to document, for the first time, the presence of *A. canalis, A. dentata,* and *A. limae* Stone in the State of Veracruz, Mexico.

Of the 17 species of *Anastrepha* reported by Hernández-Ortiz (1992) in the state of Veracruz, we found all in fruits, or captured in McPhail traps. In addition, we also found the previously unrecorded *A. alveata* (Piedra et al. 1993), *A. bicolor, A. canalis, A. dentata,* and *A. limae.*

Of the new records found for the genus *Anastrepha, A. hamata* stands out, not only because this is the first report of its host plants, but also because the larvae were found feeding only on seeds of two fruit species. Thus, this species is added to the list previously published by Hernández-Ortiz and Aluja (1993), in which *A. cordata, A. sagittata* (Stone), *A. pallens* Coquillett, *A. crebra* Stone, *A. anomala* Stone, and *A. pickeli* Lima are reported as seed-feeding species. We note however, that *A. cordata* and *A. crebra* also apparently feed in the mesocarp of fruits (Norrbom et al. 2000).

Anastrepha bahiensis, A. fraterculus, and *A. obliqua* were found simultaneously attacking the previously unreported host *Myrciaria floribunda* (local common name: Guayabilla) (Myrtaceae), in the Apazapan region. We wonder if these species are unable to recognize the host marking pheromone of their congeners or if the extremely scarce supply of alternative host plants during the time of year when this plant is in fruit, causes flies to oviposit in previously utilized and marked fruit (due to a large egload). For *A. fraterculus* and *A. obliqua,* it is relevant to mention that this plant can function as an alternative host from March until May. This could allow *A. fraterculus* to bridge the period when its previously reported hosts are unavailable (*Psidium* spp. prior to May, and *S. jambos* [L.] Alston from May to July). In the case of *Anastrepha obliqua,* we believe that this host could also serve as a "bridge" between the fruiting periods of two wild hosts (*Tapirira mexicana* Marchand, which locally bears fruits from September to November, and

Table 3. Native and exotic host plants that harbored fruit flies in Veracruz, Mexico, during our nine year study (1990–1998).

Fruit fly species	Common local name of host plant	Scientific name of host plant	Plant family
Anastrepha			
alveata	Ciruela de monte	*Ximenia americana*	Olacaceae
aphelocentema	Zapote calentura	*Pouteria hypoglauca*	Sapotaceae
bahiensis	Guayabilla*	*Myrciaria floribunda*	Myrtaceae
	Ramón or Ojite	*Brosimum alicastrum*	Moraceae
chiclayae	Granada amarilla	*Passiflora edulis*	Passifloraceae
	Granada roja	*Passiflora ciliata*	Passifloraceae
cordata	Huevo de gato	*Tabernaemontana alba*	Apocynaceae
crebra	Canela	*Quararibea funebris*	Bombacaceae
distincta	Jinicuil	*Inga jinicuil*	Leguminosae
	Chalahuite peludo	*Inga spuria*	Leguminosae
	Chalahuite	*Inga vera*	Leguminosae
fraterculus	Almendro**	*Terminalia catappa*	Combretaceae
	Guayabilla	*Myrciaria floribunda*	Myrtaceae
	Guayaba	*Psidium guajava*	Myrtaceae
	Guayaba ácida	*Psidium guineense*	Myrtaceae
	Guayaba tejón	*Psidium sartorianum*	Myrtaceae
	Pomarrosa	*Syzygium jambos*	Myrtaceae
	Durazno	*Prunus persica*	Rosaceae
hamata	Zapote Niño*	*Chrysophyllum mexicanum*	Sapotaceae
	Zapote Niño*	*Pouteria campechiana*	Sapotaceae
ludens	Mango	*Mangifera indica*	Anacardiaceae
	cultivar Criollo		
	cultivar Manila		
	cultivar Kent		
	Durazno	*Prunus persica*	Rosaceae
	Zapote Blanco	*Casimiroa edulis*	Rutaceae
	Naranja cucha	*Citrus aurantium*	Rutaceae
	Pomelo	*Citrus maxima*	Rutaceae
	Toronja	*Citrus paradisi*	Rutaceae
	Mandarina	*Citrus reticulata*	Rutaceae
	Naranja dulce	*Citrus sinensis*	Rutaceae
obliqua	Mango	*Mangifera indica*	Anacardiaceae
	var. Manila		
	var. Kent		
	var. Criollo		
	Ciruelo	*Spondias purpurea*	Anacardiaceae
	Cundoria	*Spondias* sp.	Anacardiaceae
	Jobo cimarrón	*Spondias radlkoferi*	Anacardiaceae
	Jobo	*Spondias mombin*	Anacardiaceae
	Cacao	*Tapirira mexicana*	Anacardiaceae
	Guayabilla*	*Myrciaria floribunda*	Myrtaceae
serpentina	Zapote mamey	*Calocarpum mammosum*	Sapotaceae
	Zapote niño	*Chrysophyllum mexicanum*	Sapotaceae
	Caimito	*Chrysophyllum cainito*	Sapotaceae
	Chico Zapote	*Manilkara zapota*	Sapotaceae
	Zapote calentura	*Pouteria hypoglauca*	Sapotaceae
striata	Guayaba	*Psidium guajava*	Myrtaceae
	Guayaba ácida	*Psidium guineense*	Myrtaceae
	Guayaba tejón	*Psidium sartorianum*	Myrtaceae

Table 3. Continued.

Fruit fly species	Common local name of host plant	Scientific name of host plant	Plant family
Rhagoletis			
pomonella	Tejocote	*Crataegus mexicana*	Rosaceae
turpiniae	Turpinia	*Turpinia insignis*	Staphyleaceae
sp.	Tomatillo	*Solanum iodinium*	Solanaceae
zoqui	Nogal	*Juglans pyriformis*	Junglandaceae
Hexachaeta			
(undescribed species)	Jobo Cimarrón*	*Trophis mexicana*	Moraceae
Toxotrypana			
curvicauda	Papaya	*Carica papaya*	Caricaceae
	Vaquitas*	*Gonolobus niger*	Asclepiadaceae

* First report for Mexico.
** First report for Veracruz State.

Spondias purpurea L., available from April to June). Interestingly, *M. floribunda* is heavily preyed upon local mammals who eat practically every available fruit (trees bear fruit during the peak of the dry season and thus represent one of the few available food items for wildlife). Because of this, it is very difficult to find fruit in the field.

The presence of *A. fraterculus* in fruits of *Terminalia catappa* corroborates the previous report by Patiño (1989) working in Papantla and Gutiérrez Zamora, Veracruz. However, we find it noteworthy that it was never found infesting any of the several *Citrus* species we sampled.

Unfortunately, we were not able to rear *A. bicolor, A. canalis, A. dentata, A. limae, A. pallens, A. robusta, A. spatulata*, and *A. zuelaniae* from host fruits. These species were only captured in McPhail traps. However, Hernández-Ortiz (1992) pointed out that species belonging to the *dentata* group (e.g., *A. dentata*), *daciformis* group (e.g., *A. bicolor* and *A. pallens*) and *robusta* group (e.g., *A. robusta*) probably attack plants belonging to the family Sapotaceae. Future efforts at discovering their host plants should thus be directed to all wild species of this family. According to Stone (1939) and Baker et al. (1944), *A. pallens* attacks *Bumelia spiniflora* A. DC. (Sapotaceae), while Norrbom (1998) pointed out that it infests fruits of *Sideroxylon celastrinum* (Kunth) T.D. Pennington and *S. lanuginosa* Michx. (Sapotaceae). We note that Norrbom (1998) considers that *B. spiniflora* was likely misspelled (the correct name should be *B. spinosa* A.DC.). Should the latter be true, then *B. spiniflora* is a synonym of *S. celastrinum* (Norrbom 1998). *Anastrepha leptozona* Hendel was also not reared from any of the fruits collected. However, Aluja et al. (1987) found it in *Micropholis mexicana* Gilly ex Cronquist (Sapotaceae), in the state of Chiapas, and Norrbom and Kim (1988) report its occurrence in 6 plant families. Norrbom et al. (1999) also note that *A. zuelaniae, A. limae* and *A. canalis* are associated with plants in the families Flacourtiaceae, Passifloraceae and Staphylaceae, respectively.

In the Los Tuxtlas region, Hernández-Ortiz and Pérez Alonso (1993) reported the presence of 13 species of *Anastrepha.* Of these, they hypothesized that *A. crebra, A. minuta* and *Anastrepha* sp. (close to *A. perdita*) are apparently restricted in Mexico, to tropical, evergreen rain forests. Our results, indicating that these species are only present in the tropical decidous forests of central and northern Veracruz, lend support to this hypothesis.

For *Toxotrypana curvicauda,* our report corroborates the previous records of Mason

Table 4. Fruiting phenology of fruit fly host plants in Veracruz, Mexico.

	Month											
Plant species	J	F	M	A	M	J	J	A	S	O	N	D
Anastrepha host plants												
Brosimum alicastrum				X	X	X						
Calocarpum mammosum					X	X	X	X	X			
Casimiroa edulis					X	X	X					
Chrysophyllum mexicanum	X									X	X	X
Chrysophyllum cainito				X	X							
Citrus aurantium	X	X	X			X	X	X	X	X	X	X
Citrus maxima	X	X	X								X	X
Citrus paradisi	X	X								X	X	X
Citrus reticulata	X										X	X
Citrus sinensis	X	X	X							X	X	X
Inga jinicuil						X	X	X				
Inga spuria									X	X		
Inga vera									X	X		
Mangifera indica												
cultivar Criollo				X	X	X	X	X				
cultivar Manila			X	X	X	X	X	X	X			
cultivar Kent								X	X			
Manilkara zapota			X	X	X	X	X	X				
Myrciaria floribunda			X	X	X							
Passiflora edulis					X	X						
Passiflora ciliata						X						
Pouteria hypoglauca							X	X	X			
Pouteria campechiana	X	X								X	X	X
Prunus persica					X	X	X	X				
Psidium guajava												
0–500*	X	X			X	X	X	X	X	X	X	X
500–1,000*							X	X	X	X	X	
1,000–1,500*								X	X	X	X	
Psidium guineense	X	X							X	X	X	X
Psidium sartorianum	X	X								X	X	X
Quararibea funebris	X	X	X						X	X	X	X
Spondias purpurea				X	X	X	X					
Spondias mombin								X	X			
Spondias radlkoferi									X	X	X	
Spondias sp.								X	X	X		
Syzygium jambos					X	X	X					
Tabernaemontana alba						X	X	X	X	X	X	X
Tapirira mexicana										X	X	
Terminalia catappa						X	X	X	X	X	X	X
Ximenia americana				X	X	X						
Hexachaeta host plants												
Trophis mexicana					X	X						
Toxotrypana host plants												
Carica papaya			X	X	X	X	X	X	X	X		
Gonolobus niger	X	X	X									
Rhagoletis host plants												
Crataegus mexicana								X	X	X	X	
Juglans pyriformis							X	X	X	X		
Solanum ionidium							X	X				
Turpinia insignis							X	X				

* Meters above sea level.

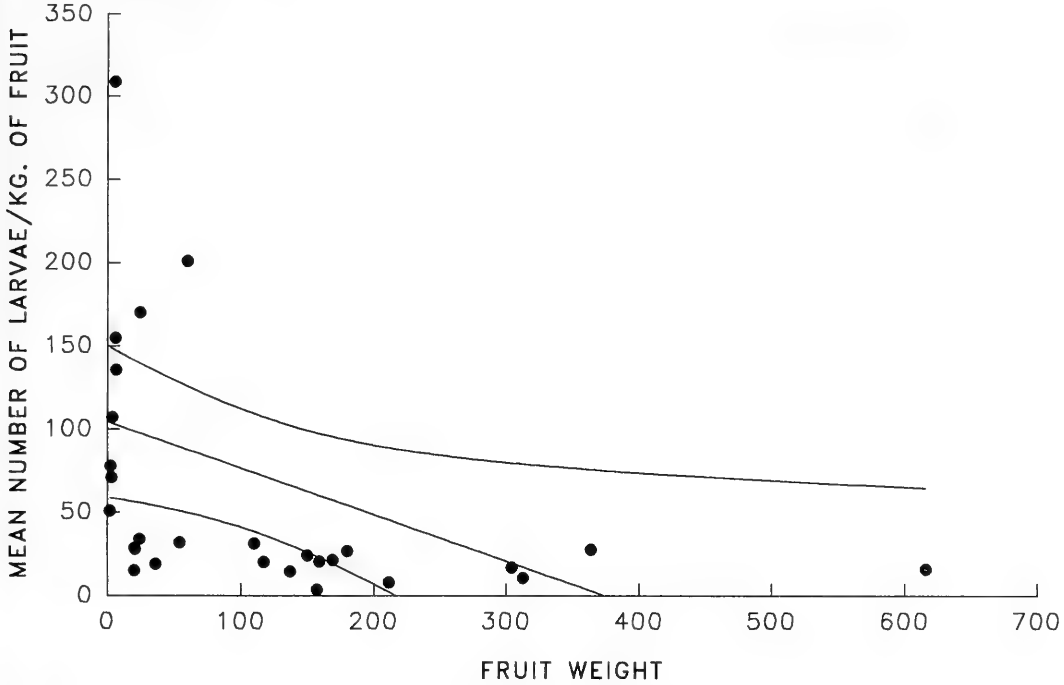

Fig. 1. Number of larvae per kilogram of fruit as influenced by size of fruit.

(1922), Castrejón-Ayala and Camino-Lavín (1991), and Landolt (1994), who pointed out that adults of this species feed mainly on fruits belonging to the families Caricaceae and Asclepiadaceae. Here we report this species infesting *Gonolobus niger,* a plant also belonging to the family Asclepiadaceae.

For *Hexachaeta* sp., we are the first to report its host plant as *Trophis mexicana.* This confirms that various species belonging to this fly genus develop in fruits of the Moraceae.

We are able to report a new host plant (*Juglans pyriformis*) for *R. zoqui.* The only other known host plant record for this fly species is *J. mollis* Engelm. (Bush 1966). Further, we also report for the first time that *Solanum ionidium* is a host plant of an undescribed species in the genus *Rhagoletis.* This adds further evidence about the importance of the family Solanaceae as hosts of this genus.

The polyphagy observed in *A. ludens* (8 plant species belonging to 3 families), *A. obliqua* (7 plant species belonging to 2 families) and *A. fraterculus* (7 species belonging to 4 families) has previously been discussed by Aluja et al. (1987) and Hernández-Ortiz and Aluja (1993). In our opinion, this polyphagy permits these four species to be abundant during practically the whole year. *Anastrepha bahiensis* was also found to be a polyphagous species, with larvae feeding on fruits belonging to two genera in two different families (*M. floribunda* [Myrtaceae] and *Brosimum alicastrum* Sw. [Moraceae]).

In contrast, some species in our study appeared to be monophagous. This is the case for *A. alveata* feeding on *Ximenia americana* (Olacaceae) (Piedra et al. 1993), and *A. aphelocentema* on *Pouteria hypoglauca* (Sapotaceae). *Anastrepha aphelocentema* was found only in the northern part of Veracruz (Papantla) (Patiño, 1989), in spite of the fact that this plant is also present in localites such as La Mancha, approximately 150 km away from Papantla. In La Mancha, fruits were attacked only by *A. serpentina.*

Table 5. Infestation patterns by *Anastrepha* flies based on size of host fruit.

Host plant	Kg. sampled	Total no. of pupae	Total no. of adults	Fruit fly species	Degree of infestation (larvae/kg of fruit)
Large (300–1,000 gr)					
Calocarpum mammosum	143.73	3,942	2,792	*A. serpentina*	27.43
Citrus paradisi	1,345.71	22,739	19,428	*A. ludens*	16.90
Mangifera indica cultivar Kent	56.57	902			15.95
			27	*A. obliqua*	
			716	*A. ludens*	
Citrus maxima	79.66	853	552	*A. ludens*	10.70
Carica papaya	126.50	529	477	*T. curvicauda*	4.18
Medium (50–300 gr)					
Chrysophyllum cainito	11.00	2,210	1,926	*A. serpentina*	201.00
Prunus persica	10.62	338			31.83
			228	*A. fraterculus*	
			37	*A. ludens*	
Manilkara zapota	101.83	3,178	2,171	*A. serpentina*	31.21
Pouteria hypoglauca[2]	19.05	506	328	*A. aphelocentema*	26.56
Casimiroa edulis	39.55	952	477	*A. ludens*	24.10
Pouteria hypoglauca[1]	17.28	369	232	*A. serpentina*	21.35
Juglans pyriformis	75.91	1,557	899	*R. zoqui*	20.51
Citrus sinensis	264.27	5,357	2,742	*A. ludens*	20.27
Citrus aurantium	669.29	13,513	8,525	*A. ludens*	20.20
Mangifera indica var. *criollo*	121.78	1,772			14.55
			20	*A. ludens*	
			995	*A. obliqua*	
Citrus reticulata	2.80	36	23	*A. ludens*	12.86
Chrysophyllum mexicanum	59.36	531	342	*A. hamata*	8.94
Mangifera indica var. *manila*	42.97	337			7.84
			58	*A. ludens*	
			222	*A. obliqua*	
Terminalia catappa	10.09	55	10	*A. fraterculus*	5.45
Inga jinicuil	22.38	77	64	*A. distincta*	3.44
Small (<50 gr)					
Spondias mombin	64.67	28,138	4,241	*A. obliqua*	435.10
Ximenia americana	16.08	4,960	2,082	*A. alveata*	308.46
Turpinia insignis	12.25	3,416	674	*R. turpiniae*	278.90
Psidium guajava	97.60	16,619			170.28
			4,879	*A. striata*	
			8,923	*A. fraterculus*	
Spondias sp.	29.20	4,514	2,155	*A. obliqua*	154.59
Inga vera	0.56	76	76	*A. distincta*	135.71
Psidium guineense	4.76	509			106.93
			73	*A. striata*	
			359	*A. fraterculus*	
Solanum ionidium	0.29	29	11	*R.* sp.	100.00
Psidium sartorianum	3.62	282			77.90
			47	*A. striata*	
			43	*A. fraterculus*	
Tapirira mexicana	14.93	1,060	325	*A. obliqua*	71.00
Spondias radlkoferi	7.57	384	131	*A. obliqua*	50.72

Table 5. Continued

Host plant	Kg. sampled	Total no. of pupae	Total no. of adults	Fruit fly species	Degree of infestation (larvae/kg of fruit)
Inga spuria	10.52	495	373	*A. distincta*	47.05
Crataegus mexicana	22.50	986	559	*R. pomonella*	43.83
Spondias purpurea	182.34	6,170	1,513	*A. obliqua*	33.84
Passiflora ciliata	0.84	24	18	*A. chiclayae*	28.57
Syzygium jambos	21.95	615	389	*A. fraterculus*	28.01
Quararibea funebris	3.26	89	67	*A. crebra*	27.30
Trophis mexicana	0.21	5	2	*Hexachaeta* sp.	23.81
Passiflora edulis	0.67	10	8	*A. chiclayae*	14.93
Tabernaemontana alba	16.43	62	49	*A. cordata*	3.77
Gonolobus niger	5.00	*	*	*T. curvicauda*	—
Brosimum alicastrum	ca. 0.30	*	*	*A. bahiensis*	—
Myrciaria floribunda	ca. 0.30	*	*	*A. obliqua* *A. fraterculus* *A. bahiensis*	—

[1] Fruit collected in La Mancha.

[2] Fruit collected in Morgadal (Poza Rica).

* Pupae and adults that emerged were not counted.

Table 6. Fruit fly species captured in McPhail traps in Central Veracruz, Mexico.

Fruit fly species	Apazapan	Llano Grande	Monte Blanco	M. de la Torre
A. alveata	X	X	X	
A. bahiensis	X			
A. bicolor	X	X	X	X
A. canalis			X	
A. chiclayae	X	X	X	X
A. cordata				X
A. dentata	X			
A. distincta	X	X	X	X
A. fraterculus	X	X	X	X
A. hamata	X		X	
A. leptozona		X	X	
A. limae		X	X	
A. ludens	X	X	X	X
A. obliqua	X	X	X	X
A. pallens	X			X
A. robusta	X			
A. serpentina	X	X	X	X
A. spatulata	X	X	X	X
A. striata	X	X	X	X
A. zuelaniae	X			
T. curvicauda	X			
Hexachaeta spp.	X	X	X	X

It is possible that the recent heavy habitat alteration caused local extinction of this species.

It is significant that in the Monte Blanco region (central Veracruz) fruits of *Pouteria campechiana* were attacked only by *A. hamata* (on seeds), whereas in Los Tuxtlas (southern part of the state), *Chrysophyllum mexicanum* fruits were attacked by both *A. serpentina* on pulp, and *A. hamata* on seeds. It is noteworthy that two species of *Anastrepha* can utilize the same host without competition. *Pouteria campechiana* seeds and pulp were also reported attacked by both *A. sagittata* and *A. serpentina,* respectively, by Baker et al. (1944). However, Aluja et al. (1987) reported only *A. serpentina* larvae feeding on pulp of *P. campechiana* fruits in the State of Chiapas (Mexico), but no trace of *A. sagittata.*

In other *Anastrepha* species, we found that their host plants belonged to multiple species of only one genus (stenophagous species). This was true for *A. distincta* in *Inga spuria* Humbl. and *I. vera* Willd. (Leguminoseae), for *A. striata* Schiner in *Psidium guajava* L., *P. guineense* Sw. and *P. sartorianum* (O. Berg) Nied. (Myrtaceae) and for *A. chiclayae* in *Passiflora edulis* Sims. and *P. ciliata* Aiton (Passifloraceae). We also confirm that *A. serpentina* is an oligophagous species with larvae found feeding in four fruit species belonging to the Sapotaceae (see Hernández-Ortiz 1992). Interestingly, *A. hamata* was also found to be an oligophagous species (larvae feed on seeds of 2 plant species belonging to the Sapotaceae).

Even though trapping efforts were made in an extended region of central Veracruz, *A. dentata, A. robusta,* and *A. zuelaniae* were captured only in Apazapan, where the vegetation has been characterized as low deciduous forest. In contrast, adults of *A. canalis* were captured only in Monte Blanco, where the vegetation was originally comprised of montane cloud forest. *Anastrepha limae* was found in both Llano Grande and Monte Blanco. This suggests that the geographic distribution of some *Anastrepha* species is restricted to certain zones, possibly because their host plants are present only in these zones.

We also found that the timing of capture of certain monophagous species coincided with the fruiting periods of their host plants. For example, *A. hamata* and *A. alveata* adults were captured in McPhail traps almost exclusively when their host fruits were available (*P. campechiana* and *C. mexicanum,* and *X. americana,* respectively). In our opinion, this is probably due to an extraordinary capacity of adult survival for long periods of time. Under laboratory conditions, *A. alveata* adults can live up to 431 days (Aluja and Jácome, unpublished data). Such adult longevities probably allow adults to lay eggs in the fruits produced the following year. However, the locations where the adults of such species persist during most of the year are unknown.

Finally, our data on the relationship of fruit size and larval infestation levels represents further evidence that small, wild fruits are more heavily infested than larger, commercially grown fruits that were for the most part, recently (on an evolutionary scale) introduced to the Americas. This relationship was recently discussed by Aluja et al. (2000) who indicated that native flies have probably still not fully developed the ability to metabolize the toxic chemicals that these exotic plants contain. As a result, and despite the fact that females lay many eggs in them, few eggs hatch or most larvae die or develop poorly.

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REVISION OF THE GENUS *PARADA* HORVÁTH (HEMIPTERA: TINGIDAE) WITH CLADISTIC ANALYSIS

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Abstract.—Three new species of *Parada* from New Caledonia are described: ***P. minuta, P. paitae*** and ***P. majuscula.*** The monotypic *Alloeocysta approba* Drake is considered a junior synonym of *Parada* and to which its only included species is transferred. The evolution of certain characters, and the relationships among species of *Parada* are presented together with a cladistic analysis. An identification key for these species is also given.

Key Words: *Parada,* Tingidae, new species, evolution, phylogeny, key

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Horváth (1925) erected *Parada* as a subgenus of *Cysteochila* Stål for the reception of *Cysteochila* (*Parada*) *taeniophora* Horváth (1925). *Cysteochila* has the paranota widely reflected, inflated, covering the lateral carinae, and the internal margins (« margine interno ») rounded, while *Parada* has the paranota narrowly reflexed, superficially adpressed onto the pronotum and not covering the lateral carinae, and the internal margins slightly sinuate and never rounded (Horváth 1925). Drake (1942) raised *Parada* to generic level, and add two new species to the genus (*P. torta* and *P. popla*). Later, he added four more new species to the genus (*P. absona, P. darlingtoni* and *P. hackeri* Drake 1952; *P. solla* Drake and Ruhoff 1961).

The genus presently comprises seven Australian species (New South Wales and Queensland) (Drake and Ruhoff 1965). Three new species from New Caledonia are described here. In addition, Drake (1961) described a new genus and a new species from a single specimen caught in New South Wales: *Alloeocysta approba.* This species, the only included species of the genus, shares with *Parada* the form of the lateral carinae, the paranota and the hood, and is considered a junior synonym. *Alloeocysta approba* Drake is transferred to *Parada.* In addition, *Cysteochila cubens* Guilbert (in press), described from New Caledonia shows affinities with the species of *Parada* and could be an intermediate species between these two genera. Among these relationships, the evolution of some characters getting narrower are discussed through a cladistic analysis. Deposition of types is specified: MNHN for Muséum National d'Histoire Naturelle, Paris; BPBM for Bernice P. Bishop Museum, Hawaii. All measurements are in millimeters.

SYSTEMATICS

Parada Horváth 1925

Cysteochila (*Parada*) Horváth 1925: 3. Type species: *Cysteochila* (*Parada*) *taeniophora* Horváth 1925: 3, by orig. desig.

Parada: Drake 1942: 4.

Alloeocysta Drake 1961: 109. **New Synonymy.** Type species: *Alloeocysta approba* Drake 1961: 109, by orig. desig.

Diagnosis.—Head with at least two frontal and two occipital spines. Bucculae wide, with apices meeting in front. Antenna long, slender, first segment short, second smallest, third longest and fourth longer than first two together, pubescent.

Pronotum gibbose, deeply punctuate, areolate at apex, pubescent near collar, tricarinate. Median carina long, slightly erected, contiguous to hood. Lateral carinae elevated, ending before collar, curved inward, not resting on pronotum, modified as to form a long inflated areolate cyst. Hood inflated, raised. Paranota long, wide, reflexed upright, not resting on pronotum, three to four areolae broad, almost reaching lateral carinae.

Hemelytra wider and longer than abdomen, slightly wider than pronotum width. Costal area uni- to biseriate, outer margins bent upward. Subcostal area bi- to triseriate, outer margins bent downward. Discoidal area five to seven areolae broad. Sutural area large, with larger areolae than subcostal and discoidal areas. Hypocostal laminae uniseriate.

Parada approba (Drake), **new combination**

(Figs. 7–8)

Alloeocysta approba Drake 1961: 109.

Comments.—According to Drake (1961) *Alloeocysta approba* is different "from other Australian genera by having the hood distinctly wider than long and the lateral carinae inflated, cyst-like on disc of pronotum" (Holotype measurements, body length 2.99; body width 1.26; hood length 0.37; hood width 0.55). All species of *Parada* have lateral carinae inflated like *A. approba* and some of them have a hood wider than long. This is the case of *P. majuscula* and *P. paitae*. *Alloeocysta approba* has antennae as long as that of the species of *Parada* (I, 0.15: II, 0.12: III, 0.85: IV, 0.3), a pronotum gibbose, deeply punctuate and areolate at apex, a hood forming a vesicule wider than long, lateral carinae modified as to form a subcylindrical areolate cyst that is closed inward by the internal margins touching the pronotum, while it is not the case for the species of *Parada*. The hemelytra are a little longer than abdomen with a costal area uniseriate, a subcostal area biseriate and a discoidal area four to five areolae broad. Despite some characters which distinguish *A. approba* from species of *Parada*; *approba* being the unique species of the genus *Alloeocysta*, the latter is considered a synonym of the genus *Parada*. Thus, I propose the new combination *Parada approba* (Drake) **n. comb.**

Type.—Holotype: ♂, Bogan river, New South Wales, Australia (Australian Museum, Sydney).

***Parada majuscula* Guilbert, new species**

(Figs. 1–3)

Description.—Head and body black, legs and antenna yellowish to brown fuscous, distal part of fourth antennal segment and tarsi brown to black. Pronotum clear brown to fuscous. Hemelytra yellowish with three dark brown spots, one near base that may occupy just basal third of costal area or be expanded to cover all of the basal third of the hemelytron, plus clear brown spots at apical third and apex of costal area. Length 3.05; width 1.17.

Head with two frontal and two small, slender occipital spines. Bucculae wide, triseriate, with apices meeting in front. Labium reaching hind coxae and labial sulcus sinuate. Sternal laminae widely separated on metasternum. Antennal measurements: I, 0.19: II, 0.12: III, 1.01: IV, 0.45), last antennal segment pubescent.

Pronotum gibbose, deeply punctuate, areolate on hind process, pubescent near collar, tricarinate. Median carina long, slightly elevated, contiguous to hood. Lateral carinae elevated, ending before collar, curved inward, not resting on pronotum, modified as to form a long inflated open cyst, four areolae broad. Hood inflated, raised, slightly wider than long (length 0.33; width 0.38). Paranota long, wide, reflexed and partially

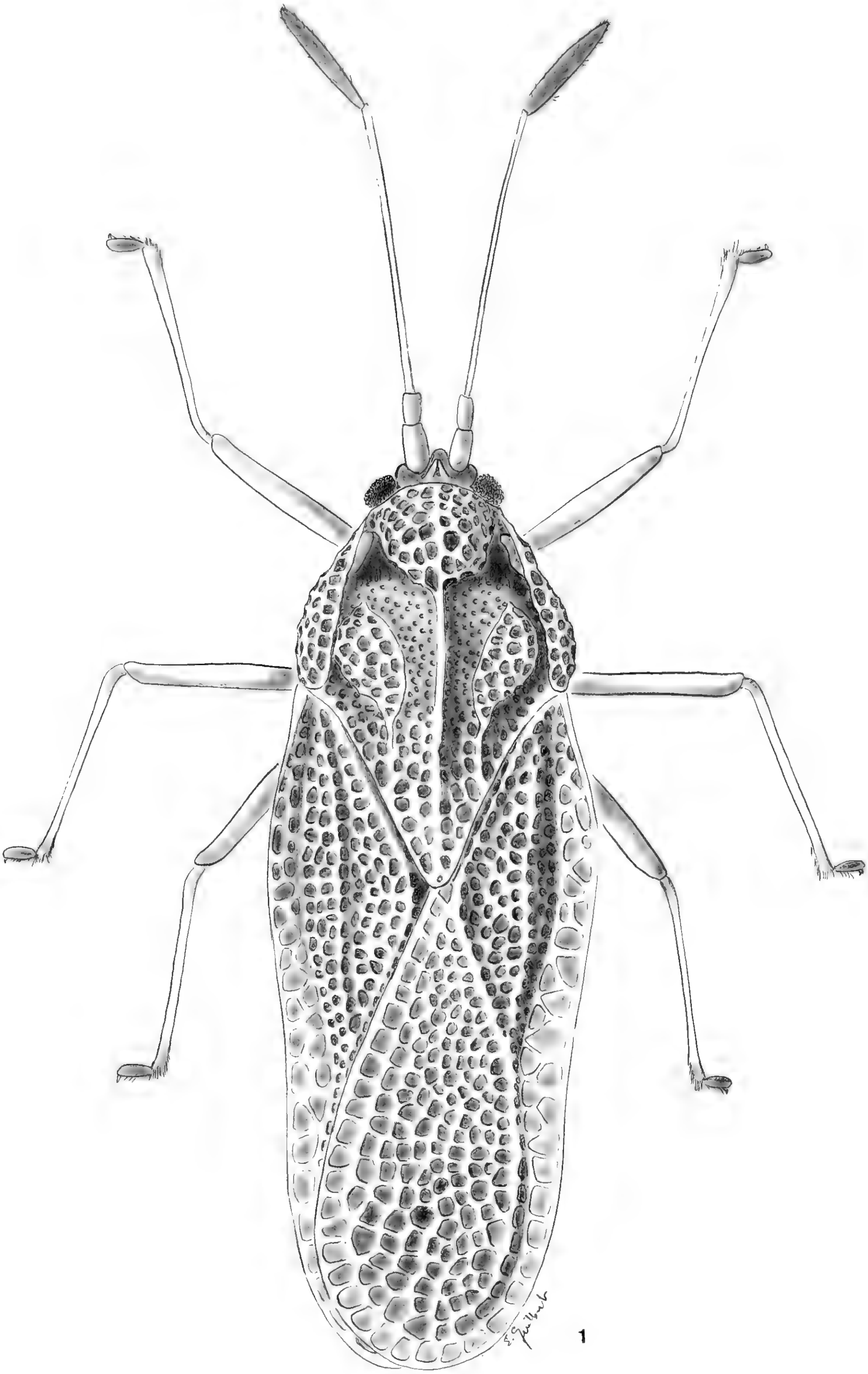

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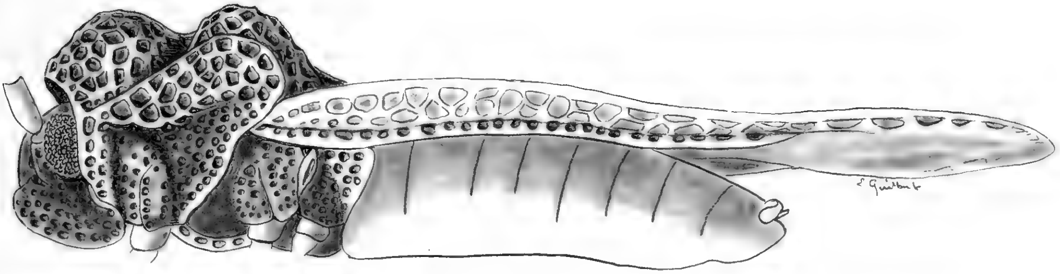
Fig. 1. *Parada majuscula,* habitus. Scale = 1 mm.



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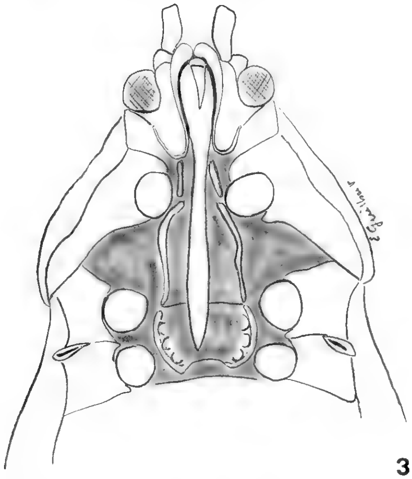

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Figs. 2–3. *Parada majuscula.* 2, Profile. 3, Ventral face. Scale = 1 mm.

recurved above pronotum, not resting on pronotum, four small areolae broad, almost reaching lateral carinae.

Hemelytra wider, longer than abdomen, slightly wider than pronotum width. Costal area bent upward, mostly biseriate but uniseriate at apex, outer areolae larger than inner. Subcostal area bent downward, triseriate. Discoidal area pentaseriate. Sutural area large, with larger areolae than subcostal and discoidal areas at apex. Hypocostal laminae uniseriate.

Types.—Holotype: ♂, New Caledonia, Rivière Bleue P7, dense evergreen rainforest, 24.X.1992, L. Bonnet de Larbogne, J. Chazeau & E. Guilbert colls (fogging) (MNHN). Paratypes: 1 ♀, same data as holotype (MNHN); 3 ♂ and 1 ♀, New Caledonia, Yahoue III.1978, N.L.H. Krauss coll., Acc. #1978.114 (BPBM); 1 ♀, New Caledonia, 6 km N of Païta, 25.I.1963, C.M. Yoshimoto coll. (BPBM); 1 ♂, New Caledonia, Mt Koghis, 400–600 m, II.1980, N.L.H. Krauss coll., Acc. #1980.128 (BPBM).

Comments.—The body length of this species may be sexually dimorphic (Table 1), but this characteristic cannot be assessed here because of the small number of specimens.

Parada paitae Guilbert, new species

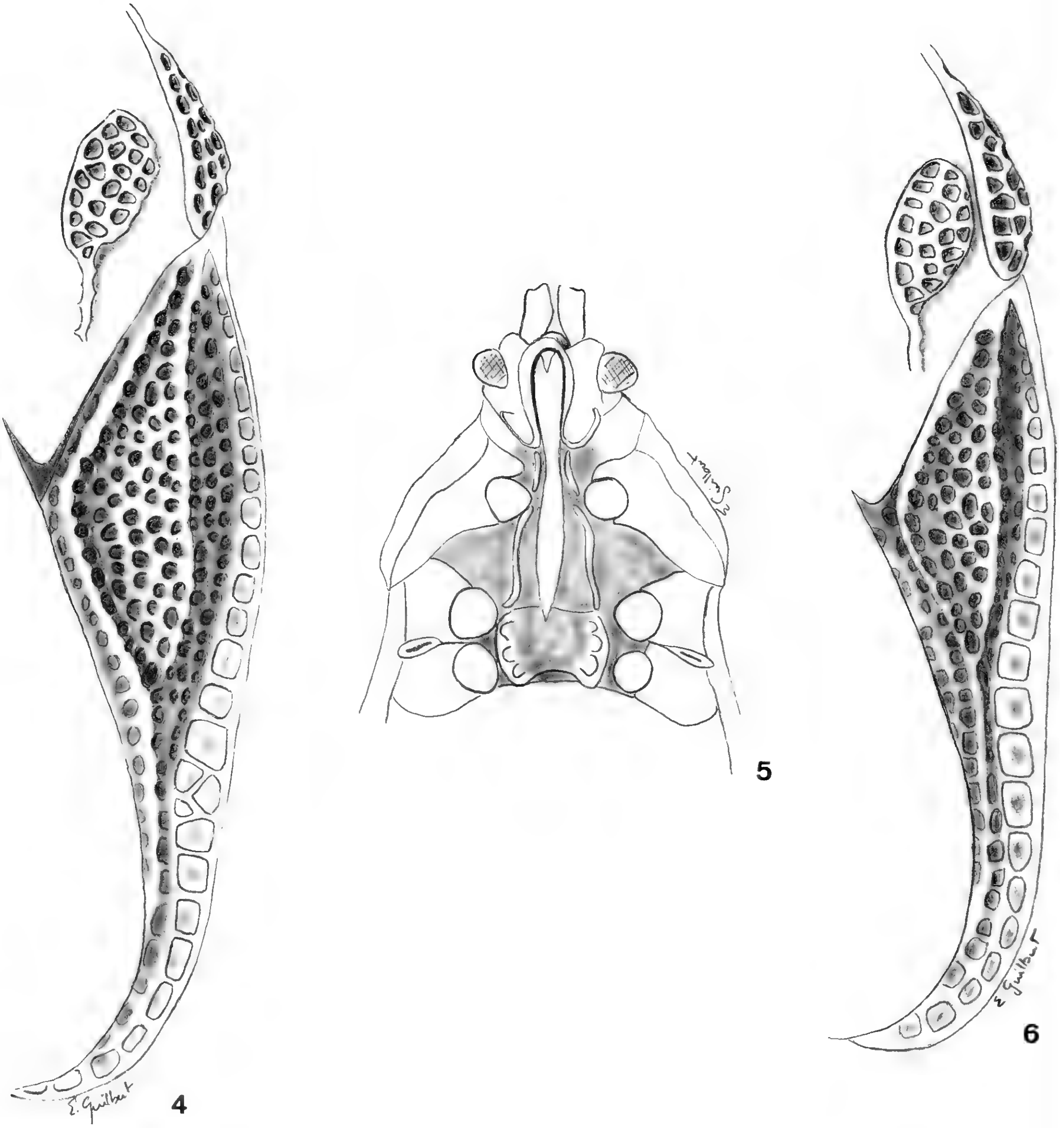
(Figs. 4–5)

Description.—Head and body brown. Pronotum, hemelytra, legs and antenna clear to yellowish, apex of last antennal segment brown fuscous. Length 2.98; width 1.17; hood length 0.31; hood width 0.31.

Same characters as *P. majuscula,* except rostrum extends between median coxae but does not reach hind coxae, costal area is uniseriate, areolae are rather large, except

Table 1. Means of body, hood and antennal segments measurements for 5 males and 3 females of *P. majuscula* in mm.

	Body		Hood		Antennal Segments			
	Length	Width	Length	Width	I	II	III	IV
Males	2.991	1.102	0.32	0.372	1.003	0.366	0.191	0.123
Females	3.149	1.272	0.349	0.400	1.010	0.292	0.200	0.123
Both	3.05	1.165	0.331	0.383	1.006	0.451	0.194	0.123



Figs. 4–6. *Parada* spp. 4, *P. paitae,* right hemelytra, paranota and lateral carina of the habitus. 5, *P. paitae,* ventral face. 6, *P. minuta,* right hemelytra, paranota and lateral carina of the habitus. Scale = 1 mm.

Table 2. Body length, body width, hood length, hood width and antennal segments measurements of the New Caledonian species and *P. approba*. Last antennal segment measurements on *P. approba* is missing on the type.

Species	Body		Hood		Antennal Segments			
	Length	Width	Length	Width	I	II	III	IV
Parada majuscula	3.05	1.17	0.33	0.38	0.19	0.12	1.01	0.45
Parada paitae	2.98	1.17	0.31	0.31	0.17	0.12	0.94	0.40
Parada minuta	2.63	0.94	0.29	0.31	0.15	0.11	0.92	0.43
Parada approba	2.99	1.26	0.37	0.55	0.15	0.12	0.85	—

one or two areolae divided into two areolae at level of apex, and discoidal area five to six areolae broad. Antennal segments measurements: I, 0.17: II, 0.12: III, 0.94: IV, 0.40.

Types.—Holotype: ♀, New Caledonia, Mont Nondoué near Païta, sclerophyllous forest, 16.X.1992, L. Bonnet de Larbogne, J. Chazeau & E. Guilbert colls (fogging) (MNHN). Paratype: 1 ♀, New caledonia, Mont Nondoué near Païta, sclerophyllous forest, 28.IV.1993, L. Bonnet de Larbogne, J. Chazeau & E. Guilbert colls (fogging) (MNHN).

Parada minuta Guilbert, new species
(Fig. 6)

Description.—Head and pronotum brown, body, hemelytra, legs and antenna clear to yellowish, last antennal segment brown fuscous, some brown spots on hemelytra on discoidal and sutural areas. Length 2.63; width 0.94; hood length 0.29; hood width 0.31.

Head short, with four tiny spines. Antennal segments as two former species. Antennal segments measurements: I, 0.15: II, 0.11: III, 0.92: IV, 0.43. Bucculae short, wide, three areolae broad. Labium short, not extending beyond mesosternum, labial sulcus widened between hind coxae.

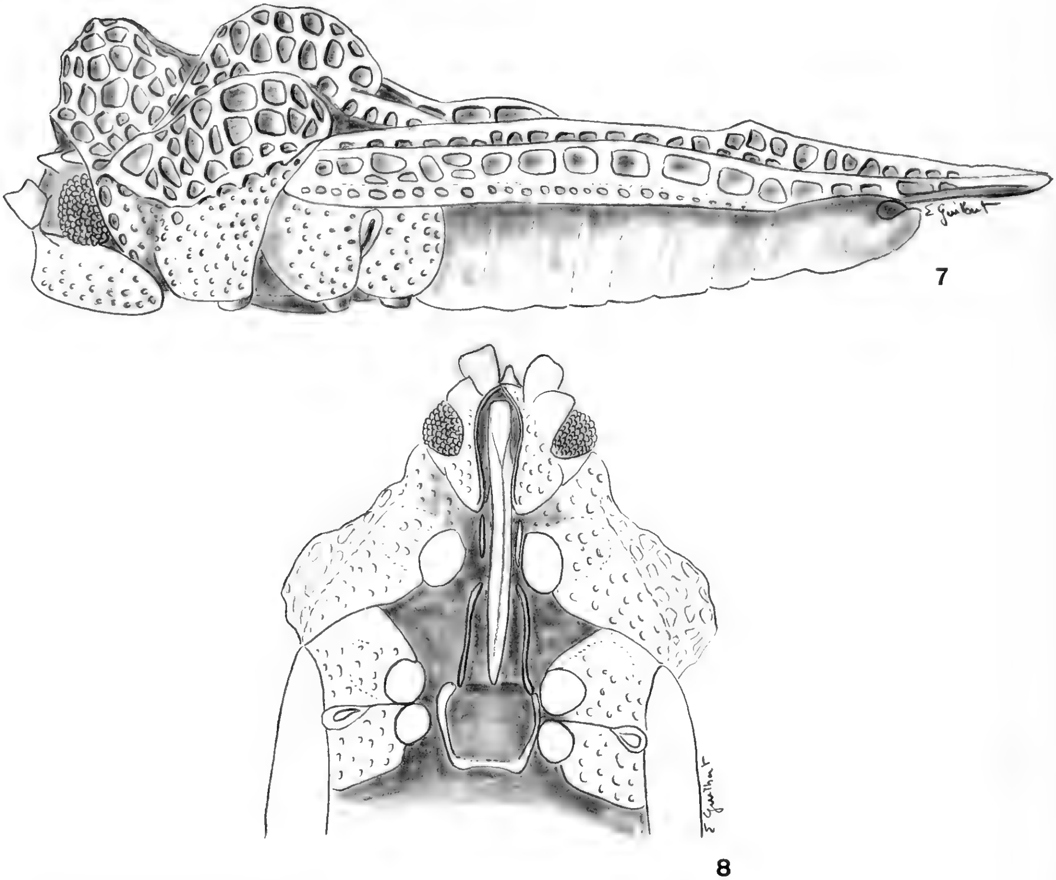
Pronotum gibbose, areolate, tricarinate, median carina uniseriate, elevated, lateral carinae wide, four areolae broad. Paranota four areolae broad.

Costal area completely uniseriate, subcostal area biseriate, discoidal area short, half length of hemelytra, five areolae broad at widest part.

Types.—Holotype: ♂, New caledonia, Ile des Pins: Vao, 0–100 m, I. 1985, N.L.H. Krauss coll. (BPBM). Paratype: 1 ♂, same data as the holotype (BPBM).

KEY TO SPECIES OF *PARADA*

1. Head armed with 4 cephalic spines 2
– Head armed with 5 cephalic spines 4
2. Subcostal area triseriate at widest part 3
– Subcostal area biseriate at widest part (Fig. 6) . . . . *P. minuta* Guilbert, n. sp.
3. Labium extending beyond hind coxae (Fig. 3) . . . . *P. majuscula* Guilbert, n. sp.
– Labium not reaching hind coxae (Fig. 5) . . . . *P. paitae* Guilbert, n. sp.
4. Paranota three areolae wide 5
– Paranota four areolae wide 6
5. Median carina areolate and uniseriate (Fig. 15) . . . . *P. solla* Drake and Ruhoff
– Median carina not areolate . . . . *P. taeniophora* (Horváth)
6. Lateral carinae five areolae wide (Fig. 10) . . . . *P. absona* Drake
– Lateral carinae less than five areolae wide . . 7
7. Third antennal segment 4 times longer than last . . . . *P. approba* (Drake)
– Third antennal segment less than 4 times longer than last 8
8. Costal area with areolae the same size than that of subcostal area (Fig. 12) . . . . *P. hackeri* Drake
– Costal area with areolae larger than that of subcostal area 9
9. Lateral carinae width of 2 areolae broad (Fig. 14) . . . . *P. darlingtoni* Drake
– Lateral carinae width of 3 areolae broad . . 10
10. Costal area largely biseriate at base (Fig. 9). . . . . *P. popla* Drake
– Costal area uniseriate except for two areolae across very base (Fig. 11) . . . . . *P. torta* Drake

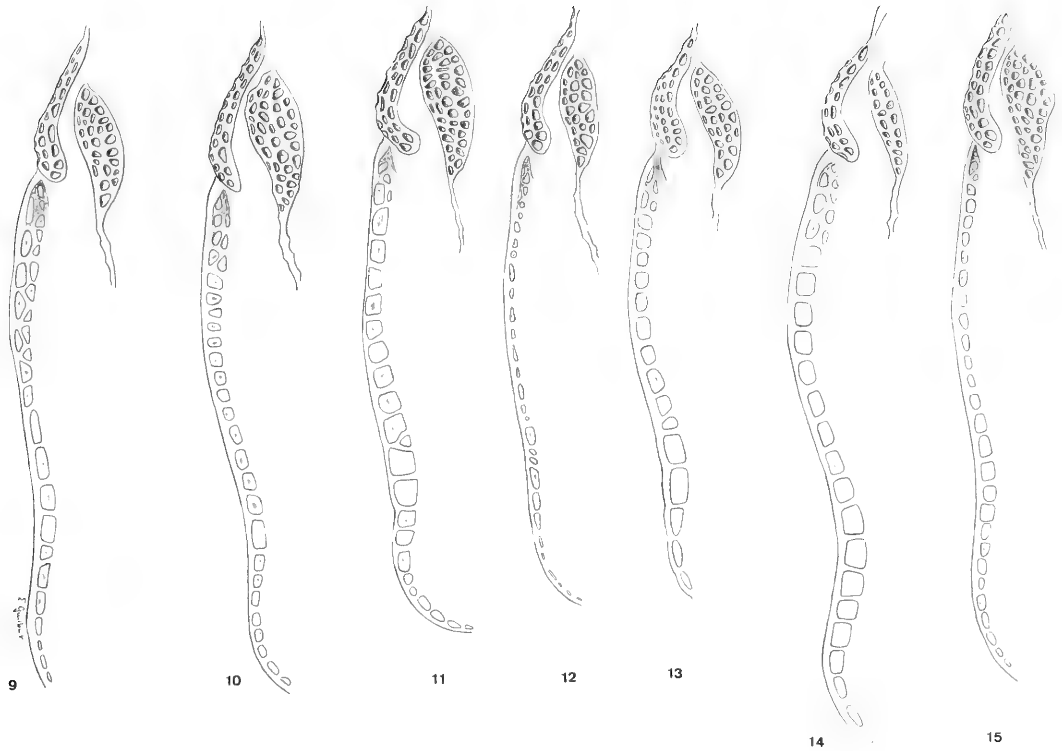


Figs. 7–8. *Parada approba.* 7, Profile. 8, Ventral face. Scale = 1 mm.

CLADISTIC ANALYSIS

Choice of the taxa.—The eleven species of the genus *Parada* are included in this analysis as the ingroup. Three species are included as outgroups: *Cysteochila cubens* Guilbert, *Physatocheila dissimilis* Guilbert and *Nobarnus pilosus* Guilbert. *Cysteochila cubens* shows some affinities with the genus *Parada,* while *N. pilosus* is clearly different. *Physatocheila dissimilis* could be considered as intermediate between these two genera by its general morphology. Therefore, 14 species were included in this analysis.

Character states.—Sixty-one morphological characters are analysed. They are analysed in two differents ways. A first analysis concern all the characters. A second analysis concern only fifty-one characters active and ten inactive. These ten characters define the size of various structures in terms of number of areolae. They are not used in the analysis because the homology between the areolae cannot be established with certainty, but they figure as attributes. When a structure has two areolae, does it mean that an areola divided into two areolae, or does a second areola appears near the existing one? The results of the two analyses are compared. Inactive characters in the second analysis are mentioned. Characters of the genitalia are not taken into account because they do not vary within the genus. Multistate characters are treated unordered. The matrix of characters is given in Table 3. Question marks represent characters lacking or uncertainly stated.



Figs. 9–15. *Parada* spp. left costal area, paranota and lateral carinae. 9, *P. popla.* 10, *P. absona.* 11, *P torta.* 12, *P. hackeri.* 13, *P. taeniophora.* 14, *P. darlingtoni. 15, P. solla.* Scale = 1 mm.

0. Head black (0), brown (1), yellowish to white (2).
1. Pronotum black (0), brown (1), yellowish (2).
2. Abdomen black (0), brown (1), yellowish (2).
3. Hemelytra black (0), brown (1), yellowish to white (2), brown with colored spots (3).
4. Body glabrous (0), pilose (1).
5. Head convex (0), flat (1).
6. Frontal spines long (0), short (1).
7. Frontal spines erect (0), prostrate (1).
8. Frontal spines stout (0), slender (1).
9. Frontal spines in contact or crossed (0), not in contact (1).
10. Occipital spines long (0), short (1).
11. Occipital spines adpressed (0), prostrate (1). The occipital spines are prostrate when the spines do not rest onto the head, otherwise they are adpressed.
12. Occipital spines stout (0), slender (1).
13. Median spine long (0), short (1), tubercle-like (2), absent (3).
14. Median spine erect (0), prostrate (1).
15. Median spine stout (0), slender (1).
16. Antennae densely pubescent (0), not pubescent (1).
17. Last antennal segment longer than first and second together (0), shorter than first and second together (1).
18. Last antennal segment longer than first (0), shorter than first (1).
19. Third antennal segment 1 time as long as the last one (0), 2 times (1), 3 times (2), 4 times (3).
20. Bucculae biseriate (0), triseriate (1), quadriseriate (2), pentaseriate (3). Inactive character.
21. Bucculae open in front (0), closed in front (1).
22. Labium almost extending beyond the

Table 3. Matrix of states of the 61 characters for 14 species.

Taxa	Character states
Nobarnus pilosus	00001100000003??0111012100100?00?01??0004200010010030??202133
Physatocheila dissimilis	0111010000010000110210111010121 0?01??0111011111111001??110420
Cysteochila cubens	22230001100012 0?1?0221200101 0?305112?0320011111111010201 0512
Parada darlingtoni	1013000010001011100211 10?0011211220321114111101101121011 1220
Parada hackeri	1113010100000111100101401011122121 11?111311110110110110111110
Parada torta	1012001110001111100221101001102142121111411110110112100111120
Parada absona	0003000111001111100211100001122152110111211111110111110111220
Parada popla	0013001110001111100211300001122132042111411110110111120111320
Parada solla	1113010110001111100211201001112162121121311111110111100111221
Parada taeniophora	1013001110001101 1??21111100111212202112131111011011211 0111120
Parada majuscula	010300111010 13??100121010101112102132121311111110111122111111
Parada paitae	1111001111101 3??100111210001122112111121411111110111101111221
Parada minuta	2223001110101 3??100111310001122102111121311111110111100111120
Parada approba	10130001 1?00?00?100311310101??2122142111411110110111110111020

metasternum (0), extending to the middle of the metasternum (1), extending little beyond the mesosternum (2), reaching the posterior margins of the mesosternum (3), extending to the middle of the mesosternum (4).

23. Mesosternal laminae subparallel (0), not subparallel (1).
24. Metasternal laminae wide (0), narrow (1).
25. Sternal laminae open behind (0), closed behind (1).
26. Pronotum strongly gibbose (0), slightly gibbose (1).
27. Pronotum pubescent (0), glabrous (1).
28. Median carina not areolate (0), uniseriate (1).
29. Median carina with large areolae (0), small areolae (1), minute areolae (2).
30. Lateral carinae ridge like (0), with one or two rows of areolae (1), with 3 to 5 rows of areolae (2), with 6 or more than 6 rows of areolae (3). Inactive character.
31. Lateral carinae erect (0), reflexed but not resting onto the pronotum (1), reflexed and resting onto the pronotum (2).
32. Lateral carinae 8 areolae long (0), 9 areolae long (1), 10 areolae long (2), 11 areolae long (3), 12 areolae long (4), 14 areolae long (5), 15 areolae long (6). Inactive character.
33. Hood absent (0), present but flat (1), cyst-like and partly covering the head (2). When the hood is present, it covers most of the head but generally not the eyes.
34. Hood higher than posterior pronotal lobe (0), not higher than posterior pronotal lobe (1).
35. Hood 3 areolae long (0), 4 areolae long (1), 5 areolae long (2), 6 areolae long (3), 7 areolae long (4). Inactive character.
36. Hood 1 areola high (0), 2 areolae high (1), 3 areolae high (2). Inactive character.
37. Collar triseriate (0), biseriate (1). Inactive character.
38. Paranota 2 areolae broad (0), 3 areolae broad (1), 4 areolae broad (2), 5 areolae broad (3). Inactive character.
39. Paranota with large areolae (0), small areolae (1), minute areolae (2).
40. Paranota more than 14 areolae long (0), 13–14 areolae long (1), 11–12 areolae long (2), 10 areolae long (3), 8–9 areolae long (4). Inactive character.
41. Paranota reflexed with free margins in contact with pronotum (0), reflexed with free margins not in contact with

pronotum (1), not reflexed with free margins not in contact with pronotum (2).

42. Paranota not covering pronotum (0), covering part of pronotum (1).
43. Hemelytra wide (0), narrow (1). Hemelytra are considered narrow when not extending far beyond the abdomen.
44. Hemelytra sharply widened at base (0), not sharply widened at base (1).
45. Junction of RM and Cu veins raised and forming a little swollen zone (0), not raised and forming a little swollen zone (1).
46. Hemelytra areolae hyaline (0), not hyaline (1).
47. Hemelytra pubescent (0), glabrous (1).
48. Hemelytral veins raised, forming ridges (0), not raised and forming ridges (1).
49. Costal area wide (0), narrow (1).
50. Costal area plane (0), raised (1).
51. Costal area areolae very small (0), small (1), large (2), very large (3).
52. Costal area 6 areolae broad (0), uniseriate (1).
53. Costal area uniseriate at base (0), biseriate at base along 3–5 areolae (1), biseriate at base along 7–10 areolae (2). The costal area is mostly uniseriate and shows in part two areolae for the same width like if the original areolae were divided in two smaller areolae (Figs. 9–15).
54. Costal area uniseriate at the middle (0), biseriate at the middle along 2–3 areolae (1), biseriate at the middle along 5–6 areolae (2).
55. Subcostal area areolae very small (0), small (1), large (2), very large (3).
56. Subcostal area large (0), small (1).
57. Discoidal area areolae very small (0), small (1), large (2), very large (3).
58. Discoidal area 4 areolae wide (0), 5 areolae wide (1), 6 areolae wide (2), 7 areolae wide (3), 8 areolae wide (4), 9 areolae wide (5). Inactive character.
59. Sutural area areolae very small (0), small (1), large (2), very large (3).
60. Sutural area 6–7 areolae wide (0), 8–9 areolae wide (1), 12 areolae wide (2), less than 6 areolae wide (3). Inactive character.

The phylogenetic analysis was performed with Hennig86 (Farris 1988). The algorithm ie* was used to build tree (s), using Fitch parsimony.

RESULTS

First analysis.—Three trees of 119 steps, with ci = 61 and ri = 50 were generated. They differ by the relative position of the three New Caledonian species among themselves. Seventy-seven percent of the active characters are not informative for the resolution of these conflicting branches. Here is presented one of the trees which corresponds to the following interpretation (Fig. 16). For the 7 informative characters, *Parada minuta* and *P. paitae* share the same state for four of them, while *P. majuscula* and *P. minuta* share the same state for one of them, and *P. majuscula* and *P. paitae* for any of them. Then, *Parada minuta* may be more closely related to *P. paitae* than to *P. majuscula.* The coefficients and number of steps for each characters is given Table 4.

The genus *Parada* (including the species *approba*) is monophyletic. The monophyly of the genus is supported by the raised veins on the hemelytra, the lateral carinae and the paranota which are curved inwards but not resting onto the pronotum.

The genus is divided in two groups, the New Caledonian group which comprise the three New Caledonian species, and the Australian group comprising the other eight species. The Australian species have five cephalic spines, while New Caledonian species have four. No unambigous synapomorphy support the monophyly of the Australian group, while the short occipital spine and the lack of a median spine are the unambiguous synapomorphies of the New Caledonian group. *Parada approba* is completely integrated in the genus; however, it is the basal species

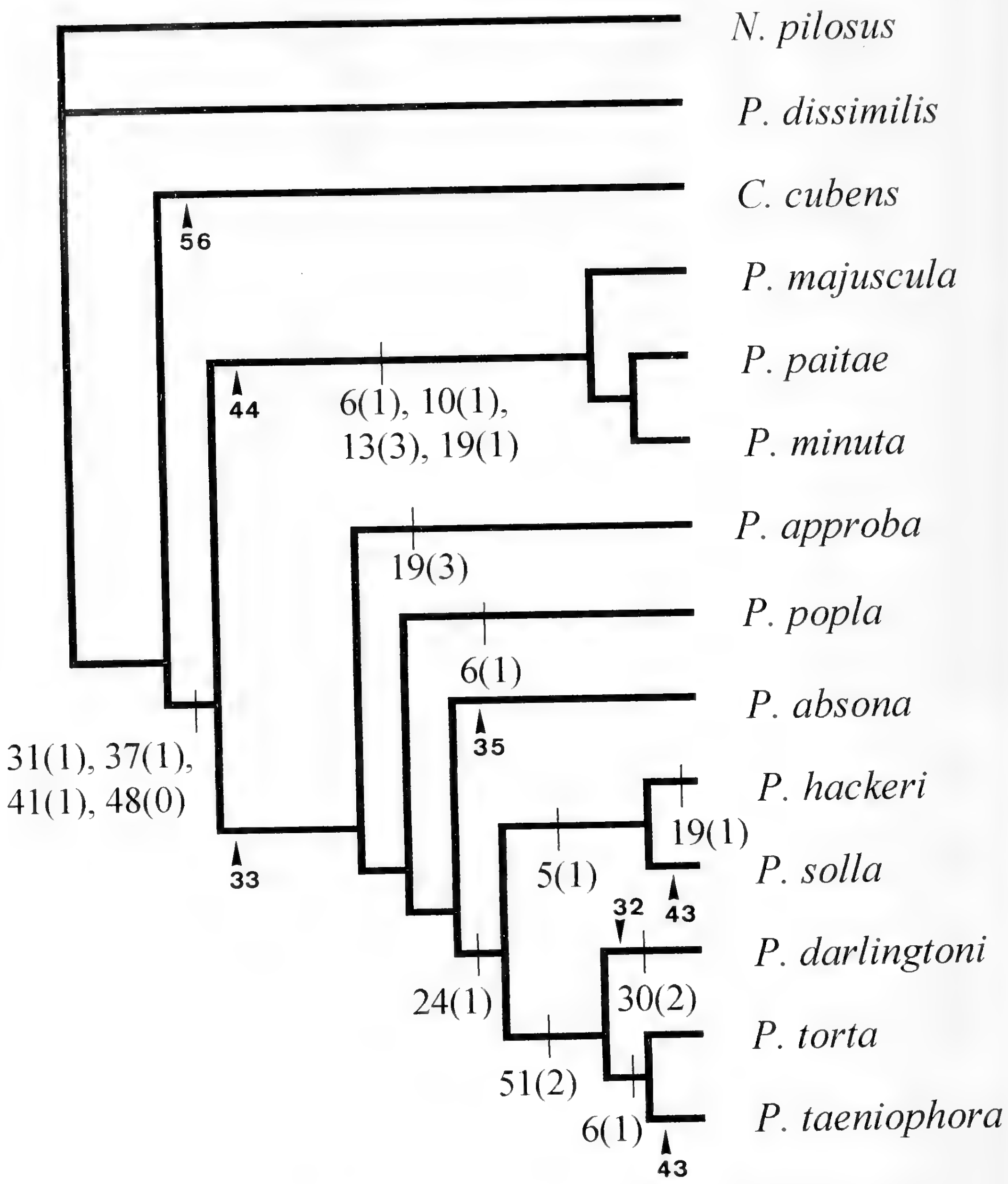


Fig. 16. One of the three cladograms obtained with the ie* command of Hennig86 on data show in table 3 (14 taxa, 61 active characters). Length = 119 steps, ci = 61, ri = 50. Paranota and lateral carinae width, respectively, in number of areolae are indicated under an arrow on the cladogram.

of the Australian group. It is characterised by the third antennal segment that is four times the length of the last. *Parada popla*, *P. absona* and *P. approba* are the basal species of the Australian group. They have a labial sulcus broad like the New Caledonian species. Among the Australian group, two subgroups can be distinguished, the *hackeri* subgroup composed by *P. hackeri* and *P. solla,* and the *dar-*

Table 4. Number of steps, ci and ri for each character for the first analysis (10 characters inactive) and the second analysis (all characters active).

Characters	Analysis 1			Analysis 1		
	Steps	ci	ri	Steps	ci	ri
1	5	40	40	5	40	40
2	5	40	40	5	40	40
3	5	40	0	5	40	0
4	4	75	0	4	75	0
5	1	100	100	1	100	100
6	2	50	66	3	33	33
7	3	33	60	3	33	60
8	2	50	50	2	50	50
9	2	50	50	2	50	50
10	2	50	0	2	50	0
11	1	100	100	1	100	100
12	1	100	100	1	100	100
13	2	50	50	2	50	50
14	5	60	60	5	60	60
15	2	50	66	3	33	33
16	1	100	100	1	100	100
17	1	100	100	1	100	100
18	1	100	100	1	100	100
19	1	100	100	1	100	100
20	4	50	50	4	50	50
21	5	40	0	5	40	0
22	1	100	100	1	100	100
23	7	57	40	8	50	20
24	3	33	66	3	33	66
25	2	50	75	4	25	25
26	3	33	0	3	33	0
27	2	50	50	2	50	50
28	1	100	100	1	100	100
29	2	50	0	2	50	0
30	4	50	0	3	66	50
31	4	75	0	4	75	0
32	1	100	100	1	100	100
33	7	85	50	7	85	50
34	3	66	50	2	100	100
35	2	50	0	2	50	0
36	7	42	0	6	50	25
37	5	40	0	3	66	66
38	1	100	100	1	100	100
39	5	60	50	3	100	100
40	2	100	100	2	100	100
41	7	57	25	6	66	50
42	2	100	100	2	100	100
43	1	100	100	1	100	100
44	1	100	100	1	100	100
45	1	100	100	1	100	100
46	4	25	25	3	33	50
47	1	100	100	1	100	100
48	1	100	100	1	100	100
49	1	100	100	1	100	100
50	1	100	100	1	100	100
51	1	100	100	1	100	100
52	4	75	75	5	60	50
53	1	100	100	1	100	100
54	5	40	25	4	50	50
55	3	66	0	3	66	0
56	2	100	100	2	100	100
57	1	100	100	1	100	100
58	2	100	100	2	100	100
59	9	55	0	8	62	25
60	4	50	0	4	50	0
61	5	60	33	4	75	66

Table 4. Continued.

lingtoni subgroup composed by *P. darlingtoni, P. torta* and *P. taeniophora.* The monophyly of both subgroups together is supported by a narrow labial sulcus. The monophyly of *hackeri* subgroup is supported by a flat hood. The monophyly of *darlingtoni* subgroup is supported by very large areolae on costal area. The slightly gibbose pronotum is autapomorphic for *P. hackeri,* and the large areolae of the median carina is autapomorphic for *P. torta.*

Second analysis.—A single tree of 168 steps, with ci = 62 and ri = 48 is generated (Fig. 17). The conflicting branch between the New Caledonian species is resolved, and *Parada minuta* is more closely related to *P. paitae* than to *P. majuscula.* As in the first analysis, the genus *Parada* is monophyletic. The monophyly being supported by the same characteristics. *Parada hackeri* is the basal species of the genus. It is the only species of *Parada* with stout frontal and occipital spines, biseriate bucculae and having the shortest rostrum of the genus. It shares the same hood shape and the same size of areolae on costal area than *Cysteochila cubens,* the outgroup most related to the genus. The other species of the genus is divided in two groups, the *torta* group, comprising *P. torta* (basal species of the group), *P. absona, P. popla, P. darlingtoni* and *P. approba,* and the *solla* group, comprising *P. solla* (basal species of the

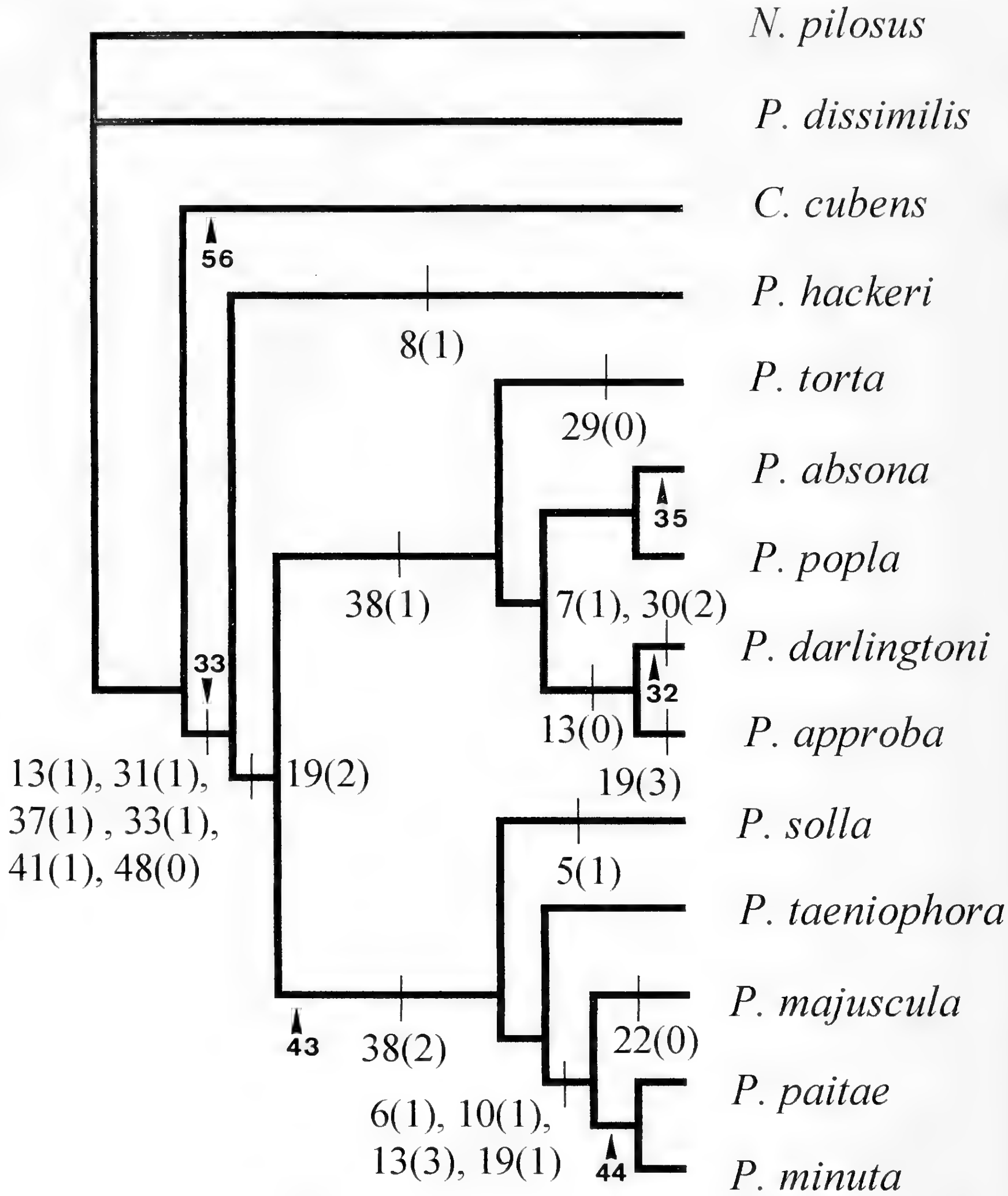


Fig. 17. The single three cladograms obtained with the ie* command of Hennig86 on data show in table 3 (14 taxa, 51 active characters). Length = 168 steps, ci = 62, ri = 48. Paranota and lateral carinae width, respectively, in number of areolae are indicated under an arrow on the cladogram.

group), *P. taeniophora, P. majuscula, P. paitae* and *P. minuta.* The *torta* group is characterized by the paranota three areolae wide, that is shared with *Parada hackeri* and the outgroup *Physatocheila dissimilis.* The *solla* group is characterized by the paranota four areolae wide, the only autapomorphic character for the group. The coefficients and number of steps vary for 15 characters over 61 between the two analysis (Table 4), 6 of them being inactive in the first one.

DISCUSSION AND CONCLUSION

The species of *Parada* can easily be recognized by the combination of the paranota (characters 41, 42), the lateral carinae (characters 30, 31) and the costal area shapes (characters 49 to 54).

Despite the different results of the two analyses, some characters have the same tendencies of evolution. The lateral carinae and the paranota width in terms of number of areolae used as attributes in the first analysis (because of their uncertain homologies) narrow from basal to terminal taxa. However, these tendencies in the second analysis are not as clear as in the first one.

In the first analysis, the width of the lateral carinae narrow from the outgroup *C. cubens* (lateral carinae 6 areolae broad) to the New Caledonian group (4 areolae broad), the Australian group (3 areolae broad) and *P. darlingtoni* (2 areolae broad), except for *P. absona* which has lateral carinae of 5 areolae broad (Figs. 9–15). The same way, the paranota narrow from *C. cubens* (5 areolae broad) to the New Caledonian group (4 areolae broad) and the Australian group (3 areolae broad). There are two reversals for *P. solla* and *P. taeniophora* which have the paranota 4 areolae broad. The others pronotal and hemelytral characters do not show such a tendency. However, the lateral carinae and the paranota are longer in terms of number of areolae for *C. cubens* than for the *Parada* species, and the lateral carinae of the New Caledonian species is shorter than the one for the Australian species.

In the second analysis, the lateral carinae narrow from *C. cubens* to *Parada* species from 6 to 3 areolae wide. They still narrow in the torta group for *P. darlingtoni* from 3 to 2 areolae wide, while they enlarge in the *solla* group for the three New Caledonian species from 3 to 4 areolae. There is also a reversion for *P. absona* which lateral carinae enlarge to 5 areolae wide. The paranota narrow from *C. cubens* to *Parada* species from 5 to 3 areolae wide but enlarge in the *solla* group to 4 areolae.

If characters such as the width among the different hemelytral areas and the various pronotal expansions like the hood, the lateral carinae and the paranota show a trend of evolution, this is not the case of other characters such as the length of the lateral carinae and the paranota. They do not show any extension or shortening through the cladogram. Thus, wide lateral carinae and wide paranota could be plesiomorphic. The two major groups found by the first analysis, are separated by a geographic barrier: the sea between the Queensland and New Caledonia, isolated from Australia since the Triassic. Then, lateral carinae and paranota still narrowed in Australia after the Triassic. However, these characters show slight variation among *Parada* species, in comparison with other genera. As a general rule, Tingidae present traits that have no apparent biological explanation and that could be hypertelic by their disproportionate size. But, these possibilities still require further study and much more data such as behavioral parameters, and host plants, need to be added to test these evolutionary hypotheses.

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A NEW NEOTROPICAL SPECIES OF *CLINODIPLOSIS* (DIPTERA: CECIDOMYIIDAE), AN IMPORTANT NEW PEST OF CULTIVATED PEPPERS (*CAPSICUM* SPP.: SOLANACEAE)

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Abstract.—A new species of cecidomyiid, **Clinodiplosis capsici Gagné,** is reported from cultivated sweet and hot pepper in Costa Rica, Guadeloupe, and French Guiana where it appears to have potential as a serious pest. Adults, pupae, and larvae are described, illustrated, and compared to other *Clinodiplosis* species.

Key Words: gall midge, sweet pepper, hot pepper

In the mid-1990s, a new species of gall midge belonging to *Clinodiplosis* was independently discovered on Guadeloupe and in Costa Rica attacking sweet pepper, *Capsicum annuum* L., and hot pepper, *Capsicum frutescens* L. The white larvae of the gall midge cause swellings on stems, leaves, and bases of flowers (Figs. 1–3). Galls can be found all year round and, where locally abundant, the cecidomyiid is a serious pest. Larvae live singly in cells within the swellings. The full grown larva pupates in the gall, the fully developed pupa forms a circular exit hole with the help of the antennal horns, emerging about halfway out of the hole, and the adult immediately emerges from the pupal skin. After adult emergence, the damaged part of the plant is susceptible to rot. Similar galls were later found in 1999 in French Guiana.

In Costa Rica, galls were collected in dry climates as in Guanacaste, wet climates as in Pérez Zeledón, and intermediate climates, such as Alajuela. They were found in gardens, backyards and greenhouses of Guanacaste, Alajuela, and Cartago Provinces, but not in commercial plantations. This absence in the larger plantations may be due to chemical applications intended for the control of the pepper weevil, *Anthonomus eugenii* Caro (Coleoptera: Curculionidae).

The new species of gall midge will readily run to *Clinodiplosis* in the key in Gagné (1994). *Clinodiplosis* is a worldwide genus of some 75 known valid species. Outside the Neotropics, most species of this genus appear not to be host specific and are usually associated with fungus growing in or on plant tissue, such as spent flowers or old galls. A few species, however, are associated with simple bud galls where they are doubtless primary plant feeders (Gagné 1989). While *Clinodiplosis* spp. may also be found associated with fungus in the Neotropics, most known regional species in this

Fig. 1. Galls of *Clinodiplosis capsici* on stems and leaves of *Capsicum* sp.

and closely related genera peculiar to the Neotropics, e.g., *Iatrophobia* and *Schismatodiplosis,* are phytophagous, host specific, and associated with complex galls (Gagné 1989), as is the new species described below.

METHODS

Galls with pupae or full-grown larvae were placed in small containers until adults emerged. Specimens of immature stages and reared adults were preserved in 70% isopropyl alcohol. Samples were mounted on microscope slides using the method outlined in Gagné (1989). Terminology for adult morphology follows usage in McAlpine et al. (1981) and for larval morphology that in Gagné (1989). Galls were obtained, adults reared, and other stages secured by H. Blanco-Metzler in Costa Rica and by J. Etienne in Guadeloupe. J. Etienne also found similar galls in French Guiana. The taxonomic investigation was the responsibility of R. J. Gagné.

Clinodiplosis capsici Gagné, new species
(Figs. 4–15)

Adult.—*Head:* Eyes connate, 11–12 facets long at vertex; facets mostly hexagonoid, all closely adjacent. Occiput with dorsal protuberance with 2 apical setae. Frons with 6–10 setae. Labella ellipsoid and pointed apically, each with several lateral setae. Palpus 4-segmented. Male antennal flagellomeres (Fig. 4) binodal; one circumfilum on basal node, two on the distal, the loops of the three circumfila subequal in length. Female flagellomeres (Fig. 5) cylindrical with long necks, surrounded by two appressed circumfila connected by two longitudinal bands.

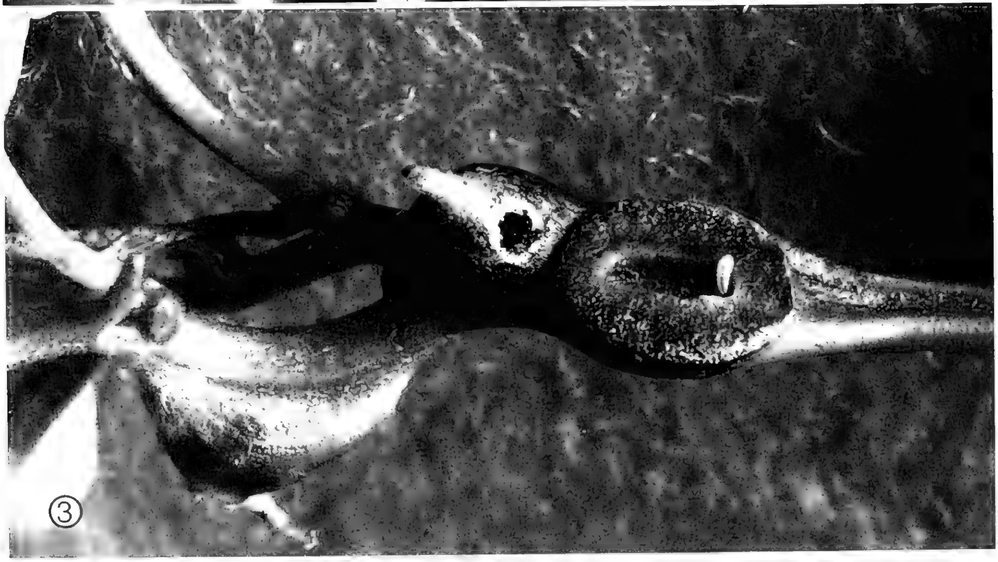
Thorax: Wing unmarked, 2.2 to 2.9 mm long, R_5 curved toward apex, joining C posterior to wing apex. Tarsal claws (Fig. 6) untoothed, curved near basal third; empodia very short, not attaining bend in claws.

Male abdomen: First through sixth tergites entire, rectangular, with single posterior row of setae, several lateral setae, scattered scales, and 2 anterior trichoid sensilla; seventh tergite unsclerotized posteriorly and lacking the posterior row of setae and scales, but lateral setae and anterior pair of trichoid sensilla present; eighth tergite undifferentiated, the only vestiture the anterior pair of trichoid sensilla. First through eighth sternites rectangular, covered with setae and with 2 anterior trichoid sensilla; eighth sternite similar to preceding except weakly sclerotized anterolaterally. Genitalia (Figs. 9–10): cerci rectangular, with posterior setae; hypoproct much longer than cerci, widest at midlength, narrowing beyond midlength and widening again posteriorly, the basal two-thirds expanded laterally to curve slightly around aedeagus, and with strong setae and several smaller ones posterolaterally; aedeagus elongate, narrower and longer than hypoproct, with longitudinal rows of sensory pits; gonocoxite elongate-cylindrical with mesoposterior surface forming nearly right angle; gonostylus elongate-cylindrical, with setulae near base and covered beyond with minute carinae and widely scattered short setae.

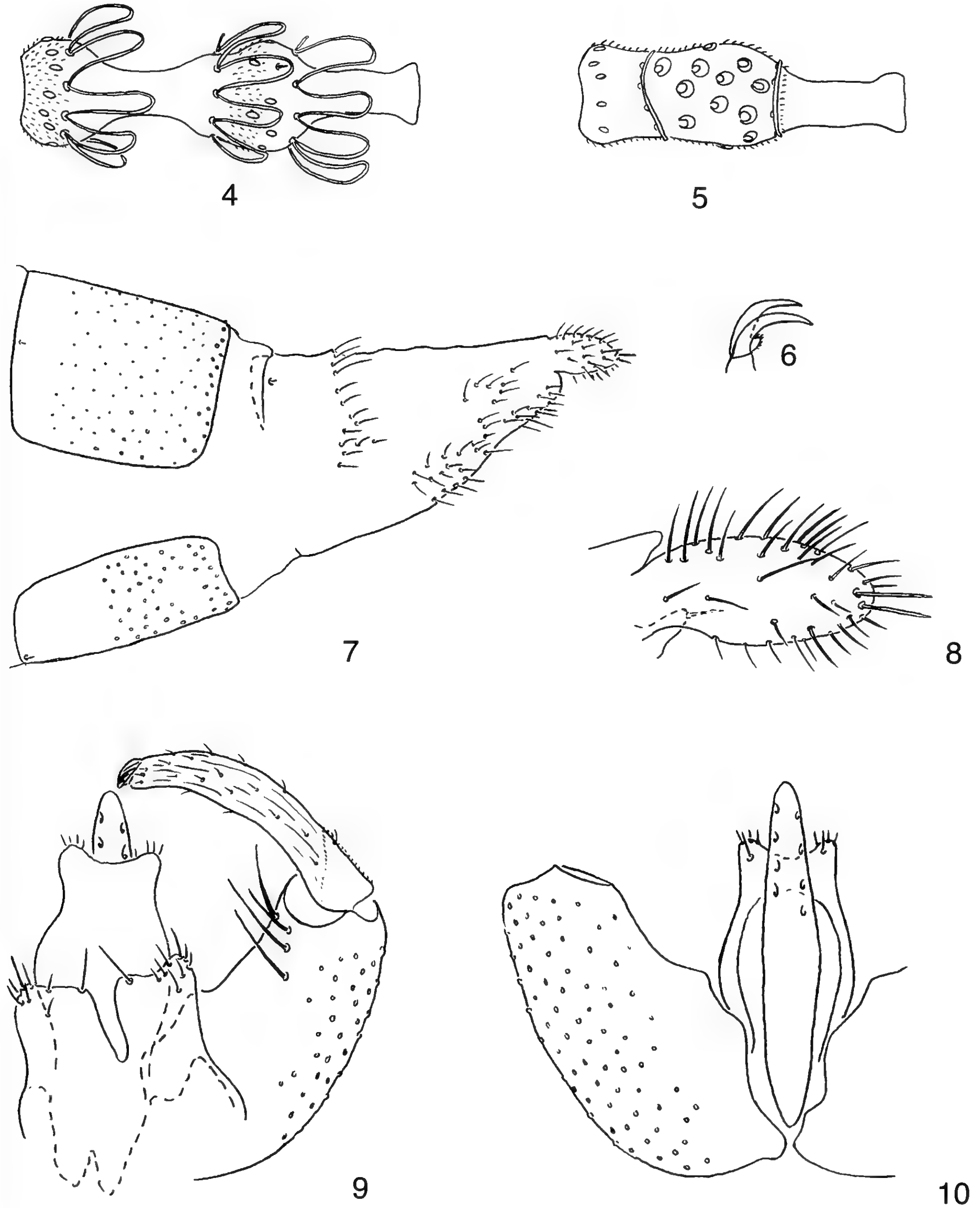
Female abdomen (Figs. 7–8): First through seventh tergites entire, rectangular, with mostly single row of posterior setae, several lateral setae, extensively covered with scales, and with 2 anterior trichoid sensilla. Eighth tergite unsclerotized, with mostly single row of posterior setae and anterior pair of trichoid sensilla the only vestiture. Second through seventh sternites quadrate, extensively covered with setae and scales and with anterior pair of trichoid sensilla. Ovipositor slightly protrusible, venter of eighth segment and dorsum of ninth and tenth segments without vestiture, venter of ninth and tenth segments with setae, cercus large, ovoid, with pair of apical sensory setae and scattered setae elsewhere, hypoproct short, narrow, with 2 posterior setae.

Pupa.—*Head* (Figs. 11–12): Antennal base pointed apically, the apex projecting ventrad; cervical sclerite with two elongate setae; face without ventral projections, with 1–2 papillae, one with seta, on each side of base of labrum. Prothoracic spiracle elongate, pointed apically. Abdominal tergites covered dorsally with uniformly small spicules, none enlarged and spiniform.

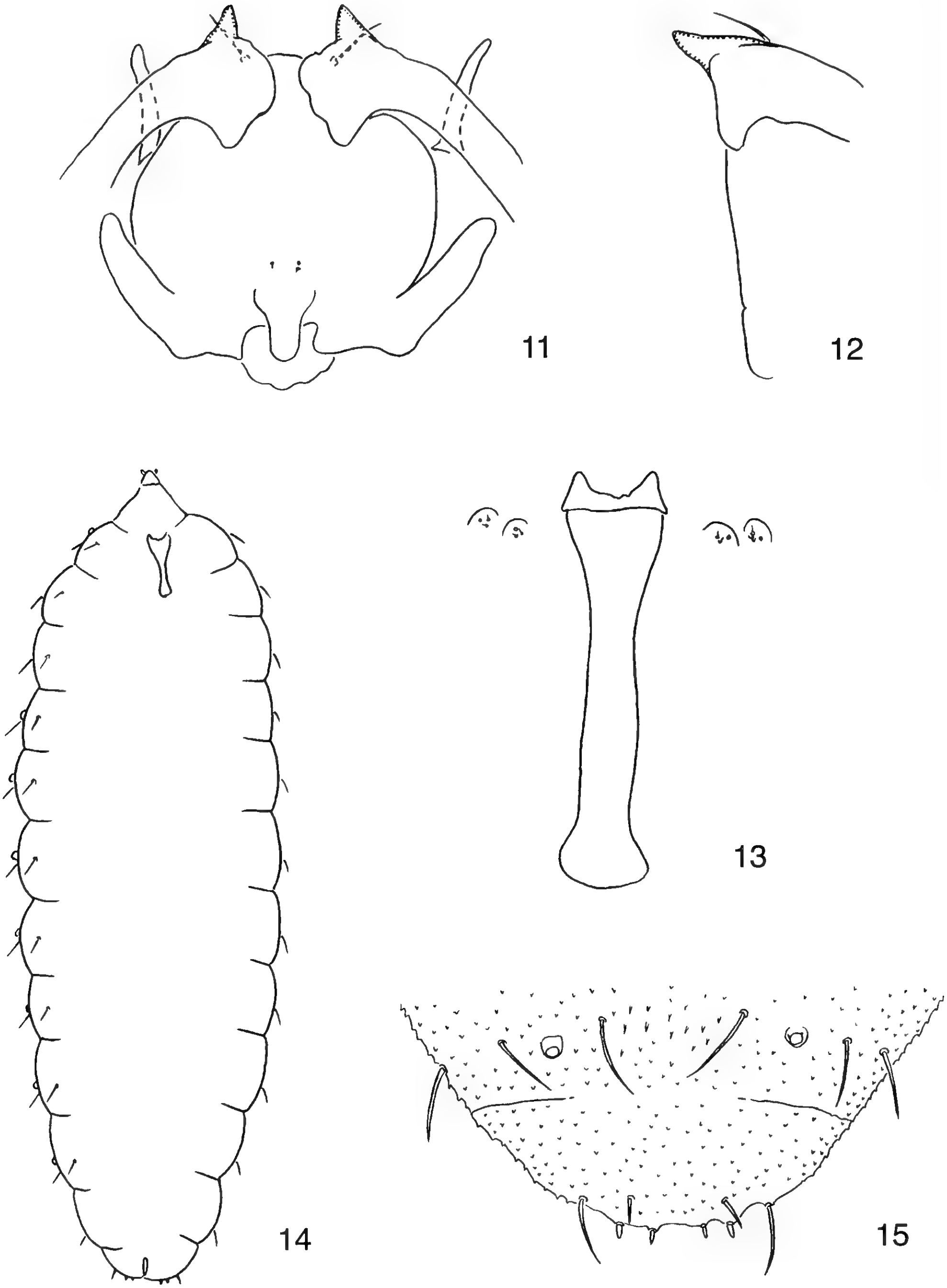
Third larval instar (Figs. 13–15).—Length, 2.5–2.7 mm. White. Integument with scattered spicules. Antenna about twice as long as wide. Spatula with 2 widely separated anterior teeth, the space between weakly indented. Lateral thoracic papillae in 2 groups of 3 on each side of central line, 2 papillae in each group each with tiny seta. Dorsal and pleural papillae elongate. Terminal segment rounded, with 8 papillae as follows: 1 pair as long as dorsal setae of previous segment; 1 pair with setae about half as long; the two posterior pairs with short, corniform setae, those of inner pair slightly narrower than outer pair.



Figs. 2–3. 2, Galls of *Clinodiplosis capsici* on stems and base of flowers of *Capsicum* sp. 3, Detail of same, one in section to show larva in larval cell.



Figs. 4–10. *Clinodiplosis capsici.* 4, Male third antennal flagellomere. 5, Female third antennal flagellomere. 6, Tarsal claws and empodium. 7, Female postabdomen, seventh segment to cerci (lateral). 8, Female cercus, detail (lateral). 9, Male genitalia, only one gonopod shown (dorsal). 10, Same, only one gonocoxite shown (ventral).



Figs. 11–15. *Clinodiplosis capsici.* 11, Pupal head (ventral). 12, Pupal head, part, showing ventral projection of antennal base (lateral). 13, Larval spatula and associated lateral papillae. 14, Larva (ventral). 15, Larval eighth and terminal segments (dorsal).

Holotype.—♂, from *Capsicum frutescens,* Guadeloupe, French Antilles, Ravine Chaude, 27-XII-1994, J. Etienne, GR 1575, deposited in the National Museum of Natural History (USNM), Washington, DC.

Other material examined (all deposited in USNM).—Same data as holotype, 1 ♂, 2 ♀, 3 pupae, 3 larvae; from *Capsicum* sp., Guadeloupe, Ste. Rose, 3-II-1993, J. Etienne, GR 1309, 2 ♂, 2 ♀, 5 pupae, 6 larvae; from *Capsicum* sp., Guadeloupe, Lamentin, 1-VII-1992, J. Etienne, GR 1110, 1 ♂, 1 ♀, 1 pupa, 1 larva; from *Capsicum annuum,* Costa Rica, Guanacaste Province, 3-I-1995, H. Blanco, 1 ♂, 1 ♀; from *Capsicum annuum,* Costa Rica, Turialba, VIII-1995, H. Blanco, 3 ♂, 2 ♀, 3 pupae.

Etymology.—The specific name, *capsici,* means "of capsicum."

Remarks.—The larva of *C. capsici* differs substantially from other *Clinodiplosis* spp. in that the corniform setae of the terminal segment are small and not each situated at the end of lobes, as is usual for the genus. It cannot be said with confidence whether in this species the lack of lobes is primitive or the result of reduction. The male and female of *C. capsici* have the general habitus of the genus, the only peculiarity being the shape of the male hypoproct, which is broadened at midlength, its sides bending slightly around the aedeagus. The pupal abdomen is without dorsal spines and resembles in that way the species of *Clinodiplosis* that feed on fungi. Unlike the new species, several other Neotropical species of *Clinodiplosis* that pupate in their galls, e.g., *Clinodiplosis eupatorii* Felt in conical leaf galls on *Chromolaena* (Asteraceae) (Gagné 1977), have enlarged dorsal spines on the pupal abdomen that are presumably adaptations in those species for escaping from the galls.

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NEW SPECIES OF PUERTO RICAN PHYCITINAE (LEPIDOPTERA: PYRALIDAE)

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Abstract.—***Zamagiria borinquensis*** and ***Oryctometopia maricaoensis*** are described as **new species**. Both were collected as adults in western Puerto Rico.

Key Words: moths, phycitines, Puerto Rico

Post-Columbian Puerto Rico has been subjected to major environmental changes. Agriculture, mainly the extensive growing for many years of sugarcane and coffee, replaced much of the native vegetation. Some refugia exist, however, chiefly as parks or reserves. These vary from tropical dry forest to tropical rain forests. Recently, entomologists at the Carnegie Museum of Natural History (CMNH) have intensively light-trapped Lepidoptera in these remaining pockets of relatively undisturbed flora. Two previously unknown species of phycitines were collected. These are described below, and are added to the 20 species (Table 1) previously recorded from Puerto Rico by Heinrich (1956).

Zamagiria borinquensis Neunzig, new species
(Figs. 1, 3–5)

Type locality.—Puerto Rico, Isabela, Bosque Estatal de Guajataca, Montanas Aymamon.

Diagnosis.—The male and female genitalia can be used to separate *Zamagiria borinquensis* from other species in the genus. Features peculiar to the new species are the short, triangular inner clasper on the inner base of the valva, the somewhat elongate, spoonshaped apical gnathal process of the male (Fig. 3), and the girdle of robust spines in the corpus bursae of the female (Fig. 5).

Description.—Forewing length 6.5–7.0 mm. Head brownish white. Labial palpus white and fuscous. Maxillary palpus white to brownish white, aigrettelike in male. Dorsum of thorax brownish white suffused with fuscous. Forewing brown dusted with white; black ridge of raised, curled scales preceding antemedial line; antemedial line white, weakly developed, with associated adjacent bands of dark scales; postmedial line similar, in color and development, to antemedial line; discal spots black, moderately distinct, separate; patch of very pale reddish brown scales at inner base of wing and scattered patches of darker reddish brown on outer ⅔ of wing. Underside of male fore and hindwing without patches or streaks of contrasting colored scales (frequently seen in other *Zamagiria*). Male genitalia (Figs. 3, 4): Uncus triangular, narrowly rounded distally; apical process of gnathos expanded into a somewhat elongate spoon-shaped process; juxta a U-shaped, thin plate with setiferous lateral arms; transtilla absent; valva slender, unarmed except for triangular, erect clasper on its inner base; aedoeagus with single, short, stout, well-sclerotized cornutus; vinculum about

Table 1. Phycitinae listed by Heinrich (1956) as occurring in Puerto Rico[1].

Crocidomera fissuralis (Walker)
Ectomyelois furvidorsella (Ragonot)
Fundella ignobilis Heinrich
Difundella distractor Heinrich
Anadelosemia texanella (Hulst)
Davara interjecta Heinrich
Davara rufulella (Ragonot)
Sarasota furculella (Dyar)
Caristanius pellucidellus (Ragonot)
Eurythmasis ignifatua Dyar
Paconius corniculatus Heinrich
Mescinia berosa Dyar
Phestinia costella Hampson
Laetilia portoricensis Dyar
Metephestia simplicula (Zeller)
Moodnopsis portoricensis Heinrich
Prosoeuzophera impletella (Zeller)
Caudellia clara Heinrich
Ribua contigua Heinrich
Varneria dubia Heinrich

[1] List does not include a few widespread neotropical phycitines that Heinrich included in his checklist as occuring in his category "West Indies," some of which may be found in Puerto Rico.

as long as greatest width. Female genitalia (Fig. 5): Ductus bursae short, about $\frac{1}{5}$ as long as corpus bursae, narrow, except slightly broadened near ostium bursae, without sclerotized plates common to most other *Zamagiria* species, but generally sclerotized anteriorly; corpus bursae elongate, with well-developed, irregular comb of many slender spines extending distally from ductus bursae to about midway on corpus, and with strongly formed band encircling corpus bursae at about middle and bearing about 24 robust spines; ductus seminalis attached to corpus bursae near junction of ductus bursae and corpus bursae.

Type material.—Holotype: ♂: Puerto Rico, Isabela, Bosque Estatal de Guajataca, Montanas Aymamon, 18°25′06N, 66°57′55″W, forest, 210 m, 14–15 June 1996, J. Rawlins, W. Zanol, R. Davidson, C. Young, M. Klingler, S. Thompson; genitalia slide HHN 4427. Paratype: 1 ♀, same collection data as for holotype; genitalia slide HHN 4428.

Figs. 1, 2. Males. 1, *Zamagiria borinquensis*, holotype. 2, *Oryctometopia maricaoensis*, holotype.

Holotype and paratype deposited in CMNH.

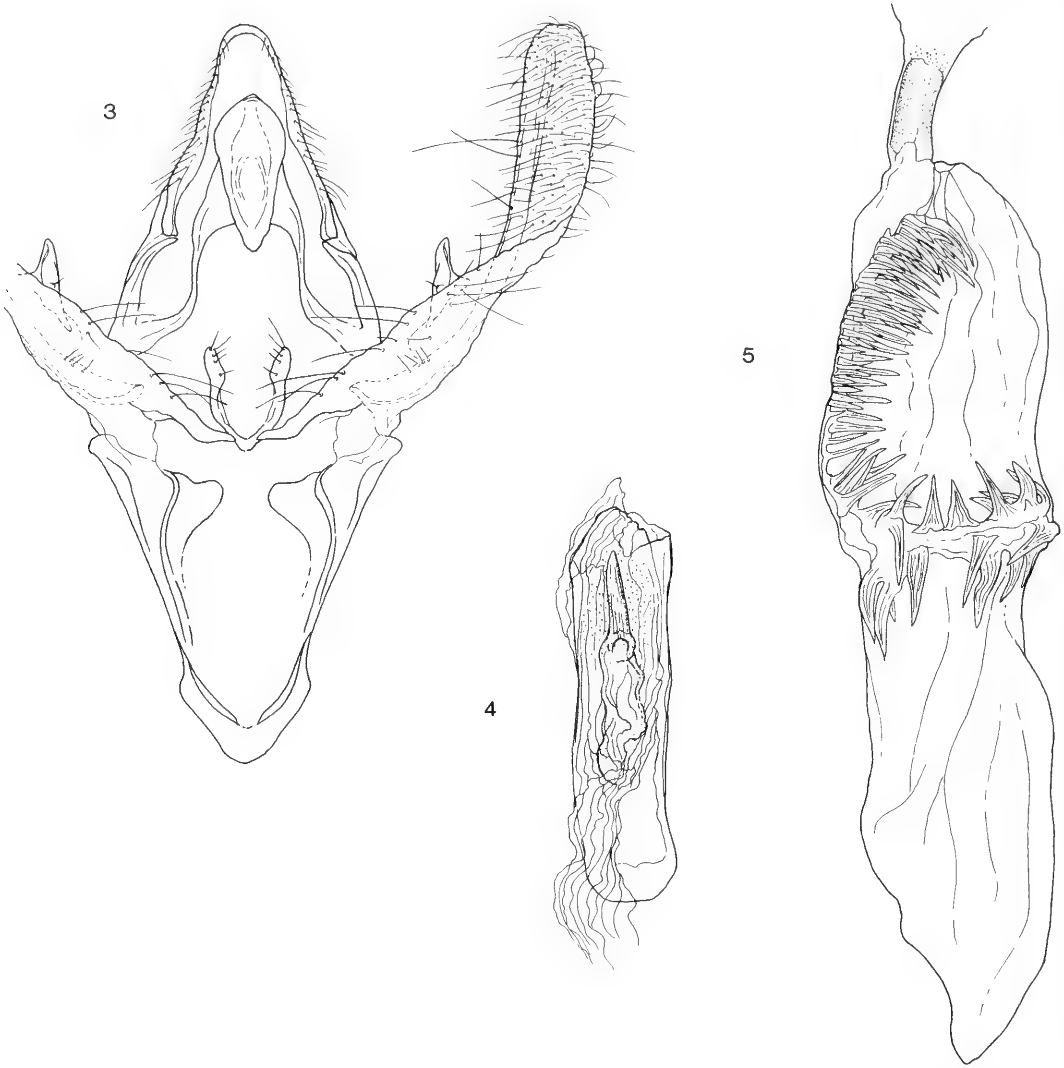
Remarks.—*Zamagiria borinquensis* is very similar externally to other species in the genus. The character states of the male, particularly the grooved head with its unusual compact tuft of scales attached to the frons, and the unique tuft, composed of several distinct types of scales, at the base of the antenna, are easily recognized traits of the species.

Etymology.—The specific epithet is derived from the Taíno name for Puerto Rico (Borínquen), and the Latin suffix *-ensis* (denoting place).

***Oryctometopia maricaoensis* Neunzig, new species**

(Figs. 2, 6–8)

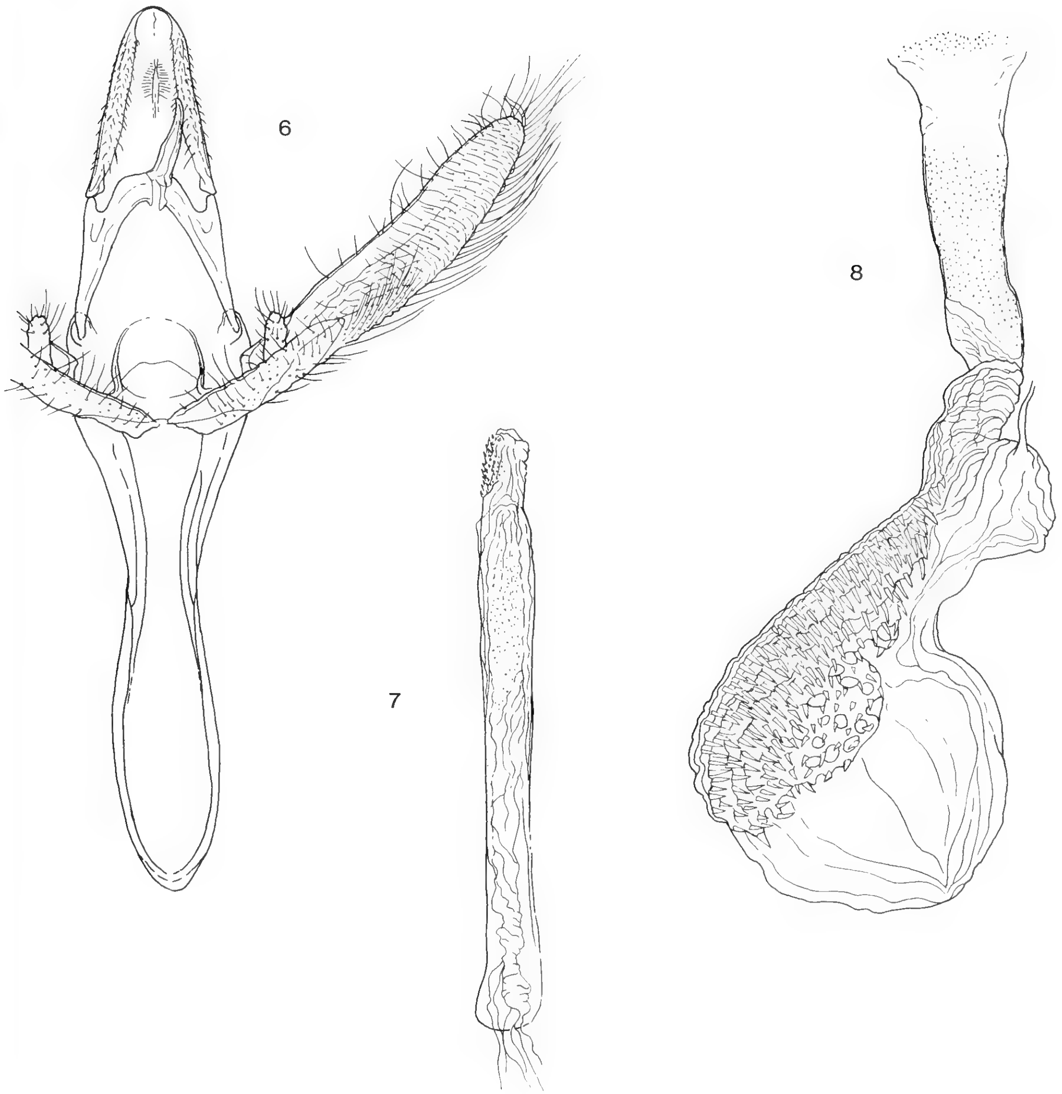
Type locality.—Puerto Rico, 3.3 km. sw Maricao, Bosque Estatal de Maricao.



Figs. 3–5. *Zamagiria borinquensis.* 3, Male genitalia (aedoeagus omitted). 4, Aedoeagus. 5, Female ductus bursae and corpus bursae.

Diagnosis.—The male is readily identified by the elongate, medially constricted vinculum (Fig. 6), and the female by the large spined plate that covers most of one side of the corpus bursae (Fig. 8).

Description.—Forewing length 10.5–12.0 mm. Head of male brownish white to pale reddish brown suffused with reddish brown, and with vertex sulcate and white; upper part of frons produced dorsally into a ridge. Head of female simple, brownish white to pale reddish brown. Labial palpus brown dusted with white and with a few scattered brownish red scales. Maxillary palpus of male aigrettelike, mostly pale brown, in part pink. Maxillary palpus of female simple, pale brownish white. Dorsum of thorax pale brown or pale purplish brown. Forewing pale purplish brown in basal ⅓; antemedial line moderately distinct to distinct, white, its inner ½ preceded by black and pale reddish brown patch, and followed by black line and associated white patch; postmedial line moderately distinct



Figs. 6–8. *Oryctometopia maricaoensis.* 6, Male genitalia (aedoeagus omitted). 7, Aedoeagus. 8, Female ductus bursae, corpus bursae and anterior part of ductus seminalis.

to distinct, white; medial area with patches of red to dark red mostly along costa and at discal spot; subterminal area with broad brownish red patch following postmedial line. Male genitalia (Figs. 6, 7): Uncus narrowly triangular, rounded at apex; apical process of gnathos a well-developed hook; juxta platelike with thin, inwardly curved lateral arms; transtilla absent; valva simple, with short, stout lobes near inner base; aedoeagus, long, slender; vesica with cluster of small spines; vinculum long and slender (about 2½ times as long as basal width), and constricted medially. Female genitalia (Fig. 8): Ductus bursae slightly shorter than corpus bursae, sclerotized over ½ its length; corpus bursae with large, many-spined plate, covering most of left side (when viewed ventrally) of bursae; plate, in part perforate; ductus seminalis attached to corpus bursae near junction of ductus bursae and corpus bursae.

Type material.—Holotype: ♂: Puerto Rico, Bosque Estatal de Maricao, 3.3 km sw Maricao, 18°09′39″N, 67°00′05″W, forest, 550 m, 10–11 June 1996, J. Rawlins, C. Young, R. Davidson, W. Zanol, S. Thompson, M. Klingler; genitalia slide HHN 4459. Paratypes: (4 ♂, 2 ♀, total); same collection data as for holotype, genitalia slides HHN 4415, 4416 (3 ♂, 2 ♀); Puerto Rico, Isabela, Bosque Estatal de Guajataca, Montanas Aymamon, 18°25′06″N, 66°57′55″W, forest, 210 m, 14–15 June 1996, J. Rawlins, W. Zanol, R. Davidson, C. Young, M. Klingler, S. Thompson (1 ♂). All specimens from Maricao deposited in CMNH; Isabela paratype in North Carolina State University Collection (NCSU).

Remarks.—The new species differs most noticeably from *Oryctometopia fossulatella* Ragonot, the only other species in the genus, in that the male genitalia lack the short, thornlike spines projecting from the lower margin of the sacculus, and have a cluster of small spines on the vesica (rather than a single spinelike cornutus), and in that the female ductus bursae is more extensively sclerotized. Nevertheless, males of both species have an enlarged frons and sunken vertex, tufted and otherwise modified antennae, simple scale tufts on abdominal segment VIII, and generally similar genitalia. Females of both have a characteristically large, sclerotized plate in the corpus bursae bearing numerous short spines.

Etymology.—The specific epithet is derived from the locality (Maricao) where almost all the specimens were collected, and the Latin suffix- *ensis* (denoting place).

ACKNOWLEDGMENTS

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TAXONOMY AND POLYTENE CHROMOSOMES OF *SIMULIUM PARNASSUM* MALLOCH (DIPTERA: SIMULIIDAE)

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Abstract.—The taxonomic status of *Simulium parnassum* Malloch was investigated cytologically and morphologically. Specimens were collected at 44 localities from the Gaspé Peninsula of Quebec to northern Alabama. A previously unreported pupal form of *S. parnassum* from two streams in South Carolina and one stream each in North Carolina and Massachusetts lacked the typical rugose sculpturing on the dorsum of the head and thorax. No additional structural characters in any life stage differentiated the two forms. A standard map of the silk-gland chromosomes was constructed and compared with the standard map for the subgenus *Simulium*. *Simulium parnassum* differed from the subgeneric standard by six inversions in IL, one in IIL, three in IIS, and an unresolved number in IIIL. Placement of *S. parnassum* in a separate species group, the *S. parnassum* species group, in the subgenus *Simulium* is suggested on the basis of cytological evidence. No fixed rearrangements were found among populations of *S. parnassum* from Quebec to Alabama nor between populations of smooth and rugose pupal forms. A Y-linked polymorphism was observed in the centromere region of chromosome I in some males, but it was not associated with either pupal form. Present evidence indicates that *S. parnassum* is a single species throughout its range.

Key Words: *Simulium parnassum,* black flies, aquatic insects, polytene chromosomes

Simulium parnassum is one of the most distinctive members of the subgenus *Simulium* in the Nearctic Region (Stone 1964). The female is shiny black and each claw is long and nearly sigmoidal, with a small tooth near its midlength. The pupal gill of six filaments and the simple, slipper-shaped cocoon are similar to those of the *S. tuberosum* and *S. venustum* species groups, but the rugose head and thorax are unique. The deeply incised, triangular postgenal cleft of the larva is distinctive. Despite the unique attributes of *S. parnassum,* this species has been assigned to the *S. tuberosum* species group (Crosskey and Howard 1997), ostensibly because of perceived similarities in the male genitalia, notably the presence of a medially directed lobe on the gonostylus. The homology of this lobe, however, is questionable based on differences in location, size, and vestiture. Accordingly, a reevaluation of the phylogenetic placement of *S. parnassum* is warranted.

Simulium parnassum was described from females taken in northern New Hampshire (Malloch 1914). Dyar and Shannon (1927) described a male from eastern Virginia as *S. hydationis,* which was synonymized with *S. parnassum* by Stone and Jamnback (1955). All life stages of *S. parnassum* have been described and figured (Stone and Jamnback 1955, Davies and Peterson 1956, Davies et al. 1962, Wood et al. 1963, Stone

Table 1. Numbers of two pupal forms (rugose, smooth) of *Simulium parnassum* collected at Smith and Abner Creeks in Pickens County, South Carolina, 1998–1999.

	Smith Creek			Abner Creek		
Year	Date	Rugose	Smooth	Date	Rugose	Smooth
1998	25 April	2	0	2 June	0	12
1998	5 May	0	4	9 June	0	20
1998	14 May	2	0	11 June	1	23
1998	23 May[1]	1	4	23 June[1]	0	1
1999	10 May	1	0	1 June	1	12
1999	15 May	1	1	5 June	0	11
1999	18 May	1	5	10 June[1]	0	26
1999	21 May	3	36			
1999	24 May	1	30			
1999	28 May	0	17			
1999	1 June[1]	0	4			

[1] No pupae found beyond these dates.

and Snoddy 1969, Adler and Kim 1986). The polytene chromosomes have not been studied, although Rothfels (1979) commented briefly on the banding sequence of two of the six chromosomal arms. Consequently, *S. parnassum* has not been investigated for sibling species, which are common among black flies (Adler 1988).

This species occurs in eastern North America from Canada to the southern end of the Appalachian Mountains (Stone and Snoddy 1969), with an isolated record from Missouri (Doisey et al. 1986). The immature stages occupy cool, rocky, forest streams (Davies et al. 1962, Adler and Kim 1986). Females are mammalophilic (Fuller 1940, Downe and Morrison 1957, Addison 1980) and can be pests of humans (Adler and Kim 1986, Gibbs et al. 1986).

Our objectives were to screen *S. parnassum* for sibling species, using morphology and polytene chromosomes, and to resolve its chromosomal banding sequence relative to the subgeneric standard of Rothfels et al. (1978), with the intent of gaining phylogenetic insight.

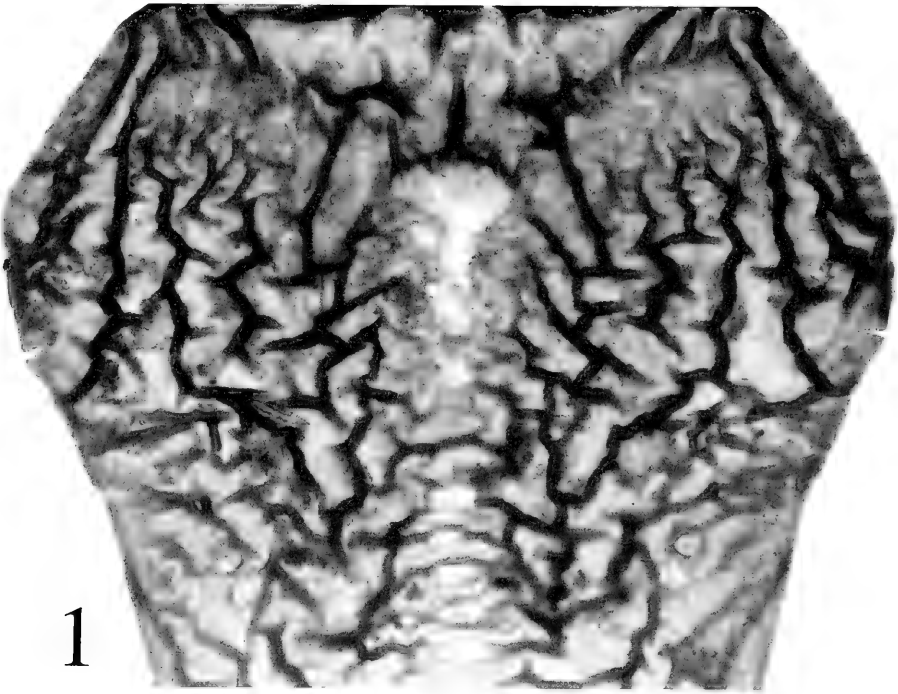
MATERIALS AND METHODS

Larvae and pupae of *S. parnassum* were collected from 1998 to 1999 at 44 sites from the Gaspé Peninsula of Quebec to northern Alabama, and were fixed in Carnoy's solution (1 part glacial acetic acid: 3 parts 95% ethanol). Additional pupae were reared individually to adults on moist filter paper in petri dishes.

Seasonal sampling of larvae and pupae was conducted at Smith Creek (35°0.17′N 82°49.01′W) and Abner Creek (35°4.27′N 82°47.11′W) in Pickens Co., South Carolina. Streams were sampled every 10 days in 1998 and every three days in 1999. In 1998, Smith Creek was sampled 3 March–11 August and Abner Creek 13 May–11 August. In 1999, both streams were sampled 17 March–26 June.

Polytene chromosomes were prepared from larval silk glands, using the Feulgen method of Rothfels and Dunbar (1953). A standard chromosome map was constructed for *S. parnassum,* following the procedures and nomenclature of Rothfels et al. (1978). The banding pattern of the standard map was compared with that of the subgeneric standard of Rothfels et al. (1978). For chromosomal arms of *S. parnassum* that had banding patterns identical to those of the subgeneric standard, the subgeneric numbering was preserved. Chromosome arms of *S. parnassum* that were rearranged relative to the subgeneric standard were given new section numbers to provide a continuous sequence. Slide-mounted chromosomes of larvae from 15 of the 44 collection sites (see Chromosomal Material Examined) were compared band for band against the standard map of *S. parnassum* in a search for rearrangements within and between populations of *S. parnassum.* Specimens and chromosomal photographic negatives and working maps were deposited in the Clemson University Arthropod Collection, Clemson, South Carolina.

Chromosomal material examined (numbers of each sex refer to larvae for which all chromosomal bands were read).—ALABAMA: Talladega Co., Cheaha State Park, Cheaha Creek, 33°28.27′N 85°49.07′W, 27 March 1998 (1 ♂); 19 May 1998 (9 ♀);



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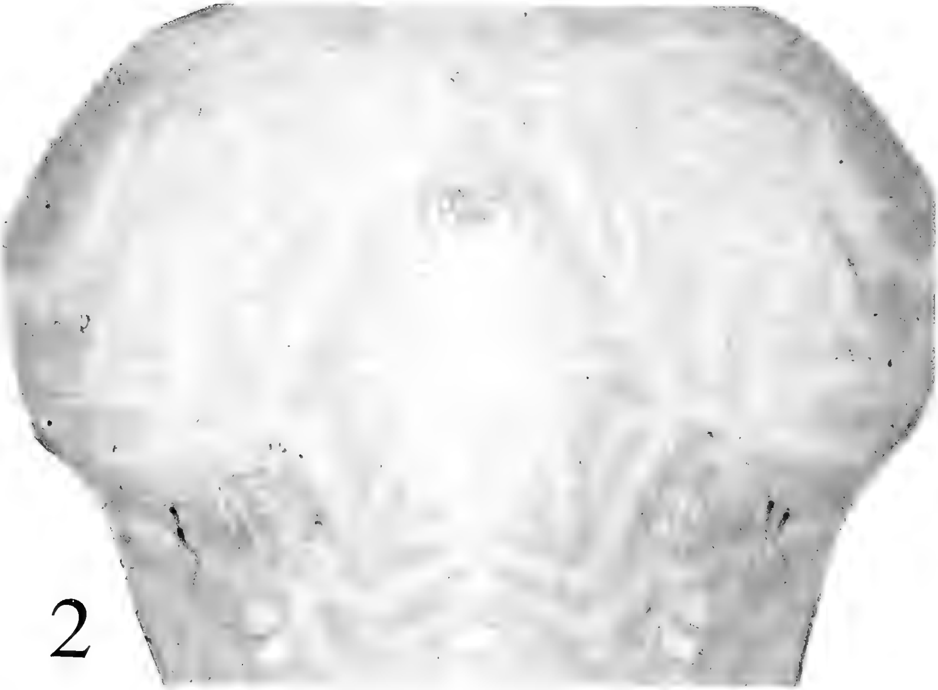

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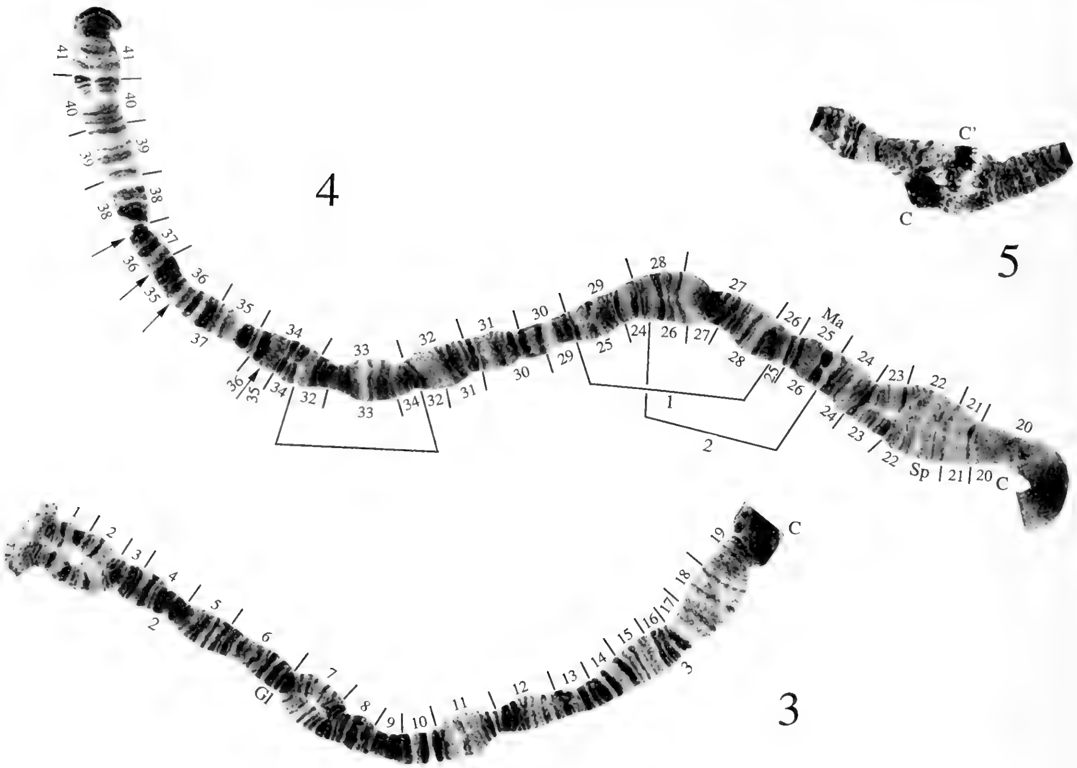
Figs. 1–2. Cephalic plates of pupal exuviae of *Simulium parnassum.* 1, Rugose form (Smith Creek, Pickens Co., South Carolina, 18 May 1999). 2, Smooth form (Abner Creek, Pickens Co., South Carolina, 11 June 1998).



Figs. 3–5. Silk-gland chromosomes of *Simulium parnassum,* with landmarks of Rothfels et al. (1978); C = centromere region. 3, Chromosome arm IS. Numbers indicate section numbers for both *S. parnassum* standard sequence and *Simulium* subgeneric standard of Rothfels et al. (1978). Male from South Carolina, Pickens Co., Oil Camp Creek, 8 May 1998 (sections 1 to center of section 13) plus female from Massachusetts, Berkshire Co., 29 June 1998 (section 20 to center of section 13); Gl = glazed, 2 = two blocks, 3 = three heavy. 4, Chromosome arm IL. Numbers on top of chromosome indicate *S. parnassum* standard banding sequence; bottom numbers correspond with those of *Simulium* subgeneric standard of Rothfels et al. (1978). Brackets indicate inversions relative to *Simulium* subgeneric standard of Rothfels et al. (1978); numbered brackets indicate sequence in which overlapping inversions occurred. Arrows indicate breakpoints for complex of three inversions relative to subgeneric standard. Female from Georgia, Dade Co., 19 May 1998; Ma = marker, Sp = spongy. 5, Centromere region of chromosome I. Male from Georgia, Dade Co., 19 May 1998; C′ = condensed, Y-linked centromere band.

Cheaha State Park, Dry Creek, 33°28.23′N 85°48.72′N, 19 May 1998 (1 ♂, 6 ♀); GEORGIA: Dade Co, Johnson's Crook, Newsome Gap Road, 0.8 km west of Moore Rd., 34°47.23′N 85°28.25′W, 19 May 1998 (2 ♂, 7 ♀); MASSACHUSETTS: Berkshire Co., Jug End Rd., 0.24 km west of Guilded Hollow Road, 42°8.99′N 73°26.98′W, 29 June 1998 (2 ♂, 16 ♀); NEW HAMPSHIRE: Carroll Co., Bear Notch Rd., 3.2 km north of SR 112, 44°1.50′N 71°19.13′W, 24 July 1998 (1 ♂); Grafton Co., SR118, 10.5 km southwest of SR 112, 43°59.00′N 71°47.93′W, 24 July 1998 (2 ♂, 7 ♀); NEW JERSEY: Sussex Co., Tillman Brook, 41°0.15′N 74°0.86′W, 22 June 1998 (1 ♂, 4 ♀); NORTH CAROLINA: Haywood Co., US Rt. 276, 1.6 km north of Cruso, 35°26.4′N 82°48.8′W, 7 June 1998 (2 ♂); Madison Co., Silver Mine Creek 35°0.53′N 82°0.48′W, 14 May 1998 (3 ♂, 2 ♀); SOUTH CAROLINA: Pickens Co., Abner Creek, SR 1105, 4.8 km east of Hwy 178, 35°4.27′N 82°47.11W′, 23 May 1998 (14 ♂, 5 ♀); 2 June 1998 (10 ♀); Oil Camp Creek, Oil Camp Creek Rd., 0.8 km west

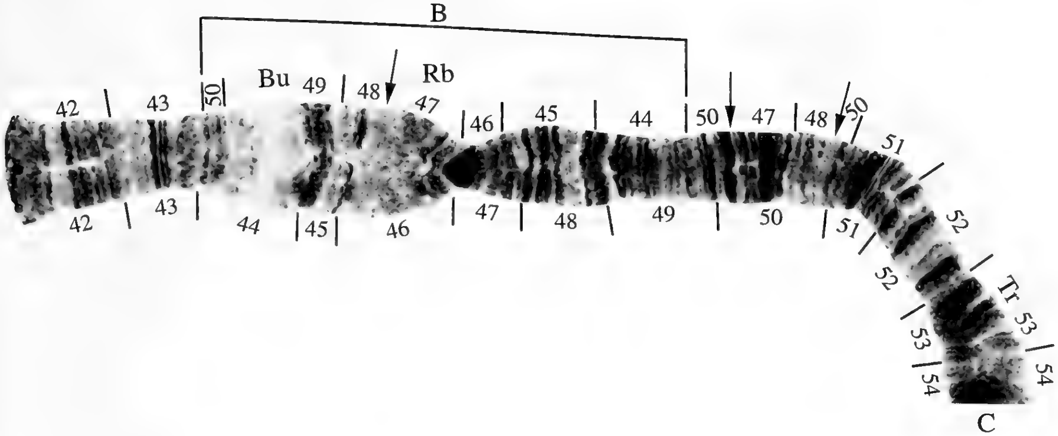


Fig. 6. Chromosome arm IIS of *Simulium parnassum,* with landmarks of Rothfels et al. (1978). C = centromere region. Section numbers on bottom indicate *S. parnassum* standard banding sequence; those on top refer to *Simulium* subgeneric standard sequence of Rothfels et al. (1978). Bracket indicates B inversion of Rothfels et al. (1978). Arrows indicate breakpoints of two overlapping inversions relative to subgeneric standard. Female from Massachusetts, Berkshire Co., 29 June 1998. Bu = bulge, Rb = ring of Balbiani, Tr = trapezoidal.

of River Falls Rd., 35°6.65′N 82°34.08′W, 8 May 1998 (7 ♂, 1 ♀); TENNESSEE: Monroe Co., Buckhorn Cr., 35°19.98′N 84°9.83′W, 6 June 1998 (2 ♂); VIRGINIA: Augusta Co., East Dry Branch, SR 688, 3.2 km north of SR 42, 38°12.70′N 79°16.31′W, 25 June 1998 (8 ♀); NEW BRUNSWICK: Restigouch Co., Collector Hwy. 180, 37 km west of Bathurst, 27 July 1998 (3 ♂, 12 ♀); QUEBEC, Gaspé Peninsula, Hwy. 132, 5.6 km south of Routhierville, 29 July 1998 (5 ♂, 19 ♀).

RESULTS

Two pupal forms of *S. parnassum* were discovered among the 472 pupae examined. Rugose pupae had a raised pattern of reticulation on the dorsal surface of the head and thorax (Fig. 1). Smooth pupae lacked surface sculpturing, although the pattern of rugosity could be seen, with substage lighting, as a vague outline on the head and thorax of the pupal exuviae (Fig. 2). Intermediates between the smooth and rugose forms were not found. No additional morphological characters in larvae, pupae, or adults were found that correlated with the smooth and rugose pupal forms.

Smooth pupae were collected from four streams. They were found with the rugose form in streams in Pickens Co., South Car-

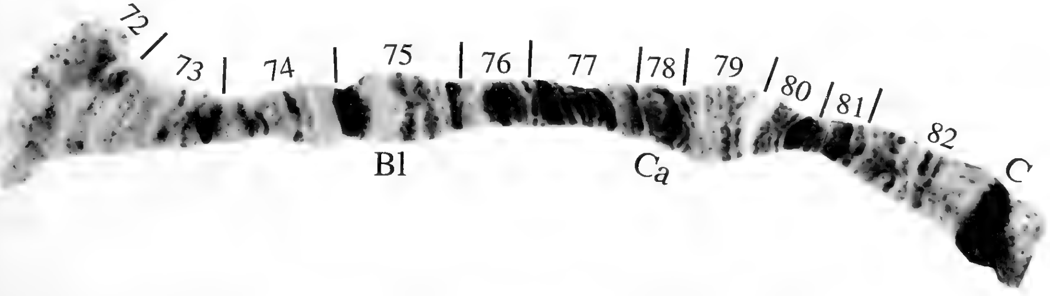
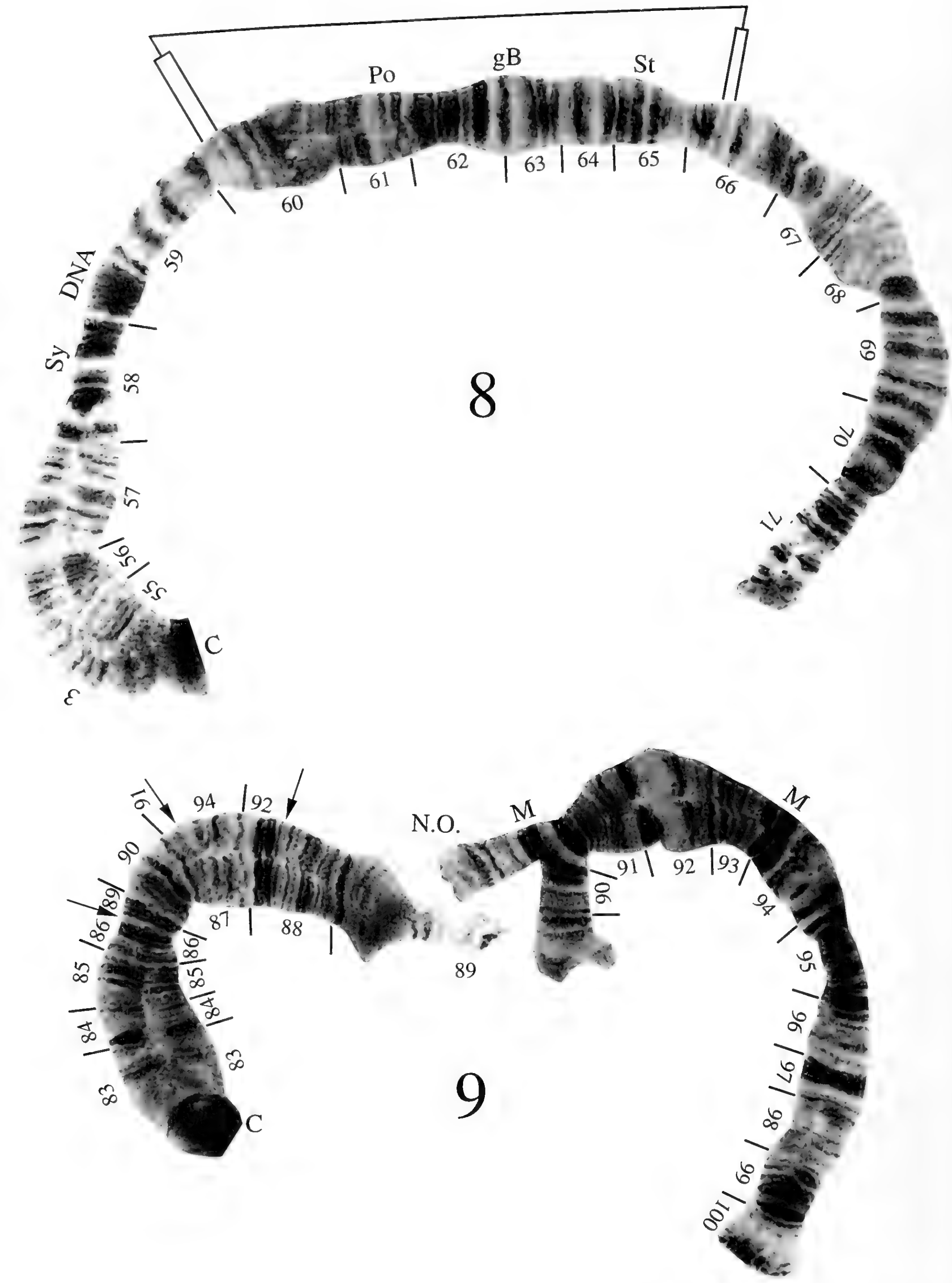


Fig. 7. Chromosome arm IIIS of *Simulium parnassum,* with landmarks of Rothfels et al. (1978). C = centromere region. Section numbers are those of both *S. parnassum* standard banding sequence and *Simulium* subgeneric standard of Rothfels et al. (1978). Male from South Carolina, Pickens Co., Oil Camp Creek, 8 May 1998. Bl = blister, Ca = capsule.



Figs. 8–9. Silk-gland chromosomes of *S. parnassum,* with landmarks of Rothfels et al. (1978). C = centromere region. 8, Chromosome arm IIL. Section numbers refer to *Simulium parnassum* standard banding sequence. Bracket indicates simple inversion relative to *Simulium* subgeneric standard of Rothfels et al. (1978). Female from Tennessee, Monroe Co., 6 June 1998 (sections 55 through 70) plus female from North Carolina, Haywood Co., 7 June 1998 (section 71). DNA = DNA puff, gB = gray band, Po = polar, St = saw tooth, Sy =

olina (Smith and Abner creeks), where they were the predominant form, and in Berkshire Co., Massachusetts. In Transylvania Co., North Carolina (South Prong Gladdy Fork), one smooth pupa and no rugose pupae were collected. Pupae from near the type localities of *S. parnassum* and *S. hydationis* were rugose. No differences in seasonality were detected in streams where both pupal forms occurred (Table 1), although the rugose form was infrequent in these streams. Seasonal differences, however, might have been apparent if populations of each form had been larger.

In Smith Creek, where a minimum-maximum thermometer had been placed, larvae first appeared on 13 March 1998; water temperature was 3.0–9.0°C for the three days prior to collection. Pupae were first found in Smith Creek on 25 April 1998; water temperature was 11.0–12.0°C during the 11 days prior to collection. In 1998, the last larvae were found at Smith Creek on 2 June (water temperature for 9 days prior to collection = 17.5–18.5°C) and in 1999 on 1 June (water temperature for 3 days prior to collection = 17.5–18.0°C). Pupae were first collected from Abner Creek on 2 June 1998 (temperature at time of collection = 18.0°C) and 1 June 1999 (16.0°C). The last larvae and pupae were collected from Abner Creek on 23 June 1998 (18.0°C) and 10 June 1999 (15.0°C).

Of 211 larvae prepared for chromosomal analysis, 72% were read, band for band, in their entirety. The banding sequences of the short arms of chromosomes I and III (Figs. 3, 7) matched those of the subgeneric standard, although we were unable to match all of the fine bands in the base of IS (sections 19 and 20). The remaining four arms had fixed rearrangements relative to the subgeneric standard. IL had one central inversion, two overlapping basal inversions, and a complex of three inversions distally (Fig. 4). IIS carried the B inversion of Rothfels et al. (1978), plus two additional inversions (Fig. 6). IIL had one central inversion (Fig. 8). The IIIL arm, with the nucleolar organizer displaced more distally relative to the subgeneric standard, was highly rearranged (Fig. 9). Many bands could be recognized, but we conservatively matched only the bands in the base of IIIL, relative to the subgeneric standard, and indicated the characteristic "marker" (*sensu* Rothfels et al. 1978), which was partitioned by rearrangements into two pieces.

We found no fixed or floating inversions in our material relative to the *S. parnassum* standard sequence. Chromosome I is implicated as the sex chromosome. Two males from Georgia (Newsome Gap Road) had differentiated centromere regions in chromosome I; the centromere band of one homologue was expanded (standard) more than the other (Fig. 5). About 52% of males ($n = 44$) from other sites showed a failure to pair on either side of the centromere of chromosome I. This failure to pair was found at sites with and without the two pupal forms. One male from Abner Creek (13 May 1998) was heterozygous for expression of the nucleolar organizer. *Simulium parnassum* was otherwise chromosomally monomorphic.

DISCUSSION

A new pupal form of *S. parnassum* was discovered in which the reticulation of the head and thorax, long used as a diagnostic character (e.g., Stone and Jamnback 1955), was absent. No intermediates between smooth and rugose pupae were found; how-

←

symmetrical, 3 = three sharp. 9, Chromosome arm IIIL. Section numbers on bottom indicate *S. parnassum* standard banding sequence; those on top refer to *Simulium* subgeneric standard sequence of Rothfels et al. (1978). Arrows indicate breakpoints of inversions. N.O. = nucleolar organizer, M = marker (divided in two pieces). Female from South Carolina, Pickens Co., Oil Camp Creek, 14 May 1998.

ever, we discovered no additional information, either morphological, chromosomal, distributional, or seasonal, to suggest that two species are present. The synonymy of *S. hydationis* with *S. parnassum* (Stone and Jamnback 1955) is justified, both morphologically and cytologically, because material from near the two type localities was morphologically and chromosomally homogeneous. However, the possibility that the two pupal forms of *S. parnassum* represent homosequential species or that homosequential sibling species exist, as they do in other black flies (e.g., Henderson 1986), cannot be excluded.

Relative to the *Simulium* subgeneric standard of Rothfels et al. (1978), we found only two inversions that are shared with other taxa. The IIS-B inversion of Rothfels et al. (1978) is shared with most species in subgenus *Simulium* (Adler et al. 1999), as is an inversion in IIIL that has one of its breakpoints at the 91/94 junction (Fig. 9) (Adler, unpublished). Because IIIL is not fully resolved, shared inversions with other taxa could be present. The remaining inversions in IL, IIS, and IIL are apparently autapotypic for *S. parnassum*. Chromosomal evidence does not suggest a relation with the *S. tuberosum* species group, which is defined by at least eight unique rearrangements, including four in IIL (Adler and Kuusela 1994), nor does it provide resolution of relationship with other species groups. Tentative placement of *S. parnassum* in a separate species group, the *S. parnassum* species group, is therefore more appropriate.

Simulium parnassum was univoltine in South Carolina. In Pennsylvania, it has been considered univoltine but with overlapping cohorts (Tessler 1991). Other authors (e.g., Stone and Snoddy 1969, Cupp and Gordon 1983) suggest that *S. parnassum* completes more than one generation per year, although conclusive evidence supporting these claims is lacking.

Based on the results of our study, we consider *S. parnassum* a single species, albeit polymorphic in pupal surface texture. We suggest, however, that additional (e.g., molecular) evidence be brought to bear to corroborate or falsify this hypothesis.

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TYPES OF SAWFLIES DESCRIBED IN THE GENUS *PONTANIA* A. COSTA (HYMENOPTERA: TENTHREDINIDAE) IN THE ILLINOIS NATURAL HISTORY SURVEY

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Abstract.—The types of ten sawfly species described in the genus *Pontania* by MacGillivray and Ross are examined. This study has resulted in the following taxonomic changes: *Pontania daedala* MacGillivray is a **new synonym** of *Pontania proxima* (Serville); *Pontania demissa* MacGillivray is a **new synonym** of *Eupontania gracilis* (Marlatt); Pontania *devincta* MacGillivray is a **new synonym** of *Pontania populi* (Marlatt); *Phyllocolpa dedecora* (MacGillivray), **n. comb.**; *Phyllocolpa derosa* (MacGillivray), **n. comb.**; and *Nematus dotata* (MacGillivray), **n. comb.** Notes are given on the types and hosts where known.

Key Words: galls, leaf rolls, *Phyllocolpa, Eitelius, Nematus*

This study of ten sawfly types described in the genus *Pontania* A. Costa deposited in the Illinois Natural History Survey, Champaign, Illinois (INHS) focuses on some that were reared by Yuasa and treated by Yuasa (1922) in his work on sawfly larvae and concurrently or later described by MacGillivray (1921, 1923); two species described by Ross (1929) are also included. Placement of these species by Smith (1979) was based on the generic concepts of that time. Study of these specimens is preliminary to further work on eastern North American gall-forming sawflies and an updated catalog of Nearctic gall-forming sawflies of the genera *Euura* Newman, *Pontania* A. Costa, *Eupontania* Zinovjev, and *Phyllocolpa* Benson. Generic concepts have changed since Smith (1979) and the gall-forming sawflies of North America are poorly known. As a result of extensive work on the Palearctic and world fauna by Zinovjev (1993) and Zinovjev and Vikberg (in press), the types of Nearctic species need to be reexamined and incorporated into the current classification.

We give some notes on each species, illustrate the types, and attempt to associate the MacGillivray species with species treated in Yuasa (1922). We propose three new synonymies and three new combinations. The other four species have been treated correctly in previous literature. Species headings are in the original combinations.

SPECIES DESCRIBED BY MACGILLIVRAY

MacGillivray (1921) described 19 species of Nematinae, including seven species of *Pontania* "as a result of an extended series of collecting and breeding of sawfly larvae by Dr. H. Yuasa at Ithaca, New York, and by the Maine Agricultural Experiment

Station at Orono, Maine." The larvae of all these species were supposed to be described by Yuasa (1922). We examined part of Yuasa's collection from Maine (Orono) which is deposited in the National Museum of Natural History, Smithsonian Institution (USNM). It consists of a set of vials with larvae or remnants of leaves with galls kept in alcohol.

MacGillivray (1923) described 22 sawfly species in a paper on sawflies collected from "the Katmai Expedition to Alaska." Only one of them was described under the genus *Pontania* and currently (after Benson 1960) it is treated as a synonym of *Phyllocolpa excavata* (Marlatt 1896) (= *megacephala* Rohwer 1908; *destricta* MacGillivray 1923; *apicifrons* Malaise 1932; *carinifrons* Benson 1940) (Benson 1960, Smith 1979).

Pontania daedala MacGillivray 1921: 33 (Figs. 1, 10, 18)

Type locality.—Ithaca, New York.

Lectotype.—Designated by Frison (1927), female, "7-6"; "cocoon; Ithaca N. Y. 21 Aug. 11 [or 17?]"; "Type of female Pontania daedala A.D. MacGillivray [red label]"; "INHS TYPE #1592."

Valid name.—*Pontania proxima* (Serville 1823) (= *P. daedala* MacGillivray), **n. syn.**

Notes.—The species was reared by Yuasa (1922), and he described the larvae of *P. proxima* (as *Pontania hyalina* Norton) from the material numbered Y-7-1, -7-4-1, -8.8, Cu-cu 201, and M-92. The remnants of host-plant leaves in the vial (M-92) deposited in the USNM cannot be identified to species, but the sawfly is undoubtedly *P. proxima.* We did not find the number "7-6" in Yuasa (1922).

The female holotype has asymmetric mandibles; ovipositor (sawsheath + oblong plate) as long as the hindtibia (Fig. 10); short cercus, about half the length of the sheath; antennal hollow glabrous and shining with only few hairs on the lower part (Fig. 18), on the upper part the border between the inner orbit and antennal hollow convex and shining; and supraclypeal area glabrous. This combination of characters places it in the *proxima* group. MacGillivray mentioned the black color of the pronotum which may separate this species from *P. hyalina* Norton (a synonym of *P. proxima*), but in the holotype, the margins of the pronotum are pale, exactly as in specimens of *P. proxima* from Europe.

Pontania decrepita MacGillivray 1921: 33 (Fig. 11)

Type locality.—Ithaca, New York.

Holotype female.—"Ithaca, N. Y. 21 July '17; 35-2-5"; "Type of female Pontania decrepita A.D. MacGillivray [red label]"; "INHS TYPE #1594."

Valid name.—*Eitelius gregarius* (Marlatt 1896) (= *Pontania decrepita* MacGillivray). Synonymy by Ross (1951).

Note.—This species (under the name *Micronematus gregarius* Marlatt) was treated by Yuasa (1922) as being collected by himself ("Y"), but without mentioning its rearing number, and he did not mention the name *Pontania decrepita* MacGillivray. The holotype has claws of the same shape as characteristic for *Eitelius* and also the short, broad ovipositor in the holotype (Fig. 11) is typical for free-feeding Nematinae.

Pontania dedecora MacGillivray 1921: 32 (Fig. 7)

Type locality.—Ithaca, New York.

Lectotype.—Designated by Frison (1927), female, designated here; "185a2, May 24, 1919"; "Type of Pontania dedcora [sic!] A.D. MacGillivray, female [red label]"; "INHS TYPE # 1595."

Valid name.—*Phyllocolpa dedecora* (MacGillivray), **n. comb.**

Note.—This species was described from two females ("Nos. 185a2, 8.51 (?)-1-1"). Yuasa (1922) mentions none of these numbers.

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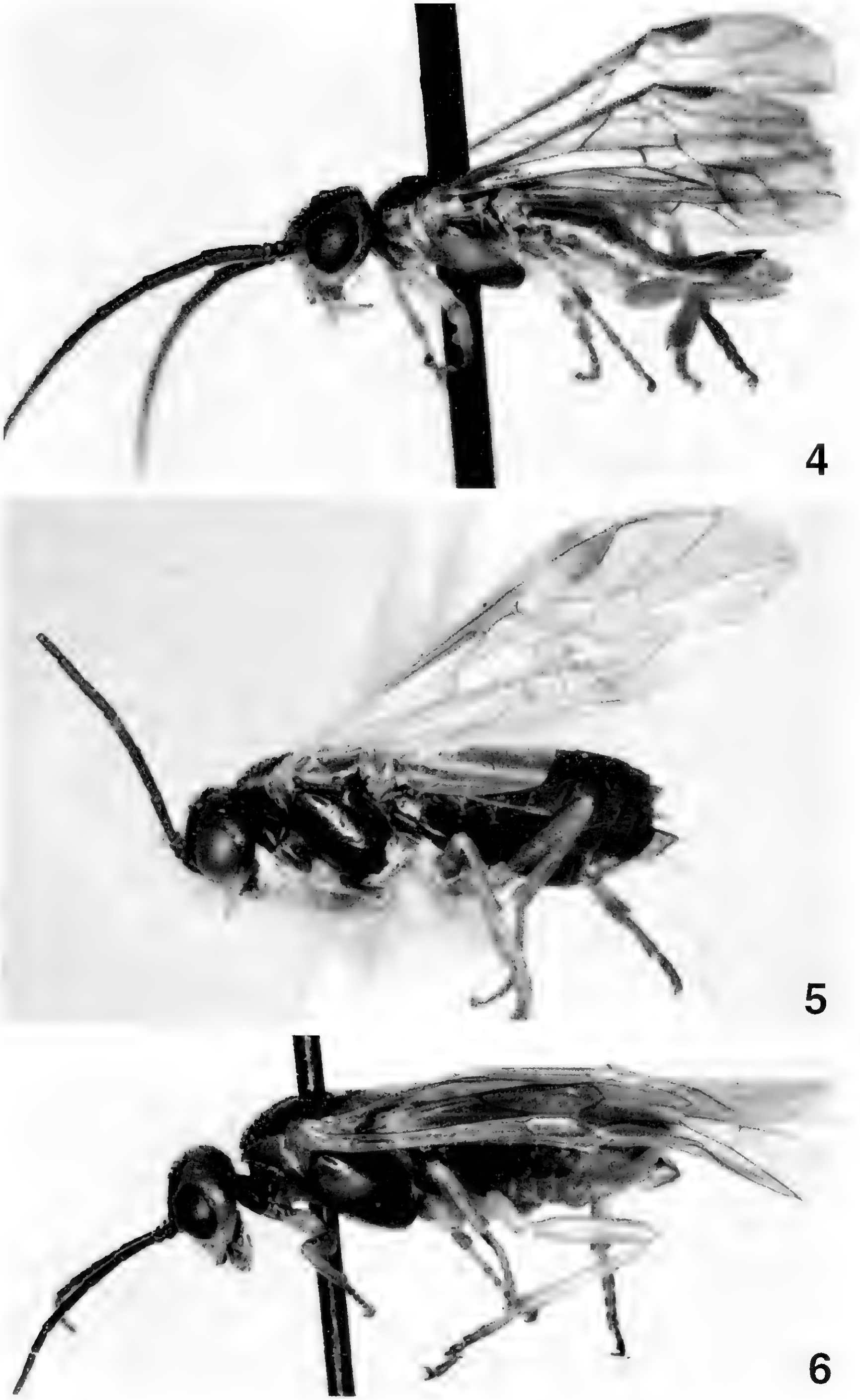
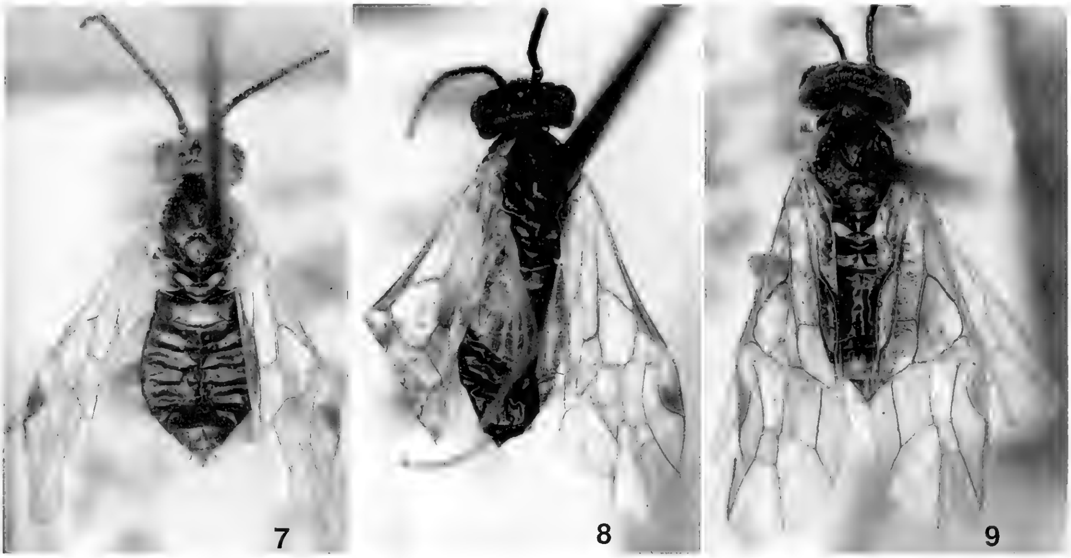
Figs. 1–3. Type specimens of *Pontania* in lateral view. 1, *P. daedala*. 2, *P. demissa*. 3, *P. devincta*.



Figs. 4–6. Type specimens of *Pontania* in lateral view. 4, *P. dotata*. 5, *P. destricta*. 6, *P. pepii*.



Figs. 7–9. Type specimens of *Pontania* dorsal view. 7, *P. dedecora.* 8, *P. derosa.* 9, *P. mariana.*

Pontania demissa MacGillivray 1921: 33 (Figs. 2, 12)

Type locality.—Ithaca, New York.

Lectotype.—Designated by Frison (1927), female, "191-1-1"; "Ithaca N. Y."; "Type of female Pontania demissa A.D. MacGillivray [red label]"; "INHS TYPE #1597."

Valid name.—*Eupontania gracilis* (Marlatt 1896) (= *Pontania demissa* MacGillivray), **n. syn.**

Notes.—Larvae and galls were described by Yuasa (1922) as *P. demissa* MacGillivray 1921 (Y-191-1-1). We have not seen larval material with this number.

Pontania demissa could be treated either as synonym of *Eupontania gracilis* (Marlatt 1896) or *E. petiolaridis* (Rohwer 1917). Both these species are associated with different willow species: *Salix sericea* Marsh., and *Salix petiolaris* Smith, respectively. These sawflies are very similar, and they might prove to be conspecific. Both willow species occur in the vicinity of Ithaca, and, at least in herbarium material studied by AGZ, the galls are known also from both host plants. However, *Salix sericea* seem to be more common there and galls only on this willow were found in the fall of 1997 around Ithaca by AGZ and T. Carr. The type of *Pontania demissa* fits best the type material of *E. gracilis,* and we consider them as synonymous.

Pontania derosa MacGillivray 1921: 34 (Fig. 8, 19)

Type locality.—Ithaca, New York.

Holotype.—Female, "142-1-1 May 13, 1919"; "Ithaca, N. Y."; "Type of female Pontania derosa A.D. MacGillivray. [red label]"; "INHS TYPE #1599."

Valid name.—*Phyllocolpa derosa* (MacGillivray), **n. comb.**

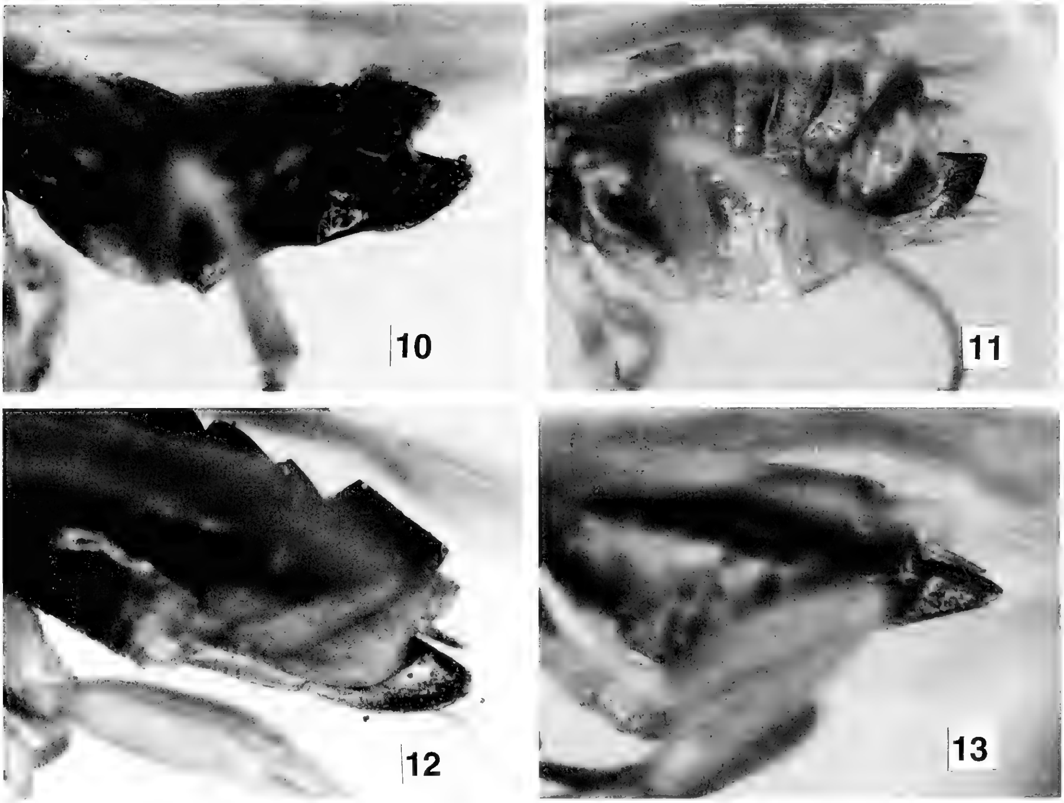
Notes.—The leaf-rolls and larvae were described by Yuasa (1922) in his key, but the host plant is unknown. The species is very similar to *Phyllocolpa nigrita* Marlatt, and these species may be conspecific.

Pontania devincta MacGillivray 1921: 34 (Figs. 3, 13)

Type locality.—Orono, Maine.

Lectotype.—Designated by Frison (1927), female: "Me. Exp. Sta. Lot. 1694 Sub. 9, 1 Aug. 13"; "Type of female Pontania devincta A.D. MacGillivray [red label]"; "INHS TYPE #1601."

Valid name.—*Pontania populi* Marlatt



Figs. 10–13. Apex of abdomen and sheath in lateral view of *Pontania* types. 10, *P. daedala*. 11, *P. decrepita*. 12, *P. demissa*. 13, *P. devincta*.

1896 (= *Pontania devincta* MacGillivray), **n. syn.**

Notes.—MacGillivray described this species from two (or more) females, with numbers Subs. 9 and 226. Yuasa (1922) mentioned the number 226, but he did not mention 9. The galls described by Yuasa, kept in the USNM (Maine: Bangor Bay, "M-226"), belong to the gall-making *Eupontania consors* (Marlatt 1898). The plant species is *Salix humilis* Marsh. with comparatively large, glabrous leaves (which is typical of plants growing in shadowy forests). We have not seen reared specimens with Nr. 226, but according to the galls, the paralectotype with this number belongs to *Eupontania consors.* However, the lectotype belongs to the leaf-rolling species group of *Pontania* s. str. and is conspecific with *Pontania populi,* a leaf-rolling species on *Populus grandidentata* Michx. It is conspecific also with a specimen identified as *P. devincta* by R. B. Benson (kept in The Natural History Museum, London) who (1960) incorrectly synonymized *Pontania devincta* under *P. excavata* Marlatt.

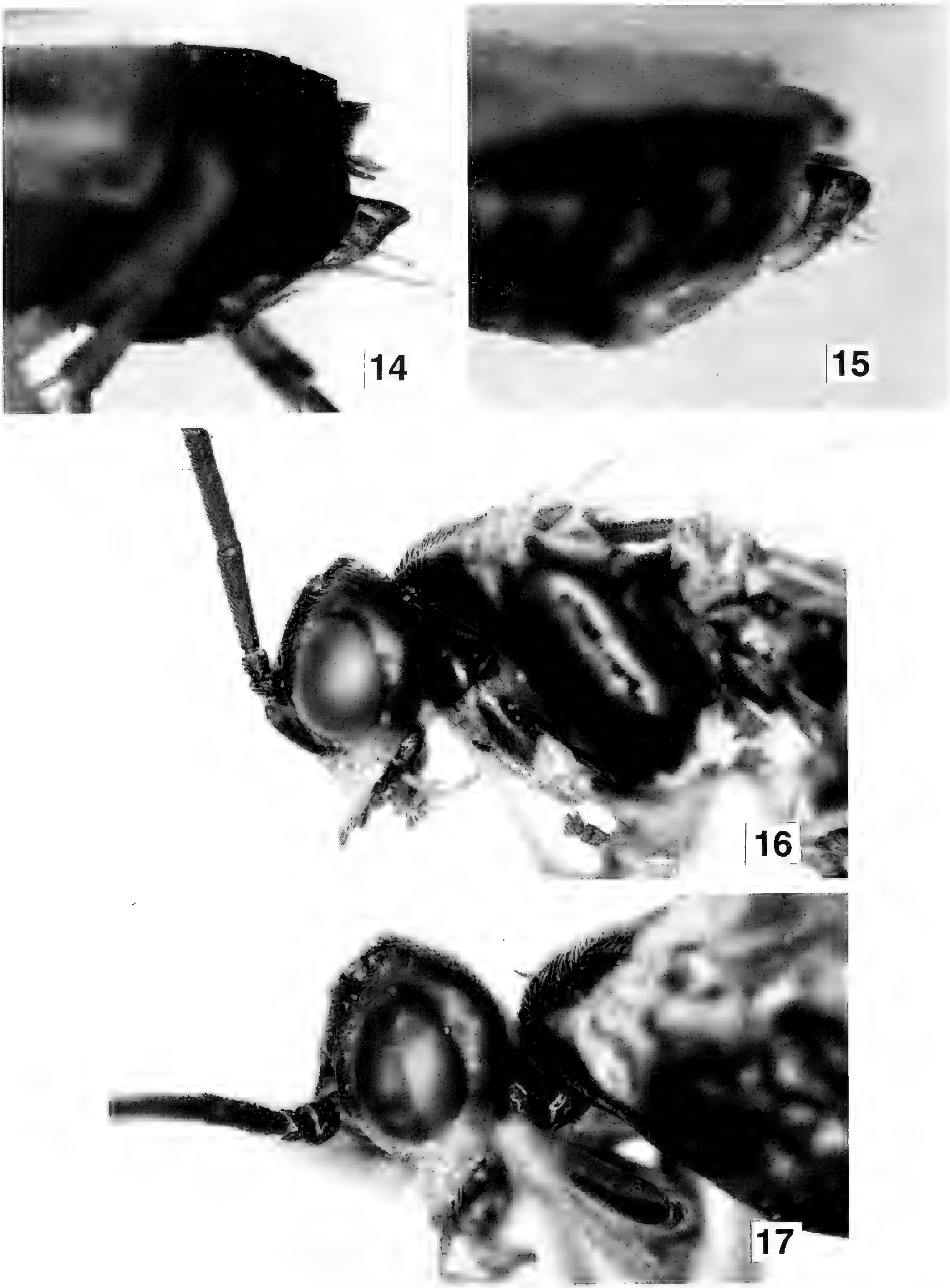
Pontania dotata MacGillivray 1921: 34
(Fig. 4)

Type locality.—Ithaca, New York.

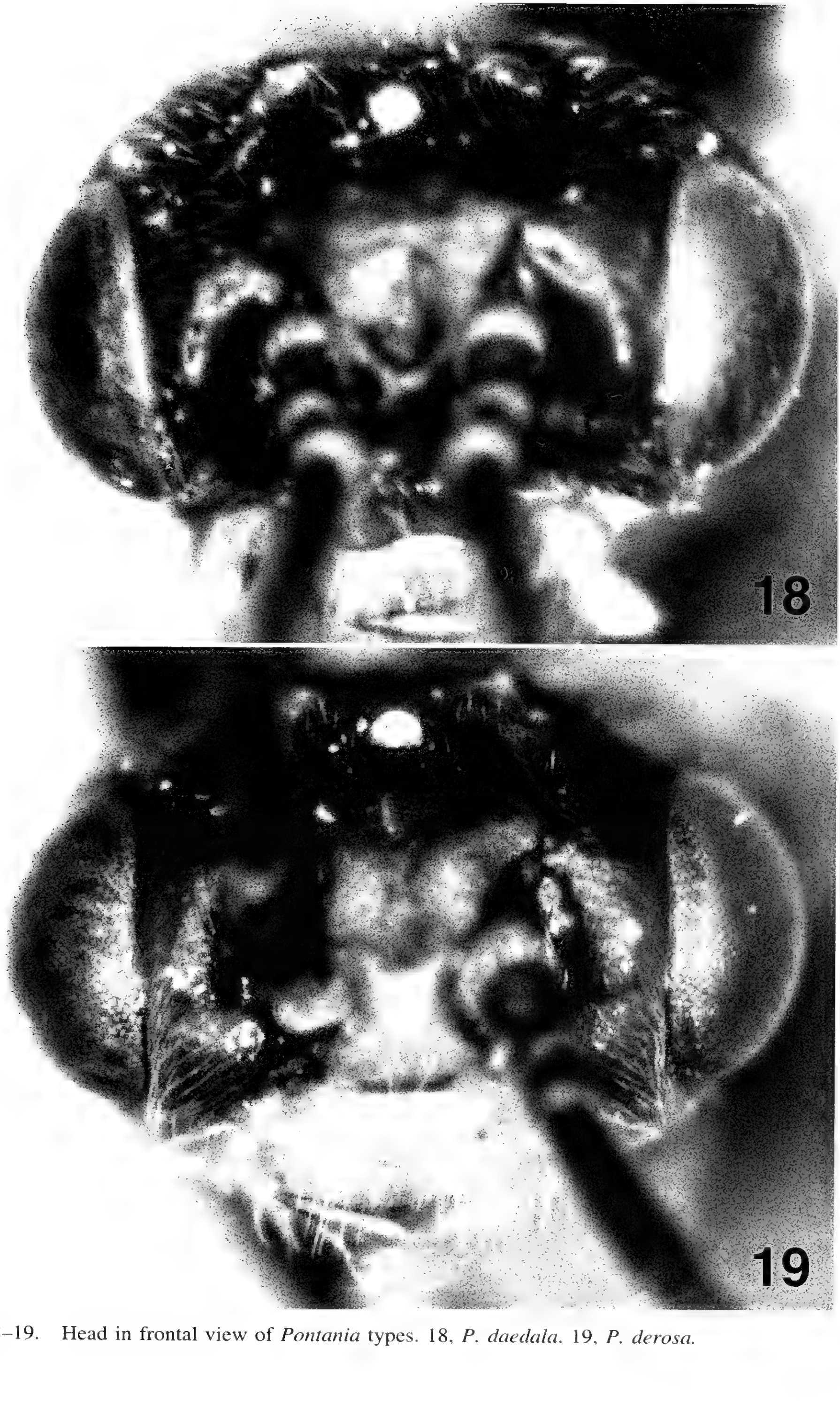
Lectotype.—Designated by Frison (1927), male, "8-48 (?)-1-1"; "Ithaca N.Y. 25 Aug. 18"; "Type of male Pontania dotatus A.D. MacGillivray [red label]"; "INHS TYPE #1603."

Valid name.—*Nematus dotatus* (MacGillivray), **n. comb.**

Note.—This species belongs to the genus *Nematus* Panzer (= *Pteronidea* Rohwer) but cannot be placed more precisely at pre-



Figs. 14–17. 14–15, Apex of abdomen and sheath in lateral view of *Pontania* types. 14, *P. destricta.* 15, *P. excavata.* 16–17, Head and thorax in lateral view of *Pontania* types. 16, *P. destricta.* 17, *P. excavata.*



Figs 18–19. Head in frontal view of *Pontania* types. 18, *P. daedala*. 19, *P. derosa*.

sent. It seems that this specimen was reared by Yuasa, but he did not mention this name or the number "8-48 (?)-1-1" in his keys. However, the larvae with a similar number (Y-8-48(?)-1) were described by Yuasa as *Pteronidea* sp. 6.

Pontania destricta MacGillivray 1923: 168
(Figs. 5, 14, 16)

Type locality.—Alaska: Katmai

Holotype.—Female (glued on the cardboard triangular point): "Katmai Alaska June '17"; "Jas S Hine Collector"; Type of Pontania destricta A.D. MacGillivray female"; "INHS TYPE #1600."

Valid name.—*Phyllocolpa excavata* (Marlatt 1896) (= *Pontania destricta* MacGillivray). Synonymy after Benson (1960).

Note.—This species belongs to the *Phyllocolpa leucapsis* group, characterized by glabrous and shining antennal hollows and the hairs of the upper posterior part of the mesepisternum directed upwards. We are not sure that it is conspecific with *Phyllocolpa excavata* (Marlatt 1896), described from "California, Colorado" and "Veta Pass, Colo." The type of *P. destricta* differs from that of *Phyllocolpa excavata* Marlatt 1896 (Figs. 15, 17) by a less rounded sawsheath with a distinct emargination beneath in lateral view (Figs. 14–15), by the shape of the inner orbits in lower part (Figs. 16–17), and by the darker coloration (while type of *P. exavata* is paler colored than it is typical for this species).

SPECIES DESCRIBED BY ROSS

H. H. Ross (1929) described four species in his paper revising Marlatt's "Group I" of *Pontania* (= *Phyllocolpa* Benson). Types of two of them are deposited in INHS.

Pontania mariana Ross, 1929: 91
(Fig. 9)

Type locality.—Canada, B.C., Vancouver.

Holotype.—Female, reared from leaf-curl on *Populus balsamifera*; "Vancouver. B. C. Larva coll. IX. 4. 1927 H. H. Ross"; "emerged VI. 4. 1928"; [red label] "HOLOTYPE Pontania mariana Ross female"; "INHS TYPE #1606."

Valid name.—*Phyllocolpa mariana* (Ross).

Host plant.—*Populus balsamifera* L.

Additional material examined.—Female (paratype), Vancouver. B. C. Larv. Coll. IX. 4. 1928 H. H. Ross; Reared from *Populus balsamifera* leaf-curl; emerged VI. 4. 1928; [red label] Paratype No 42755; PARATYPE *Pontania mariana* H. H. Ross. Deposited in the USNM.

Pontania pepii Ross, 1929: 95
(Fig. 6)

Type locality.—Montana, Florence.

Holotype.—Female, "Mont. Exper. Station Coll. Florence Mont. June 1, 1912"; "HOLOTYPE Pontania female peppii Ross [red label]"; "INHS TYPE #1608."

Valid name.—*Phyllocolpa pepii* (Ross).

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THE LARVA AND PUPA OF *SCHIZONYXHELEA FORATTINII* WIRTH AND GROGAN (DIPTERA: CERATOPOGONIDAE) WITH A DISCUSSION OF THE PHYLOGENETIC RELATIONSHIPS OF THE GENUS

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Abstract.—The larva and pupa of *Schizonyxhelea forattinii* Wirth and Grogan are described for the first time. Larval, pupal and adult character states suggest that this genus is closely related to *Stilobezzia* Kieffer and may even be most closely related to only some species of *Stilobezzia.*

Resumen.—Se describen por primera vez larva y pupa de *Schizonyxhelea forattinii* Wirth y Grogan. El estado de los caracteres de larva, pupa y adulto, sugiere que este género se halla muy relacionado a *Stilobezzia* Kieffer, y puede aún, ser más cercano a sólo algunas especies de *Stilobezzia.*

Key Words: *Schizonyxhelea, Stilobezzia,* immatures, taxonomy, phylogeny, systematics, Costa Rica, Neotropical

The immatures of the Ceratopogonidae remain as one of the most poorly known life stages of all nematoceran families. As part of a project to generate descriptions, keys and phylogenetic interpretation of these stages (Borkent, in preparation), this paper provides a description of the larva and pupa of *Schizonyxhelea forattinii* Wirth and Grogan and interprets available character stages of the genus *Schizonyxhelea* Clastrier from a cladistic perspective.

Schizonyxhelea includes two Neotropical species and both are very small in size, with wing lengths of 0.7–0.8 mm. When the genus was first proposed by Clastrier (1984), he suggested that the single known species, *S. guyana,* was similar to species of *Nannohelea* Grogan and Wirth and *Bothahelea* Grogan and Wirth. Wirth and Grogan (1988) described a second species, *S. forattinii,* including the first male of the genus and hypothesized that *Schizonyxhelea* was related to a group of genera with reduced features: *Baeohelea* Wirth and Blanton, *Baeodasymyia* Clastrier and Raccurt, *Nannohelea* Grogan and Wirth and *Rhynchohelea* Wirth and Blanton. Since then Borkent (1992, 1995), Borkent and Craig (1999) and Grogan and Borkent (1992) have shown that *Baeohelea* and *Baeodasymyia,* as sister genera, are likely an early lineage within the Ceratopogonini and that *Nannohelea* and *Rhynchohelea* belong to a group which also includes the genera *Brachypogon* Kieffer, *Ceratoculicoides* Wirth and Ratanaworabhan and *Sinhalohelea* Grogan and Borkent. The genus *Schizonyxhelea* has remained an enigma. Discovery of the immatures and examination of fresh adult material of *S. forattinii* provided an opportunity to further investigate the genus.

MATERIALS AND METHODS

Terms for larval and pupal structures follow Lawson (1951). The single live larva was discovered by placing a mud sample in water and shaking the container gently. The swimming larva was then captured with an eye-dropper and reared in a petri dish (5 cm in diameter) with a small amount of substrate (mud and detritus) from the original habitat. The larva and subsequent pupa were kept at ambient temperature (approximately 25°C) and checked daily. When needed, a small amount of water was added to the petri dish to keep the sample from drying. The larval and pupal exuviae and partially emerged adult were preserved in 70% ethanol and slide-mounted using the method described by Borkent and Bissett (1990).

Adults were also captured in the field by sweeping vegetation with an aerial net; these were examined as cleared specimens in glycerine and on slides. Specimens were compared to the holotype of *S. forattinii.*

The specimens are deposited in the Canadian National Collection in Ottawa, Ontario, Canada.

DESCRIPTION OF LARVA AND PUPA

Fourth instar larva.—Body length unknown. Head capsule (Figs. 1A, B) relatively short (111 μm), blunt (head length/width = 1.28), uniformly medium brown. Collar slightly darker than rest of head capsule, well-developed ventrally with ventrolateral anterior apodeme, separated ventromedially, terminating dorsolaterally. Frontal suture extending to near anterior margin of labrum. Ventral suture short. Most setae simple with the following divided or plumose: s, v, posterior o; arrangement as in Figs. 1A, B; bases of sensilla more or else equal in size; following sensilla not visible: j, r, z, x, n. Antenna short, further details not visible. Eye unknown. Labrum short, wide, details not visible. Mandible elongate, basal portion straight, apical third curved, sensilla not visible. Maxilla not clearly visible, palpus short. Hypostoma a broadly rounded projection. Epipharynx with 1 pair of serrate combs, divided medially (Fig. 1B). Thorax, abdomen with more or less uniform light pink pigmentation. Caudal segment, anal papillae unknown.

Pupa.—Length 1.29 mm. General coloration uniformly light brown. Body surface generally smooth with only a few tubercles and spicules associated with setae, a few restricted to the medioanterodorsal and medioanteroventral areas of abdominal segments 3–8 and anal segment. Operculum (Fig. 1C) with well-developed anteromarginal seta located on tubercle, with pore at tubercle base; dorsolateral margin with row of well-developed spines. One well-developed anterodorsal seta on moderately elongate, rounded tubercle (Fig. 1G). One long, slender and two shorter dorsolateral setae (Fig. 1H). Two short dorsomedial seta, one thicker than other (Fig. 1F). Five dorsal sensilla, i short thick seta, ii, iv short, slender setae, v, vi pores; i, ii, iv on single, rounded, short, separate tubercles (Fig. 2A). Ventromedian setae not visible (if present, they are very minute). Two ventrolateral setae slender, bases somewhat separate (Fig. 1E). Respiratory organ (Fig. 1D) somewhat curved, smooth; four spiracles situated along length, with 5–6 spiracles situated apically, opening at surface; tracheal tube of more or less equal diameter for length. Metathorax not divided medially, with medial protuberance from scutum protruding to near posterior margin. Abdomen with setae separate from one another (none on common tubercle), each bordered by comb-like or single elongate spicules. Segment 4 setal pattern (Fig. 2C) with 2 d.a.s.m., 4 d.p.m., 1 l.a.s.m., 3 l.p.m., 3 vn; setae d.p.m. i–iii not present or very small; setae d.p.m. iv, l.a.s.m., l.p.m. i, iii, all thick, stout. Anal segment (Fig. 2B) with caudal spine moderately elongate, somewhat curved apically, directed posterolaterally.

Bionomics.—The single larva was collected on December 17, 1993, 2 km northeast of Tarcoles, Costa Rica from wet mud in a small seep which flowed into the outflow of a larger spring on private property directly west of Reserva Carara. The larva

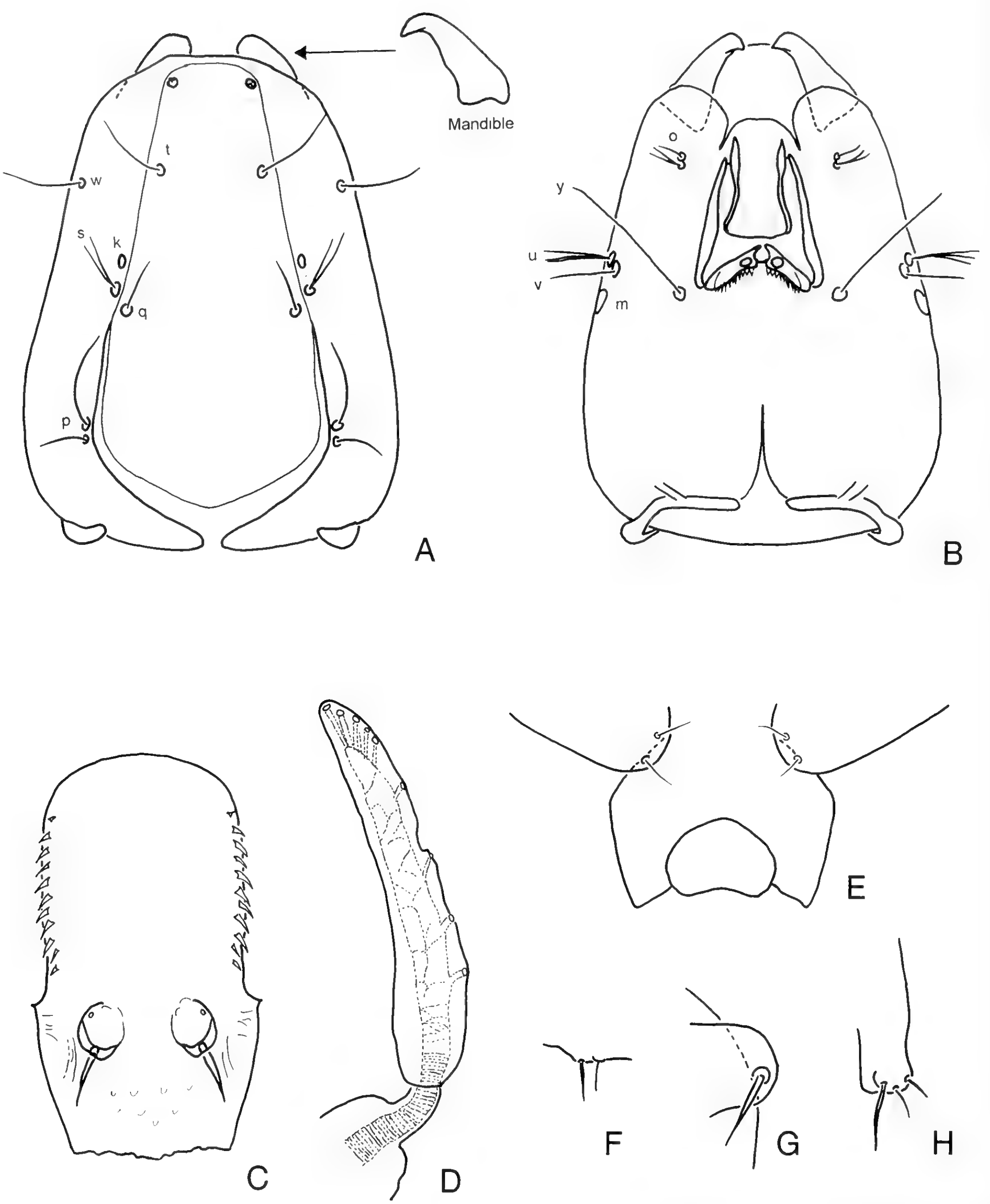

Fig. 1. Structures of *Schizonyxhelea forattinii.* A, Larval head capsule in dorsal view. B, Larval head capsule in ventral view. C, Pupal operculum. D, Pupal respiratory organ. E, Pupal mouthparts in ventral view. F, Pupal dorsomedial setae. G, Pupal anterodorsal seta. H, Pupal dorsolateral setae.

swam with the same rapid serpentine motion as do so many Ceratopogoninae. During eight months in Costa Rica (July, 1993–Feb. 1994) I collected only one larva and two male and 11 female adult *S. forattinii.* Each of the sites was at, or very near, a first order seep or spring, or a small stream and specimens were collected from August to

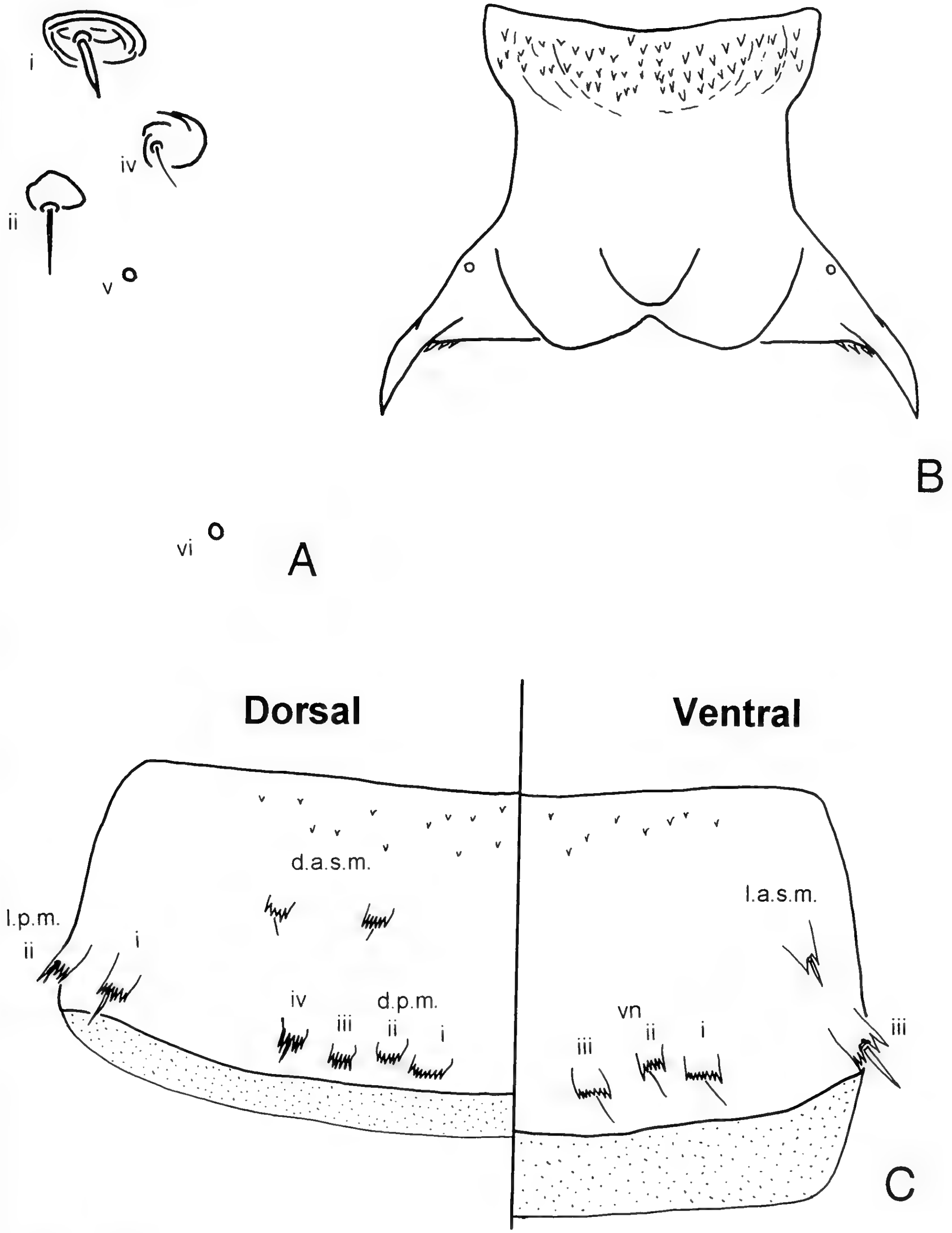

Fig. 2. Pupal structures of *Schizonyxhelea forattinii.* A, Dorsal setae. B, Anal segment in ventral view. C, Setae of fourth abdominal segment.

December (3 sites at 2 km NE Tarcoles from Aug. 3 to Dec. 17, 1993; a first order spring in Atenas Oct. 1 to Dec. 7, 1993). This suggests that immatures of this species are restricted to small lotic habitats.

Discussion

There are two newly discovered character states which provide cladistic information regarding the phylogenetic position of *Schizonyxhelea.* The first is the presence of plumose setae on the head capsule of the larva, which merely indicates the unsurprising conclusion that this taxon belongs within that group of Ceratopogoninae which is the sister group of *Ceratopogon* Meigen and, possibly *Baeodasymyia* + *Baeohelea.* This character is discussed further by Borkent and Craig (1999). The second character state concerns the nature of the male aedeagus. Borkent (1995: 97–98) discussed (as his character 39) the uniquely divided aedeagus of species of *Stilobezzia* Kieffer. Wirth and Grogan (1988) pointed out that the male aedeagus of *Schizonyxhelea* was difficult to interpret. However, reexamination of fresh material here, especially from a posterior aspect, shows that the aedeagus of *S. forattinii* is divided medially, indicating at least a sister group relationship to, or within, *Stilobezzia.*

Further character states suggest that *Schizonyxhelea* is actually closely related to a species group within *Stilobezzia* and they are discussed below. Although these features are not yet understood cladistically, continuing studies show promise for the interpretation of most of these (Borkent, in preparation).

—Larval head capsule sensilla q, s, k are all close to each other (present in *Stilobezzia flavirostris* (Winnertz) and *S. papillata* Remm, the only two species of *Stilobezzia* for which this character state has been described). The character state appears to be unique within the Ceratopogonini but is also present in some Sphaeromiini and Palpomyiini.

—The following features are shared with the pupa of *Stilobezzia bulla* Thomsen: pupal respiratory organ shape and distribution of spiracles virtually identical; presence of thick spines on margin of operculum (also present in many other genera); same number and similar size of thoracic setae; specific distribution of sensilla and spines on segment 4 especially including the anterior lateral sensilla and the presence of comblike spines associated with most sensilla very similar; presence of two medial, low projections on the dorsum of the anal segment; presence of spines on posterior margin of apicolateral processes of anal segment.

—All *Stilobezzia* pupae are missing one of the dorsal setae (probably # 3) and this appears to be nearly unique within the Ceratopogonidae. It is also known in *Baeodasymyia*; Borkent and Craig (1999) misidentified sensilla v as iii and vi as v.

—The male antenna of *Schizonyxhelea* have flagellomeres 5–10 fused. Flagellomeres 5–9 are fused in *S. bulla* and flagellomeres 5–10 in *S. thomsenae* Wirth. The males of most species of *Stilobezzia* have separate flagellomeres.

—A few genera of Ceratopogonini (including *Stilobezzia*) and most genera of Heteromyiini + Sphaeromiini + Palpomyiini + Stenoxenini have a secondary row of palisade setae (defined in detail by Borkent, in press). This is also present in *Schizonyxhelea.*

—Adult eyes of *Schizonyxhelea* have minute interfacetal pubescence. Very small interfacetal spicules are also present in *S. bulla* (otherwise rare in *Stilobezzia*).

—Wing with radial cells reduced. Although Wirth and Grogan (1988) suggested that *Schizonyxhelea* lack radial cells, the male I have had a narrow second radial cell. A number of *Stilobezzia* species have a small or completely reduced first radial cell. However, loss of radial cells is known in a number of other genera of Ceratopogonidae and the character state cannot be interpreted at present. It was likely the reduced radial cells which led Wirth and Grogan (1988) to suggest that *Schizonyxhelea* was related to other genera with reduced wing venation but, as noted in the introduction, these taxa with reduced character states are not closely related to one another. It is apparent that several lineages of Ceratopogonidae have produced small species which have independently reduced their wing venation and, for some, their mouthparts, antennae and parts of the male genitalia.

—Wing with a narrow apical band of macrotrichia. This character state is shared with *S. bulla* and *S. thomsenae* and appears to be unique with the subgenus *Stilobezzia.* Members of the subgenera *Debenhamia* Wirth and Grogan and *Acanthohelea* also have macrotrichia on the wing membrane but this is nearly always more generally distributed on the apex of the wing. *Stilobezzia (Acanthohelea) insolita* Das Gupta and Wirth from Malaysia also has a narrow band of macrotrichia and the female has a distinctively (but not unique within the Ceratopogonidae) curved single spermathecae very similar to that present in female *Schizonyxhelea.*

—Aedeagus very reduced in size. This character state is shared with *S. bulla, S. thomsenae* and a few other *Stilobezzia.* The condition is otherwise rare within the Ceratopogonidae.

—Male cerci are closely approximated. This is present in *S. thomsenae,* some other *Stilobezzia* and some other genera of Ceratopogonini.

The striking similarity of the pupae of *Schizonyxhelea forattinii* and *Stilobezzia bulla* and the presence of fusion of male flagellomeres 5–9 or 10, the narrow band of apical of macrotrichia on the wing and the reduced aedeagus shared with *S. bulla* and *S. thomsenae* probably indicates that the two species of *Schizonyxhelea* are actually small *Stilobezzia* with a somewhat reduced wing venation and with equal claws on each leg of the female. A reversion from a single claw to double claws is known in other genera such as *Serromyia* Meigen (Borkent and Bissett, 1990) and *Alluaudomyia* Kieffer (personal observation of new species) and it would not be surprising to find the same within *Stilobezzia*; indeed, I have a small *Stilobezzia* from Costa Rica with equal claws but with typical *Stilobezzia*-like wing venation (i.e., a small first and a long second radial cell is present).

It is yet possible that the pupal character states shared by *Schizonyxhelea forattinii* and *Stilobezzia bulla* are plesiomorphic within *Stilobezzia* and that *Schizonyxhelea* is therefore the sister group of *Stilobezzia.* Further study is required of character state polarities to resolve this question (Borkent, in preparation). For the present it is best to continue to recognize *Schizonyxhelea* as a valid genus.

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DESCRIPTION OF THE LAST LARVAL INSTAR AND PUPA OF *LUCIDOTA ATRA* (G. A. OLIVIER 1790) (COLEOPTERA: LAMPYRIDAE), WITH A DISCUSSION OF ABDOMINAL SEGMENT HOMOLOGY ACROSS LIFE STAGES

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Abstract.—The last larval and pupal stages of the widespread and common North American firefly, *Lucidota atra* (G. A. Olivier 1790), are described and illustrated. Last instar larvae were collected in rotting logs in the early spring and fed terrestrial snails from the same logs until the larvae pupated. The larva of *L. atra* was misidentifed in the literature and has subsequently been misidentified as a species in the genus *Photinus*. A discussion of the homology of abdominal sclerites in larval, pupal, and adult fireflies is provided.

Key Words: Lampyridae, *Lucidota atra, Photinus,* larva, pupa, morphology, firefly, lightningbug, glowworm, ventrite

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The genus *Lucidota,* as defined by Laporte (1833) and fixed by Motschulsky (1853), is restricted to the New World and contains some 64 described species. The genus ranges from the United States to Argentina. *Lucidota atra* (G. A. Olivier) occurs from the northeastern United States to Central America (McDermott 1966). The larva of this species was first described by H. F. Wickham (1895), but because larvae in the tribe Photinini are difficult to distinguish (LaBella and Lloyd 1991), a more detailed larval description is required. Peterson (1951) apparently incorrectly identified the larva on which he based his drawing of "*Photinus* sp." in his book "*Larvae of Insects.*" Upon examining "*Photinus* sp." in Peterson's larval collection at The Ohio State University and comparing it with larvae reared by one of us (MAB), it was discovered that Peterson's larva is actually *L. atra.*

For this study, last instar larvae were collected in early spring and kept until eclosion, thus allowing a positive identification from the adult. No larval descriptions exist for other species of this genus, most likely due to difficulties in rearing firefly larvae (Archangelsky and Branham 1998).

Materials and Methods

Seven last instar larvae were collected in a rotting log on April 6, 1993 outside of Lawrence, KS, and kept in a glass jar with damp wood from the log along with some terrestrial snails collected in the same wood. Empty snail shells were removed from the jar every few days. The wood inside the jar was inspected for moisture content periodically. When the wood appeared to be drying out, it was moistened with distilled water. To further simulate the inside of the log, the jar was wrapped with paper to reduce light entering the jar. No special requirements were necessary for pupation.

Three larvae and one pupa were fixed in boiling water and transferred to 70%EtOH. In order to study the larval morphology, a specimen's head, mouthparts and antennae were dissected, cleared in lactic acid, and mounted on microscope slides using Hoyer's as the mounting medium. The descriptions and drawings were done using a Wild M5 dissecting microscope and a Zeiss Axioscope 20 compound microscope, both with a camera lucida.

RESULTS

Lucidota atra (G. A. Olivier)

Description of last larval instar.—Length: 13.0 to 15.0 mm. Body elongate, fusiform, slightly flattened dorsoventrally (Fig. 1). Whitish ventrally with pink along sides of thorax and abdomen. Sclerotized regions uniformly light to dark brown and granulose. All tergites, except abdominal tergites 8 and 9, bearing 3 light colored stripes that are more or less parallel to the longitudinal axis of body.

Head capsule: Prognathous, subquadrate, dorsoventraly flattened, and robust (Fig. 2); retractable within thorax. Labrum and clypeus fused. Epicranial suture present as well as frontal sutures that extend to bases of antennae. One pair of lateral stemmata, posterior to base of antennae. Head capsule not fused ventrally (Fig. 3).

Antenna: 3-segmented, partially retractable within membranous base (Fig. 4); originating on latero-apical edges of head capsule. Basal segment widest, attached to membranous base, median portion of dorsal surface covered with medium length setae pointing anteriorly, lateral pointing setae on anterior third of segment approximately 2 to 3 times a long as setae in medial region. Second segment shorter than third, narrower, evenly covered by long setae, carrying a large globular sensorium slightly longer than third antennomere. Third segment very short, stout with several short setae, an api-

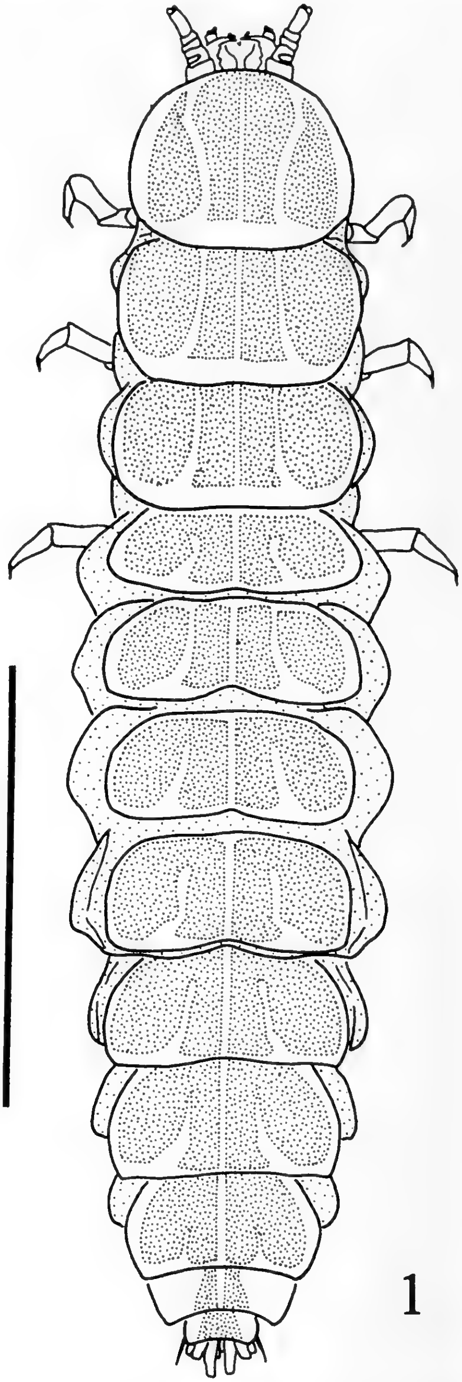
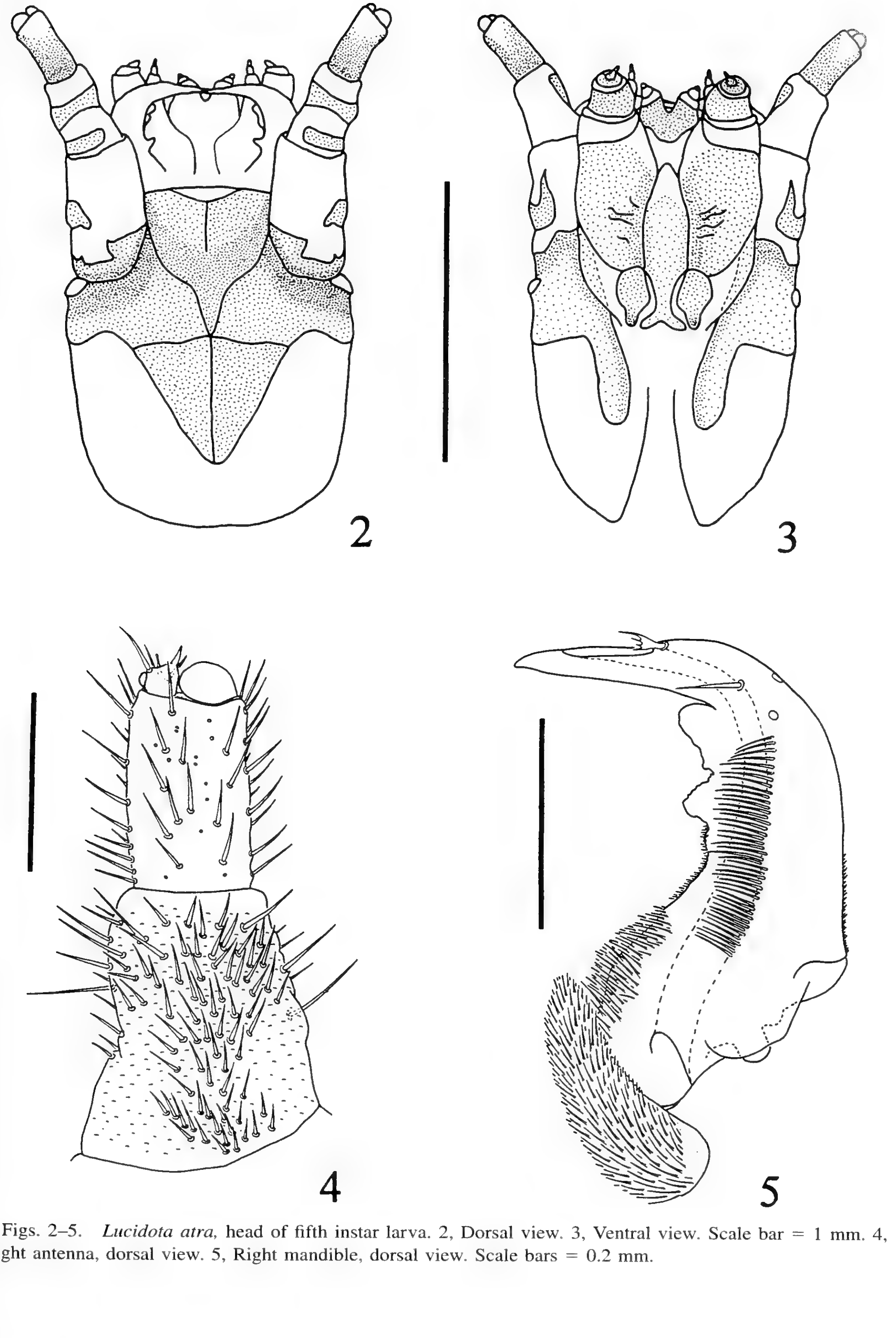
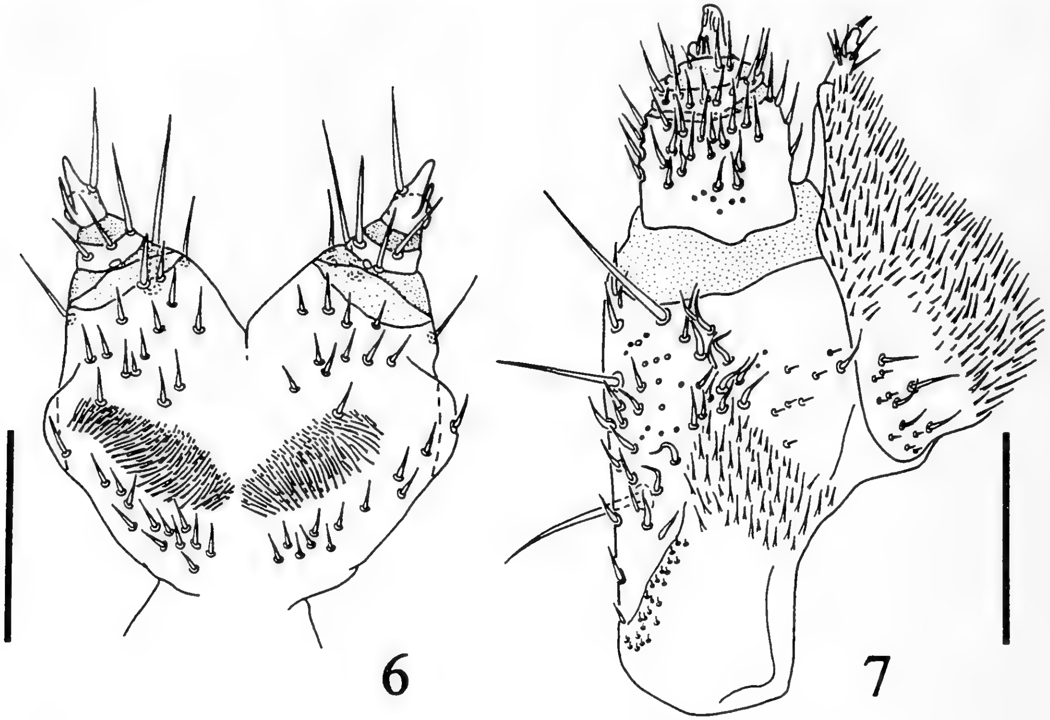


Fig. 1. *Lucidota atra,* fifth instar larva, habitus. Scale bar = 5 mm.



Figs. 2–5. *Lucidota atra,* head of fifth instar larva. 2, Dorsal view. 3, Ventral view. Scale bar = 1 mm. 4, Right antenna, dorsal view. 5, Right mandible, dorsal view. Scale bars = 0.2 mm.



Figs. 6–7. *Lucidota atra,* fifth instar larva. 6, Labium, dorsal view. Scale bar = 0.15 mm. 7, Left maxilla, dorsal view. Scale bar = 0.23 mm.

cal spine, and a small globular sensorium on inner surface just below the antennal apex.

Mandible: Symmetrical, strongly falcate, with an inner channel opening subapically on outer edge (Fig. 5). Retinaculum present, forming 2 inner teeth on the apical third of mandible. Basal third of the retinaculum covered with a dense brush of setae. Medial region of mandible covered by a single row of long setae pointing inward toward the retinaculum, perpendicular to the inner channel of the mandible; 1 long seta parallel to apical point of the mandible, just anterior to row of setae located medially. One 4-pronged seta or sensory appendage on outer margin of mandible, just before channel opening; outermost prong of this seta longer than the other 3.

Labium: Closely attached to maxilla, formed by a short and strongly sclerotized prementum, mentum (distally membranous) and submentum (fused to mentum). Prementum heart shaped, in both dorsal and ventral views with distal apical cleft (Fig. 6); in dorsal view, bearing 2 basal regions of very fine setae with longer setae present on the segments of the palp; 2 brushes of fine cuticular spines present on each side of prementum. Palpus 2-segmented; basal segment short, bearing several spines, second segment twice as long as first, pointed and somewhat forked with a single spine (Fig. 6).

Maxilla: Apical region (Fig. 7). Basal region (Fig. 3). Long and robust, closely attached to labium. Cardo (Fig. 3) irregularly shaped, bearing no setae. Stipes (Fig. 7) very broad, ventral surface covered with setae and bearing a single long seta; dorsal surface bearing 2 long setae. Galea large, 2-segmented, basal segment very long, 3 times as long as second segment and lacking setae; distal segment short, conical and bearing several short setae with 1 seta on distal apex of segment. Lacinia large, twice as long as first segment of the galea, inner surface covered with a thick brush of cuticular spines. Palpus 3-segmented, basal segment largest, subquadrate, longer than other 2 segments combined, distal two-thirds covered with medium to long setae; second segment wider than long and bearing medium length setae; distal segment subconical without setae, bearing a globular sensorium-type structure.

Thorax: Prothorax subcircular, wider at base, containing retracted head when larva is in repose. Meso- and metathorax subrectangular. Thoracic tergites subdivided by sagittal line. Each segment with pleural area formed by an upper laterotergite, below it an epimeron and episternum separated by pleural suture; mesothoracic laterotergite subdivided, anterior plate smaller, carrying mesothoracic spiracle. Prosternum medium sized; meso- and metasterna smaller, narrow, subdivided into an anterior basisternum and a posterior sternellum. 1 pair of biforous spiracles present on mesopleuron.

Legs: 5-segmented, coxae long and cylindrical, robust; trochanters small, subtriangular in lateral view; femora long and cylindrical, widening slightly apically, with a single long seta in medial inner portion; tibiotarsi as long as femora, tapering towards distal end; pretarsi strong, simple, with a pair of stout setae at base. Double row of strong setae on inner margin of tibiotarsi, lacking on inner margin of femora.

Abdomen: 10-segmented, segments 1 to 8 similar in shape, tapering toward end; each tergite subrectangular, tergites 1 through 8 divided by a sagittal line and 2 lighter colored lines parallel to sagittal line; lateral portions of tergite 8 lightly colored; lateral portions of tergite 9 lightly colored and without sagittal line; segment 10 a narrow ring surrounding anal region, carrying holdfast organ. Pleural areas well developed, segments 1 to 7 subdivided, upper plate large, suboval, carrying spiracles, lower plate small, narrowly subtriangular; pleuron 8 with only 1 suboval plate carrying a spiracle; pleural areas of segments 9 and 10 reduced. Abdominal sterna large, subquadrate, narrowing towards end of abdomen. Postero-lateral corners of sternite 8 bearing a twin spotted photic organ. Color pattern similar to that of thorax. Biforous spiracles present on pleurites 1 to 8.

Description of pupa.—Female, one day old. Slightly curved, ventrally concave; young pupa white, older pupa approaching charcoal in color. Length: 10.0 to 11.0 mm.

Head: Completely covered by pronotum in dorsal view (Fig. 9), white. Eyes small, on sides of head; antennae inserted in front of eyes, serrate with 11 obvious segments, extending in length to metacoxae; antenna and mouthparts white.

Thorax: Pronotum large, subtriangular, slight emargination on either side of anterior apex, covering head; white or cream. Meso- and metanotum shorter than pronotum, subrectangular, carrying wing pads on sides; posterior medial portion of mesonotum coming to a point, point lacking on metanotum. First and second pair of legs fully visible in ventral view; third pair of legs almost completely covered by wingpads, only metatarsus visible.

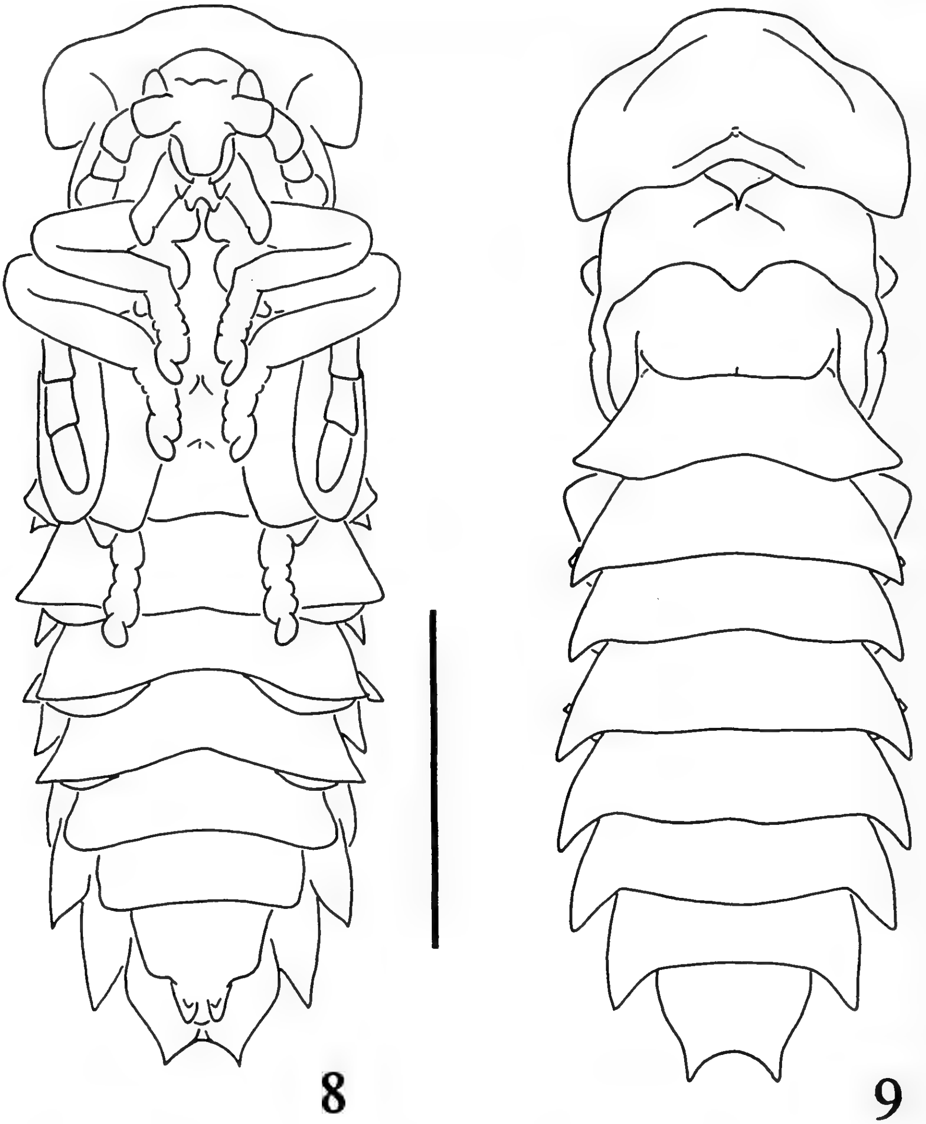
Abdomen: Segments wider than long, white. Tergite 1 with postero-lateral corners pointing perpendicular to sagittal axis of pupa; postero-lateral corners of tergites 2 through 8 coming to a point and directed posteriorly. Pleurites fused to the sternites (except for pleurite 1 which bears spiracle 1) thus forming lateral margins of abdominal "ventrites" (see Discussion.) First sternite lacking, first ventrite (sternite 2) partially visible, remaining ventrites fully visible, 7 total in female pupa, (male pupa with 8 ventrites total.) Medial-lateral corners of ventrite 7 (sternite 8) bearing a twin spotted photic organ.

Spiracles: 9 pairs; First on pleuron of mesothorax, remaining 8 on abdominal segments 1 to 8.

DISCUSSION

Biology

The activity period of *L. atra* adults range from early June to July, and the larval



Figs. 8–9. *Lucidota atra,* pupa. 8, Ventral view. 9, Dorsal view. Scale bar = 4 mm.

life is suspected to be approximately two years long, since both large and small larvae have been found together during midsummer (Balduf 1935). However, as this species has not been successfully reared from egg to adult, the two year life cycle remains speculative. Because *L. atra* larvae are typically found in rotten logs and stumps from the fall through early spring, it is assumed that these are the larvae that overwinter (Williams 1917; MacDermott 1964; MAB, personal observation). It should be noted, however, that stumps and logs are places where many coleopterists typically look for beetle larvae. Both larvae and pupae produced a glow from a two-spotted photic organ when disturbed. The two-spotted photic organ is located on the eighth sternite of the larvae and seventh ventrite (eighth sternite) of the female pupa. Therefore, it is expected that male pupa would also have a similar organ on its seventh ventrite as the seventh ventrite of adult males of this species bare such an organ, though the ability to luminesce seems to diminish shortly after eclosion (MAB, personal observation). Since no *L. atra* larvae have been found foraging in the open, they may be subterranean in habit. Adults usually fly during the day, and males follow pheromone plumes to the females (Lloyd 1972). The female is typically up to a third larger than the male.

Traditional Perspective, and Modern View

Peterson (1951) included a side view drawing of a lampyrid larva along with a mandible and antennae which was labeled "*Photinus* sp." This same drawing was included by LaBella and Lloyd (1991) and has thereafter been used as an example of a *Photinus* larva. Upon comparing our *L. atra* larvae with the actual specimen upon which Peterson based his drawing (in the Peterson Larval Collection, The Ohio State University, Columbus, Ohio), they are identical matches. Additionally, Peterson's determination label in the vial with this specimen reads "*Photinus* sp.? ." This question mark on the determination label, evidently put there by Peterson himself, was most likely accidentally overlooked, and, thus for some 49 years, the specimen has been misidentified as *Photinus* sp., rather than *Lucidota atra.* This mistake is very easy to make due to the great morphological similarity between genera in the tribe Photinini, in which both *Photinus* and *Lucidota* are assigned. The only definitive method to associate larvae and adults is to rear the larvae.

Abdominal Sclerites in Lampyridae

Considerable confusion has occurred concerning the number of abdominal sclerites in discussions of adult firefly abdomen morphology. We believe that this confusion has been caused largely by the fact that lampyrids posses a varying number of visible ventral abdominal sclerites and there is a lack of accuracy in defining the terms used in descriptions and discussions of the abdomen. Without both an understanding of the homology among abdominal sclerites and the use of accurate terminology, morphological investigations of lampyrids are bound to remain confused.

The description of both larval and pupal states of *L. atra* is instructive for following the reduction and fusion of various abdominal segments and sclerites from the larval stage, where all abdominal sclerites are present and obvious, to the pupal stage, where the effect of internalization, reduction and fusion can be first detected. In all firefly larvae currently known, there are ten abdominal segments, with the tenth being quite small and, therefore, commonly overlooked. Each abdominal segment bears a tergite, distinct pleurites that bear the spiracles (segments one through eight) and a sternite. Identification of abdominal segments and sclerites in the larvae is not difficult. Reduction of abdominal segments and the internalization of sclerites in the adults however, can make it difficult to determine homology among abdominal segments.

In Coleoptera, the adult abdomen is usually composed of ten segments in the male (with the tenth often being highly reduced or fused with the ninth), and nine in the female (with the ninth being modified to form the genital segment) (Lawrence and Britton 1991). As was pointed out by Green (1956), the first abdominal segment in adult Lampyridae is indicated only by the first abdominal tergite, except females of *Photinus granulatus* (Green, p. 597). However, investigation concluded that the pleurite bearing the first abdominal spiracle is also present, though in reduced form, in pupal *L. atra* and the adults of some lampyrids. In the adult, the first visible ventral sclerite actually is of the second abdominal segment, as the ventral portion of the first abdominal segment is usually so internalized and reduced, it is not visible ventrally. This condition is termed a "hologastrous type abdomen" (Nichols 1989). Additionally, in adult lampyrids the abdominal pleurites are fused to the sternites, thus forming a continuous ventral plate. The median half of this ventral plate was the larval sternite and the lateral regions on each side were the pleurites. Green (1956), therefore suggested ". . . it would be incorrect to refer to the ventral segments of the abdomen as sternites." Lawrence and Britton (1991) use the term "ventrites" to denote sternites that are externally visible.

In light of these two situations: sternite one lacking and the fusion of sternites with pleurites, while also keeping with Green (1956) and Lawrence and Britton (1991), we adopt the term "ventrites" to denote the visible ventral sclerites in the *L. atra* pupa, which like other firefly species, has the same abdominal morphology as the adult. In most firefly species, the female has one ventrite fewer than the male, with species in the Luciolinae being the exception, the male having six and the female having seven ventrites. McDermott (1964) stated that "The Lampyridae may be defined as that family of the Cantharoidea having usually seven visible ventral abdominal segments in the male." Apparently, McDermott did not count the ninth abdominal segment when visible, as a visible ventral segment. This may be due to the small size if the ninth ventral sclerite in relation to the other ventral sclerites and the fact that it is usually the terminal ventral sclerite. It is our present conclusion that the sclerite of the ninth abdominal segment (ventrite eight) needs to be counted as a "ventrite" when visible. Depending upon whether the eighth ventrite is concealed under ventrite seven or exposed, adult males will have either seven or eight ventrites (MAB, personal observation), with eight ventrites being found in the majority of genera family-wide, examined by MAB. Therefore, in males of most firefly species, ventrites one through eight correspond to abdominal segments two through nine. The only known exception is for members of the subfamily Luciolinae, which bear only six ventrites (McDermott 1964; Ballentyne 1987a, b) and the paedomorphic brachypterous male of the European species *Phosphaenus hemiperus* Laporte (MAB, personal observation). In the Luciolinae, the last segment exposed in the male is ventrite six (abdominal segment seven), with segment eight apparently reduced, or altogether lost, with segment nine forming part of the aedeagal sheath which is retracted into the abdomen (Ballentyne 1992). The male of *Phosphaenus hemiperus* more or less retains a larviform type abdomen. Therefore, it is no surprise that Torre-Bueno's (Nichols 1989) definition of "sternite = ventrite" is insufficient in conveying the homology of ventral abdominal segments in adults of Lampyridae.

Even though "segmental fusion" does not seem to occur in the firefly abdomen, the use of the term "ventrite" should be used with care to avoid confusion of the homology of various abdominal segments. However, the use of the term "ventrite" to denote only visible abdominal segments in the adult, while also keeping in mind (and mentioning a point of reference) that "ventrite one" is actually the ventral sclerite of the second abdominal segment (in almost all cases), is simply good nomenclature and serves to avoid confusion concerning which adult abdominal segment is being referred to.

CONCLUSION

The firefly larva labeled as "*Photinus* sp." by Peterson (1951) is actually the larva of *Lucidota atra,* which is herein redescribed in greater detail than the original description (Wickham 1895) in order to facilitate larval identification. Through rearing this species from larva to adult, it was possible to investigate the homology of abdominal segments and track possible fusion or reduction events that lead to a decrease in number of visible ventral abdominal sclerites in the adult. Fusion of both abdominal segments and "ventrites" are not known to occur in currently studied lampyrid taxa.

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LIFE HISTORY AND DESCRIPTION OF IMMATURE STAGES OF *NEASPILOTA PUBESCENS* FREIDBERG AND MATHIS (DIPTERA: TEPHRITIDAE) ON *LESSINGIA FILAGINIFOLIA* (HOOKER AND ARNOTT) M. A. LANE (ASTERACEAE) IN SOUTHERN CALIFORNIA

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Abstract.—*Neaspilota pubescens* Freidberg and Mathis is a univoltine, monophagous fruit fly (Diptera: Tephritidae) developing solely in the flower heads of *Lessingia filaginifolia* (Hooker and Arnott) M. A. Lane (Asteraceae) belonging to the subtribe Solidagininae of the tribe Astereae in southern California. The egg, second- and third-instar larvae, and puparium are described and figured. The anterior thoracic spiracle of the second instar has five papillae, reduced to two papillae in the third instar. The second instar has seven oral ridges and the third instar eight oral ridges, which, except for the most ventral, eight oral ridge in the latter instar, are ventrally toothed. The arrangement of these oral ridges in a vertical series lateral to the oral cavity is a distinguishing generic character. The larvae feed mainly on the ovules and soft achenes as first and second instars; however, as third instars, they may extend their feeding into the receptacle and supplement their diet with sap. The nonfeeding prepuparium overwinters in a protective cell that occupies much of the excavated flower head and is formed of ovule-, achene-, chaff-, pappus-, and corolla-fragments impregnated with excess sap and liquid feces that harden when dry. A few prepuparia pupate and emerge from their cells in the late summer and probably overwinter as adults, but most pupariate during the next year in late spring, and emerge as adults that aggregate on preblossom host plants to mate and subsequently oviposit. *Pteromalus* sp. (Hymenoptera: Pteromalidae) was reared as a solitary, larval-pupal endoparasitoid from a puparium of *N. pubescens.*

Key Words: Insecta, *Neaspilota, Lessingia,* Asteraceae, nonfrugivorous Tephritidae, biology, taxonomy of immature stages, flower-head feeding, monophagy, seed predation, parasitoid

Revision of the genus *Neaspilota* (Diptera: Tephritidae) by Freidberg and Mathis (1986) facilitated determination of specimens reared from California Asteraceae (Goeden 1989) and stimulated several life-history studies, including those on *N. viridescens* Quisenberry (Goeden and Headrick 1992), *N. wilsoni* Blanc and Foote (Goeden and Headrick 1999), *N. signifera* (Coquillett) (Goeden 2000a), *N. aenigma* Freidberg and Mathis (Goeden 2000b), and *N. appendiculata* Freidberg and Mathis (Goeden 2000c). This paper describes some immature stages and the life history of a sixth species from California, *N. pubescens* Freidberg and Mathis.

MATERIALS AND METHODS

The present study was based in large part on dissections of flower heads of *Lessingia filaginifolia* (Hooker and Arnott) M. A. Lane (Asteraceae) collected during 1990–1997 mainly from the following two locations in the South and North Sections, respectively, of the San Bernardino National

Forest: Bautista Canyon at 1,100 m elevation, Riverside Co. and North of South Fork Campground at 1,550 m, SW San Bernardino 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. Eight second- and 12 third-instar larvae and five puparia dissected from flower heads were preserved in 70% EtOH for scanning electron microscopy (SEM). Additional prepuparia and 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 hexamethyldisilazane (HMDS), mounted on stubs, sputter-coated with a gold-palladium alloy, and studied and photographed with a Philips XL-30 scanning electron microscope in the Institute of Geophysics and Planetary Physics, University of California, Riverside.

Most adults reared from isolated prepuparia and 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 studies of longevity and sexual maturation in the insectary of the Department of Entomology, University of California, Riverside, at 25 ± 1°C, and 14/10 (L/D) photoperiod. Two pairs of virgin males and females obtained from emergence cages also were held in each of six, separate, clear-plastic, petri dishes provisioned with a flattened, water-moistened pad of absorbant cotton spotted with honey (Headrick and Goeden 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 Goeden (2000a, b, c), Goeden et al. (1998), Goeden and Headrick (1992, 1999), Goeden and Teerink (1997; 1998; 1999a, b), Teerink and Goeden (1999), and our earlier works cited therein. Means ±SE are used throughout this paper. Voucher specimens of *N. pubescens* immature stages, adults, and parasitoids reside in my research collections.

RESULTS AND DISCUSSION

Taxonomy

Adult.—*Neaspilota pubescens* was described by Freidberg and Mathis (1986: 55–57), who pictured the unpatterned wing, along with drawings (p. 56) of the lateral aspect of the head; male right foretarsus, epandrium, distiphallus, epandrium and cerci, aculeus and its apex enlarged, and spermatheca.

Immature stages.—The first-instar larva remains undescribed, but the egg, second- and third-instar larvae and puparium are described below, as the only stages available at this writing.

Egg: Only three intact eggs were found and measured *in situ* within separate, immature, preblossom flower heads. These eggs were white, opaque, smooth, elongate-ellipsoidal, and averaged 0.71 ± 0.03 (range, 0.64–0.74) mm long and 0.18 ± 0.003 (range, 0.17–0.18) mm wide, tapered and smoothly rounded at both ends. As no eggs were examined by scanning electron microscopy, the egg of *N. pubescens* could only be generally compared with the eggs of *N. viridescens, N. wilsoni,* and *N. appendiculata,* which were described in detail by Goeden and Headrick (1992, 1999) and Goeden (2000c).

Second instar: White, elongate-cylindrical, rounded anteriorly, truncated dorsoposteriorly (Fig. 1A), body segments well-de-

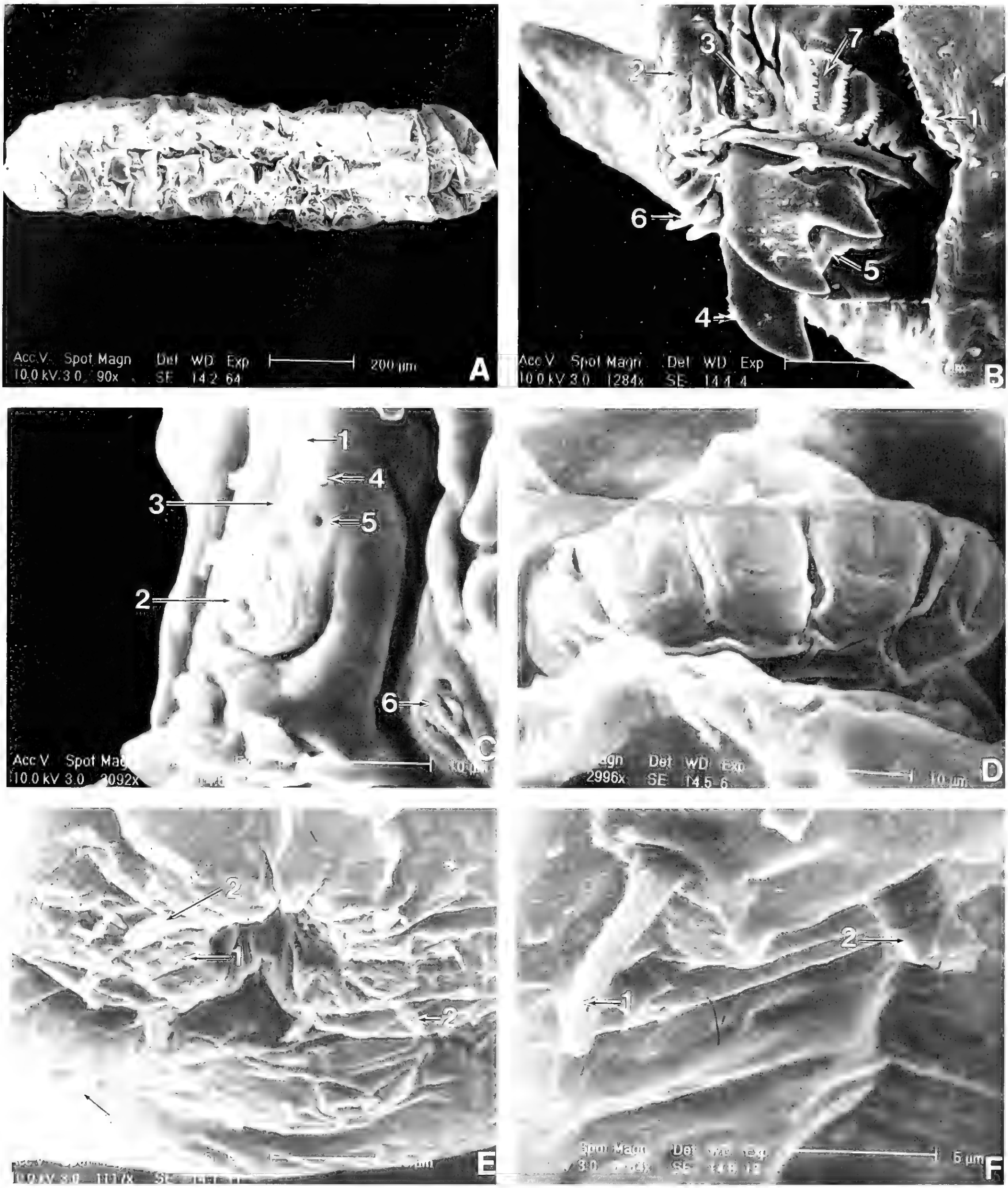

Fig. 1. Second instar of *Neaspilota pubescens:* (A) habitus, anterior to left; (B) gnathocephalon, ventrolateral view, 1-minute acanthae, 2-anterior sensory lobe, 3-stomal sense organ, 4-mouthhook, 5-median oral lobe, 6-integumental petal, 7-oral ridge; (C) anterior sensory lobe, 1-dorsal sensory organ, 2-terminal sensory organ, 3-lateral sensory organ, 4-supralateral sensory organ, 5-pit sensory organ, 6-stomal sense organ; (D) anterior thoracic spiracle; (E) caudal segment, 1-rima, 2-interspiracular process, 3-intermediate sensory complex; (F) intermediate sensory complex, 1-stelex sensillum, 2-medusoid sensillum.

fined, circumscribed anteriorly with few minute acanthae (Figs. 1B-1); dorsal sensory organ well-defined, dome-shaped (Fig. 1C-1); anterior sensory lobe (Fig. 1B-2, C) with terminal sensory organ (Fig. 1C-2), lateral sensory organ (Fig. 1C-3), supralateral sensory organ (Fig. 1C-4), and pit sensory organ (Fig. 1C-5); stomal sense organ (Figs. 1B-3, C-6) ventrolaterad of anterior sensory lobe; mouthhook bidentate (Fig. 1B-4); median oral lobe (Fig. 1B-5), flabelliform, laterally compressed (not shown); about six papilliform, integumental petals dorsal to each mouthhook (Fig. 1B-6); seven oral ridges toothed ventrally, in vertical series lateral to oral cavity (Fig. 1B-7); prothorax, at least, circumscribed anteriorly by posteriorly-directed, minute acanthae (Fig. 1B-1); anterior thoracic spiracle with five, cuboidal papillae (Fig. 1D); lateral spiracular complexes not seen; caudal segment with two stelex sensilla (not shown) dorsolaterad and ventrolaterad of posterior spiracular plate (Fig. 1E); posterior spiracular plate bears three ovoid rimae (Fig. 1E-1), ca. 0.015 mm long, and four interspiracular processes (Fig. 1E-2), each with one to four, simple or forked branches, longest measuring 0.01 mm; intermediate sensory complex (Figs. 1E-3, F) with a stelex sensillum (Fig. 1F-1) and a medusoid sensillum (Fig. 1F-2).

The habitus of the second instar of *N. pubescens* (Fig. 1A) is more like *N. wilsoni* (Goeden and Headrick 1999), *N. signifera* (Goeden 2000a), *N. aenigma* (Goeden 2000b), and *N. appendiculata* (Goeden 2000c) than the barrel-shaped second instar of *N. viridescens* (Goeden and Headrick 1992). The dorsal sensory organ of *N. pubescens* is well defined in the second instar (Fig. 1C-1), as with *N. signifera* (Goeden 2000a) and *N. appendiculata* (Goeden 2000c), but is not well defined in *N. viridescens* (Goeden and Headrick 1992), *N. wilsoni* (Goeden and Headrick 1999), and *N. aenigma* (Goeden 2000b). The integumental petals of the second instars of all six species are papilliform and six in number in *N. pubescens* (Fig. 1B-6), like *N. viridescens* (Goeden and Headrick 1992), but number four in *N. signifera* (Goeden 2000a), seven in *N. wilsoni* (Goeden and Headrick 1999) and *N. appendiculata* (Goeden 2000c) and eight in *N. aenigma* (Goeden 2000b). In the first instars of all six congeners examined to date, though not available in the present study, the integumental petals are broad, flattened, and paired (Goeden and Headrick 1992, 1999; Goeden 1999a, b). An apparent difference in *N. pubescens* is the five papillae on the anterior spiracle of the second instar (Fig. 1D), compared to eight in *N. appendiculata* (Goeden 2000c), and three to four papillae in second instars of *N. viridescens* (Goeden and Headrick 1992), *N. wilsoni* (Goeden and Headrick 1999), *N. signifera* (Goeden 2000a), and *N. aenigma* (Goeden 2000b). Finally, the interspiracular processes of *N. pubescens* each bear one to four branches like *N. aenigma* (Fig. 1E-2, Goeden 2000b), not two to four branches like *N. signifera* (Goeden 2000a), nor five to nine branches like those of *N. viridescens* (Goeden and Headrick 1992), nor two to six branches like those of *N. wilsoni* (Goeden and Headrick 1999), nor four branches like those of *N. appendiculata* (Goeden 2000c). However, it is recognized that most specimens of *N. pubescens* with branch numbers at the high end of the range will not differ from most other *Neaspilota* in this character.

Third instar: Pale yellow, ellipsoidal, with posterior spiracular plate dark brown to black, tapering anteriorly; posterior spiracular plate on caudal segment flattened and upturned dorsally ca. 60° (Fig. 2A), minute acanthae circumscribe anterior fifth of thoracic and anterior abdominal segments, but more common posteriorly (Fig. 2B-1); gnathocephalon conical (Fig. 2B); dorsal sensory organ an elliptical, flat, poorly defined pad (Fig. 2C-1) punctured centrally and peripherally by pore sensilla (Fig. 2C-2); anterior sensory lobe (Fig. 2C) bears terminal sensory organ (Fig. 2C-3), lateral sensory organ (Fig. 2C-4), supralateral sen-

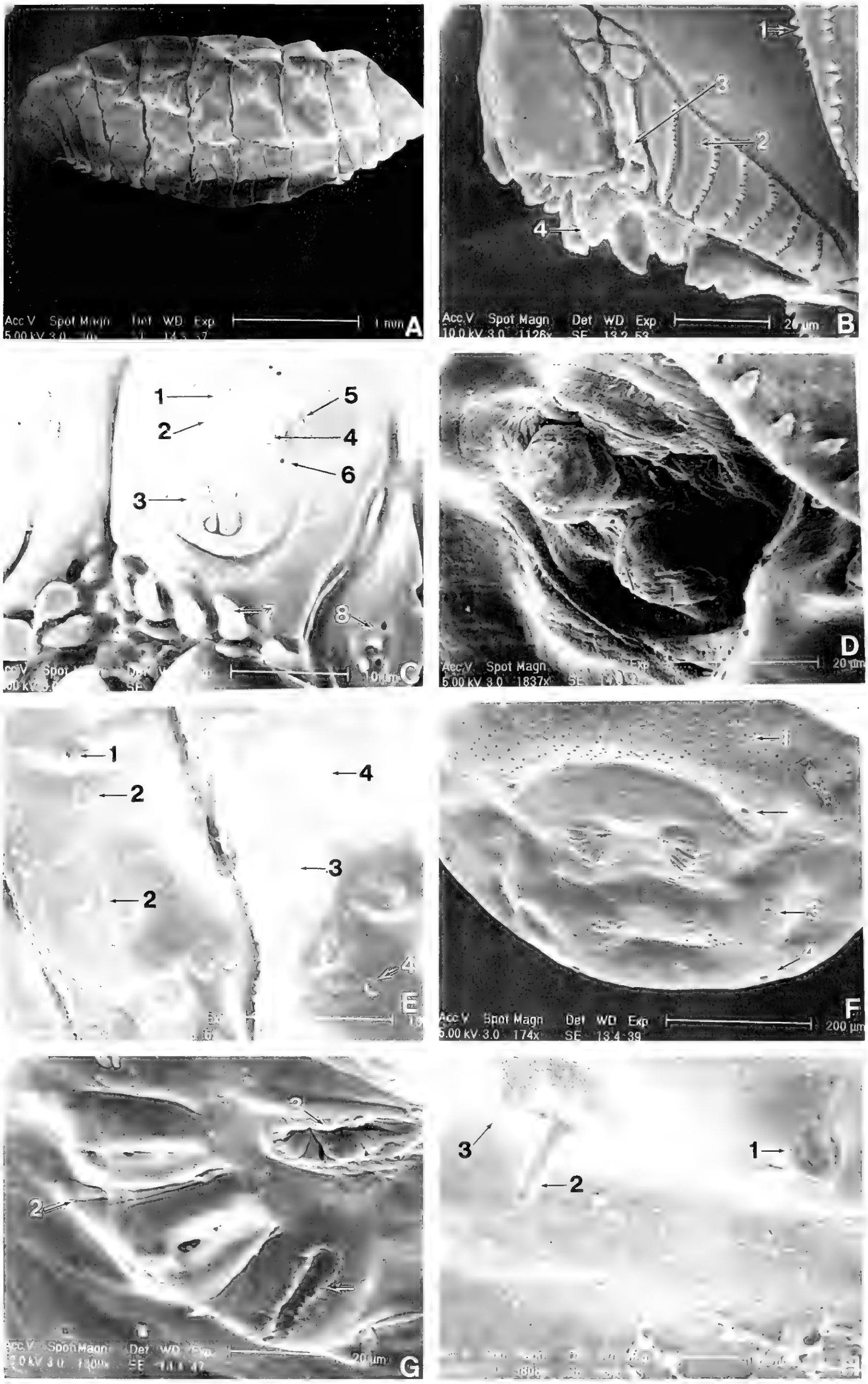

Fig. 2. Third instar of *Neaspilota pubescens:* (A) habitus, anterior to left; (B) gnathocephalon, lateral view, 1-minute acanthae, 2-oral ridge, 3-stomal sense organ, 4-mouthhook; (C) anterior sensory lobe, 1-dorsal sensory organ, 2-pore sensillum, 3-terminal sensory organ, 4-lateral sensory organ, 5-supralateral sensory organ, 6-pit sensory organ, 7-integumental petal, 8-stomal sense organ; (D) anterior thoracic spiracle; (E) metathoracic (left) and abdominal (right) lateral spiracular complexes, 1-spiracle, 2-verruciform sensilla on metathorax,

sory organ (Fig. 2C-5), and pit sensory organ (Fig. 2C-6); eight, papilliform (above) or spatulate (below), integumental petals in two rows above each mouthhook (Fig. 2C-7); eight oral ridges (Fig. 2B-2), all but most ventral ridge, toothed ventrally and lateral to oral cavity; stomal sense organ (Figs. 2B-3, C-8) ventrolaterad of anterior sensory lobe; mouthhook (Fig. 2B-4) tridentate (not shown); median oral lobe laterally flattened, apically pointed (not shown); prothorax circumscribed by minute acanthae (Fig. 2B-1); verruciform sensilla circumscribe prothorax posteriorad of minute acanthae (not shown); anterior thoracic spiracle on posterior margin of prothorax bears two oblong papillae (Fig. 2D); metathoracic lateral spiracular complex with a spiracle (Fig. 2E-1) and three verruciform sensillae, one above (not shown) and two below the spiracle (Fig. 2E-2); abdominal lateral spiracular complex with a spiracle (Fig. 2E-3) and two verruciform sensilla (Fig. 2E-4) dorsoposteriorad of, and two verruciform sensilla ventroposteriorad of, the spiracle, these sensilla arranged as two vertical pairs; caudal segment circumscribed dorsally by minute acanthae (Fig. 2F-1); a stelex sensillum dorsolaterad (Fig. 2F-2), laterad (Fig. 2F-3), and ventrolaterad (Fig. 2F-4) of posterior spiracular plate (Fig. 2G); each posterior spiracular plate (Fig. 2G) bears three ovoid rimae (Fig. 2G-1), ca. 0.03 mm in length, and four interspiracular processes (Fig. 2G-2), each with one to three, simple, pointed or forked branches, longest branch measuring 0.013 mm; intermediate sensory complex (Fig. 2H) with a medusoid sensillum (Fig. 2H-1) and a stelex sensillum (Fig. 2H-2). Each stelex sensillum surrounding the posterior spiracular plate apparently has a single, hemispherical, minute acanthus at its base (Fig. 2H-3).

The habitus of the third instar of *N. pubescens* generally is like that reported for *N. viridescens* (Goeden and Headrick 1992), *N. wilsoni* (Goeden and Headrick 1999), *N. signifera* (Goeden 2000a), and *N. aenigma* (Goeden 2000b), and *N. appendiculata* (Goeden 2000c). Like *N. signifera* (Goeden 2000a) and *N. appendiculata* (Goeden 2000c), only the anterior part of each body segment of *N. pubescens* is circumscribed by minute acanthae, whereas, in *N. aenigma* the anteriors, pleura, and posteriors of each segment are thus circumscribed (Goeden 2000b); in *N. wilsoni,* all intersegmental areas and all abdominal segments except the pleura are circumscribed (Goeden and Headrick 1999); and in *N. viridescens,* the intersegmental areas are free of acanthae (Goeden and Headrick 1992). Like *N. viridescens* (Goeden and Headrick 1992) and *N. wilsoni* (Goeden and Headrick 1999), but not like *N. signifera* (Goeden 2000a), *N. aenigma* (Goeden 2000b) and *N. appendiculata* (Goeden 2000c), the dorsal sensory organ is not well defined, and flattened, and not dome-shaped, in the third instar of *N. pubescens* (Fig. 2C-1). In the second instar of *N. wilsoni* (Goeden and Headrick 1999), *N. signifera* (Goeden 2000a), *N. appendiculata* (Goeden 2000c), and *N. pubescens* (Fig. 1C-1) the dorsal sensory organ is both prominent and dome-shaped, as it is in the first instar of all congeners except *N. signifera,* where it was hidden in my specimens and could not be examined for comparison (Goeden 2000a), and in the present study where first instars were not available.

Additional similarities involved the integumental petals in the third instars of all

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3-spiracle, 4-verruciform sensilla on first abdominal segment; (F) anal segment, 1-minute acanthae, 2-dorsolateral stelex sensillum, 3-lateral stelex sensillum, 4-ventrolaterad stelex sensillum; (G) posterior spiracular plate, 1-rima, 2-interspiracular process, 3-ecdysial scar; (H) intermediate sensory complex, 1-medusoid sensillum, 2-stelex sensillum, 3-basal, conical, minute acanthus.

five congeners examined to date, all of which are papilliform and arranged in a double row above each mouthhook (Goeden and Headrick 1992, 1999; Goeden 2000a, b, c). The stomal sense organ of the third instar of *N. pubescens* bears one or two verruciform sensilla, two pore sensilla, and one or two, cone-shaped or short papilliform sensilla (Fig. 2C-8). Thus, it appears similar in complexity to the stomal sense organ of the second instar (Figs. 1B-3, C-6); however, the stomal sense organs of the third instars of four congeneric species appear especially well-developed compared to earlier instars and each bears different combinations of sensory structures, variously described as several cone-shaped sensilla in *N. viridescens* (Goeden and Headrick 1992); as papilliform and pit-type in *N. wilsoni* (Goeden and Headrick 1999); as verruciform or "compound verruciform" in *N. signifera* (Goeden 2000a), and verruciform and pit-type in *N. aenigma* (Goeden 2000b).

The third instars of all six species of *Neaspilota* examined to date have oral ridges with dentate ventral margins characteristically arranged in vertical series ventrolaterad of the dorsal sensory organ and laterad of the oral cavity. Similar oral ridges also were described in the second instars of *N. viridescens* (Goeden and Headrick 1992), *N. wilsoni* (Goeden and Headrick 1999), *N. signifera* (Goeden 2000a), and *N. appendiculata* (Goeden 2000c). The oral ridges number eight in *N. pubescens* (Fig. 2B-2), seven or eight in the third instar of *N. aenigma* (Goeden 2000b), seven in *N. appendiculata* (Goeden 2000c), but six in the second and third instars of the other three congeners examined to date. The appearance and arrangement of these oral ridges appears to be a generic character; however, the present study and Goeden (2000c) confirm that the oral ridges vary in number among third instars of *Neaspilota* species. Also, the most ventral, eighth oral ridge of *N. pubescens* is not ventrally toothed (Fig. 2B-2). The third instars of *Trupanea imperfecta* (Coquillett), *T. jonesi* Curran, *T. nigricornis* (Coquillett), *T. pseudovicina* (Hering), *T. signata* Foote, and *T. wheeleri* Curran also bear serrated oral ridges (Goeden and Teerink 1997b, 1998, 1999a; Goeden et al. 1998; Knio et al. 1996; Teerink and Goeden 1999), but these oral ridges appear to be fewer in number, and are not arranged in a more or less regular, vertical row lateral to the mouth hook, as in *Neaspilota.*

The mouthhooks of the third instars of *N. appendiculata, N. aenigma, N. signifera, N. viridescens,* and probably *N. pubescens* (unpublished data), are tridentate (Goeden and Headrick 1992; Goeden 2000a, b); whereas, those of the third instar of *N. wilsoni* are bidentate (Goeden and Headrick 1999). Such interspecific differences in dentation are supported by our findings that the mouthhooks of third-instar *Trupanea vicina* are bidentate; whereas, those of 12 other congeners examined from California are tridentate (Goeden and Teerink 2000b and citations therein).

The number and appearance of the stelex sensilla surrounding the posterior spiracular plate differ among the *Neaspilota* species examined to date. These number only four in the first instars of *N. wilsoni* (Goeden and Headrick 1999), *N. aenigma* (Goeden 2000b), and *N. appendiculata* (Goeden 2000), but, unfortunately, were not observed with *N. signifera* (Goeden 2000a) or in the present study. This count of stelex sensilla remains at four in the second instars of *N. aenigma* (Goeden 2000b), *N. appendiculata* (Goeden 2000c), and *N. pubescens,* increases to six in third instars of *N. wilsoni* (Goeden and Headrick 1999), *N. aenigma* (Goeden 2000b), and *N. appendiculata* (Goeden 2000c). These stelex sensilla also show inter-instar (intraspecific) and interspecific differences in the incidence and appearance of the minute acanthae that may ring them basally, but this was not recognized, studied or recorded by my coworkers and me until recently (Goeden 2000b, c; Fig. 2H-2, -3).

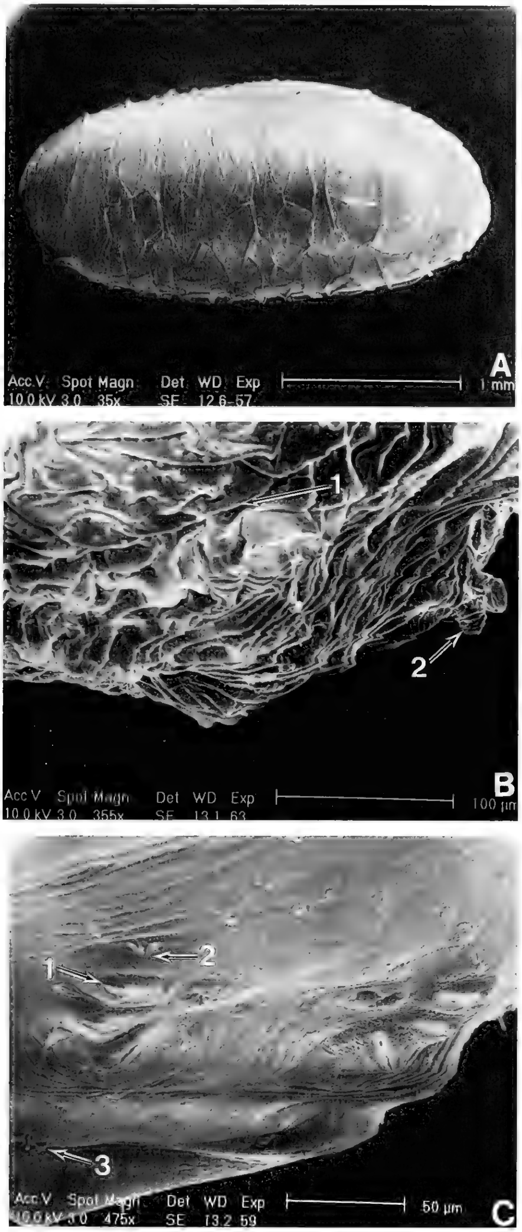

Fig. 3. Puparium of *Neaspilota pubescens:* (A) habitus, anterior to left; (B) anterior end, 1-invagination scar, 2-anterior thoracic spiracle; (C) caudal segment, 1-rima, 2-interspiracular process, 3-intermediate sensory complex.

Puparium: Mostly pale yellow, with posterior two-three segments grayish to blackened posteriorly, ellipsoidal, and smoothly rounded at both ends (Fig. 3A); anterior end bears the invagination scar (Fig. 3B-1) and anterior thoracic spiracles (Fig. 3B-2); caudal segment circumscribed by minute acanthae; three stelex sensilla, dorsolaterad, lateral, and ventrolateral of posterior spiracular plates; posterior spiracular plate bears three broadly elliptical rimae (Fig. 3C-1), and four interspiracular processes, each with one to three branches (Fig. 3C-2); intermediate sensory complex (Fig. 3C-3) with a medusoid sensillum and a stelex sensillum. Seven puparia averaged 2.79 ± 0.05 (range, 2.55–2.95) mm in length; 1.31 ± 0.06 (range, 1.10–1.60) mm in width.

DISTRIBUTION AND HOSTS

Freidberg and Mathis (1986) described the distribution of *N. pubescens* as "Southern California south of 35° north latitude and west of the Sierra Nevada Mountains." Freidberg and Mathis (1986) and Foote et al. (1993) mapped the distribution to include only California.

The only reported and confirmed host plant of *N. pubescens* (reported as *appendiculata*) is *Lessingia* (reported as *Corethrogyne*) *filaginifolia* by Goeden (1989), which belongs to the subtribe Solidagininae of the tribe Astereae in the family Asteraceae (Hickman 1993, Bremer 1994). This perennial subshrub has at least two distinct varieties and itself is widely distributed in coastal scrub, oak woodlands, and grassland below 2,600 m throughout California and into adjacent southwestern Oregon and northern Baja California, Mexico (Hickman 1993, Shreve and Wiggens 1964), where *N. pubescens* also probably occurs.

Host records in Freidberg and Mathis (1986) present a quandary, as only *N. brunneostigmata* Doane is reported from *Lessingia* (reported as *Corethrogyne*) *filaginifolia,* including both varieties *filaginifolia* and *californica* (deCandolle) M. A. Lane (reported as *C. californica*). Neither of these records obtained from Wasbauer (1972) had been checked by Freidberg and Mathis (1986). Instead, both varietal records probably should refer to *N. pubescens,* not *N.*

brunneostigmata. On the other hand, I have only reared *N. brunneostigmata* from *Lessingia glandulifera* A. Gray and *L. lemmonii* A. Gray, never *N. pubescens,* which is easily distinguished from the former tephritid using the keys in Freidberg and Mathis (1986) and Foote et al. (1993). The latter host record for *N. brunneostigmata* (as *aenigma*) was first reported by Goeden (1989), and was corrected in Foote et al. (1993). The host record for *L. glandulifera* is new. Both represent the only confirmed host records for *N. brunneostigmata.* The seven other host records for *N. brunneostigmata* listed by Wasbauer (1972) and repeated by Freidberg and Mathis (1986) remain unconfirmed and refer either to undocumented records or to probable misidentifications listed in Foote and Blanc (1963), which, of course, predated Freidberg and Mathis (1986). In summary, I believe that *N. pubescens* is a true monophage, and I suspect, the better plant taxonomist in the case whereby *C. filaginifolia* was renamed *L. filaginifolia* (Hickman 1993).

BIOLOGY

Egg.—In each of three, closed, preblossom, immature flower heads of *L. filaginifolia,* a single egg was inserted pedicel-last; two of these eggs had their long axes perpendicular to the receptacle, one rested at a 45° angle to the receptacle. The last egg had been inserted through the phyllaries and was embedded for half its length in the corolla of a peripheral floret; whereas, the other two eggs were placed between an inner phyllary and a peripheral floret. The diameters of the receptacles of these flower heads containing eggs averaged 1.7 ± 0.17 (range, 1.40–1.99) mm.

Larva.—Upon eclosion, the only two first instars found feeding in separate, preblossom flower heads either tunneled into an ovule, or into a corolla before entering the ovule to which the corolla was basally attached. The receptacles averaged 1.4 mm in diameter and an average of 1.5 ovules was damaged in these two flower heads. Neither receptacle was abraded or pitted by feeding.

Second instars continued feeding on ovules in preblossom flower heads or on soft achenes in open, blossom and post blossom flower heads. All fed within a series of adjacent ovules/soft achenes with their bodies more or less perpendicular to and their mouthparts directed towards the receptacles, but always above the receptacles. Receptacles of 12 flower heads containing second instars averaged 1.92 ± 0.17 (range, 1.42–3.42) mm in diameter. These flower heads each contained a single larva that had destroyed an average of 3.8 ± 0.6 (range, 1–8) ovules/soft achenes. Based on 23 (range, 17–34) as the average total number of ovules and achenes respectively counted in 40 preblossom to postblossom flower heads, about 9.5% (range, 2.5–20%) of the ovules/soft achenes in the 12 flower heads were damaged by second instars.

Third instars (Fig. 4A) initially continued to feed mainly on soft achenes in blossom or postblossom flower heads. Twenty-four flower heads that averaged 1.95 ± 0.14 (range, 1.10–2.56) mm in diameter each contained a single third instar. An average of 15 ± 2.1 (range, 4–34) of the soft achenes therein were damaged, or about 38% (range, 10–100%) of the average total of 40 ovules/soft achenes per flower head. These percentages of seed predation per larva per flower head, like those reported for *N. aenigma* (Goeden 2000b) and *N. appendiculata* (Goeden 2000c), are on the high side among florivorous tephritids studied by us to date (Headrick and Goeden 1998). This percent seed destruction per flower head is exceeded only by gregarious florivorous species like *Trupanea conjuncta* (Adams) (Goeden 1987) and *T. pseudovicina* Hering (Goeden and Teerink 1998) or by species with large larvae that develop in immature or small flower heads like *Paracantha cultaris* (Coquillett) (Cavender and Goeden 1982) and *Xenochaeta dichromata* Snow (Goeden and Teerink 1997a). Also, it

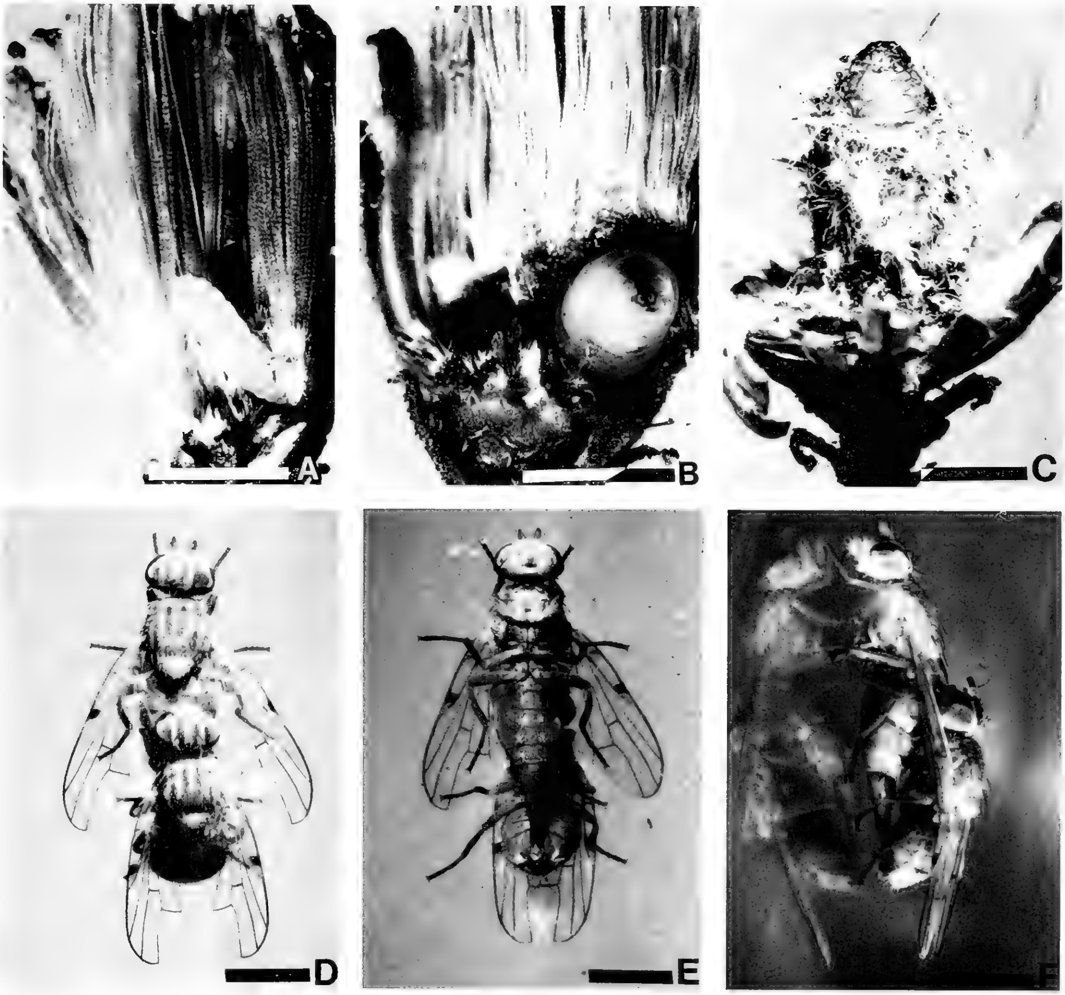

Fig. 4. Life stages of *Neaspilota pubescens* in *Lessingia filaginifolia:* (A) early third instar feeding on soft achenes in open flower head, (B) late third instar feeding on soft achenes in open flower head, (C) puparium formed in spring by overwintered prepuparium in flower head, (D) mating adults, dorsal view, (E) mating adults, ventral view, (F) mating adults lateral view. Lines = 1 mm.

should be noted that the rates of flower head infestation per sample for *N. pubescens* was very low, e.g., mean of 4.5% (range, 1.5%–10%) for five samples, like most *Neaspilota* in nature that we have studied (unpublished data).

Third instars in flower heads fed with their long axes oriented perpendicular to and mouthparts directed towards the receptacles (Fig. 4B). Only five (21%) of the third instars in the 24 infested heads scored or pitted the receptacles; however, most presumably supplemented their diet with sap. Goeden and Headrick (1992, 1999) and Goeden (2000c) described and discussed this similar type of feeding by *N. viridescens, N. wilsoni,* and *N. appendiculata,* respectively. And, as also reported for all three of these congeners that overwinter as prepuparia (Goeden and Headrick 1992, 1999; Goeden 2000c), most third instars became surrounded for about 90% of their lengths by cells, which occupied most of the interior of the flower heads and consisted of ovule-, achene-, chaff-, pappus-, and corolla-fragments cemented together by liquid feces and sap that hardened when dry (Fig. 4C). These protective cells were slightly larger than the mature larvae, externally incorporated the outer walls of achenes and the few uneaten achenes, and were blackened and smooth inside (Fig. 4C). Upon completing feeding and cell construction, the larvae oriented with their anterior ends towards the receptacles, retracted their mouthparts, and formed prepuparia (Headrick and Goeden 1998). Most individuals overwintered in diapause as prepuparia (Goeden and Headrick 1992, 1999; Goeden 2000c; Headrick and Goeden 1998), but a few individuals puparíated early and emerged in summer (July–August). Prior to pupariation the prepuparia reversed their orientation within their cells and turned 180° such that their heads were directed away from the receptacles (Fig. 4C).

Adult.—Adults emerged from overwintered, mature flower heads, and probably are long-lived. Under insectary conditions, five unmated males averaged 67 ± 23 (range, 23–152) days, but only two virgin females were available for study and averaged 27 (range, 24–30) days. Such lengthy longevities for males compare favorably with average adult longevities reported for adults of *N. viridescens* (Goeden and Headrick 1992), *N. wilsoni* (Goeden and Headrick 1999), *N. signifera* (Goeden 2000a), *N. aenigma* (Goeden 2000b), and *N. appendiculata* (Goeden 2000c).

The premating and mating behaviors of *N. pubescens* were not studied in the field, but were observed in petri dish arenas found to be so useful with many other noncongeneric, nonfrugivorous, tephritid species (Headrick and Goeden 1994). Premating behaviors observed with paired *N. pubescens* were abdominal pleural distension and side-stepping by males while tracking females (Headrick and Goeden 1994) and rapid wing hamation, sometimes combined with lofting about 20° by both sexes (Headrick and Goeden 1994). No trophallaxis or nuptial gift presentation was noted as reported with *N. viridescens* (Goeden and Headrick 1992). Seven matings, six by one pair during a 2-week period (Figs. 4D, E, F) were observed that began during late afternoon at dusk and lasted an average of 1,032 ± 73 (range, 850–1,440) min (or 17 h and 12 min on average). This was three to five times longer than the average durations of 190 min reported for *N. aenigma* (Goeden 2000b), 235 min reported for *N. wilsoni* (Goeden and Headrick 1999), 238 min reported for *N. signifera* (Goeden 2000a), 285 min reported for *N. appendiculata* (Goeden 2000c), and 318 min reported for *N. viridescens* (Goeden and Headrick 1992). It also was among the longest mating durations reported by my collaborators and me (Headrick and Goeden 1994), exceeded only by a pair of *Tephritis baccharis* (Coquillett) that mated for 2 days and nights under similar conditions (Goeden and Headrick 1991). A pair of *Dioxyna picciola* (Bigot) was reported to stay together in the field for 28 h, during which time they copulated and oviposited three times in one day, remained *in copula* on one flower head overnight, and copulated and oviposited again three times during the following day (Headrick et al. 1996), but this involved mate guarding (Headrick and Goeden 1994, Headrick et al. 1996), also observed with *N. signifera* (Goeden 2000a). As far as could be determined, the extended mating by *N. pubescens* involved continuous copulation.

The only precopulary behavior observed for the female was an elevation of the oviscape 20° to 30° coupled with rapid wing hamation and lofting, which may have signaled receptivity (but see postcopulatory behavior below). A male was observed to initiate mating by rapidly pursuing and grabbing the head of the female from the front with his forelegs and -tarsi, and wrestling her into submission while he mounted her. No copulatory induction behavior was noted with *N. pubescens* and intromission was gained rapidly. Most matings were observed only after copulation had begun, suggesting that precopulatory behavior was perfunctory. The mating position (Figs. 4D, E, F) was such that the wings of the male were parted about 20°, while the wings of the female were parted at about 60°, with both pairs of wings centered over their respective body midlines (Figs. 4D, E). The body of the female was parallel to the substrate, while the body of the male was elevated about 20° anteriorly (Fig. 4F). The hind- and midtarsi of the male usually rested on the substrate, but sometimes his midtarsi grasped the base of the oviscape, while his foretarsi hooked onto the abdominal pleura of the female midway along the abdomen (Figs. 4D, F). The male's mouthparts were positioned above the second abdominal tergite of the female (Figs. 4D, F). In this position the male tenaciously held onto the female as copulation continued, while defeating her increasingly vigorous efforts to dislodge him. These dislodgment efforts by the female consisted of walking rapidly, then stopping to strongly arch her dosum at the juncture of her thorax and abdomen while rapidly hamating and lofting her wings (Fig. 5A), or bending her oviscape upward, while kicking at his head, ventrum, and mid- and hind legs with her hind legs and tarsi. In between these bouts of female "restlessness," the pair largely remained quiescent with only their mouthparts pumping, or sometimes both forming regurgitation droplets (Headrick and Goeden 1994), or while the female groomed her head and fore legs. Besides tightly clinging to the female, the male sometimes repositioned his foretarsi so as to gain better purchase or rub his midtarsi alternately along her oviscape to induce passivity as a variation on copulatory induction behavior (Headrick and Goeden 1994). These bursts of activity by the female always preceded disengagement, but only infrequently resulted in disengagement. What action(s) finally triggered or caused the pair to separate, remain unanswered.

Two mating terminations and disengagements were observed, which involved each male turning in place and walking away from the female while pulling his genitalia from within her, a process that lasted less than 10 s in both cases (Figs. 5A, B. C). Postcopulatory behavior by *N. pubescens* mainly consisted of storing of the genitalia by males and cleaning and grooming by both sexes (Headrick and Goeden 1994); al-

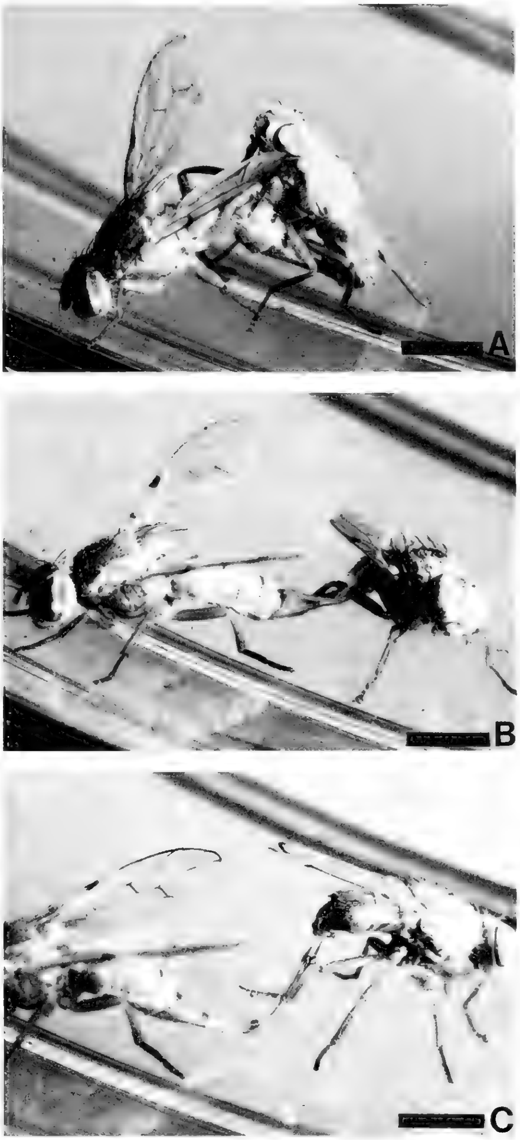

Fig. 5. Disengagement sequence at termination of mating by *Neaspilota pubescens:* (A) female arching dorsum and kicking at male with hind legs and tarsi, (B) male turning and stepping off female, (C) male pulling genitalia from female as he walks away. Lines = 1 mm.

though, instances of a female strongly elevating her oviscape was seen, as she ran away from a pursuing male to avoid recoupling following disengagement. As noted above, this same behavior often preceded mating.

Seasonal history.—The life cycle of *N. pubescens* in southern California follows an aggregative pattern (Headrick and Goeden 1994, 1998) in which the prepuparium is the principal overwintering stage. Come late spring (May), overwintered prepuparia reverse their orientation in their cells in flower heads on shoots of dead host plants and pupariate. Adults emerge during late May and early June and aggregate on preblossom shoots of *L. filaginifolia* to mate. Females oviposit in the small, newly-formed, closed, preblossom flower heads in July and larvae feed until fully grown, then enter diapause in early fall (September–October). There is a single generation per year on their sole host plant, although as mentioned above, a few adults emerge in late August–September, perhaps to produce a partial generation on late-flowering plants, or to overwinter as long-lived adults.

Natural enemies.—A single female of *Pteromalus* sp. (Hymenoptera: Pteromalidae) was reared from a puparium of *N. pubescens* as a solitary, larval-pupal endoparasitoid.

ACKNOWLEDGMENTS

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A TAXONOMIC REVIEW OF THE GENUS *DELPHINIOBIUM* MORDVILKO (HOMOPTERA: APHIDIDAE) IN CHINA

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Abstract.—The aphid genus *Delphiniobium* Mordvilko from China is reviewed. There are four species in China, *Delphiniobium gyamdaense* Zhang, *D. yezoense* Miyazaki, ***D. violisuctum*** **Qiao and Zhang, n. sp.**, and ***D. aconitifoliae*** **Zhang and Qiao, n. sp.** A key to species from China, morphological descriptions, distributions, host plants, and diagnosis of new species are provided. In addition, the apterous viviparous female of *D. gyamdaense* Zhang is described for the first time.

Key Words: Homoptera, Aphididae, *Delphiniobium,* new species, China

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Mordvilko (1914) erected the genus *Delphiniobium* for the species *Myzus junackianum* Karsch 1887. Hille Ris Lambers (1947) studied the genus *Delphiniobium* from Europe. At present, this genus is represented by eight species and one subspecies, *D. bogdouli* Szelegiewicz 1969, *D. canadense* (Robinson 1968), *D. carpaticae* Mamontova 1966, *D. hanla* Paik 1971, *D. junackianum* (Karsch 1887), *D. junackinum sylvanae* (Knechtel and Manolache 1944), *D. lycoctoni* Börner 1950, *D. yezoense* Miyazaki 1971 and *D. gyamdaense* Zhang 1981 (Remaudière and Remaudière 1997). In the course of the present study, two new species, *D. aconitifoliae* Zhang and Qiao and *D. violisuctum* Qiao and Zhang are described from China, plus two other species, *D. gyamdaense* Zhang and *D. yezoense* Miyazaki. A key to species in China is provided. In addition, the apterous viviparous female of *D. gyamdaense* Zhang 1981 is described for the first time.

MATERIALS AND METHODS

All specimens studied including types are housed in the Zoological Museum, Institute of Zoology, the Chinese Academy of Sciences, Beijing.

Aphids were mounted on microscope slides in Arabic gum, and observed under phase contrast microscopy. Terminology follows Miyazaki (1971). Drawings were made by the first author, Dr. X. L. Chen, and Mr. T. S. Zhong using microscopy. Measurements are in millimeters.

Delphiniobium Mordvilko 1914

Delphiniobium Mordvilko 1914: 65.
Type-species: *Myzus junackianum* Karsch 1887 (= *Rhopalosiphum aconiti* van der Goot 1912). By monotypy.

Generic diagnosis.—Body elliptical. Medial frontal tubercle undeveloped or developed, lateral frontal tubercles with diverging inner sides present. Thoracic stigmal pores much longer than abdominal stigmal pores. Spiracular sclerites of thorax strongly produced, with opening very large and round. Mesosternal furca with short or long stem. Antennal segment III with large and small round secondary rhinaria. Ultimate rostral segment stout. First tarsal segment chaetotaxy: 3, 3, 3. Siphunculi slender, slightly or distinctly swollen, with distinct reticulation consisting of several rows of hexagonal cells near apex, paler than cauda basally. Cauda dark, long tapering. Mainly on *Aconitum* and *Delphinium.*

In general aspects this genus resembles *Megoura* Buckton, from which it can be easily separated by the reticulated apices of the siphunculi. On the other hand many *Macrosiphum*-like species in America have swollen siphunculi with a reticulated area, but in none of them a black, sclerotic cauda occurs. Other genera with swollen siphunculi have either no reticulated area (*Amphorophora* Buckton), or (*Rhopalosiphoninus* Baker) often no rhinaria on the antennal segment III in apterous viviparous females.

Distribution.—Europe (Romania, England, Netherlands, Germany, Russia), North America (Canada), Asia (China, Japan, Korea, Mongolia).

KEY TO APTEROUS VIVIPAROUS FEMALES OF SPECIES FROM CHINA

1. Medial frontal tubercle not developed, antennal tubercles small (Fig. 22); abdominal tergite I with 14 hairs; ultimate rostral segment with 2 pairs accessory hairs; China: Shanxi (Yangcheng County) . . . . . *Delphiniobium violisuctum* Qiao and Zhang, n. sp.
– Medial frontal tubercle developed, antennal tubercles large (Figs. 1, 15); abdominal tergite I with at most 10 hairs; ultimate rostral segment with 3–5 pairs accessory hairs 2
2. Siphunculi slightly or distinctly swollen in middle; ultimate rostral segment at most 1.30 times as long as second hind tarsal segment; antennal segment III with either at most 25 secondary rhinaria or at least 44 3
– Sipunuculi not swollen; ultimate rostral segment 1.35 times as long as second hind tarsal segment; antennal segment III with 21–39 secondary rhinaria; China: Beijing (Sanpu District, Xiaolongmen District) . . . . *Delphiniobium aconitifoliae* Zhang and Qiao, n. sp.
3. Antennal segment III with 44–57 secondary rhinaria, on basal ¾ of segment; siphunculi distinctly swollen (Fig. 20); China: Qinghai (Huzhu County), Xizang (Gyamda County) . . . . *Delphiniobium gyamdaense* Zhang
– Antennal segment III with 10–25 secondary rhinaria, on basal half of segment; siphunculus slightly swollen; China: Sichuan (An County), Hebei (Kuancheng County, Wulinshan Mountain, Xiaowutai Mountain); Japan . . . . *Delphiniobium yezoense* Miyazaki

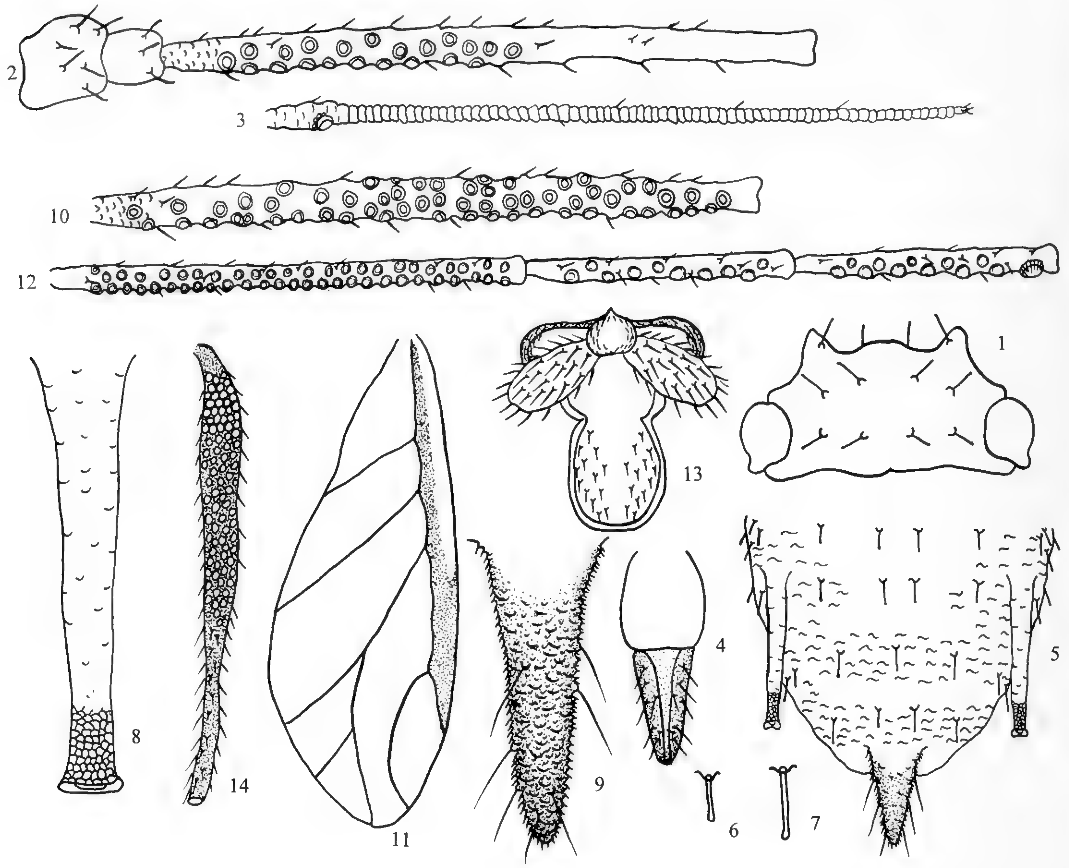
KEY TO ALATE VIVIPAROUS FEMALES OF SPECIES FROM CHINA

1. Siphunculi distinctly swollen; antennal segment III longer than segments IV + V 2
– Siphunculi indistinctly swollen; antennal segment III shorter than segments IV + V 3
2. Antennal segment III with 77–81 secondary rhinaria; yellow in life; siphunculus 2.00 times as long as cauda; China: Qinghai (Huzhu County), Xizang (Gyamda County) . . . . *Delphiniobium gyamdaense* Zhang
– Antennal segment III with 40–65 secondary rhinaria; bluish green in life; siphunculus 1.60–1.70 times as long as cauda; China: Hebei (Kuancheng County, Wulinshan Mountain, Xiaowutai Mountain), Sichuan (An County); Japan . . . . *Delphiniobium yezoense* Miyazaki
3. Median frontal tubercle indistinct; ultimate rostral segment 1.06 times as long as second hind tarsal segment; siphunculi 1.74 times as long as cauda; China: Shanxi (Yangcheng County) . . . . *Delphiniobium violisuctum* Qiao and Zhang, n. sp.
– Median frontal tubercle distinct; ultimate rostral segment 1.40 times as long as second hind tarsal segment; siphunculi 2.00 times as long as cauda; China: Beijing (Sanpu District, Xiaolongmen District) . . *Delphiniobium aconitifoliae* Zhang and Qiao, n. sp.

Delphiniobium aconitifoliae Zhang and Qiao, new species

(Figs. 1–14)

Description.—Measurements: *Apterous viviparous female*: Body 3.56 in length, 1.78 in width. Antenna 3.72, length of segments I–VI 0.15, 0.09, 1.20, 0.59, 0.50, 0.12+1.08, respectively. Ultimate rostral segment 0.19 in length, 0.09 in basal width. Hind femur 1.41, hind tibia 2.53, second hind tarsal segment 0.16. Siphunculus 0.72 in length. Cauda 0.50 in length. *Alate viviparous females*: Body 3.20 in length, 1.18 in width. Antenna 3.93, length of segments I–VI 0.14, 0.10, 1.14, 0.62, 0.58, 0.12+1.23, respectively. Ultimate rostral segment 0.21 in length, 0.11 in basal width. Hind femur 1.38, hind tibia 2.51, second hind tarsal segment 0.15. Siphunculus 0.72 in length. Cauda 0.37 in length. *Alate male*:



Figs. 1–14. *Delphiniobium aconitifoliae.* 1–9, Apterous viviparous female. 1, Dorsal view of head. 2, Antennal segments I–III. 3, Antennal segment VI. 4, Ultimate rostral segment. 5, Dorsal view of abdominal segments V–VIII. 6, Dorsal hair of body. 7, Ventral hair. 8, Siphunculus. 9, Cauda. 10–11, Alate viviparous female. 10, Antennal segment III. 11, Fore wing. 12–13, Alate male. 12, Antennal segments III–V. 13, Clasper. 14, Oviparous female, hind tibia.

Body 2.64 in length, 1.13 in width. *Oviparous female*: Body 3.61 in length, 1.83 in width.

Apterous viviparous female: Body oval, red and yellow in life. Mounted specimens: Head grey, thorax and abdomen pale, without patches. Antenna black except base of antennal segment III pale; rostral segments III–V, distal half of femora, tibiae and tarsi black, siphunculi pale at base, brown at middle, black distally, cauda and anal plate black, genital plate pale. Abdominal segments VII and VIII with slight imbrications. Spiracles large, closed, spiracular plates slightly brown. Mesosternal furca with short stem, pale. Dorsal hairs of body thick and short, stout at apex. Ventral hairs similar to but longer than dorsal hairs. Head with 1 pair cephalic hairs, 1 pair antennal tubercular hairs, 4–5 pairs dorsal hairs. Pronotum with 1 pair spinal, 1 pair pleural and 1 pair marginal hairs. Abdominal tergites I–VI each with 4–6 spino-pleural hairs, tergite VII with 2 or 3; tergites II–VII each with 2–3 pairs marginal hairs, tergite I with 1 pair marginal hairs, tergite VIII with 2 pairs hairs. Length of cephalic hairs 0.04, length of marginal hairs on abdominal tergite I 0.03, and length of dorsal hairs on tergite VIII 0.05, 0.52 times, 0.39 times and 0.75 times as long as widest diameter of antennal segment III, respectively. Median frontal tubercle developed, antennal tubercles developed and diverging, higher than median front. Antenna 6-segmented, basal part of segment III and segments IV–VI with distinct imbrications, length 1.10 times as long as body; length in proportion to segments I–VI: 13, 7, 100, 49, 41, 10+90, respectively. Antennal hairs similar to dorsal hairs, segments I–VI each with 6 or 7, 4, 25–31, 7–13, 7–10, 3 or 4 +3–8 hairs, respectively, apex of processus terminalis with 3 hairs. Length of hairs on antennal segment III 0.04, 0.57 times as long as widest diameter of segment. Antennal segment III with 21–39 large and small round secondary rhinaria (Fig. 2) on basal ⅔ of segment. Rostrum thick and large, reaching midcoxae, clypeus with 2 pairs hairs anteriorly; ultimate rostral segment 2.00 times as long as its basal width, 1.20 times as long as second hind tarsal segment, with 7 pairs hairs, 3–4 pairs accessory hairs among them. Hind femur 1.20 times as long as antennal segment III. Hind tibia 0.71 times as long as body. Length of hairs on hind tibia 0.06, 0.93 times as long as middle tibia width of segment. First tarsal segment chaetotaxy: 3, 3, 3. Siphunculi long, tapering, slightly constricted at distal ¼, with 12–14 rows of reticulations at constricted part; 0.20 times as long as body, 1.40 times as long as cauda; with flange. Cauda tapering, rough, with spinulose imbrications; with 6–8 thick and long hairs. Anal plate circular at apex, with 11–19 long and short hairs. Genital plate semicircular, with 14–16 hairs.

Alate viviparous female: Mounted specimens: Head and thorax slightly brown, head surrounding eyes black, abdomen pale, without patches. Spiracles large and opened, spiracular plates brown. Marginal areas of body and some abdominal segments behind siphunculi with distinct imbrications. Dorsal hairs of body thick and short, stout at apex. Head with 1 pair cephalic hairs, 2–3 pairs antennal tubercular hairs, 4 pairs dorsal hairs. Abdominal tergites I–VII each with 3 or 4 spinal, 1 pair pleural and 4–8 pairs marginal hairs, tergite VIII with 2–3 pairs hairs. Length of cephalic hairs 0.04, length of marginal hairs on abdominal tergite I 0.03, and length of dorsal hairs on tergite VII 0.05, 0.61 times, 0.49 times and 0.72 times as long as widest diameter of antennal segment III, respectively. Antenna 6-segmented, 1.20 times as long as body; length in proportion to segments I–VI: 12, 8, 100, 55, 51, 10+107, respectively. Antennal segment III with 29–36 hairs, length 0.03, 0.46 times as long as widest diameter of segment. Antennal segment III with 46–73 large and small round secondary rhinaria, on entire segment. Rostrum reaching midcoxae, ultimate rostral segment 1.40 times as long as second hind tarsal segment, with 8–9 pairs hairs, 5–6 pairs accessory hairs among them. Hind femur 1.21 times as long as antennal segment III. Hind tibia 0.79 times as long as body. Veins normal. Siphunculi swollen at distal half, constricted at apex, 0.23 times as long as body, 2.00 times as long as cauda. Cauda long, tapering, with 7 hairs. Anal plate with 17–19 hairs. Other characters similar to apterous viviparous female.

Alate male: Body long oval. Mounted specimens: Antenna, rostrum, distal half of femora, tibiae, tarsi, siphunculi, cauda, anal plate dark brown, other appendages slightly brown. Abdominal tergites I–V each with 1 pair spino-pleural and 1 pair marginal patches. Dorsal hairs of body with sclerites at base. Dorsal hairs slightly short, ventral hairs longer than dorsal hairs. Antenna 6-segmented, 1.50 times as long as body. Secondary rhinaria small round, on segments III–V; segment III with 53–63, segment IV with 8–11, segment V with 7–11. Forewing media two-branched, hindwing two obliques. Clasper shown in Fig. 13. Other characters similar to alate viviparous female.

Oviparous female: Body oval. Mounted specimens: Antennal segments I–III, distal part of segment IV, distal part of segment V, basal part of segment VI, distal part of rostrum, distal half of femora, tibiae, tarsi, cauda, anal plate, distal ⅕ of siphunculi dark brown, other appendages slightly brown; basal ⅕ of siphunculi pale, rest of siphunculi slightly brown. Genital plate slightly brown. Antennal segment III with 12–18 small round secondary rhinaria, on basal half of segment. Hind tibia swollen at basal half, with about 250 small round pseudo-sensoria. Other characters similar to apterous viviparous female.

Diagnosis.—The new species differs from *D. yezoense* Miyazaki as follows: Clypeus with 4 hairs (*yezoense,* 2 hairs), basal and distal of antennal segment III and basal of segment IV pale (*yezoense,* black, except basal of segment III), and yellow or red in life (*yezoense,* green or bluish green). It differs from *D. bogdouli* Szelegiewicz as follows: Antennal segment V black (*bogdouli,* basal part of segment pale), yellow or red in life (*bogdouli,* shining brown in life), and length of dorsal hairs of body 0.33 (*bogdouli,* 0.45).

Etymology.—The species name is based on the host plant, *Aconitum kusnezofii.*

Holotype.—Apterous viviparous female, No. 6804-1-2-3, 1978-VI-8, China, Beijing (Sanpu District, 116.4°E, 89.9°N), Col. G. X. Zhang and T. S. Zhong, on young twigs and upper of leaves of *Aconitum kusnezofii* Reichb.

Paratypes.—Two apterous viviparous females and 2 alate viviparous females, No. 6804, other data same as holotype; 2 alate viviparous females, 5 apterous females and 2 alate males, No. 6502, 1976-X-5, Col. B. L. Zhang, other data same as holotype; 2 apterous viviparous females, 1 alate viviparous female, 3 alate males and 12 apterous females, No. 6628, 1977-X-14, other data same as holotype; 5 apterous viviparous females and 3 alate viviparous females, No. 6230, 1976-V-18, other data same as holotype; 1 apterous viviparous female, 1 alate viviparous female and 2 apterous females, No. 11535, 1997-IX-11, China, Beijing (Xiaolongmen District, 116.0°E, 39.9°N), Col. J. G. Xiangyu, on *Aconitum* sp.

Delphiniobium gyamdaense Zhang 1981
(Figs. 15–21)

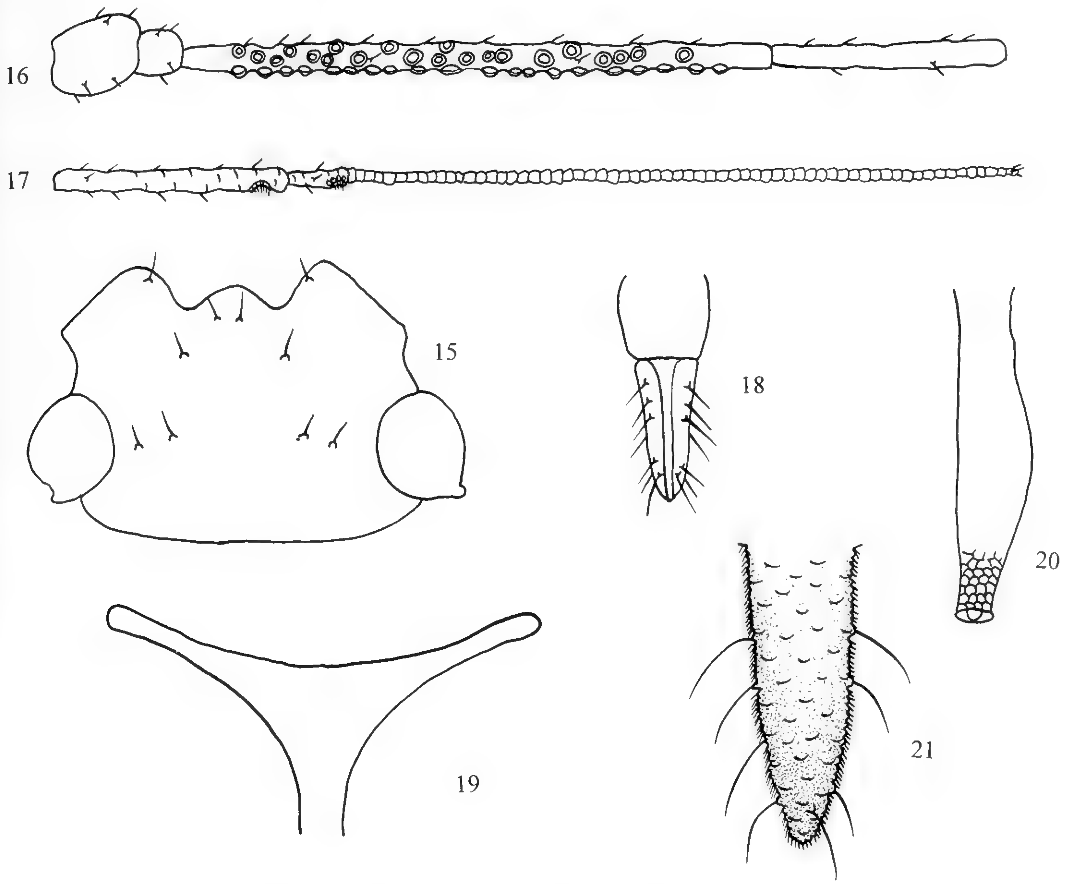
Delphiniobium gyamdaense Zhang 1981: 264.

Description.—*Apterous viviparous female:* Body 3.04 in length, 1.50 in width. Body elliptical, yellow in life, siphunculi, antennae, legs and cauda black. Mounted specimens: Head and prothorax slightly brown, mesonotum, metanotum and abdomen pale, without patches. Antennal segments dark brown, except basal part of segment III and distal part of segment VI; distal part of rostrum, distal half of femora, distal part of tibiae and tarsi dark brown; distal ⅙ of siphunculi, cauda and anal plate dark brown, others pale. Mesosternal furca with long stem. Median frontal tubercle slightly developed, antennal tubercles developed, higher than median frontal tubercle. Antenna 6-segmented, about as long as body; length in proportion to segments I–VI: 13, 8, 100, 40, 40, 10+115. Antennal segment III with 44–46 round secondary rhinaria, over the entire segment. Length of hairs on segment III ⅓ as long as widest diameter of segment. Rostrum exceeding midcoxae, ultimate rostral segment 2.35 times as long as its basal width, with 8 accessory hairs. Siphunculi long barrel-shaped, swollen at middle, width at swollen part 1.90 times distal width, distal ⅙ with reticulations, 0.16 times as long as body, 1.25 times as long as cauda. Cauda long tapering, indistinctly constricted, 2.56 times as long as its basal width, with 6 hairs. Anal plate with 16 hairs.

Specimens examined.—Three apterous viviparous females, No. 11391, 1997-VI-8, China: Qinghai (Huzhu County, 101.9°E, 36.8°N), Col. X. L. Chen, on *Aconitum* sp., Xizang (Gyamda County, 93.1°E, 29.9°N).

***Delphiniobium violisuctum* Qiao and Zhang, new species**
(Figs. 22–31)

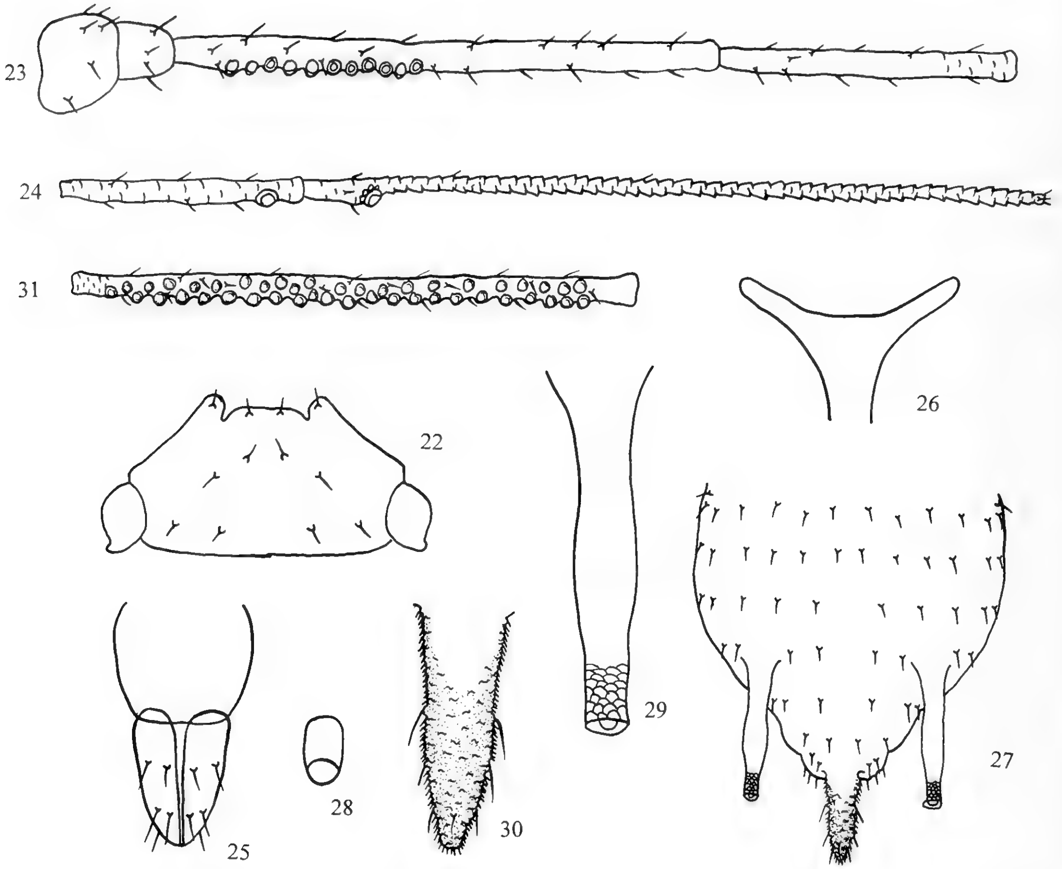
Description.—Measurements: *Apterous viviparous female:* Body 3.13 in length,



Figs. 15–21. *Delphiniobium gyamdaense,* apterous viviparous female. 15, Dorsal view of head. 16, Antennal segments I–IV. 17, Antennal segments V and VI. 18, Ultimate rostral segment. 19, Mesosternal furca. 20, Siphunculus. 21, Cauda.

1.43 in width. Antenna 3.70, length of segments I–VI 0.14, 0.10, 1.10, 0.56, 0.46, 0.14+1.27, respectively. Ultimate rostral segment 0.12 in length. Hind femur 1.37, hind tibia 2.30, second hind tarsal segment 0.16. Siphunculus 0.67 in length. Cauda 0.45 in length. *Alate viviparous female:* Body 3.40 in length, 1.58 in width.

Apterous viviparous female: Body large, dark green in life, on upper side of leaves. Mounted specimens: Head and prothorax brown, antennal segments I and II, distal ⅞ of segment III, distal ⅓ of segment IV, distal half of segment V, basal part of segment VI and distal half of processus terminalis dark brown, others brown; apex of rostrum, distal ⅗ of femora, distal ⅙ of tibiae, tarsi, distal ¼ of siphunculi, cauda and anal plate dark brown, coxae, trochanters, basal ⅕ of femora, basal ⅕ of siphunculi and genital plate slightly brown, others brown. Spiracles large, oval, opened; spiracular plate long oval, slightly pale. Mesosternal furca with long stem. Dorsal hairs of body thick, short, stout at apex. Head with 1 pair of cephalic hairs and 1 pair antennal tubercular hairs, 4 pairs dorsal hairs; pronotum with 3 pairs spinal, 2 pairs pleural and 1 pair marginal hairs; abdominal tergite I with 14 hairs, tergite VII with 4 hairs. Length of cephalic hairs 0.04, length of marginal hairs on tergite I 0.03, and length of dorsal hairs on tergite VII 0.05, 0.73 times, 0.55 times and 0.91 times as long as



Figs. 22–31. *Delphiniobium violisuctum.* 22–30, Apterous viviparous female. 22, Dorsal view of head. 23, Antennal segments I–IV. 24, Antennal segments V and VI. 25, Ultimate rostral segment. 26, Mesosternal furca. 27, Dorsal view of abdominal tergites III–VIII. 28, Spiracle on abdominal segment II. 29, Siphunculus. 30, Cauda. 31, Alate viviparous female, antennal segment III.

widest diameter of antennal segment III, respectively. Median frontal tubercle undeveloped, antennal tubercles distinct, higher than median frontal tubercle, slightly diverging at inner margins. Antenna 6-segmented, 1.18 times as long as body, length in proportion to segments I–VI: 14, 10, 100, 54, 45, 14+123. Processus terminalis 9.11 times as long as base of segment. Antennal hairs similar to dorsal hairs, antennal segments I–VI each with 7, 4, 30, 11, 6, 3+3 hairs, respectively, apex of preocessus terminalis with 3 hairs. Length of hairs on antennal segment III 0.04, 0.64 times as long as widest diameter of segment. Antennal segment III with 11 small round secondary rhinaria, on basal half of segment. Rostrum reaching midcoxae, ultimate rostral segment thick, 1.33 times as long as its basal width, 0.87 times as long as second hind tarsal segment; with 2 pairs accessory hairs. Legs normal. Hind femur 1.33 times as long as antennal segment III. Hind tibia 0.72 times as long as body. Hairs on legs slightly longer than dorsal hairs of body. Length of hairs on hind tibia 0.07, 1.40 times as long as middle width of segment. First tarsal segment chaetotaxy: 3, 3, 3. Siphunculus long barrel-shaped, 3.42 times as long as basal width, 8.13 times as long as distal width, 0.21 times as long as body, 1.48 times as long as cauda, swollen at middle, distal $\frac{1}{6}$ of siphunculi with reticulations. Cauda long, tapering, slightly constricted at middle, 2.44 times as long as its basal width, with 7 hairs. Anal plate circular at apex, with 18 hairs. Genital plate with 15 hairs, 2 long anterior hairs among them. Gonapophyses three, each with 5 or 6 hairs.

Alate viviparous female: Body large. Mounted specimens: Basal of antennal segment III pale, distal $\frac{1}{3}$ of tibiae black, distal half of femora, and other antennal segments slightly brown, other appendages dark brown; dorsum of head brown; distal of rostrum, cauda, and anal plate greyish brown; basal $\frac{2}{3}$ of siphunculi slightly brown, distal $\frac{1}{5}$ of siphunculi dark brown. Abdominal dorsum without patches. Antenna 6-segmented, segment III with 42–47 small round secondary rhinaria, on entire segment. Fore wing veins brown, media two-branched. Other characters similar to apterous viviparous females.

Diagnosis.—The new species is similar to *D. bogdouli* Szelegiewicz from Mongolia by the median frontal tubercle and antennal tubercles, but differs as follows: antennal segment III with 42–47 secondary rhinaria in alatae (*bogdouli,* 58–62); ultimate rostral segment 0.87 times as long as second hind tarsal segment (*bogdouli,* longer than, 1.10 times); siphunculi slightly swollen at middle (*bogdouli,* indistinctly swollen); and dark green in life (*bogdouli,* shining brown).

Etymology.—The new species is named based on the host plant, *Viola verecunda.*

Holotype.—Apterous viviparous female, No.Y8070-1-1-1, China: Shanxi (Yangcheng County, 112.4°E, 35.5°N), Col. Fei Zhao, 1996-VI-1, on *Viola verecunda.*

Paratypes.—One alate viviparous female and 1 apterous larvae, No.Y8070, other data same as holotype.

Delphiniobium yezoense Miyazaki 1971

Delphiniobium yezoense Miyazaki 1971: 34(1):40.

Distribution.—No.Y4347, China: Hebei (Wulinshan Mountain, 117.4°E, 40.6°N), 1983-IX-12, Col. S.P. Tian; No.Y5718, China: Hebei (Kuancheng County, 118.4°E, 40.6°N), 1983-IX-9, Col. S.P. Tian; No.Y5597, China: Hebei (Xiaowutai Mountain, 115.°E, 89.9°N), 1984-VI-22, Col. S.P. Tian; No.Y1598, China: Sichuan (An County, 104.4°E, 31.6°N), 1979-V-22, Col. H.Y. Li; No.Y1436, China: Sichuan (An County), 1978-IX, Col. H.Y. Li; Japan.

Host-plants.—*Aconitum kusnezoffi* and *A. comiichali* (in China); *A. chinense, A. kitadakense, A. yesoense* and *A. sachalinense* (in Japan).

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NEW COSTA RICAN SPECIES OF *PHYLLOPHAGA* HARRIS (COLEOPTERA: MELOLONTHIDAE: MELOLONTHINAE)

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Abstract.—Four new species of *Phyllophaga* are described from Costa Rica, ***Phyllophaga kohlmanniana*** and ***P. picadoana*** from the montane rain forest of the Monteverde Biosphere Reserve, Puntarenas, and ***P. janzeniana*** and ***P. guanacasteca*** from the tropical deciduous forests lowlands of Guanacaste. Drawings of male genital capsules, female genital plates, and tarsal claws are provided.

Resúmen.—Se describen cuatro especies nuevas de *Phyllophaga* procedentes de tres localidades en Costa Rica: ***P. kohlmanniana*** y ***P. picadoana*** del bosque lluvioso de montaña de la Reserva de la Biosfera Monteverde, Puntarenas; ***P. janzeniana*** y ***P. guanacasteca*** de los bosques tropicales caducifolios de las tierras bajas de Guanacaste. Se incluyen ilustraciones de las cápsulas genitales masculinas, de las placas genitales femeninas y de las uñas tarsales.

Key Words: *Phyllophaga,* May beetles, new species, tropical forests, Costa Rica

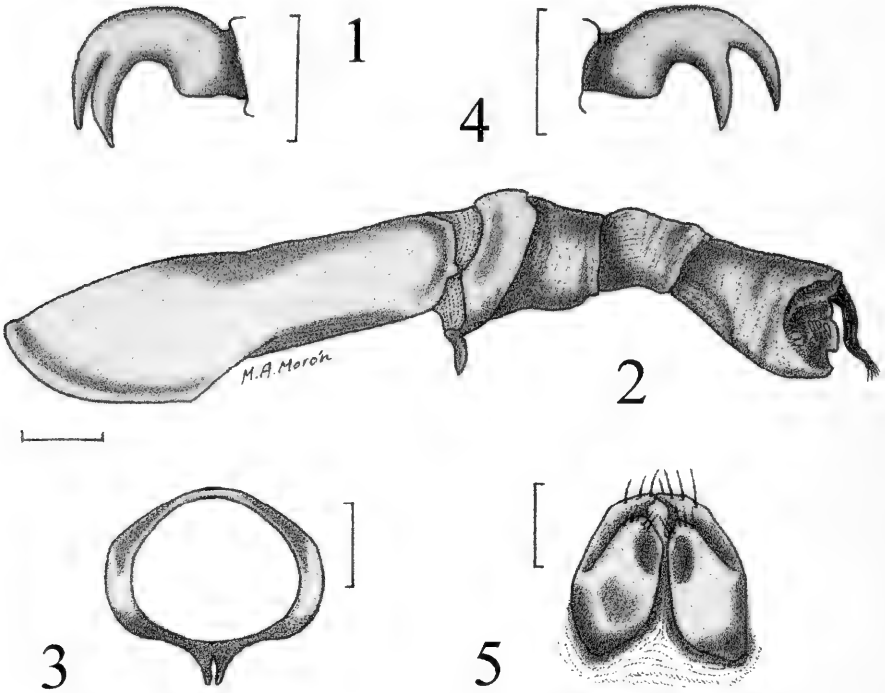
During curatorial work at the collection of INBio (1993–1999), we found specimens that represent four undescribed species of *Phyllophaga* from the provinces of Guanacaste and Puntarenas, Costa Rica. Males of these species have deep cleft or bifid tarsal claws, while the females have dentate tarsal claws. Using the criteria of Saylor (1942), Sanderson (1958), or Morón (1986), the males of these species key to the subgenus *Phytalus,* whereas the females key to the subgenus *Phyllophaga* (*s.str.*). A similar situation is present with other species from Mexico, such as *Phyllophaga ambigenus* (Bates) and *Phyllophaga mesophylla* Morón and Rivera (1992), both placed in the subgenus *Phytalus* based on the structure of the male tarsal claws and other characters. Awaiting for new advances in the supraspecific classification of the genus, we place the presently described species as *incerta sedis.* In this paper, we describe males and females, address variation within the species, and present the precise distribution data for four new species of *Phyllophaga* from the montane rain forests and deciduous tropical forests in Costa Rica.

Acronyms used in the text are as follows: CAS, California Academy of Sciences, San Francisco, USA; INBio, Instituto Nacional de Biodiversidad, Costa Rica; MXAL, private collection M.A. Morón, Xalapa, México.

Phyllophaga kohlmanniana Morón and Solís, new species

(Figs. 1–5)

Description.—*Holotype male:* Head and pronotum shiny dark brown, with dense vestiture of short whitish setae; elytra, ster-



Figs. 1–5. *Phyllophaga kohlmanniana*. 1, Male protarsal claw, lateral view. 2, Genital capsule, lateral view. 3, Paramera, distal view. 4, Female protarsal claw, lateral view. 5, Female genital plates, ventral view. Scale lines = 1 mm, except figs. 1, 4 = 0.5 mm.

nites and pygidium reddish dark brown, sligthly pruinose, completely covered with dense vestiture of uniform, whitish, short setae, that offer a macroscopic grayish, velvety appearance; mouth parts, tibiae and tarsi shiny reddish brown; coxae and femora partially pruinose. Clypeus 3.7 × wider than long, anterior border curved, not sinuate, with elevated margin, surface slightly concave, with many uniformly distributed, deep, round punctures each provided with short, erect seta. Frontoclypeal suture widely sinuate and deeply impressed. Frons 1.6 × wider than long, convex, finely punctate rugose, with short erect setae on entire surface. Antenna 10-segmented, with three segmented club, lamellae of 8th to 10th segments 1.6 × longer than length of preceeding six segments combined; segments 4 or 5 shorter than 3, with rounded prominences on anterior sides; segments 6 and 7 wider than long, with semiconical prominences on anterior sides. Frons 3.7 × wider than dorsal diameter of eye. Eye canthi long and wide, with 13–14 setae. Labrum bilobed, widely sinuated, with scattered slender setae. Mentum slightly concave, impunctate, with scarce slender setae, anterior border briefly sinuated, nearly straight. Pronotum 1.7 × wider than long and 2.9 × wider than frons. Pronotal disk shiny, but with basi-central area pruinose, total surface with deep, round punctures regularly separated by 1–2 diameters; lateral borders widely angulate, lateral marginal bead crenulate, with long, curved setae; basal bead complete, indicated by wide, deep sulcus; anterior angles straight, slightly prominent; posterior angles nearly straight, not prominent. Scutellum 1.5 × wider than long, with many small punctures. Elytron 2.3 × longer than wide, pruinose, densely and regularly punctate-setose; epipleural border narrow, extended along complete margin, slightly widened at $^{4}/_{6}$ and $^{5}/_{6}$ of its length, provided with scarce slender setae at anterior third, dull or pruinose at middle and posterior thirds; humeral calla rounded, prominent; apical calla rounded. Metathoracic wings completely developed. Propygidium pruinose, with dense setiferous punctures. Pygidium scarcely convex, pruinose, with round shaped, shallow rounded seitiferous punctures, regularly distributed; apical margin with 16 long, slender setae; basal margin effaced. Pterosterna with long, dense, yellowish setae. Visible abdominal sternites II to IV slightly depressed at midline, with a noticeable shallow sulcus; sternite V sligthly convex, pruinose, with dense setiferous punctures at middle; anal plate narrowed, transversely excavated, with elevated anterior and posterior margins, and 10 setae on apical border. Protibia nearly as long as protarsus (1:1.1), with external border tridentate, preapical spur acute, straight, longer than 2nd protarsomerus (1.2:1). Mesotibia with one oblique, well marked, setiferous carina on external side; upper apical spur straight, narrow, and 1.4 × longer than lower spur. Metatibia slightly shorter than metatarsus (1:1.2), with one oblique setiferous carina on external side; upper apical spur articulated, straight, sharply pointed, as long as basal metatarsomere, and 1.5 × longer than lower spur; lower apical spur articulated, apex acute. Tarsomeres semicylindrical, elongate, with enlarged apex, some setae apically and two lines of setae along ventral side. Tarsal claws symmetrical, similar in all legs, deeply cleft, upper tooth shorter than lower tooth (Fig. 1). Genital capsule with short, narrowed parameres, dorsal and ventrally fused, ring shaped, apex with medium size, tooth-like projections (Fig. 3). Aedeagus very long, with preapical patches of spinules at sides and sclerotized dorsal support with sinuose flagellum (Fig. 2). Tectum (= phallobase) uniformly convex. Length of genital capsule from apex of parameres to border of basal piece: 6.8 mm. Total body length: 21.2 mm. Humeral width: 10.0 mm.

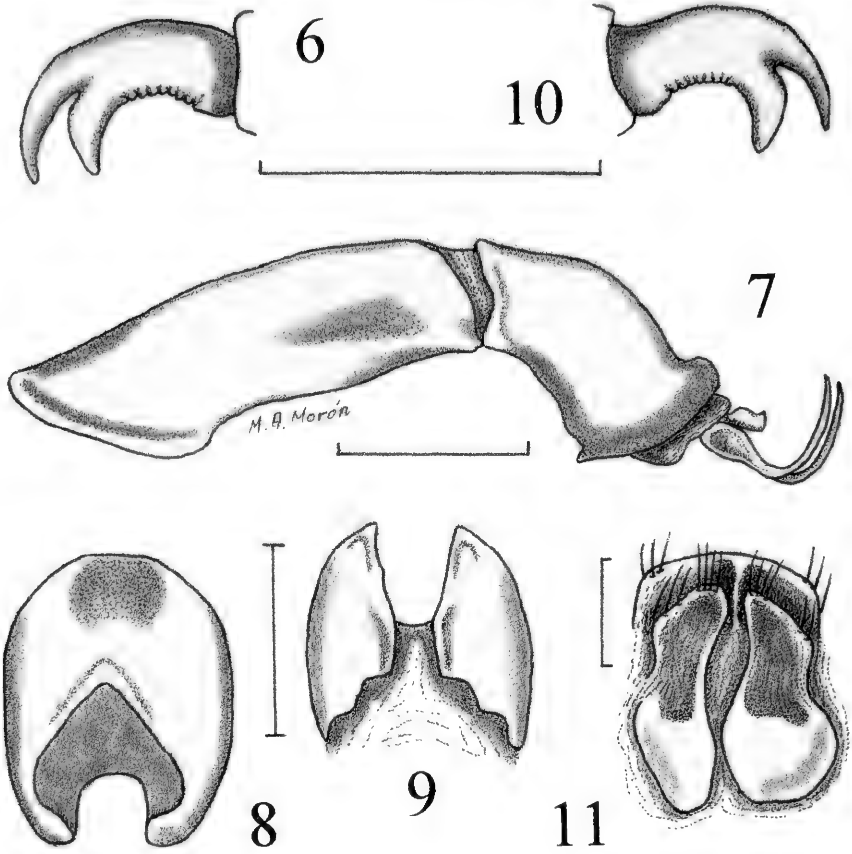
Allotype female: Similar to the male except as follows: antenna with segments 5 and 6 fused, and appearing 9-segmented. Visible abdominal sternites II to VI convex, with dense setiferous punctures; anal plate 1.8 × longer than male anal plate, very convex, punctate, with 12 slender setae at the apical border. Meso- and metatibiae each with one oblique, strong, setiferous carina near middle and other vague carina on basal third of external side. Both apical spurs of metatibia articulated, wide, lanceolate and curvated. Tarsal claws dentate, with long tooth near middle of ventral border (Fig. 4). Ventral genital plates well sclerotized, nearly symmetrical, elongated, with short setae at distal process; dorsal genital plates fused with ventral ones toward lateral sides, with acure apices directed mesad and setae on distal borders (Fig. 5). Total body length: 20.6 mm. Humeral width: 9.8 mm.

Variation.—*Male:* Similar to holotype except as follows: total body length: 19.8–21.5 mm, humeral width: 9.6–10.3 mm, pronotum of some specimens more reddish than holotype, other specimens with antennal club as long as preceeding six segments combined. Female similar to allotype except as follows: pygidium with more setiferous punctures; total body length: 19.5–20.4 mm; humeral width: 9.6–9.8 mm.

Type material.—Described from 5 ♂, 4 ♀. Holotype ♂ INBio: Costa Rica: Puntarenas, Monteverde, La Casona, IV-92, 1,520 m, N. Obando. Allotype ♀ INBio: Costa Rica: Guanacaste, SW Volcán Cacao, Est. Mengo, II-89, 1,100 m, GNP Biodiversity Survey. Paratypes INBio, MXAL: same data as holotype (2 ♂ and 2 ♀); same data as allotype (2 ♂, 1 ♀).

Type locality.—La Casona, Estación Monteverde, province of Puntarenas, Costa Rica (aprox. 10°30′N; 85°10′ W).

Biological data.—Specimens of *P. kohlmanniana* were collected at lights near cloud forests and tropical premontane forests located between 1,100–1,520 m. Phenology: February (4), April (5). Other species of *Phyllophaga* flying at the same time were *P.* (*Phyllophaga*) *tapantina* Morón



Figs. 6–11. *Phyllophaga janzeniana*. 6, Male protarsal claw, lateral view. 7, Genital capsule, lateral view. 8, Paramera, distal view. 9, Paramera, ventro-apical view. 10, Female tarsal claw, lateral view. 11, Female genital plates, ventral view. Scale lines = 1 mm, except figs. 6, 10, 11 = 0.5 mm.

and Solís, *P.* (*Phyllophaga*) *tilarana* Morón and Solís and *P. picadoana,* n.sp.

Remarks.—*Phyllophaga kohlmanniana* does not belong to any species group described by Morón (1986). The structure of the male tarsal claws suggests placement in the subgenus *Phytalus,* but the form of the female tarsal claws indicates placement in the subgenus *Phyllophaga* (*s.str.*), as is known for *P. ambygenus* (Bates) and some other Mexican and Central American species. By the color, vestiture, body size, length of tarsi, and form of clypeus is similar to *P.* (*Phytalus*) *zeteki* Saylor, 1942, described from Barro Colorado Island, Panama, but the shape and details of the male genital capsule (Fig. 2), sculpture and vestiture of the sternites, shape of tarsal claws (Fig. 1) and proportions of antennal segments will aid in the recognition of this new species.

Etymology.—This new species is dedicated to our friend, Dr. Bert Kohlmann, whose enthusiastic devotion to the study of the scarab beetles of Mexico and Central America is well known to coleopterists and also to people interested in insect ecology and biogeography.

Phyllophaga janzeniana Morón and Solís, new species
(Figs. 6–11)

Description.—*Holotype male:* Clypeus, frons and pronotum shiny dark reddish brown; elytra and pygidium shiny reddish brown, without macroscopic vestiture; mouth parts, sterna and legs shiny testaceous reddish brown. Clypeus 3.6 × wider than long, anterior border rounded, not sinuate, with elevated margin, surface slightly concave, with some wide, deep, coarse, round punctures without microscopic setae. Frontoclypeal suture sinuate and vaguely impressed. Frons 2.0 × wider than long, convex, coarsely punctate rugose, with transverse keel on anterior half and some medium size setae at sides and minute setae scattered on the posterior half of disk. Antenna 9-segmented, with 3 segmented club, lamellae as long as the length of preceeding 5 segments combined; 5th segment longer than 4 or 3; segment 6 compresed with semiconical anterior process. Frons 3.3 × wider than dorsal diameter of eye. Eye canthi long and wide, with 9–10 setae. Labrum widely concave, sligthly bilobed, with scattered slender setae. Mentum slightly concave, impunctate, with scarce, slender setae, anterior border briefly notched. Pronotum 1.6 × wider than long and 2.9 × wider than frons. Pronotal disk shiny, with deep, coarse umbiliform punctures irregularly separated by 1–3 diameters; lateral borders widely angulate, lateral marginal bead widely crenulated, with scattered, long, slender setae; basal bead vaguely indicated by punctures, mainly toward the sides; anterior angles straight, prominent; posterior angles widely obtuse, rounded. Scutellum 1.3 × wider than long, with some irregular punctures. Elytron 2.8 × longer than wider, shiny, densely rugo-punctate; epipleural border very narrow, extended along complete margin, provided with some scattered short setae; humeral calla rounded, prominent; apical calla rounded. Metathoracic wings completely developed. Propygidium glabrous, with distal half nearly shiny and basal half slightly pruinose, with sparse umbiliform punctures. Pygidium moderately convex, shiny, glabrous, coarsely rugo-punctate; apical margin with 14 long, slender setae; basal margin effaced medially. Pterosterna with medium size, moderately dense, yellowish setae. Visible abdominal sternites II and IV slightly convex, nearly polished and glabrous toward the middline; sternite V convex, shiny, irregularly rugo-punctate with scarce, scattered setae at middle; anal plate narrowed, transversely concave, irregularly punctate, anterior and posterior borders elevated, with some slender setae. Protibia slightly shorter than protarsus (1:1.2), with external border tridentate, preapical spur acute, nearly straight, as long as 2nd protarsomerus. Mesotibia with one oblique, sharp setiferous carina on external side; upper apical spur straight, narrow, and 1.1 × longer than lower spur. Metatibia nearly as long as metatarsus, with one oblique, sharp setiferous carina on external side; upper apical spur articulated, angulated, sharply pointed, 1.2 × longer than basal metatarsomere, and 1.1 × longer than lower spur; lower apical spur articulated, with acute apex. Tarsomeres semicylindrical, elongate, with enlarged apex, some setae apically and two lines of setae on ventral side. Tarsal claws symmetrical, similar in all legs, widely and deeply cleft, upper tooth nearly as long as lower tooth, posterior ventral border slightly serrated (Fig. 6). Genital capsule with medium size parameres, dorsally fused, elongated with apex expanded and curvated toward the middle line (Figs. 7–8); ventrally the paramera are not fused (Fig. 9). Aedeagus long, with a preapical dorsal sclerotized plate that support a pair of long curved spine-like sclerotized structures (Fig. 7). Tectum uniformly convex. Length of genital capsule from apex of parameres to border of basal piece: 3.7 mm. Total body length: 11.9 mm. Humeral width: 5.0 mm.

Allotype female: Similar to the male except as follows: anterior angles of clypeus more wide and rounded, expanded; antennal club as long as the length of four preceeding segments; pronotum with anterior angles more prominent and lateral bead noticeably crenulate. Visible abdominal sternites II to IV convex, with scattered setiferous punctures; sternite V more long and convex; anal plate 2 × longer than male anal plate, convex, punctate, with 10 slender setae near the posterior border. Pygidium with central part of disk slightly flattened. Both apical spurs of metatibia slightly curvated with the apex rounded. Tarsal claws with upper tooth slightly shorter than ventral one (Fig. 10). Ventral genital plates with basal half well sclerotized and distal part membranous, sclerotized only at borders, sligthly asymmetrical, basally rounded, elongated to apex, with some setae on border; dorsal genital plates poorly sclerotized, fused medially, with some setae at each side (Fig. 11). Total body length: 11.2 mm. Humeral width: 5.2 mm.

Paratype variation.—Male similar to holotype except in total body length: 10.8–11.8 mm, humeral width: 4.8–5.2 mm, pronotum and elytra of some specimens darker than holotype, other specimens with frontal transverse carina more or less accentuated. Female similar to allotype except as follows: pronotum, elytra and pygidium with more or less punctures; total body length: 10.8–11.5 mm; humeral width: 5.0–5.4 mm.

Type material.—Described from 8 ♂, 10 ♀. Holotype ♂ INBio: Costa Rica: Guanacaste, 12 km SE La Cruz, Cerro El Hacha, Casa Oeste, VI-87, 300 m, GNP Biodiversity Survey. Allotype ♀: same data as holotype (INBio). Paratypes CAS, INBio, MXAL: same data as holotype (4 ♂, 1 ♀); Guanacaste, P.N. Rincón de La Vieja, Est. Las Pailas, 1/22-VII-92, 800 m, D. García (3 ♂, 8 ♀).

Type locality.—Cerro El Hacha, 12 km SE La Cruz, province of Guanacaste, Costa Rica (approx. 10°58′N; 85°32′W).

Biological data.—Specimens of *P. janzeniana* were collected at lights in tropical deciduous forests located between 300–800 m. Phenology: June (7), July (11). Other species of *Phyllophaga* flying at the same time were *P.* (*Chlaenobia*) *scabripyga* (Bates), *P.* (*Phytalus*) *obsoleta* (Blanchard), *P.* (*Phyllophaga*) *elenans* Saylor and *P.* (*s.str.*) *hondurasana* Moser.

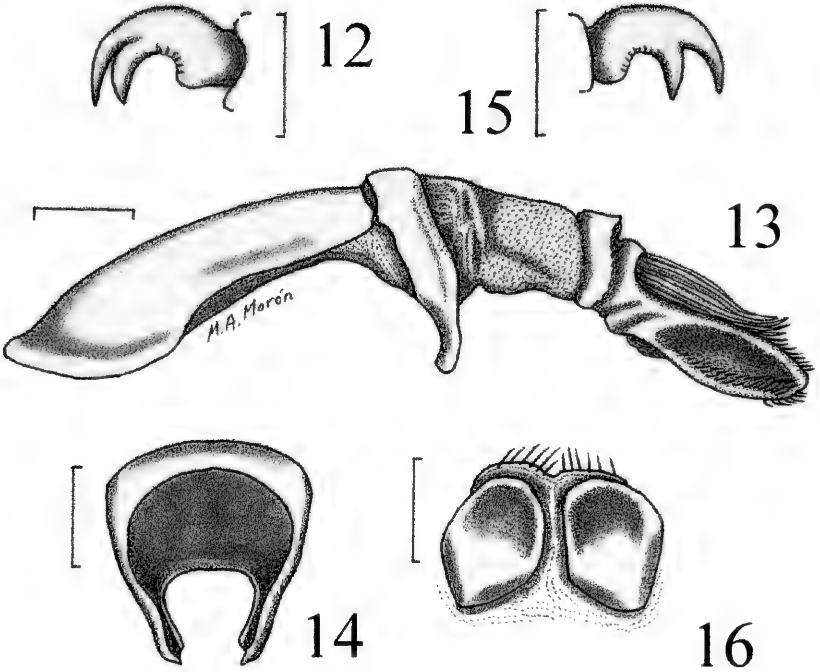
Remarks.—*Phyllophaga janzeniana* does not belong to any species group proposed by Morón (1986). It may be related to *P. soctona* Morón from Chiapas, México, which is also a small species with frontal transverse carina, 9-segmented antenna and similar tarsal claws, but the shape and details of the male genital capsule (Figs. 7–8) and female genital plates (Fig. 11) are very different. Each paramere of *P. soctona* have two large, apical teeth, and dorsal genital plates of female are not fused medially.

Etymology.—This new species is dedicated to Dr. Daniel H. Janzen, whose interest in the study and conservation of tropical forests, mainly in the Guanacaste area, is well known.

***Phyllophaga picadoana* Morón and Solís, new species**

(Figs. 12–16)

Description.—*Holotype male:* Head, pronotum and pygidium shiny dark reddish brown; with sparce vestiture of short to long setae; mouth parts, sterna and legs shiny reddish brown. Clypeus 3.2 × wider than long, anterior border shallowly and widely sinuated, with margin elevated, surface nearly flat, with large, shallow, round punctures and some scattered short setae. Frontoclypeal suture fine, vaguely indicated by a wide, shallow sinuate sulcus. Frons 1.7 × wider than long, convex, coarsely punctate rugose, covered with short to medium size slender setae. Antenna 10-segmented, with 3-segmented club, lamellae 2 × longer than length of preceeding 5 segments combined. Frons 4.1 × wider than dorsal diameter of eye. Eye canthi long and wide, with 7–8 setae. Labrum widely sinuate, slightly bilobed, with scattered slender setae. Mentum slightly convex, impunctate, with few slender setae, anterior border shallowly and widely sinuated. Pronotum 1.7 × wider than long and 3 × wider than frons. Pronotal disk shiny, with shallow, round shaped, large setiferous punctures irregular-



Figs. 12–16. *Phyllophaga picadoana*. 12, Male protarsal claw, lateral view. 13, Genital capsule, lateral view. 14, Paramera, distal view. 15, Female protarsal claw, lateral view. 16, Female genital plates, ventral view. Scale lines = 1 mm, except figs. 12, 15 = 0.5 mm.

ly separated from one another by 1–3 diameters; lateral borders widely angulate, lateral marginal bead slightly crenulated, mainly toward basal half, with scattered, long, slender setae; basal bead erased, only with shallow sulcus, mainly toward sides; anterior angles acute, prominent; posterior angles slightly obtuse, not prominent. Scutellum 1.6 × wider than long, with 10 rounded punctures. Elytron 2.4 × longer than wide, densely punctate-rugose, mostly shiny, except the preapical area and distal half of the lateral borders that have vague pruinose vestiture; epipleural border moderately narrowed, extended along complete margin, provided with scattered short, slender setae; humeral calla rounded, prominent; apical calla rounded. Metathoracic wings completely developed. Propygidium shiny, with dense setiferous punctures. Pygidium moderately convex, shiny, rugose, with round, shallow setiferous punctures irregularly distributed; apical margin with 18 long, slender setae; basal margin effaced medially. Pterosterna with long, dense, yellowish setae. Visible abdominal sternites II and IV slightly depressed, polished and nearly glabrous at the middline; sternite V convex, with a patch of granules and erect short setae on middle and with a wide, shallow transverse sulcus before posterior border; anal plate sligthly concave, vaguely furrowed at middle with some erect, medium size setae and anterior and posterior borders slightly elevated. Protibia slightly shorter than protarsus (1:1.2), with external border tridentate, preapical spur acute, nearly straight, slightly longer than 2nd protarsomerus (1:1.2). Mesotibia with one oblique, sharp, setiferous carina on external side; upper apical spur straight, narrowed, as long as the lower spur. Metatibia slightly shorter than metatarsus (1: 1.2), with one oblique, sharp, setiferous carina on external side; upper apical spur nearly lanceolate, curved, with rounded apex, as long as basal metatarsomere, and 1.4 × longer than lower spur; lower apical spur articulated, with rounded apex. Tarsomeres semicylindrical, elongate, with enlarged apex, some setae apically and two rows of setae with a fine longitudinal keel in middle of ventral side. Protarsomeres 1–3 with subapical short spines. Tarsal claws symmetrical, similar in all legs, deep cleft, upper tooth as long as lower tooth, with middle of ventral border finely serrate (Fig. 12). Genital capsule with proportionately short parameres, dorsally fused, apical thirth canaliculated by inner side (Fig. 14). Aedeagus large, with wide apical patches of spinules and dorsal preapical tuft of strong setae on a wide sclerotized support (Fig. 13). Tectum uniformly convex. Length of genital capsule from apex of parameres to border of basal piece: 4.1 mm. Total body length: 17.1 mm. Humeral width: 7.8 mm.

Allotype female: Similar to male except as follows: elytra with long erect setae near scutellum and toward apex. Pygidium less convex and rugose. Visible abdominal sternites II to V convex, with scattered setiferous punctures; anal plate convex, punctate, with many slender setae. Apical spurs of metatibia wide, lanceolate and curved. Tarsal claws with preapical tooth on ventral border, nearly as long as apical tooth, with part of ventral border serrate (Fig. 15). Ventral genital plates slightly sclerotized, nearly symmetrical, with apical border rounded (Fig. 16). Total body length: 17.3 mm. Humeral width: 8.1 mm.

Paratype variation.—Male similar to holotype except in total body length: 17.0–17.4 mm, humeral width: 7.6–7.9 mm, dorsal vestiture of some specimens less dense than holotype, other specimens with antennal club 1.8–2.1 × longer than length of preceeding five segments combined. Specimens from Chirripo have a darker color, distal half of paramera less canaliculated and have a wide shallow concavity on the dorsal part of parameral base. Female similar to allotype except as follows: elytra and pygidium with more or less setiferous punctures; total body length: 16.8–17.3 mm; humeral width: 7.9–8.1 mm.

Type material.—Described from 10 ♂ and 8 ♀. Holotype ♂ INBio: Costa Rica: Puntarenas, R.B. Monteverde, La Casona, III-92, 1,520 m, N. Obando. Allotype ♀ INBio: same data as holotype except III-1994. Paratypes CAS, INBio, MXAL: same data as holotype (5 ♂); same data as allotype (2 ♂, 3 ♀); Cartago, Turrialba, Chirripo, Grano de Oro, IX-92, 1,120 m, P. Campos (2 ♂, 4 ♀).

Type locality.—La Casona, Reserva Biológica Monteverde, province of Puntarenas, Costa Rica (approx. 10°30′N; 85°10′W).

Biological data.—Specimens of *P. picadoana* were collected at lights near montane tropical forests and coffee plantations located at 1,120–1,520 m. Phenology: March (12), September (6). Other species of *Phyllophaga* flying at the same time were *P.* (*Phyllophaga*) *tilarana* Morón and Solís, *P.* (*s.str.*) *tapantina* Morón and Solís and *P. kohlmanniana* Morón and Solís.

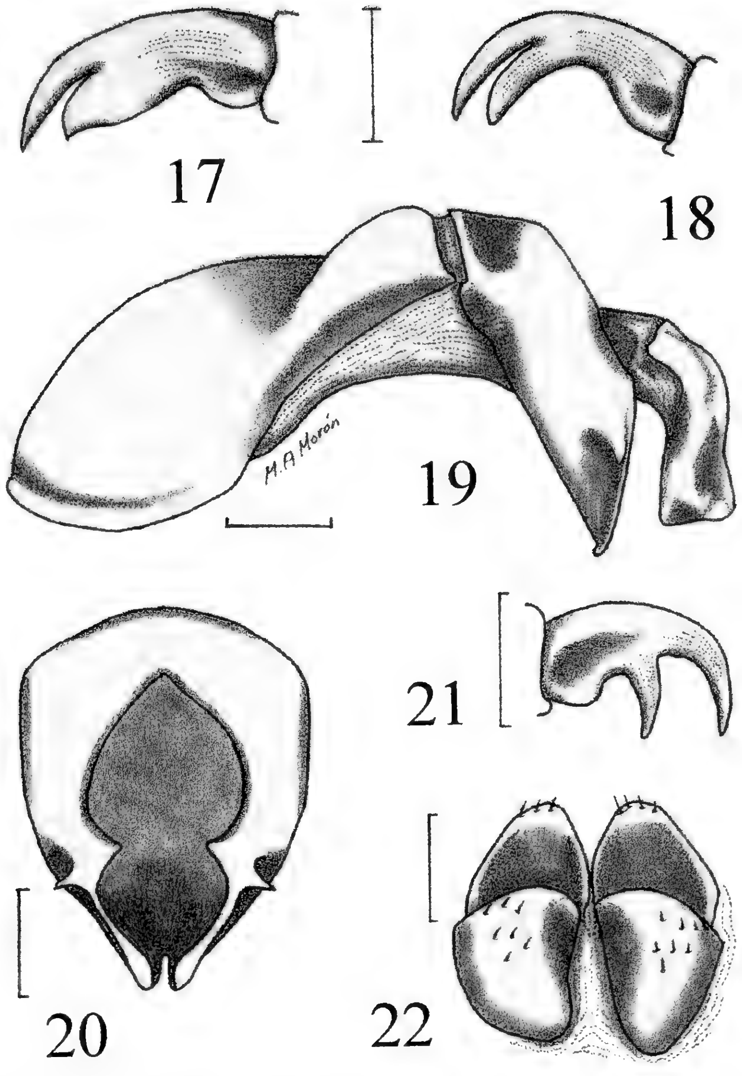
Remarks.—*Phyllophaga picadoana* does not belong to any species group proposed by Morón (1986). Externally this species resembles *P.* (*Phyllophaga*) *brevidens* Bates and allies, but the male and female tarsal claws of *P. brevidens* have a small tooth at the middle of ventral border, each paramere is deeply bifurcate and the aedeagus do not present wide apical patches of spinules.

Etymology.—The name of this new species is dedicated to the memory of the former Costa Rican biologist, Dr. Clodomiro Picado Twight, who devoted much of his life to the study of animals, tropical ecology and natural richess of that country.

***Phyllophaga guanacasteca* Morón and Solís, new species**

(Figs. 17–22)

Description.—*Holotype male:* Head, pronotum and elytra dark reddish brown with dense pruinose greyish vestiture; mouth parts, pygidium and legs shiny reddish brown; sternites light reddish brown



Figs. 17–22. *Phyllophaga guanacasteca.* 17, Male protarsal claw, lateral view. 18, Male hind tarsal claw, lateral view. 19, Genital capsule, lateral view. 20, Paramera, distal view. 21, Female protarsal claw, lateral view. 22. Female genital plates, ventral view. Scale lines = 1 mm, except figs. 17, 18, 21 = 0.5 mm.

with fine pruinose vestiture. Clypeus 3.4 × wider than long, anterior border wide and deeply sinuate, with elevated margin, surface slightly convex, with many uniformly distributed, shallow large punctures, without setae. Frontoclypeal suture sinuate and deeply impressed. Frons 1.4 × wider than long, convex, densely punctate, without setae. Antenna 10-segmented, with 3-segmented club, lamellae 1.3 × longer than length of preceeding 6 segments combined. Frons 2.5 × wider than dorsal diameter of eye. Eye canthi long and wide, with 9–11 setae. Labrum bilobed, widely sinuated, with scattered slender setae. Mentum slightly convex, impunctate, with few slender setae, anterior border nearly straight. Pronotum 1.6 × wider than long and 2.9 × wider than frons. Pronotal disk pruinose, with shallow, round small punctures regularly separated from one another by 2–4 diameters; lateral borders widely rounded, lateral marginal bead entire, with 2–3 scattered slender setae; basal bead indicated by punctures, mainly toward sides, where shallow sulcus are also indicated; anterior angles straight, slightly prominent; posterior angles obtuse, slightly prominent. Scutellum 1.5 × wider than long, scattered small punctures. Elytron 2.6 × longer than wide, pruinose, uniformly punctate with some interstriae slightly elevated; epipleural border narrow, extended along complete margin, provided with some scattered short setae; humeral calla rounded, prominent; apical calla rounded. Metathoracic wings completely developed. Propygidium pruinose, with uniform round, small punctures. Pygidium convex, shiny, with round, shallow punctures irregularly distributed; apical margin with 14 long, slender setae; basal margin effaced medially. Pterosterna with medium size, moderately dense, yellowish setae. Visible abdominal sternites II and III slightly depressed, pruinose, with small, black, granules at midline; sternite IV with dentiform irregular black granules near posterior border; sternite V with rounded area scarcely prominent at middle, covered with fine rugosities, granules and short setae; anal plate narrowed, sligthly convex, with some short setae near midline and 6 slender setae on apical border. Protibia shorter than protarsus (1:1.8), with external border tridentate, but basal tooth very reduced; preapical spur acute, nearly straight, shorter than 2nd protarsomerus (1:2.2). Mesotibia with one oblique, setiferous carina on external side; upper apical spur straight, narrowed to the apex, and 1.8 × longer than lower spur; lower spur with truncated apex. Metatibia shorter than metatarsus (1:1:3), with one oblique, setiferous carina on external side; upper apical spur straight, sharply pointed, slightly longer than basal metatarsomere (1.2:1), and 1.9 × longer than lower spur; lower apical spur articulated, curved, with rounded apex. Protarsomeres 1–4 slightly concave by ventral sides, with lateral rows of setae. Meso- and metatarsomeres semicylindrical, elongate, with enlarged apex, some setae apically and two lines of setae on ventral side. Protarsal claws slightly asymmetrical, deeply cleft, upper tooth longer and narrower than lower tooth (Fig. 17). Meso- and metatarsal claws symmetrical, deeply cleft, with upper tooth slightly longer than lower tooth (Fig. 18). Genital capsule with long parameres, dorsally fused, with preapical tooth-like projections on the external and internal borders (Figs. 19–20). Aedeagus short, with preapical, large, sclerotized asymmetrical plate (Fig. 19). Tectum with two large latero-distal rounded prominences (Fig. 19). Length of genital capsule from apex of parameres to border of basal piece: 5.9 mm. Total body length: 19.1 mm. Humeral width: 7.9 mm.

Allotype female: Similar to male except as follows: clypeal disk with more deep punctures; antennal club shorter than length of five preceeding segments (1:1.3). Pygidium smaller, slightly convex, with more punctures, mainly toward apex. Visible abdominal sternites II to IV convex, with scattered setae; sternite V slightly longer than the IV segment, with more setae; anal plate convex, punctate, with 30 slender setae. Meso- and metatibiae each with one oblique, strong, setiferous carina on external side. Both apical spurs of metatibia articulated, wide, lanceolate and curved. Protarsal segments 1–4 semicylindrical, elongated with enlarged apex, but not concave on ventral surface. Tarsal claws clearly dentate, with apical tooth nearly as long as posterior one (Fig. 21). Ventral genital plates well sclerotized, symmetrical, rounded with wide apical borders; dorsal genital plates ovate, with slightly projected rounded apex (Fig. 22). Total body length: 20.0 mm. Humeral width: 8.4 mm.

Paratype variation.—Male similar to holotype except in total body length: 18.6–19.3 mm, humeral width: 7.6–8.0 mm, dorsal color of some specimens darker than holotype or with the pruinose vestiture more or less dense. Female similar to allotype except as follows: frons and pygidium with more punctures; total body length: 19.5–20.3 mm; humeral width: 8.3–8.4 mm.

Type series.—Described from 4 ♂, 3 ♀. Holotype ♂ INBio: Costa Rica: Estación Pitilla, 9 km S Sta. Cecilia, P.N. Guanacaste, Guanacaste, Costa Rica, V-94, 700 m, C. Moraga. Allotype ♀ INBio: same data except III/IV-93, Malaise. Paratypes INBio, MXAL: same data as holotype (3 ♂, 2 ♀).

Type locality.—Estación Pitilla, 9 km S Santa Cecilia, Guanacaste National Park, province of Guanacaste, Costa Rica (approx. 10°59′26″N; 85°25′40″W).

Biological data.—Males and females of *P. guanacasteca* were collected at lights near deciduous tropical forest located at 700 m. Phenology: March–April (1), May (6). Other species of *Phyllophaga* flying at the same time were *P. hondurasana* Moser and *P. guapiles* Saylor.

Remarks.—*Phyllophaga guanacasteca* does not belong to any species group defined by Morón (1986). It is general appearance suggest a relationship with *P. (Phytalus) pruinosa* (Blanchard), but the articulated lower metatibial spur in the male, and the dentate tarsal claws of the female do not match with the diagnostic characters of the group *pruinosa.* The shape and details of the male genital capsule (Figs. 19–20) and female genital plates (Fig. 22), length of lower metatibial spur of male, sculpture of the pygidium and sternites and shape of protarsal claws (Fig. 17) will aid in the recognition of this new species.

Etymology.—Specific epithet derived from the name of the province of Guanacaste, to which this species appears to be restricted.

ACKNOWLEDGMENTS

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TWO ADDITIONAL SPECIES OF ROBBER FLIES OF THE GENUS *OMMATIUS* WIEDEMANN (DIPTERA: ASILIDAE) FROM THE BAHAMAS AND WITH REPLACEMENT NAMES FOR TWO OTHER SPECIES

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Abstract.—Two species of robber flies of the genus *Ommatius* Wiedemann are reported from the Bahamas, increasing the number of species to six. ***Ommatius mariae,* n. sp.**, from Eleuthera and Nassau, is described, illustrated, and contrasted with *O. hanebrinki* Scarbrough and Rutkauskas. *Ommatius mariae, O. hanebrinki,* and *O. hispidus* Scarbrough from the *hanebrinki* species group. A Cuban species, *O. lineolatus* Scarbrough is reported for the first time from Long Island in the Bahamas. Two new replacement names are proposed: ***Ommatius dignus* new name** for *Ommatius dimidiatus* Scarbrough and ***Ommatius fimbrillus* new name** for *Ommatius fimbriatus* Scarbrough and Poinar.

Key Words: nomenclature, Asilidae, *Ommatius,* new species, new records, Bahamas

The robber flies of the genus *Ommatius* Wiedemann from the Bahama Islands are poorly known. To date four species are reported from single localities, i.e., *O. abana* Curran (1953) from Bimini, *O. hanebrinki* Scarbrough and Rutkauskas (1983) from San Salvador, *O. membranous* Scarbrough (1985a) from Rum Cay, and *setiferous* Scarbrough (1988) from Mayaguana. Furthermore, only one sex is known for all species except for *O. hanebrinki.* This paper reports a new species of *Ommatius* Wiedemann from Eleuthera and Nassau, and the discovery of a Cuban species, *O. lineolatus* Scarbrough (1988), from Long Island. Two replacement names are proposed to correct nomenclatural errors.

METHODS

General methods and terminology follow that described by Scarbrough (1997) and McAlpine (1981), respectively. Ratios used in the text are as follows: face:head width ratio (FHWR) is the greatest width of the head in front profile divided by the width of the face at the base of the antennae; cell m1 width ratio (m1WR) is the ratio of the width of the cell at the basal third and apical two-thirds divided by the width of the base; hind femoral width:length ratio (HFWLR) is the greatest dorsal length divided by the greatest width.

Acronyms of museums used in the text are as follows: TUMZ, Museum of Zoology, Towson University, Baltimore, MD; AMNH, American Museum of Natural History, NY; CMNH, Carnegie Museum of Natural History, Pittsburgh, PA; USNM, National Museum of Natural History, Smithsonian Institution, Washington, DC; FSCA, Florida State Collection of Arthropods, Gainesville, FL; GPAC, George Poinar Collection of Amber, Department of Entomology, Oregon State University, Corvallis, OR.

Ommatius mariae Scarbrough, new species
(Figs. 1–9)

Male.—Brown. Body 11.1–12.3 mm; wing 8.3–8.6 mm. *Head:* Dull yellowish gray tomentose; frons, vertex, and narrow margin of occiput dorsally more yellow; vestiture largely whitish to pale yellow; FHWR 1.0:6.3–1.0:6.9. Antenna mostly brown setose, whitish setae present below scape; flagellum broadly oval, slightly longer than wide, and slightly longer than scape. Frons with margins parallel. Occiput with 3–5 short, thick, brown postocular bristles; bristles slightly curved forward, apices of bristles above eye.

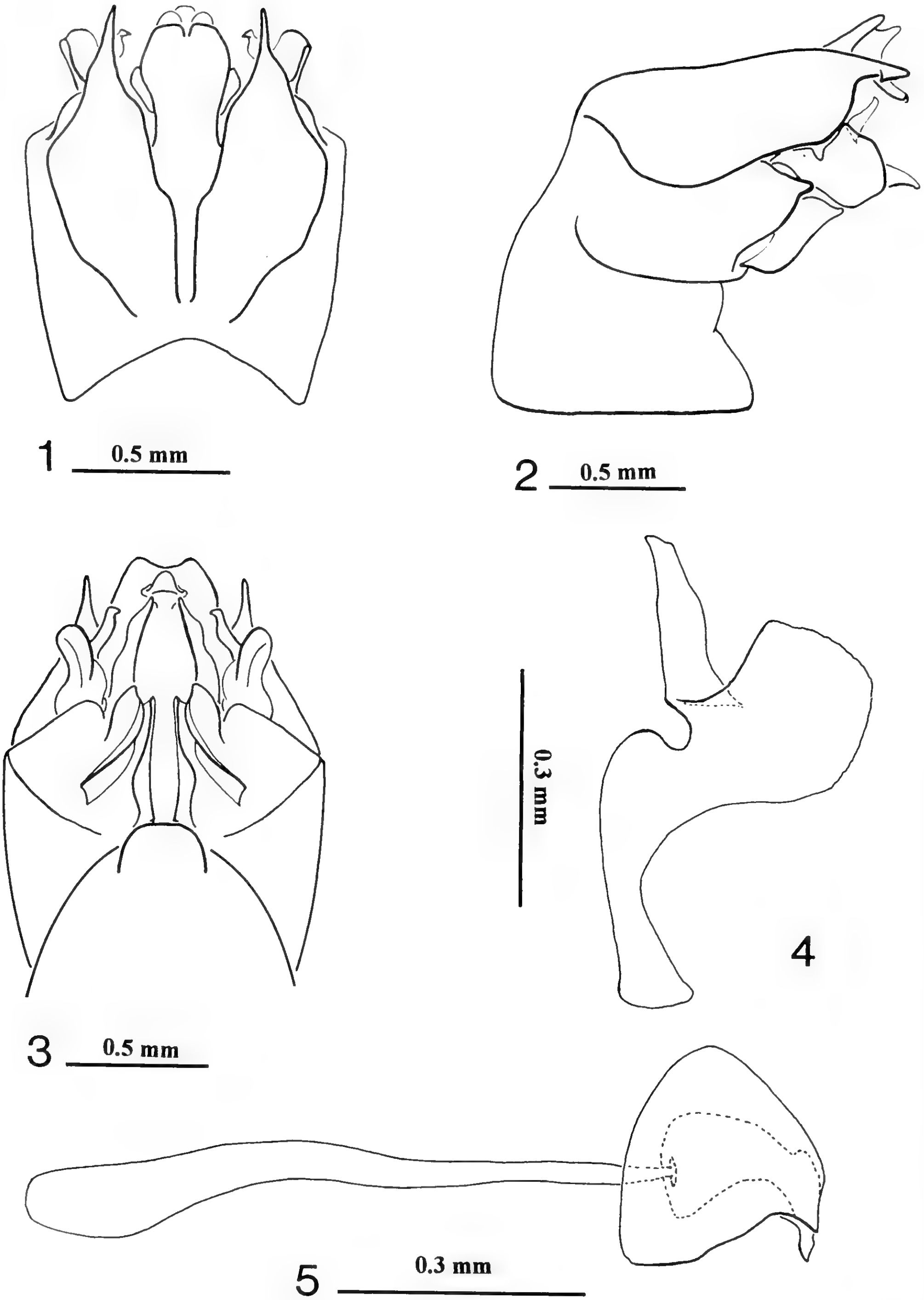
Thorax: Pronotum yellowish gray tomentose with 2 brown and 2 whitish bristles. Mesonotum with wide median stripe divided medially by a thin, light yellowish tomentose line; 2 lateral spots brown tomentose spots present; tomentum otherwise yellow to yellowish gray; setae sparse, limited to lateral margins; 3 posterior dorsocentral and 4 lateral stout, dark brown bristles. Scutellum yellowish tomentose with scattered whitish setae; 2 short, brown, marginal setae sometimes present, each about half as long as dorsal setae; preapical groove absent. Pleura dull yellowish gray tomentose anteriorly, more grayish posteriorly; vestiture whitish; halter yellow.

Wing: Margin anteriorly straight, without a costal bulge. Cell r4 narrow and long, sides only slightly divergent apically; base before apex of cell d. Crossvein r-m just beyond middle of cell d, slightly shorter than or as long as vein CuA1+M3. Cell m1 WR 1.0:1.9:1.4-1.0:2.7:2.1.

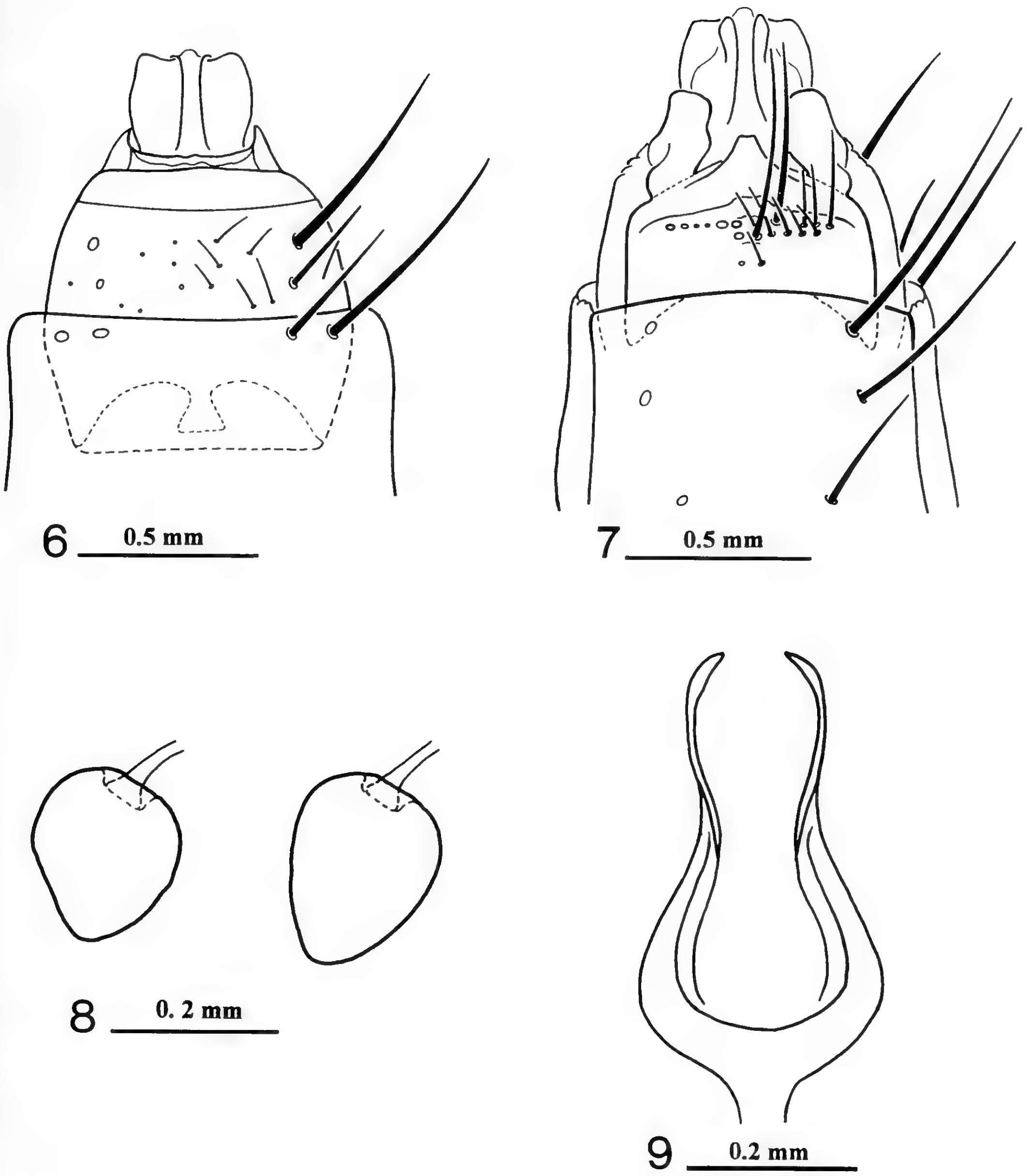
Legs: Coxae brown with grayish tomentum and pale yellow to white vestiture; fore coxa with numerous stout bristles anteriorly. Trochanters brown. Femora mostly yellow with yellowish bristles; fore femur mostly brown anteriorly with a narrow yellow band at apical third, and narrow apex dorsally and posteriorly brown; middle femur with apical half to two-thirds anteriorly and apical fourth posteriorly brown; hind femur with apical half to two-thirds anteriorly and posteriorly and apical third to half dorsally and ventrally brown. Middle femur with 2 anterior, 2 anteroventral, and 1 preapical, dorsoposterior bristles. Hind femur with 3 anterior and 5 anteroventral bristles, all long and yellowish, most stout; anteroventral bristles at middle two-thirds; 1 posteroventral bristle basally plus 6 bristles on a raised posterior tubercle at middle of hind femur; all posteroventral bristles quite thick from base to apex, only slightly flattened with round apices, most or all brown; HFWLR 1/2.8–1/3.0. Tibiae mostly yellow with yellowish bristles laterally and brown bristles apically; narrow apices and anterior surfaces of all tibiae brown; fore tibia with only narrow brown stripe anteriorly. Hind tibia short, two-thirds as long as hind femora and four-fifths as long as hind tarsus; thick, constricted preapically, apex abruptly wide, clublike. Basal tarsomere of fore and mid tarsi yellow with narrow apex brown; basal tarsomere of hind tarsus yellowish basally grading to brownish yellow apically; apical 4 tarsomeres of all tarsi brown; fore and middle tarsi with 5 and 4 yellow bristles respectively; hind tarsus with 2 yellow bristles.

Abdomen: Yellow brown basally, brown apically; mostly yellowish gray tomentum and yellowish setae present; terga brown tomentose with brown setae dorsally.

Terminalia (Figs. 1–5): Epandrium with a short, asymmetrical, apical hook; apical third with abundant short, bristly setae. Ventral lamella with a short, sclerotized, preapical, tongue-like process, sides slightly curved downward; dense, long, yellow setae present. Gonostylus with prominent wide base and a short, narrow dorsal process. Aedeagus with broad hooded sheath, distiphallus strongly arched downward with only apex exposed. Gonocoxite with long, thin, erect flanges, one along inner margin and another more lateral a long, horizontal process with pointed apex present. Hypan-



Figs. 1–5. *Ommatius mariae,* male terminalia. 1, Dorsal view. 2, Lateral view. 3, Ventral view. 4, Gonostylus. 5, Aedeagus, lateral view.



Figs. 6–9. *Ommatius mariae*, female terminalia. 6, Dorsal view. 7, Ventral view. 8, Spermatheca. 9, Genital fork.

drium strongly produced apically, apical margin subtruncate, with rounded corners.

Female.—As male, differing as follows: Body 13.6 mm; wing 10.0 mm; FHWR 1/6.9; cell m1 WR 1.0:2.1:1.4; HFWLR 1/5.6. *Head:* Face with 2 brownish yellow to brownish bristles. Occiput with 1-2 brown postocular bristles. *Thorax:* Tomentum largely dull yellowish. *Wing:* Crossvein r-m longer than vein CuA1+M3. Base of cell r4 at apex of cell d. *Legs:* Fore coxa with several, long, thin bristles. Middle and hind femora black on apical half or slightly less and with all or most anterior bristles black.

Hind femur slender, not especially swollen, without a mound-like tubercle, and bristles acutely pointed; all ventral bristles yellow and distributed in well defined rows. Tibiae with narrow apex and anterior surface black; hind tibia black except yellow on basal half anteriorly. Hind tibia slender, only gradually wider apically, apex not unusually wide or flat. Tarsi largely or entirely black with black bristles; fore and middle tarsi with basal tarsomere mostly yellow, narrow apex black; only 2–3 yellow bristles present.

Abdomen: Apical margin of tergite 7 with 2 midlateral black bristles, 1 of these contrastingly long and stout. Tergite 8 shiny, jet black, apical corner somewhat angular, oblique; a long, midlateral, black bristles present posterior to apical margin and 2–3 shorter bristles more basally, these black or yellowish. Tergite 9 dorsally with narrow base sclerotized, less than one-fifth as long as cercus, corners contrastingly wide, extending around base of ventral lamella forming a wide sclerotize bridge in dry specimens. Cercus unusually narrow with apex slightly emarginate. Ventral lamella narrowly sclerotized along inner margin. Sternites 5–7 with 3–4 long, stout bristles laterally, mostly yellowish, those in apical corner of sternite 7 black and contrastingly long. Sternite 8 shiny jet black with a transverse row of yellow setae and bristles; 4 bristles medially, darker, light amber, contrastingly long and thick, extending forward to subapex of ventral lamella. Spermathecae obovate; ducts long and thin with bases of ducts separate, each originating from very short, common duct between base of arms of genital fork. Genital fork largely membranous, apical third of each arm, narrow, slightly sclerotized.

Types.—Holotype ♂, BAHAMAS: Eleuthera, Rainbow Bay, 21.×.85, J. R. Wiley (FSCA). Allotype ♀, same data as holotype except: 29.vi-6.vii.1990, J. R. & S. C. Wiley (FSCA). Paratype: 1 ♂, same data as holotype (FSCA); 1 ♂, BWI, Nassau, 3.xii.61, N. A. Roeff (USNM).

Etymology.—Latin *mariae,* for Mary, in memory of a loving, devoted wife and mother.

Remarks.—*Ommatius mariae* and *O. hanebrinki* (holotype and allotype, USNM; paratypes, AMNH, TUMZ; others CMNH/FSCA) are very similar species, almost identical in general habitatus, and differ markedly from other known New World species. They are readily separated from each other by the uniquely modified structures of the terminalia. In addition, the whitish ocellar setae and the flat, mostly brown bristles with round tips, clustered on a raised, posterior tubercle on the hind femora further characterize the male. In *O. hanebrinki,* these bristles are flatter, yellow, and distributed more in a linear row on a lower tubercle. The anterior surface of all tibiae in the female of *O. mariae* is mostly black whereas the tibiae are yellow with narrow dark apices in *O. hanebrinki.* The basal tarsomere of the hind tarsus is black in *O. mariae* whereas it is much lighter, brownish yellow in *O. hanebrinki.* Furthermore, in *O. mariae* segment 8 is shiny, jet black; tergite 8 has scattered bristly setae dorsally and stout bristles laterally, none are present along the apical margin. Sternite 8 medially has a transverse row of numerous, short setae and four contrastingly long bristles. In *O. hanebrinki,* segment 8 is much lighter brown; tergite 8 has mixed bristly and abundant, short, recumbent setae dorsally, and several, stout bristles are present along the apical margin. The transverse row of vestiture on sternite 8 medially consists of 8–10 stout bristles and sparse, short setae.

Ommatius hanebrinki (1983), *O. hispidus* Scarbrough (1985a), and *O. mariae* are similar in several regards, and differ from all known species from Cuba and the Bahamas. This group, i.e., *hanebrinki* group, is readily recognized by the following combination of characters of the male: 1) Strongly inflated hind femur; 2) a series of flat bristles with rounded tips on the posterior margin of the hind femur; 3) an apically clubbed [*hanebrinki* and *mariae*] or long digitate process [*hispidus*] on the hind tibia; 4) the unusually long, blade-like processes of the gonocoxite in males; 5) the unusually stout bristles on the apical abdominal segments; and 6) the dorsally membranous tergite 9 which wraps below the bases of the ventral lamella, and the unusually strongly, apically pointed sternite 8 with stout bristles posteriorly in the female.

Ommatius lineolatus Scarbrough

Ommatius lineolatus Scarbrough 1988: 90–94. ♂ Holotype, ♀ allotype. Type locality Cuba (USNM).

Specimens examined.—BAHAMAS: 1 ♀ of *O. lineolatus,* Bimini (FSCA); 1 ♂ of *O. lineolatus,* Long Island (FSCA). CUBA: Holotype ♂ and ♀ of *O. lineolatus* Scarbrough (USNM).

Remarks.—*Ommatius lineolatus,* a Cuban species, is reported here from Long Island in the Bahama Islands and increases the number of species of *Ommatius* to 6 from this region. The species is readily recognized by its small size (5–6 mm), yellowish brown color of the legs, 6 ventral setae distributed the length of the antennal style, and combined characters of the terminalia. It is otherwise quite similar to *O. abana* (types series, AMNH), and may prove eventually to be that species as more material is located and studied. This type series of *O. abana* consist of only 3 females, i.e., males are unknown. The species is large (9 mm), the body is jet black, the legs are amber or reddish with black markings, and the style has only four long setae near the tip.

***Ommatius dignus* Scarbrough, new name**

Ommatius dimidiatus Scarbrough 1985b: 647–650. Figs. 9–14 (primary junior homonym of *Ommatius dimidiatus* Macquart 1850: 394, Asilidae); (types GPAC).

The binomen *Ommatius dimidiatus* Macquart (Macquart 1850) was first used for a species in the Australian region. It is now reported from Tasmania and Australia (Daniels 1989). Later (Scarbrough 1985b), the same binomen was applied to a new Neotropical species from Dominica, Lucia, and Martinique in the Lesser Antilles. I propose *dignus* (L, meaning worthy or fit) as a new replacement name.

***Ommatius fimbrillus* Scarbrough, new name**

Ommatius fimbriatus Scarbrough and Poinar 1992: 13–16. Figs 1–4 (primary junior homonym of *Ommatius fimbriatus* Hardy 1949: 301, Asilidae); (types GPAC).

Unfortunately, Scarbrough and Poinar (1992) were unaware that the binomen *Ommatius fimbriatus* had already been used for a species of an asilid fly from Australia when they used it for a fossil species in Dominican amber. I propose *fimbrillus* (L, meaning a fringe) as a new replacement name for it.

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A NEW SPECIES OF *CHLORONIA* BANKS (MEGALOPTERA: CORYDALIDAE) FROM SOUTHEASTERN BRAZIL, WITH A KEY TO THE SPECIES OF BRAZIL

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Abstract.—The Neotropical dobsonfly genus *Chloronia* (Megaloptera: Corydalidae: Corydalinae) contains 14 previously described species. In this paper, ***Chloronia pennyi,*** a new species from Minas Gerais, Brazil, is described and illustrated. In general appearance *C. pennyi* resembles most the Andean *C. bogotana* Weele, especially in the small fuscous markings on the head and the pair of fuscous bands on the pronotum. In the new species, the antennae are entirely yellow (apically infuscate in *C. bogotana*), the wings are mostly pale (patterned in *C. bogotana*), and the dark bands on the pronotum are continuous (nearly meeting in middle in *C. bogotana*). A key for adult males of the four currently recognized Brazilian species is included. New distribution records are given for *C. corripiens* (Walker) in southeastern Brazil.

Key Words: *Chloronia,* new species, Megaloptera, Brazil, Neotropics, Corydalidae, dobsonfly, taxonomy, key

The Neotropical genus *Chloronia* is distributed from northwestern and northeastern Mexico, southward into western and southeastern South America, including some of the Lesser Antilles. Individuals of this genus are rather small dobsonflies (forewing length 24–50 mm) with a characteristic color (yellow with black spots), which allows for easy recognition. After the revision by Penny and Flint (1982), Flint (1991) clarified the identity of *Chloronia bogotana* Weele and added two new species from Costa Rica (Flint 1992), and Contreras-Ramos (1995) described two new species each from Ecuador and Guatemala. In all, 15 species of *Chloronia,* including the one described in this paper, are currently recognized. Larvae of *Chloronia* have been diagnosed by Penny and Flint (1982) and Contreras-Ramos and Harris (1998). Accounts on habitat of a few species have been given by Penny and Flint (1982), Geijskes (1984), and Contreras-Ramos (1999).

In this paper, a new species of *Chloronia* from southeastern Brazil is described and illustrated. In 1998, five specimens of the new species were collected in two localities in Minas Gerais during caddisfly survey work by Ralph W. Holzenthal (UMSP) and colleagues. General similarity of the distinct Brazilian series with the distantly distributed *C. bogotana* (Andes of Bolivia, Colombia, Ecuador, and Peru), indicated high possibilities for the Brazilian specimens to belong in a new species. This was corroborated after careful examination of the male genitalia of the Brazilian series. Additional distributional records for *C. corripiens* (Walker) in southeastern Brazil, and a key for the identification of the four *Chloronia*

Fig. 1. Habitus of *Chloronia pennyi,* holotype.

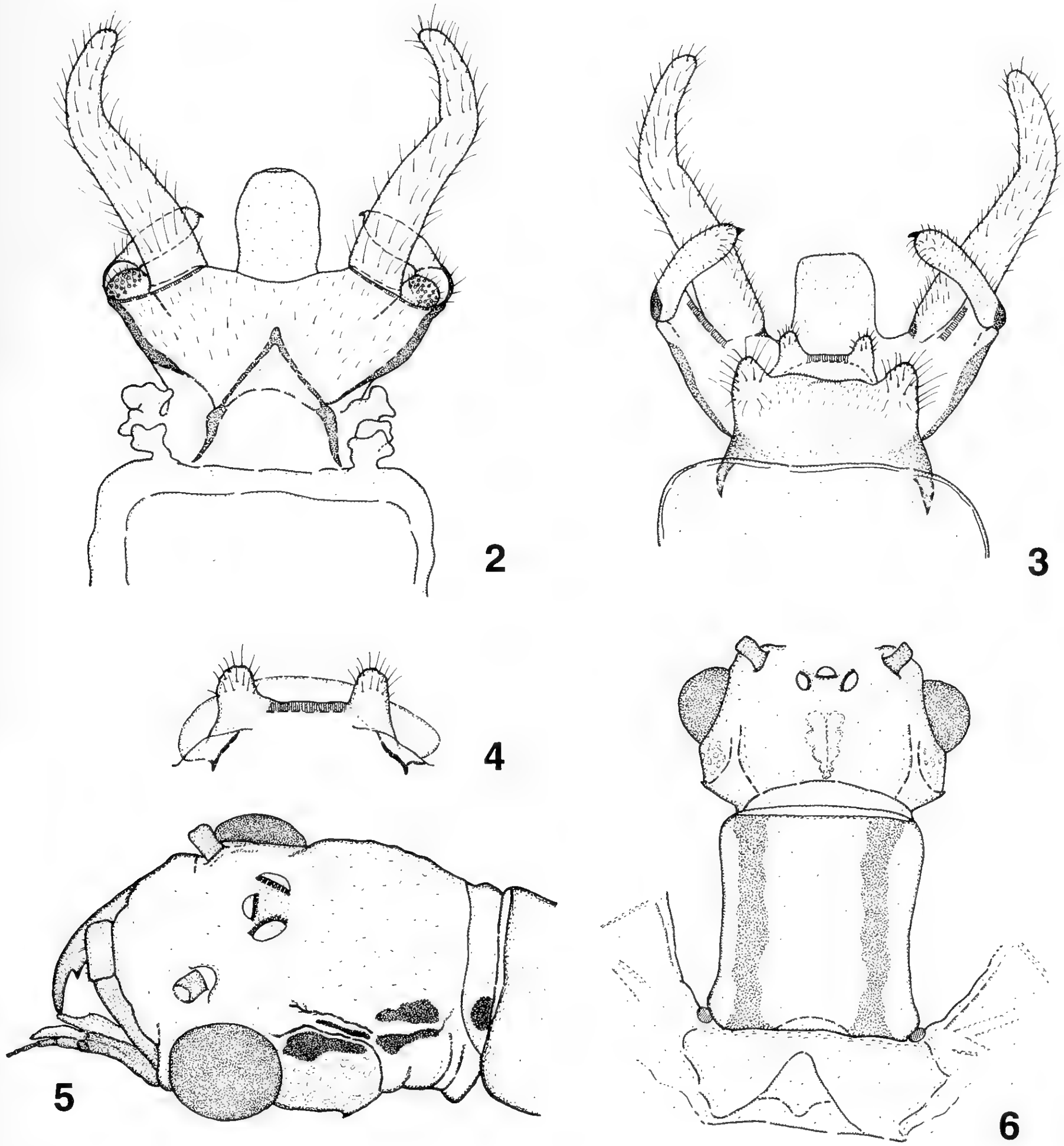
species currently recorded in Brazil also are presented in this paper.

The genitalic and venational terminology used here follows that of Glorioso (1981), as modified by Contreras-Ramos (1998). Specimens were originally preserved in 80% ethanol. Three males were spread and pinned for dry preservation. Genitalia were dissected, cleared, and stored by standard methods, as explained by Contreras-Ramos (1998). Specimens will be deposited at the entomological collections of the Museu de Zoologia, Universidad de São Paulo, Brazil (MZSP); Department of Entomology, University of Minnesota, St. Paul (UMSP); and the National Museum of Natural History, Smithsonian Institution, Washington, DC (NMNH).

Chloronia pennyi **Contreras-Ramos, new species**

(Figs. 1–6)

Diagnosis.—This species, together with *Chloronia corripiens* (Walker) and *C. plaumanni* Penny and Flint, appears to have a phylogenetically basal position in the genus. All three have an unmodified ninth sternite, a sparsely setose ninth tergum (lacking small clusters of spinous setae present in most species), as well as conspicuous dorsolateral pregenital sacs between the eighth and ninth abdominal segments. However, on the basis of general appearance, the new species is most similar to *C. bogotana.* Both have small posterolateral spots on the head (Flint 1991, figs. 5, 6) and elongate dark spots on the pronotum. In *C. bogotana,* nevertheless, the pronotal spots are discontinuous, not meeting in the middle (Flint 1991, figs. 5, 8), whereas in the new species they form a pair of continuous lateral bands (Fig. 6). Forewing coloration in *C. bogotana* is patterned, with most crossveins dark (Flint 1991, figs. 7–9). In the new species, forewings are mostly clear with few crossveins slightly dark (Fig. 1). With respect to genitalic characters, the 10th sternite of *C. pennyi* resembles that of *C. convergens* Contreras-Ramos. In both, 10th sternite lobes are sclerotized and su-



Figs. 2–6. *Chloronia pennyi*. 2, Male genitalia, dorsal. 3, Same, ventral. 4, 10th sternite. 5, Head, dorsolateral. 6, Pronotum, dorsal.

bquadrate, but in the new species lobes lack apical spines and the 10th sternite has only slightly developed anterolateral projections (Fig. 4).

Description of adult (Figs. 1, 5–6).—Head width, ♂ 3.6–4.1 mm (average 3.8 mm, n = 3), ♀ 4.1–4.3 mm (average 4.2 mm, n = 2); forewing length, ♂ 27.4–29.4 mm (average 28.3 mm, n = 3), ♀ 34.3–34.7 mm (average 34.5 mm, n = 2). Color generally pale yellow with fuscous spots and bands. Head pale yellow, mandible yellowish brown with teeth and outer side dark reddish-brown. Labrum subquadrate with pair of long, flattened setae. Clypeal margin nearly straight. Compound eyes and base of ocelli dark. Postocular spine blunt, colored as head. Pattern of fuscous wide-elongate spot at postocular plane, thin spot at adjacent ridge, pair of posterior spots, and round spot at occiput, on each side of head (Fig. 5). Antenna 37 to 44-segmented, filiform, yellow, with at most last segment infuscate. Maxilla yellow with 5-segmented palp, last two segments pale brown. Labial palp 4-segmented, yellow.

Pronotum yellow, with pair of dark, continuous, longitudinal bands (Fig. 6). Mesonotum without fuscous spots. Legs yellow, tarsal claws brown. Forewing pale yellow, hyaline, with 26–27 costal crossveins, 0–2 forked, a few in proximal ⅓ of wing with dark ends. Veins mostly yellow, R_1-Rs crossveins, forking of M, and few basal crossveins finely fuscous. Posterior margin of wing with subtle grayish maculations. Anterior 2A cell variably with a spot to only a slight maculation. Hindwing pale yellow, hyaline, but 2nd *r* brown.

Male genitalia (Figs. 2–4): Ninth tergum subtriangular, finely and sparsely setose, without patches of spinous setae; V-shaped internal inflection reaching midlength of tergum. Tenth tergites about 2.5 times as long as ninth tergum, subcylindrical, bluntly tapering, basal ⅔ divergent, apical ⅓ directed posteriorly, finely and evenly setose (Fig. 2). Ninth gonostylus incurved, fusiform, anteroventral margin slightly more convex, with sharp apical point. Ninth sternum moderately sclerotized, subquadrate, with well developed posterolateral lobes, slightly convex posteromesally (Fig. 3). Membrane between 9th and 10th sternites eversible, broadly bilobate, thickened. Tenth sternite convex, with small, sharply pointed anterolateral projections; lobes sclerotized, papilliform, subequal in width and length, sparsely and conspicuously setose (Fig. 4).

Material examined.—*Holotype ♂:* BRAZIL. Minas Gerais: Serra do Cipó, Rio Cipó in Cardeal Mota (Cach. Baixo), 19°20.553′S, 43°38.531′W, el. 750 m, 10–15.ii.1998, Holzenthal, Paprocki, Huisman [head width = 3.6 mm, forewing length = 28.0 mm] (MZSP).

Paratypes: Same data as holotype, 1 ♀ (MZSP), 1 ♂, 1 ♀ (UMSP); Minas Gerais: confluence Rio Peixe & Rio Preto do Itambé, 19°17.525′S, 43°15.457′W, el. 500 m, 4.ii.1998, Holzenthal & Paprocki, 1 ♂ (NMNH).

Etymology.—This new species is gladly dedicated to Norman D. Penny from the California Academy of Sciences, in recognition of his extensive contributions to Neotropical neuropterology, as well as acknowledging his support for the author's graduate research projects.

KEY TO KNOWN BRAZILIAN SPECIES OF *CHLORONIA* (MODIFIED FROM PENNY AND FLINT 1982)

1. Head with pair or few small fuscous spots posteriorly 3
– Head unicolorous or only with lateral margin infuscate 2
2. Lateral margin of head fuscous (Penny and Flint 1982, fig. 44) . . . . *C. plaumanni* Penny and Flint
– Lateral margin unmarked (Penny and Flint 1982, fig. 42) . . . . *C. corripiens* (Walker)
3. Pronotum with two anterior and two posterior fuscous spots, wings patterned (Penny and Flint 1982, fig. 48) . . *C. hieroglyphica* (Rambur)
– Pronotum with two fuscous, longitudinal bands (Fig. 6), wings mostly clear (Fig. 1) . . . . *C. pennyi,* new species

ADDITIONAL MATERIAL EXAMINED

Chloronia corripiens (Walker).—BRAZIL. Minas Gerais: Serra do Cipó, Cardeal Mota, Cachoeira Veu da Noiva, 19°18.912′S, 43°36.260′W, el. 800 m, 12.ii.1998, Holzenthal & Paprocki, 1 ♂ (UMSP); Paraná: Rio Mãe Catira, 10 km N Porto de Cima, 25°21.821′S, 48°52.473′W, el. 200 m, 8–9.xii.1997, Holzenthal & Huisman, 3 ♀ (UMSP).

ACKNOWLEDGMENTS

Thanks to Ralph W. Holzenthal (UMSP) for calling my attention to a series of dobsonfly specimens collected through his caddisfly survey work in Brazil, among which the new *Chloronia* species was found. Thanks also to Philip J. Clausen for curating dobsonflies (UMSP) and processing a loan to me. A brief research visit to the University of Minnesota was funded by the Instituto de Biología of the Universidad Nacional Autónoma de México. The hospitality of Fernando Muñoz-Quesada (UMSP) and family is greatly appreciated. Finally, thanks to David E. Bowles (Texas Parks and Wildlife Department) and an anonymous reviewer for improving the quality of the manuscript.

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A NEW AFROTROPICAL SPECIES OF *ALLOGNOSTA* OSTEN SACKEN (DIPTERA: STRATIOMYIDAE)

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Abstract.—***Allognosta njombe*, new species,** is described from localities around the north end of Lake Nyassa in Tanzania (type locality) and Malawi. A key to the four known species of Afrotropical *Allognosta* is provided. Additional locality records are given for *A. stuckenbergae* Lindner and *A. tessmanni* Enderlein.

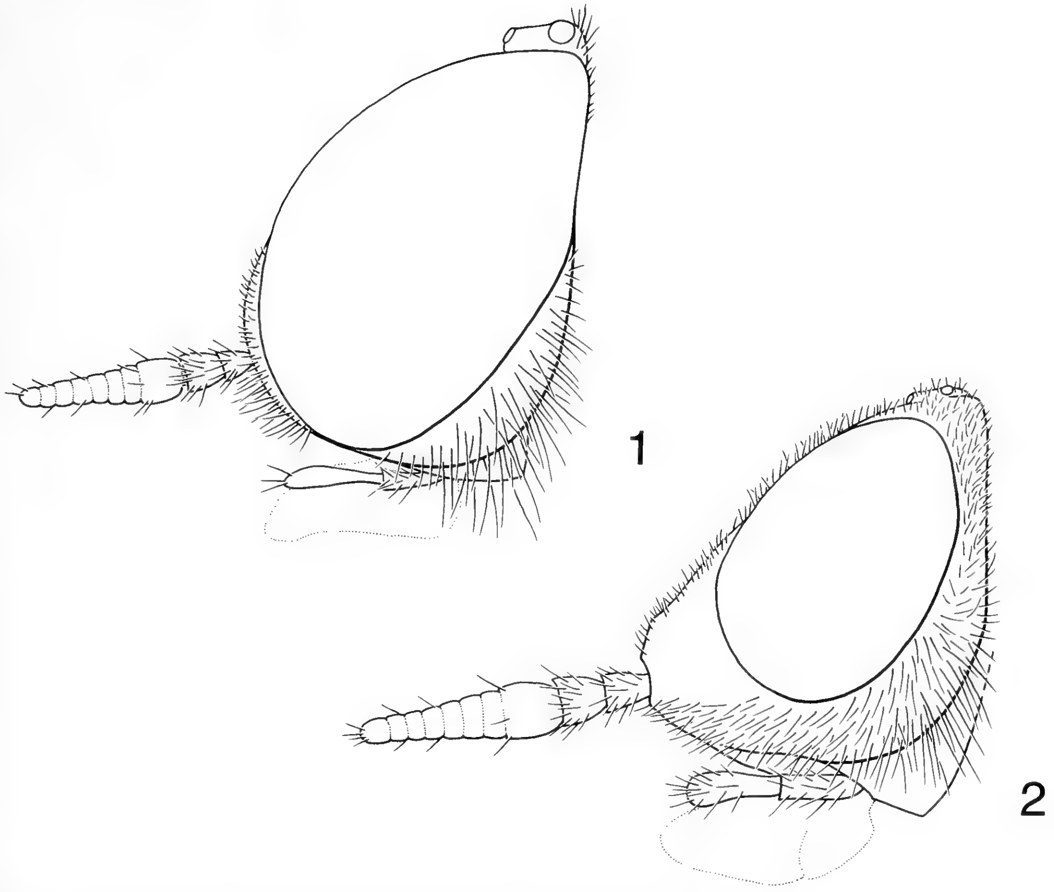
Key Words: Beridinae, Tanzania, Malawi

The genus *Allognosta* Osten Sacken is the only genus of the stratiomyid subfamily Beridinae in the Afrotropical Region. When I reviewed the Afrotropical species (Woodley 1987) I had available only 12 specimens representing three species, although about seven additional specimens of *A. stuckenbergae* Lindner were known at that time. A small number of additional specimens have come to light, including some of a new species, that are reported upon in this paper. Since my review of the African species, I have published a revision of the world genera of Beridinae (Woodley 1995) which can be consulted for general information and cladistic relationships at the generic level within the Beridinae as well as an overview of the genus *Allognosta*.

Terminology and methodology follow that used in my previous paper (Woodley 1987) except that the aedeagal complex is now called the phallic complex (Sinclair et al. 1994). Specimens studied are from the Carnegie Museum of Natural History, Pittsburgh, Pennsylvania, USA (CMNH); Natal Museum, Pietermaritzburg, Natal, South Africa (NMP); and Naturhistoriska riksmuseet, Stockholm, Sweden (NRS). The sections on material examined under already described species treat only specimens seen since my 1987 paper.

KEY TO AFROTROPICAL SPECIES OF *ALLOGNOSTA*

1. Pilosity of eyes long and dense, easily visible at low magnifications; occurring only in South Africa . . . . *A. stuckenbergae* Lindner
– Pilosity of eyes short and sparse, visible only at higher magnifications; occurring north of South Africa 2
2. Apical one-third to one-fourth of middle and hind femora darkened, strongly contrasting with whitish-yellow basal portions; second segment of palpus yellow . . . . *A. tessmanni* Enderlein
– Middle and hind femora yellowish, without strongly contrasting darker areas; second segment of palpus black 3
3. Female frons strongly produced, the antennae inserted below the prominence; male with median lobe of phallic complex similar in diameter and equal in length to lateral lobes; pleura wholly yellowish, only vaguely darker beneath wing base . . . . *A. bwamba* Woodley
– Female frons moderately produced (Fig. 2), the antennae inserted at the apex of the prominence; male with median lobe of phallic complex in dorsal view (Fig. 5) more slender and shorter than lateral lobes; pleura usually brownish to brownish-black, nearly concolorous with scutum, but sometimes paler . . . . *A. njombe*, n. sp.



Figs. 1–2. Left lateral views of heads of *Allognosta njombe*. 1, Male. 2, Female.

Allognosta njombe Woodley, new species

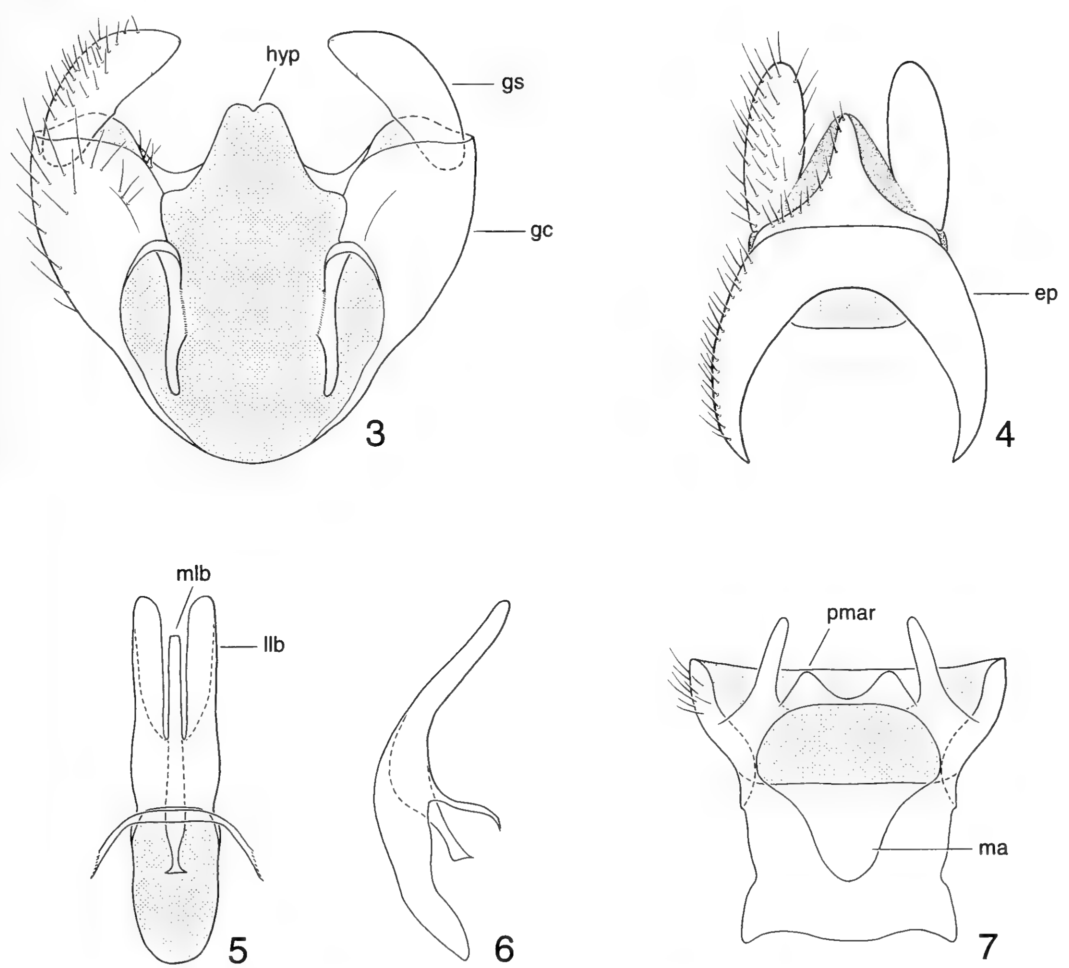
(Figs. 1–7)

Diagnosis.—This species is in a group easily distinguished from *A. stuckenbergae* by having nearly bare eyes. It differs from *A. tessmanni* Enderlein in having all femora wholly dark yellow. It is most similar to *A. bwamba* Woodley, but differs in having darker pleura, a less strongly produced frons in females, and different male genitalia.

Description.—*Male:* Head (Fig. 1) black, 1.5 time higher than long; eye large, upper ommatidia larger than lower ones, but size transition not sharply delimited; ocellar tubercle moderately prominent; face short, receding; frons very small, slightly convex; head mostly whitish-gray tomentose, sparse on frons, face, and upper occiput, almost absent on ocellar tubercle; pilosity sparse, pale on lower occiput and gena, more brownish on face; eye with extremely short, sparse pilosity, visible only at high magnification; antenna 0.8 length of head, ratio of segments 4:4:[5:2:3:3:3:3:2.5:3.5], scape and pedicel brownish-yellow, flagellomeres 1–3 yellow, those beyond three brownish; hairs on scape and pedicel moderately short, dark; first flagellomere with usual subapical dark hairs, other flagellomeres with a few scattered hairs; palpus slender, the two segments subequal in length, the second slightly clavate; both palpal segments dark brownish with pilosity mostly pale, but with a few dark hairs at apex of second segment; proboscis dark brownish. Thorax with scutum and scutellum blackish-brown with slight bronzy reflections, postpronotal lobe slightly paler, postalar callus dark yellowish; pleura dark brownish, but posterior half of anepisternum and katepisternum and entire anepimeron orangish-brown; pleura with pale tomentum but with noticeable bare area on ventral half of katepisternum; scutum and scutellum entirely, densely pilose with short, semi-erect brownish hairs, posterior part of scutum and scutellum with some longer, more erect hairs intermixed; pleura with pale pilosity except anterior half of anepisternum and entire meron and katepimeron apilose; coxae dark yellow, anterior pair slightly suffused with brown; femora dark yellowish, posterior pair a little more brownish; tibiae brownish; tarsi dark brownish, basal portions of first tarsomeres vaguely more yellowish; pilosity on legs mostly dark, some pale hairs intermixed on femora, entirely pale on coxae, scattered longer, erect hairs present on femora and tibiae; wing moderately infuscated with grayish-brown, pterostigma and veins brownish, entire wing set with dense microtrichia; halter dark brownish, basal portion of stem paler. Abdomen brownish, tergal grooves slightly darker; entire abdomen with sparse tomentum; pilosity of tergites mostly very short, dark, but longer laterally and basally, some hairs on first tergite pale, pilosity of sternites pale; terminalia with gonocoxites (Fig. 3) moderate in size, margins diverging posteriorly; apex of hypandrium moderately produced, the apex of the process feebly bilobed; gonostylus with lateral margin slightly arcuate, otherwise simple; phallic complex (Figs. 5–6) arcuate in profile, median lobe shorter and more slender than lateral lobes; epandrium (Fig. 4) small, unmodified. Length 5.3 mm.

Female: Differs from male as follows: Head (Fig. 2) 1.2–1.3 times higher than long, strongly dichoptic, eye with ommatidia uniform in size; frons 0.4–0.5 width of head at ocellar tubercle, produced at lower portion to meet upper facial margin, the antennae being inserted at anterior-most point of head in profile; upper frons with margins very slightly diverging ventrally, lower part appearing vaguely depressed, overall shiny and finely punctate; lower frons very short, slightly convex; face short, strongly receding; upper occiput margins produced posterodorsally with sharply rounded margins; upper frons and upper occipital margins without tomentum, lower frons and face with dense, pale grayish tomentum; upper frons and occipital margins with moderately dense pale golden pilosity; palpus more robust than in male, second segment more strongly clavate. Thorax with scutum and scutellum as in male but with very slight metallic purplish reflections; pilosity of scutum and scutellum shorter than in male, uniform in length, entirely pale golden colored; pleura brownish to brownish-black, vaguely paler below wing (uniformly paler in specimen from Malawi; see remarks below); hind coxa sometimes darkened; all femora uniformly dark yellowish; tibiae brownish-black, approximately basal one-third of fore and middle femora yellow, hind femur only vaguely pale at extreme base; tarsi uniformly brownish-black. Abdomen with tergites with vague purplish reflections; sternites slightly paler in color than tergites; furca (Fig. 7) with median aperture large, emarginate anteriorly; posteromedial margin triangularly emarginate medially; spermathecal ducts unsclerotized posteriorly; cerci short, second segment about 0.7 length of first. Length 5.6–6.0 mm.

Type material.—Holotype ♂ (NRS) from Tanzania is labeled: "S TANGANYIKA Melando Forest 30 mi S of Njombe 2,450 m. 10.1962 leg. *G. Heinrich*/HOLOTYPE ♂ Allognosta njombe N. E. Woodley 1999." The locality of collection is in Iringa Province in Tanzania. The specimen is missing the right front tarsus and the left middle tibia and tarsus, otherwise it is in excellent condition. The terminalia are stored in glycerin in a microvial on the specimen pin. Allotype ♀, 3 ♀ paratypes



Figs. 3–7. Male and female terminalia of *Allognosta njombe*. 3, Genital capsule, dorsal view. 4, Epandrium and postgenital segments, dorsal view. 5, Phallic complex, dorsal view. 6, Phallic complex, left lateral view. 7, Female furca, ventral view. Abbreviations: *ep*, epandrium; *gc*, gonocoxites; *gs*, gonostylus; *hyp*, hypandrium; *llb*, lateral lobe of phallic complex; *ma*, median aperture of female furca; *mlb*, median lobe of phallic complex; *pmar*, posteromedial margin of female furca.

(NRS, USNM): Tanzania: Mbeya Province, Rungve Mt., 2,600 m, 8–11.1962, G. Heinrich. 3 ♀ paratypes (NRS): Tanzania: Mbeya Province, Rungve Mt., 20 mi. SSE Mboya [probably = Mbeya], 2,600 m, 1962, G. Heinrich. 1 ♀ paratype (CMNH): Malawi: Chitipa District, Jembya Reserve, 18 km SSE Chisenga, 10-08S, 33-27E, 1,870 m, 1–10 January 1989, J. Rawlins, S. Thompson.

Distribution.—Known only from highland localities in Malawi and Tanzania around the north end of Lake Nyassa.

Etymology.—The species name is a noun in apposition based on the name of the type locality.

Remarks.—This species is most similar to *Allognosta bwamba* Woodley. The elongation of the anterior region of the head in females is similar in the two species, although in *A. njombe* the antennae are inserted at the apex of the anterior most portion of the head, not below it. The overall structure of the male terminalia is similar in the two species, especially the shape of the posterior margin of the hypandrium. Although no phylogenetic analysis has been done on *Allognosta,* it seems probable that these two species are closely related. None of the other Afrotropical species of *Allognosta* have been collected in the vicinity of Lake Nyassa.

Allognosta stuckenbergae Lindner

Allognosta stuckenbergae Lindner 1961: 1.

Material examined.—SOUTH AFRICA: 1 ♂, 1 ♀, Natal, Pietermaritzburg, Town Bush, xi.1976, R. Miller (NMP); 1 ♂, Transvaal, 12 km. S Sabi, 2530BB, indigenous bush, 3.xii.1976, R. Miller (NMP); 1 ♀, Cape Province, Hogsback, 3226DB, forest and forest margins, 13–16.xii.1985, J. & B. Londt (NMP); 2 ♀, Cape Province, Tsitsikama Coastal National Park, Stormsrivermond, 34°02′S, 23°53′E, moist medium high coastal forest with *Podocarpus,* 15–19.x.1994, Michael Söderlund, Malaise trap (NRS); 1 ♂, Cape Province, Tsitsikama Forest Reserve, 33°58′S, 23°54′E, moist high indigenous forest with *Podocarpus,* 14–19.x.1994, Michael Söderlund, Malaise trap (NRS); 1 ♀, Cape Province, Bloukrans Pass at Varkrivier, 33°57′S, 23°38′E, coastal rainforest in ravine, 14–19.x.1994, Michael Söderlund, Malaise trap (NRS).

Remarks.—All of the new locality data fit within the known range of *A. stuckenbergae* in the eastern half of South Africa.

Allognosta tessmanni Enderlein

Allognosta tessmanni Enderlein 1921: 182.

Material examined.—UGANDA/ZAIRE: 1 ♀, North of Lake Edward, Gyldenstolpe (NRS).

Remarks.—This specimen was collected on an expedition headed by Nils Gyldenstolpe along the northern parts of Lake Edward from 4 April to 6 May 1921 (Thomas Pape, personal communication).

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A NEW GENUS OF THE OROBITIDINAE AND DISCUSSION OF ITS RELATIONSHIPS (COLEOPTERA: CURCULIONIDAE)

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Abstract.—The new genus ***Parorobitis*** of the subfamily Orobitidinae and two **new species**, ***Parorobitis gibbus*** (Paraguay: Alto Parana) and ***Parorobitis minutus*** (Brazil: Curitiba, Parana), are described. The subfamily Orobitidinae is redescribed based on characters of *Orobitis* and *Parorobitis,* and diagnoses of the two genera are provided. Several characteristics of the head, thorax, wings and elytra are used to compare the Orobitidinae with the supposedly related taxa of Zygopinae, Ceutorhynchinae, and Baridinae. A key to these taxa is provided.

Key Words: Curculionidae, Orobitidinae, new taxa, South America

The subfamily Orobitidinae is comprised of two strikingly distinct genera. The Palearctic *Orobitis* Germar includes the transpalearctic *O. cyaneus* Linnaeus which develops in seed capsules of *Viola* spp. in broad-leaved and mixed forests and *O. nigrinus* Reitter from the Balkans. A new genus of this subfamily is described herein including a new species from Paraguay and another from Brazil.

These new taxa are described and an attempt is made to place them in the context of present-day weevil classification. In the last section of the paper, the close affinity of the newly described genus with the genus *Orobitis* and preliminary conclusions regarding the relationships of the Orobitidinae are presented. It is clear that examination of a much larger sample of taxa and characters in combination with rigorous analysis may be necessary to propose robust hypotheses of relationships.

As in many other beetle families, terminology of structures in weevils is fairly inconsistent and often is used in a misleading way (Thompson 1989). Although the subject of this paper is not comparative morphology or analysis of terminology, it is useful to provide a brief summary of the sources of terms for the most critical and disputed parts of the weevil body.

To describe metathoracic structures, a combination of terms proposed by Matsuda (1970) and McHugh et al. (1997) and the terms previously adapted for leaf beetles (Konstantinov and Vandenberg 1996) is used.

General wing terminology follows Kukalová-Peck and Lawrence (1993). Some unique structures of weevils were named by Zherikhin and Gratshev (1995). These terms are used for structures which were not named by Kukalová-Peck and Lawrence (1993). Terms of internal elytral structures are those used by Lyal and King (1996).

Terms proposed by Thompson (1989) are used for the spermatheca. The term "pump," widely accepted to describe the same part of the spermathecal body attached to the lobe of the duct and lobe of gland (Smith 1979, Konstantinov 1998), is used instead of "tail." As for the other parts of the female genitalia, commonly accepted terms are used (Morimoto 1962, O'Brien and Askevold 1995, Howden 1995). Morimoto (1962), Lyal (1993), and O'Brien and Askevold (1995) are the main sources of the names used for different parts of the male genitalia.

Subfamily Orobitidinae

Description.—Body small, 2–3.5 mm long, globose or transversely-subrhomboidal, prothorax and elytra strongly conjointly convex (Figs. 1–4). Black; vestiture dense, tightly appressed and inconspicuous or suberect, composed of white and dark scales.

Rostrum as (Figs. 3–6, 8) long as or slightly longer than prothorax, basally weakly curved, apically straight; dorsal margin more or less angular in lateral view over antennal base. Apical part of rostrum in female (Fig. 5) much narrower than basal part. Ventral surface of head without posterior tentorial pits and occipital sutures. Subgenal sutures fused (Figs. 10, 11). Antenna inserted at basal third of rostrum (Figs. 3, 4, 8, 9). Antennal scrobe oblique, ventral margin reaching venter of rostrum less than half way between antennal insertion and eye. Scape stout, short, less than half as long as rather long and slender funicle with 7 antennomeres (Figs. 16, 17). Eye medium-sized, weakly convex. Frons as broad as base of rostrum or slightly narrower, sometimes weakly narrowing in middle.

Mandible (Figs. 12, 13, 15) ventrally with 2 visible denticles, third denticle covered with apex of rostrum; mandible dorsally separated from maxilla by long ventrolateral appendage of rostrum (Figs. 12, 15). Labial palpi 2- (*Parorobitis*) or 3- (*Orobitis*) segmented. Mentum long.

Prothorax subtrapezoidal with base very broadly rounded or nearly straight and slightly produced posteriorly for most of its length. Sides slightly rounded or nearly straight. Basal margins of prothorax and elytra tightly coupled, sometimes jointly raised, but not crenulate. Apical margin of pronotum not raised. Postocular lobes well developed to absent. Lateral tubercles absent. Disc of pronotum flat or moderately convex in apical half, without median sulcus. Prosternum excavated, not keeled in front of fore coxae. Distance between coxae nearly equal to width of rostrum. Mesepimeron not visible from above, flat, deeply inserted between base of prothorax and elytra (Figs. 18, 23). Rostral furrow formed by rather high, lamelliform keels behind fore coxae on prosternum, sometimes lower keels also present on mesosternum.

Mesoscutellum with tall stalk (Fig. 18). Mesosternum between middle and hind coxae with broad fold projecting over hind coxae. Mesosternum and metasternum fused. Internal ridge and border between these structures barely visible. Mesendosternite situated between internal wall of coxal cavity and mesosternal ridge. Plate nearly as long as wide. Basal and apical appendages slender (Fig. 19).

Scutoscutellar ridges of metanotum not connected, directed anteroventrally. Alocristal ridges not connected in middle (Fig. 20).

Metendosternite with moderately narrow stalk. Furcal arm slender, apically widening. Lateral arm short, situated nearly in middle of furcal arm. Anterior and posterior transverse ventral processes of equal length, leaving narrow furrow between (Figs. 21, 22).

Elytra slightly longer than broad, with strongly convex or obsolete humeral prominences. Elytra with locking sutural structure composed of deep longitudinal groove

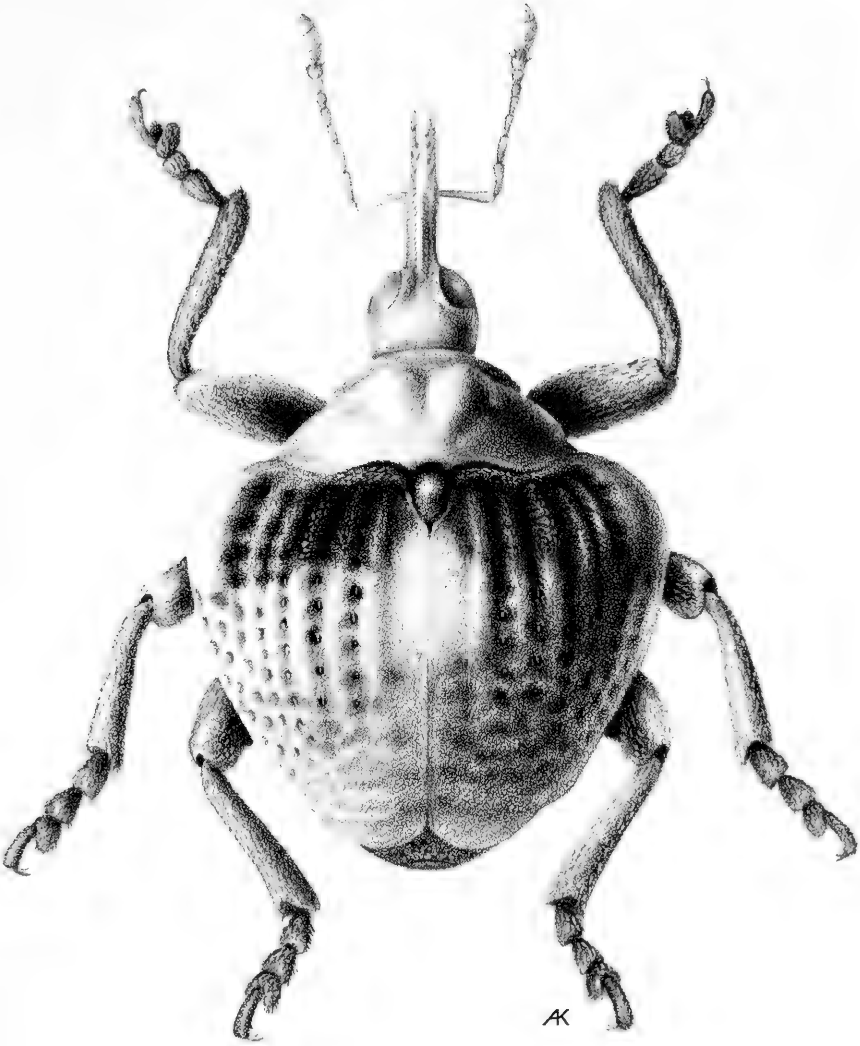

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Fig. 1. *Parorobitis gibbus*, ♂.

on left elytron (Fig. 18) and longitudinal ridge on right elytron (Fig. 27). Basal part of suture with two callosities and depressions between on left elytron. Right elytron with two depressions, and with ridge between them (Figs. 27, 28, 31, 32). Submarginal ridge of each elytron also complicated (Fig. 29, 30). Apex of elytron with longitudinal stridulatory file. Preapical groove absent (Figs. 35, 36).

Wings well-developed or slightly reduced, with well developed R, radial fissure, and first radial scelerite (Figs. 25, 26).[1]

Legs long. Femora broad from base, unarmed, subulate to moderately clavate, shallowly grooved for reception of tibiae. Tibiae (Figs. 39, 42, 43) in female not uncinate; in male, with short apical mucro (Figs.

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[1] Zherikhin and Gratshev (1995) state that the Orobitini are wingless; however, *Orobitis cyaneus* has shortened but fairly well-developed wings (Fig. 26).

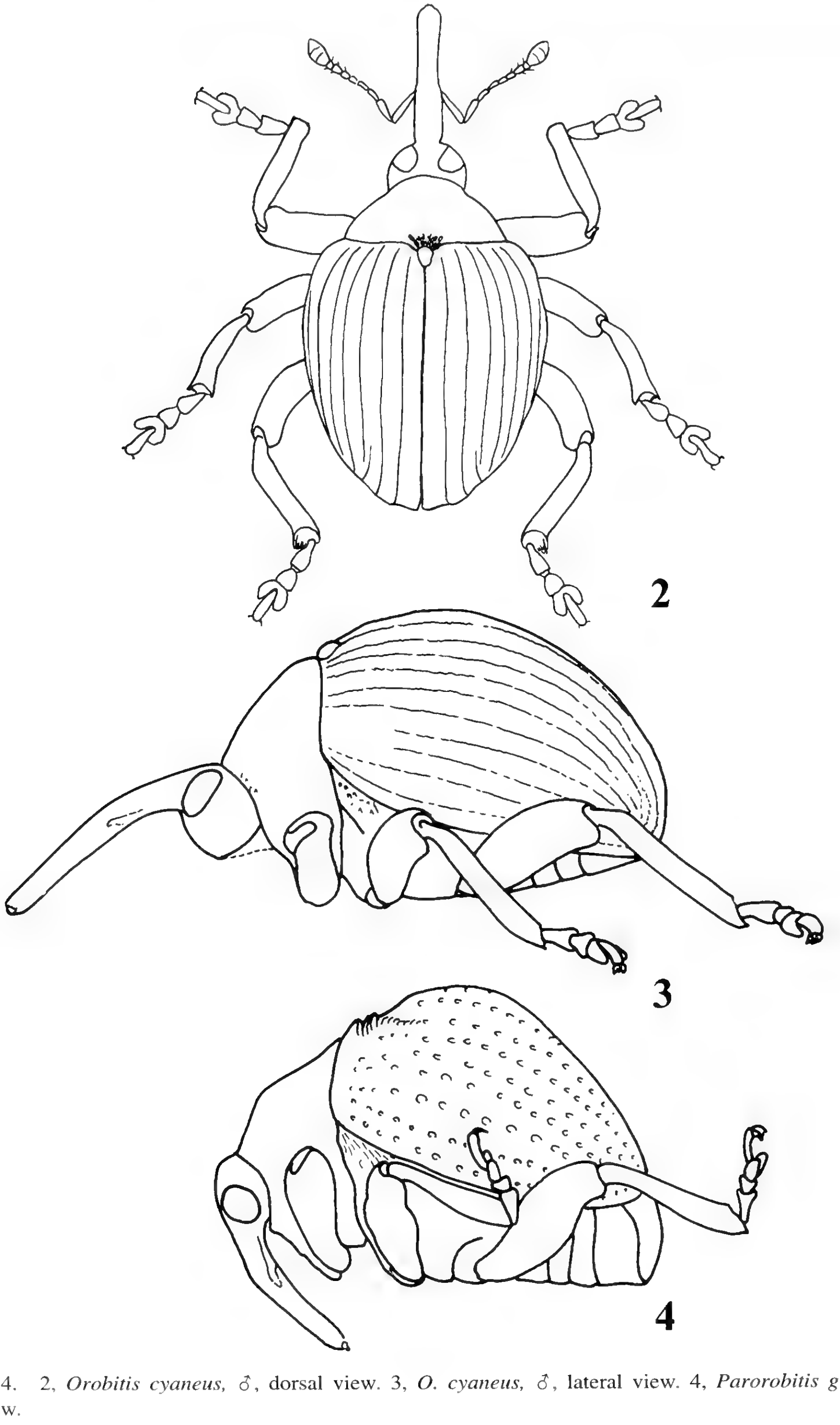


Fig. 2–4. 2, *Orobitis cyaneus,* ♂, dorsal view. 3, *O. cyaneus,* ♂, lateral view. 4, *Parorobitis gibbus,* ♂, lateral view.

40, 41). Apical comb of setae not or slightly extending onto outer margin of tibia. Third tarsomere bilobed. Claws separate, moderately divergent, with long median paired contiguous process (Figs. 46–48).

Abdomen with sterna in one plane. Sterna 1–4 of subequal length, 5 almost as long as sterna 3 and 4 together. Sternum 1 nearly completely divided by hind coxae. Hind margins of sterna 2–4 parallel, moderately curving backwards on sides (Fig. 23). Pleurite 1 long, separated from rest of tergum 1 by groove, attached by wide membrane with granulated microsculpture to metepisternum (Figs. 24). Pleura 4–7 combined with corresponding tergites. Tergum 8 exposed in males (Fig. 1).

Diagnoses of the two genera of the subfamily Orobitidinae

1 (2). Body subspherical, rounded. Humeral prominences obsolete. Basal margins of prothorax and elytra not raised (Figs. 2, 3). Dorsum almost uniformly covered with black or bluish black tightly appressed scales, shining. Dorsum of rostrum evenly curved over antennal base (Figs. 3, 9). Frons flat. Pronotum evenly convex, without median or lateral depressions. Basal margin of pronotum almost straight, imperceptibly notched opposite scutellum. Postocular lobes absent. Mesoscutellum rounded, as long as broad, weakly and evenly convex. Elytra longer than broad, all intervals flat, striae linear. Lateral margin of elytron slightly and almost evenly rounded, inconspicuously emarginate near base over mesepimera. Mesosternum without keels. Sides of meso- and metathorax evenly convex, without prominences or depressions. Fore coxa without prominence on inner side of apex. Femora nearly parallel-sided, with glabrous grooves ventrally. Claw short, length less than width of tarsomere 5 at apex (Fig. 48); median process ca. half as long as claw. Abdominal suture 1 without lateral pore. Sterna uniformly covered with yellowish scales. 2-2.8 mm. Palearctic. Larvae in seed capsules of *Viola* spp. . . . . *Orobitis* Germar

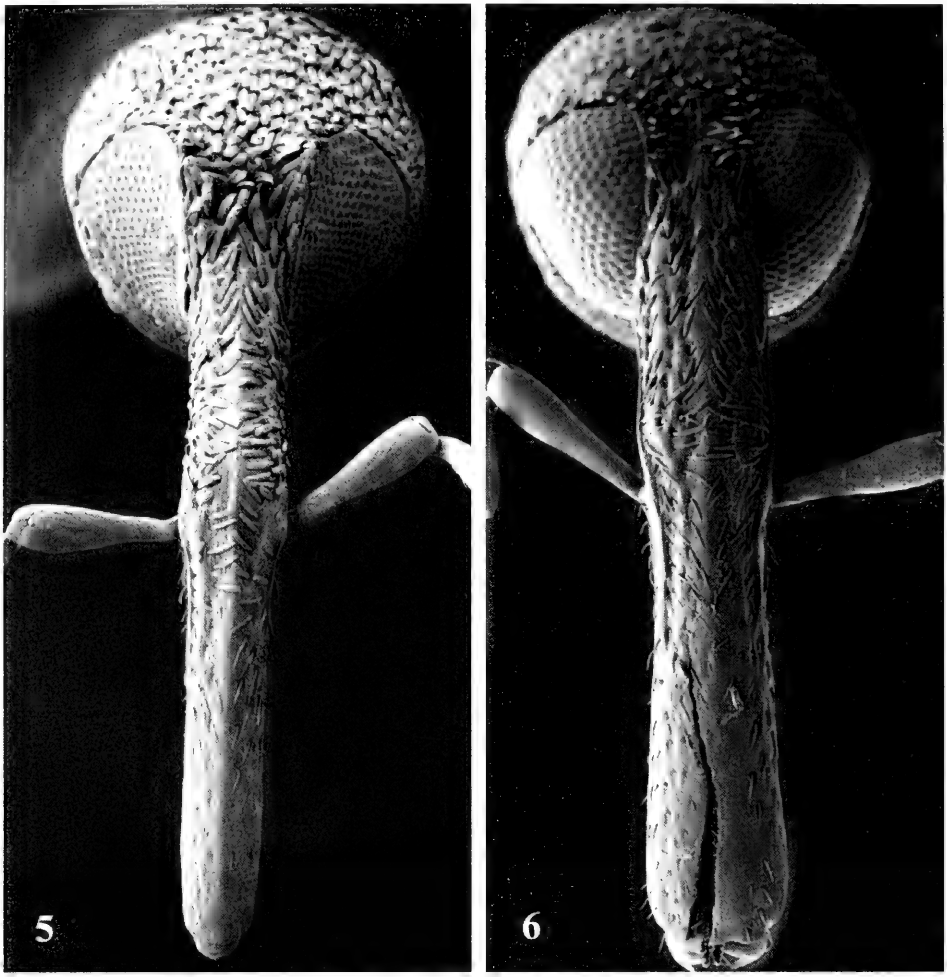
2 (1). Body subrhomboidal, angular humeral prominence convex, forming broad, moderately curved callus (Figs. 1, 4). Basal margins of both prothorax and elytra both finely conjointly raised. Dorsum with pale and dark brown spots on pronotum and contrasting basal band on elytra, with background vestiture composed of dense suberect to subappressed, linear to lanceolate, white scales. Rostral dorsum angular over antennal insertion (Figs. 4, 8). Frons moderately depressed, anterior part sloping to base of rostrum and posterior part, to vertex. Pronotum with two submedian obtuse prominences in apical half; laterally uneven. Basal margin of pronotum notched in middle and bisinuate laterally. Postocular lobes from well- to poorly developed. Mesoscutellum longer than wide, large, tuberculiform, steeply sloping anteriorly and gradually sloping to elytra. Elytra broader than long. Odd-numbered intervals weakly to moderately convex, costiform near base. Striae consisting of medium-sized, deep, remote punctures, space between latter undulate. Intervals very densely, finely punctate, nearly matt. Lateral margin of elytron moderately deeply emarginate over mesepimeron, very shallowly bisinuate behind. Mesosternum with well-developed keels reaching middle coxae. Fore coxa with obtuse prominence at apex, separated laterally by narrow sulcus. Femora distinctly clavate, with shallow grooves on ventral side, all uniformly covered with scales. Claws long, length greater than width of last-tarsomere at apex (Figs. 46, 47); median process slightly shorter than claws. Abdominal suture 1 with lateral pore under brown scaly spot. Pleural area of thorax with brown spots. 2.9–3.5 mm.. Neotropical . . . . *Parorobitis,* new genus

Parorobitis Korotyaev, O'Brien, and Konstantinov, new genus

Type species.—*Parorobitis gibbus,* new species.

Description.—Small; body short, subrhomboidal, dorsally strongly convex; prothorax and elytra conjointly convex. Body black, densely clothed with suberect to subappressed, elongate scales, dorsally with contrasting pattern of white and brown scales. Black, funicle and club of antennae and apical third of rostrum brown, tarsomere 3 dark brown.

Head capsule small. Rostrum angularly curved at antennal base, ventrally weakly arcuate, with dorsum more (in female) or less (in male) sharply angular (Figs. 4, 8).



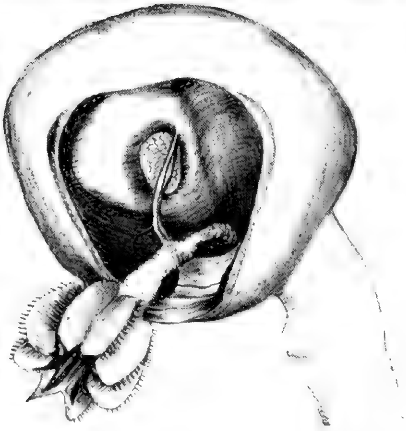

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Fig. 5–7. Head. 5, *Parorobitis gibbus*, ♂, frontal view. 6, *Orobitis cyaneus*, ♂, frontal view. 7, *P. gibbus*, view through occipital opening, tentorium and foregut with proventriculus.

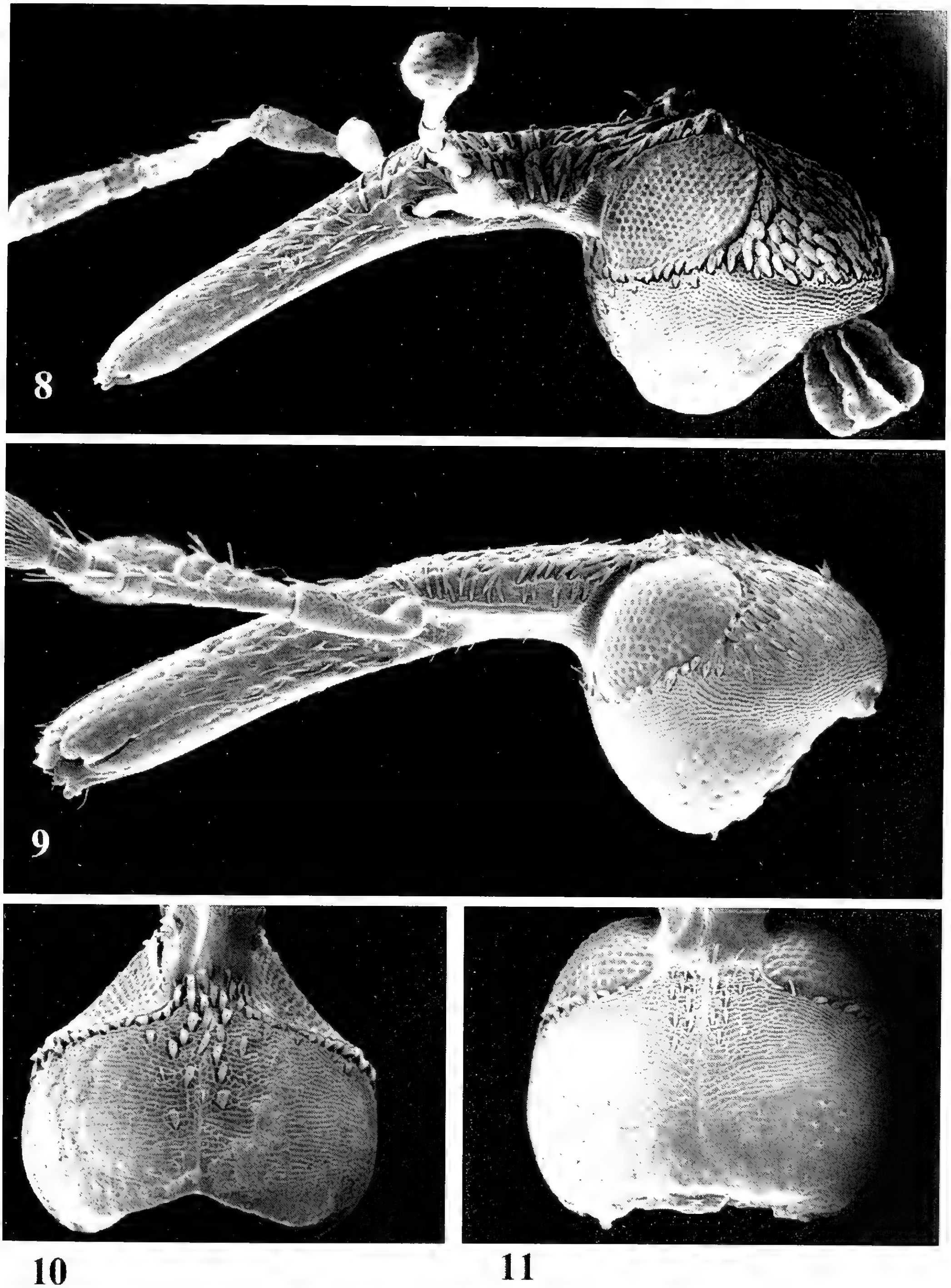

Fig. 8–11. Head, ♂. 8, 9, Lateral view. 10, 11, Ventral view. 8, 10, *Parorobitis gibbus*. 9, 11, *Orobitis cyaneus*.

Basal part of rostrum broader than apical (Fig. 5), nearly as broad as fore tibia. Apical part narrower (Fig. 5); in female, straight, cylindrical, shining. Antenna inserted at basal third of rostrum. Scape short, stout. Funicle long, antennomeres progressively shorter apically; club oval, short (Figs. 5, 16). Eyes strongly anteriorly directed. Frons at anterior margin as broad as base of rostrum, widened posteriorly, weakly depressed, slightly, transversely ridged in middle. Vertex weakly convex, not carinate. Sculpture fine. Tentorium well-developed, with moderately broad long stalk attached to ventral surface of head and two lateral branches attached to anteromedial corner of eye (Fig. 7). [It is unclear if these branches are homologous with anterior or dorsal arms.] Foregut with 8-laminate chitinized proventriculus (Fig. 7, 14). [According to Crowson (1955) this structure may well be plesiomorphic for curculionids. It is also known to occur in Cossoninae (*Caulophilus latinasus* Say) (Crowson, 1955), Baridini (*Pachybaris porosus* Lec.) (in the latter species it is much longer and all the laminae are lower), and Zygopini (*Lobotrachelus subfasciatus* Motschulsky) (it is generally shorter with every lamina being taller posteriorly and shorter anteriorly).]

Left mandible with ventral denticles closer together than on right mandible. Labial palpus 2-segmented. Sides of mentum convex (Fig. 12).

Prothorax transverse, trapezoidal. Base sinuate, noticeably produced posteriorly and enclosed by humeral prominences of elytra, shallowly notched anterior to scutellum and bisinuate laterally. Apical margin of pronotum raised. Basal margin raised to meet raised basal margin of elytra, finely carinate. Hind angles weakly projecting, sides weakly convex and strongly converging to apical prominences immediately above postocular lobes. Apical constriction moderately deep on dorsum and gradually disappearing towards prominences, which slope to anterior margin of prothorax. Sides near anterior margin with two angular prominences visible in dorsal view. Punctures on disc dense, uniform, medium-sized, rather deep; intervals between punctures shining, narrow. Ocular lobe well-developed, angular. Fore coxae separated by width of rostrum. Prosternum in front of coxae not keeled, as long as width of rostrum at base, deeply excavated, with moderately high lamelliform keels behind coxae.

Mesothorax short, transverse (Figs. 18, 19). Mesosternum with keels reaching anteromedial margin of middle coxae. In lateral view, mesosternum rather steeply declivous to metasternum. Scutellum large, strongly convex, broadly rounded on top. Mesepimeron separated from mesocoxa by mesosternal appendage (Fig. 23). Mesepimeron not visible from above, although entering deeply between bases of prothorax and elytron. Distance between mesocoxae greater than width of coxa.

Metathorax much longer than mesothorax (Fig. 18). Metanotal prescutal membrane thin and vertical. Alocrista moderately narrow, without well-developed lateral ridge. Scutum well separated by scutoscutellar groove forming large "pocket" laterally, nearly as large as scutellum. Ventrally, scutoscutellar ridge forming wide plate directed anteroventrally and dividing metanotal cavity into two almost equal-sized compartments (Fig. 20). Scutellar groove ending at basal margin of notum. Allocristal part of notum containing dorsally and ventrally separated cavity with two elongate openings. Axillary part of metanotum situated anterolaterad of scutum. Part of scutum connected with axillary area forming nearly parallel-sided, wide, weakly sclerotized appendage. Metasternum forming thick fold over hind coxa. Hind coxae separated from elytra by slightly less than width of coxa. Metepisternum convex.

Elytra much broader than pronotum, transverse, strongly narrowing apically, with unusually convex humeral prominences, separately and rather narrowly rounded at apices, and extending over base of py-

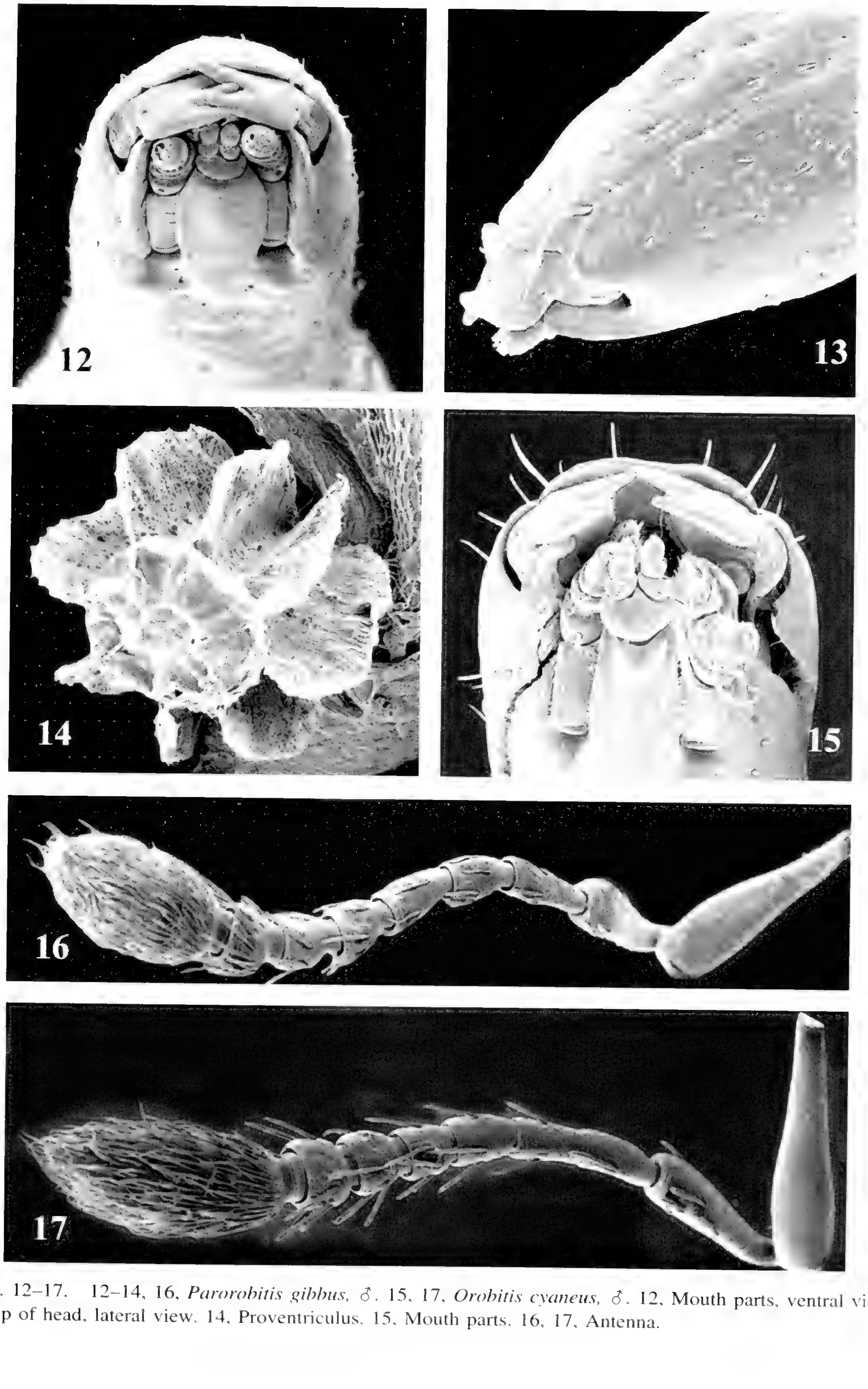

Fig. 12–17. 12–14, 16, *Parorobitis gibbus*, ♂. 15, 17, *Orobitis cyaneus*, ♂. 12, Mouth parts, ventral view. 13, Tip of head, lateral view. 14, Proventriculus. 15, Mouth parts. 16, 17, Antenna.

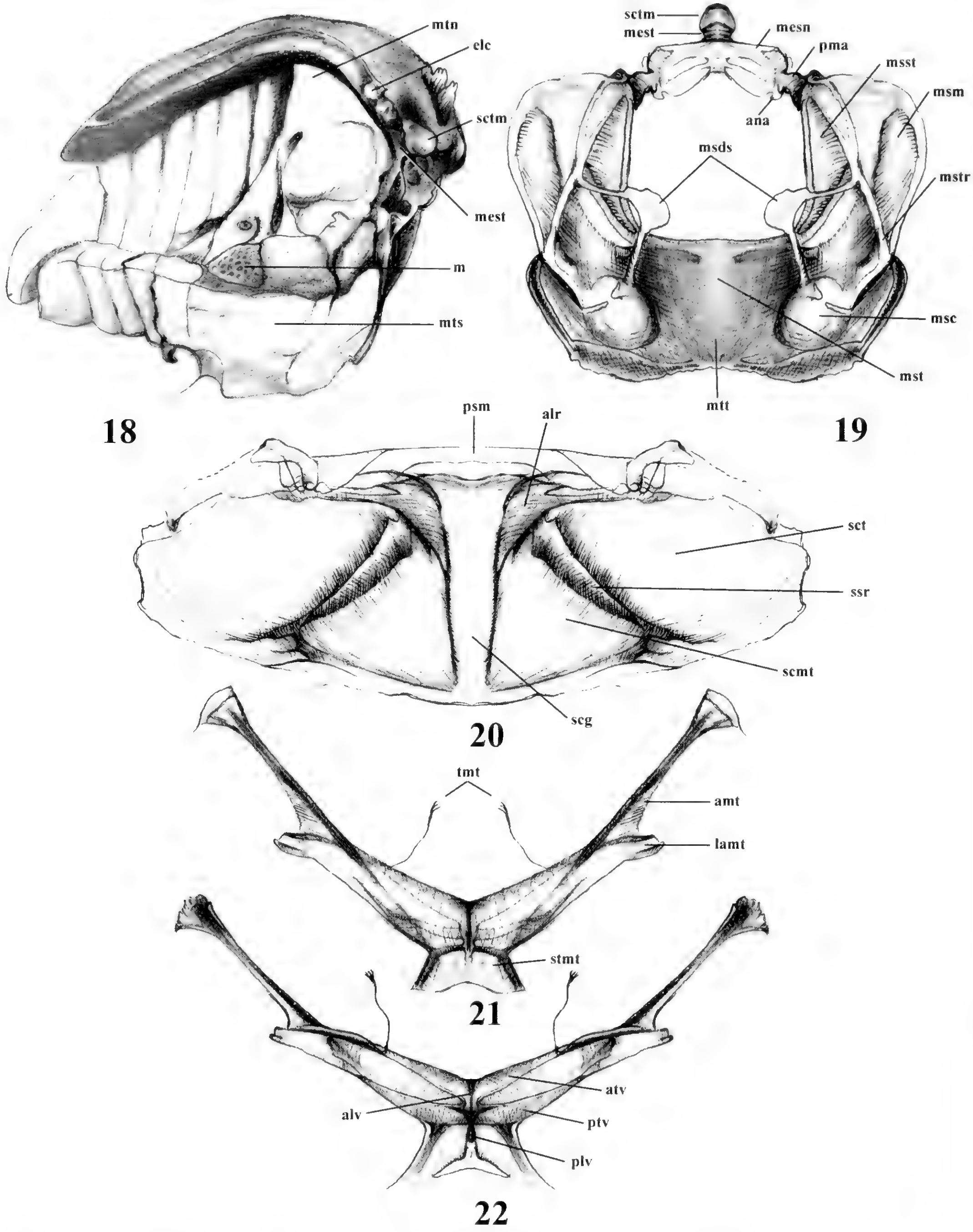

Fig. 18–22. Thoracic structures of *Parorobitis gibbus*. 18, Lateral view with right elytron removed. 19, Mesothorax and metasternum (metanotum removed), view of internal structures. 20, Metanotum, ventral view. 21, 22, Metendosternite (21, dorsal view; 22, ventral view). Abbreviations: alr = allocrista; alv = anterior part of longitudinal ventral process; amt = furcal arm; ana = anterior notal appendage; atv = anterior part of transverse ventral process; elc = elytral lock; lamt = lateral arm; m = membrane; mesn = mesonotum; mest = stalk of mesoscutellum; msc = mesocoxal cavity; msds = mesendosternite; msm = mesepimeron; msst = mesepisternum; mst = mesosternum; mstr = merosternal ridge; mtn = metanotum; mts = metepisternum; mtt = metasternum; plv = posterior part of longitudinal ventral process; pma = postmedial appendage; psm =

gidium. Lateral margin of elytron emarginate at base and very shallowly bisinuate posteriorly. Internal surface with four longitudinal striae of tiny denticles (Fig. 27). Right elytron with locking structure consisting of narrow ridge and two nearly round lateral impressions. Elytral apex covered with multidentate median callosities. Middle of apex with patch of medially directed setae (Figs. 27, 31). Striae composed of medium-sized, rather deep, sparse, round punctures. Intervals 3–4 times as broad as striae; odd-numbered intervals weakly to strongly convex, densely covered with small shallow punctures.

Wing elongate, with apex slightly darker than middle. Humeral field with short C not touching Sc. R straight, widening apically. Radial fissure indistinct. Radial fold weak. First radial sclerite well-developed and large, second small. Rr absent. Anal field with two weakly developed anal veins (Fig. 25).

Legs long, stout. Trochanters short. Femora broad from base, moderately clavate, with deep ventral constriction near apex. Shallow ventral groove in apical half covered with scales as elsewhere. Hind femur more swollen in apical part than fore and middle femora. Tibiae weakly broadening and curved outward apically; fore and middle tibiae slightly flattened, hind tibia nearly round in cross-section, medially and frontally compressed apically (Fig. 31). In female, tibiae mutic; in male, all armed with small curved mucro (Figs. 39–41).

Apical fringe of setae slightly oblique only to outer margin of tibia. Setae dense, fine and short. Tarsi of medium proportions, tarsomere 3 bilobed, nearly twice as broad as 2. Tarsomere 5 moderately widening apically, slightly more than half length extending beyond lobes of tarsomere 3. Claws large, with transversely flattened, longitudinally curved, apically subacute to acute, median process, latter slightly shorter than claws (Figs. 46, 47).

Venter weakly concave in female and more strongly so in male. Sterna 1–4 short, nearly equal in length. Sternum 5 nearly twice as long as sternum 4 (Fig. 23). Small indentation between sterna 1 and 2, slightly smaller indentations between other sterna, with latter indentations slightly more medial. Abdominal terga 1–5 short, nearly equal in length. Tergum 6 much shorter in middle. Tergum 7 slightly longer than terga 4, 5 and 6 together (Fig. 24). Tergite 8 of male with long basal projections (Fig. 57, 60).

Male genitalia: Apodemes longer than upper part of median lobe. Apical [third? fourth] of median lobe bent ventrally, gradually narrowing apicad. Spiculum gastrale long, attached to membrane of tegmen between sclerotized parts of sternum 8 (Figs. 57–62).

Female genitalia: Tergum 8 elongate, weakly sclerotized medially, with moderately well-sclerotized stripe along border. Sternum 8 with two patches of long setae apically and short setae between sclerotized arms (Fig. 51). Vagina narrow. Coxite and stylus narrow, at rest situated inside vagina (Figs. 53, 55). Spermatheca with well-developed gland and ductal lobes, receptacle more than 4× as long as wide (Figs. 52, 56).

Etymology.—This masculine generic name is the result of combining the generic name *Orobitis* and the Greek prefix *para-* meaning "close by, or similar to" and reflects the morphological similarity and close relationship of these two genera.

←

prescutal membrane; ptv = posterior part of transverse ventral process; scg = scutellar groove; scmt = metascutellum; sct = metascutum; sctm = mesoscutellum; ssr = scutoscutellar ridge; stmt = furcal stalk; tmt = tendons of meso- metafurcal muscles.

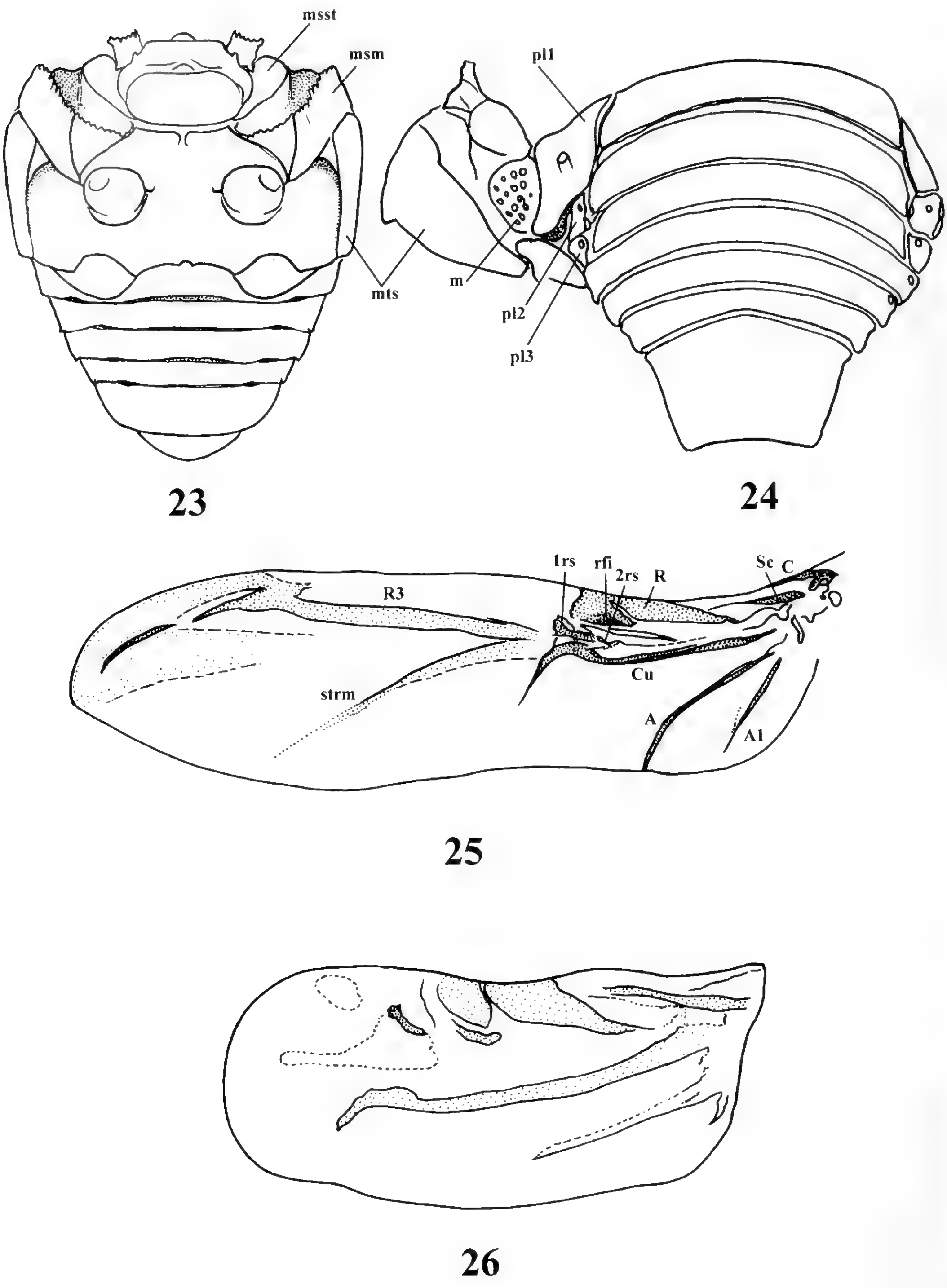

Fig. 23–26. 23–25, *Parorobitis gibbus*. 23, Meso- and metasternum and abdominal sternites. 24, Abdominal tergites, pleurites, and metepisternum. 25, Wing. 26, *Orobitis cyaneus,* wing. Abbreviations: 1rs, 2rs = radial sclerites; m = membrane; msm = mesepimeron; msst = mesepisternum; p11, 2, and 3 = abdominal pleurites; rfi = radial fissure; strm = medial stripe.

Parorobitis gibbus Korotyaev, O'Brien, and Konstantinov, new species

(Figs. 1, 4, 5, 7, 8, 12–14, 16, 18–25, 27, 29, 31, 35, 39–41, 46, 47, 51–53, 57–59)

Types.—Holotype ♂, Paraguay, Puerto P. Stroessner, 26–28.XII.1965, Nr. P. 9 (Mahunka), HMNH. Paratypes. 2 ♂, 2 ♀, same data as holotype (♂, ♀ HMNH, ♂ USNM, ♀ ZMAS). Paratypes. ♂, ♀, Paraguay: Alto Parana, 6 km W. Pto. Pres. Stroessner: 25–28.I.1983, leg. E. G. Riley (CWOB)

Description.—*Male:* Rostrum nearly as long as pronotum, with maximum width at antennal insertion, tapering basally and apically in dorsal view. Dorsal surface with sharp median carina disappearing before apex (Fig. 5). Lateral carina better developed between antennal insertion and head. Space between median and lateral carinae with row of deep punctures. Weak carinae converging on sides above antennal insertion, but vanishing separately near apex. Antenna inserted 0.35 from base of rostrum (Fig. 8). Scape shorter than funicular antennomeres 1 and 2 together, not reaching eye. Funicle rather slender and long, antennomeres progressively becoming shorter, antennomeres 5 and 6 slightly longer than wide, antennomere 7 globose. Club oval, short. Setae on flagellomeres moderately long, suberect.

Prothorax 1.65× as broad as long. Postocular lobe large, angular. Disc moderately convex, with two broad obtuse prominences in apical half, separated by shallow longitudinal depression not extending to basal half of disc. Sides of disc with rather deep round fovea postero-lateral to apical discal prominences, and with shallower fovea behind anterolateral prominences. Scutellum large, 1.4× as long as broad, rounded, very strongly convex, with steep anterior slope and gentle posterior slope to level of elytral suture. Surface of scutellum concealed by pale, sand-brown, imbricate scales.

Elytra 1.2× as broad as long, 1.6× as broad as base of prothorax, very strongly narrowing apically, with very strongly convex rounded humeral prominences. Disc strongly convex, more steeply sloping to base than to apex. Base of elytra deeply foveate along basal half of scutellum. Elytral striae with medium-sized, deep, sparse punctures. Stria 1 at base parallel to antescutellar margin of elytron and meeting incurved base of stria 2. Striae 3–6 nearly straight at base, stria 7 vanishing near the posterior margin of swollen interval 7, stria 8 reaching basal half of humeral prominence. Intervals 2 and 4 rather strongly convex, interval 6 depressed at base, becoming gradually more convex apically. Interval 8 in apical two-thirds slightly more convex than others. Preapical prominence obtuse and not very convex, stria beneath prominence deepened. Intervals matt, densely and finely punctate, lacking granulations.

Femora moderately swollen apically. Tibiae inconspicuously widening and apically curved outward. Mucro on middle and hind tibiae slightly shorter than tarsal claws; on fore tibia, half as long and much finer (Figs. 39–41). Protarsomere one about 1.7× as long as broad, protarsomere two 1.3× as long as broad, protarsomere three 0.8× as long as broad, 1.1× as long as 2. Tarsomere 5 weakly broadened apically, by two-thirds of length extending beyond lobes of tarsomere 3. Punctures on femora dense, deep, medium-sized, round; on tibiae, more or less elongate. Median claw process ca. twice as broad as claw (Figs. 46, 47).

Anal sternum flattened in middle one-third and covered with suberect to erect white hairs, sterna 3 and 4 with long, narrow, curved, suberect white scales along hind margin. Pygidium rounded, weakly transverse and raised along median line, coarsely punctate, and moderately densely covered with elongate suberect white scales.

Genitalia (Figs. 57–59): Median lobe narrowing apically, abruptly widening horizontally. Apical third with lateral patches

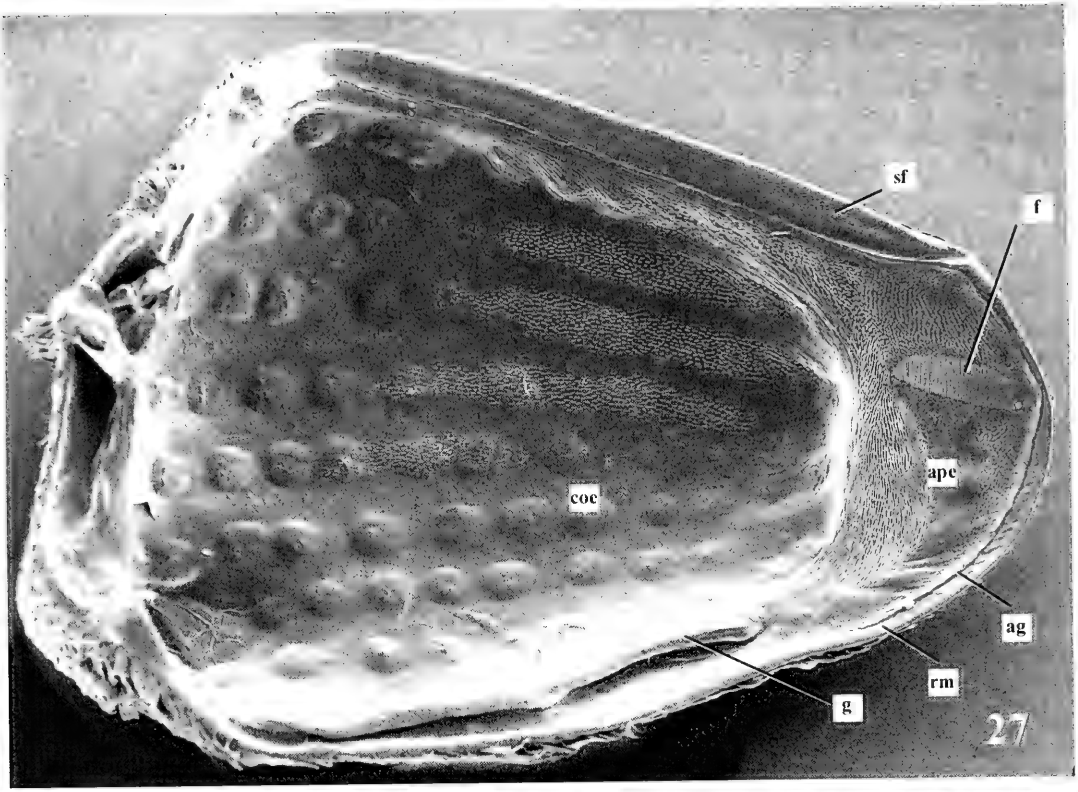

Fig. 27–28. Internal surface of right elytron. 27, *Parorobitis gibbus.* 28, *Orobitis cyaneus.* Abbreviations: ag = apical groove of elytron; ape = apical area of elytron; coe = concave area of elyton; f = file; g = submarginal ridge; rm = rim; sf = sutural flange.

of setae. Apodeme curved laterally, widening before base.

Head capsule densely covered with parallel-sided or weakly rounded, broad scales; vertex with few narrower brown scales in middle, and piceous scales on hind margin, otherwise with white scales. Basal part of rostrum with moderately dense white scales, latter half as broad as on vertex, rapidly thinning to antennal insetion; rostrum distally with sparse hair-like scales along sides to slightly beyond middle. Pronotum with moderately dense, narrow-lanceolate, brown scales in middle of disc; median depression with paler scales, often with few white scales on bottom. Brown spots on discal prominences and near base surrounded by narrow gray lines moderately densely covered with hair-like white scales; latter also covering sides of prothorax to angular line formed by broad white scales, nearly concealing pleural area and fore coxa. Anterior slope of discal prominences densely covered with narrower white scales; apical constriction with two gray spots, formed by narrow white scales. Sides also with small spot of brown scales between hind angles and lateral depression. Scutellum dull pale brown apically, with white scales at base. Base of elytra with band of brown scales; intervals 1 and 2, preapical prominences and sides in apical half densely covered with broad white scales; middle of each elytron with sparser vestiture of white, linear to narrow-lanceolate scales, latter broader in striae. Legs mottled with spots of narrow and broad white scales, sternum 1 and base of sternum 2 with brown spot on sides. Pygidium with scales not extending from punctures, broadly oval to round in basal half and elongate, slightly raised near apex; brown scales predominant in basal half; with white scales, along margins, median line, and in apical half.

Body length 3.1–3.3, width 3 mm.

Female: Rostrum 1.25× as long as prothorax, moderately widened and angularly curved at antennal insetion, with dorsal outline angular in lateral view; in apical part, straight, cylindrical, slender, about ⅔ width of fore tibia. Basal half of rostrum matt, densely covered with small shallow punctures. Median carina well developed, extending considerably beyond antennal base; lateral carinae finer. Sides of rostrum with pair of carinae converging apically from antennal base to middle of apical part of rostrum. Antennae inserted 0.3 from base of rostrum.

Tibiae without mucro. Protarsomere 1 about 1.6 as long as broad, protarsomere 2 nearly as long as broad, protarsomere 3 twice as long as 2.

Anal sternum flat. Pygidium slightly longer than broad, weakly and rather evenly convex, slightly raised along median line in apical third, narrowly rounded at apex, matt, moderately densely covered with medium-sized, fairly deep punctures.

Scutellum dull pale brown.

Female genitalia: Arms of sternum 8 moderately long (Fig. 51). Coxite and stylus slender (Fig. 53), latter nearly cylindrical. Spermathecal pump and ductal lobe forming broad loop. Apex of spermathecal pump bent toward ductal lobe (Fig. 52).

Remarks.—*Parorobitis gibbus* shares most character states with *P. minutus.* It can be separated by the whiter scale pattern of the head, larger size, longer arms of sternum 8 (Fig. 51), the slender coxite and stylus (Fig. 53), the stylus nearly cylindrical, the spermathecal pump and ductal lobe forming a moderately wide loop, the apex of the spermathecal pump bent toward the ductal lobe (Fig. 52), the median lobe narrowing apically with abrupt widening at the horizontal part, the apical third with lateral patches of setae, and the apodeme widening apically (Fig. 57–59).

Etymology.—This specific epithet is based on the Latin adjective *gibbus* = "humpbacked, protuberant" and refers to the humpbacked appearance and the two well-developed pronotal protuberances or swellings.

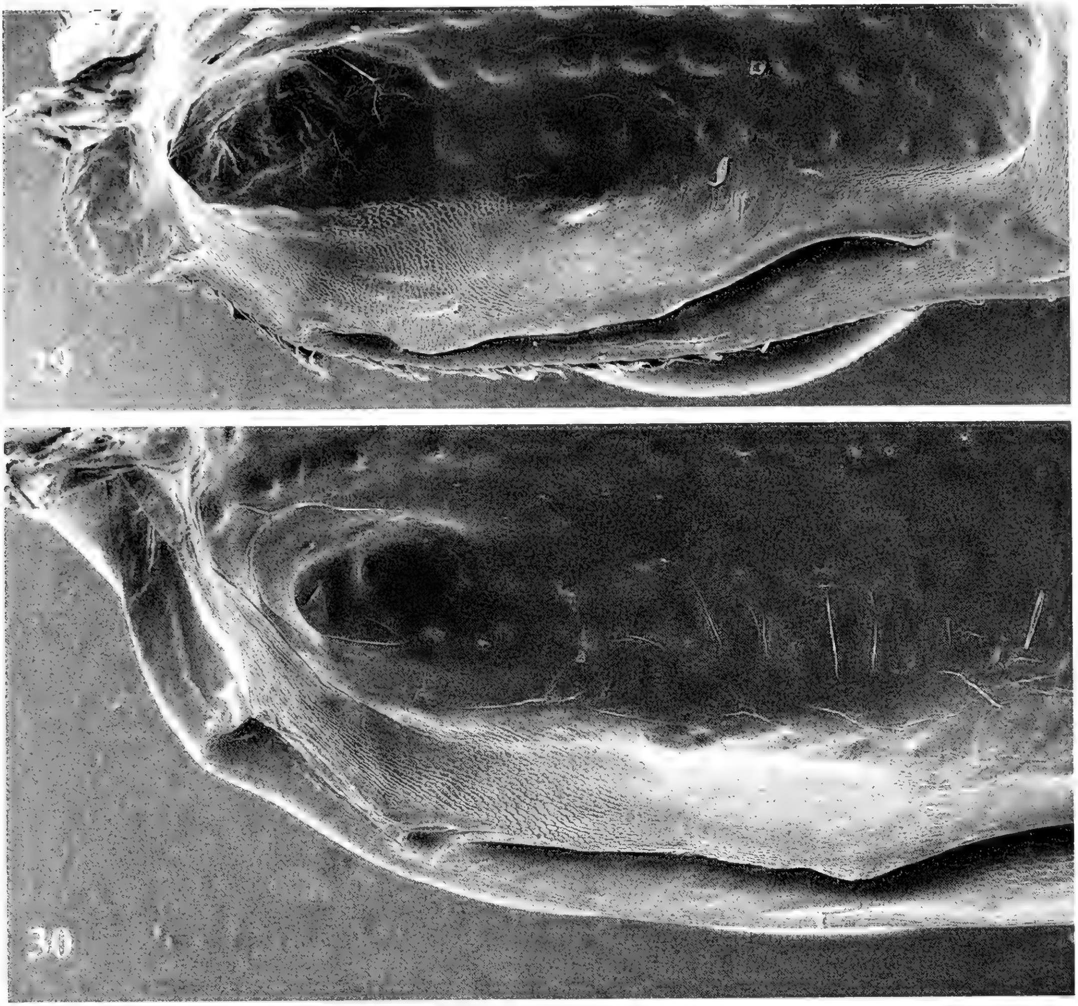

Fig. 29–30. Internal surface of right elytron, anterolateral part. 29, *Parorobitis gibbus*. 30, *Orobitis cyaneus*.

Parorobitis minutus O'Brien, Korotyaev, and Konstantinov, new species

(Figs. 54–56, 60–62)

Types.—Holotype ♂, Brazil, Curitiba, Parana, I.13.1969, Araucaria forest, leg. C. W. & L. B. O'Brien (OZUP). Paratype ♀, same data as holotype (CWOB).

Description.—*Male:* Rostrum slightly longer than pronotum, with maximum width at antennal insertion, tapering basally and apically in dorsal view. Dorsal surface with sharp median carina disappearing in front of apex. Lateral carina better developed between antennal insertion and head. Space between median and lateral carinae without punctures, covered with longitudinal wrinkles. Lateral carinae above antennal insertion parallel to each other, vanishing near apex. Antenna inserted 0.37 from base of rostrum. Scape shorter than funicular antennomeres 1 and 2 together, not reaching eye. Funicle rather slender and long, antennomeres progressively becoming shorter, antennomeres 5 and 6 slightly longer than wide, antennomere 7 globose. Club oval, short. Setae on flagellomeres long, suberect.

Prothorax 1.67× as broad as long. Postocular lobe weakly developed. Disc moderately convex, with single obtuse prominence in middle. Lateral areas of disc with-

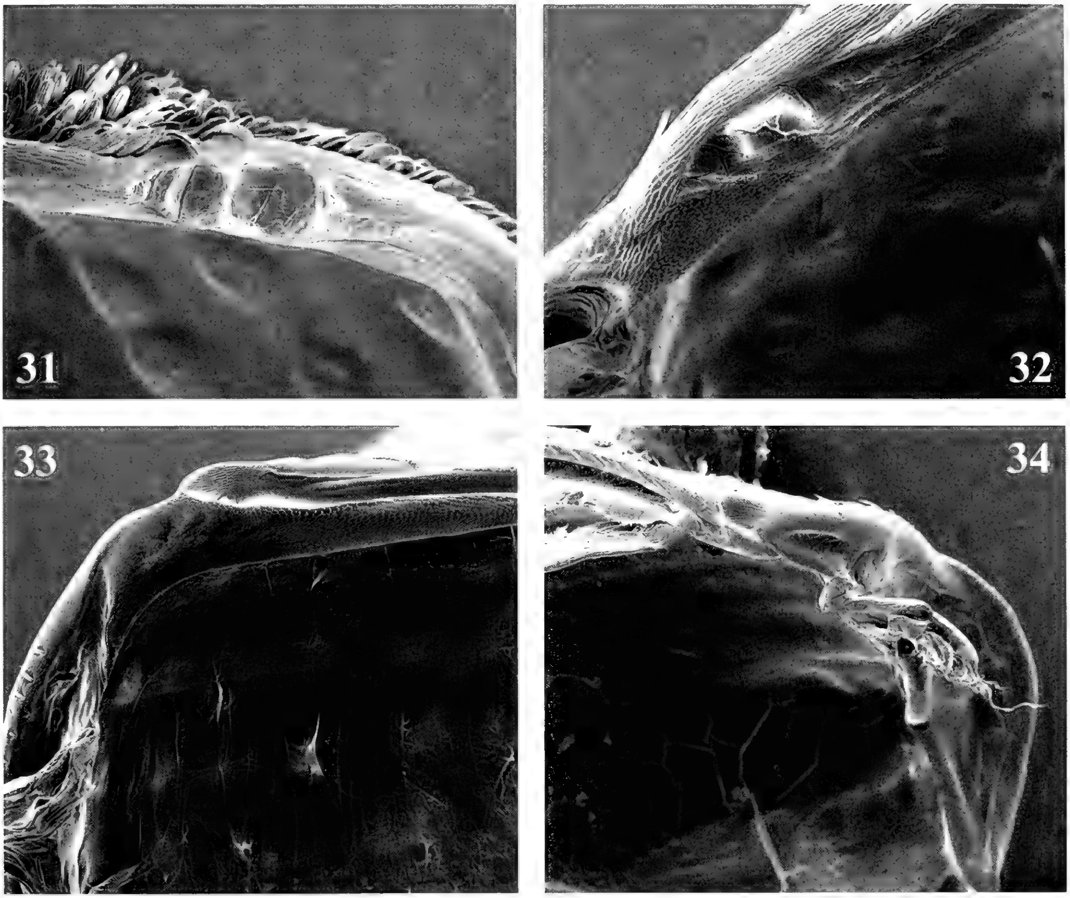

Fig. 31–34. Lock structures of elytron. 31, *Parorobitis gibbus*. 32, *Orobitis cyaneus*. 33, *Pachybaris porosa*. 34, *Lobotrachelus subfasciatus* (left elytron).

out deep fovea, with laterobasal prominence.

Scutellum large, 1.67× as long as broad, very strongly, roundly convex, with steep anterior slope and posterior slope leveling to elytral suture. Surface of scutellum concealed by brownish (in male) or pale sand-brown (in female) imbricate scales.

Elytra together 1.2× as broad as long, 1.69× as broad as base of prothorax, strongly narrowing apically, with very strongly convex, rounded humeral prominences. Disc strongly convex, more steeply sloping to base than to apex. Base of elytra deeply foveate along basal half of scutellum. Strial punctures small, moderately deep, sparse, nearly entirely covered with scales. Stria 1 parallel at base to antescutellar margin of elytron, meeting incurved base of stria 2. Striae 3–6 nearly straight at base, stria 7 vanishing in front of preapical callosity, stria 8 reaching basal half of humeral prominence. Intervals 2–6 equally convex; intervals 5 and 6 flattening apically; interval 8 in apical two-thirds nearly as convex as adjacent intervals. Preapical prominence convex, stria beneath prominence deepened. Surface of intervals matt, densely and finely punctate, lacking granulation.

Femora moderately swollen apically. Tibiae inconspicuously widening and apically curved outward. Mucro on middle and hind tibiae slightly shorter than tarsal claw;

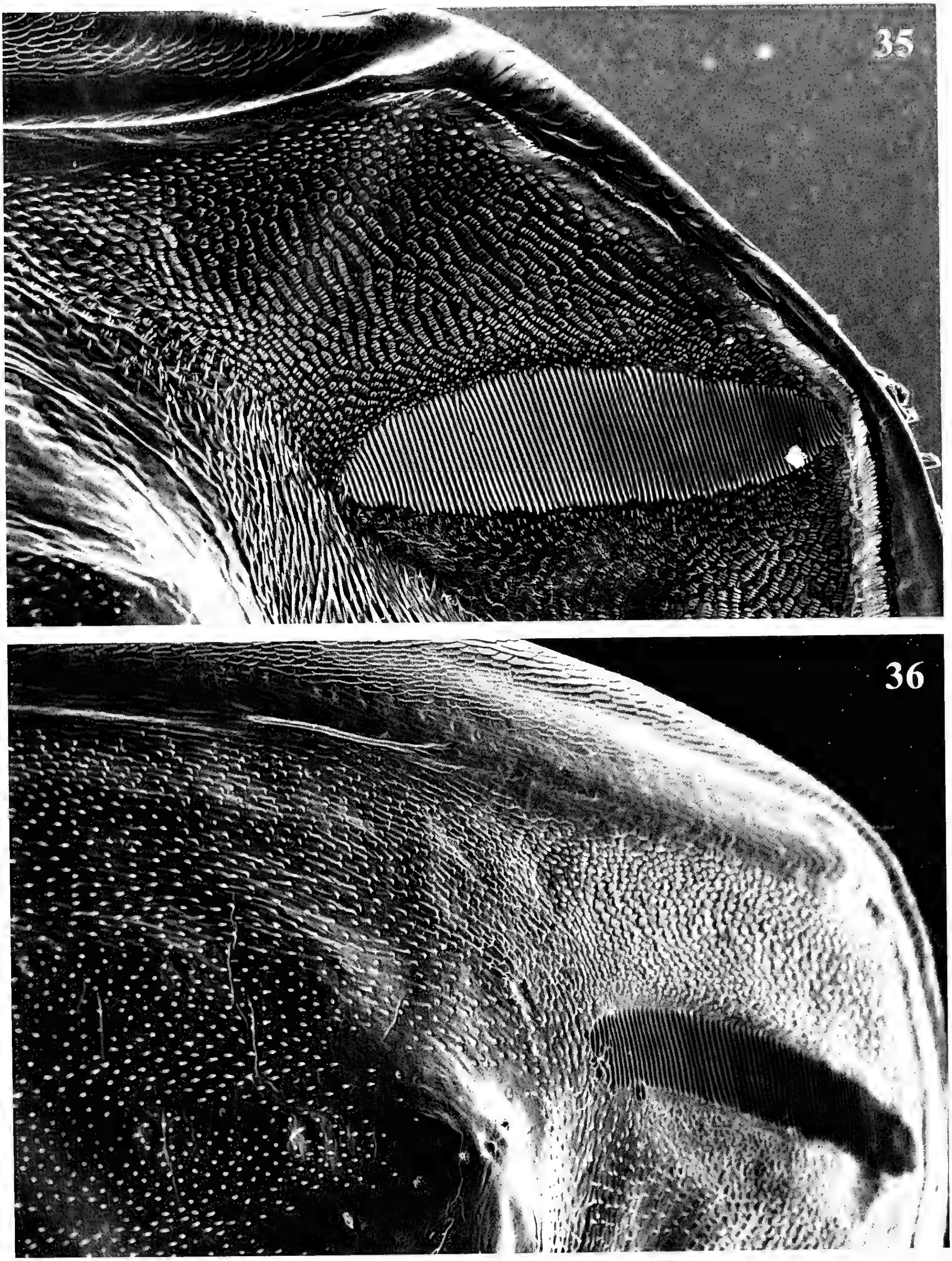

Fig. 35–36. Elytral apex with stridulatory file. 35, *Parorobitis gibbus*. 36, *Orobitis cyaneus*.

on fore tibia, mucro tiny, scarcely visible. Protarsomere one about 2× as long as broad, protarsomere two 1.2× as long as broad, protarsomere three 0.72× as long as broad, 1.3× as long as protarsomere two; protarsomere five weakly widened apically, extending two-thirds beyond lobes of protarsomere 3. Punctures on femora dense, deep, medium-sized, round; on tibiae, more or less elongate. Tarsal claws with median process ca. as broad as claw.

Anal sternum flattened in middle and covered with suberect to erect white hairs, ventrites 3 and 4 with long, narrow, curved, suberect white scales along hind margin. Pygidium rounded, weakly transverse and raised along median line, coarsely punctate, and moderately densely covered with elongate suberect white scales.

Male genitalia (Figs. 57–59): Median lobe narrowing apically without abrupt widening horizontally. Apical third without lateral patches of setae. Apodeme at base nearly as broad as at apex.

Head capsule densely covered with parallel-sided or weakly rounded broad scales; vertex with two stripes of narrow brown scales in middle, and piceous scales at hind margin, otherwise with white scales. Basal part of rostrum with moderately dense white scales half as broad as those on vertex, rapidly thinning to antennal insertion; rostrum distally with sparse hair-like scales along sides to slightly beyond middle. Pronotum with moderately dense, narrow-lanceolate, brown scales on disc and paler scales in middle, with narrow transverse stripe of white scales behind middle. Anterior slope of discal prominence densely covered with wider white scales. Sides also with small spot of brown scales above fore coxae. Scutellum dull pale brown on top, with white scales at base. Outer corner of mesepisternum with spot of black scales. Base of elytra with band of brown scales, intervals 1 and 2, preapical prominences, and sides in apical half, densely covered with broad white scales, middle of each elytron with sparser vestiture of white, linear to narrow-lanceolate scales, broader in striae. Legs mottled with spots of narrow and broad white scales, sternum 1 and base of sternum 2 with brown spot on sides. Pygidium with scales not extending beyond punctures, broadly oval to round on basal half and elongate, slightly raised near apex; brown scales predominant on basal half, white scales along margins, median line, and on apical half.

Body length 2.9–3.0, width 2.9 mm.

Female: Rostrum 1.25× as long as prothorax, moderately widened and angularly curved at antennal insertion, with dorsal outline angular in lateral view; apically straight, cylindrical, slender, about ⅔ width of fore tibia. Median carina shorter than in male; lateral carinae well developed. Antenna inserted 0.3 from base of rostrum.

Tibiae without mucro. Protarsomere one about 2.2× as long as broad, protarsomere two 1.2× as long as broad, protarsomere three 1.17× as long as protarsomere two.

Female genitalia: Arms of sternum 8 moderately short (Fig. 54). Coxite and stylus robust (Fig. 55). Stylus tapering apically. Spermathecal pump and ductal lobe forming moderately narrow loop. Apex of spermathecal pump bent in direction opposite of ductal lobe (Fig. 56).

Remarks.—*Parorobitis minutus* shares majority of the character states exhibited by *P. gibbus.* It can be distinguished by the darker scale pattern of the head, smaller size, shorter arms of sternum 8 (Fig. 54), robust coxite and stylus (Fig. 55), stylus tapering apically, spermathecal pump and ductal lobe forming rather narrow loop, apex of spermathecal pump bent in direction opposite of ductal lobe (Fig. 56), median lobe narrowing apically without abrupt widening horizontally, apical third without lateral patches of setae, and apodeme at base nearly as narrow as at apex (Fig. 60–62).

Etymology.—This specific epithet is based on the Latin adjective *minutus* = "small" and refers to the relatively small size of the body.

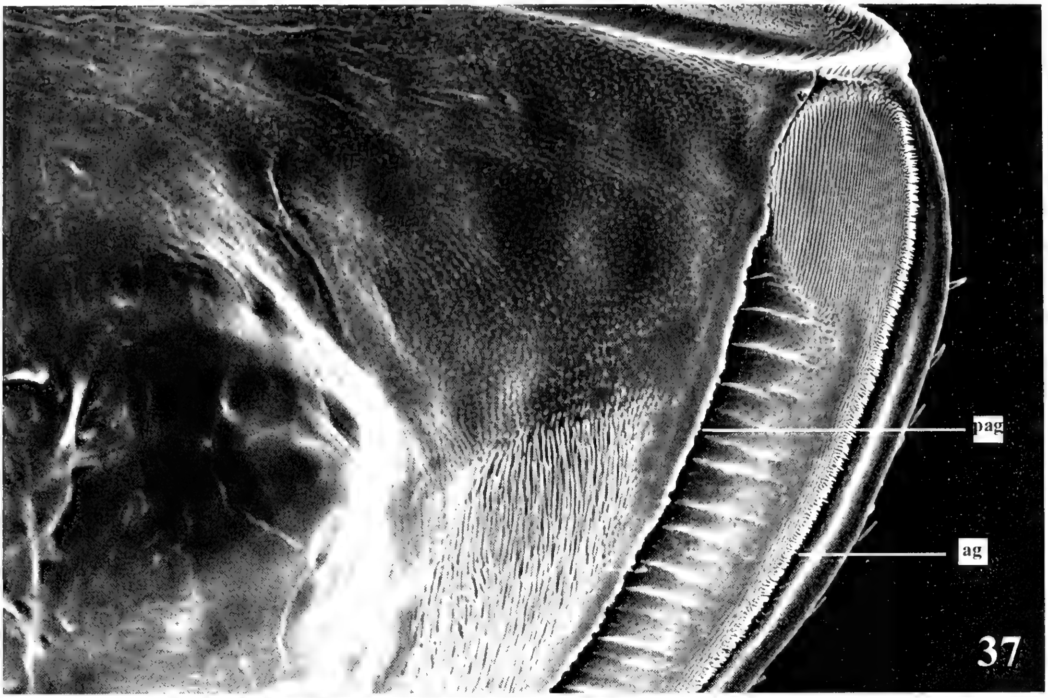

Fig. 37–38. Elytral apex with stridulatory file. 37, *Pachybaris porosa*. 38, *Lobotrachelus subfasciatus*. Abbreviations: ag = apical groove; pag = preapical groove.

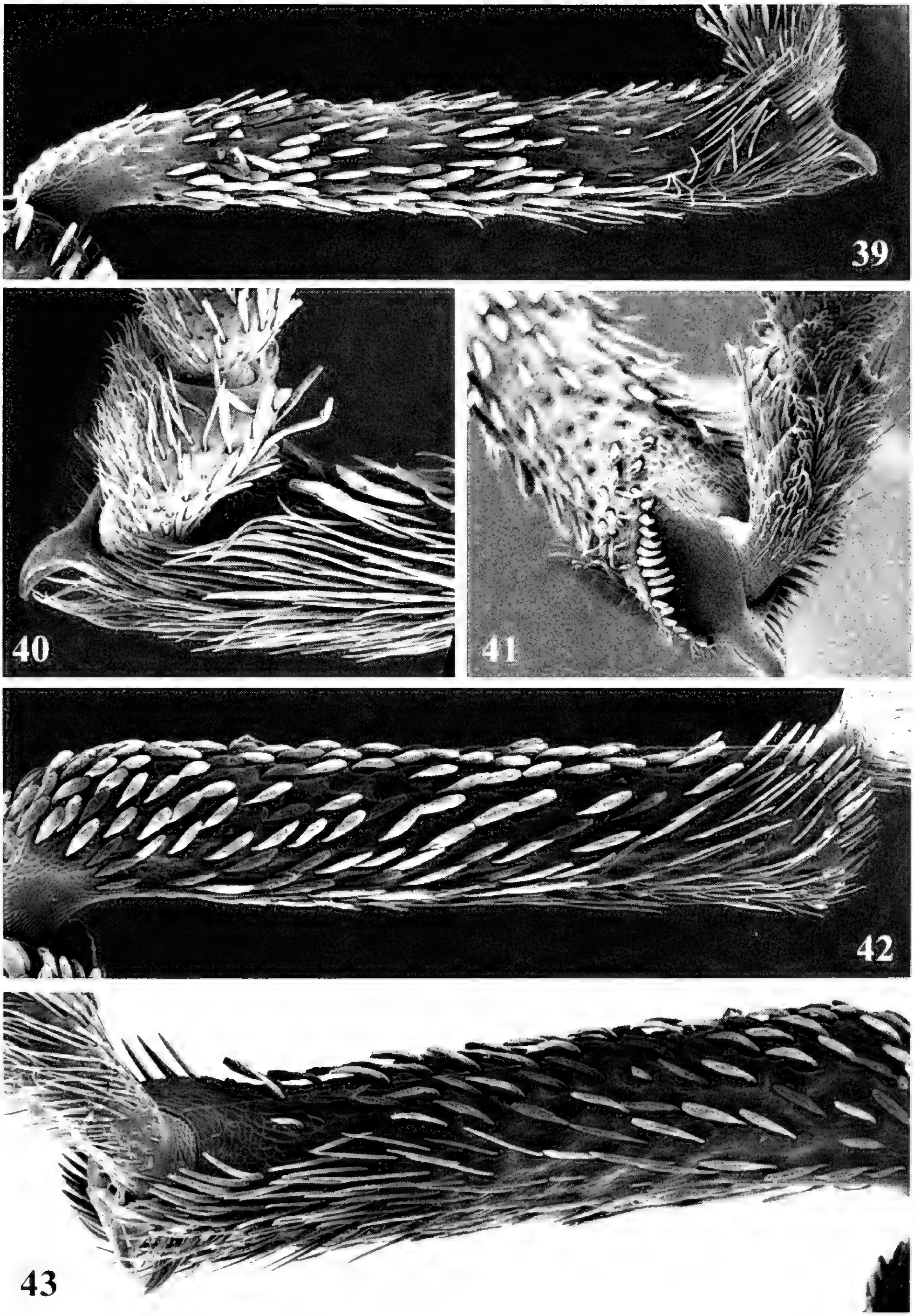

Fig. 39–43. Legs. 39–41, *Parorobitis gibbus*. 42, 43, *Orobitis cyaneus*. 39, Right metatibia, dorsal view. 40, 41, Tibial apex. 42, Right metatibia, dorsal view. 43, Right metatibia, ventral view.

DISCUSSION

In spite of the sharp differences in appearance, *Orobitis* Germar and *Parorobitis* share many important characters including the following: unusual, extremely convex shape of body; rostrum weakly curved basally, apically straight; ventral surface of head without posterior tentorial pits and occipital sutures; antennal scrobe oblique, with ventral margin reaching venter of rostrum less than half way between antennal insertion and eye; mandibles with two denticles ventrally; labial palpi 2-segmented; prothorax subtrapezoidal, with base extremely wide and broadly rounded; mesepimera not visible from above, flat, deeply inserted between base of prothorax and elytra; prosternal sulcus formed by rather high lamelliform keels behind fore coxae; mesoscutellum with tall stalk; mesosternum and metasternum fused; elytra with strongly convex humeral prominences and sutural locking mechanism; apex of elytron with longitudinal stridulatory file (Figs. 35, 36); wings with well-developed R and radial fissure; legs long; claws with well developed median process (Figs. 46–48); abdominal sternum 1 nearly completely divided by hind coxae; pleurum 1 long, separated from tergum 1 by groove, attached to metepisternum by wide membrane with granulated microsculpture (Figs. 24). One of the most convincing pieces of evidence for the close relationships between *Orobitis* and *Parorobitis* is the structure of the stridulatory device. According to Lyal and King (1996), *Orobitis* has a unique file isolated from surrounding sculpture and placed on a different part of the elytron (Figs. 28, 36). Based on these observations, Lyal and King (1996) suspected that the file of *Orobitis* is non-homologous with files of other weevils (Figs. 37, 38). *Parorobitis* shares all the distinctive characters of the stridulatory file of *Orobitis* (Figs. 27, 35).

The differentiation between the two genera is most evident in the gestalt. The strongly developed relief of the exoskeleton in *Parorobitis* readily distinguishes it from species of *Orobitis.* Perhaps this indicates greater development of thoracic muscles, possibly due to a much more active flight behavior in the species of the new genus.

The systematic relationships of the Orobitidinae are uncertain. Colonnelli (1984: 207) placed *Orobitis* in the Ithyporinae [previously considered a tribe of the Cryptorhynchinae (Hustache 1936)], and cited Hustache (1936) as justification for the placement. This is actually incorrect as Hustache does not deal with *Orobitis* in the Coleopterorum Catalogus, but only cites the original placement of *Cleogonus nuculus* (Germar) in the genus *Orobitis,* which has nothing to do with the systematic position of *Orobitis.* Zherikhin and Egorov (1990: 113) treat Orobitini as a tribe of the Baridinae (which according to them also includes Ceutorhynchini, Zygopini, and Trigonocolini).

Zherikhin and Gratshev (1995) elevated Baridinae to family, but there are some problems with this taxonomic decision. Among the synapomorphies of Barididae *sensu* Zherikhin et Gratshev, the presence of the median keel on the inner surface of metasternum seems the primary character. However, this is shared by other apparently very different groups and its distribution in combination with other characters should be studied. The first character in the wing structure listed by Zherikhin and Gratshev (1995: 773), among the most important synapomorphies of the Barididae, is the strongly curved basal wing margin. However this character state is more developed in the Zygopinae and Ceutorhynchinae (Zherikhin and Gratshev 1995, Figs. 108–121), than in Baridinae (see Figs. 122–132 in the same work). Trigonocolinae do not possess a critical diagnostic character which distinguishes Ceutorhynchinae, Zygopinae, and Baridinae from the rest of Curculionidae, i.e., the dorsally visible mesepimera, and it is not clear that this character state should be considered to be a secondary loss in Trigonocolinae as presumed by Zheri-

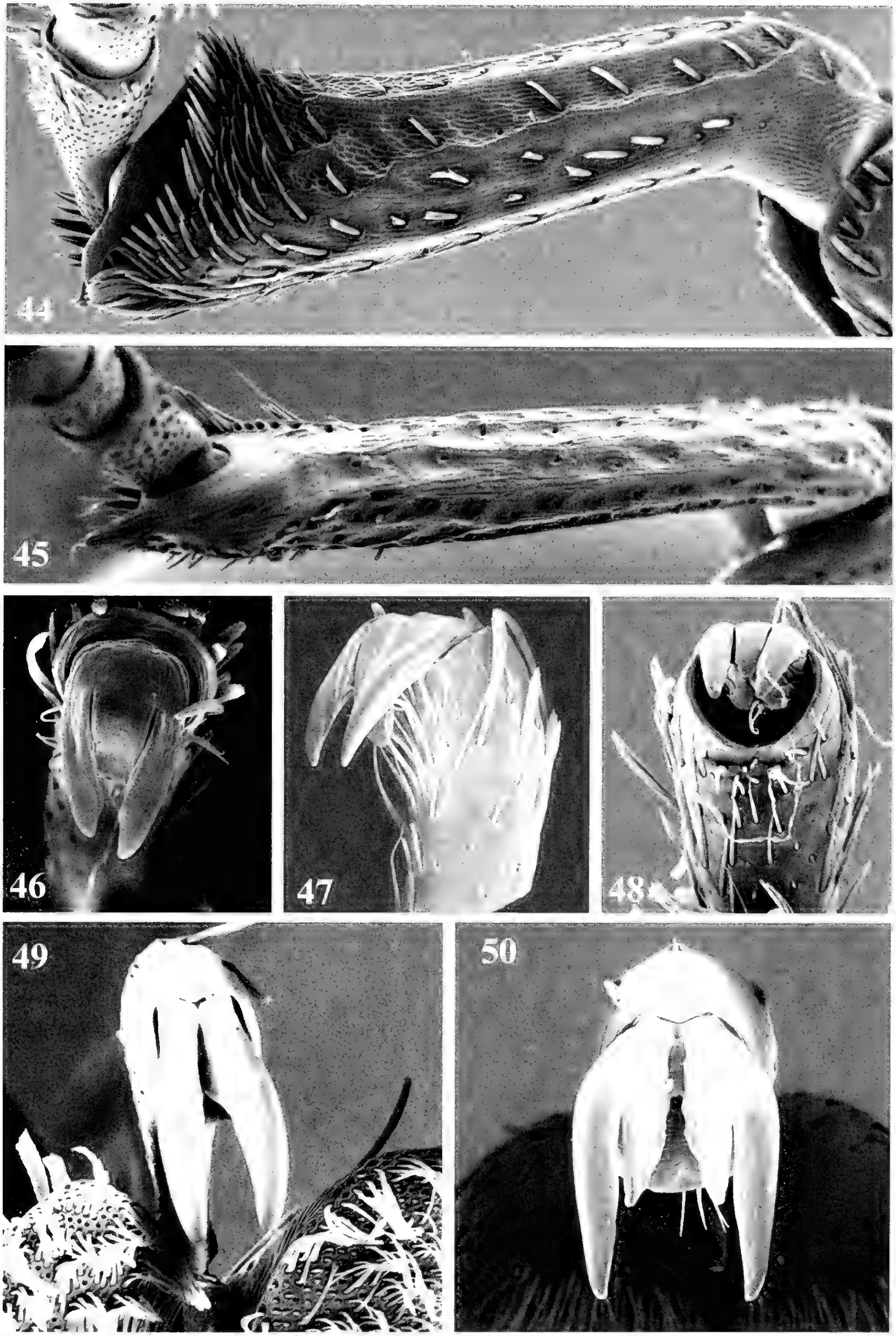

Fig. 44–50. Legs. 44, *Pachybaris porosa*, right metatibia, ventral view. 45, *Lobotrachelus subfasciatus*, right metatibia, ventral view. 46–50. Claw. 46, 47, *Parorobitis gibbus*. 48, *Orobitis cyaneus*. 49, *Pachybaris porosa*. 50, *Lobotrachelus subfasciatus*.

khin and Egorov. The large to very large scutellum, the presence of the wax powder secretion, and the often carinate elytral intervals of *Trigonocolus* do not fit the diagnosis of the Barididae. Also Zherikhin and Gratshev (1995) give no evidence from the wing structure of close affinity of Trigonocolinae with the other 4 subfamilies. We prefer to consider Trigonocolinae as short-bodied representatives of the phyletic branch also including Mecyslobini, Magdalini, and Carciliini (i.e., Molytinae in recent classifications) rather than to place them close to Orobitidinae, Ceutorhynchinae, Baridinae, or Zygopinae. Each of the last four groups can be clearly identified and is very different from each other. Except for the Orobitidinae, the other taxa have very large numbers of genera and species and are distributed worldwide. Thus it seems that additional data is needed for treating Baridinae, Ceutorhynchinae, Zygopinae and Orobitidinae as members of a single natural group. Until the presence of a longitudinal keel on the metasternum is shown to be a true synapomorphy, through rigorous character analysis, there is no reason to consider Barididae *sensu* Zherikhin and Egorov (1990) and Zherikhin and Gratshev (1995) to be a natural group.

Detailed comparative analysis of the taxa considered is far beyond the aim of this paper and needs examination of much greater number of taxa and structures. However, we would like to summarize here some characters of the Orobitidinae and their supposed relatives. We believe that revealing clear distinctions will allow better understanding of the groups, rather than lumping them together based on characters whose synapomorphic value has not been proven.

KEY FOR DIFFERENTIATION OF THE OROBITIDINAE AND WEEVIL SUBFAMILIES WITH DORSALLY VISIBLE MESEPIMERA:

1 (2). Mesepimera not clearly visible from above. Meso- and metasterna fused. Abdominal sternum 1 not longer than 2, nearly completely divided by hind coxae. Rostrum more or less bent at antennal insertion, straight or nearly straight in apical part, always narrower than basal part; not separated from frons by sulcus. Claws with appendages fused into entire flat process half as long or nearly as long as claws themselves. Body globose or subrhomboidal, very strongly convex dorsally. 1.8–3.5 mm. Palearctic and Neotropics . . . . . Orobitidinae

2 (1). Mesepimera usually clearly visible from above (not visible in Palearctic species of *Baris* Germar developing on crucifers and in some southern Asian and South African Ceutorhynchinae with subconical, strongly apically narrowing prothorax). Meso- and metasterna not fused, separated by distinct suture. Abdominal sternum 1 longer than 2, never nearly completely divided by hind coxae. Rostrum not conspicuously bent at antennal insertion. Claws simple, toothed, or appendiculate, in latter case appendages not fused in an entire flat median process. Body shape variable 3

3 (4). Prosternum with median sulcus for reception of rostrum, often prolonged on meso- or metasternum, and with more or less developed keels in front of fore coxae. Males always without horn-like projections on prosternum before coxae and without fovea between them. Head capsule not spherical, but transverse or slightly flattened dorsoventrally. Rostrum not separated from head capsule by sulcus, neither conspicuously tapering apically nor dilated to base. Antennal funicle often with fewer than 7 flagellomeres. Eyes usually more or less convex, always separated on frons (usually by not less than twice width of antennal scape). Pronotum often with raised anterior margin and with lateral (and often also discal) tubercles. Basal margin of pronotum often raised conjointly with basal margins of elytra and crenulate. Scutellum small to minute, never transverse or subcordate. Elytra usually broad, slightly longer than broad, in tropical species often broader than long. Lateral margin of elytron more or less angularly emarginate above anterior part of metepisterna, latter projecting dorsally. Many species apterous in temperate zones. Hind femora broadest, often saltatorial. Tibiae mutic (except in some *Zacladus* Reitter and *Scleropterus* Schoenherr), mucro usually developed on middle and hind tibiae in males, but often also on fore tibiae; in xerophilous species with narrow tarsi, females may have longer mucro. Claws usually toothed or appendiculate, often

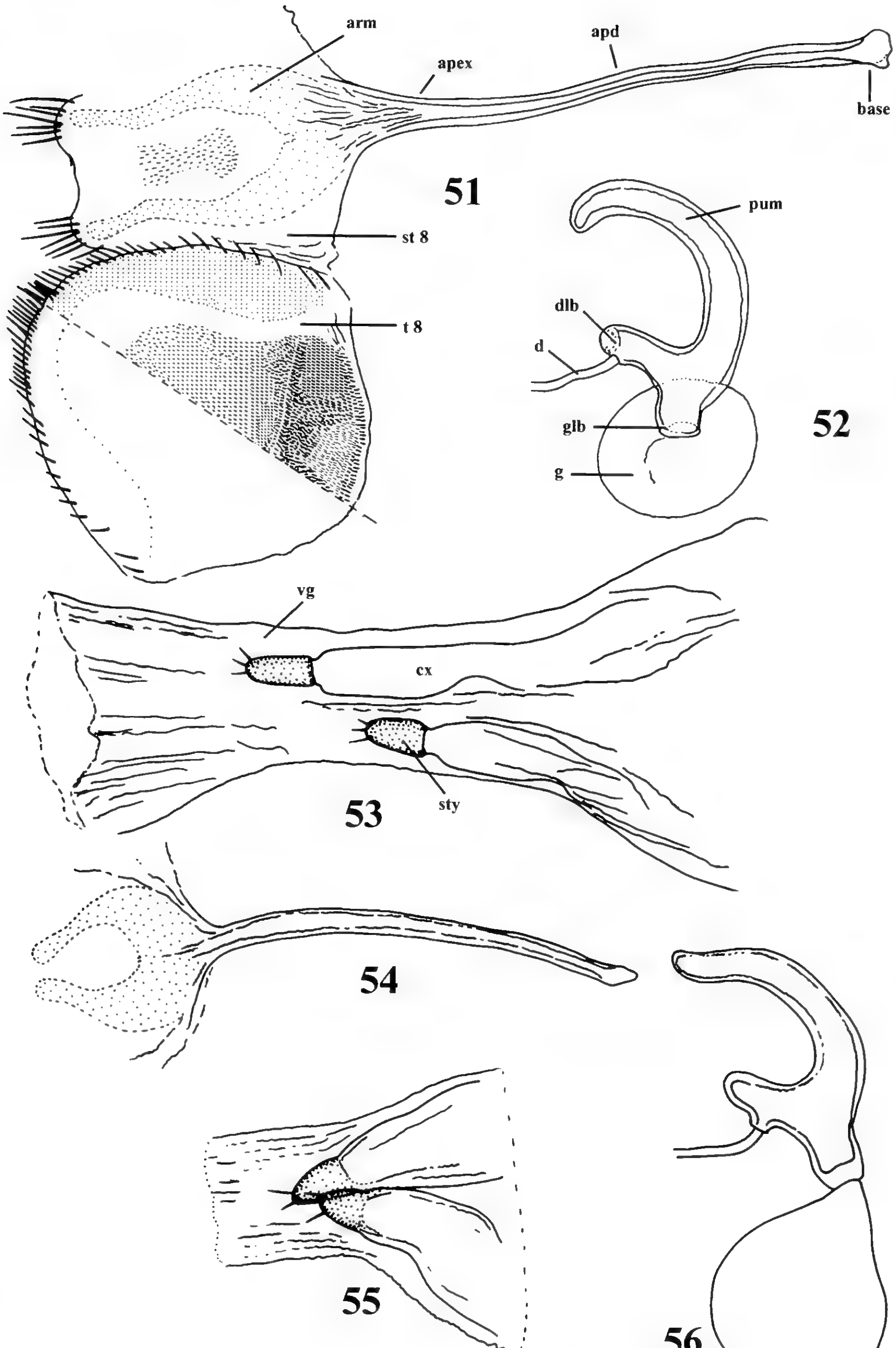

Fig. 51–56. Female genitalia. 51–53, *Parorobitis gibbus*. 54–56, *Parorobitis minutus*. 51, Sternite and tergite 8. 52, 56, Spermatheca. 53, 55, Vagina with coxites and styli. 54, Sternite 8. Abbreviations: 8 st = sternite 8; 8 t = tergite 8; arm = arm of sternite 8; apd = apodeme of sternite 8; cx = coxite; d = duct; dlb = ductal lobe; g = gland; glb = gland lobe; sty = stylus; vg = vagina.

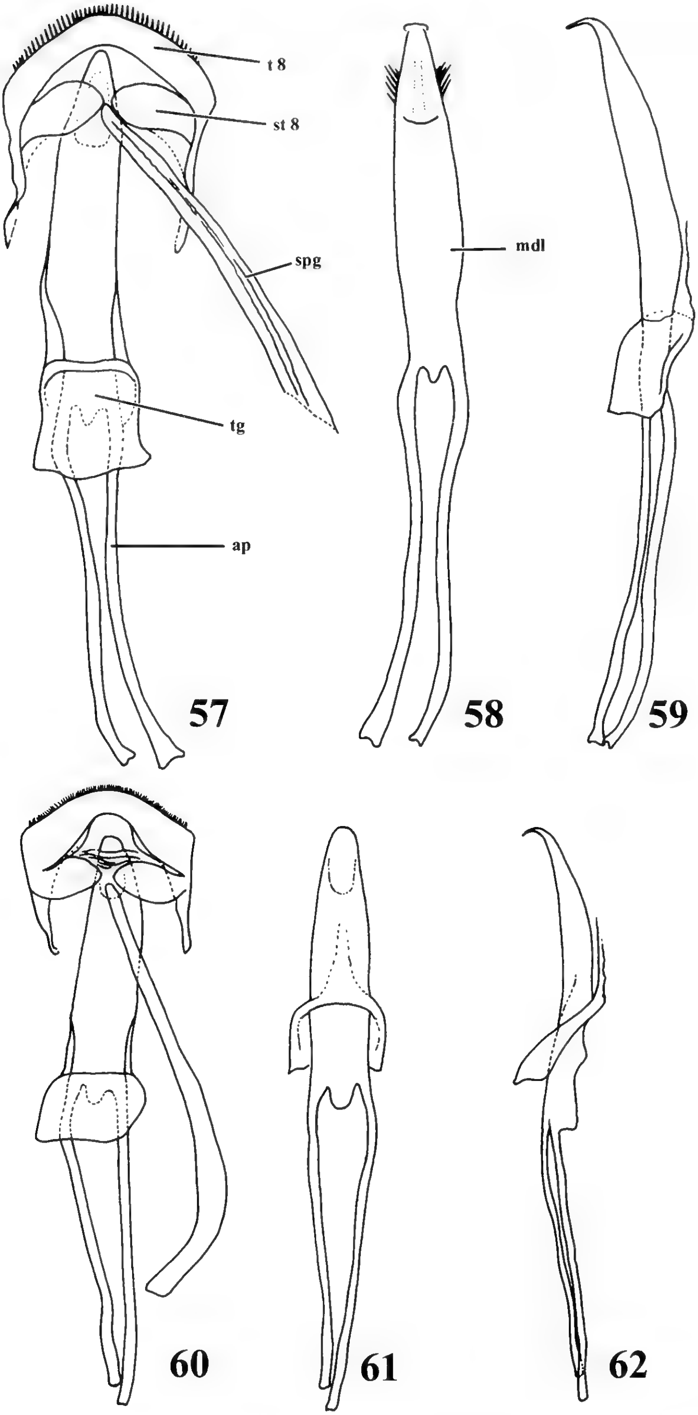

Fig. 57–62. Male genitalia and tergite 8. 57–59, *Parorobitis gibbus*. 60–62, *Parorobitis minutus*. 57, 60, Tergite 8 and aedeagus, ventral view. 58, 61, Dorsal view. 59, 62, Lateral view. Abbreviations: 8 st = sternite 8; 8 t = tergite 8; ap = apodeme; mdl = median lobe; spg = spiculum gastrale; tg = tegmen.

connate; rarely single. Pygidium exposed except in Palearctic *Trichosirocalus* Colonnelli. Host plants mostly herbaceous or lianas, larvae develop in non lignified tissue. 1.5–7.0 mm. World-wide including Arctic (but not Subantarctic) tundra . . . . Ceutorhynchinae

4 (3). Prosternum usually without median sulcus for reception of rostrum, without keels in front of fore coxae (except in Lobotrachelini, Zygopinae). Prosternum in males sometimes with horn-like projections before coxae and deeply foveate between them. Head capsule spherical or transverse. Rostrum usually separated from head capsule by sulcus and/or more or less strongly widening to base, often also tapering and flattened apically. Antennal funicle usually with 7 flagellomeres. Eyes often flat, broadly separated or contiguous. Anterior margin of pronotum never raised, sides without tubercles, disc more or less evenly convex, sometimes with median tubercle, but not sulcate. Basal margins of pronotum and elytra neither raised conjointly nor crenulate. Scutellum small to large, often convex, transverse or subcordate. Elytra often much longer than broad. Lateral margin of elytron shallowly sinuate, not conspicuously emarginate above anterior part of metepisterna. Wings usually functional except in herpetobiont species. Fore femur usually broadest, often strongly enlarged and dentate- then fore tibia strongly bent; legs not saltatorial. Tibiae uncinate; in males, often also mucronate. Claws usually simple, free or connate; rarely single. Pygidium exposed or concealed. Host plants herbs, very often lianas and trees, larvae often in lignified tissue. 0.9–35 mm. Worldwide except northern taiga and tundra 5

5 (6). Eyes contiguous or subcontiguous, very large, flat, limited to dorsal half on head capsule, not visible ventrally. Head capsule at least slightly transverse. Rostrum not separated from head capsule by sulcus, more or less widening to base, often tapering and flattened apically. (In Lobotrachelini, Zygopinae, prosternum deeply sulcate, body polished, globose, legs subulate.) Elytra elongate to transverse, usually flattened dorsally, never glabrous or metallic, usually with scales. Wings usually functional. Venter more or less strongly oblique to apex in lateral view. Femora often dentate, fore femur often strongly enlarged, then tarsus elongated, especially in males. Claws usually free, simple or toothed. Predominantly tropical and subtropical . . . . Zygopinae

6 (5). Eyes widely separated on frons, always approximate ventrally. Head capsule spherical. Rostrum usually separated from frons by sulcus. Prosternum rarely deeply sulcate for reception of rostrum. Elytra usually elongate, in many tropical forms short or subglobose, body then often glabrous or metallic. Vestiture often reduced or absent. Wings reduced in herpetobiont forms. Venter not conspicuously oblique apically in lateral view. Femora usually unarmed, fore femur rarely strongly enlarged. Claws often connate, rarely toothed or single. Worldwide except northern taiga and tundra . . . . Baridinae

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FIRST DOCUMENTED RECORD OF MONOMACHIDAE (HYMENOPTERA: PROCTOTRUPOIDEA) IN NEW GUINEA, AND DESCRIPTION OF TWO NEW SPECIES

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Abstract.—The occurrence of the genus *Monomachus* Klug (Hymenoptera: Proctotrupoidea, Monomachidae) in New Guinea is documented for the first time. Two new species, ***M. cracens*** and ***M. comptus,*** are described. These are distinguished from the three known Australian *Monomachus* as well as the numerous New World species.

Key Words: *Monomachus,* New Guinea, Australia, Proctotrupoidea, Hymenoptera, parasitoid

The family Monomachidae is a small group of parasitic Hymenoptera (Proctotrupoidea) with austral disjunct distribution. Only two genera have been recognized, *Monomachus* Klug and *Tetraconus* Szépligeti. The latter is known only from a single female specimen from Brazil. We are studying the family with the goal of elucidating the phylogenetic relationships among species and understanding their biogeography. Nineteen species-group taxa have been described from the New World from Mexico to Chile and Argentina, and these were last revised by Schulz (1911). Three additional species of *Monomachus* were recognized in the recent revision of the Australian fauna (Naumann 1985). Masner (1993) noted that the family is also to be found in New Guinea, but no species have been described. The Papuan material in fact represents two species distinct from those known in Australia. We describe them here because they do not appear to be closely related to the numerous Neotropical species; these will be the focus of a separate paper.

MATERIALS AND METHODS

Specimens for this study from New Guinea are found in the collections of the American Entomological Institute, Gainesville, FL (AEIC) and the Bishop Museum, Honolulu, HI (BPBM). Australian material is found in the Australian National Insect Collection, Canberra; Canadian National Collection of Insects, Ottawa; the Museum of Comparative Zoology, Cambridge, MA; The Natural History Museum, London; and The Ohio State University, Columbus.

The mandibles in Monomachidae are remarkably diverse in shape. We use the following terms to describe their structure. The mandible is generally divided into two areas, a basignath and distignath, separated by a subbasal groove. The groove allows for greater range of abduction of the mandibles. The distal margin of the groove is sometimes sharply marked; this corresponds to the mandibular fold of Naumann (1985) and the Basalfalte of Schulz (1911). The lowermost part of the subbasal groove is sometimes clearly visible as a sharply de-

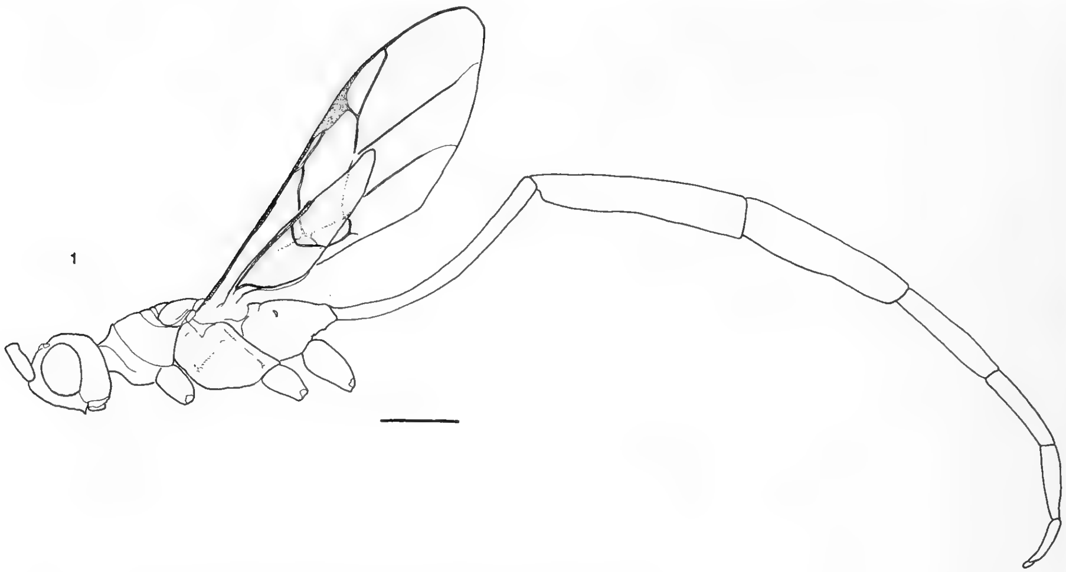


Fig. 1. *Monomachus cracens,* lateral habitus. Scale line = 1 mm.

fined diagonal sulcus. The basignath is convex and invaginated into the oral cavity when the mandibles are widely opened. The nomenclature for thoracic sulci follows Huber and Sharkey (1993).

The label data for all specimens is available in electronic format in Hymenoptera On-Line at the URL http://iris.biosci.ohio-state.edu/hymenoptera (Johnson and Musetti, in press). The OSUC numbers quoted are the individual unique identifiers for the specimens in this study.

Monomachus cracens Musetti and Johnson, new species

(Fig. 1)

Female.—Measurements for the two females are reported in pairs separated by a slash; first value refers to female bearing ID number OSUC 117646 (holotype ♀), second value refers to OSUC 117653 (paratype ♀). Fore wing length 5.0/5.8 mm. *Color:* Head, lateral margins of pronotum, central disc of mesoscutum on either side of notauli, metanotum, upper portion of mesopleuron, all of metapleuron, lateral and posterior portions of propodeum, entire metasoma brown to dark brown; mesosoma otherwise light brownish yellow; coxae and trochanters brownish yellow, legs otherwise distinctly darker brown; wing membrane clear.

Head: Clearly transverse in frontal view, width across eyes 2.10/1.96× greater than length, head width across the compound eyes (2.48 mm/2.69 mm) not differing significantly from head width across gena (2.40 mm/2.70 mm respectively). Eye height 3.54/4.71 × malar length. Vertex posteriorly with moderately dense deep setigerous punctures, each separated by approximately diameter of one puncture; punctures sparser, more irregularly sized and spaced near ocelli; punctures densely packed, but irregularly shaped near antennal insertions; vertex otherwise smooth, without microsculpture; outer margins of ocelli bordered by distinct furrows; vertex immediately behind ocelli largely glabrous. Occipital carina widely separated from oral margin ventrally, occiput with dense setigerous punctures continuing from vertex, continuing on to gena. Gena in frontal view not swollen. Frons (above clypeus, below antennal sockets) slightly convex, with dense setigerous punctures nearly throughout, i.e., extending to clypeus and beyond level of lower margin of compound eyes; with a central area immediately above clypeus smooth and glabrous, extending dorsally ⅓ height of frons. Clypeus convex, predominantly smooth and glabrous, dorsal margin marked by line of large setigerous punctures, hairs long and erect, margin broadly angled and raised medially, epistomal sulcus narrow and distinct medially, broad and poorly defined laterally. Malar space mostly punctate and pilose; malar sulcus present. Mandible with sparse setigerous punctures on distignath, hairs elongate; gradually narrowed apically; bidentate, teeth broadly rounded, ventral tooth larger, longer than dorsal; distignath broadly convex; subbasal groove fairly broad, margins rounded and somewhat indistinct, bottom of groove angled, appearing as a diagonal sulcus extending from posterior mandibular articulation to lateral clypeal lobes; basignath distinctly widest near anterior articulation, distignath reaching posterior articulation.

Mesosoma: Pronotum predominantly smooth and glabrous dorsally; transition between pronotal neck and collar broadly rounded in profile, marked by a weak transverse fold, laterally with sparse hairs and fine punctures. Mesoscutum predominantly smooth, very sparsely setose. Notauli arcuate, separated from transscutal articulation by short distance subequal to their width, without crenulae. Parapsidal furrows very indistinct. Scutellar pit wide, extending laterally beyond notaulus, deep, without crenulae, crescentic, lateral margins of pit angled posteriorly; central convex portion of scutellum quadrate, separated from axilla by simple sulcus; posterior margin of scutellum with single transverse row of small foveae. Scutellum, axillae smooth, nearly glabrous. Dorsellum transverse, slightly bulging, anteriorly with a narrow crenulate sulcus, posteriorly mostly smooth. Metapostnotum (anterior to transverse groove at base of propodeum) with pair of indistinct or broadly rounded posterior projections. Mesopleuron punctate and pilose nearly throughout, save for smooth, glabrous, concave area adjacent to mesopleural suture. Mesepisternal groove indicated by a row of foveae extending ventrally from near base of fore wing to scrobal groove, then turning anteriorly and extending below fore coxa, widely separated from the discrimen ventrally; scrobal groove indicated by transverse line of deep foveae; mesepisternum finely punctate and pilose, relatively flat ventrally, broadly rounded toward medial articulations, discrimen shallow, inconspicuous, widened posteriorly to form small depression near coxae, with densely pilose, distinctly fingerlike lobe projecting above depression on each side. Metapleuron distinctly separated from propodeum by row of deep, broad foveae; densely setose. Propodeum moderately globose in dorsal view, punctate along midline and around posterior end, dorsal surface otherwise smooth; dorsolaterally rugose, densely setose; anterior margin without teeth opposite metapostnotal projections. Fore wing with radial cell closed, length 4.5/4.0 × width, base of m-cu only slightly displaced basad of bifurcation of Cu_1; in hind wing M between Cu_1 and 1rm/Rs absent.

Metasoma: First segment (petiole) distinctly elongate, slender, strongly curved; remaining segments elongate, cylindrical, not laterally compressed; second segment longer than third, length of second 1.3/1.2× length of third; second and third segments with tergite loosely wrapped around the sternite, not closely appressed and leaving very visible separation between tergum and sternum; length of metasomatic segments as a percentage of total length: 1: 23.6/23.5; 2: 23.9/22.4; 3: 18.3/18.6; 4: 11.2/12.3; 5: 8.9/9.3; 6: 8.0/8.1; 7 to apex: 6.2/5.8.

Male.—Other than characters of sexual dimorphism in metasoma and antenna typical for family, differing from ♀ as follows: Body color generally brown above, yellowish brown below; base of legs including femora brownish yellow, brown apically. Fore wing length 4.2–4.9 mm ($\bar{x}$ = 4.54, SD = 0.268, n = 6). Sculpture on body other than frons generally with punctures much less dense and largely smooth. Propodeum with sculpture along midline more extensive, extending from anterior to posterior margins. Antenna with dense short hairs, tyloid on A4–A8 small, with fine seta. Fore wing with closed radial cell, length 3.7–4.8 × width ($\bar{x}$ = 4.20, SD = 0.379). Hind wing sometimes with a short stem of M arising from 1rm/Rs.

Material examined.—Holotype ♀: PAPUA NEW GUINEA: Wau, 1,250 m, 3.ix.1965, malaise trap, J.& M. Sedlacek (OSUC 117646, BPBM). Specimen in good condition; lacking A3–A15 from right antenna, A4–A15 from left. Paratypes: PAPUA NEW GUINEA: (NE) Wau, Morobe Distr., 1,200 m, 5.x.1962, malaise trap, J. Sedlacek, ♀ (OSUC 117653), 26.x.1961, ♂ (OSUC 117654), 23.x.1965, J. & M. Sedlacek, ♂ (OSUC 117647); (NE), Wau, Morobe Distr., 1,050 m, 11.ix.1961, malaise trap, J. Sedlacek, ♂ (OSUC 117651), 30.ix.1961, ♂ (OSUC 117652); ; NE Wau, Little Wau Ck., 1,200–1,300 m, 3.xii.1965, malaise trap, J. Sedlacek, ♂ (OSUC 117650); NE Karimui, 1,080 m, 14.vii.1963, M. Sedlacek (OSUC 117655). All specimens in BPBM.

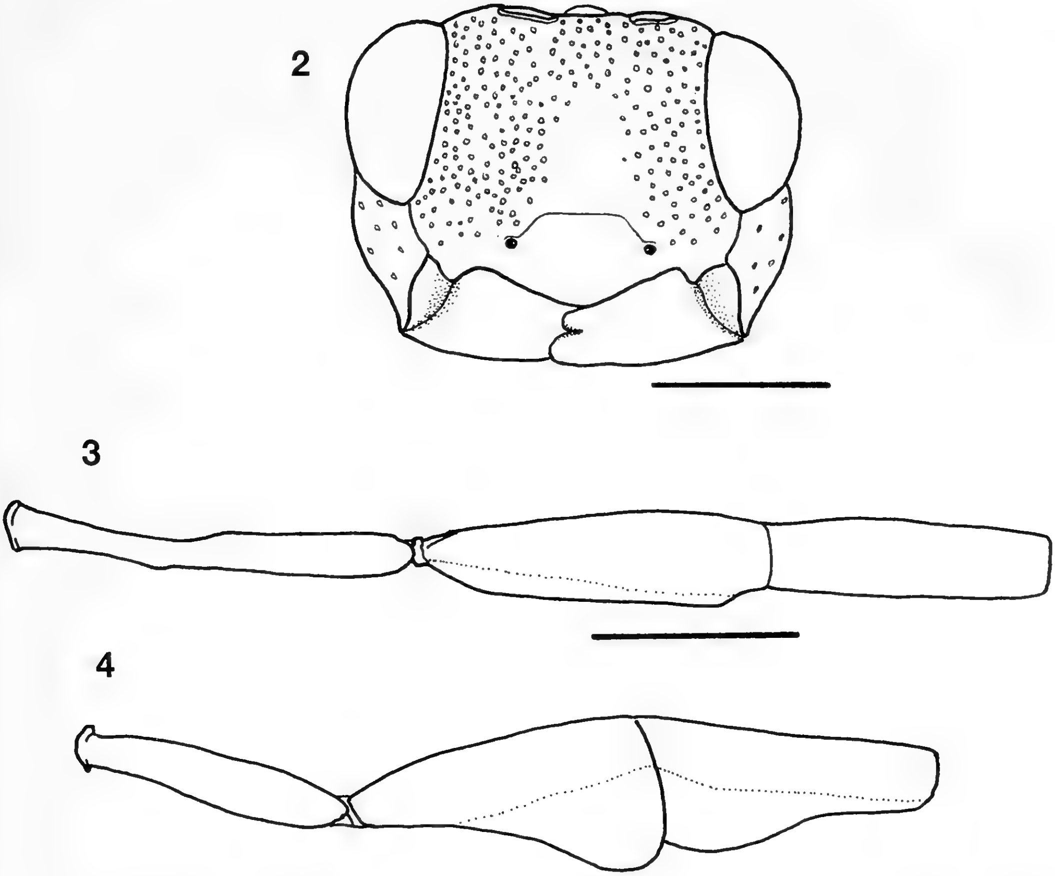
Etymology.—The specific epithet *cracens,* Latin for neat, slender, graceful, refers to the elongate petiole in the female of this species and its overall graceful habitus.

Comments.—*Monomachus cracens* may be most easily distinguished from *M. comptus* by the remarkably long and curved petiole in the female and, in both sexes, the single row of foveae at the apex of the scutellum. The ventral lobes found at the posterior end of the mesepisternum are very distinct in male and female specimens; these lobes are visible only as weak raised margins of the depression in front of the mid coxae in *M. comptus.* Additionally, the lateral profile of the pronotum is mostly smooth and rounded, with only a weak line marking the separation of the neck and the collar dorsally.

Monomachus comptus Musetti and Johnson, new species
(Figs. 2–3)

Female.—Fore wing length 5.9 mm. *Color:* Head generally dark brown, clypeus and mandibles brown; lateral portions of pronotum, disc of mesoscutum on either side of notauli (including prescutum), propodeum, mesopleuron and metapleuron dark brown; scutellum, axillae, dorsal pronotum, metanotum lighter in color, varying from brownish yellow to brown; metasoma brown; antenna brown; legs generally brownish yellow, hind leg beyond trochanter brown; wing membrane clear.

Head: Transverse in frontal view (Fig. 2), width across eyes 1.95 × wider than long, head width across the compound eyes (2.57 mm) slightly more than width across gena (2.46 mm). Eye height 3.13 × malar length. Vertex and gena with same pattern of sculpture as found in *M. cracens,* but generally more smooth and shallow; outer margins of ocelli bordered by distinct furrows. Occipital carina short, widely separated from oral margin, occiput with dense setigerous punctures. Gena in frontal view not swollen. Frons flatter than *M. cracens,* with fine setigerous punctures extending below level of the compound eyes; central smooth, glabrous area above clypeus larger, mostly flat, extending through ⅔ distance to antennal insertions; short raised carina present between antennae. Clypeus convex, smooth and nearly glabrous medially, shallowly punctate laterally, medially differentiated from frons by clear epistomal sulcus, without distinct line of large setigerous punctures, apical margin broadly angled and raised medially, epistomal sulcus poorly defined laterally. Malar area mostly smooth, with few sparse setigerous punctures near compound eyes, malar sulcus distinct. Mandible with sparse setigerous punctures on distignath, hairs elongate; gradually narrowed apically; bidentate, teeth broadly rounded, ventral tooth wider, longer than dorsal; distignath broadly con-



Figs. 2–4. Characters of *Monomachus* species. 2, *M. comptus*, head, frontal view. 3, *M. comptus*, metasomatic segments 1–3, lateral view. 4, *M. australicus*, metasomatic segments 1–3, lateral view. Stippled lines on metasoma indicate lower margin of sterna visible through cuticle of terga. Scale line = 1 mm.

vex; subbasal groove fairly broad, margins rounded and somewhat indistinct, bottom of groove angled, appearing as a diagonal sulcus extending from posterior mandibular articulation to lateral clypeal lobes; basignath distinctly widest near anterior articulation, distignath reaching posterior articulation.

Mesosoma: Pronotum predominantly smooth and glabrous dorsally; transition between pronotal neck and collar abrupt, marked by ruga; ventrally with sparse hairs and fine punctures. Mesoscutum predominantly smooth, very sparsely setose. Notauli arcuate, separated from transscutal articulation by short distance subequal to their width, finely crenulate. Parapsidal furrow present, extending over half length of mesoscutum from transscutal articulation. Scutellar pit slightly narrower, reaching laterally as far as notaulus, with fine longitudinal crenulae, only slightly crescentic, lateral margins of pit broadly rounded; central convex portion of scutellum slightly widest anteriorly, separated from axilla by finely crenulate sulcus, posterior margin of scutellum with a subapical row of large punctures, apically with 2–3 rows of smaller foveae. Scutellum, axillae nearly smooth, glabrous. Dorsellum less bulging than *M. cracens,* transverse, bordered anteriorly with sculptured sulcus half its length, posterior margin with narrow finely punctate band. Metapostnotum with pair of indistinct or broadly rounded posterior projections. Mesopleuron anteriorly punctate, setose anteriorly and ventrally, with a wide smooth and glabrous area adjacent to mesopleural sulcus extending to intersection of scrobal and mesepisternal groove. Mesepisternal groove indicated by finely crenulate fold near wing base and by line of foveae extending anteriorly from scrobal groove, these two sections widely separated, mesepisternal groove broadly separated from discrimen ventrally; scrobal groove indicated by transverse line of deep foveae; mesepisternum finely punctate, sparsely setose, protuberant ventrally, closely abutting coxae so as to hide medial articulations, discrimen indicated by shallow longitudinal invagination, widened posteriorly to form small fusiform pit near mid coxae; margin of pit slightly produced and raised laterally. Metapleuron distinctly separated from propodeum by row of small foveae; densely setose. Propodeum moderately globose in dorsal view, coriaceous throughout, with scattered setigerous punctures, with vague indication of median longitudinal carina, posteriorly with longitudinal rugulae; dorsolaterally densely setose, longitudinally rugose; anterior margin without teeth opposite metapostnotal projections. Fore wing with radial cell closed, length 4.24 × width, base of m-cu only slightly displaced basad of bifurcation of Cu_1; in hind wing base of M present arising from 1rm/Rs.

Metasoma (Fig. 3): First segment slender, fairly straight; remaining segments elongate, cylindrical, not laterally compressed; length of second segment 1.3 × length of third; length of segments as a percentage of total metasoma length: 1: 22.3; 2: 19.7; 3: 15.8; 4: 14.4; 5: 11.8; 6: 9.4; 7 to apex: 6.7.

Male.—Other than characters of sexual dimorphism in metasoma and antenna typical for family, differing from female as follows. Body color displaying same pattern as female except sometimes with less contrast between dark brown and brownish yellow areas. Fore wing length 4.8–6.2 mm ($\bar{x}$ = 5.46, SD = 0.622, n = 4). Vertex with more extensive smooth areas. Propodeum with spiracle bulging, dorsolaterally sometimes with well defined longitudinal carina. Antenna with dense short hairs, tyloid on A4–A8 small, with fine erect setae. Fore wing with radial cell closed, length 3.1–4.0 × width ($\bar{x}$ = 3.75, SD = 0.295). Hind wing sometimes with M absent between Cu_1 and 1rm/RS.

Material examined.—Holotype ♀: PAPUA NEW GUINEA: SE Mount Giluwe, 2,500–2,750 m, 30.v.1963, J. Sedlacek (OSUC 117648, BPBM). Specimen in fairly good condition; lacking A5–A15 from right antenna, and A13–A15 from left. Abdomen broken, segments four and beyond in gelatin capsule attached to pin. Paratypes: PAPUA NEW GUINEA: Daulo Pass, 2,450 m, 22.xii.1978-8.i.1979, J. Sedlacek, ♂ (OSUC 117079, AEIC); Mount Otto, 2,000 m, 22.xii.1978-9.i.1979, J. Sedlacek, ♂ (OSUC 117077, AEIC); Tari Gap, nr. Mount Hagen, 2,600 m, 29.i-4.ii.1979, J. Sedlacek, ♂ (OSUC 117080, AEIC); Mount Giluwe, 2,800 m, 3.i-8.ii.1979, J. Sedlacek, ♂ (OSUC 117078, AEIC).

Etymology.—The specific epithet *comptus,* Latin for ornamented, refers to the more elaborate sculpture on the scutellum.

Comments.—See diagnosis under description of *Monomachus cracens* for the most useful characters to distinguish the two Papuan species.

DISCUSSION

Schulz (1911) distinguished the New World species of *Monomachus* from those in Australia by means of the curvature of the petiole: strongly bowed in specimens from America, straight in those from Australia. *Monomachus cracens* (Fig. 1) clearly does not conform to this rule. Both species from New Guinea are very similar to *M. australicus* Girault in terms of the structure of the mandibles, the sculpture on the body, the shape of the head, and the shape of the clypeal margin. The color patterns observed differ from that "yellow form" described by Naumann for specimens of *M. australi-*

cus from northern Queensland most noticeably in that the lateral lobes of the mesoscutum are the same color, dark brown, as the medial lobe. The ventral mesepisternal lobes are also shared with all Australian *Monomachus*. The Australian species are immediately distinguishable on the basis of the wing venation: the base of m-cu is strongly displaced basad of the bifurcation of Cu_1 in the fore wing. The vein is inserted nearly in the middle of cell 2Cu (first subdiscal cell). All of these Old World species have the second and third metasomatic segments elongate, with the second longer than the third. Neotropical *Monomachus* typically have the second segment much shorter and apically widened, and the metasoma beyond the petiole is laterally compressed.

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DESCRIPTION OF THE PUPA OF *ARMIGERES* (*LEICESTERIA*) *OMISSUS* (EDWARDS) AND A KEY TO THE LARVAE AND PUPAE OF THE *ARMIGERES* OCCURRING IN NEPAL (DIPTERA: CULICIDAE)

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Abstract.—The pupa of *Armigeres omissus* (Edwards) is described for the first time. Keys to the larvae and pupae of *Armigeres* species occurring in Nepal are added.

Key Words: *Armigeres omissus,* pupa, keys, Nepal

The pupal stage of species of the subgenus *Leicesteria,* genus *Armigeres* occurring in Nepal were described by Darsie (1998). Subsequently, a female of *Armigeres* (*Leicesteria*) *omissus* (Edwards) was discovered in the collection of Nepal mosquitoes at the Florida Medical Entomology Laboratory, Vero Beach, FL, a new country record. Its pupa was briefly described by Delfinado (1966) and Baisas (1974). A more detailed description follows, based on specimens from Thailand since none are available from Nepal.

With this account, the pupae of all species of *Armigeres* from Nepal have now been described (Ramalingam 1987; Toma et al. 1994; Darsie 1998, 2000). Inasmuch as a detailed study of the larvae was a necessary part of the pupal verification, a larval key is also included. This is a revision of a key by Darsie and Pradhan (1990). Since then, four species have been added to the fauna, i.e., *Ar.* (*Arm.*) *theobaldi* Barraud (Pradhan and Darsie 1990), *Ar.* (*Lei.*) *inchoatus* Barraud and *Ar.* (*Lei.*) *digitatus* (Edwards) (Darsie et al. 1992) and *Ar.* (*Lei.*) *omissus,* herein.

The pupa of *Ar. omissus* possesses the generic and subgeneric characters given be Darsie (2000). It is readily distinguished from pupae of the Nepal *Armigeres* species by a combination of: the absence of seta 1-P, the paddle fringe extending to near the base, seta 6-II-V with thin branches and seta 1-II with 17 or fewer branches.

Methods and Materials

For procedures used in this study refer to Darsie (1998). No pupae of *Ar. omissus* were found in my collection from Nepal, but specimens were borrowed from the Walter Reed Biosystematic Unit, National Museum of Natural History (NMNH), Smithsonian Institution, with accompanying larval exuviae for species verification. In the description below br means branches and Le and Pe mean exuviae of the fourth instar larva and pupa, respectively.

Description

Armigeres (*Leicesteria*) *omissus* (Edwards)
(Fig. 1)

Position and size of setae as figured, range and modal number of branches in Table 1. *Cephalothorax:* Setae 1,3-CT long to very long, thin, usually single (1,2); 6-CT 0.53–0.82, $\bar{x}$ 0.66 length of 7-CT; trumpet brown, reticulate, length 0.5–0.6 mm, index 1.54–2.50, $\bar{x}$ 2.05. *Abdomen:* Seta 1-II moderately long, with 10–17 br; 2-V-VII

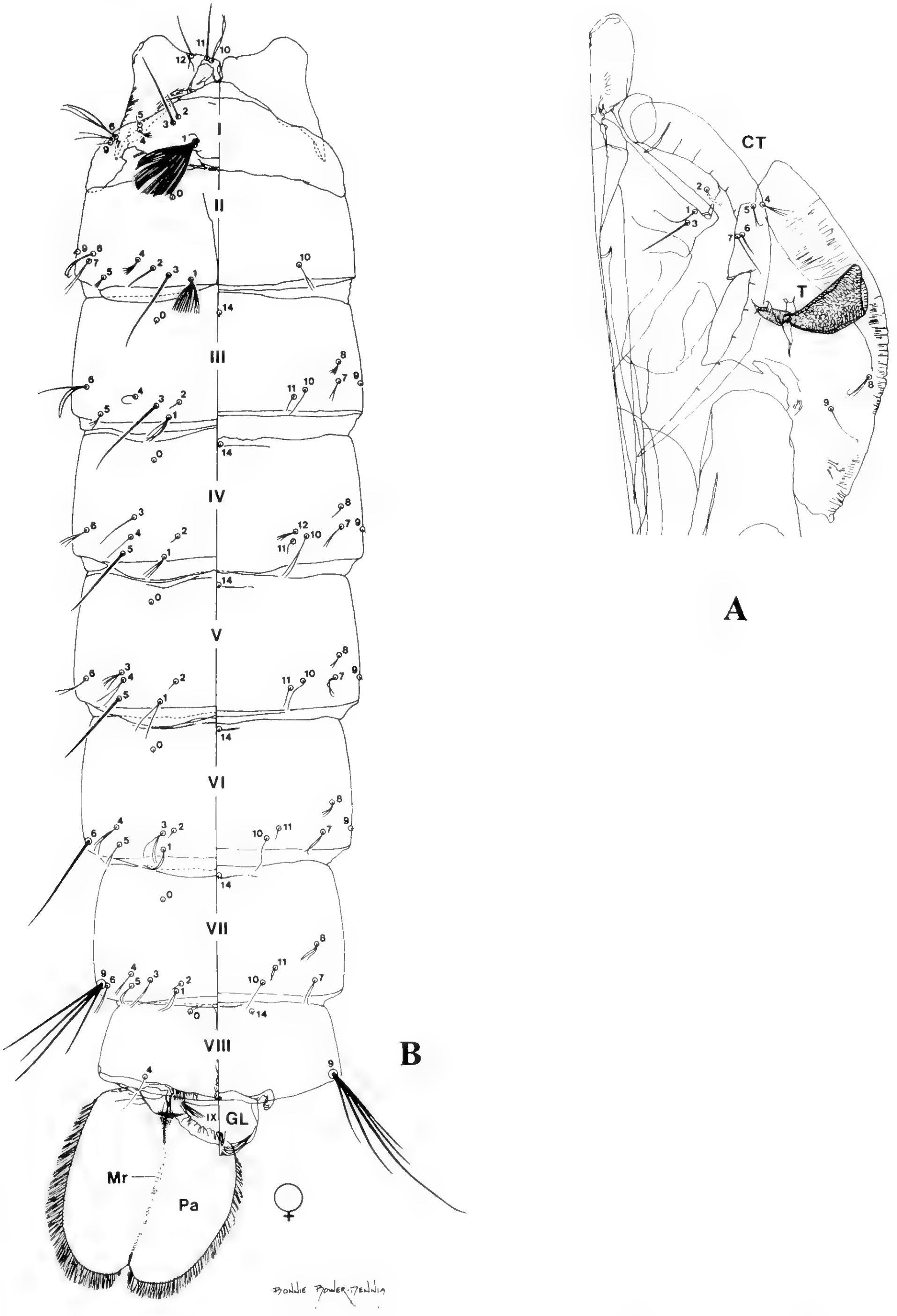

Fig. 1. Pupa of *Armigeres* (*Lei.*) *omissus*. A, Cephalothorax (left side). B, Metanotum and abdomen (dorsal left, ventral right). Abbreviations: CT = cephalothorax; GL = genital lobe; Mr = paddle midrib; Pa = paddle; T = respiratory trumpet.

Table 1. Pupa chaetotaxy of *Armigeres omissus*.

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]	5–10 (?)	10–17 (14)	2–8 (3)	2–5 (3)	2–6 (2)	1–3 (2)	2, 3 (2)	–
2	1–4 (2)	1	1	1	1	1	1	1	–
3	1, 2 (1)	1	1	1	1–7 (3)	2–5 (4)	1–3 (1)	1, 2 (1)	–
4	2, 3 (2)	2–4 (3)	2–6 (4)	1–3 (1)	1, 2 (1)	1, 2 (2)	1–3 (1)	1, 2 (1)	1, 2 (1)
5	1–3 (2)	1	2–5 (2)	1–5 (3)	1–3 (1)	1, 2 (1)	1, 2 (2)	1, 2 (1)	–
6	1	1–4 (?)	2–7 (2)	3–5 (3)	1–4 (2)	1, 2 (2)	1, 2 (1)	1–4 (1)	–
7	1, 2 (1)	1, 2 (2)	2–5 (2)	2, 3 (2)	1–3 (3)	2–4 (4)	1–3 (2)	1–3 (1)	–
8	1–3 (2)	–	–	2, 3 (3)	2, 3 (2)	2, 3 (3)	2–6 (3)	2–8 (?)	2–5 (5)
9	1	1	1	1	1	1	1	1–5 (2)	–
10	1–4 (2)	–	1, 2 (1)	1, 2 (2)	1–3 (2)	1–3 (1)	1	1	–
11	1	–	–	1–3 (1)	1–3 (1)	1–3 (1)	1–3 (1)	1–3 (2)	–
12	1	–	–	–	–	–	–	–	–
14	–	–	–	1	1	1	1	1, 2 (1)	1

[1] Range followed in parenthesis by mode.

short, single, 0.22–0.40, $\bar{x}$ 3.0 length of 1-V-VII; 3-II,III stout, 0.62–0.91, $\bar{x}$ 0.75 length of following tergum; 5-IV,V stout, more than 0.5 length of following tergum; 6-II-V short, with thin branches, usually double (1–5); 6-VI long, stout, sparsely aciculate, single, seldom double; 9-VII long, stout, aciculate, with 2–5 br, seldom single; 9-VIII long, stout, aciculate, usually with 5 br (2–5). Seta 12-IV was found in only one pupa. *Paddle:* Length 1.10–1.27 mm, index 1.05–1.29, 1-P absent, except one pupa with a seta-like spicule without alveolus, fringe long, 0.19 mm, extending to near base.

The description is based on the following specimens, all from Thailand, deposited in the NMNH: Chiang Mai Province, Huey Muang Ban Ay, V-15-64, 1♀ LePe, ex bamboo pot; Nan Province, Ban Pha Hang, elev. 400 m, VIII-19-66, 2♀ LePe, ex bamboo stump; Lampang Province, Doi Pha Huat, elev. 420 m, V-21-68, 1♀ LePe, ex bamboo stump. The Nepal specimen was collected in Jhapa District, Kanchanbari, VIII-2-91, 1♀, resting outdoors on vegetation in primary forest (coll. no. 111-x128).

KEY TO PUPAE OF *ARMIGERES* SPECIES OF NEPAL

1. Seta 1-P small or absent; seta 5-IV-V at least 0.5 length of following tergum; seta 6-CT shorter than 7-CT (subg. *Leicesteria*) 2
– Seta 1-P long, rather stout, if not, seta 5-IV,V less than 0.5 length of following tergum (*theobaldi*); seta 6-CT as long as or longer than 7-CT (subg. *Armigeres*) . . . 8
2(1). Paddle with fringe of long spicules on outer margin extending to near base . . . 3
– Paddle with fringe of long spicules on outer margin in apical 0.75 or less 6
3(2). Seta 6-II-V short, usually with 2 or more thin branches 4
– Seta 6-II-V long, stout, single 5
4(3). Seta 1-II with 28 or more branches; seta 1-I with thick unbranched base, 0.27 of total length . . . . *digitatus* (Edwards)
– Seta 1-II with 17 or fewer branches; seta 1-I with smaller unbranched base, 0.18 of total length . . . . *omissus* (Edwards)
5(3). Seta 3-IV usually 5- or 6-branched; seta 1-II sparsely aciculate . . . . *annulitarsis* (Leicester)
– Seta 3-IV usually with 4 or fewer branches; seta 1-II densely aciculate . . . . *magnus* (Theobald)
6(2). Seta 1-II with 24 or more branches; paddle with large external lobe; seta 1-II-VII subequal to seta 2 . . . . *dolichocephalus* (Leicester)

– Seta 1-II with 21 or fewer branches; paddle without large external lobe; seta 1 at least 2.0 length of seta 2 on V–VII 7

7(6). Seta 3-CT with thin branches; seta 6-VI single . . . . *inchoatus* Barraud

– Seta 3-CT with stout branches; seta 6-VI usually with 2 or more branches . . . . *dentatus* Barraud

8(1). Setae 3-II, III and 5-IV, V shorter than 0.25 length of following tergum . . . . *theobaldi* Barraud

– Setae 3-II, III and 5-IV, V longer than 0.5 length of following tergum 9

9(8). Seta 1-CT with thin branches, usually double; seta 9-VII with 9 or more branches . . . . *aureolineatus* (Leicester)

– Seta 1-CT stout, single or double; seta 9-VII with 8 or fewer branches 10

10(9). Seta 1-II small, usually with 5 or fewer thin branches, 0.36 or less length of 3-II . . . . *kuchingensis* Edwards

– Seta 1-II much thicker, with 6 or more branches, 0.5 or more length of 3-II . . 11

11(10). Seta 1-II pedunculate, brush-like, branched in apical 0.7, with with 17 or more branches . . . . *durhami* Edwards

– Seta 1-II pedunculate or not, with 6–14 branches 12

12(10). Trumpet short and broad, index 1.2–1.7; seta 3-VII closer to seta 4 than to seta 1 . . . . *subalbatus* (Coquillett)

– Trumpet long, index 2.3 or greater; seta 3-VII closer to seta 1 than to 4 . . . . *kesseli* Ramalingam

KEY TO FOURTH INSTAR LARVAE *ARMIGERES* SPECIES OF NEPAL

(Partially adapted from Macdonald 1960)

1. Abdominal segment X with dorsal saddle and very small ventral sclerotized plate . . . . *magnus* (Theobald)

– Abdominal segment X with dorsal sclerotized saddle only 2

2(1). Comb scales fringed with subequal spinules 3

– At least some comb scales with apical spine 8

3(2). Comb with more than 25 scales . . . . *inchoatus* Barraud

– Comb with fewer than 25 scales 4

4(3). Comb with 18–25 scales . . . . *annulitarsis* (Leicester)

– Comb with fewer than 18 scales 5

5(4). Most comb scales rather pointed apically, point fringed with subequal spinules . . . 6

– Comb scales rounded apically, fringed with subequal spinules 7

6(5). Seta 1-X on saddle or close to it . . . . *durhami* Edwards

– Seta 1-X distinctly removed from saddle . . . . *subalbatus* (Coquillett)

7(5). Seta 1-III-VI reaching posterior margin of following segment; seta 6-I with 3 or 4 branches . . . . *kuchingensis* Edwards

– Seta 1-III-VI only reaching basal 0.25 or less of following segment; seta 6-I with 5–9 branches . . . . *kesseli* Ramalingam

8(2). Comb with 11 or fewer scales 9

– Comb with 12 or more scales 10

9(8). Seta 1-S very small, with 2 or 3 branches; 1-X small, not inserted on saddle . . . . *aureolineatus* (Leicester)

– Seta 1-S long, rather stout, single; seta 1-X strong, inserted on saddle . . . . *theobaldi* Barraud

10(9). Abdominal segments I-VII with prominent tubercles bearing setae . . . . *dolichocephalus* (Leicester)

– Abdominal segments I–VII without tubercles 11

11(10). At least abdominal sterna II–IV with large patch of fine spicules . . . . *digitatus* (Edwards)

– Abdominal sterna II–IV without spicules 12

12(11). Seta 5-VIII with 3 or more fine branches; comb scales with 2 or more apical spines . . . . *omissus* (Edwards)

– Seta 5-VIII stout, single or double; most comb scales with single apical spine . . . . *dentatus* Barraud

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NEW RECORDS OF FLEAS (SIPHONAPTERA) FROM EASTERN WEST VIRGINIA

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Abstract.—Nine species of fleas are reported for the first time from the boreal environment in the mountains of eastern West Virginia. The new state records are *Ceratophyllus gallinae* (Schrank), *Conorhinopsylla stanfordi* Stewart, *Epitedia faceta* (Rothschild), *Hystrichopsylla tahavuana* Jordan, *Megabothris asio asio* (Baker), *M. quirini* (Rothschild), *Nearctopsylla genalis genalis* (Baker), *Rhadinopsylla media* Smit, and *Tamiophila grandis* (Rothschild).

Key Words: Appalachian Mountains, fleas, distribution, West Virginia

We report nine flea species found in the higher elevations of the Appalachian Mountains of West Virginia along the eastern border with Virginia where boreal conditions are found. There has been considerable study of the biota of the Appalachian balds (Mark 1958) and spruce and northern hardwood forests (Handley 1971, Stephenson and Adams 1984, and references therein) demonstrating plants and animals characteristic of the boreal environments of more northern regions. Results of these studies suggested to us that fleas common to more northern environments might be present in West Virginia because of the presence of appropriate mammal hosts and the existence of boreal conditions suitable for their non-parasitic larval stages. Benton (1971, 1980) added seven new species to the West Virginia list bringing the state total to 24 and further noted that an additional 20 fleas not then known from the state should be present. We add nine new flea species to the West Virginia list with all but one expected by Benton.

MATERIALS AND METHODS

Collections were made in the eastern mountains of the Ridge and Valley Province of West Virginia as often as could be arranged during all months of the year from 1984 to 1996. Bird and mammal nests were placed in a Berlese funnel overnight in the laboratory to extract fleas. Small mammals were trapped using Sherman live traps and snap traps. Live animals were placed in paper bags containing paradichloro-benzene crystals for a few minutes and then released into plastic bags for identification, sexing and a check for fleas still in the pelage. The animals were then released in the vicinity of their capture. Collection data were written on the paper bag and the contents were examined for fleas in the laboratory. Mammals found dead were brushed over a white enameled pan and fleas were placed in ethanol. Five nest boxes were placed about 3 m high in a stand of red spruce (*Picea rubens* Sargent) on Alleghany Mountain in Pocahontas County at an elevation of 1,300 m to monitor the fleas of flying squirrels.

White polyester fiber was provided as nesting material and sampled as nearly monthly as weather would permit for a year. Sampling involved removal of only half of the fiber from a nest box, placing it in a plastic bag and replacing it with fresh fiber, thereby permitting the maintenance of succeeding generations of parasites. Fleas were removed from the retained nesting material in the lab and stored in ethanol. All fleas were decolorized in 10% KOH, dehydrated in ethanol, cleared in xylene and mounted in Canada balsam. Fleas were identified using keys developed by Benton (1983) and Holland (1985). Mammal names follow Wilson and Reeder (1993).

RESULTS

The following nine flea species new to the state of West Virginia were collected.

Ceratophyllidae

Ceratophyllus gallinae (Schrank)

3 ♀ from the nest of *Sialia sialis* (L.), 26 Sept 1993, Pocahontas County, Top of Allegheny.

This European hen flea is a wide-ranging species from Alaska and Canada (Holland 1985) as well as northeastern United States (Benton 1980). Domestic chickens and native birds are the usual hosts. This is the southernmost reported occurrence of this species in the eastern United States.

Megabothris quirini (Rothschild)

1 ♀ ex *Clethrionomys gapperi* (Vigors), 15 Nov 1984, 1 ♀ ex *C. gapperi,* 20 April 1985, 1 ♀ ex *Microtus pennsylvanicus* 26 Sept 1993, all from Pocahontas County, Alleghany Mountain. 1 ♂, 2 ♀ ex *C. gapperi* 30 June 1985, 1 ♀ ex *Peromyscus leucopus* (Rafinesque), 30 June 1985, Randolph County, Spruce Knob Lake. 4 ♀ ex *C. gapperi,* 29 Aug 1985, 1 ♂ ex *M. chrotorrhinus* (Miller), 9 Dec 1985, 3 ♀ ex *C. gapperi* 18 May 1986, all from Pendleton County, Spruce Knob.

Hopla (1965) stated that *M. quirini* "is a flea that has migrated into the boreal regions from the south following the retreat of the Pleistocene glaciers." It is found on mice in seven genera (Holland 1985). Our collections were primarily from microtines. Five of 72 *C. gapperi,* 1 of 9 *M. chrotorrhinus* and 1 of 27 *P. leucopus* were infested. In the eastern United States this flea had been reported only from New York and New England (Benton 1980). The nearest record to those reported here is from southern New York, over 500 km to the northeast.

Megabothris asio asio (Baker)

1 ♂, 26 ♀ ex 9 *Microtus pennsylvanicus* and 1 ♂ ex *Peromyscus maniculatus* (Wagner), 18 Nov 1984; Pocahontas County, Alleghany Mountain; 2 ♀ ex 2 *M. pennsylvanicus,* 1 ♂ ex *P. maniculatus* and 1 ♂ ex *C. gapperi,* 20 Oct 1985 from Tucker County, Dolly Sods; 1 ♂ ex *M. chrotorrhinus*, 9 Dec 1985 Pendleton County, Spruce Knob; 1 ♂, 4 ♀ ex *M. pennsylvanicus* 30 Jun 1985, Randolph County, Spruce Knob Lake.

Numerous collections were made at these four sites during the Fall, Winter and Spring months. This is another flea found primarily on microtine hosts with a boreal distribution in eastern Canada and northeastern United States. The previous nearest record of this flea is in Pennsylvania. Thus, our Appalachian records from West Virginia extend the range about 300 km to the south.

Ctenophthalmidae

Conorhinopsylla stanfordi Stewart

1 ♂, 1 ♀ ex *Glaucomys volans* (L.) nest, 10 Nov. 1985, Pocahontas County, Alleghany Mountain.

This flea is blind and is primarily a nest flea on flying squirrels. Other hosts include squirrels in the genera *Sciurus* and *Tamiasciurus* (Holland 1985). It is known from Ontario to Maryland so this is the southernmost occurrence in the East. This flea is not plentiful in collections, probably due to a dearth of nest examinations of the flying squirrel in winter. It was found in larger numbers in more extensive nestbox arrays in neighboring Virginia.

Tamiophila grandis (Rothschild)

2 ♀ ex *Tamias striatus* (L.), 25 Sep 1993, 12 Oct 1996, Pocahontas County, Top of Allegheny.

As the name implies, this is a large flea and a parasite of the chipmunk, of which 2 of 15 were parasitized. This flea is rare in collections because it is a nest flea and is rarely taken on the host. It occurs from Ontario to southwestern Virginia where it was recently reported by Eckerlin and Painter (1995).

Epitedia faceta (Rothschild)

2 ♀ from nest of *G. volans,* 19 Jan 1986, Pocahontas County, Alleghany Mountain.

This nest flea is most abundant in the late fall and early winter (Benton 1980). Both northern and southern flying squirrels are hosts but the flea is restricted to eastern Canada and eastern United States, corresponding closely with the range of *G. volans* (Holland 1985). The southernmost reported occurrence of *E. faceta* is eastern Tennessee in the Appalachians at high elevation (Durden and Kollars 1997).

Nearctopsylla genalis genalis (Baker)

3 ♀ ex *B. brevicauda,* 9 Dec 1985, Pendleton County, Spruce Knob; 1 ♀ ex *B. brevicauda,* 3 Nov 1995, Pocahontas County, Alleghany Mountain, 4 ♀ ex *Sorex fumeus* Miller, 18 Nov 1984, Pocahontas County, Top of Allegheny.

Benton (1980) refers to this flea as a fall and winter flea and indeed our records are all in the fall months. With a range from Ontario and Illinois eastward to the Atlantic seaboard states, *N. genalis* was previously collected no further south than Pennsylvania. The Pocahontas County site extends the range of this species 300 km southward at high elevations in the Appalachians. Two of 33 *B. brevicauda* and 1 of 2 *S. fumeus* were infested.

Rhadinopsylla media Smit

1 ♀ from nest of *Neotoma floridana* (Ord), 17 Sep 1950, Pendleton County, Franklin, collected by Price and Tipton.

The single damaged specimen is deposited in the Monte L. Bean Life Sciences Museum at Brigham Young University and was kindly loaned us by Michael Hastriter.

Hystrichopsyllidae

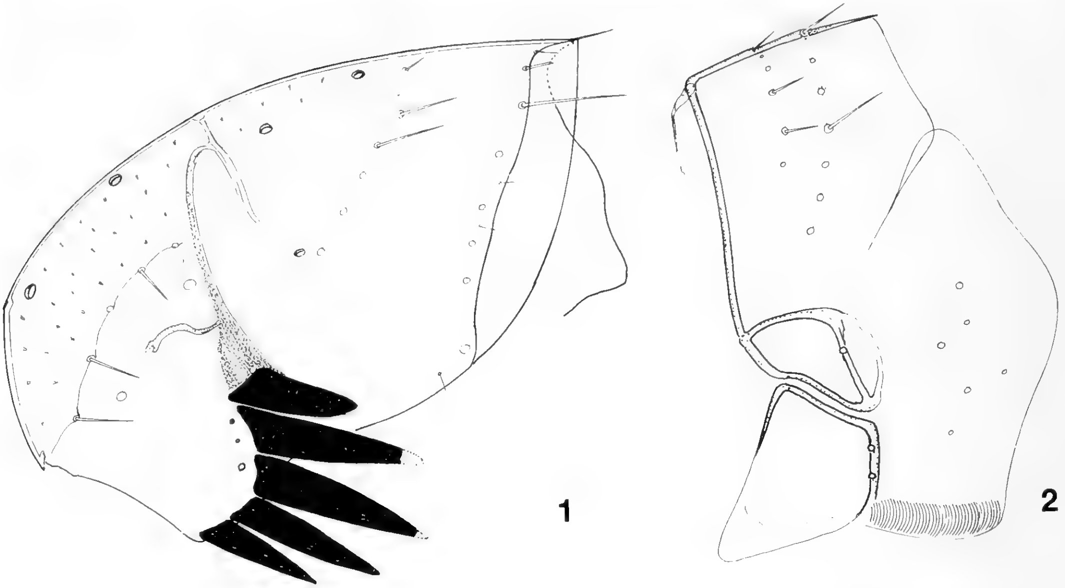
Hystrichopsylla tahavuana Jordan

1 ♀ ex *Blarina brevicauda* (Say), 18 May 1986, Randolph County, Spruce Knob Lake, and 1 ♀ from nest of *Microtus pennsylvanicus* (Ord), 25 Oct 1986, Pocahontas County, Top of Allegheny.

This large flea was described from the two host species we list. Scattered records exist from Ontario to Tennessee. Only 1 of 33 *B. brevicauda* was infested so we regard this as an uncommon flea.

DISCUSSION

Eight of the nine new records are species Benton (1971) predicted would be found in West Virginia. The only unexpected species was *Rhadinopsylla media* whose nearest reported occurrence is in Michigan and Minnesota (Benton and Timm 1976). Additional comment is warranted by the considerably greater physical separation between this record and other specimens of this seldom collected flea. Pfitzer (1950), in his unpublished master's degree thesis reported collecting a number of the closely related *Rhadinopsylla orama* Smit 1957 from Wise County, Virginia just north of the Tennessee/Virginia line. The number and location of genal spines (of the *R. media* specimen, Fig. 1) confirm placement of the West Virginia specimen in *Rhadinopsylla* and the long suture between the metanotum and metepimeron (Fig. 2) separates *R. media* from the only other eastern species, *R. orama,* which is found in the adjacent states of Virginia, Pennsylvania, and Maryland (Benton 1980), but was not observed in this study. We agree with Benton and Timm



Figs. 1–2. *Rhadinopsylla media.* 1, Head. 2, Metathorax showing suture between metanotum and metepimeron.

(1976) that more specimens are required to determine distribution of these poorly known fleas.

Epitedia faceta, Hystrichopsylla tahavuana, Megabothris a. asio, M. quirini, Nearctopsylla g. genalis and *Tamiophila grandis* have extensive distributions north of West Virginia, but are restricted to high elevations southward in the Appalachian mountains. We regard these species and their environments in West Virginia as boreal. Significant extensions of ranges were demonstrated for *N. g. genalis and M. a. asio,* previously not collected south of Pennsylvania and *M. quirini,* not collected south of New York. Conversely, *Conorhinopsylla stanfordi* and *Ceratophyllus gallinae* are widespread and not ecologically bound to the Appalachians. *Conorhinopsylla stanfordi* adults in the nests of flying squirrels have a pronounced cold weather peak of abundance and are absent for most of the year (Benton and Day 1980). Many species of birds serve as hosts of *C. gallinae* including many cavity nesters such as bluebirds (Holland 1985) which are found throughout the study area. The total number of species reported from West Virginia now stands at 33. We believe that more of Benton's (1971) hypothesized species will be discovered in West Virginia with additional collecting.

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SAWFLIES (HYMENOPTERA: TENTHREDINIDAE) DESCRIBED BY BENJAMIN D. WALSH, WITH NOTES ON THEIR HOSTS AND BIOLOGY

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Abstract.—The 15 species of sawflies described by Benjamin D. Walsh in 1866 are identified. Lectotypes are designated for six species: *Euura salicisovum, Euura salicisnodus, Nematus salicispomum, Nematus salicisdesmodioides, Nematus salicispisum,* and *Nematus quercicola.* Neotypes are designated for four species: *Pristiphora grossulariae, Euura perturbans, Nematus inquilinus,* and *Nematus hospes.* Most species described by Walsh are the gall-forming Nematinae on willows. Host plants, types of galls, and biological notes are presented where known.

Key Words: *Nematus, Pristiphora, Euura, Eupontania,* sawflies, galls, willow, *Salix,* Walsh

Benjamin D. Walsh described 15 species of sawflies, all of the subfamily Nematinae of the Tenthredinidae: *Pristiphora grossulariae* (Walsh 1866a) from Davenport, Iowa, and 14 species from near Rock Island, Illinois, in his paper treating insects associated with galls on willows (Walsh 1866b). Three of the latter species, *Nematus mendicus, N. fur,* and *Pristiphora sycophanta,* have free-feeding larvae which were only incidental in galls using them as a pupation site. All other species described in that paper are gall formers. The interpretation and fixation of the identity of the Walsh species by designation of types are especially important in the study of North American gall-forming sawflies because they are among the oldest names available. Walsh was the first in North America to describe galls and present biological information.

Walsh's collection was lost in the Chicago fire of 1871 (Mallis 1971). However, one specimen of *Pontania,* labeled as the type of "*Nematus s-pomum* Walsh" is in the Museum of Comparative Zoology at Harvard University, and more Walsh material is in the Academy of Natural Sciences of Philadelphia. None of these specimens have ever been treated as syntypes and none bear Walsh's original identification label but the specimens deposited in Philadelphia fit the descriptions and labeling of the specimens collected and described by Walsh. It is improbable that this material had been collected by anybody else. Walsh wrote that he had sent a part of his material to E. Norton (at Philadelphia): "I sent a normal female of *E. perturbans,* and a female of *E. s. ovum* to Mr. Norton, along with many male and female varieties of *Nematus s. pomum,* each specimen numbered, but none of them named" (Walsh 1866b: 254). All specimens are glued on triangular or pentagonal (in case of *Nematus salicispomum*) cardboard points and each bear a small square label with printed letters "Ill." (rare in handwriting). None of them have identification labels written by Walsh himself. The labeling varies and identification labels (if any) were added by Norton or, for *Pontania* species, also by Marlatt. Most specimens deposited in Philadelphia have small squares with numbers, and we assume that these are the specimens sent by Walsh to Norton.

In this paper we try to clarify the problems concerning sawfly species described by Walsh. Lectotypes are selected for six species: *Euura salicisovum, E. salicisnodus, Nematus salicispomum, N. salicisdesmodioides, N. salicispisum,* and *N. quercicola*; a neotype is selected for *Pristiphora grossulariae,* and lectotypes of *E. salicisovum, N. salicispomum,* and *N. salicisdesmodioides* are designated also as neotypes of *E. perturbans, N. hospes,* and *N. inquilinus* Walsh, respectively. Type material is still absent for *Euura salicisgemma, E. salicisovulum, N. mendicus, N. fur,* and *Pristiphora sycophanta.*

Of the 14 names proposed by Walsh, seven of them can be considered valid: *Euura salicisovum* (= *E. perturbans*), *E. salicisovulum, E. salicisnodus, Eupontania salicispomum* (= *E. hospes*), *E. salicisdesmodioides* (= *N. inquilinus*), *E. salicispisum* (= *N. quercicola*), and *Pristiphora sycophanta. Pristiphora grossulariae, N. mendicus,* and *N. fur* are currently treated as synonyms of *Pristiphora rufipes* Serville, 1823, *Nematus oligospilus* Foerster, and *Amauronematus histrio* Serville, 1823, respectively. However, placement of the latter two needs confirmation.

Most of the gall-making sawflies (and midges) described by Walsh have abbreviated names. He named many of his species like "*Nematus s. pomum*" or "*Euura s. nodus.*" Some authors considered them as unavailable trinomens or used different spellings for the same species (e.g., Marlatt 1896, Rohwer 1909, Ross 1951, Smith 1979). For example, one of the most common species creating apple-like galls in eastern North America has been placed either in *Nematus* or *Pontania* under the names "*s. pomum* Walsh," "*salicis-pomum* Walsh," "*pomum* Walsh," "*s-pomum* Walsh," or "*hospes* Walsh (= *s. pomum* Walsh)."

Undoubtedly, "*s.*" is only an abbreviation Walsh used. For the first species in any genus, either of midges or sawflies, Walsh clearly showed that "*s.*" means "*salicis.*" For instance: "Gall *Salicis gemma,* n. sp." and then "*Euura s. gemma,* n. sp." (Walsh 1866b: 250, No. 16). In fact, these species were described as trinomens like "*Euura salicis gemma.*" According to the *International Code of Zoological Nomenclature* (1985), these are valid names and we should accept them, expanding the abbreviation and fusing "*salicis*" with the third word. Within sawflies, these names are: *Euura salicisgemma, E. salicisovum, E. salicisovulum, E. salicisnodus, Nematus salicispomum, N. salicisdesmodioides,* and *N. salicispisum.*

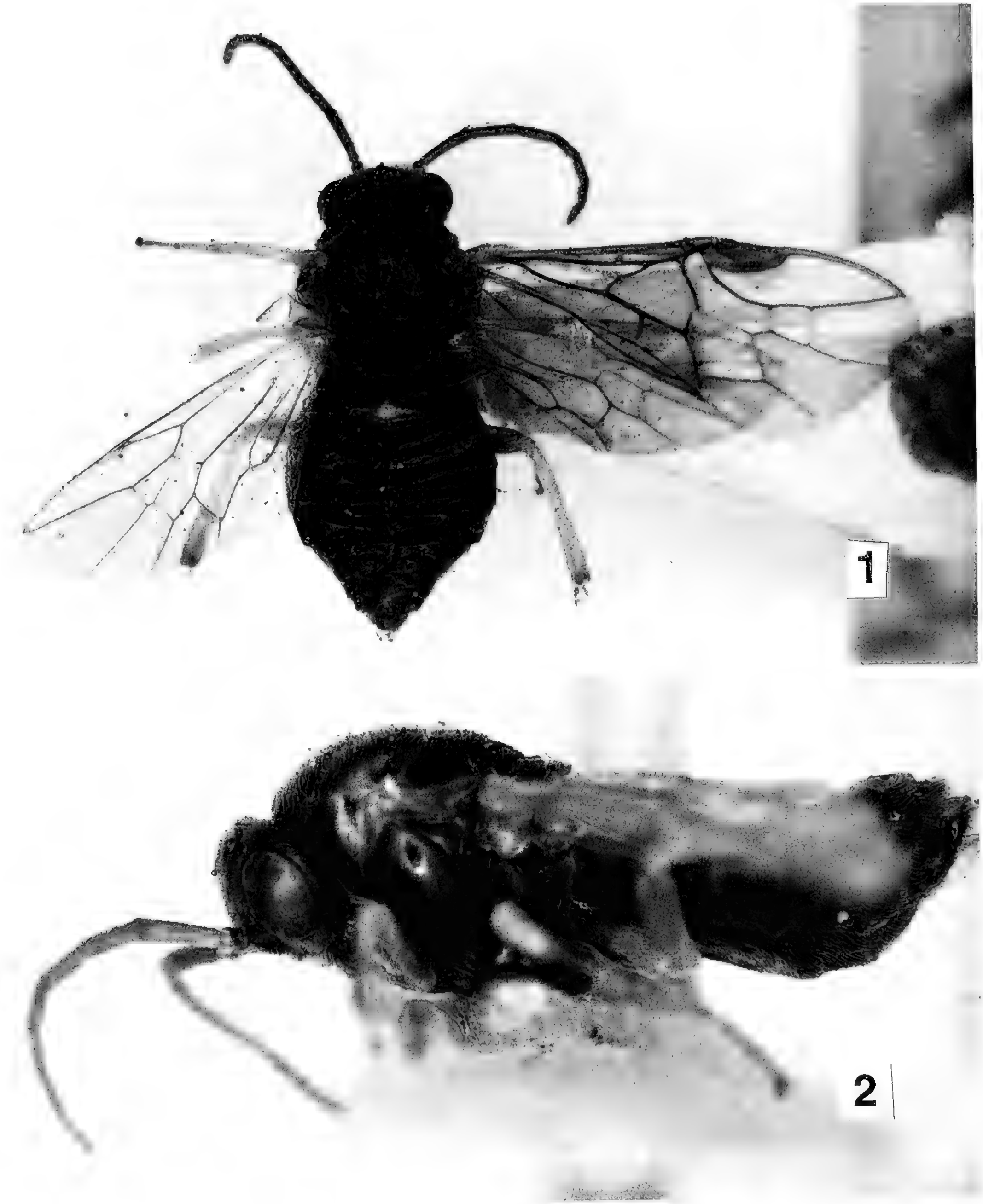
Acronyms used for museums are: USNM = National Museum of Natural History, Smithsonian Institution, Washington, DC; MCZ = Museum of Comparative Zoology, Harvard University, Cambridge, MA; ANSP = Academy of Natural Sciences of Philadelphia, PA. Species headings are the Walsh species in their original combinations.

SPECIES DESCRIBED BY WALSH

Pristiphora grossulariae Walsh was described from Davenport, Iowa (1866a). All other sawfly species described by Walsh were published in a paper on insects reared from willow galls (1866b) "found on several species of Willow in the neighborhood of Rock Island, Illinois" (Walsh 1864).

Pristiphora grossulariae Walsh
1866a: 123
(Figs. 1–2)

Type material.—Described from "four males and forty-nine females" and "forty



Figs. 1–2. *Pristiphora grossulariae*, neotype. 1, Dorsal view. 2, Lateral view.

larvae of various sizes." One female at ANSP probably belongs to the type series of this species. It is mounted similar to other specimens from Walsh's collection (Figs. 1–2), and bears Norton's identification label. We hereby select it as neotype; it is labeled "Pristiphora grossulariae W. female."

Valid name.—*Pristiphora rufipes* (Serville 1823) (= *Pristiphora grossulariae* Walsh). *Pristiphora rufipes* was previously attributed to Lepeletier; see Blank and Taeger (1998) for correct authorship of species previously attributed to Lepeletier.

Host.—*Ribes* spp.; larvae feed on different currant species, but particularly on *Ribes grossularia* L.

Notes.—This is a well-known currant pest introduced from Europe. Larvae are external leaf feeders.

Euura salicisgemma Walsh 1866b: 248, 250 (No. 16)
(Figs. 3–6)

Type material.—Described from 34 galls, 2 larvae, 1 male (reared May 5), and 1 female (reared May 2). Specimens possibly lost.

There are no specimens under the name "*salicisgemma*" in ANSP, but there are six specimens under the name *Euura orbitalis* Norton. All of them are from Illinois, each bearing a small square "Ill." These six specimens include one male of *Euura,* which we cannot identify to species, one female of *Euura salicisovum* Walsh, one *Phyllocolpa* sp., and three females of *E. orbitalis* Norton (= *salicisgemma* Walsh). One of the *E. orbitalis* specimens is labeled "Ill."; "Am. Ent. Soc. Collection"; "TYPE"; "Euura orbitalis"; "Euura orbitalis Norton [Norton's label]"; and a label "Cannot be Type. Type came from "Conn." SAR" [S.A.Rohwer] (Figs. 3–6). This specimen cannot be treated as the type of Norton's *Euura orbitalis* because Norton described it from N.Y. (Brooklyn) and Conn., and we cannot treat it as a type of Walsh's species. We were unable to find the type of *Euura orbitalis* Norton elsewhere. We doubt if any of these specimens belong to Walsh's material because they are pinned and all other Walsh specimens that we have seen are glued to points.

It would be desirable to select neotypes (preferably from reared material) for *Euura orbitalis* Norton and *Euura salicisgemma* Walsh, to fix the usage of these names, but we do not have reared material at present.

Valid name.—*Euura orbitalis* Norton 1862 (= *Euura salicisgemma* Walsh, synonymized by Norton 1867).

Host.—According to Walsh (1866b: 248, 250), this species creates bud galls on *Salix humilis* Marsh.

Notes.—This species is related to the Holarctic *Euura mucronata* (Hartig), but *E. orbitalis* is much paler colored ("head pale luteous") than any of the European species of *Euura.* Both species belong to the subgenus *Gemmura* E. L. Smith (1968), which is characterized by a short ovipositor and the habit of making bud galls. *Euura orbitalis* is separated from *E. mucronata* and *E. nigrella* Rohwer by a short sawsheath in dorsal view strongly narrowed at center with very short medial flange (Fig. 4).

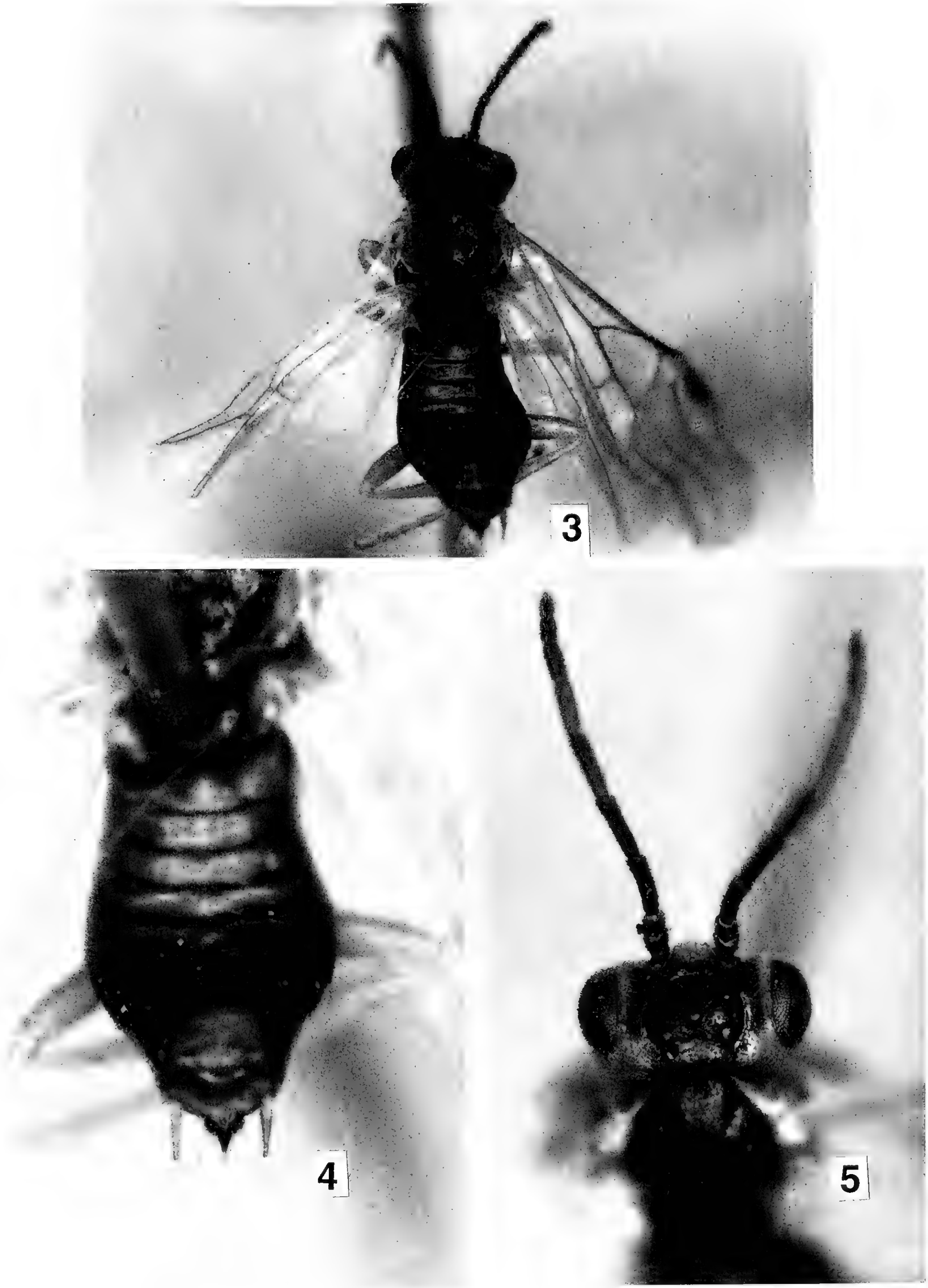
We studied specimens from Canada (Quebec and Ontario) and U.S.A. (Illinois, Missouri, New Hampshire, and New York).

Euura salicisovum Walsh 1866b: 248, 251–252 (No. 17)
(Figs. 7–10)

Type material.—Described from numerous galls, 7 larvae, 10 males, and 5 females, bred 16–27.

The lectotype female, here designated, is glued on a whitish triangle and labeled "Ill."; "18". Two paralectotype males are labeled "19"; "Euura s. ovum male Ill. Walsh" [on the underside "gall maker"]. Another paralectotype male is labeled only "Ill." (without a number). Deposited in ANSP.

The female lectotype fits Walsh's description. It is in rather good condition, but the flagellum of both antennae, the entire left hindtarsus, the apical parts of the right hindtarsus, the apex of the left midtarsus, and the apex of the left forewing are missing (Fig. 7). The lower part of the thorax is not visible. The identification labels attached to the male paralectotypes are in Norton's handwriting. There is little doubt that the selected lectotype belongs to the type series of *Euura salicisovum.* The only other possibility is that it might be a syntype of *Euura perturbans* Walsh (a syno-



Figs. 3–5. *Euura orbitalis*, specimen labeled "Ill." 3, Dorsal view. 4, Abdomen, dorsal view. 5, Head, dorsal view.

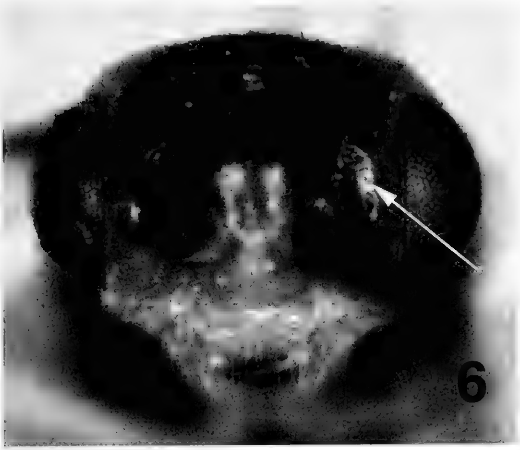


Fig. 6. *Euura orbitalis*, head, front view.

nym of *E. salicisovum*), but, according to Walsh, *E. perturbans* should be generally darker than this female.

Valid name.—*Euura salicisovum* Walsh.

Host.—According to Walsh on "*S. cordata*." Its currently accepted name is *Salix eriocephala* Michaux (= *cordata* Muhlenberg not Michaux) (Argus 1997). The galls are "monothalomous, spongy, growing from the side of the twig." Galls obviously belonging to this species were common on *S. eriocephala* around Ithaca, NY, in 1997 (Fig. 10).

Notes.—The species is pale colored and usually larger than *Euura orbitalis*. It is characterized by its longer ovipositor, sawsheath in dorsal view with a more or less gradually attenuate medial flange, and the entire sawsheath triangular in outline with the apical hairs distinctly bent apically (compare Figs. 4, 9). In both sexes, it is separated from *E. salicisnodus* (together with most of other *Euura* species) by its distinctly convex, glabrous and strongly shining inner orbits (Fig. 8) and, in dorsal view, the distinct inner orbit margins above the eye.

For further notes, see also *Euura salicisovulum* Walsh.

Euura perturbans Walsh 1866b: 254

Type material.—Described from two males and five females bred from cecidomyiidous galls ("*S. strobiloides*, O. S.; "*S. batatus* Walsh," *S. rhodoides* Walsh (galls of the preceding years); and one from a bud gall on "*Vitis cordifolia*."

We did not find appropriate specimens in ANSP to select a lectotype; however, to fix the usage of this name, we hereby select the lectotype of *Euura salicisovum* as neotype for *E. perturbans*. See *E. salicisovum* for labels on the specimen and Figs. 7–9.

Valid name.—*Euura salicisovum* Walsh (= *Euura perturbans* Walsh).

Notes.—*Euura perturbans* was synonymized by Marlatt (1896). According to Walsh, the specimens of *E. perturbans* should be distinguished from *E. salicisovum* only by "the dorsum of the abdomen varying from honey-yellow, including the lateral plates, through obfuscated [sic], to deep black with the lateral plates also black." We consider this a color variation and accept the previously proposed synonymy under *E. salicisovum*.

Euura salicisovulum Walsh 1866b: 248, 253 (No. 18)

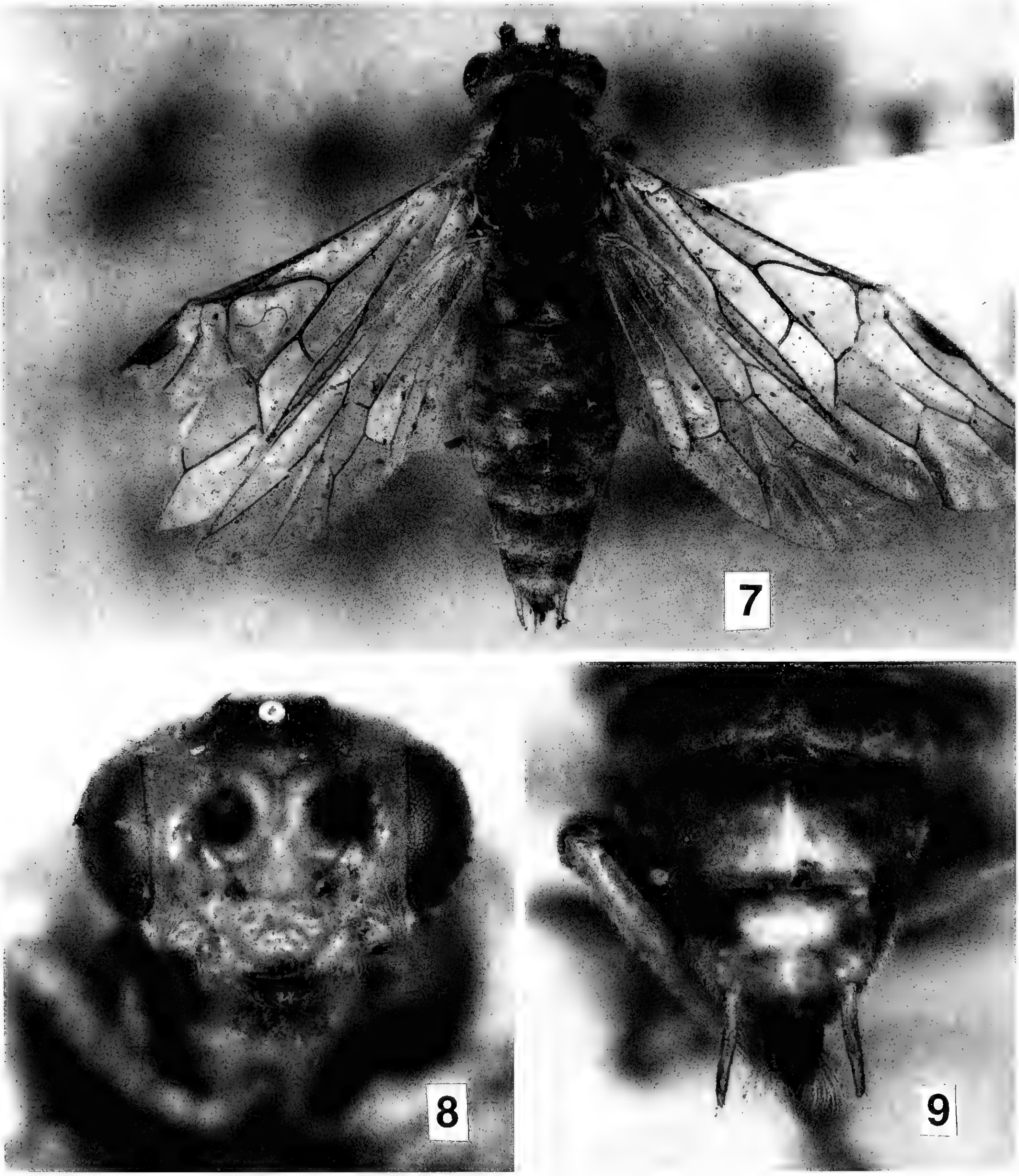
Type material.—Described from 30 galls on *Salix humilis* and 6 larvae. Probably all lost.

Valid name.—*Euura salicisovulum* Walsh.

Notes.—The galls are the same as those of *Euura salicisovum*; the larvae, according to Walsh, are distinguished from those making galls on *Salix eriocephala* being "all decidedly pale greenish," while those of *E. salicisovum* were "all decidedly yellowish." No galls were found by Walsh on *Salix discolor* which is closely related to *S. humilis*.

The taxonomic status of this species and its host plant specificity are not quite clear. Galls of this type occur not only on *Salix eriocephala* and *S. humilis* (including var. *tristis*), as stated by Walsh, but also on *S. discolor* and *S. petiolaris*. All such galls seem to be associated with a bud, which is however left unmodified, the swelling always situated just below the bud.

Specimens that seem to be conspecific



Figs. 7–9. *Euura salicisovum*, lectotype. 7, Dorsal view. 8, Head, front view; arrow indicates inner orbit. 9, Apex of abdomen, dorsal view.

with *E. salicisovum* are known from Illinois and Virginia, but all of them are either captured or reared from undetermined willows. We are not sure if they belong to *E. salicisovum* or to the complex of the sibling species involving *E. saliciovulum*. Thus, we cannot designate a neotype yet.

Euura salicisnodus Walsh 1866b: 248, 253–254 (No. 19)
(Figs. 11–12)

Type material.—Described from galls on "31 affected twigs," undetermined number of larvae, and two males.

Fig. 10. Galls of *Euura salicisovum* on stems of *Salix eriocephala*, from near Ithaca, NY.

The lectotype male, here designated is attached to a whitish elongated triangle and labeled "Ill" [in handwriting, on the underside "B D W #3"]; "Euura salicis nodus Walsh." (Fig. 3). Deposited in ANSP. It is in rather good condition with only the apex of the left flagellum and the left hindtarsus missing.

Valid name.—*Euura salicisnodus* Walsh.

Host.—According to Walsh "*Salix longifolia.*" Its currently used name is either *Salix interior* Rowlee (= *longifolia* Muhlenberg) or *Salix exigua* ssp. *interior* (Rowlee) Cronquist (see Argus 1997). The galls are "a mere enlargement of the twig, polythalamous, pitchy inside, with its cells all internal" (Fig. 12).

Notes.—The male lectotype fits the description well. It is separated from other males of *Euura* described by Walsh, by "black spot enclosing the ocelli is larger, and is confluent with the eye for its entire length, leaving no orbit between them."

This species is probably related to *E. atra* Jurine, a species introduced from Europe together with its host plants *Salix alba* L. and *S. fragilis* L. and their hybrids. Both species are characterized by the rather flat inner orbits and by the narrow sawsheath gradually tapering to its apex in dorsal view. The longest lateral hairs are distributed throughout the entire apical and ventral part of the sheath (in lateral view) and a glabrous medial flange is lacking. *Euura salicisnodus* is separated from *E. atra* by its extensive paler coloration and the galls which form an enlargement of the twig. *Euura atra* does not produce enlargements of the twig; its galls are practically unnoticeable.

Examined specimens are from Illinois, New York, Michigan (?), Ohio, and Canada (London, Ontario). Two species described from the western United States, *Euura macgillivrayi* Rohwer and *Euura exigua* E. L. Smith, are associated with the same willow species (or very closely related ones) and

Figs. 11–12. *Euura salicisnodis,* lectotype. 11, Dorsal view. 12, Gall on stems of *Salix interior,* from near Ithaca, NY.

they might prove to be only geographical forms of *E. salicisnodus.*

Nematus salicispomum Walsh 1866b: 248, 255–256 (No. 20) (Figs. 13–16)

Type material.—Described from very numerous specimens of galls, an undetermined amount of larvae, 26 males and 46 females "bred April 16–25 and one female bred many years ago."

The lectotype female (Figs. 13–16), here designated, is on a pentagonal piece of brown cardboard, labeled "Ill"; "12"; "Return to Am. Ent. Soc."; "Pontania pomum Walsh"; "N. s. pomum Walsh." Deposited in ANSP.

In the ANSP, there are 11 paralectotypes, 6 females and 5 males, all mounted on similar pentagonal cardboard points: 2 females and 3 males are without a number, and 1 female is labeled "Ill.; 152"; "Return to Am. Ent. Soc." The heads of one male and of one female are missing, otherwise they are in good condition. One female labeled "Ill."; "TYPE 14013"; "Cresson"; "Nematus s-pomum Walsh"; "MCZ // Museum of Comparative Zoology" is deposited in the MCZ. Two females and 2 males, all on similar cardboard points and similarly labeled "Ill."; "Return to Am. Ent. Soc." with two of them bearing C. L. Marlatt's identification labels "Pontania pomum Walsh" are deposited in the USNM.

Valid name.—*Eupontania salicispomum* (Walsh), **new combination.** See Zinovjev (1993) for the definition of *Eupontania.*

Host.—The galls are on *Salix eriocephala* Michaux (= *S. cordat*a). A subsidiary host plant might be *Salix discolor* Muhlenberg. Walsh wrote about it as follows: "On *S. cordata,* (and very rarely on *Salix discolor*)"; he found galls of *Nematus salicispisum* and galls "so identical in appearance with *S. pomum*" on the same bushes." "In both the above two cases a few *discolor* bushes were growing in the midst of very large numbers of *S. cordata,* the species on which *S. pomum* is normally found." These data on its host plant specificity seem to be reliable, but confirmation by rearing adults is needed.

The galls are roundish (apple-like), transected by the leaf blade with a large part of the gall visible from the upper side of the leaf, but the larger part of the gall is situated below leaf surface (illustrated by Zinovjev and Smith 1999: 361, fig. 2).

Notes.—In this species, the hind tibial spur is shorter than the apical tibial breadth, the frontal area lacks hairs on its anterior part, the inner orbits are glabrous and shiny (Fig. 15) with hairs only along the eye margin, and the sawsheath in dorsal view is a narrow triangle with rounded margins (Fig. 16). The frontal wall of the frontal area is usually considerably protruding (e.g., in reared specimens from New York), but in specimens of the type series, the whole upper head in lateral view is rather flat.

Nematus salicisdesmodioides Walsh 1866b: 248, 257–258 (No. 20) (Fig. 17)

Type material.—Described from an undetermined number of galls, "three or four" larvae, 2 males and 8 females, bred April 2–15.

The lectotype female (Fig. 17), here designated, is attached to an elongated triangle and labeled "Ill."; "13"; "Return to Am. Ent. Soc."; "Pontania desmodioides female Wlsh." [identification label of Marlatt]; "N. desmodioides Walsh [identification label of Norton]. Deposited in ANSP.

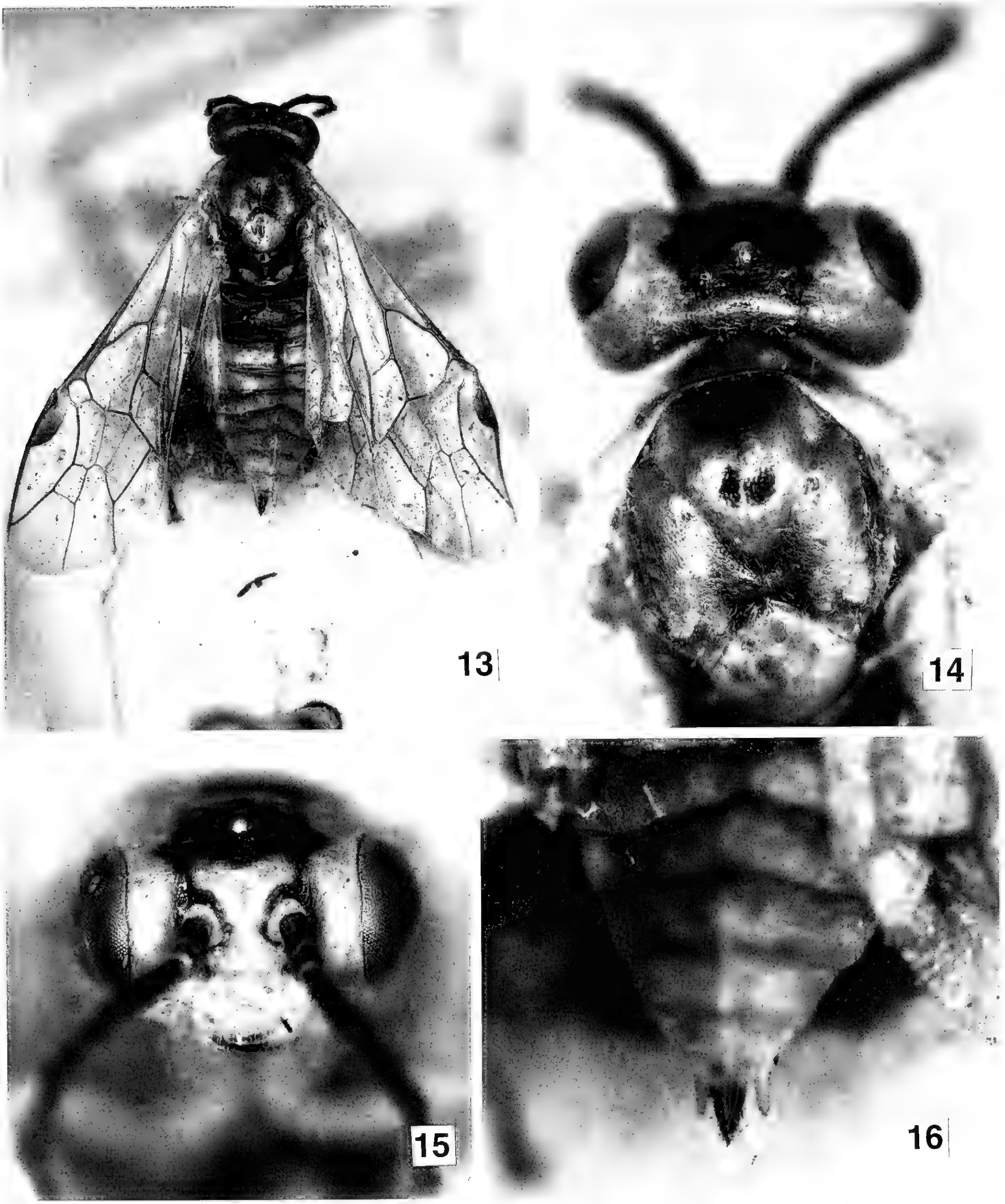
A paralectotype male is deposited in ANSP. It is mounted similar to the female, and it is labeled the same (with number 13), but without an identification label.

Valid name.—*Eupontania salicisdesmodioides* (Walsh), **new combination.**

Host.—*Salix humilis* Marshall.

Notes.—The galls are "semicircular in outline, sessile" (transected by the leaf blade and equally developed on both sides of the leaf).

The female can be separated from other



Figs. 13–16. *Eupontania salicispomum*, lectotype. 13, Dorsal view. 14, Head, dorsal view. 15, Head, front view; arrow indicated inner orbit. 16, Apex of abdomen, dorsal view.

Eupontania by the following combination of characters: sawsheath in dorsal view as a long triangle with an acute apex and straight sides and with hairs directed more posteriorly than laterally (with an angle of less than 90°); upper part of head in lateral view densely covered by hairs thoughout; hind tibial spurs shorter than apical tibial breadth; and inner orbits with dense hairs.

An additional female was examined from Massachusetts (deposited in ANSP) [seen by Marlatt because of his label].

Fig. 17. *Eupontania salicisdesmodiodes,* lectotype, dorsal view.

Nematus salicispisum Walsh 1866b: 248, 258–260 (No. 21bis) (Figs. 18–20)

Type material.—Described from many galls, larvae, two males, and three females.

The lectotype female, here designated (Figs. 18–20), is attached to a long triangular cardboard point, labeled "Ill."; "14"; "Return to Am. Ent. Soc." Two paralectotypes males are similarly labeled as the lectotype; one is labeled number 14 as is the lectotype, and the other is labeled number 15.

Valid name.—*Eupontania salicispisum* (Walsh), **new combination.**

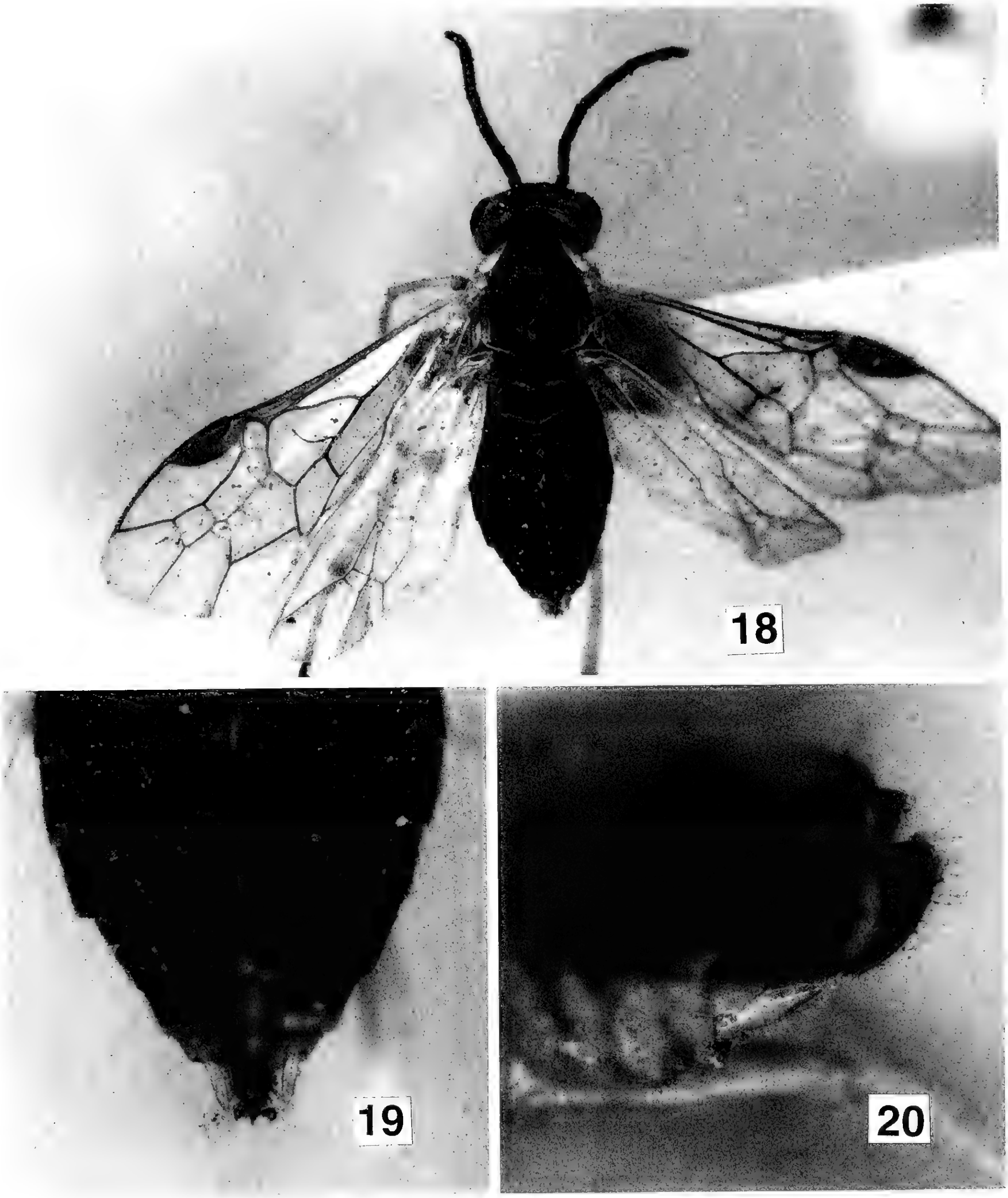
Host.—*Salix discolor:* The gall is illustrated by Zinovjev and Smith (1999: fig. 1). They are small, rounded, and attached to the sideveins, with a very small scar visible from the upperside and concave below the leaf surface.

Notes.—In the key to Palearctic species (Zinovjev 1993) this species runs to the *viminalis* group (length of inner hind tibial spur subequal to maximum width of hind tibial apex and rather thin). It is characterized also by its small size; short ovipositor (Fig. 20); sawsheath in dorsal view as a short triangle with rounded sides (Fig. 19) with the longest hairs directed more laterally than posteriorly and more strongly bent near their apices; upper part of head in lateral view with dense erect hairs, but front wall of frontal area glabrous; antennal hollow glabrous and shining; and inner orbits with hairs well developed.

Nematus quercicola Walsh 1866b: 260 (Figs. 21–24)

Type material.—Described from 2 males, 7 females reared from "an undescribed, cabbage-like, polythalamous, Cecidomyiidous gall on the White Oak . . ."

The lectotype (Figs. 21–24) is a female labeled "Ill"; "N. quercicola Walsh" [Norton's label]; "Return to Am. Ent. Soc.";

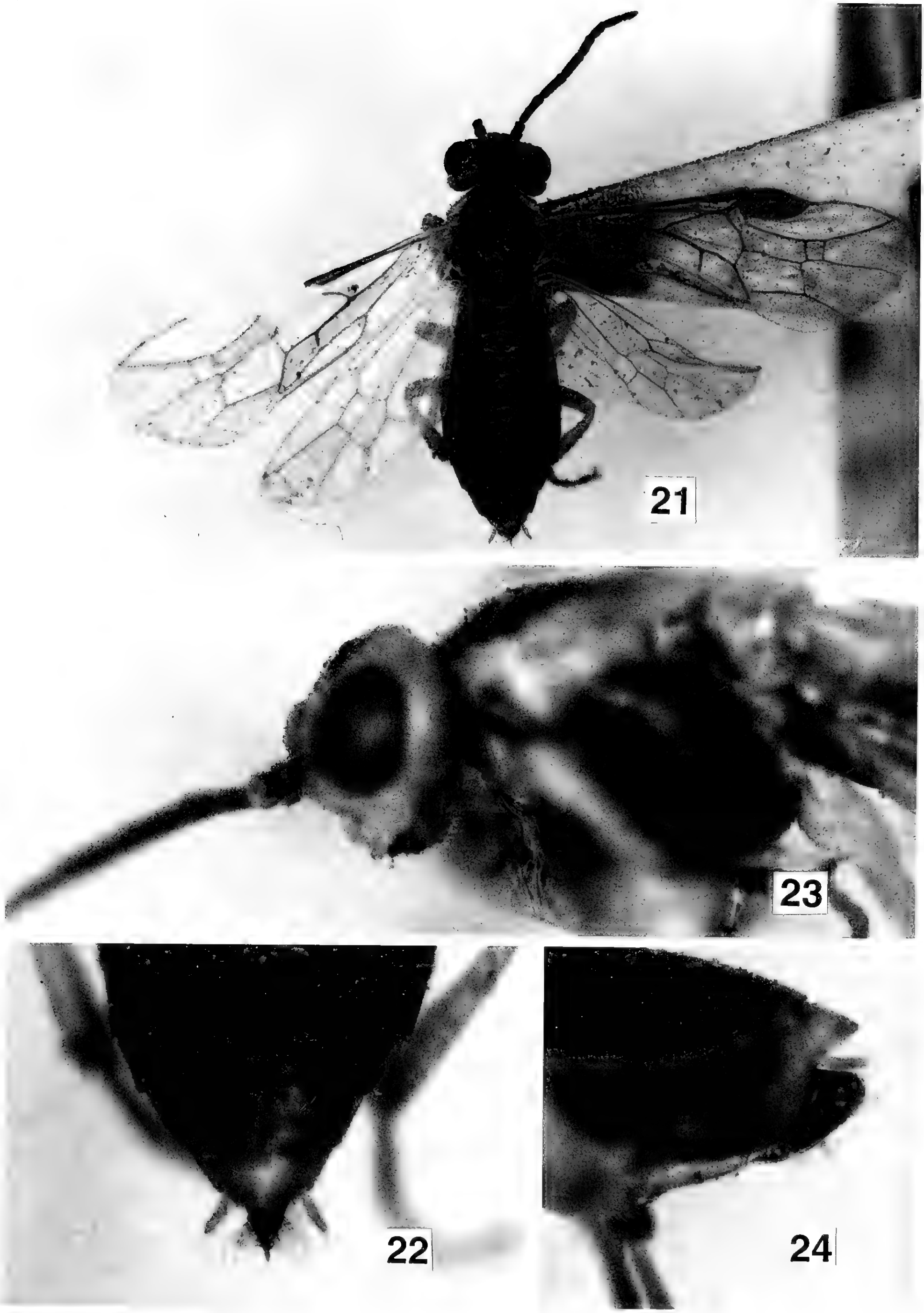


Figs. 18–20. *Eupontania salicispisum*, lectotype. 18, Dorsal view. 19, Apex of abdomen, dorsal view. 20, Apex of abdomen, lateral view.

"Pontania pisum Wlsh female" [Marlatt's identification label]. Deposited in ANSP.

Valid name.—*Eupontania salicispisum* (Walsh) (= *Nematus quercicola* Walsh).

Notes.—*Nematus quercicola* was treated as a synonym of the preceding species by Marlatt (1896), or by others (e.g., Smith 1979) as a *nomen nudum* because the only character mentioned by Walsh to distinguish it from the preceding species was that "all *N. s. pisum* went underground to pupize" and "*N. quercicola* pupized in the



Figs. 21–24. *Nematus quercicola,* lectotype. 21, Dorsal view. 22, Apex of abdomen, dorsal view. 23, Head and thorax, lateral view. 24, Abdomen, lateral view.

gall." A biological feature such as this, by formal reasons, could be treated as a "character," and we should accept this name as an available one. According to Walsh, this species "cannot be distinguished from the gallmaking *N. s. pisum* male, female."

Nematus inquilinus Walsh 1866b: 260–261

Type material.—Described from one male, three females, bred from the cecidomyiidous gall "S. rhodoides Walsh. No appropriate material was found in ANSP. The neotype female, here designated is the lectotype of *Nematus salicisdesmodiodes* Walsh (Fig. 17).

Valid name.—*Eupontania salicisdesmodiodes* (Walsh) (= *Nematus inquilinus* Walsh).

Notes.—This species was placed in synonymy with *Nematus salicisdesmodioides* Walsh (Marlatt 1896) and was listed as "unplaced" by Smith (1979). The type material was reared from galls on *Salix humilis,* the host plant of *Eupontania salicisdesmodioides.* To fix the usage of this name we designate the lectotype of *Nematus salicisdesmodioides* as neotype of *Nematus inquilinus* Walsh.

Nematus hospes Walsh 1866b: 261

Type material.—Described from one male and two females from the gall of *s. strobiloides* Osten-Sacken. No type material was located, but there is no strict evidence that absolutely all specimens under the name *N. salicispomum* belong to the original type series. To fix the usage of this name we select the lectotype of *N. salicispomum* Walsh (Figs. 13–16) as the neotype of *N. hospes* Walsh.

Valid name.—*Eupontania salicispomum* (Walsh) (= *Nematus hospes* Walsh).

Notes.—According to Walsh "absolutely undistinguishable from the normal type of the gall-making *N. s. pomum.*" Marlatt (1896) synonymized *N. hospes,* and these species have always been treated as conspecific.

Nematus mendicus Walsh 1866: 261

Type material.—Described from one male, three females: "one female bred May 2 from the Tenthredinous gall *S. pomum* n. sp. of the preceding year's growth, and another female, August 5, from the Cecidomyidous gall *S. brassicoides* Walsh of the same year growth; the other female and the male captured at large." No type material was located.

Valid name.—*Nematus oligospilus* Foerster 1854 (= *Nematus mendicus* Walsh).

Host.—Willows, *Salix* spp.

Notes.—Benson (1962) synonymized *Nematus mendicus,* thus treating *N. oligospilus* as a Holarctic species. It is in a complex of green *Nematus* species with external leaf-feeding larvae. Further studies may reveal several species in this complex. Currently, we accept Benson's synonymy.

Nematus fur Walsh 1866: 263

Type material.—Described from a single male "bred March 29 from an old bored subpeduncled spherical gall, .57 inch in diameter, made by *Cecidomyia s. batataus* Walsh on *S. humilis.*" The type was not located.

Valid name.—Currently, *Nematus fur* is treated as a synonym of *Amauronematus histrio* Serville 1823. However, its taxonomic position is not quite clear. It is possibly a valid species of *Amauronematus.*

Notes.—This species was treated by Ross (1951) as a synonym of *Amauronematus luteotergum* Norton 1861, and by Smith (1979) as synonym of *A. histrio* Lepeletier 1823 (= *luteotergum* Norton). However, these treatments do not fit exactly the description of *N. fur.* According to Walsh, *Nematus fur* has "black legs" and "wings subhyaline, slightly tinged with fuliginous." This dark coloration of the wings and legs is rare in the Nematinae, and we could not find appropriate specimens in collections that fit the description of *N. fur.* Otherwise, according to its morphology (particularly microsculpture) and its ability to bore for pupation into plant tissue, it almost certainly belongs to *Amauronematus*.

Pristiphora sycophanta Walsh 1866b: 263

Type material.—Described from a single male "bred August 9 from a cocoon found, July 27, inside the Cecidomyidous gall *S. brassicoides* Walsh of the same year growth." The type was not found.

Valid name.—*Pristiphora sycophanta* Walsh.

Host plants.—This is a common *Pristiphora* on willows. The cecidomyidous gall from which the type was reared was on *Salix interior.*

Notes.—Numerous specimens were taken in Clarke Co., VA, where the predominant willows around a pond were *Salix nigra* Marsh. Malaise trap collections at this locality included *P. sycophanta* specimens throughout the spring and summer, indicating that there are several generation a year. This supports our interpretation of *P. sycophanta,* which Walsh stated was reared from the same years growth.

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A NEW SPECIES OF THE SUBGENUS *SABETHOIDES* OF *SABETHES* (DIPTERA: CULICIDAE) FROM VENEZUELA AND BRAZIL

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Abstract.—The adult male, pupa and larva of ***Sabethes* (*Sabethoides*) *conditus*, n. sp.,** are described from localities in western Brazil and northern Venezuela. The species is distinguished from *Sabethes chloropterus* (von Humboldt), which it closely resembles in all life stages.

Key Words: Diptera, Culicidae, *Sabethes, Sabethoides,* new species, mosquito, Brazil, Venezuela

Mosquitoes of subgenus *Sabethoides* Theobald of genus *Sabethes* Robineau-Desvoidy are some of the more common insects in Neotropical forests, yet they are poorly known and rarely studied. No significant taxonomic research has been done on the subgenus since Lane (1953). This is surprising since one of the species, *Sa. chloropterus* (von Humboldt), has repeatedly been found infected with St. Louis encephalitis virus (Galindo et al. 1959) and is known to transmit yellow fever virus to humans (Galindo et al. 1956). In addition to *Sa. chloropterus,* the subgenus includes *Sa. glaucodaemon* (Dyar and Shannon), *Sa. tridentatus* Cerqueira, and at least 2 undescribed species. With the addition of the new species described in this paper, *Sabethoides* now includes 4 formally recognized species.

The new species described here very closely resembles *Sa. chloropterus* in all life stages, and undoubtedly has been confused as this species in the past. For this reason, future study may indicate that it is also a vector of arboviruses.

MATERIALS AND METHODS

This study is based on specimens borrowed from the National Museum of Natural History, Smithsonian Institution, Washington, DC. Observations of the adults were made under simulated natural light. Larval and pupal chaetotaxy were studied using a combination of bright field and differential interference contrast microscopy. Measurements and counts were taken from all specimens of the type series where the structures in question were present. Numbers in parentheses represent modes of the reported ranges unless indicated otherwise. The form of presentation, descriptive terminology and abbreviations used in the species description follow Harbach and Knight (1980, 1982) and recent papers published as part of an ongoing revision of the genus *Sabethes* (Harbach and Peyton 1991; Har-

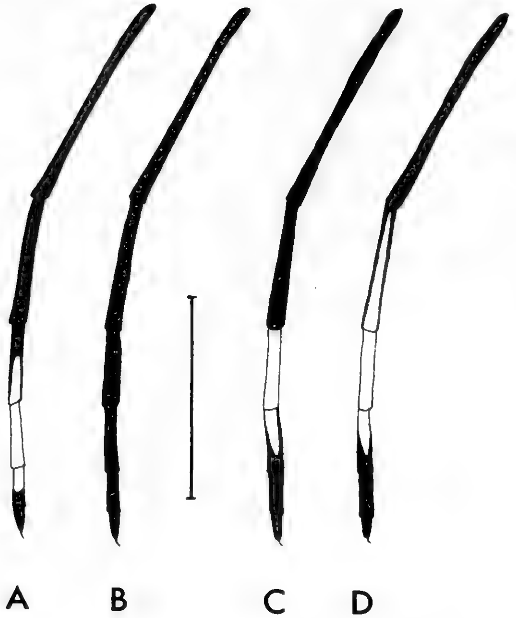

Fig. 1. Tibia and tarsus of midleg of *Sabethes* (*Sabethoides*) *conditus* (A, B) and *Sa. chloropterus* (C, D). A, C, Anterior; B, C, posterior. Scale = 2.0 mm.

bach 1991a, 1994, 1995a, b; Harbach and Petersen 1992; Hall et al. 1999).

***Sabethes* (*Sabethoides*) *conditus*, Moses, Howard, and Harbach, new species**

(Figs. 1–4)

Sabethes (*Sabethoides*) sp 4 of Heinemann and Belkin 1978: 373.

This species exhibits the diagnostic characteristics of the subgenus noted by Harbach (1991a): midtarsus marked with white scaling; prespiracular, upper proepisternal and lower mesokatepisternal setae present; prealar setae absent; and legs without paddles.

Male.—Medium-sized mosquito with brilliant metallic-coloured scaling; scales of head capsule, thorax and abdomen very broad and flat; scales of vertex with different combinations of metallic blue, violet and green reflections depending on angle of light; scales of postgena, thoracic pleura and coxae silvery white; antepronotum ranging from dark gold to bright cerulean blue depending on angle of light; scaling of postpronotum similar to pleura but with a slight golden hue; scutal and scutellar scales metallic gold with cerulean reflections; mesopostnotum without scales; proboscis and legs predominantly metallic blue and violet, proboscis darker; wing entirely dark-scaled with blue, gold and violet iridescence when viewed from certain angles; abdominal terga primarily metallic gold with narrow pale basal bands, from dorsal angles golden areas appear cerulean to green and basal bands mauve to violet, basal bands broader laterally and silvery-white in lateral view. *Head:* Eyes joined above and below. Occiput with transverse row of short semierect scales at back of head. Ocular setae short, dark, close to margin of eye; 2 long, bronzy, approximated interocular setae present. Antenna: Dark; length 1.29–1.36 mm ($\bar{x}$ = 1.34 mm), significantly shorter than proboscis; pedicel large, surface silvery pubescent; flagellum rather strongly verticillate, proximal whorls with 9 or 10 setae, longest setae about 0.33 length of antenna. Clypeus and frons without setae and scales, dark. Proboscis long, slender, straight; length 2.00–2.10 mm ($\bar{x}$ = 2.05 mm); distal 0.3 gradually expanded laterally, becoming twice as broad as proximal part; dark-scaled with ventral patch of yellowish white scaling extending 0.5 to 0.8 from base. Maxillary palpus short, about 0.08 length of proboscis; silvery-scaled dorsally, bare ventrally. *Thorax:* Integument brown. Dorsum with dark setae on anterior promontory (10, 11), antepronotum (11–13), supraalar area (10–15), scutellum (3,4 long setae on lateral lobes; 2 long setae projecting downward from midlobe) and mesopostnotum (4). Pleura with prespiracular (2), upper proepisternal (1), lower mesokatepisternal (1,2) and upper mesepimeral setae (9–11); prespiracular setae dark, others yellow or golden. Lower part of proepisternum without scales, scales on upper part contiguous with scales on anteprocoxal membrane; scales present on upper portion of postprocoxal membrane; mesopleuron with scales covering all but lower anterior margin of mesokatepisternum, extreme dorsal margin of postspiracular area, narrow ventral and upper posterior margins of mesepimeron and mesomeron; scales absent from metapleuron, metameron and postmetacoxal membrane. *Wing:* Length 3.2 mm; dorsal scales broader and slightly asymmetrical on anterior and distal veins; alula with fine piliform scales on margin distally; calypters without setae. *Halter:* Scabellum without scales, integument pale; pedicel and capitellum dark-scaled. *Legs:* Coxae and trochanters with silvery-white scales, trochanters with some dark scales dorsally at apex; femora dark above and golden below; all tibiae and fore- and hindtarsi entirely dark-scaled; anterior surface of midtarsus (Fig. 1) white-scaled from middle of tarsomere 2 to middle of tarsomere 4 (paratype from Brazil with white scaling encircling tarsomere 3 and part of 4). Forefemur about 1.2 length of proboscis, same length as midfemur, about 1.3 length of hindfemur; hindtibia about as long as hindfemur, hindtarsomere 1 about 1.2 length of hindfemur. Ungues small, simple, black. *Abdomen:* Coloration as noted above, sternal scales distinctly larger and less recumbent than tergal scales. *Genitalia* (Fig. 2): Tergum VIII (ventral in position; not illustrated) with deep V-shaped emargination at middle of posterior margin, posterior border on either side of emargination with 3 or 4 irregular rows of long close-set setae, posterior half of surface before setae covered with recumbent spatulate scales that rather abruptly grade into a cluster of much larger scales on posterolateral corners, scales of cluster about half length of marginal setae. Tergum and sternum IX fused laterally, forming a complete ring of sclerotization; ninth tergal lobes small, not produced, each bearing 3 flattened setae with apices bent laterad; interlobular bridge moderately broad. Gonocoxite stout, width more than half length in lateral view, tapered in distal third, tergomesal surface membranous, distal sternal area covered with scales and short setae, bearing 3 long tergomesal setae below basal mesal lobe; basal mesal lobe of irregular shape, roughly trapezoidal in ventral (tergal) view, partly covered with small slender setae and bearing 2 large setae at caudolateral angle. Gonostylus (side view) large, about two-thirds length of gonocoxite; stem stout, short, less than half length of head; head as illustrated, bearing 5 well developed lobes (**A, C, E, M, M′**), a slightly produced lobe **B** and an elongate tergal fimbriate process; lobe A, elongate tapered process arising tergomesal of base of lobe M, bearing several short stout setae at apex; lobe E, rather short conical lobe borne mesally at bases of lobes A and M, with large blade-like seta and 2 smaller needle-like setae at apex; lobe B, lateral minutely spiculate swelling associated with sternomesal margin of lobe E, bearing 3 large sternally directed setae with distal ends flattened and expanded subapically; lobe M, irregular partially subdivided median apical lobe bearing broadly V-shaped tergal process with short striated arms and more proximal long slender tergally directed fimbriate process comprised of partially fused and coalesced filaments with free ends bending toward base of gonostylus; lobe M′, elongate irregular process arising from sternolateral margin at base of lobe M, subapical tergolateral margin with several short thickened setae and more proximal small flattened sigmoidal seta, sternal margin with laterally compressed projection bearing a narrowed retrorse apex; lobe C, large mesally slanted process arising from sternal margin at base of lobe M′, bearing pattern of decumbent spine-like spicules on mesal side of apical margin and cluster of long sternally directed filaments on lateral side at proximal end. Aedeagus longer than wide, widest in basal half; submedian tergal arms fused to form broad median tergal bridge; apical tergal arms fused to form narrow apical bridge; median sternal plate rather membranous, apex not markedly flared, hood-like. Proctiger (in lateral view) with broad basal sclerotization (tergum X); paraproct slender,

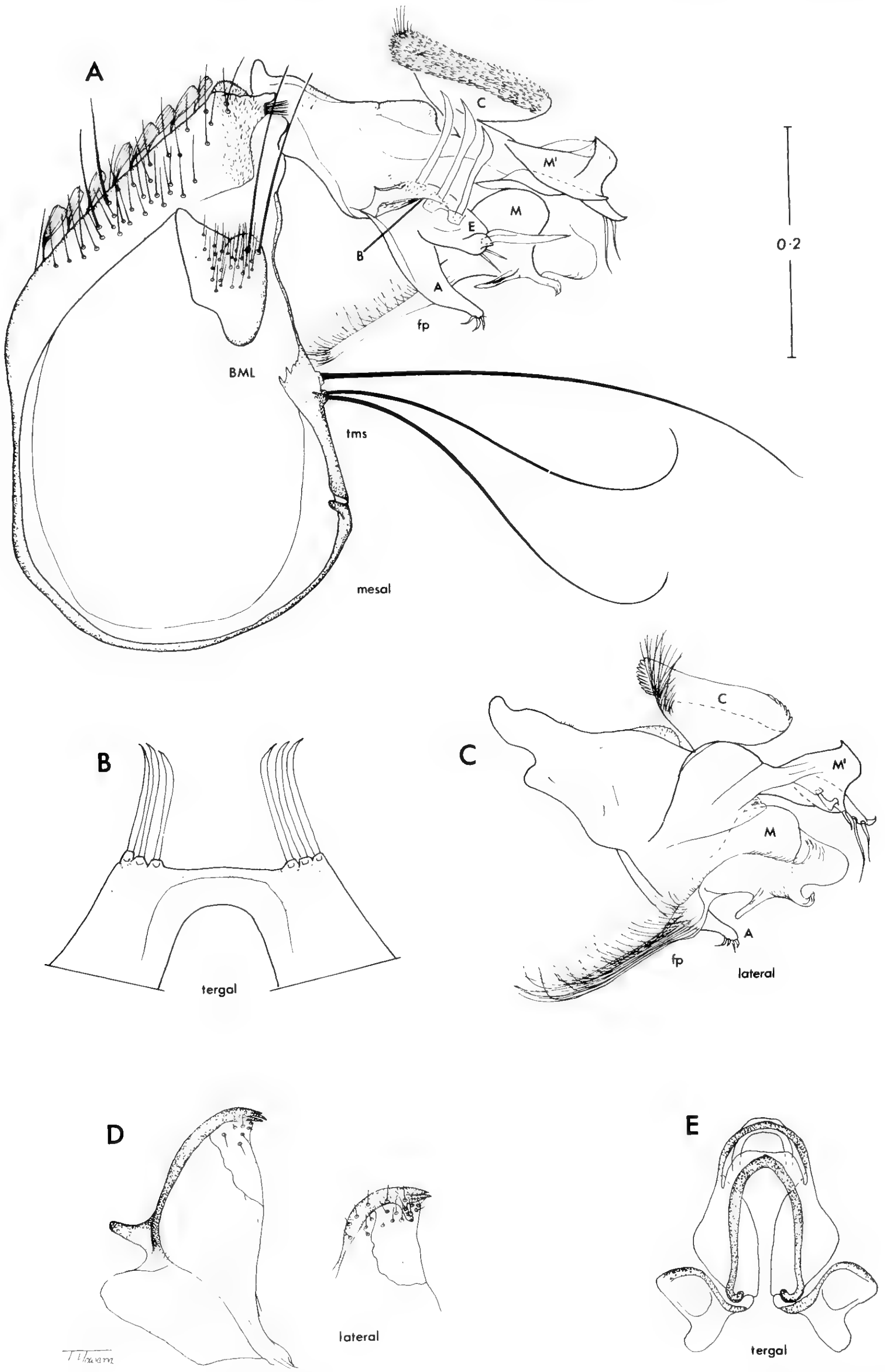

Fig. 2. Male genitalia of *Sabethes* (*Sabethoides*) *conditus*. Aspects as indicated for (A) gonocoxopodite; (B) tergum IX; (C) gonostylus; (D) proctiger; (E) aedeagus, with parameres attached. A, B, C, E, M and M′ = gonostylar lobes; BML = basal mesal lobe; fp = fimbriate process; tms = tergomesal setae. Scale in mm.

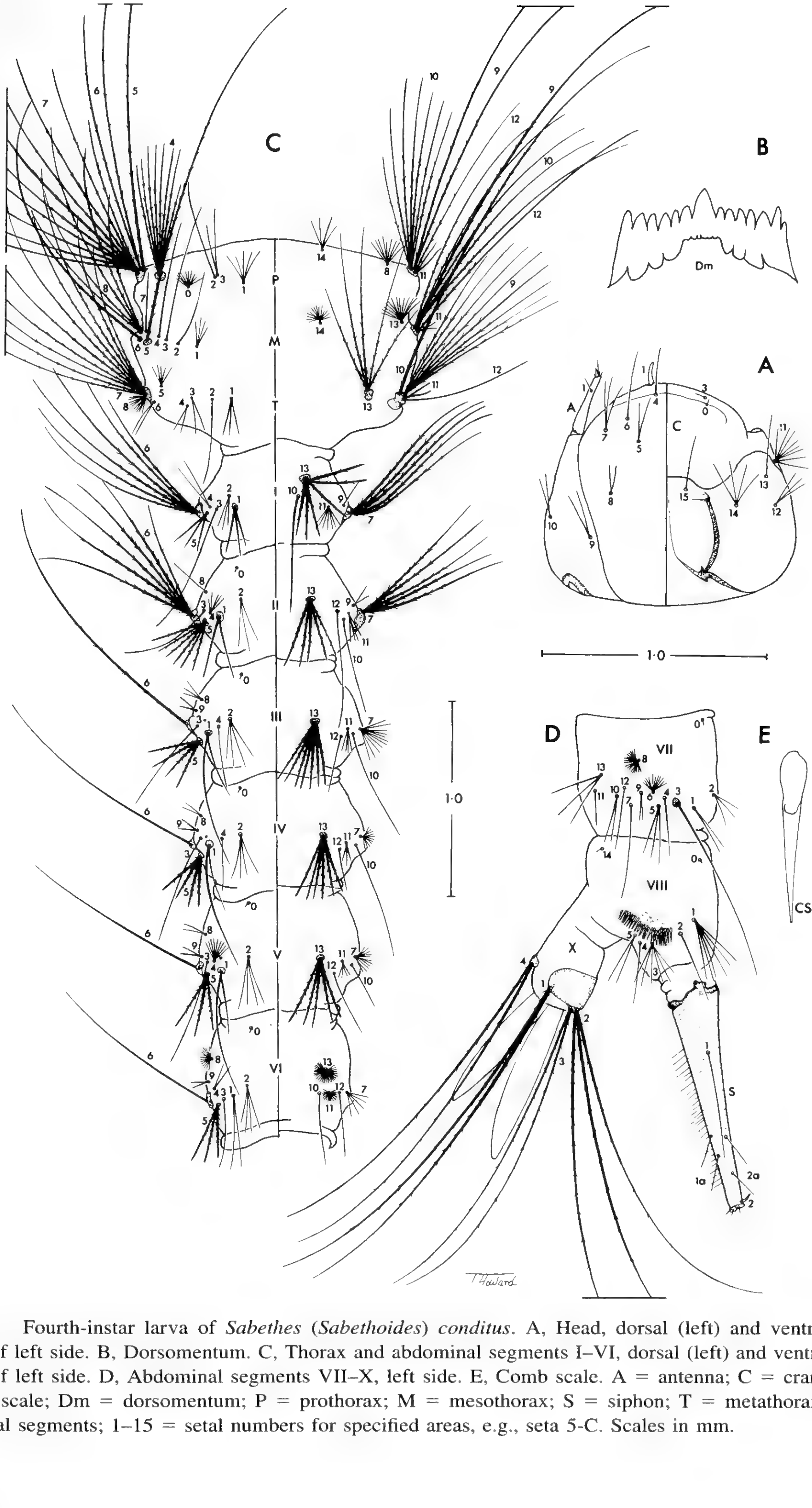

Fig. 3. Fourth-instar larva of *Sabethes* (*Sabethoides*) *conditus*. A, Head, dorsal (left) and ventral (right) aspects of left side. B, Dorsomentum. C, Thorax and abdominal segments I–VI, dorsal (left) and ventral (right) aspects of left side. D, Abdominal segments VII–X, left side. E, Comb scale. A = antenna; C = cranium; CS = comb scale; Dm = dorsomentum; P = prothorax; M = mesothorax; S = siphon; T = metathorax; I–X = abdominal segments; 1–15 = setal numbers for specified areas, e.g., seta 5-C. Scales in mm.

Table 1. Numbers of branches for setae of fourth-instar larvae of *Sabethes* (*Sabethoides*) *conditus*.

	Head	Thorax			Abdominal segments	
Seta	C	P	M	T	I	II
0	1	10–13	—	—	—	1
1	1	5,6(5,6)	3–5(4)	3	2,3(3)	2
2	—	1	1	1	2,3(2,3)	3,4(3)
3	1	2	1	2,3(2)	1	1
4	1	6–9(7)	1	2–4(2)	2–4(3)	4–6(4)
5	2	1,2(1)	1	3–5(3)	3	5,6(6)
6	1	2	1	1–3(2)	5,6(6)	5–8(5)
7	3–5(3)	7,10(10)	1	10–12(10)	5–7(5)	4–6(6)
8	2,3(2)	9–11(10)	5,6(6)	10–12(10)	—	1,2(1)
9	2	2,3(2)	1,3(1)	7,8(7,8)	1	2
10	1,2(2)	6–8(7)	5,6(5)	1	1	1
11	6–9(9)	1,2(2)	1,2(2)	1,2(1)	6–8(7)	4
12	3,4(3)	1	1	1	—	1
13	1	—	13–16	5,6(6)	6,7(6)	5–7(6)
14	4,5(5)	2–4(4)	12–19(19)	—	—	—
15	1–3(1)	—	—	—	—	—

apex with 2 or 3 appressed teeth, rather large subapical area distinctly sclerotized, bearing 6–23 cercal setae.

Female.—Not definitely associated with the male (see Systematics, below); 2 presumed females from Brazil resemble the males from Venezuela except for the absence of a pale patch on the ventral surface of the proboscis and in having slightly more extensive pale scaling on the anterior surface of the midtarsus, extending from proximal 0.2 of tarsomere 2 to apex of 4.

Egg.—Unknown.

Larva, fourth instar (Fig. 3).—Exhibiting the subgeneric characters noted by Harbach 1991a; similar to *Sa. chloropterus* (*cf.* Fig. 4 in Harbach 1991b); character and placement of setae as figured, numbers of branches in Table 1. *Head:* Slightly wider than long, widest in posterior half; length about 1.0 mm; width about 1.3 mm. Occipital foramen widely V-shaped with arms extending dorsolaterally to point laterad of level of seta 9-C, margins heavily tanned, ventrocaudal margin with collar-like edge. Anterior margin of labiogula weakly denticulate; hypostomal suture complete, gently curved. Dorsomentum (Fig. 3B) short, with 6,7 teeth on either side of median tooth, median tooth and most lateral tooth larger than others. Maxilla, including apical tooth, about half length of head, with 8–10 lateral teeth, first lateral tooth larger than the others which become progressively smaller. Setae 4,6-C single, simple; 7-C usually triple; 9-C inserted at level distinctly posterior to 10-C; 10-C single or double; 14-C without thickened branches; 15-C inserted cephalad of 14-C near anterior margin of labiogula, long with 1–3(1) branches. *Antenna:* Short, cylindrical; slightly tapered distally, length about 0.28 mm. Seta 1-A single, simple, borne dorsally about 0.8 from base, length about 2 times width of antenna at point of insertion. *Thorax:* Integument hyaline, smooth. Setae 0,1,8,14-P, 1,13,14-M and 5,8-T with multiple short flexible branches; 11-P,M,T single or double, 11-P,M with slender flexible branches, 11-T with stiff thickened branches; 13-T with multiple branches, about length of thorax. *Abdomen:* Integument hyaline, smooth except for rows of minute spicules before comb. Seta 1-I,II with thickened branches, 1-III-V long, double with one branch markedly shorter; 2-I laterad of seta 1, 2-II-VII well mesad and anterior to seta 1; 6,7-I,II similar, strongly developed with multiple

Table 1. Continued.

Abdominal segments						
III	IV	V	VI	VII	VIII	X
1	1	1	1	1	1	—
2	2	2	2	2,3(2)	5–8(5)	2
3,4(3,4)	3,4(4)	3,5(3,5)	3,4(3)	2,3(2)	1	3,4(3,4)
1	1	1	1	1	6,7(6,7)	2
1	1	8–11(8)	1,2(1)	1	1	2
4,5(4,5)	3,4(4)	3,4(3)	2,3(2)	2–5(3)	2	—
1	1	1	1	10–14(13)	—	—
9–12	11–16	11–13(12)	5–8(7)	1	—	—
2,3(3)	2	1,2(2)	14–17	19–25	**1–S,**	**1**
2,3(2,3)	2,3(2)	2	1,2(1,2)	2	**1a–S,**	**1**
1	1	1,2(1)	1	1,2(2)	**2a–S,**	**1**
4,5(4,5)	3,4(3)	2–6	15–21	1	—	—
1	1	1	1	1	—	—
5–7(7)	5–6(5,6)	5,6(5)	29–34(29)	3,4(3)	—	—
—	—	—	—	—	1	—
—	—	—	—	—	—	—

aciculate branches, 6-III-VI long, single and progressively shorter; 5-II-VI and 13-I-V strongly developed, stellate, with stiff aciculate branches; 13-III-V apparently with more branches ($\bar{x}$ = 17) than *Sa. chloropterus* ($\bar{x}$ = 12); punctures present on segments III–V. *Segment VIII:* Comb a single row of 21–26 long slender spine-like scales (Fig. 3E) without fringe of minute spicules, scales close-set with flared bases sometimes partially joined. *Siphon:* Relatively long and slender, gradually tapered from base to apex; moderately tanned, surface more or less evenly covered with short rows of minute spicules; length about 1.3 mm, width at mid-length about 0.1 mm, index about 13. Pecten of about 30 fine filaments extending from below level of insertion of seta 1-S to point distal to seta 1a-S. Seta 1-S inserted 0.25 from base of siphon, 1a-S includes 1 or 2, usually 2, and 2a-S includes 2 or 3, usually 3, single setae; seta 2-S stout, slightly sinuous and minutely forked at tip (not apparent in Fig. 3D). *Segment X:* Saddle borne on posterodorsal quarter of segment, surface more or less evenly covered with rows of minute spicules; length about 0.2 mm; siphon/saddle index about 6.5. Setae 1–4-X equally well developed; 1,3,4-X double, 2-X usually triple (3,4).

Pupa (Fig. 4).—Exhibiting the subgeneric characters noted by Harbach 1991a; similar to *Sa. chloropterus*; character and positions of setae as illustrated, numbers of branches in Table 2. *Cephalothorax:* Lightly tanned. Seta 1-CT strongly developed, double, branches sigmoidally curved with hooked tips; 5-CT also well developed, double or triple, more often triple. *Trumpet:* Moderately tanned, slightly flattened but little if at all expanded laterally; length 0.32–0.39 mm ($\bar{x}$ = 0.35 mm), width at mid-length 0.11–0.14 mm, index 2.78–2.91 ($\bar{x}$ = 2.81); pinna short, length about 0.08 mm. *Abdomen:* Lightly tanned, terga and sterna darker anteriorly; length about 3.7 mm. Seta 1-I well developed, with about 80 terminal branches; 6,7-I long, 6-I single, longer than 7-I; 2-II-VII lateral to seta 1; 5-II,III with multiple branches, much shorter than 5-IV-VI, 5-IV-VI very long, more than twice length of following tergum; seta 4-IV short, with multiple branches, generally with more branches than in *Sa. chloropterus* which usually has 1 or 2; 10-II and 13-VI present on both sides in 2 available

Table 2. Numbers of branches for setae of pupae of *Sabethes* (*Sabethoides*) *conditus*.

	Cephalothorax	Abdominal segments			
Seta	CT	I	II	III	IV
0	—	—	1	1	1
1	2	10–14(10)*	5,6(6)	2,3(3)	2,3(2)
2	2,3(3)	1	1	1	1
3	2,3(2,3)	1,2(1)	1	1	2–4(3)
4	2–4(3)	5–7(6)	5,6(5)	3–5(4)	2–6
5	3	1	6–11	5–8(5)	1†
6	1–3(2)	1	1	1	1
7	2–4(3)	3	3,4(3,4)	4,6(4,6)	3–8
8	3,4(3)	—	—	4–7	2
9	1	1	1	1	1
10	1,2(1)	a‡	1,2(1)	1,2(2)	2
11	3,4(3)	1	2,3(2,3)	3	1,2(2)
12	1,2(1,2)	—	—	—	—
13	—	—	—	—	—
14	—	—	—	—	—

* Primary branches.
† Presumed (see legend for Fig. 4).
‡ Alveolus only.

specimens, 13-VI quite variable in size and number of branches (3–12), apparently absent in *Sa. chloropterus*. *Genital lobe:* Lightly tanned, length (male only) about 0.36 mm. *Paddle:* Lightly tanned, asymmetrical, broadest at base, tapered distally, inner part narrow, less than 0.5 width of outer part, and minutely spiculate at apex; length about 0.7 mm, width at widest point about 0.45 mm, index 1.55.

Systematics.—*Sabethes conditus* resembles *Sa. tridentatus* and *Sa. glaucodaemon,* but differs in having distinctly shorter upper meseperimeral setae. These setae reach the lateral area of the mesopostnotum in *Sa. conditus* and extend to near the middle of the mesopostnotum in the other two species. The male of *Sa. conditus* also differs in the presence of ventral pale scaling on the proboscis, the pattern of pale scaling on the mid-tarsi, and the structure of the genitalia. *Sabethes conditus* has undoubtedly been misidentified as *Sa. chloropterus* in the past, mainly because most studies have focused on females that appear to be essentially isomorphic for the two species.

Knight and Stone (1977) list four junior synonyms for *Sa. chloropterus: Sabethes nitidus* (Theobald), *Sabethoides confusus* (Theobald), *Sabethoides rangeli* (Surcouf and Gonzales-Rincones), and *Sabethoides imperfectus* (Bonne-Webster and Bonne). *Sabethes nitidus* was included in error because the lectotype designation by Belkin (1968) validated this nominal taxon as a distinct species of subgenus *Sabethes,* and the paralectotype male that Knight and Stone used as a basis for synonymy with *Sa. chloropterus* has no taxonomic status. We know from concurrent studies of *Sabethoides* that the holotype female of *Sabethoides imperfectus* is not conspecific with *Sa. chloropterus* and will be formally synonymized with another species in a future revision of the subgenus (by R.E.H.). The holotype females of *Sabethoides confusus* and *Sabethoides rangeli* are both in very poor condition, and even though *Sabethoides confusus* has no midlegs, both specimens clearly belong to a species of *Sabethoides* other than *Sa. glaucodaemon* or *Sa. tridentatus.* The holotype of *Sabethoides rangeli* has faint white scaling on the ventral surface of the proboscis (0.5 to 0.8 from base), a feature that is not known in females of *Sa. chloropterus* or the pre-

Table 2. Continued.

Abdominal segments					Paddle
V	VI	VII	VIII	IX	P
1	1	1	1	—	—
2	2,3(2)	2,3(3)	—	—	—
1	1	1	—	—	—
2,3(2)	2,3(2)	3,4(3)	—	—	—
3–6(6)	2	1	1,2(1,2)	—	—
1	1	3–5(4)	—	—	—
1,2(2)	1,2(1,2)	5,6(5,6)	—	—	—
5–8	1,2(1,2)	1,2(1,2)	—	—	—
2,3(2)	6–9(7)	10–15(14)	—	—	—
1	1	13–15(14)	23–27(26)	—	—
1	1	2,3(2)	—	—	—
1,2(2)	4–6(4)	1	—	—	—
—	—	—	—	—	—
—	3–12	—	—	—	—
—	—	—	1	—	—

sumed females of *Sa. conditus* examined in this study. In the absence of any evidence to suggest that the holotype of either *Sabethoides confusus* or *Sabethoides rangeli* may be conspecific with *Sa. conditus* rather than *Sa. chloropterus,* these nominal forms are retained in synonymy with the latter species.

The male of *Sa. conditus* is easily distinguished from the male of *Sa. chloropterus* in having a lesser amount of pale scaling on the proboscis and midtarsus, and a very differently constructed gonostylus. The proboscis of *Sa. conditus* has ventral pale scaling extending from 0.5 to 0.8 beyond the base whereas in *Sa. chloropterus* it extends from 0.3 to 0.8 beyond the base. Similarly, the midtarsus has pale scaling on the anterior surfaces of tarsomeres 2–4 in *Sa. conditus* (also on the posterior surface of tarsomeres 3 and 4 in the paratype from Brazil) whereas it occurs on the anterior surfaces of tarsomeres 2 and 3 and the posterior surfaces of tarsomeres 1–4 in *Sa. chloropterus.*

The two females of *Sa. conditus* from Brazil are presumed to belong to this species because specimen numbers on the labels indicate that they were collected and reared from pupae along with the paratype male. Apparently no collection records, additional data or associated pupal exuviae exist in the Smithsonian Institution to confirm this (J. Pecor, personal communication). The two females have the same pattern of pale scaling on the midlegs and appear to resemble verified females of *Sa. chloropterus* in overall habitus (the midlegs of *Sa. chloropterus* sometimes also have a variable amount of pale scaling on the posterior surfaces of tarsomeres 2–4). If these two specimens are females of *Sa. conditus,* then the female of this species is indistinguishable from the female of *Sa. chloropterus.*

No diagnostic characters were found to distinguish the larva and pupa of *Sa. conditus* from those of *Sa. chloropterus,* but some partially differential characteristics have been noted that may prove to be useful once additional material becomes available for further study. In the pupa, seta 4-IV has 2–6 branches whereas specimens of *Sa. chloropterus* only have 1 or 2 (usually 2), and seta 13-VII, a unique feature among mosquitoes, is present on both sides in the two available specimens of *Sa. conditus.* In the larva, the mean sum of branches of seta 13-III-V on one side is 17 compared to 12 in *Sa. chloropterus,* comb scales apparently

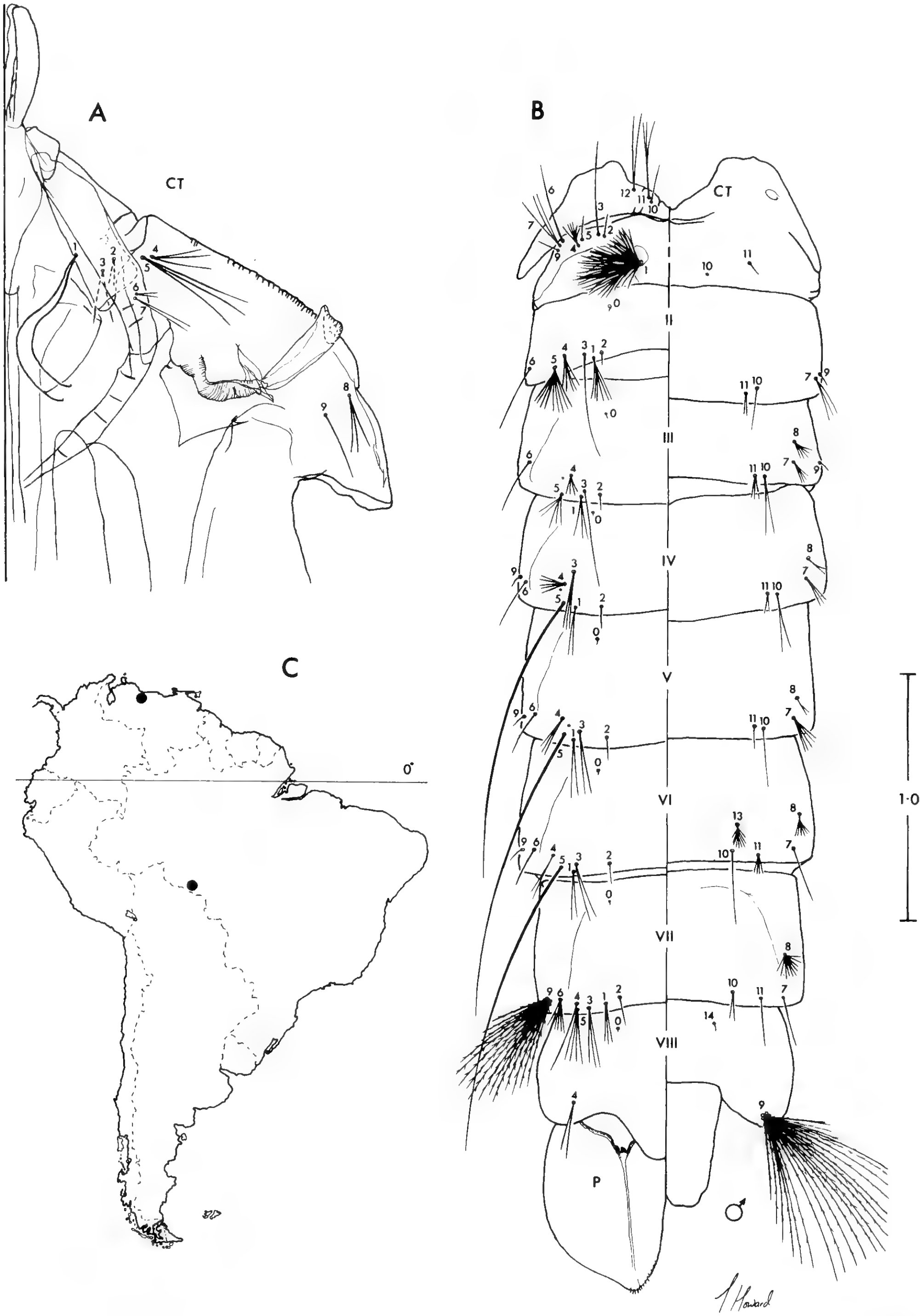

Fig. 4. A, B, Pupa of *Sabethes* (*Sabethoides*) *conditus*. A, Left side of cephalothorax, dorsal to right. B, Dorsal (left) and ventral (right) aspects of metathorax and abdomen. C, Localities in Venezuela and Brazil where type specimens of *Sa. conditus* were collected (see Material examined). Seta 5-IV was absent in available specimens and is drawn similar to 5-V,VI based on this development in *Sabethoides*. CT = cephalothorax; P = paddle; I–VIII = abdominal segments; 1–14 = setal numbers for specified areas, e.g., seta 3-I. Scale in mm.

lack the fringes of minute spicules that are present in *Sa. chloropterus,* and seta 4-X is double whereas it has 3 or 4 branches in *Sa. chloropterus.*

Etymology.—The specific name of *conditus* is a Latin adjective (masculine) meaning unseen or hidden. The name refers to the fact that the species undoubtedly has been mistaken for *Sa. chloropterus* in the past.

Bionomics.—The type specimens from Venezuela were collected as larvae found in brownish water contained in a small hole located 0.6 m above ground level in a leguminous tree. The treehole also contained larvae of *Culex (Anoedioporpa) conservator* Dyar and Knab. Nothing else is in definitely known about the bionomics of *Sa. conditus,* but it is likely that some of the information published about *Sa. chloropterus* actually applies to this species.

Distribution.—The type specimens were collected at the two localities indicated in Fig. 4C, one in northern Venezuela and the other in western Brazil. *Sabethes conditus* is undoubtedly widely distributed between and around these localities. Reports of *Sa. chloropterus* from this region may apply to *Sa. conditus* or a mixture of the two species.

Material examined.—Eleven specimens (3 ♂, 2 ♂ genitalia, 2 ♀, 2 larval exuviae, 2 pupal exuviae), including 2 larval rearings. VENEZUELA: Aragua, Ocumare de la Costa, Puerto Ocumare, just E of (19PFM3459), near sea level, 10 Jul 1969, J. A. Bergland and J. Valencia, 1 ♂ with associated larval and pupal exuviae and dissected genitalia on separate slides (VZ133-11), associated larval and pupal exuviae of lost ♂ (VZ133–22) and 1 ♂ (VZ133-1) (small treehole in partial shade 4 m above ground in leguminous tree in coconut plantation; water temporary, brown, turbid). BRAZIL: Rondônia, Costa Marques, 31 Jan 1992, USAMRU-B personnel, 1 ♂ (BR513 (65)-102) with dissected genitalia on microscope slide and 2 ♀ (BR513 (65)-100 and -102).

The males above comprise the type series of *Sa. conditus.* The holotype (VZ133-11), with associated larval and pupal exuviae and dissected genitalia on separate microscope slides, and 3 paratypes (VZ133-1, VZ133-22, BR513 (65)-102) are deposited in the National Museum of Natural History, Smithsonian Institution. The two females are excluded from the type series because they are not definitely associated with the males, and may not be conspecific with them.

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We thank personnel of the Walter Reed Biosystematics Unit, Smithsonian Institution, Washington, DC, for the loan of specimens. We are grateful to Robert Hancock, Cumberland College, Williamsburg, Kentucky, for assistance and advice to Dusty Moses. Jane Carter of the same college is acknowledged for co-ordinating the International Enrichment Program that provided the Biological Internship to Dusty Moses that made this study possible.

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CORRECTIONS AND ADDITIONS TO THE "CATALOG OF THE STILT BUGS, OR BERYTIDAE, OF THE WORLD (INSECTA: HEMIPTERA: HETEROPTERA)"

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Abstract.—The catalog of the stilt bugs of the world, containing entries for 36 valid genera and 168 valid species, appeared in early 1998. Since then, we have discovered a number of errors thanks to the help of several colleagues. Corrections and additions range from minor misspellings to the omission of taxa. Among the more important entries concern the date of description of *Metacanthus* Costa and its type species and the addition of the two overlooked species, *Neides propinquus* Horváth and *Gampsocoris gatai* Günther.

Key Words: Heteroptera, Berytidae, catalog, omitted taxa, gender, type fixations, dating, misspellings, literature cited

The world stilt bug catalog (Henry and Froeschner 1998. Catalog of the stilt bugs, or Berytidae, of the world (Insecta: Hemiptera: Heteroptera). Contributions of the American Entomological Institute 30(4): 1–72.) appeared in early 1998. Since then, we have discovered a number of mistakes, including those brought to our attention by Drs. I. M. Kerzhner, Jean Péricart, Wolfgang Rabitsch, and J. L. Stehlík. These errors, most of which involve Old World taxa, have prompted us to provide this paper in the interest of making the corrections available for inclusion in Dr. Péricart's forthcoming catalog of the Palearctic Berytidae.

The corrections, additions, and other changes in this paper are arranged by page and follow the general format of our Catalog (Henry and Froeschner 1998). The one exception to the format is that we give only "author and date" for text references documenting the country distribution. The user should consult the bibliography for the full citation of these references.

Corrections and Additions

Page 6. To the distribution of *Apoplymus pectoralis* Fieber add Albania (Josifov, 1986) and Cyprus (Lindberg, 1948).

Page 8. Under the genus *Neides,* the type designation for junior synonym *Podicerus* Duméril is not "Monotypic." Correct type of designation to "Designated by Kirkaldy, 1900, Entomologist, 33(449): 265."

Page 8. Under entry for *Neides aduncus* Fieber, 1859, correct spelling of type locality "Corisca" to "Corsica."

Page 8. Under distribution for *Neides afghanus* Seidenstücker correct the distribution of "Russia" to "Tajikistan and Turkmenistan."

Page 9. Add following species after *Neides gomeranus* Heiss:

Neides propinquus Horváth, 1901

1901 *Neides propinquus* Horváth, Drit. Asia. Fors. Graf. Eug. Zich. 2: 259. [Siberia].

Distribution: Mongolia, Russia (Siberian, Far Eastern) (Hoberlandt, 1968, Acta Faun. Entomol. Mus. Natl. Pragae, 13: 51; Kanyukova, 1988, *In*: Key Insects Far-Eastern USSR, Hemiptera, 2: 882).

Host: Unknown.

Page 9. Under 1865 *Neides depressus* entry, correct date given for Reuter from 1971 to 1871.

Page 9. Under synonymy of *Neides tipularius* (Linnaeus), the junior synonym *Cimex araneoides* Goeze was synonymized by Harrer (G. A.), not Schaeffer. From distribution, transfer "Far Eastern" records to *Neides propinquus* (I. M. Kerzhner, personal communication, following Kanyukova, 1988, *In*: Key Insects Far-Eastern USSR, Hemiptera 2: 882), and also drop ending "k" from "Derzhaskyk"and change 2nd "u" in "Lukushuk" to an "a." To the distribution of *N. tipularius* add Greece (Josifov 1986), Hungary (Horváth, 1898), Luxembourg (Reichling and Gerend, 1994), and Slovakia (Stehlík and Vavřínová 1995); and to notes of *N. tipularius* add "and Stehlík and Vavřínová (1995, Acta Mus. Moraviae, 79: 159) discussed the habitats, host, and life history."

Page 11. Under host of *Paleologus feanus* and distribution of *Paraberytus similis,* correct spelling of "Linnavuouri" to "Linnavuori."

Page 12. Authorship for the tribe Berytinini, derived from the nominate family name Berytinidae (based on the type genus *Berytinus* Kirkaldy), should be credited to Southwood and Leston, 1959, not Henry, 1997a.

Page 12. To the distribution of *Berytinus clavipes* (Fabricius) add Bulgaria (Josifov, 1986), Hungary (Horváth, 1898), Luxembourg (Reichling and Gerend, 1994), Macedonia (Göllner-Scheiding, 1978), Romania (Sienkiewiz, 1964), Slovakia (Stehlík and Vavřínová, 1995), Slovenia (Gogala and Gogala, 1991), Switzerland (Rampazzi and Dethier, 1997), and Yugoslovia (Horváth, 1903); and to notes of *B. clavipes* add "and Stehlík and Vavřínová (1995, Acta Mus. Moraviae, 79: 154) discussed the habitats, life cycle, and hosts."

Page 13. To the distribution of *Berytinus consimilis* (Horváth) add Slovakia (Stehlík and Vavřínová, 1995); and to notes of *B. consimilis* add "and Stehlík and Vavřínová (1995, Acta Mus. Moraviae, 79: 159) discussed the habitats and the host."

Page 13. To the distribution of *Berytinus crassipes* (Herrich-Schaeffer) add Slovakia (Stehlík and Vavřínová, 1995, Acta Mus. Moraviae, 79: 159); and to notes of *B. crassipes* add "and Stehlík and Vavřínová (1995, Acta Mus. Moraviae, 79: 159) discussed the habitats, host, and wing polymorphism."

Page 14. To the distribution of *Berytinus geniculatus* (Horváth) add Slovakia (Stehlík and Vavřínová, 1995); and to notes of B. *geniculatus* add "and Stehlík and Vavřínová (1995, Acta Mus. Moraviae, 79: 160) discussed the habitats, hosts, and the life cycle."

Page 14. To the distribution of *Berytinus distinguendus* (Ferrari) add Egypt (Linnavuori, 1964) and Hungary (Horváth, 1898).

Page 15. Change date of publication of *Berytinus hiriticornis* (Brullé) and subspecies *B. hirticornis hirticornis* (Brullé) from 1835 to 1836, following dating used in Palearctic Catalog (Aukema and Rieger, 1996); to the distribution of *B. hirticornis* add Luxembourg (Reichling and Gerend, 1994) and Slovakia (Stehlík and Vavřínová, 1995); and add to notes of *B. clavipes* "and Stehlík and Vavřínová (1995, Acta Mus. Moraviae, 79: 157) discussed the habitats and hosts."

Page 15. To the distribution of *Berytinus hirticornis nigrolineatus* (Jakovlev) add Bulgaria (Josifov, 1986) and Greece (Rieger, 1995).

Page 15. To the distribution of *Berytinus hirticornis pilipes* (Puton) add Greece (Heiss, 1984) and Spain (Wagner, 1960).

Page 16. To the distribution of *Berytinus minor minor* (Herrich-Schaeffer) add Albania and Bulgaria (Josifov, 1986), Austria, Romania, and Switzerland (Sienkiewicz, 1964), Hungary (Horváth, 1898), Luxembourg (Reichling and Gerend, 1994), and Slovenia (Gogala and Gogala, 1991).

Page 17. Under distribution of *Berytinus montivagus* (Meyer-Dür), drop second "k" in Derzhansky, 1997; to the distribution of *B. montivagus* add Slovakia (Stehlík and Vavřínová, 1995); and to notes of B. *montivagus* add "and Stehlík and Vavřínová (1995, Acta Mus. Moraviae, 79: 161) discussed the habitats, hosts, and the life cycle."

Page 17. To the distribution of *B. signoreti* (Fieber) add Luxembourg (Reichling and Gerend, 1994), Slovakia (Stehlík and Vavřínová, 1995), and Tunisia (Linnavuori, 1965), and to the notes of B. *signoreti* add the reference "Stehlík and Vavřínová, 1995, Acta Mus. Moraviae, 79: 162."

Page 18. Under heading of *Berytinus strangulatus* (Rey), correct date from 1887 to 1888. Also, correct spelling of "L'Exchange" to "L'Echange" and the type locality from "Europe" to "France."

Page 18. To the distribution of *B. striola* (Ferrari) add Slovakia (Stehlík and Vavřínová, 1995) and to notes of *B. striola* add "and Stehlík and Vavřínová (1995, Acta Mus. Moraviae, 79: 163) discussed the habitats, hosts, and life cycle."

Page 20. To distribution of *Gampsocoris culicinus culicinus* Seidenstücker add Slovakia (Stehlík and Vavřínová, 1995); and to notes of *G. culicinus* add "and Stehlík and Vavřínová (1995, Acta Mus. Moraviae, 79: 165) discussed the habitats, host, and life history."

Page 21. To the distribution of *Gampsocoris enslini* Seidenstücker add Albania, Armenia, Azerbaidzhan, Bulgaria, Georgia, Greece, Iran, Yugoslavia (Pericart, 1984).

Page 21. Add following species entry:

Gampsocoris gatai Günther, 1996

1996 *Gampsocoris gatai* Günther, Mitt. Int. Entomol. Ver., 21: 125. [Spain].

Distribution: Spain.

Host: *Teucrium charidemi* Sandwith [Lamiaceae] (Günther, 1998, Russian Entomol. Soc. 1: 106); the host was given incorrectly as *Ononis natris* ssp. *ramosissima* (Desf.) Batt. in original description (Günther, 1996, Mitt. Int. Entomol. Ver., 21: 128).

Page 23. Under *Gampsocoris punctipes punctipes* (Germar) entry, correct Burmeister, 1835, reference from "Handbk" to "Handbch." Under Wagner, change date 1955 to 1954 and spelling of "*seidenstuckeri*" to "*seidenstueckeri.*" To the distribution add Luxembourg (Reichling and Gerend, 1994), Saudi Arabia (Linnavuori, 1986), and Slovakia (Stehlík and Vavřínová, 1995); and to notes of *G. punctipes* add "and Stehlík and Vavřínová (1995, Acta Mus. Moraviae, 79: 166) discussed the habitats, host, and life history."

Page 30. Close parentheses and eliminate one period at end of "Distribution" for *Capyella horni* Breddin.

Page 29. Under genus *Capyella* and in Literature Cited (p. 53), correct date for *Capytum* Strand from 1926 to 1928.

Page 32. Under *Jalysus albidus* Stusak, correct spelling of host genus from "*Adensotemma*" to "*Adenostemma.*" Also modify spelling in host index, p. 56, under both the generic and species entries.

Page 35. We incorrectly listed *Berytus elegans* Costa, 1847 (nec Curtis) as a junior synonym of *Berytus meridionalis* Costa, 1843 and as the type species of *Metacanthus* Costa, 1847. This interpretation is in error and should have referred to *Neides elegans* Curtis, as noted on page 23 of our catalog, where we correctly list *Neides elegans* Curtis as a junior synonym of *Berytus punctipes* (the type species of *Gampsocoris* Fuss). The problem leading to this situation began when Costa (1843) described his species *Berytus meridionalis* and suggested that it should be placed in a new genus, which he tentatively (but not formally) named *Metacanthus.* Later, he (Costa, 1847) described and more formally proposed the name *Metacanthus,* but used *Berytus elegans* Curtis (based on his figure) as the type species, instead of *B. meridionalis.* If Costa's (1847) later description is followed, with *B. elegans* as the type species, then the genus *Metacanthus* becomes a junior synonym of *Gampsocoris*; thus, disrupting the stability of the largest stilt bug genus. Because of this stituation, we fully agree with Dr. J. Péricart's (personal communication) suggestion that Costa's (1843) first description of *Metacanthus* should be accepted, with *Berytus meridionalis* as the type species, a course of action followed by him (Péricart, 1984) in his well-known book on the Berytidae of the Mediterranean Region.

Therefore, modify the genus *Metacanthus* as follows:

Genus *Metacanthus* Costa, 1843

1843 *Metacanthus* Costa, Cimic. Neopol., p. 26. Type species: *Berytus meridionalis* Costa, 1843. Original designation.

Note: We follow Péricart (1984), who considered that Costa (1843) sufficiently described and validated the name *Metacanthus* and designated as its type, *B. meridionalis.* To accept otherwise is to seriously jeopardize stability and change the name of the largest stilt bug genus, *Metacanthus* Costa.

Page 35. To the distribution of *Metacanthus* (*Cardopostethus*) *annulosus* (Fieber) add Slovakia (Stehlík and Vavřínová, 1995).

Page 36. Modify the subgenus *Metacanthus* as follows (following generic modification above, p. 35):

Subgenus *Metacanthus* Costa, 1843

1843 *Metacanthus* Costa, Cimic. Neopol., p. 26. Type species: *Berytus meridionalis* Costa, 1843. Original designation.

Page 36. Under *Metacanthus acintus,* correct spelling of "Nannaizab" to "Nonnaizab."

Page 36. Correct spelling of species names *Metacanthus* "*ataoensis*" to "*antaoensis,*" three times.

Page 36. The first combination of *Gampsocoris delhiensis* Menon and Ghai in *Metacanthus* was by Josifov (1965, Reichenbachia 5: 285), not Wheeler and Schaefer (1982, Ann. Entomol. Soc. Am., 75: 502).

Page 37. In note under *Metacanthus lineatus* (Jakovlev), correct spelling of *M.* "*maghrebrinus*" to "*maghrebinus.*"

Page 37. Change date for description of *Metacanthus meridionalis* (Costa) from 1844 to 1843; delete entry for "1847 *Metacanthus elegans* Costa, Cimic. Neapol. Cent., p. 259. [Italy]. Synonymized by Bergroth, 1913, Mém. Soc. Entomol. Belg., 22: 177." as explained under genus above (p. 35); correct spelling of "Corisca" to "Corsica" under *Megalomerium pallidum* entry; and correct spelling of "Linnavuouri" to "Linnavuori."

Page 38. In distribution under *Metacanthus mollis* Stusak, correct spelling of Linnavuouri to Linnavuori; and to the distribution of *M. mollis* add Saudi Arabia, Somalia, and Yemen (Linnavuori, 1986).

Page 39. In distribution under *Metacanthus nitidus* Stusak, correct spelling of "Linnavuouri" to "Linnavuori."

Page 39. Change spelling of *Metacanthus "pertenerus"* (Breddin) to *M. "pertenerum"* three times at species and both subspecies entries. Also add to index entries for *"Metacanthus pertenerum"* (p. 68) and *"Metacanthus, pertenerum vittatus"* (p. 72).

Page 40. For the type species of the genus *Neometacanthus* and under the species *Neometacanthus picticornis,* correct spelling of "Noualheir" to "Noualhier."

Page 42. To the distribution of *Yemma gracilis* Linnavuori add Yemen (Linnavuori and van Harten, 1997).

Page 43. The genus *Yemma* is feminine; therefore correct spelling of the specific epithet "*Yemma signatus*" to "*Yemma signata*" in first line and add "[*sic*]" to Hsiao, 1977 entry.

Page 44. Under *Metatropis rufescens,* correct Burmeister, 1835, reference from "Handbk." to "Handbch." To the distribution of *M. rufescens* add Luxembourg (Reichling and Gerend, 1994) and Slovakia (Stehlík and Vavřínová, 1995); and to notes of *M. rufescens* add "and Stehlík and Vavřínová (1995, Acta Mus. Moraviae, 79: 159) discussed the habitats, host, and life history."

Page 45. The genus *Metatropis* is feminine; therefore correct spelling of the specific epithet *"Metatropis tesongsanicus"* to "*Metatropis tesongsanica*" in first line and add "[*sic*]" after original combination.

Page 45. Correct spelling of "Reiger" to "Rieger" under Aukema and Rieger, 1995 and 1996.

Page 46. Change date of Brullé 1835 reference to 1836, following the Aukema and Rieger (1996).

Page 46. Correct dates of Costa, A. from 1844–1862 to 1843–1862, including first part "1843 (separate, part 1, 7:143–405 . . .," following Kerzhner (1983, Mitt. Zool. Mus. Berlin 59: 191).

Page 46. Under Curtis (1824–40) reference correct spelling of "Literatureae" [second to last line] to "Literaturae."

Page 48. Under Germar, 1817–1847, reference, switch order of dates from "16–17 (1837); 18–19 (1936)" to 1936 and 1937; and under Gmelin, 1790, reference, correct spelling of "editre" to "edite"; under Goeze, 1778, reference, capitalize "Natursystems."

Page 49. Under Herrich-Schaeffer reference, change leading date 1851 to 1836–1853 and title from "Wazenartigen Insecten" to "Die Wanzenartigen Insecten"; under Horváth, 1885, delete "de" in Revue d'Entomologie; under Horváth, 1901, change "Forsehungsreise" to "Forschungsreise"; and under Horváth, 1912, change "Tijschrift" to "Tijdschrift."

Page 50. Under Josifov, 1959, capitalize "art" in Heteropteren-Art; under Josifov, 1965, capitalize "systematik"; under Josifov, 1974, change "In Russian" to "In Bulgarian"; under Lindberg, 1934, change "F" to lower case in "För"; and under Lindberg, 1958, correct journal spelling to Societas "Scientiarum Fennicae."

Page 51. Under A. Puton, 1876, add to beginning of title "Notes pour."

Page 52. Under Putshkov, 1974, add "[In Ukranian]"; under Rey, 1888, change "L'Exchange" to "L'Echange"; change authorship of J. C. Schaeffer, 1784 to G. A. Harrer, 1784 and move forward alphabetically; and under Scholtz, 1847, change "de" to "der."

Page 53. Under Stål, 1870–1876, correct "Svenskaps" to "Svenska"; and under Strand, 1926, correct the date to "1928," change "nomenclatoric" to "nomenclatorica," and change "Arkiv" to "Archiv" and insert "für."

Page 54. Under Stusak, 1976 a 1976c, spell out "Bulgarian Academy of Sciences."

Page 55. Delete Wagner 1955 "Ergebnisse, einer . . . ."; under Wagner, 1965, correct spelling of "Commentiones" to "Commentationes."

Add the following papers to the bibliography:

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Linnavuori, R. 1964. Hemiptera of Egypt, with remarks on some species of the adjacent Eremian region. Annales Zoologici Fennici 1: 306–356.

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Linnavuori, R. 1986. Heteroptera of Saudi Arabia. Fauna of Saudi Arabia. 8: 31–197.

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Reichling, L. and R. Gerend. 1994. Liste des Hétéroptères du Grand-Duché de Luxembourg. Bulletin de la Société des Naturalistes Luxembourgeois 95: 273–286.

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THREE NEW SPECIES OF *DIPOGON* FOX (SUBGENUS *DIPOGON*) (HYMENOPTERA: POMPILIDAE) FROM CENTRAL AND WESTERN NORTH AMERICA

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Abstract.—Three **new species** are described in the genus *Dipogon,* subgenus *Dipogon* (Pompilidae). They are: ***D. kiowa*** (Prowers and Delta counties, Colorado), ***D. konza*** (Douglas Co., Kansas), and ***D. anasazi*** (Montezuma Co., Colorado).

Key Words: Hymenoptera, Pompilidae, *Dipogon,* new species, North America

Species of *Dipogon* Fox are not often taken by conventional collecting methods, as they are rarely attracted to flowers or honeydew. They occur principally in wooded areas, where most nest in cavities in wood. Males are rarely taken except when reared from trap nests (Medler and Koerber 1957, Krombein 1967). One species of subgenus *Deuteragenia* Sustera has been reared from stems of weeds and garden plants (Williams 1966) and a species of subgenus *Dipogon* has been reared from stems of *Sambucus* (Wasbauer 1966), but most specimens have been taken in association with trees. Townes (1957) recognized five species of subgenus *Dipogon* north of Mexico, but four more have since been added (Wasbauer 1960, 1966; Evans 1987). Three more species are added here, all thus far known only from females. All have the frons and thoracic dorsum polished and largely devoid of recumbent pubescence and the punctures of the frons distinct but minute and widely spaced. Thus they belong to the *graenicheri* group of Townes (1957) provided the limits of that group are expanded to include species in which the microtrichiae of the fore wing are not necessarily much larger and more crowded in the fuscous bands than elsewhere.

Dipogon (*Dipogon*) *kiowa* Evans, new species

Holotype.—♀, COLORADO: Prowers Co., Lamar, tree trunks, 4–7 Sept. 1998 (D. Leatherman) [National Museum of Natural History].

Paratypes.—♀, same data; ♀, same locality and collector, Willow Creek Park, 15–16 Aug. 1998; 6 ♀, same locality and collector as type, 26–31 July 1999; ♀, COLORADO: Delta Co., Crawford State Park, *ex* Utah juniper, 5 Aug. 1999 (D. Leatherman) [Paratypes in National Museum of Natural History and Colorado State University].

Etymology.—Named for the Kiowa Indians that formerly roamed the Arkansas Valley. On July 27, 1820, members of the Long Expedition visited an encampment of Kiowas not far from the type locality.

Description of type.—Length 5.5 mm; fore wing length 4.2 mm. Head ferruginous, including mouthparts and antenna, except first two and last antennal segments partially infuscated, ocellar triangle and paired streaks just below them weakly infuscated.

Pronotum ferruginous, with a pair of fuscous spots anterodorsally; remainder of thoracic dorsum and central part of propodeum black; meso- and metapleura and lateral parts of propodeum ferruginous; thoracic venter black. Metasoma black except sides of first tergite stained with reddish. Legs ferruginous except suffused with black as follows: upper surface of mid and hind coxae and trochanters, basal and apical extremities of fore and mid femora and much of mesal surface of hind femur, outer surface of fore and mid tibiae and all of hind tibia, basal segment of mid and hind tarsi. Wings hyaline, with a narrow brown band at the basal vein and a large brown area extending from the stigma through the third discoidal cell; microtrichiae slightly denser in the dark bands than elsewhere, especially dense at the basal vein.

Surface of head polished, only very faintly alutaceous; clypeus with several strong setae; frons with small punctures separated by 5–10 times their own diameters, each giving rise to a very short, erect seta. Thorax with integument shining, mesoscutum slightly more alutaceous and more close punctate than frons; scutellum and metanotum with dense, recumbent silvery to golden pubescence; meso- and metapleura polished, very weakly alutaceous; mid and hind coxae strongly silvery-sericeous; propodeum polished, with sparse, small punctures; metasoma sparsely silvery-sericeous.

Width of head 1.05 times length of head to margin of clypeus; middle interocular distance 0.60 times width of head; eyes convergent above, upper interocular distance 0.75 times lower. Postocellar and ocello-ocular distances subequal. First four antennal segments in a ratio of 17:9:29:22. Posterior margin of pronotum arcuate; slope of propodeum low and even, midline not impressed. Second submarginal cell maximum length 3 times its maximum height and 1.6 times maximum length of third submarginal cell.

Variation.—Two of the paratypes are considerably smaller than the type, with fore wing length 3.2 mm. Otherwise, there is little variation in size or morphology within the series. Two of the Lamar paratypes have the frons wholly ferruginous, and one Lamar paratype as well as the one from Delta Co. have the frons as well as the vertex and occiput black. These darker specimens also have the thorax and legs more heavily infuscated than in the other paratypes.

Remarks.—The polished and nearly bare integument, combined with the contrastingly dense pubescence on the scutellum and metanotum, plus the unusual color pattern, distinguish this species. In contrast to *graenicheri* Banks (1939), the body is more extensively marked with black and the metasoma wholly black; also the fasciae of the fore wing are less intense and the microtrichiae only slightly more dense within the wing bands. *Dipogon parkeri* Wasbauer (1966), described from Nevada, has a color pattern not unlike *kiowa,* but the head, thoracic dorsum, and propodeum are duller, with stronger surface sculpturing and an overlay of appressed pubescence. In *parkeri* the eyes are less convergent above, the upper interocular distance measuring 0.89 times the lower.

Dipogon (*Dipogon*) *konza* Evans, new species

Holotype.—♀, KANSAS: Douglas Co., Lawrence, 25 Aug. 1986, Douglas Yanega, on *Gonolobus* vine [Snow Entomological Museum, University of Kansas].

Paratypes.—3 ♀, same data except 26 Aug., 4 and 27 Sept. 1896; ♀, Lakeview, near Lawrence, 24 Sept. 1966, G. C. Eickwort; ♀, Breidenthal Reserve, 2 mi. N Baldwin, Douglas Co., 22 Aug.–8 Sept. 1982, malaise trap, D. B. Wahl [paratypes at University of Kansas, Colorado State University, and National Museum of Natural History].

Etymology.—Named for the Konza Indians, using the spelling employed by early explorers in what is now the state of Kansas.

Description of type.—Length 4.2 mm; fore wing length 3.4 mm. Body entirely glossy black except clypeus and sides of pronotum brownish; mandible dark brown basally, yellow-brown apically; antenna wholly light ferruginous, legs also of this color except coxae suffused with brown. Wings hyaline, somewhat luteous, veins on outer part translucent; fore wing unbanded but with a small brown cloud just distad of stigma; microtrichiae of uniform size and distribution except somewhat more crowded along basal vein.

Clypeus with several strong setae. Frons and vertex strongly polished, without surface sculpturing, with minute punctures separated by many times their own diameters, each giving rise to a short, erect seta. Thorax and propodeum similarly polished and sparsely punctate except scutellum finely, closely punctate and mesosternum with fine, appressed, silvery pubescence. Metasoma polished, very weakly alutaceous, with the usual strong setae ventrally and apically; first 3 tergites with only scattered, short setae.

Width of head 1.06 times length of head; middle interocular distance 0.61 times head width; eyes weakly convergent above, upper interocular distance 0.9 times lower. Vertex weakly elevated above eye tops, postocellar and ocello-ocular distances subequal. First 4 antennal segments in a ratio of 17:9:20:17. Posterior margin of pronotum arcuate; slope of propodeum low and even, midline not impressed. Second submarginal cell with its maximum length 3 times the maximum height, 1.5 times maximum length of third submarginal.

Variation.—Individuals in this series vary in fore wing length from 3.0 to 3.8 mm. All have the deep brown to black glossy integument and the light ferruginous antennae and legs (at least beyond the coxae), but the largest female is streaked with ferruginous along the sides of the thorax and propodeum. Although there are no distinct wing fasciae in any of the specimens, in two there is weak clouding along the basal vein.

Remarks.—The clear wings, with only faint localized clouding in some specimens, set this species apart from other species of *Dipogon* except for *fulleri* Krombein (1962), a member of the subgenus *Winnemanella.* The glossy black integument contrasting to the pale appendages also characterizes this species.

Dipogon (Dipogon) anasazi Evans, new species

Holotype.—♀, COLORADO: Montezuma Co., Soda Canyon, Mesa Verde National Park, 6 Aug. 1999, B. Kondratieff, S. Wells, W. Cranshaw, P. Pineda, & W. Painter [National Museum of Natural History].

Etymology.—This species is named for the Anasazi, the remains of whose homes provide the major treasures of Mesa Verde National Park.

Description of type.—Length 4.8 mm; fore wing length 4.4 mm. Entire body and appendages light ferruginous, eyes and ocelli contrastingly nearly black. Wings hyaline, slightly luteous basally; fore wing with a weak brown band at basal vein and a broad brown cloud below the stigma and basal half of marginal cell. Microtrichiae of fore wing distinctly darker and more crowded within the two dark bands than elsewhere.

Integument of head, thorax, and propodeum strongly polished and without surface sculpturing, also without appressed pubescence. Clypeus with several strong setae, but frons with only short, erect hairs arising from small punctures separated by many times their own diameters. Thorax and propodeum similarly with sparse, small punctures except posterior fifth of mesoscutum and all of scutellum and metanotum with dense, fine punctures. Metasoma also polished but with rather dense, fine punctures, posterior segments with usual stiff bristles.

Head 1.04 times as wide as high, vertex roundly elevated above eye tops. Middle interocular distance 0.62 times head width; upper interocular distance 0.84 times lower. Ocelli in a compact triangle, ocello-ocular distance 1.2 times postocellar distance. First 4 antennal segments in a ratio of 19:10:25: 21. Second submarginal cell with its maximum width 2.8 times maximum height, 1.3 times maximum width of third submarginal cell.

Remarks.—This species has many features in common with *graenicheri* Banks (1939). It differs in the wholly pale coloration and weaker wing bands; also the body is even more highly polished, the vertex more elevated above the eye tops, and the punctures of the frons and thorax are more sparse.

The type and only known specimen was collected by Samuel Wells by beating junipers in a relatively dry canyon that had been burned over a few years earlier.

DISCUSSION

Dipogon diablo Wasbauer (1960) was assigned by the describer to the *graenicheri* group, but the head and thoracic dorsum and dull and minutely granulo-reticulate as well as sparsely covered with appressed pubescence. Thus it does not appear closely related to the species considered here. The following couplets may serve to separate females of the *graenicheri* group as defined here.

KEY

1. Fore wing not fasciate (may have a small brown spot distad of stigma); body glossy black, legs and antenna light ferruginous (body may be streaked with ferruginous along sides of mesosoma) . . . . *konza,* n.sp.
– Fore wing bifasciate; color not as above 2
2. Entire body pale ferruginous, with contrasting dark eyes and ocelli; integument highly polished; vertex roundly elevated above eye tops . . . . *anasazi,* n. sp.
– Not entirely ferruginous nor integument as highly polished; vertex more weakly elevated above eye tops 3
3. Mesosoma and at least basal third of metasoma ferruginous; legs ferruginous . . . . *g. graenicheri* Banks
– Mesosoma fuscous at least dorsally, metasoma wholly black; legs in large part fuscous 4
4. Body black, antenna, fore leg, and tarsi except basally, tinged with fulvous; microtrichiae of fore wing much darker and more crowded in fasciae than elsewhere; scutellum and metanotum not more densely pubescent than mesonotum . . . . *graenicheri atratus* Townes
– Mesosoma black, pleura and lateral parts of propodeum ferruginous; microtrichiae of fore wing barely darker and more crowded in fasciae than elsewhere; scutellum and metanotum densely pubescent . . . . *kiowa,* n. sp.

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For the loan of types and other specimens, I am indebted to Robert W. Brooks, University of Kansas; Michael S. Kelley, Museum of Comparative Zoology; Steve Heydon, University of California at Davis; and Wojciech Pulawski and Bob Zuparko of the California Academy of Sciences.

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CATALOGUE OF THE TYPE SPECIMENS OF TORTRICIDAE (LEPIDOPTERA) IN THE COLLECTION OF THE NATIONAL MUSEUM OF NATURAL HISTORY, SMITHSONIAN INSTITUTION, WASHINGTON, D.C.

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Abstract.—Type specimens of the family Tortricidae deposited in the collection of the National Museum of Natural History, Smithsonian Institution, are listed alphabetically by species (or subspecies), along with an abbreviated literature citation to the original description and collection data for the specimen. The type collection includes 1,001 name-bearing types of Tortricidae: 851 holotypes, 50 lectotypes (6 of which are designated herein), 60 species represented by one or more syntypes, 38 species represented by the only known extant specimen from the original series, 1 neotype, and 1 "pseudo-type." The collection includes the vast majority of the tortricid species described by C. Fernald, A. Busck, C. Heinrich, J. Clarke, A. Blanchard, and A. Kawabe. It also includes the types of numerous species described by Lord Walsingham, W. Kearfott, H. Dyar, N. Obraztsov, J. Razowski, J. Powell, W. Miller, R. Brown, and J. Brown.

Key Words: leafrollers, lectotype, holotype, syntype, original description, host plants

The type collection of Tortricidae in the National Museum of Natural History (USNM), Smithsonian Institution, represents a significant worldwide resource for researchers interested in tortricid moths (i.e., the leafrollers). The strengths of the collection lie in the faunas of North and South America, the Orient (Japan, Taiwan, Philippine Islands), and Oceania. The C. H. Fernald Collection, purchased in 1924 (Clarke 1974), formed the foundation, containing types (primarily "cotypes") of numerous species described by Fernald, Lord Walsingham, and W. D. Kearfott, and a few described by A. Grote, B. Clemens, and A. Packard. Walsingham sent Fernald "cotypes" of most of the species he described from California and Oregon (Walsingham 1879) from material in The Natural History Museum (formerly British Museum of Natural History). Kearfott also gave Fernald examples from his type series; the majority of Kearfott's material eventually was deposited in the American Museum of Natural History, New York. Klots (1942) resolved most of the nomenclatorial difficulties associated with the Kearfott "cotypes," designating numerous lectotypes, primarily in the collection of the American Museum of Natural History. Miller (1970) resolved most of nomenclatorial problems associated with the Fernald "cotypes," designating lectotypes for the vast majority of his species of North American Olethreutinae. Few lectotypes have been designated for the Walsingham (1879) species from California and Oregon.

From 1905–1930 August Busck and Carl Heinrich, both U.S. Department of Agriculture employees at the museum, added numerous tortricid types, primarily from North and South America, through their prolific taxonomic research on microlepidoptera. In particular, over 150 species were described by Heinrich (1923, 1926) in his revisions of the Olethreutinae of North America. Also during the early part of the century, Walsingham's (1914) contribution to the "Biologia Centrali-Americana" appeared; it included the descriptions of many new species, with most of the material split between The Natural History Museum and the USNM. By this time, Walsingham was designating a type for each new species, so there is little ambiguity regarding these primary types.

In the 1960s, revisions of New World genera by Obraztsov (1961, 1962, 1963, 1964, 1966a, b, c) resulted in the addition of many tortricid types to the USNM collection. From 1968–1982 specific large research projects such as Alexis Diakonoff's studies of the microlepidoptera of the Philippine Islands (Diakonoff 1968) and of Sri Lanka (Diakonoff 1982), and J. F. G. Clarke's work on Neotropical "Phaloniidae" (Clarke 1968) and the microlepidoptera of Rapa Island and Micronesia (Clarke 1971, 1976) added many types of Tortricidae. The Blanchard Collection, donated in 1985 (Davis 1985), also added many tortricid types, nearly all from Texas. The Atsushi Kawabe collection, composed almost exclusively of Oriental species and donated in 1990 (Davis 1996), added significant numbers to the tortricid type collection as well, broadening greatly the geographic coverage. Use of the tortricid holdings of the USNM by specialists worldwide (e.g., Richard L. Brown, John W. Brown, John B. Heppner, William E. Miller, Jerry A. Powell, Josef Razowski, and others) has continued to increase type holdings.

Through recent curatorial efforts, the type specimens of the family Tortricidae have been organized into a single collection. The specimens are arranged in alphabetic sequence by species (or subspecies) in individual, labeled unit trays and stored in 13 insect drawers in the USNM. The purpose of this paper is to present a list of the type specimens. The list is arranged alphabetically by species (or subspecies), followed by the author, year of publication, and genus (or genus and species for subspecies) in which the taxon was originally described. This information is followed by an abbreviated citation of the publication in which the description appears. The sex, type designation (i.e., holotype, lectotype, syntype, "type", neotype, "pseudo-type"), and collection data also are included. We attempt to provide the maximum collection data, relying on both the text of the original description and information on specimen labels. For example, country, county, province, etc. frequently are not present on the specimen labels; this information is provided where retrievable accurately. Abbreviations used in the list include the following: AMNH = American Museum of Natural History, New York; BMNH = The Natural History Museum, London; NHMW = Naturhistorisches Museum, Wien; r.f. = reared from; em: = emerged; mi = mile(s); ′ = feet (elevation). Where the collecting date can have more than one interpretation, it is presented in quotes. For example, "Aug. 8/15" could be interpreted as 8 August 1915 or 8–15 August [no year].

The modern practice of designating a holotype was not followed by most tortricid workers before 1900 (e.g., Riley, Grote, Zeller), and some early authors (e.g., Walsingham, Dyar) labeled all specimens of the original series as "type." Where the original type series consists of a single specimen, as clearly stated by the author, we refer to it as the holotype even though not specifically designated as such in the original description. Where only a single specimen is presumed still to be extant from the original series (and a type was not specifically designated), we refer to this specimen as the "type" (in quotes). In this case, the specimen is a potential lectotype because it may be the only remaining representative from the original series. Where two or more specimens of the original series are present and no type was specifically designated in the original description, we refer to these specimens as syntypes. We defer the latter two cases to the future work of specialists to designate appropriate lectotypes for these, as needed. Six specimens are unpublished lectotypes unambiguously selected and labeled by Obraztsov (n = 3), Powell (n = 2), and Clarke (n = 1); these selections are designated in this paper.

The USNM tortricid type collection includes 851 holotypes, 50 lectotypes (6 of which are designated herein), 60 species represented by one or more syntypes, 38 "types" (i.e., the only known extant specimen from the original series), 1 neotype, and 1 "pseudo-type."

LIST OF SPECIES

abiephaga Issiki, 1962 (*Ariola*); in Issiki and Mutuura, Publ. Entomol. Lab. Univ. Osaka Pref. 7: 3. Holotype ♂, Japan, Honsyu, Koozuke, Manza, 27 July 1958, S. Issiki & T. Yasuda.

abietana Fernald, 1908 (*Argyroploce*); Canad. Entomol. 40: 349. Holotype ♂, USA, Massachusetts, Hampshire Co., Amherst. According to Fernald this species was "Described from three male specimens taken in Amherst, Mass., one of which I make the type . . ."

abievora Issiki, 1961 (*Epagoge*); in Issiki and Mutuura, Microlepidoptera injurious to coniferous plants in Japan: 34. Holotype ♂, Japan, Osaka, Ikeda, 20 November 1958, T. Kodama.

abornana Busck, 1939 (*Lorita*); Bull. South. Calif. Acad. Sci. 38: 101. Holotype ♀, USA, California, Los Angeles Co., El Segundo, r.f. *Cuscuta californica,* em: 11 July 1938, W. Pierce.

abbreviatana Walsingham, 1879 (*Paedisca*); Ill. Lepid. Heter. British Museum 4: 54. Syntype ♂, USA, Pennsylvania. According to the original description, this species was described from two males from Washington [D.C. according to Heinrich 1923], August 1872. The other specimen is presumed to be in the BMNH. The USNM specimen bears the typical Walsingham "Type" label, but the collecting locality is not consistent with the original description.

abundantia Clarke, 1976 (*Heleanna physalodes*); Insects of Micronesia 9: 15. Holotype ♂, Micronesia, Kusaie, Pukusrik, 1 m, 3 April 1953, J. Clarke.

accessa Heinrich, 1931 (*Epinotia*); Proc. U.S. Natl. Mus. 79: 9. Holotype ♂, Panama, Trinidad River, March 1912, A. Busck.

achlyoptera Clarke, 1976 (*Cryptaspasma*); Insects of Micronesia 9: 58. Holotype ♀, Micronesia, Guam, Ritidian, 7 August 1945, J. Gressitt.

acrocroca Diakonoff, 1982 (*Acanthoclita*); Zool. Verhandel. (Leiden) 193: 28. Holotype ♂, Sri Lanka, Ratnapura District, Uggalkaltota, 350′, Irrigation Bungalow, 31 January–8 February 1970, D. Davis & B. Rowe.

acrospodia Diakonoff, 1982 (*Spanistoneura*); Zool. Verhandel. (Leiden) 193: 9. Holotype ♂, Sri Lanka, Kandy District, 1,800′, Peak View Motel, 15–24 January 1970, D. Davis & B. Rowe.

adana Heinrich, 1923 (*Rhyacionia*); Bull. U.S. Natl. Mus. 123: 18. Holotype ♂, USA, Massachusetts, Essex Co., Forest Hill, 5 April 1910, W. Raff.

ademonia Clarke, 1968 (*Irazona*); Proc. U.S. Natl. Mus. 125: 42. Holotype ♀, Costa Rica, La Florida, 500′, W. Schaus.

adjuncta Heinrich, 1924 (*Gypsonoma*); J. Wash. Acad. Sci. 14: 389. Holotype ♂, Canada, Ontario, Toronto, June 1913, Parish.

adobe Brown, 1992 (*Catastega*); J. New York Entomol. Soc. 100: 224. Holotype ♂, USA, Arizona, Cochise Co., Chiricahua Mountains, 4 mi W Portal, 5,300′, 3–6 August 1964, D. Davis.

adoceta Diakonoff, 1964 (*Bactra*); Zool. Verhandel. (Leiden) 70: 11. Holotype ♂, Brazil, Paraná, Castro, W. Schaus.

aechnemorpha Diakonoff, 1982 (*Gypsono-

ma); Zool. Verhandel. (Leiden) 193: 48. Holotype ♂, Sri Lanka, Ratnapura District, Uggalkaltota, 350′, Irrigation Bungalow, 31 January–8 February 1970, D. Davis & B. Rowe.

aelina Diakonoff, 1982 (*Cydia*); Zool. Verhandel. (Leiden) 193: 21. Holotype ♂, Sri Lanka, Ratnapura District, Uggalkaltota, 350′, Irrigation Bungalow, 31 January–8 February 1970, D. Davis & B. Rowe.

aenigmana Powell, 1964 (*Acleris*); Univ. Calif. Publ. Entomol. 32: 99. Holotype ♂, USA, California, Nevada Co., Truckee, "Oct 8–15."

aequilibra Diakonoff, 1982 (*Aemulatrix*); Zool. Verhandel. (Leiden) 193: 3. Holotype ♂, Sri Lanka, Ratnapura District, Uggalkaltota, 350′, Irrigation Bungalow, 31 January–8 February 1970, D. Davis & B. Rowe.

aesculana Riley, 1881 (*Proteopteryx*); Trans. St. Louis Acad. Sci. 4: 321. "Type" ♂, USA, Missouri, "boring the tender terminal twigs of Buckeye and of Maple . . ." Riley described this species from eight specimens; we have been able to locate only one. The specimen is clearly labeled "Type" in Riley's hand.

aethalea Obraztsov, 1964 (*Proeulia*); Proc. U.S. Natl. Mus. 116: 188. Holotype ♂, Chile, Santiago, La Obra, October 1952, L. Peña.

aglaia Clarke, 1955 (*Orthocomotis*); Trans. Royal Entomol. Soc. London 107: 149. Holotype ♀, Brazil, Rio de Janeiro, Itatiaya, 700 m, 12 October 1926, J. Zikán.

agricolana Walsingham, 1879 (*Paedisca*); Ill. Lepid. Heter. British Museum 4: 42. Two syntypes (2 ♂♂), USA, California. This species was described from five males from California and Oregon, collected in May and June. As is typical of Walsingham specimens from this era, both of the syntypes cited above are labeled "Type." Neither has an abdomen; although there is a slide label attached to one of the specimens, the slide has not been found.

ainslieana Obraztsov, 1962 (*Anopina*); Am. Mus. Novit. 2082: 34. Holotype ♂, USA, New Mexico, Dona Ana Co., Mesilla, C. Ainslie.

aktita Miller, 1978 (*Rhyacionia*); in Powell and Miller, U.S. Dept. Agric., Agric. Handb. 514: 24. Holotype ♂, USA, New Jersey, Ocean Co., Lakehurst, 5 May 1962, R. Hodges.

alaskae Heinrich, 1923 (*Epinotia cruciana*); Bull. U.S. Natl. Mus. 123: 229. Holotype ♂, USA, Alaska, Yukon, 3 August 1916, G. Harrington [cited as "Huntington" by Heinrich]. The collecting locality, probably referring to Yukon River or some other locality in Alaska, is somewhat ambiguous because Yukon Territory is in Canada, not Alaska.

albafascia Heinrich, 1929 (*Ancylis*); Proc. U.S. Natl. Mus. 75: 19. Holotype ♂, USA, California, Tulare Co., Mineral King, "June 24–30."

albicapitana Busck, 1914 (*Evetria*); Proc. Entomol. Soc. Wash. 16: 147. Holotype ♂, Canada, Saskatchewan, Prince Albert, r.f. *Pinus divaricata,* em: 12 March 1914, J. Blumer. Although the type label indicates "*Evetria capitana*" rather than *albicapitana,* the USNM type number (Cat. No. 18444) and the collection data on the specimen match that given in the original description.

albicaudana Busck, 1915 (*Sparganothis*); Proc. Entomol. Soc. Wash. 17: 85. Holotype ♂, USA, Pennsylvania, Notch, r.f. maple, em: 5 July 1913, A. Busck.

albiciliana Fernald, 1882 (*Sericoris*); Trans. Am. Entomol. Soc. 10: 70. Lectotype ♂, USA, Maine, Penobscot Co., Orono. Designated by Miller (1970).

albidula Heinrich, 1926 (*Olethreutes buckellana*); Bull. U.S. Natl. Mus. 132: 189. Holotype ♂, USA, California, Inyo Co., 15–30 June 1922, O. Poling.

albimaculana Fernald, 1879 (*Grapholitha*); Canad. Entomol. 11: 157. Lectotype ♂, USA, Maine, Penobscot Co., Orono. Designated by Miller (1970).

albipuncta Heinrich, 1926 (*Bactra verutana*); Bull. U.S. Natl. Mus. 132: 84. Holotype ♂, USA, Colorado, Adams Co., Denver, Oslar.

albopunctana Brown, 1999 (*Dimorphopalpa*); Pan-Pac. Entomol. 75: 85. Holotype ♂, Venezuela, Aragua, Rancho Grande, 1,100 m, 16–19 January 1966, S. & W. Duckworth.

aliana Kawabe, 1965 (*Clepsis*); Kontyû 34: 460. Holotype ♂, Japan, Kurodake (Hokkaido), Mt. Daisetsu, 22 July 1952, A. Matsura.

alishana Kawabe, 1986 (*Epiblema*); Entomol. Pap. Pres. Kurosawa, Tokyo: 82. Holotype ♂, Taiwan, Chiai Hsien, Alishan, 2,300 m, 7 August 1971, Y. Shibata.

alleniana Fernald, 1882 (*Tortrix*); Trans. Am. Entomol. Soc. 10: 68. "Type" ♂, USA, Maine, Penobscot Co., Orono, July. This species was described from three males and three females; we have been able to locate only one male. The specimen is clearly labeled as "Type" in Fernald's hand.

allochroma Diakonoff, 1968 (*Costosa*); Bull. U.S. Natl. Mus. 257: 81. Holotype ♂, Philippine Islands, Davao Province, Mindanao, E slope Mt McKinley, 5,600′, 16 September 1946, CNHM Philippine Zool. Exped. 1946–47, H. Hoogstraal.

alphabetica Walsingham, 1914 (*Eucosma*); Biol. Centr.-Am., Lepid., Het. 4: 236. Holotype ♂, Mexico, Puebla, Popocatepetl [Park], 8–11,000′, July 1906, W. Schaus. Described from a single specimen identified as "Type."

alphitopa Clarke, 1968 (*Hysterosia*); Proc. U.S. Natl. Mus. 125: 7. Holotype ♂, Venezuela, Aragua, Rancho Grande, 16–23 October 1966, S. & W. Duckworth.

alterana Heinrich, 1923 (*Thiodia*); Bull. U.S. Natl. Mus. 123: 46. Holotype ♂, USA, Maryland, Montgomery Co., Plummers Island, 1 August 1903, A. Busck.

altissima Kawabe, 1978 (*Eubrochoneura*); Tinea 10: 177. Holotype ♂, Japan, Honshu, Shizouka Pref., Odaru Spa, S Izu, 29 April 1968, A. Kawabe.

amatana Dyar, 1901 (*Eulia*); J. N. Y. Entomol. Soc. 9: 24. Three syntypes (3 ♀♀), USA, Florida, Palm Beach Co., Palm Beach, r.f. *Nectandra* [= *Ocotea*] (n = 1). Dyar described this species from the three specimens cited above.

amblyopa Clarke, 1976 (*Cryptophlebia*); Insects of Micronesia 9: 106. Holotype ♂, Micronesia, Palau Islands, Koror Island, Koror, January–May, light trap, Beardsley.

ambodaidaleia Miller, 1983 (*Phaneta*); Ann. Entomol. Soc. Am. 76: 101. Holotype ♀, USA, South Carolina, Berkeley Co., Wedge Plantation, McClellanville, 16 March 1968, D. Ferguson.

ambogonium Pogue, 1986 (*Apolychrosis*); in Cibrián-Tovar et al., Cone and Seed Insects of the Mexican Conifers: 21. Holotype ♂, Mexico, Mexico, San Miguel Atlautla, 2,500 m, r.f. *Pinus leiophylla,* em: 14 September 1983, W. Sanchez.

americana Fernald, 1882 (*Teras*); Trans. Am. Entomol. Soc. 10: 66. Lectotype ♂, USA, Massachusetts, "Cambr. B." [Cambridge?]. Designated by Obraztsov (1963).

amoena Kawabe, 1986 (*Phaecasiophora*); Entomol. Pap. Pres. Kurosawa, Tokyo: 77. Holotype ♂, Taiwan, Hualien Hsien, Hungyeh Spa, 200 m, 29–30 March 1984, A. Kawabe.

amorpha Clarke, 1986 (*Dichelopa*); Smithsonian Contrib. Zool. 416: 123. Holotype ♂, Marquesas Islands, Nuku Hiva, Tapuaooa, 2,500′, 30 January 1968, J. Clarke.

amphibola Diakonoff, 1982 (*Diplosemaphora*); Zool. Verhandel. (Leiden) 193: 21. Holotype ♂, Sri Lanka, Ratnapura District, Uggalkaltota, 350′, Irrigation

Bungalow, 31 January–8 February 1970, D. Davis & B. Rowe.

anaranjada Miller, 1959 (*Laspeyresia*); Florida Entomol. 42: 131. Holotype ♀, USA, Georgia, Crisp Co., Cordele, r.f. *Pinus palustris,* 21 May 1950, C. Speers.

anastea Diakonoff, 1968 (*Archidemis*); Bull. U.S. Natl. Mus. 257: 30. Holotype ♂, Philippine Islands, Davao Province, Mindanao, E slope Mt McKinley, 7,000′, 22 September 1946, CNHM Philippine Zool. Exped. 1946–47, H. Hoogstraal.

anaxia Clarke, 1968 (*Amallectis*); Proc. U.S. Natl. Mus. 125: 32. Holotype ♀, Guatemala, Volcán Santa María, July, Schaus and Barnes.

andromedana Barnes & McDunnough, 1917 (*Olethreutes*); Contrib. Nat. Hist. Lepid. North Am. 3: 223. "Type" ♂, USA, Florida, Lee Co., Fort Meyers, r.f. *Andromeda,* "Apr 24–30." According to the original description, this species was described from two males and four females. Although a holotype was not designated, the specimen cited above is clearly labeled "Type."

angusana Fernald, 1892 (*Peronea*); Canad. Entomol. 24: 178. Two syntypes (1 ♂, 1 ♀), USA, New York, West Farms, J. Angus; and USA, Maine, Penobscot Co., Orono, 1 August 1884. According to the original description these two specimens comprise the type series.

animosana Busck, 1907 (*Tortrix*); J. N. Y. Entomol. Soc. 15: 235. Holotype ♀, Mexico, Jalapa, W. Schaus.

anisoneura Diakonoff, 1982 (*Eupoecilia*); Zool. Verhandel. (Leiden) 193: 6. Holotype ♂, Sri Lanka, Ratnapura District, Uggalkaltota, 350′, Irrigation Bungalow, 31 January–8 February 1970, D. Davis & B. Rowe.

anisoptera Clarke, 1976 (*Dudua*); Insects of Micronesia 9: 95. Holotype ♂, Micronesia, Guam, Mt. Chachao, 16 May 1936, O. Swezey.

anthrocodelta Clarke, 1971 (*Dichelopa*); Smithsonian Contrib. Zool. 56: 104. Holotype ♂, Rapa Island, Maugaoa, 950' (292 m), 23 November 1963, J. & T. Clarke.

aperta Diakonoff, 1968 (*Archips*); Bull. U.S. Natl. Mus. 257: 28. Holotype ♀, Philippine Islands, Luzon, Mountain Province, Baguio, 7 May 1945, J. Franclemont.

aporema Dognin, 1912 (*Cnephasia*); Heteroceres Nouveaux de L'Amerique du Sud 6: 49. Holotype ♂, Colombia, Fassel.

aporrhegma Clarke, 1986 (*Dichelopa phalaranthes*); Smithsonian Contrib. Zool. 416: 136. Holotype ♂, Marquesas Islands, Nuku Hiva, Tapuaooa, 2,500′, 30 January 1968, J. & T. Clarke.

apospasta Obraztsov, 1964 (*Proeulia*); Proc. U.S. Natl. Mus. 116: 191. Holotype ♀, Chile, Concepcion, October 1902, E. Reed.

approximana Heinrich, 1919 (*Olethreutes*); Insect. Inscit. Menst. 7: 65. Holotype ♂, USA, New York, Rensselaer, rolling terminal leaves of loosestrife [*Lysimachia*], 12 June 1916, N.Y.S. Coll.

aprilana Grote, 1877 (*Exentera*); Canad. Entomol. 9: 227. Two syntypes (1 ♂, 1 ♀), USA, New York, Albany Co., Albany, April. According to the original description, this species was described from one male and one female collected the "end of April" by Lintner and Hill. The syntypes consist only of wings glued to pieces of cardboard: two forewings of the male, one forewing of the female. The sexes of the specimens are indicated on the specimen labels.

aquila Busck, 1914 (*Homona*); Proc. U.S. Natl. Mus. 47: 53. Holotype ♂, Panama, Cabima, May 1911, A. Busck.

arammclaina Razowski, 1987 (*Heppnerographa*); Bull. Polish Acad. Sci. 35: 64. Holotype ♂, Costa Rica, Cartago Province, Tuis, 28 May–4 June, W. Schaus.

argema Clarke, 1986 (*Dichelopa*); Smithsonian Contrib. Zool. 416: 152. Holotype ♀, Marquesas Islands, Fatu Hiva, Mt. Teoaiua, 2,000′, 22 March 1968, J. & T. Clarke.

argentifasciata Heppner, 1989 (*Choristoneura*); Florida Entomol. 72: 104. Holotype ♂, USA, Florida, Glades Co., Fisheating Creek, Palmdale, 7–10 May 1964, R. Hodges.

argentifurcatana Grote, 1876 (*Conchylis*); Canad. Entomol. 8: 206. Syntype ♂, Canada, Ontario, Port Stanley, W. Saunders. Although the specimen bears a label "London, Ont.," according to the original description the specimens were taken at Port Stanley, by "W. Saunders from London, Ontario." The disposition of the other syntype is unknown to us.

argentina Brown, 1991 (*Cuproxena*); in Brown and Powell, Univ. Calif. Publ. Entomol. 111: 64. Holotype ♀, Argentina, Misiones, Puerto Rico, 4–8 April 1971, C. & O. Flint.

argillacea Clarke, 1976 (*Ruthita*); Insects of Micronesia 9: 26. Holotype ♀, Micronesia, Guam, May 1936, O. Swezey.

argodonta Clarke, 1955 (*Orthocomotis*); Trans. Royal Entomol. Soc. London 107: 154. Holotype ♀, Brazil, "St. Catherines" [Santa Catarina], F. Johnson.

argutipunctana Blanchard & Knudson, 1983 (*Phaneta*); J. Lepid. Soc. 37: 143. Holotype ♂, USA, Texas, Hemphill Co., Canadian, 15 August 1971, A. & M. E. Blanchard.

argyraspis Razowski, 1984 (*Saphenista*); Ann. Zool. Warsaw 38: 278. Holotype ♀, Venezuela, Distrito Federal, 14 km NE Tovar, 28–29 February 1976, C. & O. Flint.

argyrospiloides Clarke, 1971 (*Dichelopa*); Smithsonian Contrib. Zool. 56: 118. Holotype ♀, Rapa Island, Maurua, 600' (184 m), 25 October 1963, J. Clarke.

arizonana Powell, 1975 (*Epiblema*); Pan-Pac. Entomol. 51: 101. Holotype ♂, USA, Arizona, Coconino Co., Oak Creek Canyon, Flagstaff, r.f. *Rudbeckia laciniata,* em: 28 June 1936, G. Englehardt.

arizonensis Heinrich, 1914 (*Evetria albicapitana*); Proc. U.S. Natl. Mus. 57: 57. Holotype ♂, USA, Arizona, Santa Catalina Mountains, r.f. *Pinus cembroides,* 23 June 1917, Hopkins no. 13977, G. Hofer.

arrhostia Clarke, 1968 (*Phtheochroa*); Proc. U.S. Natl. Mus. 125: 56. Holotype ♀, Peru, Cusco, Machu Picchu, 2,385 m, 5 March 1959, J. Clarke.

arthuri Dang, 1984 (*Cochylis*); Canad. Entomol. 116: 253. Holotype ♂, Canada, Saskatchewan, S.E. Saskatoon, r.f. *Helianthus* sp., August 1980.

asthenia Clarke, 1968 (*Carolella*); Proc. U.S. Natl. Mus. 125: 55. Holotype ♂, Guatemala, Palin, July, Schaus & Barnes.

asynthetes Diakonoff, 1968 (*Gatesclarkeana*); Bull. U.S. Natl. Mus. 257: 42. Holotype ♂, Philippine Islands, Cadiz, Occ. Negros, "3/8/29," Batabas.

atascosana Blanchard, 1979 (*Eucosma*); J. Lepid. Soc. 33: 212. Holotype ♂, USA, Texas, Cameron Co., Laguna Atascosa, 22 November 1973, A. & M. Blanchard.

atayalicana Kawabe, 1989 (*Acleris*); Tinea 12: 195. Holotype ♂, Taiwan, Hualien Hsien, Tayuling, forest, 2,500 m, 9–18 June 1980, D. Davis.

atomosana Busck, 1907 (*Phalonia*); J. N. Y. Entomol. Soc. 15: 22. Holotype ♂, USA, Pennsylvania, Allegheny Co., Pittsburgh, 17 August 1905, H. Engel.

atomosana Walsingham, 1879 (*Paedisca*); Ill. Lepid. Heter. Brit. Mus. 4: 42. Syntype ♂, USA, California [San Francisco or Bear Valley according to the original description], May–June, 1871. This species was described from two males; the other syntype is presumably in the BMNH.

atrata Diakonoff, 1973 (*Lobesia*); Zool. Monogr. Rijksmus. Nat. Hist. 1: 382. Holotype ♂, Marianas Islands, Guam, Piti, "7/9/36," O. Swezey.

atrilinea Clarke, 1976 (*Cryptophlebia*); Insects of Micronesia 9: 115. Holotype ♀, Micronesia, Ponape, Colonia, 14 January 1953, J. Clarke.

atriplaga Clarke, 1976 (*Duessa*); Insects of Micronesia 9: 28. Holotype ♀, Micronesia, Rota, nr. Sabana, 21 June 1946, Townes 807, at light.

atristriga Clarke, 1953 (*Epinotia*); J. Wash. Acad. Sci. 43: 228. Holotype ♂, USA, Illinois, Putnam Co., 24 March 1938, M. Glenn. Although the collection date of the holotype is cited as "March 17, 1945" in the original description, the specimen listed above is unambiguously labeled as the holotype.

atrodentana Fernald, 1882 (*Eccopsis*); Trans. Am. Entomol. Soc. 10: 71. Lectotype ♂, Canada, Ontario, London, W. Saunders. Designated by Miller (1970).

atsushii Bae, 1993 (*Lobesia*); Japan. J. Entomol. 61: 516. Holotype ♂, Taiwan, Hualien Hsien, Mt. Hohuanshan, 3,100 m, 30 July–1 August 1983, A. Kawabe.

audaculana Busck, 1907 (*Archips*); J. N. Y. Entomol. Soc. 15: 235. Holotype ♀, Mexico, Veracruz, Orizaba, R. Muller.

aurantia Clarke, 1976 (*Adoxophyes*); Insects of Micronesia 9: 127. Holotype ♀, Micronesia, Ponape, Colonia, 12–17 January 1953, J. Clarke.

aurantica Busck, 1920 (*Epagoge*); Insect. Inscit. Menst. 8: 84. Holotype ♀, Costa Rica, Cartago Province, Juan Vinas, W. Schaus.

auraria Clarke, 1949 (*Eulia*); Acta Zool. Lilloana (Tucumán) 7: 583. Holotype ♂, Chile, Santiago Province, Cajon de Maypo, Cordillera, El Cencio, 12–20 January 1948, T. Ramirez.

aurata Diakonoff, 1968 (*Adoxophyes*); Bull. U.S. Natl. Mus. 257: 11. Holotype ♂, Philippine Islands, Luzon, Mt. Makiling, Baker.

aureana Busck, 1907 (*Phalonia*); J. N. Y. Entomol. Soc. 15: 26. Holotype ♀, USA. Pennsylvania, Allegheny Co., Oak Station, 17 June 1906, F. Marloff.

aureola Diakonoff, 1977 (*Nexosa*); Zool. Verhandel. (Leiden) 158: 15. Holotype ♀, British New Guinea, Hydrographer Mountains, 2,500′, March 1918, Eichhorn Bros.

auricaput Razowski, 1971 (*Acleris*); Acta Zool. Cracov. 16: 550. Holotype ♀, Taiwan, Hassenzan, 6 June 1942, S. Issiki.

aurichalceana Riley, 1881 (*Melissopus*); Trans. St. Louis Acad. Sci. 4: 323. "Type" ♂, USA, Fernald, r.f. acorns, "1/6/76." Riley did not mention the number of specimens he examined; this is the only Riley specimen of *aurichalceana* we have been able to locate. It is labeled "Type" in Riley's hand.

auricomana Busck, 1907 (*Tortrix*); J. N. Y. Entomol. Soc. 15: 236. Holotype ♂, Mexico, June 1906, R. Muller.

auriferana Busck, 1911 (*Tortrix*); Proc. U.S. Natl. Mus. 40: 227. Holotype ♂, Brazil, Paraná, Castro, W. Schaus, "6187 Wlsm. 1908."

austrina Miller, 1985 (*Eucosma*); Ann. Entomol. Soc. Am. 78: 243. Holotype ♂, USA, Texas, Hemphill Co., Canadian, 15 August 1971, A. & M. Blanchard.

azumina Yasuda & Kawabe, 1980 (*Archips*); Tinea 11: 13. Holotype ♀, Japan, Nagano Pref., Azumi V., Shimajima-Dan, 780 m, 15 April 1977, N. Hibano.

baccharivora Pogue, 1988 (*Lorita*); Proc. Entomol. Soc. Wash. 90: 449. Holotype ♂, USA, Florida, Okeechobee Co., Lake Okeechobee, 27°N, 81°W, September 1984 (lab. reared), D. Green.

bactrana Heinrich, 1923 (*Eucosma*); Bull. U.S. Natl. Mus. 123: 117. Holotype ♂, USA, Colorado, San Juan Co., Silverton, "July 16–23."

baea Razowski, 1987 (*Transtillaspis*); Bull. Polish Acad. Sci. 35: 79. Holotype ♂, Colombia, Nariño, Volcán Galeras, 2,900 m, 13 January 1959, J. Clarke.

bakeri Diakonoff, 1968 (*Homona*); Bull. U.S. Natl. Mus. 257: 20. Holotype ♂, Philippine Islands, Luzon, Mt. Makiling, Baker.

balia Diakonoff, 1982 (*Acanthoclita*); Zool. Verhandel. (Leiden) 193: 30. Holotype

♂, Sri Lanka, Ratnapura District, Uggalkaltota, 350′, Irrigation Bungalow, 31 January–8 February 1970, D. Davis & B. Rowe.

balioleuca Clarke, 1976 (*Adoxophyes*); Insects of Micronesia 9: 136. Holotype ♂, Micronesia, Ponape, N. slope Tamatamansakir, 19 January 1953, J. Clarke.

bana Kearfott, 1907 (*Phalonia*); Trans. Am. Entomol. Soc. 33: 73. Lectotype ♂, USA, Illinois, Cook Co., Chicago, June, J. Reading. Designated by Klots (1942).

banana Busck, 1906 (*Lipoptycha*); Proc. Biol. Soc. Wash. 19: 182. Holotype ♂, USA, Colorado, South Park, Oslar.

baracana Busck, 1907 (*Hysterosia*); J. N. Y. Entomol. Soc. 15: 33. Holotype ♂, USA, Missouri, St. Louis Co., St. Louis, 11 July 1906, McElhose.

bascanion Razowski, 1987 (*Transtillaspis*); Bull. Polish Acad. Sci. 35: 75. Holotype ♂, Peru, Cusco, Machu Picchu, 2,700 m, 6 February 1959, J. Clarke.

basipunctana Walsingham, 1879 (*Paedisca*); Ill. Lepid. Heter. Brit. Mus. 4: 40. Syntype ♀, USA, California, "Lower Lake," 22 June 1871. Walsingham described this species from two males and three females; the other syntypes are presumed to be in the BMNH.

batesi Heinrich, 1932 (*Talponia*); Proc. Entomol. Soc. Wash. 34: 20. Holotype ♂, Guatemala, Antiqua, 5,000′, r.f. *Annona cherimoia,* M. Bates.

batoidea Razowski, 1987 (*Transtillaspis*); Bull. Polish Acad. Sci. 35: 75. Holotype ♂, Peru, Cusco, Machu Picchu, 5 February 1959, J. Clarke.

bauhiniae Busck, 1934 (*Ancylis*); Entomol. Am. 13: 155. Holotype ♂, Cuba, Santiago de Vegas, Hab., leaftier in *Bauhinia heterophylla,* 4 December 1931, R. Olera.

bebela Razowski, 1987 (*Transtillaspis*); Bull. Polish Acad. Sci. 35: 82. Holotype ♂, Colombia, Bogotá, Chico, 25 January 1959, J. Clarke.

beckeri Clarke, 1973 (*Eumarozia*); J. Lepid. Soc. 27: 269. Holotype ♂, Costa Rica, Cartago Province, Turrialba, r.f. *Juglans,* em: 29 August 1972, V. Becker.

benjamini Heinrich, 1923 (*Thiodia*); Bull. U.S. Nat. Mus. 123: 66. Holotype ♂, USA, Utah, Vineyard, 12 September 1912, T. Spalding.

bicolor Kawabe, 1963 (*Acleris*); Tyo to Ga 14: 70. Holotype ♂, Japan, Nagano Pref., Honshu, Naka-karuisawa, 23 September 1962, T. Maenami.

bicolor Kawabe, 1978 (*Aterpia*); Tinea 10: 174. Holotype ♂, Japan, Tsushima Island, Taterayama, 2 November 1973, T. Watanabe.

bicolor Powell, 1961 (*Decodes*); J. Lepid. Soc. 14: 122. Holotype ♀, USA, California, Napa Co., Mt. St. Helena, 18 April 1939, E. Johnston.

bicolora Kawabe, 1976 (*Zeiraphera*); Tinea 10: 42. Holotype ♂, Japan, Gunma Pref., Kumanotaira, 14 July 1952, M. Hoshino.

bicornigera Razowski, 1984 (*Histura*); Acta Zool. Cracov. 27: 212. Holotype ♂, Colombia, Fassel.

bicornis Diakonoff, 1968 (*Homona*); Bull. U.S. Natl. Mus. 257: 18. Holotype ♂, Philippine Islands, Luzon, Los Baños, Baker.

biemina Kawabe, 1980 (*Apotomis*); Tinea 11: 18. Holotype ♂, Japan, Miyagi Pref., Tokatta, 13 September 1971, W. Watanabe.

bigaulae Brown, 1999 (*Eubetia*); J. New York Entomol. Soc. 106: 181. Holotype ♂, Venezuela, Aragua, Rancho Grande, cloud forest, 1,100 m, 30–31 March 1978, blacklight, J. Heppner.

binotata Brown & Obraztsov, 1991 (*Cuproxena*); in Brown and Powell, Univ. Calif. Publ. Entomol. 111: 61. Holotype ♀, Brazil, Santa Catarina, 22 July 1935, F. Hoffman.

biquadrana Walsingham, 1876 (*Paedisca*); Ill. Lepid. Heter. Brit. Mus. 4: 45. Syntype ♂, USA, California, Shasta Co., Pitt River, "end of July" 1871. Walsingham described this species from two males; the other syntype is presumed to be in the BMNH.

bira Kawabe, 1976 (*Endothenia*); Tinea 10: 43. Holotype ♂, Japan, Ishikawa Pref., Anamizu, Bira, 18 August 1961, A. Kawabe.

birdana Busck, 1907 (*Hysterosia*); J. N. Y. Entomol. Soc 15: 32. Holotype ♀, USA, New York, Rye, "bores *Helianthus*," H. Bird.

biserrata Brown, 1991 (*Paraptila*); J. Lepid. Soc. 44: 269. Holotype ♂, Costa Rica, Cartago Province, Turrialba, 22–28 February 1965, S. & W. Duckworth.

bittana Busck, 1906 (*Hemimene*); Proc. Biol. Soc. Wash. 19: 179. Holotype ♂, USA, Pennsylvania, Allegheny Co., Pittsburgh, 29 May 1905, H. Engel.

blackmorei Obraztsov, 1963 (*Acleris emargana*); Proc. U.S. Natl. Mus. 114: 208. Holotype ♂, Canada, British Columbia, Goldstream, 7 August 1923, E. Blackmore.

blanchardi Miller, 1978 (*Rhyacionia*); in Powell and Miller, U.S. Dept. Agric., Agric. Handb. 514: 19. Holotype ♂, USA, Texas, Montgomery Co., Conroe, 10 March 1968, A. & M. Blanchard.

blechra Razowski, 1987 (*Transtillaspis*); Bull. Polish Acad. Sci. 35: 79. Holotype ♂, Colombia, Nariño, Volcán Galeras, 2,900 m, 13 January 1959, J. Clarke.

bobana Kearfott, 1907 (*Eucosma*); Trans. Am. Entomol. Soc. 33: 26. "Type" ♂, USA, Colorado, Salida, 11 June 1888, W. Dietz. This species was described from three "co-types" (Salida, Colorado; Southwestern Colorado; Harris Co., Texas). Although Heinrich (1923) indicated that the "type" (from Salida, Colorado) was in the AMNH, Klots (1942) correctly identified the USNM as the place of disposition. Klots designated the AMNH specimen (Southwestern Colorado) as a "lectoparatype." The disposition of the third syntype is unknown.

bolanderana Walsingham, 1876 (*Paedisca*); Ill. Lepid. Heter. Brit. Mus. 4: 42. Two syntypes (2 ♂♂), USA, California, Siskiyou Co., Mount Shasta, August 1871. This species was described from three males and two females; the other syntypes are presumed to be in the BMNH.

boliviae Razowski, 1988 (*Proeulia*); Acta Zool. Cracov. 31: 407. Holotype ♂, Bolivia, Cochabamba, Incachaca, tropical cloud area, 2,100 m, 27 August–5 September 1956, L. Peña.

boliviana Brown, 1991 (*Bidorpitia*); in Brown and Powell, Univ. Calif. Publ. Entomol. 111: 75. Holotype ♀, Bolivia, Cochabamba, Incachaca, tropical cloud area, 2,100 m, 27 August–5 September 1956, L. Peña.

boliviana Razowski, 1984 (*Histura*); Acta Zool. Cracov. 27: 212. Holotype ♂, Bolivia, Cochabamba, Incachaca, tropical cloud area, 2,100 m, 27 August–5 September 1956, L. Peña.

boscantica Dognin, 1912 (*Tortrix*); Heteroceres L'Amerique du Sud 6: 48. Holotype ♂, Colombia, Cali, San Antonio, Fassel.

bourquini Clarke, 1949 (*Eulia*); Acta Zool. Lilloana (Tucumán) 7: 581. Holotype ♀, Brazil, Paraná, Castro, W. Schaus.

brachistocera Razowski, 1987 (*Transtillaspis*); Bull. Polish Acad. Sci. 35: 81. Holotype ♂, Colombia, Bogotá, Chico, 25 January 1959, J. Clarke.

brachystigma Clarke, 1965 (*Nesochoris*); Proc. U.S. Natl. Mus. 117: 76. Holotype ♂, Chile, Juan Fernandez Island, Masatierra, El Rabanal, 350 m, 27 February 1951, P. Kuschel.

bracteatana Fernald, 1881 (*Grapholitha*); in Comstock, Annu. Rept. Dept. Agric. 1881: 265. Lectotype ♂, USA, California, Jolon, em: 13 September 1880. Designated by Miller (1970).

bramiliana Brown, 1991 (*Cuproxena*); in Brown and Powell, Univ. Calif. Publ. Entomol. 111: 61. Holotype ♂, Brazil, Rio de Janeiro, Petropolis, 600 m, 10 October 1985, S. Miller.

brandinojuxta Razowski, 1987 (*Transtillas-

pis); Bull. Polish Acad. Sci. 35: 77. Holotype ♂, Bolivia, Cochabamba, Incachaca, tropical cloud area, 2,100 m, 27 August–5 September 1956, L. Peña.

brauni Heinrich, 1931 (*Anchylopera*); Proc. U.S. Natl. Mus. 79: 11. Holotype ♂, USA, Ohio, Adams Co., Beaver Pond, 11 May 1927.

braziliana Brown, 1991 (*Punctapinella*); Los Angeles Co. Mus. Contrib. Zool. 423: 4. Holotype ♀, Brazil, Santa Catarina, 20 November 1936, F. Hoffman.

britana Busck, 1906 (*Hemimene*); Proc. Biol. Soc. Wash. 19: 178. Lectotype ♂, Canada, British Columbia, Kaslo, H. Dyar. Designated by Miller (1983).

britannia Kearfott, 1904 (*Acleris*); Canad. Entomol. 36: 138. Holotype ♂, Canada, British Columbia, Kaslo, H. Dyar.

broui Knudson, 1986 (*Dichrorampha*); J. Lepid. Soc. 40: 323. Holotype ♂, USA, Louisiana, St. Tammany Parish, 4.2 mi NE Abita Springs, sec. 24, T6, SR 128, uv [light], 12 April 1985,V. Brou.

brunana Brown, 1990 (*Hynhamia*); Entomol. Scand. 21: 325. Holotype ♂, Peru, Angasmarca.

brunneopurpuratum Heinrich, 1923 (*Exartema*); Proc. Entomol. Soc. Wash. 25: 118. Holotype ♀, USA, Virginia, Fairfax Co., Falls Church, r.f. alder, em: 1 August 1913.

bumeliana Heinrich, 1926 (*Goditha*); Bull. U.S. Natl. Mus. 132: 8. Holotype ♂, USA, Texas, Dallas Co., Dallas, "*Dichrorampha boumelliana* Boll mss., two generations, June and Oct. in the rolled leaves of *Boumellia languinosa.*" Although misspelled as "*rumeliana*" immediately prior to its description, it is spelled correctly as "*bumeliana*" previously on the same page, where it is identified as the type species of *Goditha.*

burgessiana Zeller, 1875 (*Phoxopteris*); Verhandel. Zool.-Bot. Ges. Wein 25: 252. "Type" ♀, USA, Massachusetts, Essex Co., Beverly, 18 June 1869. This species was described from a male and two females; the specimen listed above is the only Zeller specimen of *burgessiana* we could find.

bununa Kawabe, 1989 (*Acleris*); Tinea 12: 196. Holotype ♀, Taiwan, Hualien Hsien, Tayuling, 2,560 m, 1 April 1984, A. Kawabe.

busckana J. A. Comstock, 1939 (*Pharmacis*); Bull. South. Calif. Acad. Sci. 38: 112. Holotype ♂, USA, California, Los Angeles Co., El Segundo, em: 16 November 1938, W. Pierce.

busckana Heinrich, 1923 (*Rhyacionia*); Bull. U.S. Natl. Mus. 123: 17. Holotype ♂, USA, New York, Nassau Co., Long Island, Bellmore, April 1913, G. Englehardt.

busckana Keifer, 1933 (*Clepsis*); Calif. Dept. Agric. Mon. Bull. 22: 351. Holotype ♂, USA, California, San Francisco, 8 February 1933, r.f. *Scophularia californica,* em: 3 March 1933, H. Keifer.

buscki Brown, 2000 (*Accuminulia*); J. Lepid. Soc. 53: 61. Holotype ♂, Chile, Santiago Province, reared from grape (fruit), em: 12 April 1954, M. Ramsay.

bushiensis Kawabe, 1980 (*Epinotia*); Tinea 11: 22. Holotype ♂, Japan, Saitama Pref., Bushi, Iruma, 20 October 1978, H. Inoue.

bushnelli Busck, 1914 (*Evetria*); Proc. Entomol. Soc. Wash. 66: 144. Holotype ♀, USA, New Mexico, Ft. Bayard, r.f. *Pinus ponderosa,* em: 19 March 1914, C. Bushnell.

caeruleana Walsingham, 1879 (*Grapholitha*); Ill. Lepid. Heter. Brit. Mus. 4: 66. Syntype ♂, USA, Oregon, Rouge River, May 1872. Walsingham described this species from one male and one female; the female is presumed to be in the BMNH.

caeruleumana Kawabe, 1980 (*Zeiraphera*); Tinea 11: 24. Holotype ♂, Japan, Akita Pref., Tamagawa, 2 September 1970, T. Watanabe.

caesiata Clarke, 1968 (*Cochylis*); Proc.

U.S. Natl. Mus. 125: 18. Holotype ♀, Venezuela, Aragua, Rancho Grande, 1,100 m, 16–23 October 1966, S. & W. Duckworth.

californiae Heinrich, 1923 (*Hystricophora strygiana*); Bull. U.S. Natl. Mus. 123: 256. Holotype ♂, USA, California, Lake Tahoe, Deer Park Springs, "July 8–15." Heinrich (1923) consistently misspelled *Hystrichophora* in his revision.

callosoma Clarke, 1976 (*Cryptophlebia*); Insects of Micronesia 9: 112. Holotype ♀, Micronesia, Guam, Pt. Oca, near Agana, 12 May 1945, Bohart & Gressitt.

campestrana Zeller, 1875 (*Sericoris*); Verhandel. Zool.-Bot. Ges. Wein 25: 282. "Type" ♂, USA [Maine or Massachusetts according to the original description], Packard. Zeller did not mention the number of specimens examined, although it is clear that he had both sexes. This is the only Zeller specimen of *campestrana* that we were able to find.

campicolana Walsingham, 1879 (*Cochylis*); Ill. Lepid. Heter. Brit. Mus. 4: 29. Two syntypes (♂, ♀), USA, California, Mendocino Co., 10 June 1871. Walsingham described this species from three males and two females; the other syntypes are presumed to be in the BMNH.

canariana Barnes & Busck, 1920 (*Hysterosia*); Contrib. Nat. Hist. Lepid. North Am. 4: 218. Holotype ♂, USA, Arizona, White Mountains.

candidus Pogue, 1986 (*Apolychrosis*); in Cibrián-Tovar et al., Cone and Seed Insects of the Mexican Conifers: 23. Holotype ♂, Mexico, Puebla, Atotocoyan, r.f. *Pinus strobus,* em: 2 October 1981, T. Mendez.

canitia Clarke, 1986 (*Dichelopa*); Smithsonian Contrib. Zool. 416: 149. Holotype ♀, Marquesas Islands, Nuku Hiva, Tapuaooa, 2,500′, 30 January 1968, J. & T. Clarke.

canofascia Forbes, 1930 (*Olethreutes*); Sci. Surv. Porto Rico and Virgin Islands 12: 86. Holotype ♂, Puerto Rico, Rio Piedras, 10 July 1916, E. Smith.

canusana Wright, 1997 (*Phaneta*); in Wright, Brown and Gibson, J. Lepid. Soc. 51: 122. Holotype ♂, USA, Ohio, Adams Co., Lynx Prairie Preserve, Station 6, 17 March 1989, D. Wright.

capitana Busck, 1906 (*Hemimene*); Proc. Biol. Soc. Wash. 19: 178. Holotype ♂, USA, Colorado, South Park, Oslar.

capizziana Obraztsov, 1963 (*Acleris*); Proc. U.S. Natl. Mus. 114: 252. Holotype ♀, USA, Oregon, Bendon, 24 September 1956, J. Capizzi.

capronata Razowski, 1988 (*Ernocornutia*); Acta Zool. Cracov. 31: 398. Holotype ♂, Colombia, Cauca, Paramo de Parace, Lake San Rafael, 3,570 m, 27 January 1959, J. Clarke.

carduana Busck, 1907 (*Polychrosis*); J. N. Y. Entomol. Soc. 15: 134. Holotype ♀, USA, Maryland, Montgomery Co., Hyattsville, r.f. thistle, August 1906, A. Busck.

carnana Barnes & Busck, 1920 (*Tortrix*); Contrib. Nat. Hist. Lepid. North Am. 4: 214. Holotype ♂, USA, California, San Bernardino Co., San Bernardino Mountains, Camp Baldy, "June 24–20."

carpophagoides Clarke, 1951 (*Cryptophlebia*); J. Wash. Acad. Sci. 41: 299. Holotype ♂, Argentina, Tucumán, r.f. seeds of pacará, K. Hayward.

caryana Fitch, 1856 (*Grapholitha*); New York Agric. Rept. 16: 459. Two syntypes (2 ♂♂), USA, New York [no data on specimen labels],"14,957," Type No. 394. Fitch did not indicate the number of specimens examined.

cataclasta Diakonoff, 1982 (*Dicnecidia*); Zool. Verhandel. (Leiden) 193: 42. Holotype ♂, Sri Lanka, Anuradhapura District, Wildlife Sanctuary Bungalow, Hunuwipagama, Wilpattu, 200′, 10–19 March 1970, D. Davis & B. Rowe.

cathedra Clarke, 1976 (*Lobesia*); Insects of Micronesia 9: 105. Holotype ♂, Micronesia, Guam, Pt. Oca, 30 May 1945, Bohart & Gressitt.

catopta Razowski, 1988 (*Ernocornutia*); Acta Zool. Cracov. 31: 397. Holotype ♂, Colombia, Cauca, Paramo de Parace, Lake San Rafael, 3,570 m, 27 January 1959, J. Clarke.

caulocatax Razowski, 1984 (*Conchylis*); Ann. Zool. Cracov. 38: 278. Holotype ♂, Venezuela, Bolivar, Morichal Tauca, 22 km E Rio Caura, 8–9 February 1976, C. & O. Flint.

celiae Clarke, 1976 (*Laspeyresia*); Insects of Micronesia 9: 120. Holotype ♀, Micronesia, Yap Islands, Yap Island, Colonia, 21 June 1957, C. Sabrosky.

celtisana Riley, 1881 (*Paedisca*); Trans. St. Louis Acad. Sci 4: 319. Holotype ♂, USA, Texas, r.f. *Celtis,* Boll. Riley described this species from one specimen.

cephalanthana Heinrich, 1921 (*Phalonia*); J. Agric. Res. 20: 825. Holotype ♂, USA, Texas, Charlotte, r.f. *Cephalanthus occidentalis,* em: 16 September 1918, C. Heinrich.

cercocarpana Dyar, 1903 (*Eucosma*); Proc. Entomol. Soc. Wash. 5: 297. Three syntypes (3 ♂♂), USA, Colorado, Platte Canyon, r.f. *Cercocarpus parvifolius,* Dyar & Caudell. Dyar described this species from three males and one female.

cerinus Kawabe, 1978 (*Neoansthamna*); Tinea 10: 182. Holotype ♂, Japan, Honshu, Nippara, Tokyo, 20 June 1964, A. Kawabe.

cervinana Fernald, 1882 (*Teras*); Trans. Am. Entomol. Soc. 10: 65. Lectotype ♂, USA, Massachusetts, Cambridge (?). Designated by Obraztsov (1963).

chalcana Packard, 1867 (*Conchylis*); Proc. Boston Soc. Nat. Hist. 11: 56. "Type" (sex unknown; only a forewing), Canada, Labrador, Strawberry Harbor, near Cape Webuc, 26 July. The description does not indicate how many specimens Packard examined, but the species is listed as "uncommon."

chalybeana Fernald, 1882 (*Peronea*); Trans. Am. Entomol. Soc. 10: 65. Two syntypes (1 ♂, 1 ♀), USA, New York, "L.I." [Long Island]. Of the three specimens referred to by Fernald (i.e., two males and one female from Orono, Maine and New York), only the two specimens from New York have been located by us.

changi Kawabe, 1989 (*Capua*); Tinea 12: 192. Holotype ♂, Taiwan, Haulien Hsien, Hohuanshan, 3,100 m, 30 July–1 August 1983, A. Kawabe.

charma Clarke, 1968 (*Phalonia*); Proc. U.S. Natl. Mus. 125: 16. Holotype ♀, Argentina, Tucumán, Ciudad Universitaria, 800 m, 17 February 1959, J. Clarke.

chica Brown, 1984 (*Corticivora*); Proc. Entomol. Soc. Wash. 86: 283. Holotype ♂, USA, Florida, Highlands Co., Lake Placid, Archbold Biol. Sta., 1–7 May 1964, R. Hodges.

chiquitana Barnes & Busck, 1920 (*Platynota*); Contrib. Nat. Hist. Lepid. North Am. 4: 213. Holotype ♂, USA, California, San Bernardino Co., Loma Linda.

chlamydata Dognin, 1912 (*Polyortha*); Heteroceres Nouveaux L'Amerique du Sud 6: 50. Holotype ♂, Colombia, Cali, San Antonio.

chloromonas Razowski, 1984 (*Chlorortha*); Acta Zool. Cracov. 27: 215. Holotype ♂, Venezuela, Aragua, Rancho Grande, 1,100 m, 16–23 October 1966, S. & W. Duckworth.

chortodes Diakonoff, 1968 (*Eudemis*); Bull. U.S. Natl. Mus. 257: 52. Holotype ♂, Philippine Islands, Mountain Province, Luzon, Baguio, 2 June 1945, J. Franclemont.

chrysea Heinrich, 1926 (*Bactra verutana*); Bull. U.S. Natl. Mus. 132: 85. Holotype ♂, USA, California, San Bernardino Co., Loma Linda, "March 24–30."

cibdela Razowski, 1988 (*Argyrotaenia*); Acta Zool. Cracov. 31: 409. Holotype ♂, Colombia, Cusco, Tambomachay, 3 February 1959, J. Clarke.

cibriani Miller, 1988 (*Rhyacionia*); J. Lepid. Soc. 42: 236. Holotype ♂, Mexico,

Mexico, Paso de Cortes, r.f. *Pinus hartwegii,* 12 March 1984, D. Cibrián.

cinderella Riley, 1872 (*Acleris*); Board of Agric., 4th Annu. Rept. Noxious, Beneficial and Other Insects . . . of Missouri: 46. "Type" ♀, USA, Missouri [no data on specimen label], "928.P." The description does not indicate how many specimens Riley examined; this is the only Riley specimen of *A. cinderella* we could find. Although there is no indication in Riley's hand that is was among the original type series, two subsequent labels identify it as "type."

cinereolineana Heinrich, 1923 (*Thiodia*); Bull. U.S. Natl. Mus. 123: 52. Holotype ♂, USA, Utah, Juab Co., Eureka, 21 April 1910, T. Spalding.

cirrholepida Clarke, 1976 (*Icelita*); Insects of Micronesia 9: 43. Holotype ♂, Micronesia, Palau, Koror Island, Koror, 25 April 1957, C. Sabrosky.

citrana Fernald, 1889 (*Tortrix*); Entomol. Am. 5: 18. "Type" ♀, USA, California, "the larva had eaten into an orange from Coquillett." There is no indication of how many specimens Fernald examined; this specimen is clearly labeled "Type."

citrogramma Clarke, 1976 (*Cryptophlebia*); Insects of Micronesia 9: 115. Holotype ♀, Micronesia, Kusaie, Hill 541, 165 m, 18 April 1953, J. Clarke.

claduncus Razowski, 1988 (*Chilips*); Acta Zool. Cracov. 31: 389. Holotype ♂, Chile, Centro-Austral, January–March 1898, V. Izquerdo.

clarkeana Razowski, 1984 (*Polyortha*); Acta Zool. Cracov. 27: 224. Holotype ♀, Argentina, Tucumán, Ciudad Universitaria, 800 m, 17 February 1959, J. Clarke.

clarkei Blanchard & Knudson, 1983 (*Phaneta*); Proc. Entomol. Soc. Wash. 85: 847. Holotype ♂, USA, Texas, Hemphill Co., Canadian National Grassland, Lake Marvin, 9 October 1982, E. Knudson.

clarkei Diakonoff, 1964 (*Bactra*); Zool. Verhandel. (Leiden) 70: 8. Holotype ♂, British Guiana, Vrijheidslust, larva in stem of sedge (*Cyperus*), H. Moore.

clarkei Obraztsov, 1963 (*Acleris*); Proc. U.S. Natl. Mus. 114: 251. Holotype ♂, USA, Washington, Kittitas Co., Cle Elum, 9 April 1931, J. Clarke.

clarkei Obraztsov, 1966 (*Pseudomeritastis*); Proc. U.S. Natl. Mus. 118: 226. Holotype ♂, Colombia, Cauca, 17 km SE Popayan, 2,000 m, 10 January 1959, J. Clarke.

clarki Clarke, 1951 (*Corticivora*); J. Wash. Acad. Sci. 41: 46. Holotype ♂, USA, Connecticut, North Guilford, r.f. red pine (*Pinus resinosa*), G. Plumb.

clavana Fernald, 1882 (*Semasia*); Trans. Am. Entomol. Soc. 10: 72. Lectotype ♂, USA, Massachusetts, Truro, August 8. Designated by Miller (1970).

clavosa Diakonoff, 1973 (*Lobesia*); Zool. Monogr. Rijksmus. Nat. Hist. 1: 381. Holotype ♂, Samoa, Fagatogo, Tutuila, 12 August 1940, ex-*Trema*(?), O. Swezey.

claypoleana Riley, 1882 (*Steganoptycha*); Am. Nat. 16: 914. "Type" ♀, USA, Ohio, em: 2 June 1883. There are two identically labeled Riley specimens (i.e., "360L, Iss. June 2 '83"), one of which has a USNM type label affixed. The original description does not indicate how many specimens Riley examined.

clemensiana Fernald, 1879 (*Tortrix*); Canad. Entomol. 11: 155. Lectotype ♂ (designated here), USA, Maine/Massachusetts/New York/Wisconsin [no locality data on specimen label], 10 August 1880. Selected by Obraztsov in 1956. Fernald described this species from 20 males and 17 females; he did not designate a type specimen or a type locality, instead listing the states from which he had specimens.

clenchi Clarke, 1980 (*Proeulia*); J. Lepid. Soc. 34: 182. Holotype ♂, Chile, Desventuradas Islands, San Ambrosio Island, 450 m, 8 November 1960, G. Kuschel.

cneca Obraztsov, 1964 (*Proeulia*); Proc. U.S. Natl. Mus. 116: 193. Holotype ♂, Chile, Santiago, Guayacan, 1,100 m, October 1952, L. Peña.

cockerellana Kearfott, 1907 (*Tortrix*); Trans. Am. Entomol. Soc. 33: 71. Lectotype ♂, USA, Colorado, Garfield Co., Glenwood Springs, August 1889. Designated by Rubinoff and Powell (1999).

cockleana Kearfott, 1904 (*Enarmonia*); Canad. Entomol. 36: 137. Three syntypes as follows: Canada, Alberta, Banff, "VIII.9" (2 ♂♂) (one labeled "cotype," the other with a red USNM type label); Canada, Manitoba, Awene, 20 July 1905, Criddle (1 ♀) (labeled "cotype"). Although Klots (1942) designated lectotypes for nearly all other Kearfott Olethreutinae in the AMNH, he refers to "two paralectotypes" of this species.

collilonga Blanchard & Knudson, 1984 (*Pelochrista*); Proc. Entomol. Soc. Wash. 86: 446. Holotype ♂, USA, Texas, Brown Co., Lake Brownwood State Park, 21 April 1966, A. & M. Blanchard.

coloradanus Fernald, 1882 (*Lophoderus*); Trans. Am. Entomol. Soc. 10: 67. Two syntypes (1 ♂, 1 ♀), USA, Colorado. According to the original description, this species was described from one male and one female from Colorado.

coloradensis Adamski, 1986 (*Apotomis*); Canad. Entomol. 118: 662. Holotype ♂, USA, Colorado, Maysville, 17 August 1945, H. Ramstadt.

coloradensis Heinrich, 1920 (*Evetria colfaxiana*); Proc. U.S. Natl. Mus. 57: 55. Holotype ♂, USA, Colorado, Mount Manitou, r.f. cones of *Abies concolor,* 6 October 1915, J. Pollock, W. Edmonston, G. Hofer, and A. Champlain.

comandrana Fernald, 1892 (*Teras*); Canad. Entomol. 24: 121. Lectotype ♀, USA, Massachusetts, Hampshire Co., Amherst, "Hatch Ex. Station." Designated by Obraztsov (1963).

comandranum Clarke, 1953 (*Exartema*); J. Wash. Acad. Sci. 43: 230. Holotype ♂, USA, Illinois, Putnam Co., r.f. *Comandra umbellata,* 11 June 1942, M. Glenn.

comstocki Clarke, 1952 (*Sonia*); Bull. South. Calif. Acad. Sci. 51: 62. Holotype ♂, USA, California, San Diego Co., San Felipe Wash, 11 September 1938, J. Comstock.

comstockiana Fernald, 1879 (*Retinia*); Canad. Entomol. 11: 157. Lectotype ♂, USA, New York, Tompkins Co., Ithaca. Designated by Miller (1970).

concitatricana Heinrich, 1923 (*Gwendolina*); Bull. U.S. Natl. Mus. 123: 189. Holotype ♂, USA, Texas, Kerr Co., Kerrville, 1 June 1906, F. Pratt.

concubitana Heinrich, 1923 (*Gretchena*); Bull. U.S. Natl. Mus. 123: 181. Holotype ♂, USA, Florida, Leon Co., Monticello, r.f. "Hickoria" [*Carya*], 15 March 1914, J. Gill.

conditana Walsingham, 1879 (*Penthina*); Ill. Lepid. Heter. Brit. Mus. 4: 31. Syntype ♂, USA, California, Mendocino Co., 24 May 1871. Walsingham described this species from two males; the other syntype is presumed to be in the BMNH.

confusa Obraztsov, 1962 (*Anopina*); Am. Mus. Novit. 2082: 30. Holotype ♂, Mexico, Guerrero, Sierra de las Aguas Escondidas, 9,500′, July, H. Smith.

conigerana Zeller, 1875 (*Tortrix*); Verhandel. Zool.-Bot. Ges. Wien 25: 227. "Type" ♂, USA, Maine, Packard. Zeller described this species from one male from Maine, three females from Massachusetts, and one female from New York. This is the only specimen of the original series that we could find.

coniogramma Clarke, 1976 (*Eucosma*); Insects of Micronesia 9: 53. Holotype ♂, Micronesia, Kusaie, Pukusrik, 9–14 February 1953, J. Clarke.

consacculuana Brown, 1991 (*Dorithia*); in Brown and Powell, Univ. Calif. Publ. Entomol. 111: 47. Holotype ♂, Mexico, Chiapas, San Cristóbal [de] las Casas, 17–21 July 1964, P. Spangler.

consobrina Busck, 1914 (*Homona*); Proc. U.S. Natl. Mus. 46: 54. Holotype ♀, Panama, Porto Bello, March 1911, A. Busck.

consobrinana Heinrich, 1923 (*Eucosma*); Bull. U.S. Natl. Mus. 123: 128. Holotype ♂, USA, South Dakota, Union Co., Elk Point, August 1913, C. Ainslie.

consociana Heinrich, 1923 (*Eucosma*); Bull. U.S. Natl. Mus. 123: 101. Holotype ♂, USA, Utah, Juab Co., Eureka, 23 July 1911, T. Spalding.

constantia Clarke, 1968 (*Cochylis*); Proc. U.S. Natl. Mus. 125: 22. Holotype ♀, Peru, Cusco, Machu Picchu, 2,700 m, 6 February 1959, J. Clarke.

constellatana Zeller, 1875 (*Sericoris*); Verhandel. Zool.-Bot. Ges. Wein 25: 279. "Type" ♂, USA, New York, "2/71," Speyer. Zeller described this species from six males and two females from Ohio and New York. This is the only Zeller specimen of *S. constellatana* we could find.

contrasta Brown, 2000 (*Lobogenesis*); Proc. Entomol. Soc. Wash. 102: 32. Holotype ♂, Bolivia, Incachaca, Cochabamba, tropical cloud forest area, 2,100 m, 27 August–5 September 1956, L. Peña.

contrastana Kearfott, 1907 (*Commophila*); Canad. Entomol. 39: 160. Lectotype ♂, USA, Pennsylvania, Allegheny Co., Oak Station, 13 June 1907, F. Marloff. Designated by Klots (1942).

conversana Walsingham, 1879 (*Grapholitha*); Ill. Lepid. Heter. Brit. Mus. 4: 66. Syntype ♂, USA, Oregon, Camp Watson, "John Day's river," "beginning of April 1872." This species was described from three males and one female; the other syntypes presumably are in the BMNH.

coppelia Clarke, 1976 (*Icelita tatarana*); Insects of Micronesia 9: 36. Holotype ♂, Micronesia, Guam, Piti, 15 September 1936, r.f. *Intsia bijuga,* O. Swezey.

cordiae Busck, 1934 (*Ancylis*); Entomol. Am. 13: 154. Holotype ♂, Cuba, Havana, Santiago de Vegas, leaf tier on *Cordia globosa,* 26 November 1931, A. Otero.

cornifoliana Riley, 1881 (*Phoxopteris*); Trans. St. Louis Acad. Sci. 4: 324. "Type" ♂, USA, Kansas, Riley Co., Manhattan, r.f. *Cornus paniculata,* em: 7 April 1873. Of two specimens referred to in the original description, this is the only specimen we have found.

cornucopis Walsingham, 1914 (*Enarmonia*); Biol. Centr.-Am., Lepid., Heter. 4: 240. Holotype ♀, Mexico, Oaxaca, Salina Cruz, W. Schaus. Described from the single female "Type."

cornuta Brown & Obraztsov, 1990 (*Cuproxena*); in Brown and Powell, Univ. Calif. Publ. Entomol. 111: 53. Holotype ♂, Costa Rica, Cartago Province, Juan Vinas, W. Schaus.

cornutana Dyar, 1903 (*Epinotia*); Proc. Entomol. Soc. Wash. 5: 231. Holotype ♀, USA, Arizona, Coconino Co., Williams, "22.7," H. Barber. According to the original description, this species was described from a single female.

cortesi Clarke, 1987 (*Cryptophlebia*); Acta Entomol. Chileana 14: 8. Holotype ♂, Chile, Iquique Province, Region Tarapaca, Valle de Azapa, 25 m, r.f. *Acacia macracantha,* 10 January 1969, R. Mendoza.

corylana Fernald, 1882 (*Eccopsis*); Trans. Am. Entomol. Soc. 10: 71. Lectotype ♂, USA, New Hampshire, White Mountains. Designated by Miller (1970).

corynetes Diakonoff, 1982 (*Epinotia*); Zool. Verhandel. (Leiden) 193: 59. Holotype ♂, Sri Lanka, Ratnapura District, Uggalkaltota, 350′, Irrigation Bungalow, 31 January–8 February 1970, D. Davis & B. Rowe.

cosmocosta Razowski 1987 (*Coryssovalva*); Tinea 12(suppl.): 130. Holotype ♂, Colombia, Cauca, Paramo de Parace, Lake San Rafael, 3,570 m, 29 January 1959, J. Clarke.

costaricana Razowski 1984 (*Histurodes*); Acta Zool. Cracov. 27: 213. Holotype

♂, Costa Rica, San Pedro de Montes de Oca.

costimaculana Fernald, 1882 (*Penthina*); Trans. Am. Entomol. Soc. 10: 70. Lectotype ♀, USA, Maine, Penobscot Co., Orono, 17 June 1881. Designated by Miller (1970).

costinotana Franclemont, 1986 (*Lozotaenia*); Proc. Entomol. Soc. Wash. 88: 57. Holotype ♂, USA, Maine, Penobscot Co., Passadumkeag, 30 June 1956, J. Franclemont.

cracens Diakonoff, 1982 (*Eupoecilia*); Zool. Verhandel. (Leiden) 193: 6. Holotype ♂, Sri Lanka, NE District, Kanda-ela Reservoir, 5.6 mi SW Nuwara Eliya, 6,200′, 10–21 February 1970, D. Davis & B. Rowe.

crambitana Walsingham, 1879 (*Paedisca*); Ill. Lepid. Heter. Brit. Mus. 4: 43. Syntype ♂, USA, California, Mount Shasta, August 1871. This species apparently was described from one male and one female; the female presumably is in the BMNH.

cristata Clarke, 1955 (*Orthocomotis*); Trans. Royal Entomol. Soc. London 107: 155. Holotype ♂, Costa Rica, Cachi, W. Schaus.

crocoptila Diakonoff, 1968 (*Peridaedala*); Bull. U.S. Natl. Mus. 257: 79. Holotype ♀, Philippine Islands, Davao Province, Mindanao, E slope Mt. McKinley, 7,000′, 22 September 1946, CNHM Philippine Zool. Exped. 1946–47, H. Hoogstraal.

cruentana Blanchard & Knudson, 1981 (*Phaneta*); J. Lepid. Soc. 35: 169. Holotype ♂, USA, Texas, Anderson Co., Engeling Wildlife Management Area, near Tennessee Colony, 28 June 1978, A. & M. Blanchard.

cryptica Brown, 1991 (*Bidorpitia*); in Brown and Powell, Univ. Calif. Publ. Entomol. 111: 75. Holotype ♀, Venezuela, Aragua, Rancho Grande, 1,100 m, 1–5 October 1966, S. & W. Duckworth.

cupressi Heinrich, 1923 (*Epinotia hopkinsana*); Bull. U.S. Natl. Mus. 123: 207. Holotype ♂, USA, California, Cypress Point, r.f. cones of *Cupressus macrocarpus,* 4 November 1915, J. Miller.

cyanosticha Clarke, 1976 (*Cymolomia*); Insects of Micronesia 9: 55. Holotype ♂, Micronesia, Kusaie, Hill 1010, 300 m, 13 April 1953, J. Clarke.

cyclopiana Heinrich, 1926 (*Polychrosis*); Bull. U.S. Natl. Mus. 132: 97. Holotype ♀, USA, New Jersey, Burnt Hills, r.f. seed pods of swamp magnolia, July 1920, H. Weiss.

cydna Razowski, 1993 (*Apotoforma*); Acta Zool. Cracov. 36: 185. Holotype ♀, Venezuela, Rancho Grande, 1,100 m, 16–23 October 1966, S. & W. Duckworth.

cylichna Razowski, 1994 (*Cylichneulia*); SHILAP Revta. Lepid. 22: 68. Holotype ♀, Venezuela, Aragua, Rancho Grande, 15–21 June 1967, 1,100 m, R. Poole.

daemonicana Heinrich, 1923 (*Eucosma*); Bull. U.S. Natl. Mus. 123: 111. Holotype ♂, USA, New Mexico, Manzano National Forest, Hell Cañon, "flying," 14 September 1916, C. Heinrich.

dapsilis Heinrich, 1929 (*Eucosma*); Proc. U.S. Natl. Mus. 75: 5. Holotype ♂, USA, Wyoming, Park Co., Yellowstone National Park, North Park.

dativa Heinrich, 1928 (*Rhyacionia*); Proc. Entomol. Soc. Wash. 30: 61. Holotype ♂, Japan, Yokahama, r.f. *Pinus thunbergii,* em: 1 July 1925, A. Kariya.

davisi Kawabe, 1989 (*Archips*); Tinea 12: 191. Holotype ♂, Taiwan, Hualien Hsien, Tayulin, 2,500 m, 9–18 June 1980, D. Davis.

deceptana Busck, 1907 (*Pharmacis*); J. N. Y. Entomol. Soc. 15: 29. Holotype ♀, USA, Texas, Kerr Co., Kerrville, W. Barnes.

deceptiva Clarke, 1949 (*Eulia*); Acta Zool. Lilloana (Tucumán) 7: 581. Holotype ♀, Brazil, Santa Catarina, Nova Teutonia, F. Plaumann.

decor Kawabe, 1978 (*Enarmonia*); Tinea

10: 188. Holotype ♂, Japan, Honshu, Chiba Pref., Tokiwadaira, 5 June 1977, A. Kawabe.

decora Obraztsov, 1966 (*Pseudomeritastis*); Proc. U.S. Natl. Mus. 118: 230. Holotype ♂, Bolivia, Cochabamba, Incachaca, tropical cloud area, 2,100 m, 27 August–5 September 1956, L. Peña.

decorosa Heinrich, 1929 (*Hystricophora*); Proc. U.S. Natl. Mus. 75: 20. Holotype ♂, USA, Florida, Enterprise, "4.16." Heinrich (1923) consistently misspelled *Hystrichophora* in his revision.

definitivana Heinrich, 1923 (*Anchylopera*); Bull. U.S. Natl. Mus. 123: 270. Holotype ♂, USA, Nevada, "July 16–23."

deflexana Heinrich, 1923 (*Epiblema*); Bull. U.S. Natl. Mus. 123: 144. Holotype ♂, USA, Texas, Cameron Co., Brownsville, 27 May 1917, A. Busck.

delicata Yasuda & Kawabe, 1980 (*Croesia*); Tinea 11: 13. Holotype ♂, Japan, Nagano Pref., Okutatesina, 23 August 1963, A. Kawabe.

delicatana Heinrich, 1923 (*Gretchena*); Bull. U.S. Natl. Mus. 123: 185. Holotype ♂, USA, Pennsylvania, Allegheny Co., Oak Station, "May 1–10," F. Marloff.

delphinoides Heinrich, 1923 (*Thiodia*); Bull. U.S. Natl. Mus. 123:59. Holotype ♂, USA, Utah, Juab Co., Eureka, 16 July 1911, T. Spalding.

delphinus Heinrich, 1923 (*Thiodia*); Bull. U.S. Natl. Mus. 123: 45. Holotype ♂, USA, California, Lake Tahoe, Deer Park Springs, "July 1–7."

dendrophila Clarke, 1971 (*Dichelopa*); Smithsonian Contrib. Zool. 56: 105. Holotype ♂, Rapa Island, Maugaoa, 950' (292 m), r.f. *Cyathea rapensis,* em: 3 November 1963, J. & T. Clarke.

deprecatoria Heinrich, 1926 (*Olethreutes*); Bull. U.S. Natl. Mus. 132: 177. Holotype ♂, Canada, British Columbia, Wellington, July, G. Taylor.

derelicta Heinrich, 1929 (*Eucosma*); Proc. U.S. Natl. Mus. 75: 13. Holotype ♂, USA, North Carolina, Polk Co., Tryon, 13 August 1904, Fiske.

diabolana Blanchard, 1979 (*Eucosma*); J. Lepid. Soc. 33: 214. Holotype ♂, USA, Texas, Culberson, Co., Sierra Diablo Wildlife Management Area, 6,000′, 31 March 1970, A. & M. Blanchard.

diamphidia Clarke, 1968 (*Lasiothyris*); Proc. U.S. Natl. Mus. 125: 49. Holotype ♂, Peru, Cusco, Machu Picchu, 5 February 1959, J. Clarke.

dicaeus Diakonoff, 1968 (*Archips*); Bull. U.S. Natl. Mus. 257: 26. Holotype ♂, Philippine Islands, Luzon, Mt. Makiling, Baker.

digitana Heinrich, 1923 (*Epinotia*); Bull. U.S. Natl. Mus. 123: 215. Holotype ♂, Canada, British Columbia, Kaslo Creek, H. Dyar.

dilutifuscana Walsingham, 1879 (*Sericoris*); Ill. Lepid. Heter. Brit. Mus. 4: 33. Syntype ♂, USA, southern Oregon, 2 June 1872. Walsingham described this species from two males; the other syntype is presumed to be in the BMNH.

dimorpha Clarke, 1949 (*Eulia*); Acta Zool. Lilloana (Tucumán) 7: 585. Holotype ♀, Brazil, Santa Catarina, 28 March 1936, F. Hoffman.

dimorphana Barnes & Busck, 1920 (*Tortrix*); Contrib. Nat. Hist. Lepid. North Am. 4: 215. Holotype ♂, Canada, British Columbia, Victoria.

discobola Diakonoff, 1968 (*Strepsicrates*); Bull. U.S. Natl. Mus. 257: 85. Holotype ♂, Philippine Islands, Davao Province, Mindanao, E slope Mt. McKinley, 7,200′, 10 September 1946, mossy stunted forest, CNHM Philippine Exped. 1946–47, H. Hoogstraal.

discretivana Heinrich, 1921 (*Eucosma*); J. Agric. Res. 20: 823. Holotype ♂, USA, Texas, Harris Co., Sheldon, 10 April 1919, Johnson.

dispersa Brown, 1990 (*Auratonota*); Florida Entomol. 73: 154. Holotype ♂, Panama, Cocle Province, Valle, 22 April 1965, S. & W. Duckworth.

disputabilis Obraztsov 1963 (*Acleris*); Proc.

U.S. Natl. Mus. 114: 262. Holotype ♂, Canada, British Columbia, Goldstream, 16 October 1902.

dissitana Grote, 1879 (*Ptycholoma*); North Am. Entomol. 1: 29. "Type" ♀, USA, 4 July 1878. This specimen, labeled "type" by someone other than Grote, is the only Grote specimen of *P. dissitana* we could locate. The original description does not indicate how many specimens were examined.

distincta Obraztsov, 1966 (*Pseudomeritastis*); Proc. U.S. Natl. Mus. 118: 228. Holotype ♀, Costa Rica, Cartago Province, La Florida, 500′, W. Schaus.

dognini Obraztsov, 1966 (*Pseudatteria*); Proc. U.S. Natl. Mus. 118: 588. Holotype ♂, Ecuador, Environs of Loja, 1887.

dominica Brown, 1993 (*Auratonota*); Pan-Pac. Entomol. 69: 314. Holotype ♂, West Indies, Dominica, 1.7 mi E Point Casse, light trap, 24 March 1965, W. Wirth.

domna Clarke, 1968 (*Amallectis*); Proc. U.S. Natl. Mus. 125: 34. Holotype ♂, Colombia, Nariño, Volcán Galeras, 3,000 m, 14 January 1959, J. Clarke.

donaldana Kawabe, 1993 (*Notocelia*); Tinea 13: 238. Holotype ♂, Taiwan, Nantou Hsien, Mei-feng, 30 km S Tayuling, 2,200 m, 1–8 July 1980, D. Davis.

doria Clarke, 1976 (*Laspeyresia*); Insects of Micronesia 9: 123. Holotype ♂, Micronesia, Palau, Babelthuap, Ngarhelong, 1 May 1957, C. Sabrosky.

dorsalana Dyar, 1903 (*Tortrix*); Proc. Entomol. Soc. Wash. 5: 231. Syntypes (4 ♂♂, 2 ♀♀), USA, Arizona, Coconino Co., Williams, r.f. oak, em: 14 June 1901, A. Schwartz. According to the original description, Dyar described this species from four males and four females; all of the syntypes cited above are labeled "Type No. 6736 USNM," consistent with the original description.

dorsata Clarke, 1988 (*Dichelopa*); Smithsonian Contrib. Zool. 416: 133. Holotype ♀, Marquesas Islands, Hiva Oa, Mt. Feani, 3,400′, 1 March 1968, J. & T. Clarke.

druana Walsingham, 1914 (*Tortrix*); Biol. Centr.-Am., Lepid., Heter., 4: 288. Holotype ♂, Mexico, Durango, r.f. cynipid gall on *Quercus,* em: 11 February 1897. This species was described from the single male.

dryocremna Meyrick, 1932 (*Polyortha*); Exotic Microlepidoptera 4: 343. Lectotype ♀ (designated here), Guatemala, Palin, Schaus & Barnes. Selected by J. Clarke. Meyrick's description indicates "6 ex. [examples] (type U.S. Nat. Mus.)."

duckworthorum Brown, 1991 (*Cuproxena*); in Brown and Powell, Univ. Calif. Publ. Entomol. 111: 67. Holotype ♂, Costa Rica, Cartago Province, Turrialba, 17–21 February 1965, S. & W. Duckworth.

dulciana Heinrich, 1923 (*Gretchena*); Bull. U.S. Natl. Mus 123: 182. Holotype ♂, USA, New Jersey, Greenwood Lake, "V.30," W. Kearfott.

dysmorphia Clarke, 1968 (*Lasiothyris*); Proc. U.S. Natl. Mus. 125: 47. Holotype ♂, Bolivia, Cochabamba, Incachaca, tropical cloud area, 2,100 m, 27 August–5 September 1956, L. Peña.

eburata Heinrich, 1929 (*Eucosma*); Proc. U.S. Natl. Mus. 75: 6. Holotype ♂, USA, Arizona, Mohave Co., "Aug. 24–31."

edemoidana Dyar, 1903 (*Eucosma*); Proc. Entomol. Soc. Wash. 5: 229. Two syntypes (2 ♀♀), USA, Arizona, Coconino Co., Williams, "19-7," W. Barnes; USA, New Mexico, Las Vegas HS, "18.8." According to the original description, this species was described from the two females cited above.

egens Razowski, 1999 (*Netechma*); Polskie Pismo Entomol. 68: 97. Holotype ♂, Colombia, Nariño, Volcán Galeras, 2,900 m, 13 January 1959, J. Clarke. Razowski (1999) incorrect identifies the disposition of the type as NHMW.

elaborata Kawabe, 1976 (*Pseudohedya*);

Tinea 10: 45. Holotype ♂, Japan, Aomori Pref., Tuta Spa, 20 July 1957, A. Kawabe.

eleonora Obraztsov, 1962 (*Anopina*); Am. Mus. Novit. 2082: 12. Holotype ♂, USA, Arizona, Apache Co., Alpine, 6 June 1937, G. & J. Sperry.

elitha Clarke, 1976 (*Heleanna physalodes*); Insects of Micronesia 9: 19. Holotype ♂, Micronesia, Ponape Island, Colonia, 13 January 1953, J. Clarke.

elongana Brown, 1990 (*Cuproxena*); in Brown and Powell, Univ. Calif. Publ. Entomol. 111: 54. Holotype ♂, Venezuela, Amazonas (territory), Cerro de Neblina Camp VII, 1,850 m, 0°51′N, 65°58′W, 2–4 December 1984, Brown.

embaphion Razowski, 1984 (*Saphenista*); Ann. Zool. Warsaw 38: 276. Holotype ♂, Venezuela, Mérida, 8 km SE Apartaderos, 22 February 1976, C. & O. Flint.

embolina Razowski, 1984 (*Saphenista*); Ann. Zool. Warsaw 38: 277. Holotype ♀, Venezuela, Mérida, 4 km S Santo Domingo, 19–23 February 1976, C. & O. Flint.

emera Razowski, 1993 (*Acleris*); Acta Zool. Cracov. 36: 191. Holotype ♂, Bolivia, Cochabamba, Incachaca, 27 August–5 September 1956, L. Peña.

emigratella Busck, 1909 (*Amorbia*); Proc. Entomol. Soc. Wash. 11: 201. Syntype ♂, Hawaiian Islands, Oahu, Tantulus, O. Swezey. Busck did not indicate how many specimens he examined.

enucleata Razowski, 1999 (*Netechma*); Polskie Pismo Entomol. 68: 95. Holotype ♂, Colombia, Nariño, Volcán Galeras, 300 m, 14 January 1959, J. Clarke. Razowski (1999) incorrect identifies the disposition of the type as NHMW.

episticta Clarke, 1949 (*Eulia*); Acta Zool. Lilloana (Tucumán) 7: 584. Holotype ♂, Brazil, Santa Catarina, Nova Teutonia, September 1948, F. Plaumann.

equadora Brown, 1990 (*Paraptila*); J. Lepid. Soc. 44: 271. Holotype ♂, Ecuador, Shell-Mera, 18 April 1958, R. Hodges.

erigeronana Riley, 1881 (*Conchylis*); Trans. St. Louis Acad. Sci. 4: 316. Holotype ♂, USA, Texas, Columbia, r.f. "cecidomyidous gall on *Erigeron,*" em: 24 February 1879, E. Schwarz. Riley described this species from a single specimen.

erotella Heinrich, 1923 (*Carpocapsa*); Proc. Entomol. Soc. Wash. 25: 121. Holotype ♀, USA, Maryland, Montgomery Co., Hyattsville, r.f. *Pinus taeda,* em: 22 May 1915, A. Busck.

erubesca Kawabe, 1978 (*Gypsonoma*); Tinea 10: 187. Holotype ♂, Japan, Hokkaido, Sapporo, Matuyama Park, 30 July 1950, A. Mutsuura.

escharia Clarke, 1976 (*Trymalitis*); Insects of Micronesia 9: 142. Holotype ♂, Micronesia, Guam, Ritidian, 2 August 1945, J. Gressitt.

essigana Busck, 1929 (*Amorbia*); Calif. Dept. Agric. Mon. Bull. 18: 276. Holotype ♂, USA, California, San Diego Co., Chula Vista, r.f. avocado leaves, 8 December 1928, R. McLean.

ethnica Heinrich, 1923 (*Epinotia*); Bull. U.S. Natl. Mus. 123: 201. Holotype ♂, USA, California, San Diego Co., San Diego, "June 16–23."

euchaldera Clarke, 1955 (*Orthocomotis*); Trans. Royal Entomol. Soc. London 107: 146. Holotype ♂, Colombia, June 1909, Fassel.

eupista Diakonoff, 1968 (*Stenarchella*); Bull. U.S. Natl. Mus. 257: 99. Holotype ♂, Philippine Islands, Davao Province, Mindanao, La Lum Mt., Calian, 5,000′, 29–21 December 1920, Clagg, CM Acc. 9163.

evestigana Razowski, 1984 (*Polyortha*); Acta Zool. Cracov. 27: 221. Holotype ♂, El Salvador, Cerro Miramundo, 2,300 m, 11 January 1969, S. Steinhauser.

exacerbatricana Heinrich, 1923 (*Epiblema*); Bull. U.S. Natl. Mus 123: 146. Holotype ♂, USA, North Carolina, Southern Pines, "Aug. 16–23."

exaeresimum Heinrich, 1926 (*Exartema*); Bull. U.S. Natl. Mus. 132: 160. Holotype ♂, USA, Texas, Dallas Co., Dallas.

excerptionana Heinrich, 1923 (*Eucosma*); Bull. U.S. Natl. Mus. 123: 117. Holotype ♂, USA, Nevada, Washoe Co., Verdi, "June 1 to 10," A. Vachell.

exclusoriana Heinrich, 1923 (*Eucosma*); Bull. U.S. Natl. Mus. 123: 110. Holotype ♂, USA, Texas, La Salle Co., Cotulla, 12 May 1906, Crawford & Pratt.

excusabilis Heinrich, 1923 (*Eucosma*); Bull. U.S. Natl. Mus. 123: 123. Holotype ♂, USA, California, Lake Tahoe, Deer Park Springs.

exolivata Clarke, 1955 (*Orthocomotis*); Trans. Entomol. Soc. London 107: 148. Holotype ♀, Brazil, Santa Catarina, Nova Teutonia, August 1936, H. Parish.

exomilana Franclemont, 1986 (*Lozotaenia*); Proc. Entomol. Soc. Wash. 88: 58. Holotype ♂, USA, North Carolina, Macon Co., Highlands, 3,865′, 11 July 1958, J. Franclemont.

exoristus Razowski, 1988 (*Exoletuncus*); Acta Zool. Cracov. 31: 390. Holotype ♂, Colombia, Cauca, Paramo de Parce, Lake San Rafael, 3,570 m, 29 January 1959, J. Clarke.

expolitana Heinrich, 1923 (*Eucosma*); Bull. U.S. Natl. Mus. 123: 132. Holotype ♂, USA, Utah, Utah Co., Provo, 11 August 1908, T. Spalding.

exulis Issiki & Stringer, 1932 (*Gnorismoneura*); Stylops 1: 125. Holotype ♂, Taiwan, Taihoku, 18 October 1923, S. Issiki.

famula Zeller, 1875 (*Teras tristana*); Verhandel. Zool.-Bot. Ges. Wien 25: 214. Lectotype ♂, North America [no collecting data]. Designated by Obraztsov (1963). Zeller's original description refers to a male, consistent with the specimen cited above. However, the associated Busck genitalia slide (Dec 6 1924; USNM 25944) is of a female, and Obraztsov's (1963: 236) lectotype designation also refers to the specimen as female.

fernaldana Grote, 1880 (*Paedisca*); N. Am. Entomol.: 98. "Type" ♂, USA, Colorado. This is the only Grote specimen of *fernaldana* we could locate; it bears a labeling identifying it as the type, but not in Grote's hand. The original description does not indicate how many specimens were examined.

fernaldana Walsingham 1879 (*Cochylis*); Ill. Lepid. Heter. Brit. Mus. 4: 27. Syntype ♂, USA, northern California, September 1871. This species was described from four males and one female; all of the other syntypes are presumed to be in the BMNH.

ferreana Busck, 1915 (*Sparganothis*); Proc. Entomol. Soc. Wash. 17: 86. Holotype ♀, USA, New York, Herkimer Co., Ilion, 10 July 1912, H. McElhose.

ferruginana Fernald, 1882 (*Semasia*); Trans. Am. Entomol. Soc. 10: 72. Lectotype ♀, USA, Massachusetts, Goodell. Designated by Miller (1970).

ferrugineana Riley, 1881 (*Exartema*); Trans. St. Louis Acad. Sci. 4: 317. "Type" ♂, USA, Missouri, St. Louis Co., St. Louis, r.f. leaves of plum. Riley described this species from two males, only one of which could be located by us.

ferruginiguttana Fernald, 1882 (*Teras*); Trans. Am. Entomol. Soc. 10: 65. "Type" ♀, USA, Colorado. Of two females that comprised the type series, we could find only one. It is represented by a portion of the thorax bearing a single leg and a small piece of the left forewing.

ferruginus Pogue, 1986 (*Apolychrosis*); in Cibrián-Tovar et al., Cone and Seed Insects of the Mexican Conifers: 21. Holotype ♂, Mexico, Tlaxcala, Municipio de Terrenate, Villareal, r.f. *Pseudotsuga macrolepis,* em: 18 August–6 September 1981, J. Mendez & R. Campos.

fertoriana Heinrich, 1923 (*Thiodia*); Bull.

U.S. Natl. Mus. 123: 264. Holotype ♂, Canada, British Colombia, Goldstream, "10-5-03."

filiana Busck, 1907 (*Hendecaneura*); J. N. Y. Entomol. Soc. 15: 135. Holotype ♂, USA, California, Riverside Co., West Riverside, 26 October 1905.

finitimana Heinrich, 1923 (*Kundrya*); Bull. U.S. Natl. Mus. 123: 192. Holotype ♂, USA, New Hampshire, Rockingham Co., Hampton, 11 June 1909, S. Shaw.

fishiana Fernald, 1882 (*Peronea*); Trans. Am. Entomol. Soc. 10: 66. Lectotype ♂, USA, Maine, Penobscot Co., Orono, 17 September 1879. Designated by Obraztsov (1963).

flavana Fernald, 1905 (*Eucosma pergandeana*); Canad. Entomol. 37: 399. Lectotype ♂, USA, Texas. Designated by Miller (1970).

flavibasana Fernald, 1882 (*Cenopis*); Trans. Am. Entomol. Soc. 10: 69. Lectotype ♂ (designated here), USA, Illinois. Selected by Powell in 1965. Although there is little doubt that the lectotype is one of 2 specimens referred to in the original description, Fernald misidentified the sex, indicating two females, one from Texas and one from Illinois.

flavifasciana Kawabe, 1976 (*Olethreutes*); Tinea 10: 47. Holotype ♀, Japan, Gunma Pref., Kuridaira, 20 July 1951, M. Hoshino.

flavillana Dyar, 1903 (*Epinotia*); Proc. Entomol. Soc. Wash. 5: 230. Three syntypes (1 ♂, 2 ♀♀), USA, Arizona, Coconino Co., Williams, bred from flower stalk, June. According to the original description, this species was described from three specimens.

flexicostalis Dognin, 1908 (*Tortrix*); Ann. Soc. Entomol. Belgium 52: 32. Holotype ♂, Peru (SE), Oconeque, Carabaya, "10.07," Warren.

flexura Clarke, 1986 (*Dichelopa*); Smithsonian Contrib. Zool. 416: 124. Holotype ♂, Marquesas Islands, Hiva Oa, Feani, 3,800′, 20 February 1968, J. & T. Clarke.

flintana Brown, 1991 (*Cuproxena*); in Brown and Powell, Univ. Calif. Publ. Entomol. 111: 69. Holotype ♀, Mexico, Jalisco, Rt. 94, km 42, N Chapala [4 mi toward Guadalajara from Chapala; top of hill], 16–18 July 1966, O. Flint & A. Ortiz.

footiana Fernald, 1882 (*Eccopsis*); Bull. Buffalo Soc. Nat. Sci. 4: 53. Lectotype ♀, USA, New York. Designated by Miller (1970).

formosanus Kawabe, 1987 (*Archippus*); Tinea 7: 122. Holotype ♂, Taiwan, Chiayi, Alishan, 2,200 m, 9–11 July 1964, H. Inoue.

foxcana Kearfott, 1907 (*Phalonia*); Trans. Am. Entomol. Soc. 33: 84. Lectotype ♂, USA, Ohio, Hamilton Co., Cincinnati, 18 August 1903, A. Braun. Kearfott described this species from three specimens from Cincinnati, Ohio, and Plummers Island, Maryland, with no indication of which locality was the source of two of the three. Klots (1942) designated the above-mentioned lectotype, indicating that there were two lectoparatypes in the AMNH: a female from Plummers Island and another specimen without an abdomen (he didn't provide its collection data). Although he correctly cited the date of collection of the lectotype, he incorrectly cited its collection locality as Plummers Island.

fragariae Walsh & Riley, 1869 (*Anchylopera*); Am. Entomol. 1: 89. Lectotype ♀, USA, Illinois, Whiteside or Bureau Co. According to the original description, this species was described from nine specimens, only two of which could be located by us. Designated by Miller (1973).

fragariana Busck, 1919 (*Tortricodes*); Proc. Entomol. Soc. Wash. 21: 52. Holotype ♂, Canada, British Columbia, Victoria, 17 August 1918.

frangula Clarke, 1968 (*Amallectis*); Proc. U.S. Natl. Mus. 125: 30. Holotype ♀, Venezuela, Aragua, Rancho Grande, 1,100 m, 16–23 October 1966, S. & W. Duckworth.

fraternana Busck 1907 (*Hendecaneura*); J. N. Y. Entomol. Soc. 15: 134. Holotype ♂, USA, California, Riverside Co., West Riverside, October.

fratruelis Heinrich, 1923 (*Eucosma*); Bull. U.S. Natl. Mus. 123: 98. Holotype ♂, USA, North Carolina, Southern Pines, 8–15 August.

fraudabilis Heinrich, 1923 (*Eucosma*); Bull. U.S. Natl. Mus. 123: 98. Holotype ♂, USA, North Carolina, Southern Pines. According to the original description, the type series was collected between 1 June and 23 July.

fritillana Blanchard & Knudson, 1981 (*Eucosma*); J. Lepid. Soc. 35: 170. Holotype ♂, USA, Texas, Anderson Co., Engeling Wildlife Management Area, near Tennessee Colony, 28 June 1978, A. Blanchard.

frustrana W. Comstock, 1880 (*Retinia*); Rept. U.S. Dept. Agric. 1879: 236. Lectotype ♀, USA, Virginia, near Washington (D.C.), "*Tortrix* on *P. inops,*" em: 18 June 1879. Designated by Miller (1967).

fucana Walsingham, 1879 (*Lozotaenia*); Ill. Lepid. Heter. Brit. Mus. 4: 12. Syntype ♂, USA, Oregon (southern), May 1872. This species was described from four males; the other syntypes are presumably in the BMNH.

fullerea Riley, 1869 (*Penthina*); J. Horticult., Boston, Oct. 1868: 12. "Type" ♀, USA, "seed pods of *Antherrinum.*" An associated label indicates that the specimen is an unpublished lectotype selected by Miller in 1982. Riley did not indicate how many specimens he examined.

fulvomixtana Kawabe, 1974 (*Zeiraphera*); Tyo to Ga 25: 98. Holotype ♂, Japan, Gunma Pref., Doaiguchi, 12 July 1972, S. Shimeki.

fumipennis Dognin, 1904 (*Atteria*); Ann. Soc. Entomol. Belgium 48: 133. Holotype ♂, Colombia, Micay, Août, 1869.

fumosana Powell, 1978 (*Rhyacionia*); in Powell and Miller, U.S. Dept. Agric., Agric. Handb. 514: 21. Holotype ♂, USA, Colorado, El Paso Co., Colorado Springs, Rock Creek Canyon, 2 May 1959, M. May.

fumoviridana Heinrich, 1923 (*Epinotia*); Bull. U.S. Natl. Mus. 123: 208. Holotype ♂, USA, California, Siskiyou Co., Shasta Retreat, "Aug. 16–23."

fuscalbana Zeller, 1876 (*Sericoris*); Verhandel. Zool.-Bot. Ges. Wein 25: 284. "Type" ♂, USA, [Maine or Massachusetts according to the original description], Packard. This is the only Zeller specimen of *fuscalbana* that we were able to locate. The original description does not indicate how many specimens were examined, but it does indicate that the series included only males.

fuscana Barnes & Busck, 1920 (*Peronea*); Contrib. Nat. Hist. Lepid. North Am. 4: 216. Holotype ♂, Canada, Manitoba, Aweme, 18 April 1905, Criddle.

fuscodorsana Kearfott, 1904 (*Commophila*); Canad. Entomol. 36: 141. Holotype ♂, Canada, British Colombia, Kaslo, 7 June 1903, J. Cockle. Klots (1942) correctly stated that the holotype is in the USNM, consistent with the original description.

fuscomaculatus Brown, 2000 (*Odonthalitus*); Proc. Entomol. Soc. Wash. 102: 42. Holotype ♀, Mexico, Michoacan, San Lorenzo, Rt. 15, km 206, 19 July 1966, O. Flint & A. Ortiz.

galena Clarke, 1971 (*Tritopterna*); Smithsonian Contrib. Zool. 56: 124. Holotype ♂, Rapa Island, Teumukopuke, 500′, 7 October 1963, J. & T. Clarke.

galerasiana Razowski, 1988 (*Uncicida*); Acta Zool. Cracov. 31: 396. Holotype ♂, Colombia, Nariño, Volcán Galeras, 2,900 m, 13 January 1959, J. Clarke.

gallaesaliciana Riley, 1881 (*Grapholitha*); Trans. St. Louis Acad. Sci. 4: 320. "Type" ♀, USA, Missouri, St. Louis Co., St. Louis, "Lepidopterous gall on willow," 17 June 1873. This is one of two specimens cited by Riley in the original description; the location of the other is unknown.

gambra Razowski, 1988 (*Ernocornutina*); Acta Zool. Cracov. 31: 399. Holotype ♂, Argentina, Tucumán, Ciudad Universitaria, 800 m, 17 February 1959, J. Clarke.

gampsognathos Razowski, 1988 (*Gauruncus*); Acta Zool. Cracov. 31: 405. Holotype ♂, Bolivia, Cochabamba, Incachaca, tropical cloud area, 2,100 m, 27 August–5 September 1956, L. Peña.

garai Miller, 1987 (*Gretchena*); J. Lepid. Soc. 41: 151. Holotype ♀, Ecuador, 4 km S Loja, r.f. *Juglans neotropica,* 28 June 1986, A. Samaniego.

gatesclarkei Kawabe, 1992 (*Acleris*); Tinea 13: 171. Holotype ♂, Taiwan, Nantou Hsien, Tsuifeng, 2,400 m, 29 December 1989, A. Kawabe.

gelastes Razowski, 1988 (*Gauruncus*); Acta Zool. Cracov. 31: 404. Holotype ♂, Argentina, Tucumán, Ciudad Universitaria, 800 m, 17 February 1959, J. Clarke.

gemellana Heinrich, 1923 (*Eucosma circulana*); Bull. U.S. Natl. Mus. 123: 96. Holotype ♂, USA, Florida, Hillsborough Co., St. Petersburg, May.

gentilii Brown, 1998 (*Argentulia*); J. Lepid. Soc. 52: 180. Holotype ♂, Argentina, Neuquén, Paso Cordoba, 1,300 m, 20 February 1980, M. Gentili.

georgiella Hulst, 1887 (*Myelois*); Entomol. Am. 3: 136. "Type" ♂, USA, Colorado. This is the only Hulst specimen we could find of *M. georgiella*; it is labeled "type." The original description does not indicate how many specimens were examined.

gerda Busck, 1911 (*Olethreutes*); Proc. U.S. Natl. Mus. 40: 227. Holotype ♀, French Guiana, St. Jean, Maroni, W. Schaus.

giganteana Riley, 1881 (*Paedisca*); Trans. St. Louis Acad. Sci. 4: 318. "Pseudotype" ♀, USA, Missouri, "Barlon." According to Riley's original description, this species was described from 2 females, one from "Kansas (G. F. Gaumer)" and one from "Iowa, March, 1874 (Hoffmeister)." Although not included in the original series, the specimen from Missouri bears a type label in Riley's hand and represents a potential neotype if one is deemed necessary.

gigantica Busck, 1920 (*Hysterosia*); Insect. Inscit. Menst. 8: 87. Holotype ♀, Mexico, Distrito Federal, Mexico City, R. Muller.

gilletteana Dyar, 1903 (*Eucosma*); Proc. Entomol. Soc. Wash. 5: 229. Syntype ♂, USA, Arizona, Coconino Co., Williams, "16.6"; four syntypes (3 ♂♂, 1 ♀), USA, Colorado. According to Dyar, this species was described from the series (n = 5) cited above; all of the specimens bear red labels "Type No. 6737 U.S.N.M."

gloriola Heinrich, 1931 (*Eucosma*); Proc. Entomol. Soc. Wash. 33: 196. Holotype ♂, USA, Connecticut, Stamford, B.T.R. Lab colony, r.f. white pine tip, 6 May 1931.

gnoma Clarke, 1986 (*Dichelopa*); Smithsonian Contrib. Zool. 416: 138. Holotype ♂, Marquesas Islands, Fatu Hiva, Hanavave, 10′, 12 April 1968, J. & T. Clarke.

goodelliana Fernald, 1882 (*Phoxopteris*); Trans. Am. Entomol. Soc. 10: 69. Lectotype ♂, USA Maine, New Hampshire, or Massachusetts [no locality data on specimen labels]. Designated by Miller (1970).

graceana Powell, 1960 (*Argyrotaenia*); Pan-Pac. Entomol. 36: 93. Holotype ♂, USA, California, San Bernardino Co., San Bernardino Mts., Hathaway Creek, 2 August 1940, C. Henne.

grandicula Heinrich, 1926 (*Laspeyresia*); Bull. U.S. Natl. Mus. 132: 54. Holotype ♂, USA, Virginia, Giles Co., Mountain Lake, 14–21 June 1907. A. Braun.

grandiflavana Walsingham, 1879 (*Paedisca*); Ill. Lepid. Heter. Brit. Mus. 4: 50. Syntype ♀, USA, California, Lake Co., 17–19 June 1871. This species was described from one male and two females; the other syntypes presumably are in the BMNH.

grandis Busck, 1907 (*Phalonia*); J. N. Y. Entomol. Soc. 15: 23. Holotype ♀, USA, Colorado, Jefferson Co., Golden, Chimney Gulch, Oslar, 1 July 1904.

gratiana Kawabe, 1974 (*Hedya*); Tyo to Ga 25: 101. Holotype ♂, Japan, Honmura, Kuchinoerabujima Island, 14 August 1973, r.f. *Glochidon obovatum,* A. Kawabe.

gratuitana Heinrich, 1923 (*Epiblema*); Bull. U.S. Natl. Mus. 123: 268. Holotype ♂, USA, Washington, East Sound, 11 July 1901.

graziella Blanchard, 1968 (*Eucosma*); J. Lepid. Soc. 22: 143. Holotype ♂, USA, Texas, Brewster Co., Big Bend National Park, Green Gulch, 11 October 1966, A. & M. Blanchard.

grindeliana Busck, 1906 (*Cydia*); Canad. Entomol. 38: 211. Two syntypes (1 ♂, 1 ♀), USA, Texas, Clarendon, r.f. *Grindelia squarrosa,* 28 September 1905, em: 4 October 1905, Hunter. In the original description, Busck identified the type as labeled "Type #9804"; however, both of the specimens listed above have identical red type labels with this number.

griselda Blanchard & Knudson, 1981 (*Eucosma*); J. Lepid. Soc. 35: 173. Holotype ♂, USA, Texas, Brewster Co., Big Bend National Park, Chisos Basin, 7 April 1967, A. & M. Blanchard.

groteana Fernald, 1882 (*Cenopis*); Trans. Am. Entomol. Soc. 10: 69. Holotype ♀, USA, Ohio. This species was described from a single specimen.

guerrerana Obraztsov, 1964 (*Anopina*); Am. Mus. Novit. 2082: 15. Holotype ♂, Mexico, Guerrero, Sierra de las Aguas Escondidas, 9,500′, July, H. Smith.

guiana Busck, 1913 (*Olethreutes*); Insect. Inscit. Menst. 1: 92. Holotype ♂, British Guiana [Guyana], Georgetown, "larvae feed on a common weed in the cane field."

gunniana Busck, 1907 (*Phalonia*); J. N. Y. Entomol. Soc. 15: 26. Holotype ♀, USA, Maryland, Montgomery Co., Plummers Island, September 1903, A. Busck.

guttulana Blanchard, 1979 (*Eucosma*); J. Lepid. Soc. 33: 214. Holotype ♂, USA, Texas, Kennedy Co., Padre Island National Seashore, 19 July 1976, A. & M. Blanchard.

gyraleus Diakonoff, 1982 (*Archips*); Zool. Verhandel. (Leiden) 193: 87. Holotype ♂, Sri Lanka, Ratnapura District, Uggalkaltota, 350′, Irrigation Bungalow, 31 January–8 February 1970, Davis & Rowe.

habrosana Heinrich, 1923 (*Exentera*); Bull. U.S. Natl. Mus. 123: 178. Holotype ♂, USA, California, San Diego Co., San Diego, 17 March 1912, W. Wright.

hadrotes Clarke, 1986 (*Dichelopa*); Smithsonian Contrib. Zool. 416: 126. Holotype ♂, Marquesas Islands, Nuku Hiva, Tunoa Ridge, 2,900′, 23 January 1968, J. & T. Clarke.

hasseanthi Clarke, 1952 (*Eucosma*); Bull. South. Calif. Acad. Sci. 52: 60. Holotype ♂, USA, California, Orange Co, "bred from *Hasseanthus variegatus,*" 23 August 1936, T. Hower.

heindelana Fernald, 1905 (*Acleris*); Am. Nat. 39: 870. Lectotype ♀, Canada, Manitoba, Winnipeg, A. W. Hanham. Designated by Obraztsov (1963).

heliocausta Dognin, 1912 (*Atteria*); Heterocеres Nouveaux de L'Amerique du Sud 6: 51. Holotype ♂, Colombia, Cali, San Antonio, 2,000 m, 22 September 1908, Fassel.

helianthana Riley, 1881 (*Grapholitha*); Trans. St. Louis Acad. Sci. 4: 319. "Type" ♂, USA, Texas, "gall on sunflower," 12 August 1873. Riley described this species from two specimens, only one of which has been located by us.

hemeropis Dognin, 1912 (*Olethreutes*); Heteroceres Nov. L'Amerique du Sud 6: 49. Holotype ♂, Colombia, Cali, San Antonio, Fassel.

hemitephras Clarke, 1976 (*Lasiothyris*); Proc. U.S. Natl. Mus. 125: 51. Holotype ♀, Mexico, Puebla, Tehuacan, 10 October.

henicodes Razowski, 1988 (*Bicavernaria*); Acta Zool. Cracov. 31: 400. Holotype ♂, Peru, Cusco, Machu Picchu, 2,385 m, 6 February 1959, J. Clarke.

hennei Clarke, 1947 (*Eucosma*); Bull. South. Calif. Acad. Sci. 46: 51. Holotype ♂, USA, California, Los Angeles Co., El Segundo sand dunes, em: 3 October 1940, C. Henne.

heos Razowski, 1988 (*Helicteulia*); Acta Zool. Cracov. 31: 388. Holotype ♂, Bolivia, Cochabamba, Incachaca, tropical cloud area, 2,100 m, 27 August–5 September 1956, L. Peña.

herbacea Clarke, 1955 (*Orthocomotis*); Trans. Royal Entomol. Soc. London 107: 151. Holotype ♂, Costa Rica, San Pedro de Montes de Oca, r.f. avocado, em: 15 January 1933, C. Ballou.

herbaria Busck, 1920 (*Sociphora*); Insect. Inscit. Menst. 8: 85. Holotype ♂, Guatemala, Cuyuga, W. Schaus.

heterophaea Clarke, 1968 (*Phalonidia*); Proc. U.S. Natl. Mus. 125: 36. Holotype ♂, Colombia, Antioquia, La Estrella, 1,730 m, 13 December 1959, F. Luis Gallego M.

heucherana Heinrich, 1923 (*Epinotia*); Bull. U.S. Natl. Mus. 123: 217. Holotype ♂, USA, Virginia, Arlington Co., Rosslyn, larvae mining leaves of "alum root" [*Heuchera americana*], C. Heinrich.

hieroglyphana Blanchard & Knudson, 1984 (*Grapholita*); Proc. Entomol. Soc. Wash. 86: 448. Holotype ♂, USA, Texas, Culberson Co., Guadalupe Mountains, Nickel Creek, 10 July 1968, A. & M. Blanchard.

hieroglypta Walsingham, 1914 (*Olethreutes*); Biol. Centr.-Am. Lepid., Heter. 4: 250. Holotype ♂, Mexico, Veracruz, Orizaba, W. Schaus. Walsingham clearly designated a "Type" male deposited in the USNM.

hipeana Grote, 1876 (*Conchylis*); Canad. Entomol. 8: 207. Holotype ♂, Canada, Ontario, Port Stanley, W. Saunders. Although the specimen bears a label "London, Ont.," according to the original description it was taken at Port Stanley, by "W. Saunders from London, Ontario." This species was described from a single male.

hiranoi Kawabe, 1980 (*Gypsonoma*); Tinea 11: 27. Holotype ♂, Japan, Nagano Pref., Nakakaruizawa, 14 June 1964, A. Kawabe.

hiroshii Kawabe, 1980 (*Zeiraphera*); Tinea 11: 26. Holotype ♂, Japan, Gunma Pref., Kumaneta'ra, 14 July 1952, M. Hoshino.

hirsutana Walsingham, 1879 (*Paedisca*); Ill. Lepid. Heter. Brit. Mus. 4: 50. Syntype ♂, USA, California, Sonoma Co., 23 May 1871. This species was described from four males; the other three presumably are in the BMNH.

hodgesi Heppner, 1989 (*Argyrotaenia*); Florida Entomol. 72: 102. Holotype ♂, USA, Florida, Glade Co., Fisheating Creek, 7–10 May 1964, R. Hodges.

hodgesi Razowski, 1993 (*Apotoforma*); Acta Zool. Cracov. 36: 186. Holotype ♀, Panama, Cerro Campana, 11–14 July 1967, O. S. Flint.

hodsoni Miller, 1986 (*Pseudexentera*); J. Lepid. Soc. 40: 223. Holotype ♂, USA, Pennsylvania, Allegheny Co., Oak Station, 10 April 1910, F. Marloff.

hoffmanana Brown, 1991 (*Cuproxena*); in Brown and Powell, Univ. Calif. Publ. Entomol. 111: 60. Holotype ♀, Brazil, Santa Catarina, Neu-Bremen, 12 June 1931, F. Hoffman.

hohuanshana Kawabe, 1986 (*Zeiraphera*); Entomol. Pap. Pres. Kurosawa, Tokyo: 79. Holotype ♂, Taiwan, Hualien Hsien, Hohuanshan, 3,100 m, 30 July–1 August 1983, A. Kwabe.

hohuanshana Kawabe, 1989 (*Acleris*); Tinea 12: 194. Holotype ♂, Taiwan, Hualien Hsien, Hohuanshan, 3,100 m, 30 July–1 August 1983, A. Kawabe.

hohuanshanensis Kawabe, 1985 (*Clepsis*); Tinea 12: 5. Holotype ♂, Taiwan, Hualien Hsien, Hohuanshan, 3,100 m, 30 July–1 August 1983, A. Kawabe.

holographa Clarke, 1965 (*Nesochoris*); Proc. U.S. Natl. Mus. 117: 74. Holotype ♂, Chile, Masatierra, Plazoleta del Yunque, 200 m, 9 February 1952, P. Kuschel.

homolopa Diakonoff, 1968 (*Eudemis*); Bull. U.S. Natl. Mus. 257: 54. Holotype ♀, Philippine Islands, Davao Province, Minandao, 5717.

horii Kawabe, 1987 (*Cryptophlebia*); Tinea 12: 141. Holotype ♂, Japan, Okinawa Island, Okubi, Kin, r.f. *Bruguiera gymnorrhyza,* 8 May 1983, S. Hori.

hoshinoi Kawabe, 1964 (*Hastula*); Tyo to Ga 15: 2. Holotype ♂, Japan, Honshu, Tokyo, Setagaya, 16 June 1963, A. Kawabe.

hostilis Diakonoff, 1956 (*Bactra*); Zool. Verhandel. (Leiden) 29: 57. Holotype ♂, Japan, Honshiu, Funakoshi, Yokosuka, 11 September 1953.

houseri Miller, 1959 (*Petrova*); Ohio J. Sci. 59: 230. Holotype ♂, USA, Ohio, Washington Co., Veto, r.f., *Pinus echinata,* 18 June 1954, W. Miller.

huachucensis Obraztsov, 1961 (*Argyrotaenia montezumae*); Am. Mus. Novit. 2048: 7. Holotype ♂, USA, Arizona, Cochise Co., Huachuca Mtns., August 1905, H. Skinner.

hubbardana Busck, 1907 (*Phalonia*); J. N. Y. Entomol. Soc. 15: 27. Holotype ♀, USA, Arizona, Pima Co., Tucson, r.f. *Koeberlinia spinosa,* em: 12 May 1897, H. Hubbard.

hypericana Ely, 1910 (*Peronea*); Proc. Entomol. Soc. Wash. 12: 68. Holotype ♀, USA, Virginia, Fairfax Co., Great Falls, r.f., *Hypericum prolificum,* em: 17 June 1909, C. Ely.

icelitodes Diakonoff, 1982 (*Eucosma*); Zool. Verhandel. (Leiden) 193: 45. Holotype ♂, Sri Lanka, Mannar District, Olaithoduvai, 10 mi NW of Mannar, 0–50′, 4–5 November 1976, G. Hevel, R. Dietz, S. Karunaratne & D. Balasooriya.

icogramma Clarke, 1968 (*Irazona*); Proc. U.S. Natl. Mus. 125: 38. Holotype ♀, Guatemala, Volcán Santa María, October, Schaus and Barnes.

illotana Walsingham, 1879 (*Paedisca*); Ill. Lepid. Heter. Brit. Mus. 4: 48. Two syntypes (1 ♂, 1 ♀), Oregon, Rogue River, May 1872. Walsingham described this species from two males and one female; the other male syntype is presumed to be in the BMNH.

imbrica Kawabe, 1978 (*Hedya*); Tinea 10: 181. Holotype ♂, Japan, Yakushima Island, Shiratani, 14 September 1972, T. Watanabe.

imbridana Fernald, 1905 (*Cydia*); Canad. Entomol. 37: 400. Lectotype ♂, USA, Kansas, Pottawatomie Co., Onaga, F. Crevecoeur. Designated by Miller (1970).

imitativa Heinrich, 1926 (*Grapholitha*); Bull. U.S. Natl. Mus. 132: 34. Holotype ♂, USA, California, San Francisco.

implicata Heinrich, 1924 (*Proteoteras*); J. Wash. Acad. Sci. 14: 390. Holotype ♂, USA, Florida, Dade Co., Everglades, ex-larva, "April 16–23."

implicata Heinrich, 1931 (*Thiodia*); Proc. U.S. Natl. Mus. 79: 7. Holotype ♂, USA, Washington, Rochester, 13 June 1929, W. Baker.

improvisana Heinrich, 1923 (*Epinotia*); Bull. U.S. Natl. Mus. 123: 269. Holotype ♂, USA, California, Tulare Co., Mineral King, "June 16–23."

incognita Obraztsov, 1963 (*Acleris*); Proc. U.S. Natl. Mus. 114: 254. Holotype ♀, USA, Idaho, Moscow Mountains, 7 August 1933, J. Clarke.

inconspicua Obraztsov, 1964 (*Proeulia*); Proc. U.S. Natl. Mus. 116: 190. Holotype ♂, Chile, Santiago, La Obra, October 1952, L. Peña.

indagatricana Heinrich, 1923 (*Thiodia*); Bull. U.S. Natl. Mus. 123: 56. Holotype ♂, USA, Utah, Utah Co., Provo, 26 August 1908, T. Spalding.

indentanus Dyar, 1903 (*Phthinolophus*); Proc. Entomol. Soc. Wash. 5: 306. Twenty-nine syntypes from various localities in the eastern United States. A female from USA, Virginia, Fortress Munroe, 24 June 1884, H. Dyar, was placed in the type collection, presumably by J. Clarke; the rest of the syntypes are in the main collection. According to the original description, this species was described from 17 males and 21 females.

indigena Yasuda, 1978 (*Eurydoxa*); Trans. Lepid. Soc. Jap. 29: 119. Holotype ♂, Taiwan, Rengwati, 29 March 1929, S. Issiki.

infelix Heinrich, 1923 (*Epiblema*); Bull. U.S. Natl. Mus. 123: 151. Holotype ♂, USA, North Carolina, Polk Co., Tryon, 25 May 1904, Fiske.

infernalis Heinrich, 1920 (*Commophila*); Proc. U.S. Natl. Mus. 57: 61. Holotype ♂, USA, New Mexico, Manzano Natl. Forest, Hell Canyon, r.f. berries of *Juniperus,* 31 June 1917, C. Heinrich.

infida Heinrich, 1926 (*Aphania*); Bull. U.S. Natl. Mus. 132: 121. Holotype ♂, Canada, Quebec, St. Johns Co., St. Therese Island, 9 June 1915, W. Chagnon.

infimbriana Dyar, 1904 (*Thiodia*); Proc. U.S. Natl. Mus. 27: 927. Holotype ♀, Canada, British Columbia, Kaslo, H. Dyar.

influana Heinrich, 1923 (*Thiodia*); Bull. U.S. Natl. Mus. 123: 49. Holotype ♂, USA, California, Siskiyou Co., Shasta Retreat, "July 1–7."

infuscata Heinrich, 1923 (*Endothenia*); Proc. Entomol. Soc. Wash. 25: 109. Holotype ♂, USA, Maryland, Forest Glen, 10 July 1914, O. Heidemann.

ingens Heinrich, 1926 (*Laspeyresia*); Bull. U.S. Natl. Mus. 132: 63. Holotype ♀, USA, Florida, Hillsborough Co., St. Petersburg.

ingrata Heinrich, 1926 (*Laspeyresia*); Bull. U.S. Natl. Mus. 132: 50. Holotype ♂, Canada, Manitoba, Aweme, 25 May 1905, Criddle.

injectiva Heinrich, 1926 (*Hedulia*); Bull. U.S. Natl. Mus. 132: 65. Holotype ♂, USA, Nevada, Reno, r.f. cones of *Pinus,* em: 24 January 1911, J. Smith.

inopinata Heinrich, 1928 (*Laspeyresia*); Proc. Entomol. Soc. Wash. 30: 91. Holotype ♂, China, South Manchuria, Kinshu, on apple, 4 August 1927, T. Kondo.

inopiosa Heinrich, 1926 (*Laspeyresia*); Bull. U.S. Natl. Mus. 132: 46. Holotype ♀, USA, Idaho, Kootenai Co., Coeur d'Alene, r.f. *Pinus contorta,* em: 11 May 1916, J. Evendon.

inouei Kawabe, 1968 (*Pandemis*); Tinea 7: 121. Holotype ♂, Taiwan, Chiayi County, Alishan, 2,200 m, 9–11 July 1964, H. Inoue.

inouei Kawabe, 1972 (*Eupoecilia*); Tinea 9: 250. Holotype ♂, Japan, Kagosakatoge, base of Mt. Fuji, 13 August 1969, H. Inoue.

inouei Kawabe, 1987 (*Metendothenia*); Tinea 12: 139. Holotype ♂, Japan, Mie Pref., Hokusei-machi, Otsujishinden, 8 May 1986, T. Mano.

insidiosana Heinrich, 1923 (*Epiblema*); Bull. U.S. Natl. Mus. 123: 145. Holotype ♂, USA, North Carolina, Southern Pines, "June 1–7."

insignata Heinrich, 1924 (*Thiodia*); J. Wash. Acad. Sci. 14: 386. Holotype ♂, USA, Colorado, San Juan Co., Silverton, "July 8–15" [genitalia slide only; pinned specimen has not been found].

insignis Heinrich, 1928 (*Petrova*); Proc. Entomol. Soc. Wash. 30: 63. Holotype ♂, Japan, Yokohama, r.f. *Pinus thunbergii,* em: 27 August 1924.

inspersa Heinrich, 1931 (*Phaecasiophora*); Proc. U.S. Natl. Mus. 79: 13. Holotype ♂, USA, Florida, Hillsborough Co., St. Petersburg, 3 March 1915, R. Ludwig.

insulanus Kawabe, 1965 (*Archippus*); Tyo to Ga 16: 23. Holotype ♂, Japan, Okinoerabu-jima Is., 8 April 1957, M. Umebayashi.

interruptolineana Fernald, 1882 (*Penthina*); Trans. Am. Entomol. Soc. 10: 70. Lectotype ♂, USA, New Hampshire or Massachusetts [no locality data on specimen labels]. Designated by Miller (1970).

invidana Barnes & Busck, 1920 (*Tortrix*); Contrib. Nat. Hist. Lepid. North Am. 4: 215. Holotype ♂, Canada, British Columbia, Vancouver Island, Duncans, Hanham.

iodes Clarke, 1968 (*Hysterosia*); Proc. U.S. Natl. Mus. 125: 4. Holotype ♂, Guatemala, Volcán Santa María, Schaus & Barnes.

iresinephora Razowski, 1988 (*Eriotortrix*); Acta Zool. Cracov. 31: 403. Holotype ♂, Colombia, Bogotá, Chico, 23 January 1959, J. Clarke.

iridana Barnes & Busck, 1920 (*Platynota*); Contrib. Nat. Hist. Lepid. North Am. 4: 212. Holotype ♀, USA, Florida, Hillsborough Co., St. Petersburg, June.

irroratana Walsingham, 1879 (*Paedisca*); Ill. Lepid. Heter. Brit. Mus. 4: 48. Syntype ♂, USA, California, Mendocino Co., 7–10 June 1871. Walsingham described this species from five males; all but the USNM syntype are presumed to be in the BMNH.

isipida Razowski, 1988 (*Eriotortrix*); Acta Zool. Cracov. 31: 403. Holotype ♂, Colombia, Bogotá, Chico, 23 January 1959, J. Clarke.

issikii Kawabe, 1980 (*Aterpia*); Tinea 11: 17. Holotype ♂, Japan Honmura, Kuchinoarabu Island, 27–31 July 1973, A. Kawabe.

issikii Razowski, 1977 (*Hysterosia*); Tyo to Ga 28: 35. Holotype ♀, Japan, Kuwayama, 23 June 1916.

ivana Fernald, 1901 (*Tortrix*); J. N. Y. Entomol. Soc. 9: 51. Holotype ♂, USA, Florida, r.f. *Iva imbricata,* 10 March 1900. This species was described from a single male.

japonensis Kawabe, 1980 (*Cydia*); Tinea 11: 28. Holotype ♂, Japan, Akita Pref., Onuma Spa, Hachimantai, 9–10 August 1974, R. Sato.

japonica Kawabe, 1978 (*Eucoenogenes*); Tinea 10: 185. Holotype ♂, Japan, Honshu, Gunma Pref., Mt. Mikaboyama, 2 August 1968, S. Shimeki.

jenningsi Powell, 1978 (*Rhyacionia*); in Powell and Miller, U.S. Dept. Agric., Agric. Handb. 514: 17. Holotype ♂, USA, Arizona, Sitgreaves National Forest, r.f. *Pinus ponderosa,* D. Jennings.

jinboi Kawabe, 1965 (*Clepsis*); Kontyu 34: 459. Holotype ♂, Japan, Honshu, South Alps, Sanpuku-goya, 1 August 1964, K. Jinbo ["Jimbo" on label].

jinboi Kawabe, 1976 (*Cymolomia*); Tinea 10: 44. Holotype ♂, Japan, Hokkaido, Mt. Daisetsu (Kurodake), 16 August 1969, K. Jinbo.

jordani Clarke, 1955 (*Orthocomotis*); Trans. Royal Entomol. Soc. London 107: 142. Holotype ♂, Brazil, New Bremen, 11 August 1936, F. Hoffman.

juglandana Fernald, 1879 (*Tortrix*); Canad. Entomol. 11: 155. Two syntypes (1 ♂, 1 ♀), USA, Massachusetts/Ohio/Wisconsin, and Canada (Ontario) [no locality data on specimen labels]. Fernald described this species from 11 males and 15 females; he did not designate a type specimen or a type locality, instead listing the states from which he had specimens.

luncticiliana Walsingham, 1879 (*Paedisca*); Ill. Lepid. Heter. Brit. Mus. 4: 75. Two syntypes (2 ♂♂), USA, California, Shasta Co., 16 July 1871. This species was described from seven males; the other five presumably are in the BMNH.

kana Busck, 1906 (*Hemimene*); Proc. Biol. Soc. Wash. 19: 182. Lectotype ♂, Canada, British Columbia, Kaslo, H. Dyar. Designated by Miller (1983).

khasiensis Miller, 1977 (*Petrova*); J. Lepid. Soc. 31: 135. Holotype ♂, India, Assam

(Meghalaya), Upper Shillong, March 1963.

kincaidiana Fernald, 1900 (*Phoxopteris*); in Dyar, Proc. Wash. Acad. Sci. 2: 500. Holotype ♂, USA, Alaska, Metlakahtla, "6.4.99," Harriman Expedition '99, T. Kincaid.

kirishimensis Kawabe, 1974 (*Eudemopsis*); Kontyu 42: 390. Holotype ♂, Japan, Kagoshima Pref., Mt. Kirishima [Karisima], 30 June 1958, A. Kawabe.

kiyosatoensis Kawabe, 1980 (*Endothenia*); Tinea 11: 20. Holotype ♂, Japan, Yamamshi Pref., Kiyosato, 1,300 m, 25–28 August 1971, A. Kawabe.

knudsoni Miller, 1986 (*Pseudexentera*); J. Lepid. Soc. 40: 224. Holotype ♂, USA, Texas, Kleberg Co., Riviera Beach site, 24 February 1984, E. Knudson.

koebelei Obraztsov, 1959 (*Aphelia*); Am. Mus. Novit. 1964: 7. Holotype ♂, USA, Washington, Easton, Koebele.

komonana Kearfott, 1907 (*Hysterosia*); Canad. Entomol. 37: 121. Lectotype ♂, USA, California, Santa Clara Co. Designated by Klots (1942).

kurosawai Kawabe, 1986 (*Notocelia*); Entomol. Pap. Pres. Kurosawa, Tokyo: 80. Holotype ♂, Taiwan, Hualien Hsien, Hohuanshan, 3,100 m, 30 July–1 August 1983, A. Kawabe.

kusaiensis Clarke, 1976 (*Dudua aprobola*); Insects of Micronesia 9: 86. Holotype ♂, Micronesia, Kusaie, Mutunlik, 14 February 1953, J. Clarke.

kuscheli Clarke, 1980 (*Proeulia*); J. Lepid. Soc. 34: 184. Holotype ♂, Chile, Desventuradas Islands, San Ambrosia Island, 450 m, on flowers of *Thamnoseris lacerata,* 14 November 1960, G. Kuschel.

kusunokii Kawabe, 1993 (*Apotomis*); Tyo to Ga 43: 257. Holotype ♂, Japan, Keunshita, Mt. Daisetsu, 28 July 1983.

laciniana Zeller, 1875 (*Phoxopteris*); Verhandel. Zool.-Bot. Ges. Wein 25: 253. "Type" ♂, USA, Massachusetts, 1871. Of the three males and one female referred to in the original description, this is the only specimen we have been able to locate.

laetitia Clarke, 1968 (*Cochylis*); Proc. U.S. Natl. Mus. 125: 25. Holotype ♂, Argentina, Tucumán, Ciudad Universitaria, 800 m, 20 February 1959, J. Clarke.

lagopana Walsingham, 1879 (*Steganoptycha*); Ill. Lepid. Heter. Brit. Mus. 4: 71. Syntype ♀, USA, California, Colusa Co., 28 June 1871. This species was described from two males and three females; presumably all but the above mentioned syntype are in BMNH.

lamberti Franclemont, 1986 (*Sparganothis*); Proc. Entomol. Soc. Wash. 88: 56. Holotype ♂, USA, South Carolina, Oconee Co., Cherry Hill Recreation Area, Route 107, 2,000′, 22 August 1958, J. Franclemont.

lambertiana Busck, 1915 (*Tortrix*); Proc. Entomol. Soc. Wash. 17: 86. Holotype ♂, USA, Oregon, Jackson Co., Ashland, r.f. *Pinus lambertii,* em: 27 June 1914, P. Sergent. Although the original description gives "Oakland, Oreg." as the type locality, the label on the specimen indicates Ashland.

lantana Busck, 1910 (*Crocidosema*); Proc. Entomol. Soc. Wash. 12: 132. Holotype ♂, Hawaii, Oahu, Tantalus, O. Swezey.

larana Brown, 2000 (*Lobogenesis*); Proc. Entomol. Soc. Wash. 102: 29. Holotype ♂, Venezuela, Lara, Yacumba National Park, 13 mk SE Sanare, 4,800′, cloud forest, blacklight, 4–7 March 1978, J. Heppner.

largo Heppner, 1981 (*Cydia*); J. Lepid. Soc. 35: 278. Holotype ♂, USA, Florida, Monroe Co., Key Largo, 15 mi NE Key Largo City, 16 June 1974, J. Heppner.

laricana Busck, 1916 (*Laspeyresia*); Proc. Entomol. Soc. Wash. 18: 152. Holotype ♀, USA, Montana, Evaro, r.f., *Larix occidentalis,* May 1914, J. Brunner.

lariciana Kawabe, 1980 (*Zeiraphera*); Tinea 11: 24. Holotype ♂, Japan, Nagano Pref., Shig-kôgen, 28 June 1964, Ozawa.

latens Heinrich, 1929 (*Thiodia*); Proc. U.S. Natl. Mus. 75: 2. Holotype ♂, USA, California, Tulare Co., Monachee Meadows, 8,000′, "July 8–14."

lathami Forbes, 1937 (*Eucosma*); J. N. Y. Entomol. Soc. 43: 131. Holotype ♂, USA, New York, Long Island, Orient, 18 June 1935, R. Latham.

latiana Brown, 1991 (*Cuproxena*); in Brown and Powell, Univ. Calif. Publ. Entomol. 111: 52. Holotype ♂, Venezuela, Aragua, Rancho Grande, 1,100 m, 10 May 1967, L. Rodriguez & C. Andara.

laticurva Heinrich, 1929 (*Eucosma*); Proc. U.S. Natl. Mus. 75: 4. Holotype ♂, USA, California, Sierra Nevada.

latipunctana Walsingham, 1879 (*Cochylis*); Ill. Lepid. Heter. Brit. Mus. 4: 29. Syntype ♂, USA, California, Mendocino Co., 31 May 1871. This species was described from two males; the other syntype presumably is in the BMNH.

lautana Powell, 1960 (*Argyrotaenia*); Pan-Pac. Entomol. 36: 90. Holotype ♂, USA, California, San Bernardino Co., San Bernardino Mtns., Camp Baldy, "June 24–30."

lavana Busck, 1907 (*Phalonia*); J. N. Y. Entomol. Soc. 15: 27. Holotype ♂, USA, Maryland, Montgomery Co., Hyattsville, A. Busck.

leguminana Busck, 1907 (*Phalonia*); J. N. Y. Entomol. Soc. 15: 28. Holotype ♂, USA, Washington, D.C., r.f. *Gleditchia horrida,* Feburary.

leguminis Heinrich, 1943 (*Laspeyresia*); Proc. Entomol. Soc. Wash. 45: 71. Holotype ♂, Peru, r.f. beans, 19 August 1930, Willie.

leopardana Busck, 1906 (*Hemimene*); Proc. Biol. Soc. Wash. 19: 181. Holotype ♀, USA, Maryland, Montgomery Co., Hyattsville, June 1906, A. Busck.

lepida Heinrich, 1924 (*Epinotia cruciana*); J. Wash. Acad. Sci. 14: 391. Holotype ♂, USA, New Hampshire, Coos Co., Mt. Washington, 4,000′, "July 24–31."

leucobasis Busck, 1916 (*Laspeyresia*); Proc. Entomol. Soc. Wash. 18: 152. Holotype ♂, USA, Montana, Evaro, r.f. *Larix occidentalis,* May 1914, J. Brunner.

leucognoma Clarke, 1976 (*Eumarissa*); Insects of Micronesia 9: 32. Holotype ♂, Micronesia, Guam, Mt. Alifan, ex-umbellifer(?), 21 May 1936, O. Swezey.

leucothorax Clarke, 1955 (*Orthocomotis*); Trans. Royal Entomol. Soc. London 107: 150. Holotype ♂, Brazil, New Bremen, 6 June 1936, F. Hoffman.

lindana Fernald, 1892 (*Steganoptycha*); Canad. Entomol. 24: 178. Lectotype ♂, Canada, Ontario, Hamilton. Designated by Miller (1970).

lindseyana Obraztsov, 1962 (*Choristoneura lambertiana*); Am. Mus. Novit. 2101: 16. Holotype ♂, USA, California, Modoc Co., Warner Mtns., 3 mi E Davis Creek, 15–23 July 1922, 5,500′, A. Lindsey.

lineana Fernald, 1901 (*Eucosma*); J. N. Y. Entomol. Soc. 9: 50. Holotype ♀, USA, Florida, Palm Beach Co., Palm Beach, r.f. *Anona laurifolia,* H. Dyar. This species was described from a single female.

linitipunctana Blanchard & Knudson, 1983 (*Phaneta*); J. Lepid. Soc. 37: 140. Holotype ♂, USA, Texas, Nueces Co., North Padre Island, 9 September 1974, A. & M. Blanchard.

listerana Kearfott, 1907 (*Pharmacia*); Trans. Am. Entomol. Soc. 33: 80. Lectotype ♂ (designated here), USA, Pennsylvania, Lackawanna Co., Nicholson, 6 July 1904, A. Lister. Selected by Obraztsov in 1953.

lobata Razowski, 1988 (*Argyrotaenia*); Acta Zool. Cracov. 31: 408. Holotype ♂, Bolivia, Cochabamba, Incachaca, tropical cloud area, 2,100 m, 27 August–5 September 1956, L. Peña.

loricana Grote, 1880 (*Phoxopteris*); Canad. Entomol 12: 218. "Type" ♂, USA, Ohio, Montgomery Co., Dayton, G. Pilate. According to the original description, the "type is in the collection of Fernald," which almost certainly refers to the specimen cited above.

louisiana Busck, 1907 (*Phalonia*); J. N. Y. Entomol. Soc. 15: 24. Holotype ♂, USA, Missouri, St. Louis Co., 2 mi W St. Louis, August 1904, A. Busck.

luciferana Kawabe, 1980 (*Zeiraphera*); Tinea 11: 26. Holotype ♂, Japan, Miyagi Pref., Sakunmi, 22 June 1969, T. Watanabe.

luctuosana Blanchard, 1979 (*Epiblema*); J. Lepid. Soc. 33: 184. Holotype ♂, USA, Texas, Nueces Co., N. Padre Island, 6 April 1978, A. & M. Blanchard.

luculentana Heinrich, 1920 (*Evetria*); Proc. U.S. Natl. Mus. 57: 56. Holotype ♂, USA, Colorado, El Paso Co., r.f. *Pinus scopulorum,* 5 May 1916, W. Edmonston.

luoyingensis Kawabe, 1992 (*Acleris*); Tinea 13: 175. Holotype ♂, Taiwan, Hualien Hsien, Houhuanshan, Luoying Lodge, 2,800 m, 31 December 1988, A. Kawabe.

lupicinia Clarke, 1971 (*Dichelopa*); Smithsonian Contrib. Zool. 56: 113. Holotype ♂, Rapa Island, Pt. Maraia, r.f. *Rumex crispus,* em: 26 October 1963, J. & T. Clarke.

macdunnoughi Obraztsov, 1963 (*Acleris*); Proc. U.S. Natl. Mus. 114: 214. Holotype ♀, USA, Massachusetts, Worcester Co., Winchendon, 29 September 1902.

machimiana Barnes & Busck, 1920 (*Sparganothis*); Contrib. Nat. Hist. Lepid. North Am. 4: 211. Holotype ♀, USA, Arizona, Cochise Co., Paradise, July.

macswaini Powell, 1980 (*Decodes*); Pacific Insects 22: 89. Holotype ♂, Mexico, Nuevo Leon, 3 mi E Galeana, 5,000′, 7–9 August 1963, W. Duckworth & D. Davis.

maculana Fernald, 1901 (*Lipoptycha*); J. N. Y. Entomol. Soc. 9: 51. Holotype ♂, USA, Florida, Palm Beach Co., Palm Beach, r.f. *Schoepfia arborescens,* em: 24 February 1900, H. Dyar. There are three specimens in the USNM collection with virtually identical collecting data, two of which bear labels in Fernald's hand indicating "type"; the latter two are undoubtedly the two males that comprise the original series. Although Miller (1970) was unable to find the holotype, one of the males bears a red USNM type label ("Type 5413") consistent with the original description, implicating it as the holotype.

maculatana Walsingham, 1879 (*Paedisca*); Ill. Lepid. Heter. Brit. Mus. 4: 48. Two syntypes (2 ♀♀), USA, California, Lake Co., 17–19 June 1871. This species was described from three males and three females; the other syntypes presumably are in the BMNH.

maenamii Kawabe, 1974 (*Olethreutes*); Tyo to Ga 25: 102. Holotype ♂, Japan, Izu Island, Shikinejima, 16 June 1966, T. Maenami.

magnifica Razowski & Becker, 1999 (*Auratonota*); Revta. Bras. Zool. 16: 1174. Holotype ♂, Venezuela, Aragua, Rancho Grande, 1,100 m, at light in montane tropical forest, 16 June 1973, J. C. & K. G. Schaffer.

magnoliana Fernald, 1892 (*Cacoecia*); Canad. Entomol. 24: 121. "Type" ♂, USA, New York, Tompkins Co., Ithaca, C.U. Exp. No. 292, r.f. *Magnolia acuminata,* 22 June 1891, M. Slingerland. Fernald did not indicate how many specimens he examined.

maiana Kearfott, 1907 (*Phalonia*); Trans. Am. Entomol. Soc. 33: 82. Lectotype ♂, USA, New Jersey, Essex Co., Essex County Park, 9–14 May 1910, W. Kearfott. Designated by Klots (1942).

maiorina Heinrich, 1923 (*Bactra*); Proc. Entomol. Soc. Wash. 25: 105. Holotype ♂, USA, Virginia, Arlington Co., Arlington, r.f. *Scirpus fluviatilis,* 1 July 1920.

malana Fernald, 1882 (*Eccopsis*); Trans. Am. Entomol. Soc. 10: 72. Lectotype ♂, USA, New York, Kings Co., Brooklyn, J. Smith. Designated by Miller (1970).

manilkara Heppner, 1981 (*Dichrorampha*); Florida Entomol. 64: 274. Holotype ♂, USA, Florida, Monroe Co., Middle Torch Key, 12 June 1974, r.f. *Manilkara emarginata,* em: 6 July 1974, J. Heppner.

manoi Kawabe, 1987 (*Hedya*); Tinea 12: 140. Holotype ♂, Japan, Mie Pref., Hokushei-machi, Otsujishenden, 8 May 1986, T. Mano.

mareda Clarke, 1955 (*Orthocomotis*); Trans. Royal Entomol. Soc. London 107: 142. Holotype ♂, Brazil, Nova Teutonia, May 1938, F. Plaumann.

mariana Fernald, 1882 (*Lophoderus*); Trans. Am. Entomol. Soc. 10: 67. Lectotype ♂ (designated here), USA, Maine, Penobscot Co., Orono. Selected by Obraztsov 1956. According to the original description, Fernald had four males from Maine (Orono), Massachusetts, and New York.

maritima Dyar, 1904 (*Ancylis*); Proc. Entomol. Soc. Wash. 6: 221. Eight syntypes, USA, Rhode Island, Washington Co., Weekapaug, r.f. *Lathyrus maritima,* H. Dyar. One of the syntypes was placed in the type collection, presumably by J. Clarke; the remainder are in the main collection.

marloffiana Busck, 1907 (*Phalonia*); J. N. Y. Entomol. Soc. 15: 26. Holotype ♀, USA, Pennsylvania, Allegheny Co., Oak Station, 7 June 1906, F. Marloff.

marmoreana Heinrich, 1923 (*Epinotia*); Bull. U.S. Natl. Mus. 123: 222. Holotype ♂, USA, Utah, Tooele Co., Stockton, 16 July 1913, T. Spalding.

marquesana Clarke, 1986 (*Duessa*); Smithsonian Contrib. Zool. 416: 155. Holotype ♂, Marquesas Islands, Nuku Hiva, Tunoa Ridge, 2,900′, 23 January 1968, J. & T. Clarke.

maurodicha Clarke, 1976 (*Herpystis*); Insects of Micronesia 9: 74. Holotype ♂, Micronesia, Kusaie, Mutunlik, 22 m, 21 April 1953, J. Clarke.

maximana Barnes & Busck, 1920 (*Peronea*); Contrib. Nat. Hist. Lepid. North Am. 4: 216. Holotype ♂, Canada, British Columbia, Victoria, A. Croker.

mayelisana Blanchard, 1979 (*Phaneta*); J. Lepid. Soc. 33: 209. Holotype ♂, USA, Texas, Cottle Co., Paducah, 17 April 1968, A. & M. Blanchard.

medioalbana Knudson, 1986 (*Pammene*); J. Lepid. Soc. 40: 325. Holotype ♂, USA, Texas, Gonzales Co., Palmetto State Park, 23 March 1985, E. Knudson.

mediopartitum Heinrich, 1923 (*Exartema*); Proc. Entomol. Soc. Wash. 25: 113. Holotype ♂, USA, Virginia, 1 June 1884.

megalorhis Diakonoff, 1982 (*Sychnochlaena*); Zool. Verhandel. (Leiden) 193: 117. Holotype ♀, Sri Lanka, NE District, Kanda-ele Reservoir, 5.6 mi NW Nuwara Eliya, 6,200′, 10–21 February 1970, D. Davis & B. Rowe.

megasaccula Brown, 1991 (*Bidorpitia*); in Brown and Powell, Univ. Calif. Publ. Entomol. 111: 73. Holotype ♂, Guatemala, Purulha, July, Schaus & Barnes.

melanantha Diakonoff, 1968 (*Peridaedala*); Bull. U.S. Natl. Mus. 257: 77. Holotype ♀, Philippine Islands, Mindanao, Davao Prov., E slope Mt. McKinley, mossy stunted forest, at light, 19 September 1946, CNHM Philippine Zool., Exped. 1946–47, H. Hoogstraal & D. Heyneman.

melania Clarke, 1955 (*Orthocomotis*); Trans. Royal Entomol. Soc. London 107: 153. Holotype ♂, Jamaica, St. Ann Parish, 1,750′, E. Bell.

melanomesum Heinrich, 1923 (*Exartema*); Proc. Entomol. Soc. Wash. 25: 119. Holotype ♂, USA, Maine, Piscataquis Co., Sebec Lake, "July 16–23."

melanoleuca Clarke, 1968 (*Irazona*); Proc. U.S. Natl. Mus. 125: 44. Holotype ♂, Mexico, Puebla, r.f. *Pinus,* January 1960, Guevara.

melasma Clarke, 1968 (*Hysterosia*); Proc. U.S. Natl. Mus. 125: 9. Holotype ♂, Guatemala, Chejel, June, Schaus and Barnes.

melia Clarke, 1976 (*Adoxophyes*); Insects of Micronesia 9: 133. Holotype ♂, Micronesia, Guam, Fadian, 19 August 1936, ex-*Colubrina,* O. Swezey.

melidora Razowski 1984 (*Ardeutica*); Acta Zool. Cracov. 27: 217. Holotype ♂, Cuba, Sierra del Cobra Oriente, Loma del Gato, 2,600′, 24–30 September 1935, J. Acuña, S. Bruner & L. Scaramuzza.

meligma Clarke, 1986 (*Dichelopa*); Smithsonian Contrib. Zool. 416: 141. Holotype ♂, Marquesas Islands, Fatu Hiva, Tahuna, 2,000′, 22 March 1968, J. & T. Clarke.

membrosa Heinrich, 1926 (*Laspeyresia*); Bull. U.S. Natl. Mus. 132: 49. Holotype ♀, USA, Texas, Bexar Co., San Antonio, r.f. *Prosopis,* 29 June 1917, A. Busck.

mendaciana Blanchard & Knudson, 1983 (*Suleima*); Proc. Entomol. Soc. Wash. 85: 848. Holotype ♂, USA, Texas, Brewster Co., Big Bend National Park, Dugout Wells, 28 September 1981, E. Knudson.

mendora Clarke, 1968 (*Cochylis*); Proc. U.S. Natl. Mus. 125: 24. Holotype ♂, Chile, Santiago Province, Cajon de Maypo, Cordillera, El Canelo, 12–20 January 1948, T. Ramirez.

mengelana Fernald, 1894 (*Sericoris*); Entomol. News 5: 131. Lectotype ♂, Greenland, McCormick Bay. Designated by Miller (1970).

meridionalis Yasuda & Kawabe, 1980 (*Archips*); Tinea 11: 9. Holotype ♂, Japan, Hatsuno, Is. Amami-oshima, 11–13 August 1977, A. Seino.

meritana Heinrich, 1923 (*Epinotia*); Bull. U.S. Natl. Mus 123: 226. Holotype ♂, USA, Utah, Carbon Co., Hiawatha, r.f. *Pinus,* em: July 1921, H. Peck.

messalina Clarke, 1971 (*Dichelopa*); Smithson. Contrib. Zool. 56: 102. Holotype ♀, Rapa Island, Maugaoa, 950’ (292 m), 7 Nov 1963, J. &. T. Clarke.

metallica Busck, 1914 (*Evetria*); Proc. Entomol. Soc. Wash. 16: 146. Holotype ♂, USA, Montana, Missoula Co., Missoula, r.f. pitch of yellow pine, 2 May 1913, J. Brunner.

metariana Heinrich, 1923 (*Eucosma*); Bull. U.S. Natl. Mus. 123: 133. Holotype ♂, USA, California, Siskiyou Co., Shasta Retreat, “June 16–23.”

mexicana Busck, 1907 (*Pharmacis*); J. N. Y. Entomol. Soc. 15: 30. Holotype ♂, USA, New Mexico, Beulah, 8,000′, T. Cockerell, USNM type 10238.

mezion Razowski 1984 (*Ardeutica*); Acta Zool. Cracov. 27: 218. Holotype ♂, Cuba, Sierra del Cobre Oriente, Loma del Gato, 2,600′, 24–30 September 1935, J. Acuña, S. Bruner & L. Scaramuzza.

mesostigmatias Diakonoff, 1977 (*Thaumatographa*); Zool. Verhandel. (Leiden) 158: 42. Holotype ♂, Taiwan, Rantaisan, 15 May 1933, S. Issiki.

messalina Clarke, 1971 (*Dichelopa*); Smithsonian Contrib. Zool. 56:102. Holotype ♀, Rapa Island, Maugaoa, 950’ [292 m], 7 November 1963, J. & T. Clarke.

microptera Clarke, 1953 (*Endothenia*); J. Wash. Acad. Sci. 43: 230. Holotype ♂, USA, Illinois, Putnam Co., 24 August 1949, M. Glenn.

mieae Kawabe, 1980 (*Lobesia*); Tinea 11: 20. Holotype ♂, Japan, Narahara, Hachiooji-shi, Tokyo, 9 August 1978, A. Kawabe.

migratana Heinrich, 1923 (*Thiodia*); Bull. U.S. Natl. Mus. 123: 53. Holotype ♂, USA, California, Inyo Co., Olanche, “Apr 24–30.”

mimica Clarke, 1976 (*Herpystis*); Insects of Micronesia 9: 78. Holotype ♀, Micronesia, Palau Islands, Koror Island, Koror, 29 May 1957, C. Sabrosky.

minor Brown 1990 (*Macrochlidia*); J. N. Y. Entomol. Soc. 98: 373. Holotype ♂, Venezuela, Aragua, Charoni Pass, 1,400 m, 20 January 1965, S. & W. Duckworth.

minorata Heinrich, 1924 (*Eucosma giganteana*); J. Wash. Acad. Sci. 14: 388. Holotype ♂, USA, Texas, Liberty Co., Liberty, em: 28 July 1922, F. Bottimer.

minutana Kearfott, 1905 (*Eucosma*); Proc. U.S. Natl. Mus. 28: 356. Lectotype ♂, USA, New Jersey, Essex Co., Montclair, July 1908, W. Kearfott. Designated by Blanchard (1979).

mira Heinrich, 1929 (*Anchylopera*); Proc. U.S. Natl. Mus. 75: 17. Holotype ♂, USA, Colorado, Jefferson Co., Chimney Gulch, Golden, April, Oslar.

mira Razowski, 1989 (*Saphenista*); SHILAP Revista Lepidopterologia 17: 206. Holotype ♀, Guatemala, Volcán Santa María, November, Schaus & Barnes.

miramundi Razowski, 1988 (*Clarkenia*); Acta Zool. Cracov. 31: 407. Holotype ♀, El Salvador, Cerro Miramundo, 233 January 1971, S. Steinhauser.

mirosignata Heinrich, 1929 (*Eucosma*); Proc. U.S. Natl. Mus. 75: 11. Holotype ♂, USA, Arizona, Pima Co., Baboquivari Mountains, 15–30 October 1924, O. Poling.

miscitata Heinrich, 1926 (*Laspeyresia*); Bull. U.S. Natl. Mus. 132: 64. Holotype ♂, USA, California, Shasta National Forest, r.f. *Pinus jeffreyi,* May 1912, Hopk. 11414, J. Miller.

misturana Heinrich, 1923 (*Thiodia*); Bull. U.S. Natl. Mus. 123: 54. Holotype ♂, Canada, Saskatchewan, Oxbow, 9 June 1907, F. Knab.

mobilensis Heinrich, 1923 (*Eucosma*); Bull. U.S. Natl. Mus. 123: 125. Holotype ♂, USA, Alabama, Baldwin Co., near Daphne, eastern shore of Mobile Bay, "from root cuttings of *Chrysoma* (*Solidago*) *pauciflosculosa* . . . during September (1920)," em: 3 October 1920, T. van Aller.

mochana Busck, 1913 (*Olethreutes*); Insect. Inscit. Menst. 1: 92. Holotype ♀, British Guiana, Mocha, "bred from *Vochysea guianensis,*" H. Moore.

modestana Busck, 1907 (*Hysterosia*); J. N. Y. Entomol. Soc. 15: 32. Holotype ♂, USA, Pennsylvania, Allegheny Co., Pittsburgh, 2 July 1905, H. Engel.

moffatiana Fernald, 1905 (*Proteoteras*); Canad. Entomol. 37: 16. Lectotype ♂, Canada, Ontario, London. Designated by Miller (1970).

molesta Busck, 1916 (*Laspeyresia*); J. Agric. Res. U.S. Dept. Agric. 7: 373. Holotype ♂, USA, Virginia, Arlington Co., Arlington, r.f. peach, em: 12 October 1916.

molybdaina Clarke, 1976 (*Adoxophyes*); Insects of Micronesia 9: 138. Holotype ♂, Micronesia, Ponape, Colonia, 7 January 1953, J. Clarke.

molybdina Clarke, 1968 (*Carolella*); Proc. U.S. Natl. Mus. 125: 53. Holotype ♀, Mexico, San Luis Potosí, Tamazunchale, 6 January 1947, Chapman.

monela Clarke, 1976 (*Icelita*); Insects of Micronesia 9: 39. Holotype ♀, Micronesia, Kusaie, Mutunlik, 22 m, 29 January 1953, J. Clarke.

monetiferanum Riley, 1881 (*Exartema*); Trans. St. Louis Acad. Sci. 4: 317. Holotype ♂, USA, Alabama, Barbour Co., Eufala, G. Latimer. Riley described this species from a single specimen.

monitorana Heinrich, 1920 (*Eucosma*); Proc. U.S. Natl. Mus. 57: 58. Holotype ♂, USA, Pennsylvania, Danville, r.f. cones of *Pinus,* em: 4 May 1916, A. Champlain.

monstrata Razowski, 1984 (*Aphalonia*); Ann. Zool. Warsz. 38: 276. Holotype ♂, Peru, Divisoria, 5,200′, 20–23 June 1982, C. Covell.

montana Busck, 1914 (*Evetria*); Proc. Entomol. Soc. Wash. 16: 147. Holotype ♂, USA. Montana, Elliston, r.f. *Pinus contorta,* em: 10 December 1913, J. Brunner.

montana Bartlett-Calvert, 1892 (*Antithesia*); Univ. Santiago Chile, Univ. Ann. 84: 831. Neotype ♂, Argentina, Neuquén, Chapelco, Techos, 1,400 m, 24 January 1984, M. & P. Gentili. Designated by Brown (1998).

monticolana Kawabe, 1964 (*Clepsis*); Tyo to Ga 15: 1. Holotype ♂, Japan, Toyama Pref., Honshu, Mt. Tateyama, 29 August 1962, A. Kawabe.

moriutii Kawabe, 1987 (*Stenodes*); Microlepid. Thailand 1: 72. Holotype ♂, Thailand, Chiang Mai, Doi Pui, ca.

1,300 m, 26–27 October 1985, S. Moriuti, T. Saito & Y. Arita.

mormonensis Heinrich, 1923 (*Evetria*); Bull. U.S. Natl. Mus. 123: 44. Holotype ♂, USA, Utah, Sal Lake Co., Salt Lake City, C. Ainslie.

murtfeldtiana Riley, 1881 (*Anchylopera*); Trans. St. Louis Acad. Sci. 4: 323. "Type" ♂, USA, Missouri, r.f. oak, em: 19 May 1875, M. Murtfeldt. Riley described this species from three specimens, only one of which could be located by us.

musetta Blanchard & Knudson, 1983 (*Phaneta*); Proc. Entomol. Soc. Wash. 85: 845. Holotype ♂, USA, New Mexico, Socorro Co., Gran Quivara Natl. Monument, 6,600′, 1–3 July 1964, D. Davis.

mydros Obraztsov, 1966 (*Idolatteria*); Proc. U.S. Natl. Mus. 119: 6. Holotype ♀, Ecuador, Environs de Loja, 1887.

myopori Clarke, 1971 (*Dichelopa*); Smithsonian Contrib. Zool. 56: 115. Holotype ♂, Rapa Island, Pariati Bay, r.f. *Myoporum rapensis,* em: 30 Nov 1963, J. & T. Clarke.

myoxa Razowski, 1984 (*Polyortha*); Acta Zool. Cracov. 27: 220. Holotype ♂, Brazil, Santa Catarina, Nova Teutonia, November 1961, F. Plaumann.

naevifera Razowski, 1984 (*Polyortha*); Acta Zool. Cracov. 27: 223. Holotype ♂, Venezuela, Aragua, Rancho Grande, 10–21 February 1969, Duckworth & Dietz.

nakajimai Kawabe, 1992 (*Acleris*); Tinea 13: 172. Holotype ♂, Taiwan, Hualien Hsien, Houhuanshan, Luoying Lodge, 2,800 m, 31 December 1988, A. Kawabe.

naoma Clarke, 1953 (*Epiblema*); J. Wash. Acad. Sci. 43: 226. Holotype ♂, USA, Illinois, Putnam Co., r.f. *Ratibida pinnata,* 25 June 1950, M. Glenn.

nebulosana Packard, 1867 (*Grapholitha*); Proc. Boston Soc. Nat. Hist. 11: 61. Syntype ♂, Canada, Labrador, Strawberry Harbor, 26–30 July. Although the original description does not indicate how many specimens were examined nor identify a type, it states that the species "is not infrequent at Strawberry Harbor . . ."

negligens Kawabe, 1978 (*Neoanathamna*); Tinea 10: 185. Holotype ♂, Japan, Shikoku, Kagawa Pref., Mt. Zozu, 22 May 1968, H. Toshima.

negundana Dyar, 1902 (*Cacoecia*); in Caudell, Proc. Entomol. Soc. Wash. 5: 78. "Type" ♂, USA, Colorado, El Paso Co., Pike's Peak, Dyar & Caudell. Dyar briefly diagnosed this species in a report by Caudell (1902) without mentioning any specimens or designating a type.

neoclyta Razowski, 1988 (*Clarkeulia*); Acta Zool. Cracov. 31: 405. Holotype ♂, Colombia, Nariño, Volcán Galeras, 2,900 m, 13 January 1959, J. Clarke.

neomexicana Dyar, 1903 (*Evetria*); Proc. Entomol. Soc. Wash. 5: 286. Holotype ♂, USA, New Mexico, San Miguel Co., Las Vegas. This species was described from the single male cited above.

nepotinana Heinrich, 1923 (*Thiodia*); Bull. U.S. Natl. Mus. 123: 263. Holotype ♂, USA, Utah, Juab Co., Eureka, 30 May 1911, T. Spalding.

nephelodes Clarke, 1968 (*Amallectis*); Proc. U.S. Natl. Mus. 125: 27. Holotype ♂, Bolivia, Cochabamba, Incachaca, tropical cloud area, 2,100 m, 27 August–5 September 1956, L. Peña.

nigra Miller, 1966 (*Laspeyresia*); J. Lepid. Soc. 20: 251. Holotype ♂, Mexico, Tlaxcala, February 1964, "en semilla *P. ayacahuite.*"

nigralbana Walsingham, 1879 (*Paedisca*); Ill. Lepid. Heter. Brit. Mus. 4: 41. Syntype ♂, USA, California, Mendocina Co., 10 June 1871. This species was described from two males and two females; the other syntypes are presumed to be in the BMNH.

nigricolor Yasuda & Kawabe, 1980 (*Kawabeia*); Tinea 11: 10. Holotype ♂, Japan, Nagano Pref. Azumi V., Shimajima-dani, 780 m, 23 October 1976, N. Hirano.

nigrilineana Kawabe, 1963 (*Acleris*); Tyo to Ga 14: 71. Holotype ♂, Japan, Nagano Pref., Honshu, Asama-sanso, 4 May 1962, A. Kawabe.

nigriplagana Franclemont, 1986 (*Archips*); Proc. Entomol. Soc. Wash. 88: 59. Holotype ♂, USA, New York, Tompkins Co., McLean Bogs Reserve, 2 July 1953, J. Franclemont.

nigrivelata Walsingham, 1914 (*Tortrix*); Biol. Centr.-Am., Lepid., Heter. 4: 283. Holotype ♂, Panama, Canal Zone, Tabernilla, A. Busck. Walsingham described this species from a single male.

nigromaculata Issiki, 1930 (*Simaethis*); Ann. Mag. Natl. Hist. 6: 423. Holotype ♀, Japan, Honsyu, Iwawakisan, 9 August 1918, S. Issiki.

nigropunctata Kawabe, 1985 (*Geogepa*); Tinea 12: 7. Holotype ♂, Taiwan, Chiai Hsien, Fenchihu, 1,400 m, 8 August 1971, Y. Shabata.

ninana Dyar, 1903 (*Carpocapsa*); List Lepid. North Am.: 471. Two syntypes (1 ♂, 1 ♀), USA, Arizona, Fort Grant, 18 July 1892. Authorship of this taxon (as *Grapholitha ninana*) usually is attributed to Riley; the name first appeared in Riley's contribution to Smith's (1891: 93) checklist of the Lepidoptera of North America without a description or reference to specimens examined. Heinrich (1926: 60) correctly recognized that Dyar presented the first description, based on Riley's specimens, in a footnote in his checklist (Dyar 1903), and hence should be considered the author.

nipponana Razowski, 1977 (*Stenodes*); Tyo to Ga 28: 35. Holotype ♂, Japan, Sikoku, Asizuri-Saki, 10 May 1951, S. Issiki.

nipponica Kawabe, 1976 (*Eucosma*); Tinea 11: 40. Holotype ♂, Japan, Kanagawa Pref., Oyama, 13 May 1958, A. Kawabe.

nitida Clarke, 1955 (*Orthocomotis*); Trans. Royal Entomol. Soc. London 107: 143. Holotype ♂, Guatemala, Cayuga, "4," Schaus & Barnes.

nitida Horak, 1984 (*Heterochorista*); Syst. Entomol. 9: 429. Holotype ♂, Papua New Guinea, Morobe District, Wau, 1,200 m, mercury vapor light, 8–14 December 1976, G. Hevel & R. Dietz.

niveopunctata Dognin, 1905 (*Polyortha*); Ann. Soc. Entomol. Belgium 49: 85. Holotype ♀, Ecuador, Environs de Loja, 1893.

niveosana Packard, 1867 (*Sciaphila*); Proc. Boston Soc. Nat. Hist. 11: 55. Holotype ♂, Canada, Labrador, Hopedale, 3 August. The original description appears to have been based on a single male.

nota Kawabe, 1978 (*Cryptophlebia*); Tinea 10: 188. Holotype ♂, Japan, Honshu, Ishikawa Pref., Anamizu, Bira, 9 August 1961, A. Kawabe.

notialis Miller, 1985 (*Eucosma*); Ann. Entomol. Soc. Am. 78: 244. Holotype ♂, USA, Texas, Kerr Co., Kerrville, 6 June, Lacey.

novimundi Heinrich, 1920 (*Laspeyresia*); Canad. Entomol. 52: 257. Holotype ♂, USA, Wisconsin, Door Co., Sturgeon Bay, 14 July 1920, C. Fluke.

nymphana Blanchard & Knudson, 1983 (*Gretchena*); Proc. Entomol. Soc. Wash. 85: 851. Holotype ♂, USA, Texas, Anderson Co., Tennessee Colony, Gus Engeling Wildlife Management Area, 15 April 1968, A. & M. E. Blanchard.

nuntia Heinrich, 1929 (*Eucosma*); Proc. U.S. Natl. Mus. 75: 10. Holotype ♂, USA, Utah, Juab Co., Callao, 17 April 1922.

nythobia Clarke, 1971 (*Cryptophlebia*); Smithsonian Contrib. Zool. 56: 133. Holotype ♀, Rapa Island, Haurei, r.f. *Myoporum rapensis,* 19 September 1963, J. & T. Clarke.

oachranta Diakonoff, 1974 (*Polylopha*); Zool. Verhandel. (Leiden) 131: 72. Holotype ♀, Saipan Island, Marianas, 0.5 mi E Tanapag, 20 April 1945, H. Dybas.

obfuscana Riley, 1888 (*Paedisca*); Proc.

Entomol. Soc. Wash. 1: 33. "Type" ♂, USA, r.f. *Solidago,* 2 June 1884. Riley did not indicate the number of specimens examined.

obliqua Diakonoff, 1982 (*Grapholita*); Zool. Verhandel. (Leiden) 193: 20. Holotype ♂, Sri Lanka, Anuradhapura District, Wildlife Sanctuary Bungalow, Hunuwilagama, Wilpattu, 200′, 10–19 March 1970, Davis & Rowe.

obnigrana Heinrich, 1923 (*Proteoteras*); Bull. U.S. Natl. Mus. 123: 169. Holotype ♂, USA, New Hampshire, Cheshire Co., Dublin, A. Busck.

obnisa Heinrich, 1926 (*Laspeyresia*); Bull. U.S. Natl. Mus. 132: 47. Holotype ♀, Canada, British Columbia, Fraser Mills, 16 June 1922, E. Blackmore.

occidentalis Heinrich, 1923 (*Thiodia striatana*); Bull. U.S. Natl. Mus. 123: 58. Holotype ♂, USA, California, Siskiyou Co., Shasta Retreat, "July 16–23."

oceani Diakonoff, 1956 (*Bactra*); Zool. Verhandel. (Leiden) 29: 59. Holotype ♂, Fiji Islands, Nadi, at light, July, J. Illinoworth.

ochracea Clarke, 1955 (*Orthocomotis*); Trans. Royal Entomol. Soc. London 107: 144. Holotype ♂, Costa Rica, Cartago Province, Juan Vinas, W. Schaus.

ochraceana Fernald, 1901 (*Epiblema*); J. N. Y. Entomol. Soc. 9: 51. Holotype ♂, USA, Florida, Palm Beach Co., Palm Beach. This species was described from a single male.

ochroma Clarke, 1986 (*Dichelopa*); Smithsonian Contrib. Zool. 416: 138. Holotype ♂, Marquesas Islands, Nuku Hiva, Tapuaooa, 2,500′, 30 January 1968, J. & T. Clarke.

ochrosaphes Clarke, 1955 (*Orthocomotis*); Trans. Royal Entomol. Soc. London 107: 152. Holotype ♂, Brazil, Santa Catarina, 27 December 1935, F. Hoffman.

ocliferia Heinrich, 1926 (*Hemimene*); Bull. U.S. Natl. Mus. 132: 21. Holotype ♂, USA, Nevada, Washoe Co., Pyramid Lake.

oenotherana Riley, 1881 (*Conchylis*); Trans. St. Louis Acad. Sci. 4: 316. "Type" ♀, USA, Missouri, r.f. *Oenothera,* M. Murtfeld. Riley refers to four specimens in the original description; we have been able to locate only the specimen cited above.

ogasawaraensis Kawabe & Ku, 1978 (*Metendothenia*); Tinea 10: 169. Holotype ♂, Japan, Ogasawara Island, Omura, Chichijima, 14 June 1972, Y. Watanabe.

okubiensis Kawabe, 1987 (*Eucosma*); Tinea 12: 141. Holotype ♂, Japan, Okinawa Island, Okubi, Kin, r.f. *Bruguiera gymnorrhiza,* 26 April 1983, S. Hori.

olivaceana Fernald, 1882 (*Eccopsis*); Trans. Am. Entomol. Soc. 10: 71. Lectotype ♂, USA, Pennsylvania. Designated by Miller (1970).

olivaceana Riley, 1881 (*Grapholitha*); Trans. St. Louis Acad. Sci. 4: 320. Holotype ♂, USA, Illinois, J. Muhleman. Riley described this species from a single specimen.

olivata Dognin, 1905 (*Tortrix*); Ann. Soc. Entomol. Belgium 49: 85. Holotype ♂, Colombia, Popayan, 1895.

onychistica Diakonoff, 1982 (*Age*); Zool. Verhandel. (Leiden) 193: 57. Holotype ♂, Sri Lanka, Mannar District, Mannar Island, 2 mi. NE Mannar, 15′, 22 March 1970, D. Davis & B. Rowe.

opistocapna Diakonoff, 1977 (*Thaumatographa*); Zool. Verhandel. (Leiden) 158: 38. Holotype ♂, New Guinea, Wareng, 12 July 1936, S. Issiki.

opposita Heinrich, 1931 (*Epinotia*); Proc. U.S. Natl. Mus. 79: 7. Holotype ♂, Peru, Lima, D. Willie, "No. 154.29."

optimana Dyar, 1893 (*Eucosma*); Proc. Entomol. Soc. Wash. 5: 180. Syntype ♂, USA, Colorado, Garfield Co., Glenwood Springs, "Oct 1–7," W. Barnes; syntype ♀, USA, Colorado, Eagle Co., T. Cockerell. The two specimens listed comprise the type series.

orcula Razowski, 1988 (*Oregocerata*); Acta Zool. Cracov. 31: 393. Holotype ♂, Bolivia, Cochabamba, Incachaca, tropical cloud area, 2,100 m, 27 August–5 September 1956, L. Peña.

oregonensis Heinrich, 1923 (*Thiodia*); Bull. U.S. Natl. Mus. 123: 47. Holotype ♂, USA, Oregon, Klamath Co., Crater Lake, "July 24–31."

oribasus Razowski, 1988 (*Oryguncus*); Acta Zool. Cracov. 31: 402. Holotype ♂, Peru, Cusco, Machu Picchu, 2,700 m, 6 February 1959, J. Clarke.

ornatula Heinrich, 1924 (*Thiodia*); J. Wash. Acad. Sci. 14: 385. Holotype ♂, USA, Pennsylvania, Allegheny Co., Oak Station, 21 June 1909, F. Marloff.

orphnoxantha Obraztsov, 1966 (*Pseudomeritastis*); Proc. U.S. Natl. Mus. 118: 227. Holotype ♂, Costa Rica, Cartago Province, Tuis, 2,400′, W. Schaus.

osmundana Fernald, 1879 (*Penthina*); Canad. Entomol. 11: 156. Lectotype ♀, USA, Maine, Penobscot Co., Orono, July, r.f. *O. regalis.* Designated by Miller (1970).

ostentatrix Heinrich, 1923 (*Hystricophora*); Bull. U.S. Natl. Mus. 123: 270. Holotype ♂, USA, California, Tulare Co., Mineral King, "Aug. 1–7." Heinrich (1923) consistently misspelled *Hystrichophora* in his revision.

oxybela Razowski, 1988 (*Ptynognathosia*); Acta Zool. Cracov. 31: 394. Holotype ♂, Colombia, Cauca, Paramo de Parace, Lake San Rafael, 3,570 m, 29 January 1959, J. Clarke.

oxycoccana Packard, 1869 (*Peronea*); Guide to the Study of Insects: 334. "Type" ♂, USA, eastern states. This is the only Packard specimen of this species we could locate; it is clearly labeled as the type. Packard did not indicate how many specimens he examined.

oxygona Diakonoff, 1968 (*Eudemis*); Bull. U.S. Natl. Mus. 257: 50. Holotype ♀, Philippine Islands, Los Baños, 2 July 1932, A. Evangelista.

oxyropa Razowski, 1990 (*Ptoseulia*); SHILAP Rev. Lepid. 18: 212. Holotype ♂, Costa Rica, Cartago Province, Turrialba, 22–28 February 1965, S. & W. Duckworth.

ozonia Razowski, 1990 (*Ptoseulia*); SHILAP Rev. Lepid. 18: 213. Holotype ♀, Bolivia, Cochabamba, Incachaca, tropical cloud area, 2,100 m, 27 August–5 September 1956, L. Peña.

packardiana Fernald, 1886 (*Tortrix*); Bull. U.S. Dept. Agric. Entomol. 12: 20. Two syntypes (2 ♂♂), USA, Maine, Peaks Island, Casco Bay; and USA, New Hampshire; both specimens are labeled "cotype." Freeman (1958) correctly indicated that the "type" is in the USNM, listing Peaks Island as the type locality. This could be interpreted as his designation of the Maine specimen as the lectoype.

pallens Kawabe, 1980 (*Neoanathamna*); Tinea 11: 22. Holotype ♂, Japan, Hitotsu-uchi, Shionoe, Kagawa, 2 June 1973, H. Tashima.

pallidibasalis Heinrich, 1920 (*Laspeyresia*); Proc. U.S. Natl. Mus. 57: 60. Holotype ♂, USA, Oregon, Kaolin Beds, r.f. cones of *Abies concolor,* 7 September 1915, Sergent & Patterson.

pallifasciata Powell, 1978 (*Rhyacionia*); in Powell and Miller, U.S. Dept. Agric., Agric. Handb. 514: 28. Holotype ♂, USA, Arizona, Coconino Co., Fort Valley, 2.5 mi NW Flagstaff, 10 July 1981, R. Hodges.

palmetum Heinrich, 1928 (*Laspeyresia*); Proc. Entomol. Soc. Wash. 30: 6. Holotype ♂, USA, Florida, near Royal Palms State Park, "III.4," F. Jones.

palpana Walsingham, 1879 (*Paedisca*); Ill. Lepid. Heter. Brit. Mus. 4: 54. Two syntypes (2 ♂♂), USA, California, Siskiyou Co., Mount Shasta, August 1871. This species was described from five males and one female. All but the two syntypes listed above are presumed to be in the BMNH.

paracinderella Powell, 1964 (*Acleris*); Univ. Calif. Publ. Entomol. 32: 96. Holotype ♂, USA, California, Nevada Co., r.f., *Prunus dumosa,* C. Riley.

paracornuta Brown, 1991 (*Cuproxena*); in Brown and Powell, Univ. Calif. Publ. Entomol. 111: 55. Holotype ♂, Venezuela, Aragua, Rancho Grande, 1,100 m, 16–23 October 1966, S. & W. Duckworth.

paradisiae Heinrich, 1923 (*Hystricophora*); Bull. U.S. Natl. Mus. 123: 255. Holotype ♂, USA, Washington, Pierce Co., Mount Rainier, Paradise Valley, "July 24–30." Heinrich (1923) consistently misspelled *Hystrichophora* in his revision.

paragnoma Clarke, 1986 (*Dichelopa*); Smithsonian Contrib. Zool. 416: 139. Holotype ♀, Marquesas Islands, Hiva Oa, Puamau, 8 February 1968, J. & T. Clarke.

parallelana Walsingham, 1879 (*Cochylis*); Ill. Lepid. Heter. Brit. Mus. 4: 28. Syntype ♀, USA, California, Lake Co., 18 June 1871. This species was described from two males and two females; the other syntypes are presumably in the BMNH.

parana Busck, 1911 (*Tortrix*); Proc. U.S. Natl. Mus. 40: 228. Holotype ♀, Brazil, Paraná, Castro, "6234 Wlsm. 1908."

paraplesiana Blanchard, 1979 (*Sonia*); J. Lepid. Soc. 33: 184. Holotype ♂, USA, Texas, Harris Co., Houston, 5 June 1968, A. & M. Blanchard.

parmata Razowski, 1984 (*Ardeutica*); Acta Zool. Cracov. 27: 216. Holotype ♂, Costa Rica, Ojo de Agua, Rt. 2, km 75, 20 July 1967, O. Flint.

parva Brown, 1984 (*Corticivora*); Proc. Entomol. Soc. Wash. 86: 279. Holotype ♂, USA, Arkansas, Washington Co., Devil's Den State Park, 24 June 1966, R. Hodges.

parvana Kawabe, 1980 (*Phalonidia*); Tinea 11: 29. Holotype ♂, Japan, Yamanashi Pref., Kiyosato, 22 July 1972, A. Kawabe.

passerana Walsingham, 1879 (*Paedisca*); Ill. Lepid. Heter. Brit. Mus. 4: 49. Syntype ♀, USA, California, Mendocino Co., 9–10 June 1871. According to the original description, this species was described from four males. Because the USNM specimen is almost certainly part of the type series, Walsingham apparently erred in his determination of the sexes. There is a congeneric male specimen in the type collection labeled as "*Paedisca plumigerana* Wlsm. Cal. Type"—apparently a Walsingham manuscript name.

pastigiata Heinrich, 1929 (*Thiodia*); Proc. U.S. Natl. Mus. 75: 3. Holotype ♂, USA, California, Tulare Co., Monachee Meadows, 8,000′, "July 8–14."

pediasios Miller, 1985 (*Eucosma*); Ann. Entomol. Soc. Am. 78: 241. Holotype ♂, USA, Texas, Terrel Co., Sanderson, 25 April 1981, E. Knudson.

penai Brown, 2000 (*Lobogenesis*); Proc. Entomol. Soc. Wash. 102: 27. Holotype ♂, Bolivia, Incachaca, Cochabamba, 2,100 m, tropical cloud forest area, 27 August–5 September 1956, L. Peña.

penai Clarke, 1968 (*Amallectis*); Proc. U.S. Natl. Mus. 125: 28. Holotype ♀, Bolivia, Cochabamba, Incachaca, tropical cloud area, 2,100 m, 27 August–5 September 1956, L. Peña.

penai Razowski, 1988 (*Inape*); Acta Zool. Cracov. 31: 395. Holotype ♂, Bolivia, Cochabamba, Incachaca, tropical cloud area, 2,100 m, 27 August–5 September 1956, L. Peña.

pennsylvaniana Kearfott, 1907 (*Proteopteryx*); Trans. Am. Entomol. Soc. 33: 48. "Type" ♂, USA, Pennsylvania, Beaver Co., New Brighton, 22 March 1903, H. Merrick [genitalia slide only; we have been unable to find the pinned specimen]. The original description of *pennsylvaniana* consists of the final paragraph of the description of *Proteopertyx albicapitana*: "It is not impossible that fuller knowledge of the life histories of the western and eastern forms may prove them to be separate and distinct, in which case I would propose the name *pennsylvaniana* for the latter." Klots (1942) makes no mention of this species; i.e., presumably no Kearfott specimens are in the AMNH.

pergandeana Fernald, 1905 (*Eucosma*); Canad. Entomol. 37: 399. Lectotype ♂, USA, Virginia, 4 June 1882. Designated by Miller (1970).

periculosana Heinrich, 1923 (*Epiblema*); Bull. U.S. Natl. Mus. 123: 268. Holotype ♂, Canada, British Columbia, Mount McLean, 5,500′, August, A. Hanham.

peroneana Barnes & Busck, 1920 (*Tortrix*); Contrib. Nat. Hist. Lepid. North Am. 4: 214. Holotype ♂, USA, Arizona, Cochise Co., Palmerlee [Huachuca Mountians].

perplexana Fernald, 1901 (*Epiblema*); J. N. Y. Entomol. Soc. 9: 51. Holotype ♂, USA, Florida, Palm Beach Co., Palm Beach, H. Dyar.

perpropinqua Heinrich, 1929 (*Eucosma*); Proc. U.S. Natl. Mus. 75: 8. Holotype ♂, USA, Arizona, Pima Co., Indian Oasis, Sells Post Office, 15–30 April 1923, O. Poling.

persolita Heinrich, 1929 (*Eucosma*); Proc. U. S. Natl. Mus. 75: 7. Holotype ♂, USA, Texas, Cameron Co., San Benito, "March 16–23."

perspicua Diakonoff, 1968 (*Sycacantha inodes*); Bull. U.S. Natl. Mus. 257: 61. Holotype ♂, Philippine Islands, Luzon, Mt. Makiling, Baker.

perspicuana Barnes & Busck, 1920 (*Hysterosia*); Contrib. Nat. Hist. Lepid. North Am. 4: 218. Holotype ♀, USA, Arizona, Cochise Co., Paradise, August.

peruvianus Razowski, 1988 (*Telurips*); Acta Zool. Cracov. 31: 391. Holotype ♂, Peru, Cusco, Machu Picchu, 2,700 m, 6 February 1959, J. Clarke.

phaeostropha Clarke, 1976 (*Duessa*); Insects of Micronesia 9: 30. Holotype ♀, Micronesia, Rota, Rota, 22 m, at light, 20 July 1946, Townes 805.

phalaenopa Diakonoff, 1968 (*Argyroptocha*); Bull. U.S. Natl. Mus. 257: 70. Holotype ♂, Philippine Islands, Luzon, Mt. Makiling, Baker.

pharetrata Razowski, 1987 (*Terinebrica*); Tinea 12(suppl.): 136. Holotype ♂, Argentina, Tucumán, Ciudad Universitaria, 800 m, 17 February 1959, J. Clarke.

philerocherda Diakonoff, 1964 (*Bactra*); Zool. Verhandel. (Leiden) 70: 31. Holotype ♂, British West Indies, Dominica, Antrim, 1,000′, 13 March 1956, J. Clarke.

physoptila Diakonoff, 1968 (*Peridaedala*); Bull. U.S. Natl. Mus. 257: 75. Holotype ♂, Philippine Islands, Davao Province, Mindanao, Mt. Apo, 7,000′, at light, November 1946, CNHM Philippine Zool. Exped., Alcasid.

piceae Issiki, 1961 (*Panoplia*); in Issiki & Mutuura, Shinyogu Kagai Shogarui: 36. Holotype ♂, Japan, Honsyu, Sinano, Omekura, 14 July 1957, r.f. pupa on German *Picea,* T. Yasuda.

piceaea Busck, 1916 (*Olethreutes*); Proc. Entomol. Soc. Wash. 18: 151. Holotype ♂, USA, Colorado, El Paso Co., Colorado Springs, "bred during May and July in the Forest Insect Division from *Picea parryana* and *Picea engelmanni,*" J. Polloch & B. Harvey.

picicola Dyar, 1906 (*Eucosma*); J. N. Y. Entomol. Soc. 14: 108. Holotype ♀, USA, Washington, Pierce Co., Mt. Rainier, Paradise Valley, r.f. *Abies lasiocarpa,* H. Burke. According to the original description, this species was described from a single female.

pimana Busck, 1907 (*Phalonia*); J. N. Y. Entomol. Soc. 15: 24. Holotype ♀, USA, Arizona, Pima Co., Baboquivera Mtns., August.

piperana Busck, 1906 (*Hemimene*); Proc. Biol. Soc. Wash. 19: 177. Holotype ♂, USA, Washington, Whitman Co., Pullman, 19 July 1898.

pithecolobiae Busck, 1934 (*Gymnandrosoma*); Entomol. Am. 13: 156. Holotype ♂, Cuba, Havana Province, Santiago, Vegas, 15 July 1931, A. Otero.

placidus Yasuda & Kawabe, 1980 (*Acleris*);

Tinea 11: 12. Holotype ♂, Japan, Nippara, Tokyo, 11 April 1964, A. Kawabe.

platina Clarke, 1968 (*Irazona*); Proc. U.S. Natl. Mus. 125: 45. Holotype ♂, Costa Rica, Alajuela Province, Mount Poas, May.

platyxantha Clarke, 1986 (*Dichelopa*); Smithsonian Contrib. Zool. 416: 131. Holotype ♀, Marquesas Islands, Fatu Hiva, Mt. Teoiaua, 2,000′, 22 March 1968, J. & T. Clarke.

pleodontia Razowski, 1987 (*Monortha*); Bull. Polish Acad. Sci. 35: 65. Holotype ♂, Panama, Rio Trinidad, March 1912, A. Busck.

pleurogramma Clarke, 1976 (*Duessa*); Insects of Micronesia 9: 28. Holotype ♂, Micronesia, Kusaie, Mutunlik, 22 m, 30 March 1953, J. Clarke.

plicata Brown, 1992 (*Catastega*); J. N. Y. Entomol. Soc. 100: 224. Holotype ♀, USA, Arizona, Santa Cruz Co., Santa Rita Mountains, Madera Canyon, Bog Spring Camp Ground, 5,100′, 10–26 July 1964, D. Davis.

plumbata Clarke, 1951 (*Anchylopera*); J. Wash. Acad. Sci. 41: 296. Holotype ♂, Argentina, Tigre, May 1944, F. Bourquin.

plumbosana Kawabe, 1972 (*Olethreutes*); Tinea 9: 244. Holotype ♂, Toyama Pref., Ohmaki, 3 June 1951, M. Hoshino.

plummeriana Busck, 1906 (*Hemimene*); Proc. Biol. Soc. Wash. 19: 181. Holotype ♂, USA, Maryland, Montgomery Co., Plummers Island (in Potomac River above Washington, D.C.), May 1906.

plummeriana Busck, 1907 (*Phalonia*); J. N. Y. Entomol. Soc. 15: 24. Holotype ♂, USA, Maryland, Montgomery Co., Plummers Island, 1 May 1903, A. Busck.

poecilogramma Clarke, 1976 (*Adoxophyes*); Insects of Micronesia 9: 125. Holotype ♂, Micronesia, Kusaie, Hill 1010, 300 m, light trap, 13 April 1953, J. Clarke.

pollexifera Razowski, 1989 (*Tambomachaya*); SHILAP Revta. Lepid. 17: 205. Holotype ♂, Peru, Cusco, Tambomachay 3,690 m, 3 February 1959, J. Clarke.

polysticta Clarke, 1976 (*Cryptaspasma*); Insects of Micronesia 9: 63. Holotype ♀, Micronesia, Kusaie, Mt. Matante, 300 m, 1 February 1953, J. Clarke.

ponderosa Powell, 1968 (*Eucosma*); Hilgardia 39: 13. Holotype ♂, USA, Oregon, Lake Co., Embody's Mill, nr. Silver Lake, r.f. *Pinus ponderosa,* 5 August 1915, P. Sergent.

ponderosana Obraztsov, 1962 (*Choristoneura lambertiana*); Am. Mus. Novit. 2101: 14. Holotype ♂, USA, Colorado, Sugarloaf, r.f. *Pinus ponderosa,* 7 August 1937, J. Beal.

ponera Walsingham, 1914 (*Tortrix*); Biol. Centr.-Am., Lepid., Heter. 4: 279. Holotype ♂, Mexico, Puebla, Popocateptl Park, 13,000′, W. Schaus. Walsingham clearly identifies the USNM male as "Type" in the original description.

poolei Brown, 1991 (*Bidorpitia*); in Brown and Powell, Univ. Calif. Publ. Entomol. 111: 73. Holotype ♂, Venezuela, Aragua, Rancho Grande, 1,100 m, 8–14 August 1967, R. Poole.

populana Busck, 1916 (*Laspeyresia*); Proc. Entomol. Soc. Wash. 18: 151. Holotype ♀, USA, Montana, Missoula Co., Missoula, 15 June 1914, J. Brunner.

postica Bae, 1993 (*Lobesia*); Japan. J. Entomol. 61: 522. Holotype ♀, Taiwan, Pintung Hsien, Kenting Park, 100 m, 26–27 March 1984, A. Kawabe.

pottsi Clarke, 1976 (*Dudua*); Insects of Micronesia 9: 94. Holotype ♂, Micronesia, Truk, Wena (Moen), Civil Administration Area, 6 March 1949, R. Potts.

praesumptiosa Heinrich, 1923 (*Epiblema*); Bull. U.S. Natl. Mus. 123: 143. Holotype ♂, USA, Texas, Cameron Co., Brownsville, 27 May 1917, A. Busck.

prochaldera Clarke, 1955 (*Orthocomotis*); Trans. Royal Entomol. Soc. London 107: 145. Holotype ♂, Equador, Environs de Loja, 1890.

proxima Clarke, 1976 (*Dudua*); Insects of Micronesia 9: 91. Holotype ♀, Micronesia, Ponape, Colonia, 9 January 1953, J. Clarke.

pruni Heinrich, 1923 (*Anchylopera burgessiana*); Bull. U.S. Natl. Mus. 123: 239. Holotype ♂, USA, New Jersey, Caldwell, 17 May 1903, W. Kearfott.

psathyra Diakonoff, 1989 (*Lopharcha*); Tinea 12: 202. Holotype ♂, Japan, Kyusyu, Hikosan, 15 July 1937, S. Issiki.

pseudogamma Brown, 1990 (*Paraptila*); J. Lepid. Soc. 44: 265. Holotype ♂, El Salvador, Santa Tecla, 28–29 October 1967, E. Todd.

pseudolivata Clarke, 1955 (*Orthocomotis*); Trans. Entomol. Soc. London 107: 147. Holotype ♂, Brazil, New Bremen, 7 October 1936, F. Hoffman.

pseudomalesana Clarke, 1986 (*Cydia*); Smithsonian Contrib. Zool. 416: 164. Holotype ♂, Marquesas Islands, Fatu Hiva, Omoa, 16 March 1968, J. & T. Clarke.

pseudoplesia Brown, 1991 (*Cuproxena*); in Brown and Powell, Univ. Calif. Publ. Entomol. 111: 60. Holotype ♂, Venezuela, Aragua, Rancho Grande, 1,100 m, 22–31 July 1967, R. Poole.

pseudotsugana Kearfott, 1904 (*Cydia*); Canad. Entomol. 36: 110. Holotype ♂, Canada, British Columbia, Kaslo, r.f. *Pseudotsuga,* larva collected 24 June. Although the specimen bearing the Kearfott type label (Type No. 7788) has no locality data, the pupal shell and associated plant material indicate that it is the specimen referred to as "also bred by him [Dyar] from larvae taken June 24 on *Pseudotsuga* sp."

ptycta Razowski, 1987 (*Popayanita*); Tinea 12(suppl.): 126. Holotype ♂, Colombia, Cauca, 17 km SE Popayan, 2,000 m, 10 January 1959, J. Clarke.

ptygma Razowski, 1993 (*Apotoforma*); Acta Zool. Cracov. 36: 186. Holotype ♀, Mexico, San Luis Potosí, 8 August 1966, O. Flint. Although the specimen is not labeled as the holotype, Razowski's description was clearly based on this single female specimen.

pulchella Kawabe, 1963 (*Acleris*); Tyo to Ga 14: 71. Holotype ♂, Japan, Honshu, Tokyo, Tama Hills, 27 June 1958, M. Suzuki.

pulcheria Clarke, 1971 (*Dichelopa*); Smithsonian Contrib. Zool. 56: 120. Holotype ♂, Rapa Island, Perau, 1,900′, 15 October 1963, J. & T. Clarke.

pulcherrima Razowski, 1971 (*Acleris*); Acta Zool. Cracov. 16: 548. Holotype ♀, Taiwan, Hassenzan, 5 June 1942, S. Issiki.

pulsatillana Dyar, 1903 (*Eucosma*); Proc. Entomol. Soc. Wash. 5: 297. Nineteen syntypes, USA, Colorado, Jefferson Co., "foothills at Boulder and Golden," r.f. *Pulsatilla hirsutissima.* According to the original description, this species was described from 20 males and eight females.

pulveratana Walsingham, 1879 (*Paedisca*); Ill. Lepid. Heter. Brit. Mus. 4: 45. Syntype ♂, USA, California, San Francisco, 16 May 1871. This species was described from four males, three of which are presumed to be in the BMNH.

punctidiscanum Dyar, 1904 (*Gymnandrosoma*); Proc. Entomol. Soc. Wash. 6: 60. Two syntypes (2 ♂♂), USA, Washington, D.C., May, L. Howard; Pennsylvania, New Brighton. The two specimens comprise the original type series.

purpuratus Kawabe, 1965 (*Archips*); Tyo to Ga 16: 16. Holotype ♂, Japan, Gunma Pref., Mt. Akagi, 19–21 July 1964, A. Kawabe.

purpurea Dognin, 1904 (*Atteria*); Ann. Soc. Entomol. Belgium 48: 132. Holotype ♀, Ecuador, Environs de Loja, 1893.

quadrifasciana Fernald, 1882 (*Tortrix*); Trans. Am. Entomol. Soc. 10: 67. Two syntypes (2 ♂♂), USA, Maine. According to the original description, Fernald had specimens from Maine, New Hampshire, Massachusetts, New York, and Illinois. Although the number of specimens examined was not given in the description, Fernald's unpublished list of types donated to the USNM indicates three "cotypes."

quercana Fernald, 1882 (*Cenopis*); Trans. Am. Entomol. Soc. 10: 69. Lectotype ♀ (designated here), USA, Texas, Dallas Co., Dallas, 29 May. Selected by Powell in 1965. Fernald described this species from four males and four females from New York, Missouri, and Texas.

quercifoliana Fitch, 1858 (*Tortrix*); New York Agric. Rept.: 826. "Type" ♂, USA, New York [no locality data on specimen label]. Fitch did not indicate the number of specimens he examined; this is the only Fitch specimen of this species we could find.

radicana Heinrich, 1923 (*Griselda*); Bull. U.S. Natl. Mus. 123: 186. Lectotype ♂, Canada, British Columbia, on spruce, G. Hewitt. Designated by Obraztsov (1965).

rafaeliana Razowski, 1989 (*Saphenista*); SHILAP Revta. Lepid. 17: 206. Holotype ♂, Colombia, Cauca, Paramo de Parace, Lake San Rafael, 3,570 m, 27 January 1959, J. Clarke.

rana Busck, 1907 (*Phalonia*); J. N. Y. Entomol. Soc. 15: 22. Holotype ♂, USA, Pennsylvania, Allegheny Co., Pittsburgh, 30 July 1905, H. Engel.

razowskii Kawabe, 1963 (*Tortricodes*) Tinea 6: 7. Holotype ♂, Japan, Chiba Pref., Narashino, 4 March 1958, A. Kawabe.

razowskii Kawabe, 1992 (*Clepsis*); Tinea 13: 178. Holotype ♂, Taiwan, Hualien Hsien, Kuanyuan, 2,400 m, 7–8 August 1987, A. Kawabe.

reprobata Clarke, 1976 (*Lobesia*); Insects of Micronesia 9: 104. Holotype ♀, Micronesia, Guam, Pt. Oca, 4 June 1945, Bohart and Gressitt.

rescissoriana Heinrich, 1920 (*Eucosma*); Proc. U.S. Natl. Mus. 57: 58. Holotype ♂, USA, Oregon, Sprague River, r.f. cones of *Pinus murrayana,* 30 May 1914, P. Sergent.

retrusa Razowski, 1993 (*Acleris*); Acta Zool. Cracov. 36: 191. Holotype ♀, Mexico, Jalapa, November 1963, r.f. *Rubus,* N. Krauss.

rhodographa Clarke, 1971 (*Dichelopa*); Smithsonian Contrib. Zool. 56: 103. Holotype ♂, Rapa Island, Perau, 1000' (307 m), r.f. *Veronica rapensis,* em: 18 November 1963, J. Clarke.

rhoifructana Kearfott, 1904 (*Polychrosis*); Trans. Am. Entomol. Soc. 30: 296. Holotype ♂, USA, Ohio, Wayne Co., Wooster, Insectory, 29 January 1884, Murtfeldt.

rigidana Fernald, 1880 (*Retinia*); in Comstock, Annu. Rep. Dept. Agric. 1880: 237. Lectotype ♀, USA, New York, Tompkins Co., Ithaca. Designated by Miller (1970).

rosaocellana Knudson, 1986 (*Eucosma*); J. Lepid. Soc. 40: 322. Holotype ♂, USA, Texas, Hemphill Co., Gene Howe WMA, 18 May 1985, E. Knudson.

rubra Kawabe, 1992 (*Neopotamia*); Japan. Hetero. J. 170: 358. Holotype ♂, Taiwan, Huslien Hsien, Hohuanshan, 3,100 m, 30 July–1 August 1983, A. Kawabe.

ruidosana Heinrich, 1923 (*Epinotia*); Bull. U.S. Natl. Mus. 123: 216. Holotype ♂, USA, New Mexico, Lincoln National Forest, Ruidosa Canyon, larvae mining leaves of "Alum root" [*Heuchera wootoni*], 8 May 1917, C. Heinrich.

ruptimacula Dognin, 1904 (*Tortrix*); Ann. Soc. Entomol. Belgium 48: 132. Holotype ♀, Ecuador, Cayanuma, Loja.

russata Heinrich, 1924 (*Epinotia cruciana*); J. Wash. Acad. Sci. 14:391. Holotype ♂, Canada, British Columbia, Victoria, 24 June 1923.

russeola Heinrich, 1929 (*Eucosma*); Proc. U.S. Natl. Mus. 75: 6. Holotype ♂, USA, California, Los Angeles Co., 11 June 1921, K. Coolidge.

sabiniana Kearfott, 1907 (*Evetria*); Trans. Am. Entomol. Soc. 33: 2. "Type" ♂, USA, California, Sacramento Co., r.f. *Pinus sabiniana,* 9 August 1885. Kearfott described this species from two specimens, one in the USNM collection and one in his personal collection. Although the Kearfott collection is deposited at the AMNH, Klots (1942) makes no mention of a specimen of this species there.

saetigera Razowski, 1987 (*Terinebrica*); Tinea 12(suppl.): 137. Holotype ♂, Bolivia, Cochabamba, Incachaca, tropical cloud area, 2,100 m, 27 August–5 September 1956, L. Peña.

sagax Razowski, 1984 (*Polyortha*); Acta Zool. Cracov. 27: 221. Holotype ♂, Bolivia, Cochabamba, Incachaca, J. Steinbach.

saileri Clarke, 1987 (*Cryptophlebia*); Acta Entomol. Chilean 14: 7. Holotype ♂, Chile, Iquique Province, Region Tarapacá, Pampa Tamarugal, Fundo Refresco, r.f. *Prosopis tamarugo,* 29 June 1985, D. Bobadilla.

salaciana Blanchard & Knudson, 1981 (*Eucosma*); J. Lepid. Soc. 35: 176. Holotype ♂, USA, Texas, Nueces Co., North Padre Island, 13 October 1979, A. & M. Blanchard.

saliciana Clemens, 1864 (*Hedya*); Proc. Entomol. Soc. Philadelphia 3: 515. Syntype ♂, USA, [probably eastern U.S.; no data on specimen label or in original description], r.f. *Salix longifolia,* Walsh. Although Clemens indicated the number of specimens examined and the depository (e.g., "Coll. Ent. Soc. Philadelphia") for most species described in this work, he did not do so for this or the following species, *H. salicicolana.*

salicicolana Clemens, 1864 (*Hedya*); Proc. Entomol. Soc. Philadelphia 3: 515. Two syntypes (1 ♂, 1 ♀), USA, [probably eastern U.S.; no data on specimen labels or in original description], r.f. *Salix humilis,* Walsh.

salmicolorana Heinrich, 1923 (*Thiodia*); Bull. U.S. Natl. Mus. 123: 62. Holotype ♂, USA, Utah, Tooele Co., Stockton, 30 July 1913, T. Spalding.

salmonicolor Powell, 1978 (*Rhyacionia*); in Powell and Miller, U.S. Dept. Agric., Agric. Handb. 514: 15. Holotype ♂, USA, Texas, Jeff Davis Co., Davis Mtns., Mt. Locke, 19 May 1971, A. & M. Blanchard.

salvadorana Brown & Powell, 2000 (*Anopina*); Univ. Calif. Publ. Entomol. 120: 57. Holotype ♂, El Salvador, Cerro Miramundo, 2,300 m, 11 January 1969, S. Steinhauser.

salweenensis Miller, 1977 (*Petrova*); J. Lepid. Soc. 31: 136. Holotype ♂, Thailand, Baw Luang, 20 March 1972, D. Chaiglom.

sambuci Clarke, 1952 (*Polychrosis*); J. Wash. Acad. Sci. 43: 228. Holotype ♂, USA, Illinois, Putnam Co., r.f. *Sambucus canadensis,* 5 July, M. Glenn.

santacrucis Obraztsov, 1963 (*Acleris*); Proc. U.S. Natl. Mus. 114: 225. Holotype ♂, USA, California, Santa Cruz Co., Santa Cruz, 29 October 1932, W. Tilden.

santamariana Razowski, 1988 (*Ortognathosia*); Acta Zool. Cracov. 31: 392. Holotype ♂, Guatemala, Volcán Santa María, Barnes & Schaus.

sapodilla Heppner, 1981 (*Dichrorampha*); Florida Entomol. 64: 271. Holotype ♂, USA, Florida, Dade Co., Homestead, r.f. *Achras zapota,* 14 April 1974, R. Baronowski.

saracana Kearfott, 1907 (*Cenopis*); Trans. Am. Entomol. Soc. 33: 68. "Type" ♂, USA, New Jersey, Essex Co., Essex County Park, hills above Montclair, July 1907, W. Kearfott. Kearfott described this species from one male and two females, two field-collected and one reared from sassafras. Klots (1942) does not mention this species in his treatment of Kearfott types in the AMNH.

satoi Kawabe, 1978 (*Pseudohedya*); Tinea 10: 174. Holotype ♂, Japan, Hokkaido, Mt. Tentosan, Abashiri, 4–5 August 1975, R. Sato.

sayonae Kawabe, 1985 (*Acleris*); Tinea 12: 5. Holotype ♂, Taiwan, Nantou Hsien, Nanshanchi, 25–26 July 1983, A. Kawabe.

saxicolana Walsingham 1879 (*Cochlyis*); Ill. Lepid. Heter. Brit. Mus. 4: 29. Syntype ♂, USA, southern Oregon, end of May, 1872. Walsingham described this species from three males; the other two are presumed to be in the BMNH.

scalaris Diakonoff, 1968 (*Petrova*); U.S. Natl. Mus. Bull 257: 86. Holotype ♀, Philippine Islands, Mountain Province, Luzon, base of Mt. Data, 5,500′, 22 April 1946, CNHM Philippine Zool. Exped. 1946–47, H. Hoogstraal.

scardiana Dognin, 1905 (*Cnephasia*); Ann. Soc. Entomol. Belgium 49: 86. Holotype ♀, Ecuador, El Monje de Loja, 1894.

schizodelta Diakonoff, 1982 (*Grapholita*); Zool. Verhandel. (Leiden) 193: 18. Holotype ♀, Sri Lanka, Ratnapura District, Uggalkaltota, 350′, Irrigation Bungalow, 31 January–8 February 1970, D. Davis & B. Rowe.

schwarziana Busck, 1907 (*Phalonia*); J. N. Y. Entomol. Soc. 15: 25. Holotype ♀, USA, Maryland, Montgomery Co., Plummers Island (in Potomac River above Washington, D.C.), July 1903, A. Busck.

scleroductus Brown, 1991 (*Punctapinella*); Los Angeles Co. Mus. Contrib. Zool. 423: 4. Holotype ♀, Brazil, Rio de Janiero, 3 July 1929, J. Zikán.

sedatana Busck, 1906 (*Hemimene*); Proc. Biol. Soc. Wash. 19: 177. Holotype ♂, USA, Colorado, South Park, 27 August 1905.

segregata Heinrich, 1924 (*Thiodia*); J. Wash. Acad. Sci. 14: 388. Holotype ♂, USA, California, Tulare Co., Monachee Meadows, "July 16–23."

seiugata Razowski, 1987 (*Terinebrica*); Tinea 12(suppl.): 138. Holotype ♀, Peru, Cusco, Machu Picchu, 2,385 m, 4 February 1959, J. Clarke.

semicirculana Fernald, 1882 (*Tortrix*); Trans. Am. Entomol. Soc. 10: 68. Lectotype ♂, USA, Colorado, Morrison, 1880. Designated by Brown and Powell (1991).

senatrix Heinrich, 1924 (*Exentera*); J. Wash. Acad. Sci. 14: 390. Holotype ♂, USA, Arizona, Cochise Co., Paradise, "March 8–15."

senilis Razowski, 1987 (*Silenis*); Tinea 12(suppl.): 128. Holotype ♂, Bolivia, Cochabamba, Incachaca, tropical cloud area, 17 August–5 September 1956, 2,100 m, L. Peña.

seorsa Heinrich, 1924 (*Epinotia*); J. Wash. Acad. Sci. 14: 392. Holotype ♂, Canada, British Columbia, Vavenby, 16 September 1922, T. Moilliet.

separationis Heinrich, 1923 (*Epiblema praesumptiosa*); Bull. U.S. Natl. Mus. 123: 143. Holotype ♂, USA, Texas, Cameron Co., Brownsville, 27 May 1917, A. Busck.

seraphicana Heinrich, 1923 (*Hystricophora asphodelana*); Bull. U.S. Natl. Mus. 123: 258. Holotype ♂, USA, Washington, Whitman Co., Pullman, 13 May 1898, C. Piper. Heinrich (1923) consistently misspelled *Hystrichophora* in his revision.

serapicana Heinrich, 1923 (*Eucosma*); Bull. U.S. Natl. Mus. 123: 266. Holotype ♂, USA, Montana, Cascade Co., Great Falls, 8 July 1921, H. Dyar.

serena Clarke, 1968 (*Cochylis*); Proc. U.S. Natl. Mus. 125: 20. Holotype ♂, Brazil, Santa Catarina, Nova Teutonia, July 1963, F. Plaumann.

sertula Diakonoff, 1982 (*Licigena*); Zool. Verhandel. (Leiden) 193: 16. Holotype ♂, Sri Lanka, Kandy, Udawattekelle, 15–24 January 1970, D. Davis & B. Rowe.

shastana Walsingham, 1879 (*Paedisca*); Ill. Lepid. Heter. Brit. Mus. 4: 46. Syntype ♂, USA, California, Siskiyou Co., Mount Shasta, August 1871. This species was described from two males: one syntype in the USNM and the other apparently in the BMNH.

shastensis McDunnough, 1955 (*Anchylopera columbiana*); Am. Mus. Novit.

1725: 12. Holotype ♂, USA, California, Siskiyou Co., Shasta Retreat, "June 8–15."

shibatai Kawabe, 1985 (*Archips*); Tinea 12: 1. Holotype ♂, Taiwan, Chiai Hsien, Fenchihu, 1,400 m, 3 August 1973, Y. Shibata.

shikokuensis Kawabe, 1984 (*Epinotia*); Tinea 11: 187. Holotype ♂, Japan, Shikoku, Kagawa Pref., Oku-shio-iri, 5 August 1972, H. Toshima.

shimekii Kawabe, 1974 (*Zeiraphera*); Tyo to Ga 25: 97. Holotype ♂, Japan, Gunma Pref., Yunotaira, 26 July 1968, A. Kawabe.

sicaria Diakonoff, 1982 (*Acroclita*); Zool. Verhandel. (Leiden) 193: 55. Holotype ♂, Sri Lanka, Galle District, Kanneliya, 200′, 15–17 October 1976, G. Hevel, R. Dietz, R. Karunaratne & D. Balasooriya.

sierrae Blanchard & Knudson, 1983 (*Eucosma*); Proc. Entomol. Soc. Wash. 85: 850. Holotype ♂, USA, Texas, Culberson Co., Sierra Diablo Wildlife Management Area, 6,400′, 30 August 1970, J. Franclemont.

sierrae McDunnough, 1955 (*Anchylopera simuloides*); Am. Mus. Novit. 1725: 14. Holotype ♂, USA, California, Tulare Co., Mineral King, "June 24–30."

signiferana Heinrich, 1923 (*Epinotia*); Bull. U.S. Natl. Mus. 123: 232. Holotype ♂, USA, California, San Diego Co., San Diego, 14 November 1911, W. Wright.

silvertonana Obraztsov, 1962 (*Anopina*); Am. Mus. Novit. 2082: 19. Holotype ♂, USA, Colorado, San Juan Co., Silverton, "July 24–31."

silvertoniensis Heinrich, 1923 (*Epinotia*); Bull. U.S. Natl. Mus. 123: 214. Holotype ♂, USA, Colorado, San Juan Co., Silverton, "July 16–23."

simplex Diakonoff, 1968 (*Ebodina*); Bull. U.S. Natl. Mus. 257: 35. Holotype ♂, Philippine Islands, Luzon, Mt. Makiling, Baker.

simplex McDunnough, 1925 (*Eucosma*); Canad. Entomol. 57:21. Holotype ♀, USA, Iowa, Woodbury Co., Sioux City, 7 May 1916.

simpsoni Busck, 1903 (*Carpocapsa pomonella*); Proc. Entomol. Soc. Wash. 5: 236. Holotype ♂, USA, Idaho, Ada Co., Boise, 8 August 1902, C. Simpson.

simulata Heinrich, 1928 (*Rhyacionia*); Proc. Entomol. Soc. Wash. 30: 62. Holotype ♀, Japan, Yokahoma, r.f. *Pinus thunbergii,* em: 5 July 1924, A. Kariya.

sinistra Heinrich, 1926 (*Bactra*); Bull. U.S. Natl. Mus. 132: 87. Holotype ♀, USA, Louisiana, Sabine River Ferry, opposite Orange, Cornell University Lot 542, Sub 20, 20 June 1917.

siskiyouensis Heinrich, 1923 (*Epinotia pulsatillana*); Bull. U.S. Natl. Mus. 123: 202. Holotype ♂, USA, California, Siskiyou Co., Shasta Retreat, "Aug 16–23."

skinnerana Heinrich, 1923 (*Suleima*); Bull. U.S. Natl. Mus. 123: 157. Holotype ♂, USA, Arizona, Cochise Co., Huachuca Mountain, Carr Canyon, August 1905, H. Skinner.

sonae Clarke, 1949 (*Eulia*); Acta Zool. Lilloana (Tucumán) 7: 587. Holotype ♂, Brazil, Santa Catarina, 12 July 1935, F. Hoffmann.

sotipena Brown, 1986 (*Epinotia*); J. Lepid. Soc. 40: 341. Holotype ♀, USA, Maryland, Montgomery Co., Plummers Island, Potomac River, 7 April 1962, R. W. Hodges.

spaldingiana Obraztsov, 1961 (*Argyrotaenia*); Am. Mus. Novit. 2048: 20. Holotype ♂, USA, Utah, Utah Co., Provo, 4 August 1908, T. Spalding.

spartinana Barnes & McDunnough, 1916 (*Phalonia*); Canad. Entomol. 48: 144. Holotype ♂, USA, South Dakota, Union Co., Elk Point, r.f. *Spartina,* 30 July 1915, C. Ainslie.

spectra Brown, 1992 (*Catastega*); J. N. Y. Entomol Soc. 100: 211. Holotype ♂, USA, Texas, Jeff Davis Co., Mt. Locke, McDonald Observatory, 19 July 1971, A. Blanchard.

spinacea Razowski, 1994 (*Psiathovalva*);

SHILAP Revta. Lepid. 22: 69. Holotype ♂, Venezuela, Aragua, Rancho Grande, 1,100 m, 11–15 January 1966, S. & W. Duckworth.

spinea Razowski, 1999 (*Netechma*); Polski Pismo Entomol. 68: 93. Holotype ♂, Bolivia, Cochabamba, Incachaca, 2,100 m, tropical cloud area, 27 August–5 September 1956, L. Peña. Razowski (1999) incorrect identifies the disposition of the type as NHMW.

spiraeifoliana Heinrich, 1923 (*Polychrosis*); Proc. Entomol. Soc. Wash. 25: 106. Holotype ♂, USA, Pennsylvania, Luzerne Co., Hazelton, r.f. *Spiraea salicifolia,* "5/29-19c."

spirographa Diakonoff, 1968 (*Bubonoxena*); Bull. U.S. Natl. Mus. 257: 66. Holotype ♂, Philippine Islands, Luzon, Mt. Makiling.

stadiana Barnes & Busck, 1920 (*Peronea*); Contrib. Nat. Hist. Lepid. North Am. 4: 217. Holotype ♂, Canada, Ontario, Ottawa, 18 September 1905, C. Young.

stauroma Diakonoff, 1968 (*Polemograptis*); Bull. U.S. Natl. Mus. 257: 33. Holotype ♂, Philippine Islands, Negros Oriental, Canlaon, 915 m, light trap, 20 December 1959, L. Quate.

stellifera Kawabe, 1978 (*Hiroshiinoueana*); Tinea 10: 181. Holotype ♂, Japan, Yakushima Island, Kurio, 7 August 1972, T. Watanabe.

stenampyx Diakonoff, 1982 (*Ancylis*); Zool. Verhandel. (Leiden) 193: 64. Holotype ♂, Sri Lanka, Kandy District, Udawattekelle, 3 November 1966.

stenotes Clarke, 1976 (*Alcina*); Insects of Micronesia 9: 21. Holotype ♂, Micronesia, Guam, Tenjo, r.f. *Styphelia,* 16 May 1936, R. Usinger.

stevensi Powell, 1980 (*Decodes*); Pacific Insects 22: 90. Holotype ♂, USA, Colorado, Larimer Co., Owl Canyon, 12 km NW Fort Collins, June 1977, R. Stevens.

straminoides Grote, 1873 (*Conchylis*); Bull. Buffalo Soc. Nat. Sci. 1: 16. "Type" ♂, USA, New York, Buffalo. According to Fernald's unpublished list, two Grote specimens of this species were received by the USNM; we found only one. The single Grote specimen cited above is clearly labeled as the type.

strianus Fernald, 1905 (*Archips*); Canad. Entomol. 37: 399. "Type" ♂, Canada, Quebec, A. Hanham. Fernald mentions 3 specimens in his description: a male from London, Ontario; a female from New Hampshire; and a male from Quebec. He indicated that the former two were in his personal collection and the last was in the USNM.

striatana Brown, 1999 (*Dimorphopalpa*); Pan-Pac. Entomol. 75: 88. Holotype ♂, Venezuela, Aragua, Rancho Grande, 1,100 m, 21–25 January 1966, S. & W. Duckworth.

striatanoides Brown, 1999 (*Dimorphopalpa*); Pan-Pac. Entomol. 75: 88. Holotype ♂, Ecuador, Carcí, Maldonado, 2,200 m, 6–11 January 1963, V. Becker.

strigatella Brown, 1992 (*Catastega*); J. N. Y. Entomol. Soc. 100: 216. Holotype ♂, USA, Texas, Brewster Co., Big Bend National Park, Chisos Basin, 29 July 1982, E. Knudson.

strigosa Heinrich, 1926 (*Aphania*); Bull. U.S. Natl. Mus. 132: 118. Holotype ♂, USA, Alaska, Dawson, 16 June 1916, B. Clark.

strigulana Brown & Obrazstov, 1991 (*Dorithia*); in Brown and Powell, Univ. Calif. Publ. Entomol. 111: 46. Holotype ♀, Mexico, Veracruz, Las Vegas [= Las Vigas], 8,000′, 1887, W. Schaus.

stygiana Dyar, 1903 (*Thiodia*); Proc. Entomol. Soc. Wash. 5: 230. Five syntypes (3 ♂♂, 2 ♀♀), USA, Colorado, Jefferson Co., Golden, May–June, Dyar & Caudell; syntype ♂, USA, Arizona, Williams. This species was described from the six specimens cited above. One male from Colorado was placed in the type collection, presumably by J. Clarke; the other specimens are in the main collection.

suadana Heinrich, 1923 (*Eucosma*); Bull.

U.S. Natl. Mus. 123: 130. Holotype ♂, USA, Utah, Vineyard, 6 August 1912, T. Spalding.

subcandida Heinrich, 1929 (*Thiodia formosana*); Proc. U.S. Natl. Mus. 75: 1. Holotype ♂, Canada, Alberta, Bilby, 12 June 1924, O. Bryant.

subditiva Heinrich, 1929 (*Eucosma tahoensis*); Proc. U.S. Natl. Mus. 75: 9. Holotype ♂, USA, California, Lake Tahoe, Deer Park Springs, "June 24–30."

subelectana Kawabe, 1976 (*Olethreutes*); Tinea 10: 46. Holotype ♂, Japan, Ohmaki, Toyama Pref., 3 June 1951, M. Hoshino. Although the specimen is labeled "*Olethreutes pseudoereciana,*" it is clearly the specimen referred to in the original description.

subflavana Walsingham, 1879 (*Paedisca*); Ill. Lepid. Heter. Brit. Mus. 4: 48. Syntype ♂, USA, California. According to the original description, this species was described from two males and one female from Rouge River, Oregon, end of May 1871. The USNM specimen bears a typical Walsingham type label and is presumed to be part of the original series; we cannot explain the discrepancy in the locality data.

subminimana Heinrich, 1923 (*Thiodia*); Bull. U.S. Natl. Mus. 123: 61. Holotype ♂, USA, California, San Diego Co., San Diego, "Aug 1–7."

subolivata Clarke, 1955 (*Orthocomtis*); Trans. Royal Entomol. Soc. London 107: 148. Holotype ♂, Costa Rica, Cartago Province, Tuis, 5,800′, 28 August 1908, W. Schaus.

subretracta Kawabe, 1976 (*Olethreutes*); Tinea 10: 45. Holotype ♂, Japan, Tokyo, Mt. Takao, 11 June 1952, M. Hoshino & T. Haga.

subsolana Miller, 1978 (*Larisa*); J. Lepid. Soc. 32: 258. Holotype ♂, USA, Arkansas, Washington Co., Devil's Den State Park, 26 June 1966, R. Hodges.

subretiniana Obraztsov, 1962 (*Choristoneura*); Am. Mus. Novit. 2101: 9. Holotype ♂, USA, California, Tulare Co., Monachee Meadows, 8,000′, "July 16–23."

substitutionis Heinrich, 1923 (*Gypsonoma*); Bull. U.S. Natl. Mus. 123: 163. Holotype ♂, Canada, Manitoba, Aweme, 27 July 1905, Criddle.

subtropica Miller, 1960 (*Rhyacionia*); J. Lepid. Soc. 14: 231. Holotype ♀, USA, Florida, Okaloosa Co., Valparaiso, r.f. *Pinus,* em: 26 May 1927, E. Gemner.

subviridis Heinrich, 1929 (*Epinotia*); Proc. U.S. Natl. Mus. 75: 15. Holotype ♂, USA, California, San Diego Co., San Diego, 5 July 1921 [genitalia slide only; pinned specimen has not been found]. A paratype specimen is also in the type collection.

sugii Kawabe, 1976 (*Epiblema*); Tinea 10: 42. Holotype ♂, Japan, Tokyo, Setagaya, 16 June 1963, A. Kawabe.

sugii Kawabe, 1989 (*Dichrorampha*); Tinea 12: 196. Holotype ♂, Taiwan, Hualien Hsien, Kuanyuan, 2,400 m, 7–8 August 1987, A. Kawabe.

sulawesiensis Kawabe, 1993 (*Bathypluta*); Tyo to Ga 43: 237. Holotype ♀, N Sulawesi, Tandano, December 1988.

sulphurica Razowski, 1999 (*Netechma*); Polski Posmo Entomol. 68: 95. Holotype ♀, Brazil, Santa Catarina, 21 January 1936, F. Hoffman. Razowski (1999) incorrect identifies the disposition of the type as NHMW.

superba Razowski, 1988 (*Clarkenia*); Acta Zool. Cracov. 31: 406. Holotype ♂, Colombia, Cauca, Paramo de Parace, Lake San Rafael, 3,570 m, 27 January 1959, J. Clarke.

symphyla Razowski, 1984 (*Polyortha*); Acta Zool. Cracov. 27: 222. Holotype ♂, Bolivia, Cochabamba, Incachaca, J. Steinbach.

synchysis Pogue, 1986 (*Apolychrosis*); in Cibrián-Tovar et al., Cone and Seed Insects of the Mexican Conifers: 27. Holotype ♂, Mexico, Tlaxcala, Municipio de Terrenate, Villareal, r.f., *Abies religiosa,* em: 10 January 1985.

synneurana Barnes & Busck, 1920 (*Amor-*

bia); Contrib. Nat. Hist. Lepid. North Am. 4: 211. Holotype ♀, USA, Arizona, Redington.

taedana Miller, 1978 (*Petrova*); Ann. Entomol. Soc. Am. 71: 337. Holotype ♀, USA, Florida, Seminole Co., Geneva, 21 May 1967, R. Leuschner.

taetera Razowski, 1984 (*Histurodes*); Acta Zool. Cracov. 27: 214. Holotype ♂, Guatemala, Cerro Zunil, 4,000–5,000′, Champion.

tahoensis Heinrich, 1923 (*Eucosma*); Bull. U.S. Natl. Mus. 123: 112. Holotype ♂, USA, California, Lake Tahoe, Deer Park Springs, "July 8–15."

taiwana Kawabe, 1986 (*Zeiraphera*); Entomol. Pap. Pres. Kurosawa, Tokyo: 79. Holotype ♂, Taiwan, Chiai Hsien, Alishan, 2,200 m, 12 August 1974, Y. Kishida.

taiwana Kawabe, 1992 (*Acleris*); Tinea 13: 174. Holotype ♂, Taiwan, Nantou Hsien, Tayuling, forest, 2,500 m, 9–18 June 1980, D. Davis.

taiwana Kawabe, 1992 (*Neopotamia cryptocosma*); Japan. Hetero. J. 170: 359. Holotype ♂, Taiwan, Hualien Hsien, Kuanyuan, 2,400 m, 7–8 August 1987, A. Kawabe.

taiwanensis Kawabe, 1985 (*Archips*); Tinea 12: 3. Holotype ♂, Taiwan, Nantou Hsien, Lushan Spa, 1,200 m, 27–29 July 1983, A. Kawabe.

taiwanica Razowski, 1977 (*Aethes cnicana*); Tyo to Ga 28: 37. Holotype ♂, Taiwan, Tattaka, 6 June 1943, S. Issiki.

taleana Grote, 1878 (*Grapholitha*); Canad. Entomol. 10: 54. Holotype ♂ (only a forewing), USA, Illinois, T. Bean. The original description appears to have been based on a single male specimen.

tamaensis Kawabe, 1974 (*Epinotia*); Tyo to Ga 25: 96. Holotype ♂, Japan, Tokyo, Tama Hill, 22 April 1958, A. Kawabe.

tambomachaya Razowski, 1988 (*Seticosta*); Acta Zool. Cracov. 31: 401. Holotype ♀, Peru, Cusco, Tambomachya, 3,690 m, 3 February 1959, J. Clarke.

tantilla Heinrich, 1926 (*Satronia*); Bull. U.S. Natl. Mus. 132: 17. Holotype ♂, USA, Florida, Alachua Co., Archer, 4 May 1882.

tayulingensis Kawabe, 1986 (*Dichrorampha*); Entomol. Pap. Pres. Kurosawa, Tokyo: 83. Holotype ♂, Taiwan, Hualien Hsien, Tayuling, 2,560 m, 2–3 August 1983, A. Kawabe.

taxifoliella Busck, 1914 (*Evetria*); Proc. Entomol. Soc. Wash. 16: 146. Holotype ♀, USA, Montana, Missoula Co., hill at canyon east of Missoula, r.f. *P. taxifolia,* 24 April 1913, J. Brunner.

telesocia Razowski, 1994 (*Cylichneulia*); SHILAP Revta. Lepid. 22: 68. Holotype ♂, Venezuela, Aragua, Rancho Grande, 1,100 m, 16–19 January 1966, S. & W. Duckworth.

temerana Busck, 1907 (*Phalonia*); J. N. Y. Entomol. Soc. 15: 28. Holotype ♂, USA, Pennsylvania, Allegheny Co., Oak Station, 21 May 1906, F. Marloff.

tenebrica Heinrich, 1929 (*Anchylopera*); Proc. U.S. Natl. Mus. 75: 17. Holotype ♂, Canada, Alberta, Bilby, 12 June 1924, O. Bryant.

tenebrica Razowski, 1987 (*Terinebrica*); Tinea 12(suppl.): 135. Holotype ♂, Peru, Cusco, Machu Picchu, 2,385 m, 6 February 1959, J. Clarke.

terminana Busck, 1907 (*Hysterosia*); J. N. Y. Entomol. Soc. 15: 33. Holotype ♂, USA, Pennsylvania, Allegheny Co., Pittsburgh, H. Engel.

tetropsis Busck, 1913 (*Eucosma*); Insect. Inscit. Menst. 1: 91. Holotype ♂, British Guiana, Kirby, r.f. guava, H. Moore.

teutoniana Brown, 1999 (*Dimorphopalpa*); Pan-Pac. Entomol. 75: 89. Holotype ♂, Brazil, Santa Catarina, Nova Teutonia, 27°11′S, 52°23′W, 300–500 m, September 1963, F. Plaumann.

texasana Blanchard & Knudson, 1984 (*Anopina*); Proc. Entomol. Soc. Wash. 86: 449. Holotype ♂, USA, Texas, Jeff Davis Co., Mt. Locke, 6,700′, 26 April 1981, E. Knudson.

thelmae Diakonoff, 1968 (*Capua*); Bull.

U.S. Natl. Mus. 257: 23. Holotype ♂, Philippine Islands, Mindanao, Bukidnon, Mt. Katanglad, 1,480 m, 27–31 October 1959, L. Quate & C. Yashimoto. Although the holotype is labeled "*Capua thalmae,*" the original description uses the correct spelling of "*thelmae.*"

theodora Clarke, 1976 (*Herpystis*); Insects of Micronesia 9: 76. Holotype ♂, Micronesia, Kusaie, Mutunlik, 22 m, 24 January–30 April 1953, J. Clarke.

theta Brown, 1991 (*Punctapinella*); Los Angeles Co. Mus. Contrib. Zool. 423: 4. Holotype ♀, Venezuela, Aragua, Rancho Grande, 1,100 m, 15–21 August 1967, R. Poole.

thylacophora Diakonoff, 1968 (*Peridaedala*); Bull. U.S. Natl. Mus. 257: 76. Holotype ♂, Philippine Islands, Davao Province, Mindanao, E. slope Mt. McKinley, 17 September 1946, CNHM Philippine Zool. Exped., H. Hoogstraal.

tocullionana Heinrich, 1920 (*Eucosma*); Proc. U.S. Natl. Mus. 57: 59. Holotype ♂, USA, Connecticut, Lyme, r.f. cones of *Picea,* em: 16 May 1916, A. Champlain.

tokui Kawabe, 1974 (*Didrimys*); Tyo to Ga 25: 101. Holotype ♂, Japan, Yakushima Island, Aiko-dake, 30 March 1972, T. Watanabe.

tokui Kawabe, 1974 (*Eudemopsis*); Kontyu 42: 389. Holotype ♂, Japan, Yakushima Island, Mt. Aiko-dake, 8 June 1972, T. Watanabe.

tonsilis Razowski, 1984 (*Ardeutica*); Acta Zool. Cracov. 27: 217. Holotype ♂, Costa Rica, Cartago Province, Juan Vinas.

tonto Powell, 1980 (*Decodes*); Pacific Insects 22: 93. Holotype ♀, USA, Arizona, Pinal-Gila Co. line, Miami Superior Highway, 4,790′, 1–15 April 1925, O. Poling.

toreuta Grote, 1873 (*Penthina*); Bull. Buffalo Soc. Nat. Sci. 1: 92. Holotype ♂, USA, Pennsylvania.

tornosema Clarke, 1968 (*Phalonia*); Proc. U.S. Natl. Mus. 125: 12. Holotype ♀, Guatemala, Volcán Santa María, June, Schaus and Barnes.

torostoma Clarke, 1972 (*Laspeyresia*); Proc. Entomol. Soc. Wash. 74: 467. Holotype ♀, Costa Rica, Cartago Province, Turrialba, r.f. string bean stems, 8 March 1965, L. Bonnefil.

toshimai Kawabe, 1974 (*Eudemopsis*); Kontyû 42: 389. Holotype ♂, Japan, Kochi Pref., Mt. Ashizuriyama, Cape Ashizuri, 27 May 1973, H. Toshima.

toshimai Kawabe, 1978 (*Griselda*); Tinea 10: 186. Holotype ♂, Japan, Shikoku, Kagawa Pref., 15 July 1972, T. Toshima.

towadaensis Kawabe, 1978 (*Statherotis*); Tinea 10: 176. Holotype ♂, Japan, Honshu, Aomori Pref., Towada, 3 August 1969, Sato & Oshima.

trema Brown & Obraztsov, 1991 (*Cuproxena*); in Brown and Powell, Univ. Calif. Publ. Entomol. 111: 56. Holotype ♂, Mexico, Guerrero, December 1920, R. Muller.

triangulana Brown, 1992 (*Catastega*); J. N. Y. Entomol. Soc. 100: 220. Holotype ♂, USA, Arizona, Gila Co., 4 mi ESE Pine, 4,500 ft, 1 September 1961, R. W. Hodges.

triangulana Kearfott, 1908 (*Tortrix*); J. N. Y. Entomol. Soc. 16: 179. Lectotype ♂, USA, California, San Diego Co., San Diego, 31 July 1907. Designated by Obraztsov (1962).

tricia Clarke, 1976 (*Heleanna physalodes*); Insects of Micronesia 9: 17. Holotype ♂, Micronesia, Kapingamarani Atoll, Hare Island, r.f. *Callophyllum inophyllum,* 3 August 1946, Townes.

tridens Razowski, 1988 (*Seticosta*); Acta Zool. Cracov. 31: 400. Holotype ♂, Colombia, Cauca, Paramo de Parace, Lake San Rafael, 3,570 m, 27 January 1959, J. Clarke.

trifida Adamski, 1986 (*Apotomis*); Canad. Entomol. 118: 666. Holotype ♂, USA, Washington, Ferry Co., Sherman Pass, 23 July 1962, J. Clarke.

triopis Diakonoff, 1959 (*Cryptaspasma*); Zool. Verhandel. (Leiden) 43: 32. Holotype ♂, Guam Island, Commander Mariana's Hill, March 1949, K. Maehler.

triphera Brown & Obraztsov, 1991 (*Cuproxena*); in Brown and Powell, Univ. Calif. Publ. Entomol. 111: 56. Holotype ♂, Panama, Cabima, May 1911, A. Busck.

triquetra Obraztsov, 1964 (*Proeulia*); Proc. U.S. Natl. Mus. 116: 189. Holotype ♂, Chile, Nuble, Chillán, 10 November 1961, H. Lister.

tristriata Kearfott, 1907 (*Sparganothis*); Trans. Am. Entomol. Soc. 33: 67. Syntype ♂, USA, Minnesota, Duluth. Unpublished lectotype selected by R. Lambert, labeled by J. Powell. Klots (1942) indicated that there was a female "cotype" in the AMNH, but did not designate it as the lectotype.

tsugae Issiki, 1961 (*Epagoge*); in Issiki and Mutuura, Microlepidoptera injurious to coniferous plants in Japan: 36. Holotype ♂, Japan, Osaka, Ikeda Pref., 23 May 1958, T. Kodama. Komai (1999) unnecessarily designated a lectotype for this species; apparently he was unaware that the holotype was deposited in the USNM.

tsuifengana Kawabe, 1992 (*Acleris*); Tinea 13: 175. Holotype ♂, Taiwan, Nantou Hsien, Tsuifeng, 2,400 m, 29 December 1989, A. Kawabe.

tsushimaensis Kawabe, 1978 (*Hedya*); Tinea 10: 173. Holotype ♂, Japan, Tsushima Island, Nenbutsuzaka, 27 June 1973, T. Watanabe.

turbula Clarke, 1968 (*Irazona*); Proc. U.S. Natl. Mus. 125: 40. Holotype ♀, Guatemala, Volcán Santa María, July, Schaus and Barnes.

turialba Busck, 1920 (*Hysterosia*); Insect. Inscit. Menst. 8: 86. Holotype ♀, Costa Rica, Cartago Province, Juan Vinas, February, W. Schaus.

twila Clarke, 1955 (*Orthocomotis*); Trans. Royal Entomol. Soc. London 107: 152. Holotype ♂, Brazil, Santa Catarina, Nova Teutonia, February 1948, F. Plaumann.

ulteriorana Heinrich, 1920 (*Evetria*); Proc. U.S. Natl. Mus. 57: 55. Holotype ♂, USA, Oregon, Waldo, r.f. *Psuedotsuga taxifolia,* 16 August 1914, Keen & Sergent.

umbrana Barnes & Busck, 1920 (*Sparganothis*); Contrib. Nat. Hist. Lepid. North Am. 4: 212. Holotype ♂, USA, Colorado, Adams Co., Denver, Oslar.

umbraticana Heinrich, 1923 (*Thiodia*); Bull. U. S. Natl. Mus. 123: 70. Holotype ♂, USA, Colorado, Jefferson Co., foothills above Golden, 13 March 1901, Dyar & Caudell.

unciana Dognin, 1904 (*Atteria*); Ann. Soc. Entomol. Belgium 48: 133. Holotype ♀, Ecuador, Zamora, September 1886.

undata Walsingham, 1914 (*Tortrix*); Biol. Centr.-Am., Lepid., Heter. 4: 286. Holotype ♂, Mexico, Puebla, Popocatepetl Park, 8,000′, June 1906, W. Schaus.

unguiculus Clarke, 1951 (*Episimus*); J. Wash. Acad. Sci. 41: 297. Holotype ♀, Argentina, Tigre, March 1946, F. Bourquin.

unica Heinrich, 1923 (*Epinotia*); Bull. U.S. Natl. Mus. 123: 221. Holotype ♂, USA, Tennessee, Knox Co., Knoxville, r.f. *Bradburya virginiana,* G. Ainslie.

urbana Busck, 1912 (*Tortrix*); Proc. Entomol. Soc. Wash. 14: 86. Holotype ♂, Mexico, Mexico City, November 1911, R. Muller.

ustulatana Blanchard & Knudson, 1983 (*Eucosma*); Proc. Entomol. Soc. Wash. 85: 849. Holotype ♂, USA, Texas, Washington Co., Brenham, 4 June 1979, E. Knudson.

usuiana Kawabe, 1976 (*Epibactra*); Tinea 10: 39. Holotype ♂, Japan, Gunma Pref., Usui Pass, 5 June 1951, M. Hoshino.

usurpata Razowski, 1987 (*Utrivalva*); Bull. Polish Acad. Sci. 35: 67. Holotype ♂, Guatemala, Volcán Santa María, W. Schaus.

uta Clarke, 1953 (*Eucosma*); J. Wash. Acad. Sci. 43: 226. Holotype ♂, USA, Illinois, Putnam Co., 10 July 1938, M. Glenn.

vaccinii Clarke, 1971 (*Dichelopa*); Smithsonian Contrib. Zool. 56: 107. Holotype ♂, Rapa Island, Maugaoa, 950' (292 m), r.f. *Veronica rapensis,* 5 November 1963, J. & T. Clarke.

vagana Heinrich, 1923 (*Epinotia*); Bull. U.S. Natl. Mus. 123: 230. Holotype ♂, USA, Washington, Liaga, r.f. *Pyrus rivularis* [wild crab apple], 20–24 July 1918, em: 20 July 1918, E. Heckard.

variana Fernald, 1886 (*Teras*); Bull. U.S. Dept. Agric. Entomol. 12: 17. "Type" ♂, USA, Maine. This is the only example of this species we could locate from the Fernald Collection. Fernald did not indicate how many specimens he examined.

varnicosa Brown, 2000 (*Lobogenesis*); Proc. Entomol. Soc. Wash. 102: 36. Holotype ♀, Argentina, Tucumán, Ciudad Universitaria, 17 February 1959, J. Clarke.

venatana Kawabe, 1992 (*Acleris*); Tinea 13: 178. Holotype ♂, Taiwan, Nantou Hsien, Tsuifeng, 2,400 m, 29 December 1989, A. Kawabe.

verecundana Blanchard, 1979 (*Phaneta*); J. Lepid. Soc. 33: 210. Holotype ♂, USA, Texas, Hemphill Co., Canadian, 15 August 1971, A. & M. Blanchard.

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NOTE

Fitchia aptera Stål (Hemiptera: Reduviidae): Seasonal History and Habits in Mid-Appalachian Shale Barrens

Fitchia aptera Stål is an infrequently collected though widely distributed harpactorine reduviid. Adults are 9–14 mm long, elongate, and dull yellow, with a dark longitudinal stripe on either side of the abdominal midline; this dorsal stripe is conspicuous in the brachypterous morph. Slater and Baranowski (1978. How to Know the True Bugs, W. C. Brown, Dubuque, Iowa. 256 pp.) illustrated the brachypterous and macropterous forms. *Fitchia aptera* can be confused with the only other member of this Nearctic genus, *F. spinosula* Stål; characters traditionally used to distinguish the two sympatric species—including presence or absence of prothoracic spines—are unreliable (McPherson et al. 1992. Florida Entomologist 75: 222–230). McPherson et al. (1992) redescribed the adults and provided additional characters to separate these species.

DeCoursey (1963. Bulletin of the Brooklyn Entomological Society 58: 151–156) described and illustrated the immature stages and determined their duration by rearing *F. aptera* in the laboratory ("room temperature," RH not stated); nymphs were fed small flies and homopterans. DeCoursey (1963) reported mean development (egg to adult) of 60 days (range 51–67; n not stated) and found that *F. aptera* has only four nymphal instars. Swadener and Yonke (1973. Journal of the Kansas Entomological Society 46: 123–136) reared this reduviid in the laboratory (21°C night, 29°C day; 40–60% RH), reporting that total development averaged 70 days (range 60.5–74.5; n = 134 eggs, n = 3 instar IV). They also confirmed the presence of only four instars.

In contrast to the availability of biological data from laboratory studies, little is known about the habits of *F. aptera* in nature. Readio (1927. University of Kansas Science Bulletin 17: 5–291) did not treat the bionomics of this species in his studies on reduviid biology. This mainly ground-dwelling assassin bug occurs by day at the bases of grass clumps in old fields, the adults overwintering under boards, stones, or at roots of grasses. Adults occasionally can be swept from tall grasses in early evening. Nymphs are found on the ground, mainly in grassy areas (DeCoursey 1963). Hagerty and McPherson (2000. Great Lakes Entomologist 32: 133–160) reviewed additional collection records and in Illinois reported an adult at the roots of a grass clump, three adults from sweeping herbaceous vegetation, and another adult from sweeping a grassy field.

Here I give notes on the seasonality of *F. aptera* in shale barrens and outcrops in the mid-Appalachians. Collections and observations were made while inventorying the plant bug (Hemiptera: Miridae) fauna of moss phlox (*Phlox subulata* L.) during 1989–1995. Mats of this prostrate perennial (family Polemoniaceae) were shaken over a white tray (Wheeler. 1995a. Proceedings of the Entomological Society of Washington 97: 435–451), and adults and all instars of *F. aptera* were collected; nymphs were determined to instar in the laboratory, using DeCoursey's (1963) descriptions. Voucher specimens, including nymphs, are deposited in the National Museum of Natural History, Smithsonian Institution, Washington, D.C.

Unless otherwise stated, *F. aptera* was collected from mats of moss phlox at the following localities. The numbers of nymphs (Roman numerals = instars) and adults (A) are given parenthetically after other collection data.

Maryland: Allegany Co., Country Club shale barren, 2.5 km NE of Cumberland, 2 July 1994 (1 III). Pennsylvania: Bedford

Co., shale slope, Rt 56 E of Fishertown, 24 June 1990 (1 I); shale slope, Rt. 96 NE of Ryot, 24 June 1990 (2 I) & 10 May 1992 (1 A). Virginia: Bath Co., Fort Lewis shale barren, Rt. 678 at Cowpasture River, 26 June 1994 (1 I); Highland Co., Head Waters shale barren nr. jct. Rts. 250 & 616, 23 June 1990 (7 I–II), 25 Aug. 1990 (1 IV; 2 A ex undet. sprawling plant), 10 July 1993 (3 II; 2 II ex base of *Eriogonum allenii* S. Wats), 1 Aug. 1993 (2 II, 1 III), 26 June 1994 (1 I, 1 II), 6 Aug. 1994 (1 II, 1 III), 26 Aug. 1994 (1 IV); Rockbridge Co., Furnace Mountain shale barren, ca. 3 km S of Natural Bridge Station, 24 May 1995 (1 I, 1A ex *Antennaria plantaginifolia* (L.) Richardson); Rockingham Co., shale slope, For. Rd. 87, W of Fulks Run, 19 May 1994 (1 A; 1 A at base of *Tephrosia virginiana* (L.) Pers.), 25 June 1994 (1 I); Shenandoah Co., Short Mountain shale barren, ca. 4.6 km SE of Mount Jackson, 10 July 1993 (1 III). West Virginia: Greenbrier Co., shale slope, Whites Draft Rd., Alvon, 4 July 1994 (1 II); Hampshire Co., shale bank, Rt. 29, 5.6 km N of Slanesville, 30 June 1990 (1 II); Hardy Co., shale bank, Mathias, 30 June 1990 (1 II).

Insect-plant associations in shale barrens have been little studied (e.g., Wheeler 1995a; Braunschweig et al. 1999. pp. 83–98. *In* Anderson, R. C. et al., eds., Savannas, Barrens, and Rock Outcrop Communities of North America. Cambridge University Press, UK), but these xeric communities of high soil-surface temperatures (sometimes 50–60°C; Braunschweig et al. 1999) harbor great insect richness (Wheeler 1995a, b. Virginia Journal of Science 46: 148). The predacious *F. aptera* can be added to the diverse insect fauna of moss phlox in mid-Appalachian shale barrens and outcrops (Wheeler 1995a, b). All collections were from the Valley and Ridge physiographic province except the one in Rockbridge Co., Va., which was from the Blue Ridge province. According to McPherson et al. (1992), Maryland, Virginia, and West Virginia are new state records.

Only small numbers of *F. aptera* were found during any 45–60 minutes' sampling of moss phlox, the seven early instars on 23 June 1990 representing the most individuals in any sample. Adults, all brachypters (n = 6), were found at four sites where nymphs were present; nymphs at other sites probably also were *F. aptera* rather than *F. spinosula.*

Overwintered adults were found under mats of moss phlox, at the base of *Tephrosia virginiana,* or among stolons of *Antennaria plantaginifolia* during May in shale barrens and outcrops. Except for the late-May collection in Rockbridge Co., Va., first instars were not observed before late June despite intensive sampling of moss phlox during April, May, and early June (Wheeler 1995a). An early instar was observed feeding on an immature isopod at the Head Waters shale barren in Virginia in late June. Third and fourth instars were present from early July to late August, suggesting a rather late-season, univoltine life cycle. Two adults found in late August likely were those of a new, rather than overwintered, generation. No nymphs or adults were observed during sampling of moss phlox in September and early October.

In Connecticut, DeCoursey (1963) reported that overwintered adults of *F. aptera* become active in April. An adult collected in early April in Missouri did not oviposit in the laboratory until mid-May and continued to lay eggs until mid-July (Swadener and Yonke 1973). Such observations, coupled with mean development of 60 (DeCoursey 1963) or 70 days (Swadener and Yonke 1973), also suggest that *F. aptera* is a relatively late-season reduviid.

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NOTE

First Host Plant and Parasitoid Record for *Anastrepha spatulata* Stone (Diptera: Tephritidae)

Anastrepha spatulata Stone has been reported in the U.S. (S. Texas), Mexico, Central America (Guatemala S. to Panamá), Venezuela and Tobago (Norrbom et al. 1999. Myia 9: 65–251 [p. 82 for *A. spatulata*]). In Mexico, it is commonly captured in McPhail traps placed in commercial fruit orchards (Aluja et al. 2000. Proceedings of the Entomological Society of Washington 102: 802–815). In the past 60 years, there have been considerable, but until now unsuccessful, efforts to discover its host plant. This species, together with *A. alveata* Stone, *A. alveatoides* Blanchard, *A. distans* Hendel, *A. interrupta* Stone, *A. manihoti* Lima, *A. montei* Lima, *A. pickeli* Lima, and *A. umbrosa* Blanchard, form the *spatulata* species group (Norrbom et al. 2000. pp. 343–362. *In* Aluja and Norrbom, eds., Fruit Flies (Diptera: Tephritidae): Phylogeny and Evolution of Behavior, CRC Press).

We report here on *A. spatulata* infestations in *Schoepfia schreberi* Gmelin fruit (Olacaceae). This bushy plant is locally known in Veracruz as "guayabillo" or "palo meco." Fully ripe fruits measure, on the average, 1.92 ± 0.06 cm (diameter, n = 25) and weigh 185 ± 0.061 mg (n = 25). A mature plant measures ca. 2.10 m in height. Floral buttons of *S. schreberi* were observed from January 20th to February 5th. The flowering period was recorded from the 1st to the 12th of February and the fruiting season occurred between the 10th and the 20th of February (all during 1998). Fly larvae were always found feeding in the seed of the fruit (there is one seed per fruit). There was always only one larva per fruit. Given the small size of the host, fully mature larvae, 8.6 ± 0.12 mm (n = 8) in length, looked very compressed inside the host. We collected 3 batches (different collection dates) of ripe fruit from the ground adjacent to four *S. schreberi* bushes. A total of 583 g of fruit were collected on February 2, 9, and 18, 1998. Fruit was handled as described by Aluja et al. (2000). Pupae were harvested between 1 and 6 days after the fruit collecting date. The 583 g of fruit yielded 579 pupae (0.993 pupae/g of fruit). Mean pupal weight was 12 ± 0.001 mg (n = 13). We divided pupae into two batches. One was kept under field conditions and another was transported to the laboratory. The collection site was Llano Grande, Municipio de Teocelo, Veracruz, Mexico, at 720 m altitude (19°22′N and 26°53′W). Native vegetation around this site is a tropical deciduous and subdeciduous forest (Castillo-Campos. 1995. Ecología del Paisaje del Municipio de Jalcomulco, Veracruz, MS Thesis, UNAM, Mexico City).

Between February 29 and March 5, 454 *A. spatulata* adults (223 females, 231 males), 17 *Doryctobracon areolatus* (Szepligeti) (10 females, 7 males) and 2 *Doryctobracon toxotrypanae* (Muesebeck) (2 females) emerged. We note that the *D. areolatus* individuals emerging from *A. spatulata* were uniformly more darkly colored than those individuals of the same species, parasitizing, in the same region, *A. alveata, A. obliqua* (Macquart), *A. striata* Schiner and *A. fraterculus* (Wiedemann) (Lopez et al. 1999. Biological Control 15: 119–129). Length of the pupal period for flies was 22 ± 3 and 27 ± 9 days under laboratory and field conditions, respectively (mean temperature of 26 ± 1°C and 23 ± 3°C under laboratory and field conditions, respectively). In the case of the parasitoids, the length of the pupal period for *D. areolatus* was 25 ± 9 and 26 ± 5 days under laboratory and field conditions, respectively (same temperature conditions as flies). For *D. toxotrypanae* it was 21 days (laboratory conditions only). Another 9 *D. areolatus* (8 females, 1 male) entered diapause and emerged after ca. 11 months (range of 308–341 days). Diapause by *D. areolatus* in the same region has been recently reported by Aluja et al. (1998. Annals of the Entomological Society of America 91: 821–833).

Schoepfia schreberi had been previously reported as a host plant of *A. interrupta* (McClanahan. 1951. State Plant Board of Florida Biennial Report No. 18, p. 44; as *S. chrysophylloides*). Interestingly, the host plant of another fly belonging to the same species group (*A. alveata*), also belongs to the family Olacaceae (Piedra et al. 1993. Proceedings of the Entomological Society of Washington 95: 127). Based on the few host records for the *spatulata* group (Norrbom. 2000. Diptera Data Dissemination Disk 2, *in press*), it appears that flies in this assemblage of species are specialized on only two plant families, Olacaceae and Euphorbiaceae.

Our discovery of *D. toxotrypanae* parasitizing a species of *Anastrepha* is noteworthy since this parasitoid had been previously reported parasitizing only *T. curvicauda* Gerstaecker (Wharton and Marsh. 1978. Journal of the Washington Academy of Sciences 68: 147–167). *Toxotrypana curvicauda* is common in the study region where it has been recently reported infesting *Gonolobus niger* (Cav.) R. Br. (Asclepiadaceae) fruit (Aluja et al. 2000). It is thus likely that the *D. toxotrypanae* individuals parasitizing *A. spatulata* stemmed from parasitized *T. curvicauda*. We note, however, that *D. toxotrypanae* is only distinguished from *D. crawfordi* on the basis of color differences (*D. toxotrypanae* is darker) (R. A. Wharton, pers. comm.). Based on the latter, the question remains open as to which of the two above mentioned *Doryctobracon* species was actually parasitizing *A. spatulata* in our study region.

Voucher specimens of *S. schreberi* and *A. spatulata* are placed in the herbarium and insect collection of the Instituto de Ecología, A.C. in Xalapa, Veracruz, Mexico. *Anastrephe spatulata* individuals were also sent to the National Museum of Natural History, Washington, DC (A. L. Norrbom) and *D. areolatus* and *D. toxotrypanae* individuals were sent to the parasitoid collection of Texas A&M University, College Station, TX (R. A. Wharton).

Specimen identification was by the following: *A. spatulata* (A. L. Norrbom, Systematic Entomology Laboratory, ARS, USDA, % National Museum of Natural History, Washington, DC); *D. areolatus* and *D. toxotrypanae* (Robert Wharton, Texas A & M University, College Station), and *Schoepfia schreberi* (Carlos M. Durán-Espinoza, Instituto de Ecología, A.C., Xalapa, Veracruz, Mexico). Financial support was provided by the Campaña Nacional contra las Moscas de la Fruta, Comisión Nacional para el Conocimiento y Uso de la Biodiversidad (CONABIO) (Grant No. H296), Sistema Regional de Ciencia del Golfo (CONACyT-SIGOLFO) (Grant No. 96-01-003-V) and the U.S. Department of Agriculture (ARS, USDA) (Grant Numbers 198-23 and 58-6615-3-025).

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BOOK REVIEW

Aphids on the World's Crops, An Identification and Information Guide, Second Edition, by R. L. Blackman and V. F. Eastop. John Wiley & Sons, Baffins Lane, Chichester, Sussex PO19 1UD, England. 466 pp. 2000. $145.00.

The first edition of *Aphids on the World's Crops* was published in 1984 and brought together information available previously only in widely-distributed papers and publications containing species' descriptions and keys. The information in the keys, in the systematic reviews, and in the photographs, will allow a non-specialist to identify, with a good degree of accuracy, aphids colonizing (feeding and producing young) the crops treated.

The second edition has seven sections. Section A (pages 1–24) contains general information on systematics, life cycles, host-plant relationships, geographical distribution, and morphology and key characters. Section B (pages 25–214) begins with a statement on the limitations and use of the keys and is devoted to crops and their aphids. This section includes an alphabetical listing of the Latin names of crops with their common names followed by an alphabetical listing of the crops by common names, a list of the aphids reported to colonize the crop, and keys to those aphids. Section C (pages 215–362) covers a discussion of the aphids and includes a brief introduction followed by an alphabetical listing by genus and species of the aphids treated. This section is a wealth of information on aphids and includes field characters, host plants, virus transmission, distribution, and biology. Section D (pages 363–365) covers techniques on collecting, preserving and mounting, and labeling and storage. Section E (pages 367–373) contains sources of information on regionally classified faunal publications; general biology; morphology, anatomy, and physiology; genetics and development; migration and dispersal; relationships with other insects; host-plant relationships; control; and bibliographies. Section F (pages 375–414) is a list of references. Section G (pages 415–466) is a photographic guide to slide-mounted aphids.

While both editions are 466 pages in length, the second edition is about ⅓ larger in size, covers 38 more species, and contains more information in the keys and the systematic section. While the basic format is unchanged, the arrangement of the text and the collection of the illustrations in plates rather than their being shown with each key couplet is a more efficient use of space, is more pleasing to the eye, and does not detract from the value of or ease in following the information. The biggest improvement, from a user's standpoint, is that the type in the section with the keys is larger and more legible. The photomicrographs and illustrations are much improved with the target characters easier to see. Having the names of the species with each photographic plate is useful, but I missed having the listing of all species at the beginning of the photographic guide.

Aphids on the World's Crops remains the only current, world-wide reference with general and specific information on aphids colonizing crops and is a must have for anyone working in this field. Everyone who has a copy of the first edition will want to keep it as a reference (mine is well worn) but will want to purchase a copy of the second edition as a valuable working tool.

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BOOK REVIEW

Classification of Lepidoptera. Part 1. Introduction, by John B. Heppner. Holarctic Lepidoptera, Volume 5, Supplement 1. Published by the Association for Tropical Lepidoptera, Gainesville, FL. 1998. 148 pp. + 6 pp. index. Soft bound, 8.5 × 11 in. ISBN 1070-4140. $25.00

This volume, the first of a proposed three-part "Manual of Lepidoptera," is chuck full of interesting factoids, keys, illustrations, and references. It presents a "new" higher classification of the order with novel (and sometimes unusual) groupings of families based on the author's expertise and biases. Included are a tabular summary of Heppner's (1991) previous work on species richness and biogeographic distribution of each of the superfamilies; "schematic phylogenies" of most of the major groups (apparently based on intuition rather than analysis); an impressive data matrix (Table 2) of 24 morphological characters of adults, larvae, and pupae across all the superfamilies; an extensive key to adults of the major families, previously published by Heppner (1996); 33 pages of illustrations of wing venation of all major groups (never before compiled and presented in such an easily browsed manner); and references, lots of them, subdivided by category (e.g., taxonomy, morphology, biology, biogeography). The volume brings together widely scattered concepts and literature, synthesized in Heppner's unmistakable style.

If this book had been published 10 years ago, it might have stood for a decade as the standard reference on the order. Unfortunately, any impact that it potentially may have had likely will be overshadowed by the recently published Handbook of Zoology (Kristensen 1999). Heppner's timing could not have been worse. In contrast to Heppner's single-authored manual, the editor of the Handbook enlisted the assistance of 29 leading authorities in particular Lepidoptera families, creating a work of grand proportions.

Aside from being scooped by the Handbook, Heppner's work is plagued by a few quirky shortcomings and/or inconsistencies. Based on my knowledge of Tortricoidea (I have limited knowledge of the higher classification of the entire order), I perused the volume for details of this superfamily. Table 1 indicates that it includes 6,683 species, with 250 species occurring in the Ethiopian (Afrotropical) region. Actually, there are over 8,000 described species of Tortricidae (based on a checklist I have compiled), and Diakonoff, in various publications (e.g., Diakonoff 1960, 1970, 1973, 1981, 1983), treated over 250 species of tortricids from Madagascar alone. Also, of ten genera of Tortricidae for which wing venation is illustrated (page 78), Heppner uses older, antiquated names for two: "*Tortrix*" for *Xenotemna* (*X. pallorana*) and "*Clysiana*" for *Eupoecilia* (*E.* sp.). Given these minor errors in the group with which I am most familiar, I am skeptical about the quality of information presented for other superfamilies.

In some cases, Heppner appears to have disregarded the published findings of other specialists. For example, Epstein's (1996) analysis of the limacodid-group of families provides compelling evidence that Megalopygidae, Aididae, Dalceridae, and Limacodidae form a monophyletic group within Zygaenoidea. Yet in Heppner's classification, Megalopygidae (including Aidinae) is placed in Zygaenoidea, while Dalceridae and Limacodidae are included in Cossoidea.

Despite its incongruities and shortcomings, Heppner's compendium is a valuable source of information on the classification of Lepidoptera, and comparisons with the Handbook of Zoology are premature since parts 2 and 3 of Heppner's work presumably will present morphological and biological details on each of the superfamilies, one of the strengths of the Handbook. Comparisons with the Handbook also are unfair given the considerable difference in price—Heppner's part 1 sells for about $25.00; the Handbook goes for a whopping $250! Because currently proposed classifications of the Lepidoptera exhibit little consensus, all must be viewed as viable and reasonable alternative interim solutions. Heppner's contribution will not go unnoticed.

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OBITUARY

Clyde Fuhriman Smith
(1913–2000)

Clyde Fuhriman Smith enjoyed a distinguished, multi-faceted career in entomology, with an enduring interest in the taxonomy of aphids and their host-plant associations. He was born 10 August 1913, in Franklin County, Idaho, where his early education began. Smith went on to study entomology, earning degrees at Utah State Agricultural College (now Utah State University: B.S. 1935, M.S. 1938: George F. Knowlton, major advisor) and the Ohio State University (Ph.D. 1939: Alvah Peterson, major advisor). His entomological education extended far beyond course work with part-time or short, full-time periods as research assistant, teaching assistant, extension assistant, and research fellow, exposing him to a wide range of insects and crops.

In September 1939, Smith accepted a position in Raleigh as an Assistant Entomologist at the North Carolina Agricultural Experiment Station and N.C. State College (now University) and subsequently progressed to Associate Professor (1943–1950), Professor and Department Head

(1951–1963), Professor (1964–1979), and Professor Emeritus (1980–2000). Smith worked on insects and mites associated with nearly every major crop plant in North Carolina as documented by his publications (listed below). Under his leadership, the Department of Entomology (initially a section of the Division of Biological Sciences) more than doubled in number of faculty. After his tenure as head, he returned to research on cucumber and peach insects, notably the management of the pickleworm, a complex problem requiring intensive and complete control. As a professor emeritus, he continued publishing on aphid systematics and served on the NCSU Insect Collection's Museum Council.

Stretching far beyond his microscope and boxes of prepared specimens, Smith's laboratory embraced North Carolina's orchards, forests, farms, gardens, pest-infested buildings, and roadside vegetation. He excelled at working with and gaining the trust of farmers and orchardists, talents vital to conducting meaningful scientific research in the days before university-supported experimental research farms.

Smith had an extraordinary ability to bring together scientific colleagues and others to exchange information. The present names of organizations he founded or helped to found are the Southeastern Peach Workers Conference (initiated 1948), N.C. Agricultural Chemicals School (1949), N.C. Pest Control Technicians School (1950), N.C. Pest Control Association (1950), N.C. Entomological Society (1956, first President), and *Heliothis* Conference (late 1950s, now meeting with the Entomological Society of America). In 1972, Smith received the N.C. Entomological Society's Entomologist of the Year award. Furthermore, he held membership in several other scholarly societies: Entomological Society of America (President of Southeastern Branch in 1972), Entomological Society of Washington, Society of Systematic Zoology, Georgia Entomological Society, Gamma Sigma Delta, Society of the Sigma Xi, and Phi Kappa Phi. Smith was also instrumental in the passage of the N.C. Structural Pest Control Act of 1955 and served as chair of the N.C. Structural Pest Control Commission from 1955 to 1967.

Internationally known as a leading researcher on the systematics of aphids and their parasites, Smith deposited his large research collection of aphids at the NCSU Insect Collection. It is rich in material from North Carolina and Utah, but includes specimens from around the world as well as Smith's collection notebooks (including field notes). His collection of small parasitic wasps (Hymenoptera: Braconidae: Aphidiinae) is also held at NC State. Additionally, the W. F. Barr Entomological Collection, University of Idaho, Moscow, and the Entomological Museum of Utah State University, Logan, both hold significant numbers of aphid slides donated by Smith. The primary types for most (75) of the aphid species that Smith authored (or coauthored) are deposited at the U.S. National Collection of Insects and Mites housed at Beltsville, Maryland (www.sel.barc.usda.gov/aphid/aphframe.htm).

Among Smith's numerous publications on aphids are: *Aphididae of Puerto Rico* (1963, with L. F. Martorell and M. E. Pérez-Escolar), *Bibliography of the Aphididae of the World* (1972b), *Keys to and Descriptions of the Genera of Pemphigini in North America* (1974), *An Annotated List of Aphididae of North America* (1978, with C. S. Parron), *An Annotated List of Aphididae of the Caribbean Islands and South America* (1979, with M. M. Cermeli [Cermeli-Lollini]), and *A Key to Many of the Common Alate Aphids of North Carolina* (1992, with R. W. Eckel and E. Lampert). Smith's doctoral dissertation, which treated a group of small wasps parasitic on aphids, was the basis for his *Aphidiinae of North America* (1944c).

The extensive collection of papers Smith used to compile his bibliographies, checklists and taxonomic works is deposited with the NCSU Libraries's Special Collections

Department as the Clyde F. Smith Papers (Collection Number MC 221). These papers, some of which are rare, encompass literature, reprints, pamphlets, and books, primarily pertaining to the insect family Aphididae. Associated with the papers are approximately 288,000 index cards on Aphididae with indexes that include: an annotated generic and specific index to all literature cited in Smith's 1972 *Bibliography of Aphididae*, a host-plant index indicating the aphids associated with each host, the source citing this association, and an index of aphid-parasitoid associations. Together, the 1972 *Bibliography* and the 1978 *Annotated List of Aphididae of North America* provide indexes to the Smith Papers.

His hobbies included gardening, hunting, fishing, lapidary, and genealogical research. Another more unusual pastime was watching Hopkins' Bioclimatic Law play itself out among the plants and associated arthropods of North Carolina, a state with extremes in topography. This empirical law, which Smith taught in his fruit insect course, states that:

> "*Other conditions being equal, the variation in the time of occurrence of a given periodical event in life activity in temperate North America is at the general average rate of 4 days to each 1 degree of latitude, 5 degrees of longitude and 400 feet of altitude, later northward, eastward and upward in the spring and early summer, and the reverse in late summer and autumn.*" (Hopkins, A. D. 1918. United States Department of Agriculture, Monthly Weather Review Supplement 9: 7).

Over a 10-year period, Smith observed the seasonal development of a scrawny flowering peach tree near his office. He used it as an index to the first appearance in the spring of the adults of the plum curculio, whose grubs would later infest the peaches of the North Carolina Sandhills. Smith had, of course, observed and predicted other phenological events across the state correlated with the vernal development of that peach tree. He then would cajole his graduate students into bets of soft drinks concerning what they would find at the research site when they arrived. Smith lost a few sodas, but not many.

Frequently, he suggested graduate student research projects that ranged far from his own expertise, expecting and inspiring students to learn on their own, as he had throughout his life. His graduate students included: R. Bastida, C. S. Black, Jr., C. S. Parron, and L. Van Balen (all M.S.); M. M. Cermeli-Lollini, H. L. Comroy, M. H. Farrier, J. Graham, H. B. Moore, Jr., A. T. Olive, M. E. Pérez-Escolar, and C. G. Wright (all Ph.D.). Smith genuinely enjoyed observing and puzzling out nature, including the complex life histories of his beloved aphids.

On 13 February 2000, his long, productive life drew to a close, following a period of ill-health initiated by a stroke in January 1999.

Clyde F. Smith will be long remembered for his devotion to family, community, and church (Church of Jesus Christ of Latter Day Saints) as well as his professional achievements. He will be missed by his many friends, co-workers, and family members, particularly his ever supportive wife, Crystle; three children, Clara Beth, Carolynn, and Clyde Leslie, and their spouses; 15 grandchildren; and 14 great-grandchildren.

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Society Meetings

1044th Regular Meeting—January 6, 2000

The 1044th regular meeting of the Entomological Society of Washington (ESW) was called to order in the Cathy Kerby conference room (CE-340) of the National Museum of Natural History, Washington, D.C., by incoming President Dave Furth at 7:35 pm. The meeting was attended by 20 members and 10 guests. Stu McKamey read the minutes of the 1043rd meeting, which were approved without modification.

Chris Thompson called a point of order, that the ESW audit was not presented. Don Anderson reported that the audit was signed by committee members and provided a summary of the status: ESW is doing fine. Thompson moved to accept the report and the motion was quickly seconded and the audit approved unanimously. There were no new applicants for membership and no new members were present. One visitor was introduced. In miscellaneous business, there was short discussion about the ESW website, which has not yet materialized.

For exhibits, Dave Furth announced the Washington Academy of Science website (*http://www.washacadsci.org*), displayed the calendars of the Entomological Society of America and the Organization for Tropical Studies, displayed insect toys recently collected without permits in Canada and Mexico, insect tacks (is nothing safe from the IRS?) and even a bee-motif shower curtain. Warren Steiner added to his 'global warming' insect sighting list: buckeye and sulpher butterflies spotted on December 12, to which a January 2nd monarch eclosion was added from the audience. Warren noted the insects included in the revamped NMNH elephant exhibit and lastly announced a new publication: the Proceedings of the Appalachian Biogeography Symposium, edited by ESW member Ralph Eckerlin. Edd Barrows completed the exhibits with a butterfly mobile calendar.

John Brown introduced the evening's speaker, past ESW President Mike Schauff, who took us on a trip "Out and About Down Under: Collecting Tiny Wasps in Australia." In truth, three of his trips were cleverly merged into one tour, all beautifully documented with slides of cities, waterfalls, panoramic vistas, beaches, charismatic megafauna, and not-so-charismatic megafauna: crocodiles, snakes, and huge leeches. We started our trip in subtropical SE Australia, which proved the best for his parasitic chalcidoid wasps. We traveled northward into the understory of the Queensland tropical rainforest, which was, as expected, poor collecting. From there we moved inland to the edge of the more arid central plateau, heavily agricultural but with open forests and drainage areas that yielded many chalcidoids. Then, drawn like a moth to flame, we headed into the 'red center' desert of the continent. Collecting was excellent in the shaded areas around Ayer's Rock, Uluru National Park, where water persists year-round. We continued south to Adelaide, Bookmark Biosphere Reserve in the Murray River watershed, and Kangaroo Island, collecting wasps and enjoying the abundant marsupials, sometimes scaring them away from the best shade spots for a break from the sun, other times sharing a research station with them. Eventually we had to return to Canberra, but couldn't leave without collecting on Black Mountain, located just behind CSIRO headquarters. Collecting permits for the trip were arranged by state and by National Park and required a couple months' advance planning.

The meeting was adjourned at 8:50 pm. Refreshments were provided by John Brown.

Respectfully submitted,
Stuart H. McKamey
Recording Secretary

1045th Regular Meeting—February 3, 2000

The 1045th regular meeting of the Entomological Society of Washington (ESW) was called to order in the Cathy Kerby conference room (CE-340) of the National Museum of Natural History, Washington, D.C., by President Dave Furth at 7:35 pm. The meeting was attended by 22 members and 4 guests. Stu McKamey read the minutes of the 1044th meeting, which were approved with minor modification.

Steve Lingafelter read the names of four new applicants for membership: Kevin O'Neill, Wayne Wehling, Qiao Gexia, and Daniel E. Perez-Gelabert. Two new members and two visitors were introduced.

For exhibits, Chris Thompson called attention to a recent Nature article on the putative forces driving the evolutionary origin of butterflies, an excellent new handbook for taxonomy (*Describing Species: Practical Taxonomic Procedure for Biologists*), and a new, world catalog of beeflies. Edd Barrows noted a special issue of the *American Entomologist* on biodiversity and had one on display. Ralph Eckerlin displayed a new Spanish language entomology text: *Insectos y Otros Artrópodos de Importancia Médica y Veterinaria,* by E. Méndez. Daniel Perez had on hand two new publications from the Dominican Republic: a catalog of Dominican amber fossils and an Occasional Publication on taxonomy from the national museum. Dave displayed a recent Science article on 'hire classification' (i.e., charging for patronyms), a new curation book (*Care and Conservation of Natural History Collections*), a new book on the systematics of Western North American butterflies, and "Bug Bites," chocolate candies with insect trading cards.

Stu McKamey introduced the meeting's speaker, Dr. Steven Lingafelter, ESW member and Research Scientist with the USDA Systematic Entomology Laboratory. He spoke to us about "Asian Longhorned Beetles of the Genus *Anoplophora*: a New Threat to the United States." First detected in New York in 1996 but probably present for 10 years, these large, showy beetles have received wide media coverage owing to their destruction of living ornamental trees. The larvae are the real culprits, boring in the live wood for up to a year. Control here and even in Asia often consists of eradication: destroying any infested trees. Lingafelter's connection to *Anoplophora* is his taxonomic expertise on longhorns (Cerambycidae) and the need to resolve species delimitations in the genus, with about 50 nominal species, to aid control and interception efforts. Additionally, all distribution records will be databased and an identification guide will be produced. Most records of the genus are from Japan, Korea, and China, where Lingafelter visited recently to examine institutional and private collections, and to do more collecting. The Chinese portion was coordinated through the joint U.S.A.-China Institute of Biological Control and the Chinese Forestry Institute. The showy patches of color on the beetles' elytra, traditionally used to delimit species, are actually quite variable among and even within populations. The genitalia are, surprisingly, not very useful either. The species appear to fall into five morphological groups defined by minor structural, external features. Quarantine controls have been strengthened and continued vigilance is required to avoid additional introductions of *Anoplophora.*

The meeting was adjourned at 8:53 pm. Refreshments were provided by John Brown.

Respectfully submitted,
Stuart H. McKamey
Recording Secretary

1046th Regular Meeting—March 2, 2000

The 1046th regular meeting of the Entomological Society of Washington (ESW) was called to order in the Cathy Kerby conference room (CE-340) of the National Museum of Natural History, Washington, D.C., by President Dave Furth at 7:37 pm. The meeting was attended by 23 members and 10 visitors. M. Alma Solis read the minutes of the 1045th meeting, which were approved without modification.

Steve Lingafelter read the names of three new applicants for membership: Ken Karns, Tam Nguyen, and Art Evans. One new member was introduced.

For exhibits, Ralph Eckerlin brought the book entitled *Kinabalu,* edited by K. M. Wong & A. Phillipps and Chris Thompson brought *Biology Systematics: Principles and Applications* by Randall T. Schuh. Dave Furth brought the following books and articles: *Ants at Work* by Deborah Gordon; *Ecology of Insects: Concepts and Applications,* edited by M. R. Speight, M. D. Hunter & A. D. Watt; *Forester Moths* by K. A. Efetov & G. M. Tarmann; *Insect Plant Relationships* edited by S. J. Simpson, A. J. Mordue & J. Hardie; *The Johns Hopkins University of School of Hygiene and Public Health, Lloyd E. Rozeboom Mosquito Collection* (1999. Amer. Mosquito Control Assoc. 15: 526–551), and two articles by Ashley Gurney entitled *A Short History of the Entomological Society of Washington* (1976. Proc. Entomol Soc. Wash. 78: 225–239), and *Who Designed the Schmitt Box?* (1975. Bull. Entomol. Soc. Amer. 21: 225–228). Edd Barrows brought some sawflies from Dyke Marsh. Gaby Chavarria advertised the film, *Pollinators in Peril,* to air on TBS Superstation, Monday, March 27, 11:00 pm/et., 8:00 pm/pt., and modeled a "pollinator" blouse worn by her.

John Brown introduced the speaker, Dr. Gabriella Chavarria, National Fish and Wildlife Foundation (NWF) and Research Associate at the National Museum of Natural History. Her talk was entitled "Pollination Conservation: the Truth About the Birds and the Bees." She spoke generally on pollination biology, flower morphology, kinds of bees, and co-evolution between flowers and pollinating organisms. At the NWF she has been instrumental in a "Save the Pollinators" program. Every 3rd bite of food is brought to humans by a pollinator. The best pollinators are bees (72.3%), among many others, including vertebrates such as birds and bats. But these pollinators are threatened by habitat destruction and by habitat and chemical habitat fragmentation. The major threats to *Apis mellifera* have been parasitic mites, bee diseases and pests, competition with africanized bees, and pesticide use. Fortunately, there are native bees to serve as alternative pollinators such as mason bees and bumblebees. Some solutions to the threats are: pollination research and monitoring, international agreements to protect migrating species, incorporation of wildlife corridors between agricultural areas, environmentally safe golf courses, planting native plants in backyards, and placing "bee condominiums." She suggested reading *The Forgotten Pollinators* by Steve Buckman & Gary Nabhan.

The meeting was adjourned at 8:35 pm. Refreshments were provided by John Brown.

Respectfully submitted,
M. Alma Solis

1047th Regular Meeting—April 6, 2000

The 1047th regular meeting of the Entomological Society of Washington (ESW) was called to order in the Cathy Kerby conference room (CE-340) of the National Museum of Natural History, Washington, D.C., by President Dave Furth at 7:32 pm. The meeting was attended by 20 members and 1 guest. Stu McKamey read the minutes of the 1046th meeting, which were approved with minor modification.

Steve Lingafelter read the names of five new applicants for membership: Netta Dorchin, James Kruse, Gordon F. Pratt, Gale E. Ridge-O'Connor, and David Campbell. No new members were present.

For exhibits, Ed Cohen displayed the November 1999 issue of The American Museum of Natural History containing an article on the flight mechanics of insects. Dave Furth announced BugFest on the Mall

May 20th, encouraging ESW support; displayed a new CD on the NHB East Court and the entomology compactor construction; had the three latest issues of *Food Insects Newsletter* from Montana State University; announced CDs on beetles by John Lawrence, CSIRO; a world catalog of Cassidinae; *The Cicadidae of China,* in Chinese but full of photos [Ilustrataj Insect-faunoj: 2, Chou & Lei (eds.)]; and a new Peterson field guide to western butterflies by P. Opler & A. Bartlett Wright. He also solicited opinions for an ESW website, should the project get started. Lastly, Furth announced the annual ESW banquet, tentatively scheduled for June 8 with guest speaker Dave Grimaldi.

John Brown introduced the night's speaker, Jim Whitfield (University of Arkansas/University of Illinois) who presented his research on the "Phylogeny of Microgastroid Braconid Wasps, and What it Tells Us About Polydnavirus Evolution." Like other insects with endoparasitoid larvae, these wasp larvae battle the hosts' immune systems. Their special tools are polydnaviruses: viral genes incorporated into their own genome and therefore inherited between generations. The expression of these genes suppresses the host's immune response and can also alter its nutrition and developmental rate. Dr. Whitfield investigated the origin of this virus-wasp relationship by comparing their phylogenies at three taxonomic levels: subfamilies, genera, and species. Looking at wasp subfamilies, evidence from morphology or molecules or both, and analyzed by parsimony or maximum likelihood all confirmed a single origin of the association, with no subsequent loss. At the generic level, all data sets were congruent concerning which branches were short vs. long, but despite all attempts to wring out well supported hypotheses of relationship, all they could show was a rapid radiation of genera. That is, the problem seemed to be the evolutionary pace of the microgastroid wasp genera, which is confirmed independently by fossils, rather than flaws in the methods or data. At the species level, analysis is difficult because the viral genes are meshed into the wasp genome, yet separated from each other. Whitfield and colleagues so far have found two viral genes and their phylogenies match closely that of their wasp hosts. Dr. Whitfield concluded that the viral genes were probably incorporated 60 to 80 million years ago and were followed by rapid diversification at the generic level.

The meeting was adjourned at 8:55 pm. Refreshments were provided by John Brown.

Respectfully submitted,
Stuart H. McKamey
Recording Secretary

1048th Regular Meeting—May 4, 2000

The 1048th regular meeting of the Entomological Society of Washington (ESW) was called to order in the Cathy Kerby conference room (CE-340) of the National Museum of Natural History, Washington, D.C., by President Dave Furth at 7:36 pm. The meeting was attended by 18 members and 4 guests. Stu McKamey read the minutes of the 1047th meeting, which were approved without modification.

Steve Lingafelter, the membership chair, was in Nepal so no new applicants for membership were read. No new members were present.

For exhibits, Warren Steiner passed around a live caterpillar hunter (*Callasoma,* Carabidae), John Brown announced the ESW Annual Banquet, June 8 at the Uniformed Services University of Health Sciences in Bethesda, Maryland. The feature will be a talk about the "New Jersey Mud Pits and the Glories of Fossil Insect Work," presented by Dave Grimaldi of the American Museum of Natural History, New York. Tickets are $24 per person, $12 for students and half-people. Dave Furth dominated the rest of the exhibits: notes from the ESW executive e-meeting, at which it was decided that starting in October the regular meetings would be held at 7:00 pm; announced the BugFest on the Mall and again invited members to participate; announced the opening of a one-year exhibit on "Vanishing Pollinators" at the National Zoo in the Amazonia Science Gallery; displayed some new books: *Insects and Their Spermatozoa and Their Phylogeny; Catalog of the Heteroptera of the Palearctic—Miridae*; *The Preying Mantids*; and *The Butterflies of Hong Kong,* which in addition to the usual photographs gives details on their morphology, larvae, and parasites.

John Brown announced the evening's speaker, Michael G. Pogue of the Systematic Entomology Laboratory, based in the National Museum of Natural History. He spoke to us about "The Armyworm Genus *Spodoptera* Guenée (Lepidoptera: Noctuidae): a Multimedia Review." *Spodoptera* has 30 species and includes the single most serious pest of Lepidoptera; other species of the genus are also serious pests. The genus is mainly subtropical and tropical but some migrate into temperate regions. The genus is particularly abundant in Africa, Southeast Asia, Borneo, and South America. Dr. Pogue's monographic goals are to treat every species comprehensively, estimate their phylogeny, build a specimen database, and provide an interactive key. Features he uses to delimit species are taken from wing color, genitalia of both sexes, and larvae. The database actually consists of six linked databases: specimens (more than 10,000 records), a gazetteer (more than 4,000 *Spodoptera* localities with latitude and longitude), larval hosts, parasitoids, predators, and a bibliography. The latter four are now available on the WWW (http://160.111.87.10:591/entomology/spodoptera/spodintro.html). The Expert System is in progress. Although primarily a key, the system is designed to give experts additional information once an identification is attained. The system uses the LucID windows program (University of Queensland and CSIRO), which is very flexible. The builder can code character states as polymorphic or "likely misinterpreted," options difficult to incorporate into traditional, couplet-based keys. The user can choose characters in any order, display characters ranked by difficulty, and see existing images of any character states. Each choice produces a shorter list of possible species. A traditional key for 30 species will have 29 couplets, so to identify the majority of the species a user passes through 15 couplets. In comparison, identification paths using LucID are much shorter. For example, any species of *Spodoptera* can usually be identified within five character state choices. Dr. Pogue plans to continue adding to the database as time permits.

The meeting was adjourned at 8:55 pm. Refreshments were provided by John Brown.

Respectfully submitted,
Stuart H. McKamey
Recording Secretary

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PROCEEDINGS
of the
ENTOMOLOGICAL SOCIETY
of
WASHINGTON

Volume 102

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MISCELLANEOUS

Entomological Society of Washington

Publications.—Available *Miscellaneous Publications* and *Memoirs* of the Society are listed on the inside back cover of each issue.

Instructions for Authors.—Instructions were last published in 2000, 102(3): 771–772.

Bylaws.—The bylaws were last published in 1966, 98(3): 610–614. Several amendments were proposed at the December 3, 1998 regular meeting and passed at the January 7, 1999 regular meeting. See minutes of the Society meetings, 1999, 101(2): 467 (1034th regular meeting), and 1999, 101(4): 920 (1035th regular meeting).

Membership.—A membership list is published every three years and was last published in 1999, 101(4): 914–919.

Seal.—The history of the official seal of the Society was published by Jon L. Herring, 1964, 66(1): 1, and was reprinted in 1997, 99(1): 208.

History.—The following articles relate to the history of the Society:

Wade, J. S. 1936. The officers of our Society for fifty years (1884–1934). Proceedings of the Entomological Society of Washington 39: 121–132.

Gurney, A. B. 1976. A short history of the Entomological Society of Washington. Proceedings of the Entomological Society of Washington 78(3): 225–239.

Spilman, T. J. 1984. Vignettes of 100 years of the Entomological Society of Washington. Proceedings of the Entomological Society of Washington 86(1): 1–10.

Stoetzel, M. B. 1984. ESW past-presidents for the years 1884 through 1983, photographs and support officers. Proceedings of the Entomological Society of Washington 86(1): 11–35.

The papers by Spilman and Stoetzel were part of the centennial issue of the Society, 1984, 86(1). The centennial banquet was held at the University of Maryland, College Park, March 12, 1984; see Society Meetings, 1984, 86(4): 975–976.

The 100th regular meeting of the Society was celebrated February 2, 1995 and was held at the Beltsville Agricultural Research Center, Beltsville, MD. It was attended by 115 members and guests and written up in the minutes of Society meetings 1995, 97(4): 897–898.

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
No. 22.	Systematics of the North American Species of *Trichogramma* Westwood (Hymenoptera: Trichogrammatidae), by John D. Pinto. 287 pp. 1999	28.00

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.

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